A.C. No._____

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL

(AUTONOMOUS)

Re-accredited 'A^{+}' Grade by NAAC

'College with Potential for Excellence' Status Awarded by UGC

'Best College Award' by University of Mumbai

Program: B. Sc.

Revised Syllabus of F.Y.B.Sc. Microbiology

Choice Based Credit, Grading and Semester System

w.e.f. Academic Year 2019-20

PREAMBLE OF THE SYLLABUS

With the introduction of Academic autonomy by the esteemed Changu Kana Thakur Arts ,Commerce and Science College, New Panvel from the academic year 2019-2020, the existing syllabus of F.Y.B.Sc. Microbiology is restructured according to the CBCGS pattern for its implementation from 2019-2020. This syllabus is prepared to make students more knowledge oriented in Microbiology subject. The new and updated syllabus is based on interdisciplinary approach with vigour and depth taking care of the syllabus which is not heavy for the F.Y.BSc. students. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline. It reflects the changing needs of the students, pertaining to the fields of Bio-Chemistry and Molecular Biology. The well-organized curriculum including basic as well as advanced concepts progressively from first year to the third year and shall inspire the students for pursuing higher studies in Microbiology and for becoming an entrepreneur and also enable students to get employed in the Microbiology subject based industries.

OBJECTIVES TO BE ACHIEVED:-

- To enrich students' knowledge and train them in the subject of Microbiology.
- To introduce the concepts of application and research in Microbiology.
- To inculcate sense of scientific responsibilities and social and environment
- awareness.
- To help students build-up a progressive and successful career.

F.Y.B.Sc Microbiology Syllabus (General Outline)
Revised for Choice Based Credit System
To be implemented from the Academic year 2019-20

	SEMESTER I	
Course Code	**Title**	**Credits**
USC1MI 1 Theory	**FUNDAMENTALS OF MICROBIOLOGY.**	**2 Credits (45 lectures)**
Unit-I	History,Introduction & Scope Of Microbiology, Biosafety In Microbiology	15 lectures.
Unit-II	Prokaryotic Cell Structure & Eukaryotic Cell Structure	15 lectures.
Unit-III	Macromolecules	15 lectures.
USC1MI 2 Theory	**BASIC TECHNIQUES IN MICROBIOLOGY.**	**2 Credits (45 lectures)**
Unit-I	Microscopy & Staining	15 lectures.
Unit-II	Microbial Nutrition,Cultivation,Isolation & Preservation	15 lectures.
Unit-III	Control Of Microorganisms	15 lectures.
USC1MI P	**PRACTICALS**	**2 Credits**
	SECTION-1 FUNDAMENTALS OF MICROBIOLOGY. (Practicals Based On Unit-I,II & III Of USMB-101	**1 Credit (45 lectures)**
	SECTION-2 BASIC TECHNIQUES IN MICROBIOLOGY. (Practicals Based On Unit-I,II & III Of USMB-102	**1 Credit (45 Lectures)**
	SEMESTER II	
USC2MI-1 Theory	**BASICS OF MICROBIOLOGY.**	**2 Credits (45 Lectures)**
Unit-I	Study Of Different Groups Of Microbes-I	15 lectures.
Unit-II	Study Of Different Groups Of Microbes-II	15 lectures.
Unit-III	Microbial Growth	15 lectures.
USC2MI-2 Theory	**EXPLORING MICROBIOLOGY.**	**2 Credits (45 Lectures)**
Unit-I	Microbial Interactions	15 lectures.
Unit-II	Microbes & Human Health	15 lectures.
Unit-III	Advance Techniques In Microbiology & Instrumentation	15 lectures.
USC2MIP	**PRACTICALS**	**2 Credits**
	SECTION-1 BASICS OFMICROBIOLOGY. (Practicals Based On Unit-I,II & III Of USMB-201)	**1 Credit (45 Lectures)**
	SECTION-2 EXPLORING MICROBIOLOGY. (Practicals Based On Unit-I,II & III Of USMB-202)	**1 Credit (45Lectures)**

F.Y.B.Sc Microbiology: Detail Syllabus
Revised for Credit Based Semester & Grading System
To be implemented from the academic year 2019-20

Bachelor of Science in Microbiology Duration: Six Semesters			
	SEMESTER I		
Course Code	**Title**	**Credits**	Notional Periods
USC1MI-1 Theory	**FUNDAMENTALS OF MICROBIOLOGY.**	**2 Credits (45 lectures)**	Self Study (45)
Unit-I	**1.1 History,Introduction & Scope Of Microbiology:** a. Discovery of microorganisms b. Conflict over spontaneous generation c. Golden Age Of Microbiology-Koch Postulate, Medical Microbiology, Immunology d. Development of industrial microbiology and microbial ecology e. Scope and relevance of microbiology f. Future of microbiology **1.2 Biosafety In Microbiology:.** a. Means of laboratory infection b. Potentially hazardous procedures c. Responsibility d. Risk Assessment e. Restricted access f. Safety equipments g. Immunization and medical records h. Training of personnel i. Laboratory procedures j. Levels of Containment	15 lectures. (10 Lec.) (05 Lec.)	15

Unit-II	**2.1 Prokaryotic Cell Structure and functions:** a. Cell wall b. Cell membrane c. Components external to cell wall-Capsule, Slime layer, Flagella, Pili, Fimbriae d. Cytoplasmic matrix-Inclusion bodies, magnetosomes, Ribosomes, gas vesicles e. Nucleoid, Plasmids Bacterial endospores and their formation **2.2 Eukaryotic Cell Structure and functions:** a. Overview of Eucaryotic cell structure b. The plasma membrane and membrane Structure c. Cytoplasmic matrix, microfilaments, intermediate filaments, and microtubules d. Organelles of the Biosynthetic-secretory and endocytic pathways –Endoplasmic reticulum & Golgi apparatus. e. Definitions of Lysosome, Endocytosis, Phagocytosis, Autophagy, prooteasome, Eucaryotic ribosomes f. Mitochondria g. Chloroplasts h. Nucleus –Nuclear Structure i. External Cell Coverings: Cilia And Flagella j. Comparison Of Prokaryotic And Eukaryotic Cells	15 lectures. (07 Lec.) (08 Lec.)	15
Unit-III	**Macromolecules** **3.1Chemical foundations**: a. Biomolecules as compounds of carbon with a variety of functional groups. b. Universal set of small molecules. c. Macromolecules as the major constituents of cells. d. Configuration and Conformation with definitions and suitable examples only. e. Types of Stereoisomers and importance of stereoisomerism in biology. f. Types of bonds and their importance: Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic **3.2 Water- Structure, properties in brief.** **3.3Carbohydrates**: Definition, Classification, Biological role. Monosaccharides, oligosaccharides (maltose, cellobiose, sucrose, lactose) and polysaccharide (starch, glycogen, peptidogycan, cellulose) **3.4 Lipids:** Fatty acids as basic component of lipids and their classification (Lehninger), nomenclature, storage lipids and structural lipids.Types of lipids with general structure of	15 lectures.	15

	each and mention examples. **3.5 Amino acids& proteins:** General structure and features of amino acids (emphasis on amphoteric nature) Classification by R-group, Uncommon amino acids and their functions Peptides and proteins- Definition and general features and examples with biological role. Primary, secondary, tertiary, quaternary structures of proteins- Brief outline. **3.6 Nucleic acids**: Nitrogenous bases- Purines , Pyrimidines Pentoses-Ribose, Deoxyribose, Nomenclature of Nucleosides and nucleotides, N-β-glycosidic bond, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds). Basic structure of RNA and DNA.		
USC1MI-2 Theory	**BASIC TECHNIQUES IN MICROBIOLOGY.**	**2 Credits (45 lectures)**	Notional Periods Self Study (45)
Unit-I	**Microscopy & Staining**	15 lectures.	**15**
	1.1 Microscopy: History of microscopy, Optical spectrum, Lenses and mirrors: Simple and compound light microscope, Dark field Microscopy, Phase contrast **1.2 Staining procedures** a. Dyes and stains: Types, Physicochemical basis Fixatives, Mordants, Decolorizers b. Simple and differential staining c. Special staining (Cell wall, Capsule, Lipid granules ,Spores, Metachromatic granules & Flagella)	08 Lectures 07 Lectures	
Unit-II	**Microbial Nutrition,Cultivation,Isolation& Preservation**	15 lectures.	15
	2.1 Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors. **2.2** Nutritional types of microorganisms **2.3** Types of Culture media with examples **2.4** Isolation of microorganisms and pure culture Techniques		

	2.5 Preservation of microorganisms **2.6** Culture Collection Centres		
Unit-III	**Control Of Microorganisms**	15 lectures.	15
	2.1 Definition of frequently used terms & Rate of microbial death,Factors affecting the effectiveness of antimicrobial agents & Properties of an ideal disinfectant **2.2 Evaluation of disinfectant** –Tube dilution & Agar plate techniques, Phenol coefficient , Tissue toxicity index **2.3 Physical methods of microbial control** a. Dry & moist heat – mechanisms, instruments used and their operations b. Electromagnetic radiations – Ionizing radiations, mechanisms –advantages & disadvantages c. Bacteria proof filters d. Low temperature e. Osmotic pressure f. Desiccation **2.4 Chemical methods of microbial control** - mechanism & advantages & disadvantages (if any) applications. a. Phenolics b. Alcohols c. Heavy metals and their compounds d. Halogens e. Quaternary ammonium compounds f. Halogens g. Dyes h. Surfaces active agents/Detergents i. Aldehydesp j. Peroxygens k. Sterilizing gases		

	2.5 Chemotherapeutic agents - List types of agents active against various groups & mention the site of action(Detailed mode of action not to be done)		
USC1MIP	**PRACTICALS**	**2 Credits**	Notional Periods
	SECTION-1 FUNDAMENTALS OF MICROBIOLOGY.	**1 Credit (45 lectures)**	Self Study (45)
Unit-I	1. Assignment : Contribution of Scientists in the field of Microbiology **2.** Special staining: Cell wall, capsule, endospore, flagella, lipid, metachromatic granules.		
Unit-II	3. Handling corrosive chemical using rubber teat method for pipetting. Prevention of mouth pipetting and use of auto-pipettes. 4. Discard of highly infectious pathogenic samples like T.B, sputum etc. 5. Explain safety inoculation hood for infection inoculations and laminar air flow. 6. On accidental spillage of/ breakage of culture containers-precautions to be taken. 7. Demonstration of microbes in air, cough, on table surface, finger tips. 8. Permanent slides of Eukaryotes & its organelles:		
Unit-III	9. Qualitative detection : 10. Carbohydrates- Benedicts, Molisch's test. 11. Proteins, amino acids- Biuret, Ninhydrin.		
	SECTION-2 BASIC TECHNIQUES IN MICROBIOLOGY.	**1 Credit (45 lectures)**	Self Study (45)
Unit-I	1. Parts of a microscope. 2. Monochrome and differential staining procedures, Gram staining& Negative Staining.		

Unit-II	3. Introduction to Laboratory equipments, disinfection & discarding techniques in laboratory 4. Methods of preparation of glassware for Sterilization 5. (Pipettes, Petri Plates, Plastic wares, Flasks, Micropipettes, microtitre plates) & Control of micro organisms using moist heat & dry heat sterilization (Sterilization of Dry powders, Rubber gloves, Bandages, Screw capped tubes, Sterilizable plasticwares) 6. Effect of UV Light, Desiccation, surface tension, Osmotic Pressure, heavy metals(Oligodynamic action) 7. Effect of dyes, phenolic compounds and chemotherapeutic agents(disc inhibition method) 8. Evaluation of Disinfectant by Coupon Method		
Unit-III	9. Preparation of Culture Media: a. Liquid medium(Nutrient Broth) b. Solid Media(Nutrient agar,Sabourauds agar) c. Preparation of slant ,butts & plates 10. Inoculation techniques and Study of Growth: a. Inoculation of Liquid Medium b. Inoculation of Solid Media(Slants, Butts and Plates) c. Study of Colony Characteristics of pigment & non- pigment producing bacteria. d. Study of Motility (Hanging Drop Preparation) 11. Use of Differential & Selective Media: (MacConkey , Salt Mannitol Agar & Cetrimide agar) 12. Determination of Optimum growth conditions: a)Temperature, b) pH		

	SEMESTER II		
Course Code	**Title**	**Credits**	**Notional Periods**
USC2MI-1 Theory	**BASICS OF MICROBIOLOGY.**	**2 Credits (45 lectures)**	Self Study (45)
Unit-I	**Study Of Different Groups Of Microbes-I:** **1.1Viruses**: a) Historical highlights, General properties of viruses, prions,viroids b) Structure of viruses-capsids, envelopes, genomes, c)Cultivation of viruses- overview d) Bacteriophages: Lytic cycle. Lysogeny, Structure and Life cycle of T4 phage. **1.2 Ricketssia, Coxiella, Chlamydia,Mycoplasma:** general features, medical significance **1.3Actinomycetes**: General features of Nocardia and Streptomyces Importance: ecological, commercial and medical **1.4 Archaea**: Introduction- Major Archaeal physiological groups, Archaeal cell wall, lipids and membranes, Ecological importance	15 lectures. 07 Lectures 03 Lectures 02 Lectures 03 Lectures	15
Unit-II	**Study Of Different Groups Of Microbes-II:** Classification, Morphological characteristics, cultivation, reproduction and significance **2.1 Protozoa**- Major Categories of Protozoa Based on motility, reproduction. Medically important Protozoa Life cycle of Entamoeba **2.2 Algae -** Characteristicsof algae: morphology, Pigments, reproduction Cultivation of algae. Major groups of Algae –an overview.Biological,Medical and economic importance of Algae. Differences between Algae and Cyanobacteria **2.3 Fungi and Yeast-**Characteristics: structure, Reproduction.Cultivation of fungi and yeasts. Major fungal divisions- overview. Life cycle of yeast,Biological and economical importance **2.4 Slime molds and Myxomycetes**	15 lectures. 04 Lectures 05 Lectures 05 Lectures 01 Lecture	15

Unit-III	**Microbial Growth:** **3.1** a. Definition of growth, Mathematical Expression, Growth curve b. Measurement of growth c. Direct microscopic count – Breed's count ,Petroff – Haussercounting chamber- Haemocytometer. d. Viable count – Spread plate and Pour plate technique e. Measurements of cell constituents. f. Turbidity measurements – Nephelometer and spectrophotometer techniques g. Synchronous growth, Continuous growth (Chemostat and Turbidostat) h. Influence of environmental factors on growth. i. Microbial growth in natural environment. j. Counting viable non-culturable organisms-Quorum sensing techniques	15 lectures.	15
USC2MI-2 Theory	**EXPLORING MICROBIOLOGY.**	**2 Credits (45 lectures)**	Self Study (45)
Unit-I	**Microbial Interactions:**	15 lectures.	15
	1.1 Types of Microbial Interactions : Mutulism, Cooperation, Commensalisms, Predation Parasitism, Amensalism, Competition **1.2 Human Microbe Interactions** . a) Normal flora of the human body : Skin, Nose & Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear, Mouth, Stomach, Small intestine, Large intestine, Genitourinary tract . b) Relationship between microbiota& the host . c) Gnotobiotic animals **1.3 Microbial associations with vascular plants** a) Phyllosphere		
	b) Rhizosphere & Rhizoplane c) Mycorrhizae d) Nitrogen fixation : Rhizobia, Actinorhizae, Stem Nodulating Rhizobia e) Fungal & Bacterial endophytes f) Agrobacterium & other plant pathogens		
Unit-II	**Microbes & Human Health:**	15 lectures.	15

	2.1 Difference between infection & disease. Important terminology: Primary infection, secondary infection.Contagious infection, occupational disorder, clinical infection,subclinical infection, Zoonoses,genetic disorder, vector borneinfection,virulence,pathogen & herd immunity. **2.2 Factors affecting infection:** Microbial factors: adherence, invasion, role of virulence factors in invasion,microbial enzymes & toxins, bacterial colonization & its effects. Host factors: natural resistance, species resistance, racial resistance. **2.3 Individual resistance**: Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes & host is dynamic. **2.4 Host defense against infection: Overview** i) First line of Defence: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes. ii) Second line of defence: Biological barriers: Phagocytosis,Inflammation iii) Third line of defence: Brief introduction to antibody mediated & cell mediated immunity.		
Unit-III	**Advance Techniques In Microbiology & Instrumentation:**	15 lectures.	15
	3.1 Electron Microscope:TEM,SEM, **3.2** Contrast enhancement for electron microscope **3.3** Fluorescent Microscope, Confocal Microscope **3.4** pH meter ,pH meter Validation and calibration **3.5** Colorimeter **3.6** Validation and calibration of Autoclave & Hot air Oven **3.7** Concepts :Laminar air flow systems, Biosafety cabinets , Walk in Incubators, Industrial autoclaves,Cold Room.		
USC2MIP	**PRACTICALS**	**2 Credits**	
	SECTION-1 **BASICS OFMICROBIOLOGY.**	**1 Credit** **(45 lectures)**	Self Study (45)
Unit-I	1. Spot assay and plaque assay of Bacteriophage (Demonstration) 2. Slide Culture technique (Actinomycetes & Fungal Culture)		
Unit-II	3.Isolation of yeast, cultivation of other fungi Cultivation on Sabourauds agar		
	4. Static & Shaker Cultures. *5.* Fungal Wet mounts & Study of Morphological Characteristics :*Mucor,Rhizopus,Aspergillus, Penicillium.* 6. Permanent slides of Algae, Protozoa		

Unit-III	7. Growth curve (Demonstration) only in complex media. 8.Breed's Count 9.Haemocytometer 10.Viable count: Spread plate and pour plate 11.Brown's opacity 12.Effect of pH and temperature on growth 13.Measurement of cell dimensions-Micrometry		
	SECTION-2 **EXPLORING MICROBIOLOGY.**	**1 Credit** **(45 lectures)**	Self Study (45)
Unit-I	1. Normal flora of the Skin & Saliva 2. Wet Mount of Lichen 3. Bacteroid Staining & Isolation of *Rhizobium* 4. *Azotobacter* isolation & staining		
Unit-II	6.Study of virulence factors – Enzyme Coagulase 7.Study of virulence factors – Enzyme Hemolysin 8.Study of virulence factors – Enzyme Lecithinase		
Unit-III	9.Use of standard buffers for calibration and determination of pH of a given solution 10.Determination of λ_{max} & Verification of Beer Lambert's law 11.Determination & efficiency of Autoclave, Hot air oven , LAF 12.Writing of SOP's for Instruments 13.Visit to a Central Instrumentatin laboratory of college.		

REFERENCES: USC1MI-1 & USC1MI-2

1. Prescott ,Hurley.Klein-Microbiology, 7th edition, International edition, McGraw Hill.
2. Kathleen Park Talaro& Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.
3. Michael T.Madigan & J.M.Martin,Brock ,Biology of Microorganisms 12th Ed. Internationaledition 2006, Pearson Prentice Hall.
4. A.J.Salle,Fundamental Principles of Bacteriology.
5. Stanier.Ingraham et al ,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
6. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
7. BIS:12035.1986: Code of Safety in Microbiological Laboratories

8. Outlines of Biochemistry 5/E, Conn P. Stumpf, G. Bruening and R. Doi. John Wiley & Sons. New York 1995
9. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005
10. Microbiology An Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.

REFERENCES: USC2MI-1 & USC2MI-2

1. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
2. A.J.Salle, Fundamental Principles of Bacteriology,McGraw Hill Book Company Inc.1984
3. Cruikshank, Medical Microbiology , Vol -II
4. Prescott ,Hurley.Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
5. Michael T.Madigan & J.M.Martin,Brock ,Biology of Microorganisms 11th Ed. International edition ,2006, Pearson Prentice Hall.
6. Ananthanarayan And Paniker, Textbook Of Microbiology,10th edition ,2013,University Press Hyderabad.

MODALITY OF ASSESSMENT

Theory Examination Pattern:

(A) Semester End Theory Assessment - 75 Marks

i. Duration - These examinations shall be of **2.5 Hours** duration.

ii. Theory question paper pattern :-

1. There shall be **four** questions. On each unit there will be one question with **20** Marks each & fourth one will be based on all the three units with 1**5** Marks.
2. All questions shall be **compulsory** with internal choice within the questions.
3. First Three Questions may be sub divided into sub questions of **eight** marks objective questions and **twelve** marks of short or long questions of 6 marks each. Please ensure that the allocation of marks depends on the weightage of the topic.

PRACTICAL EXAMINATION PATTERN

(B) External (Semester end practical examination) :- 50 Marks Per Section
(Section-I based on course-1 **& Section-II based on course**-2)

Sr.No.	Particulars	Marks		Total
1.	Laboratory work (Section-I + Section-II)	35 + 35	=	70
2.	Journal	05 + 05	=	10
3.	Viva	05 + 05	=	10
4.	Assignment/Visit report/Case study/SOP writing/Quiz	05 + 05	=	10

PRACTICAL BOOK/JOURNAL

Semester I:

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/ Co-ordinator / Incharge of the department ; failing which the student will not be allowed to appear for the practical examination.

Semester II

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.

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Overall Examination and Marks Distribution Pattern

Semester I

Course	USC1MI-1	USC1MI-2	Grand Total
Theory	100 02 Credits	100 02 Credits	200 04 Credits
Practicals	50 02 Credits	50 02 Credits	100 04 Credits
Total Marks	150	150	300
Total Credits	04 Credits	04 Credits	08 Credits

Semester II

Course	USC2MI-1	USC2MI-2	Grand Total
Theory	100 02 Credits	100 02 Credits	200 04 Credits
Practicals	50 02 Credits	50 02 Credits	100 04 Credits
Total Marks	150	150	300
Total Credits	04 Credits	04 Credits	08 Credits

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OBJECTIVES TO BE ACHIEVED:-

- To enrich learners' knowledge and train them in the pure microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate sense of scientific responsibilities and social and environment awareness.
- To help learners build-up a progressive and successful career.

S.Y.B.Sc Microbiology Syllabus (General Outline) Revised for Choice Based Credit System To be implemented from the Academic year 2020-21

	SEMESTER I	
Course Code	**Title**	**Credits**
USc3 Mi1 Theory	**Estimation of Biomolecules and Introduction Bioenergetics and Biostatistics**	**2 Credits (45 lectures)**
Unit-I	Extraction and analysis of Biomolecules	15 lectures.
Unit-II	Introduction to Bioenergetics, Thermodynamics and Biostatistics	15 lectures.
Unit-III	Preparation of solutions and Biochemical Calculations	15 lectures.
USc3 Mi2 Theory	**Introduction to fermentation technology and Applied Microbiology**	**2 Credits (45 lectures)**
Unit-I	Introduction to fermentation Technology	15 lectures.
Unit-II	Introduction to Food and Dairy Microbiology	15 lectures.
Unit-III	Fresh Water and Sewage Microbiology	15 lectures.
USc3 Mi 3 Theory	**Introduction to Microbial Genetics and Molecular Biology**	2 Credits (45 lectures)
Unit-I	Nucleic acid chemistry, Electrophoresis and Sequencing	15 lectures.
Unit-II	Prokaryotic DNA replication, mutation and DNA repair mechanism	15 lectures.
Unit-III	Prokaryotic transcription and translation	15 lectures.
USc3 Mi P	**PRACTICALS**	**3 Credits**
	SECTION-1 **Estimation of Biomolecules and Introduction Bioenergetics and Biostatistics** (Practicals Based On Unit-I,II & III Of USC3 MI 1)	**1 Credit (45 lectures)**
	SECTION-2 **Introduction to Fermentation Technology and Applied Microbiology** (Practicals Based On Unit-I,II & III Of USC3 MI 2)	**1 Credit (45 Lectures)**
	SECTION-3 **Introduction to Microbial Genetics and Molecular Biology** (Practicals Based On Unit-I,II & III Of USC3 MI 3)	**1 Credit (45 lectures)**
	SEMESTER II	
USc4 Mi-1 Theory	**Introduction to Metabolism and Enzymology**	**2 Credits (45 Lectures)**

Unit-I	Introduction to metabolism	15 lectures.
Unit-II	Enzyme Kinetics	15 lectures.
Unit-III	**Membrane Transport**	15 lectures.
USc4Mi-2 Theory	**Introduction to Medical Microbiology and immunology**	**2 Credits (45 Lectures)**
Unit-I	Common infectious diseases, Epidemiology and Public Health Awareness	15 lectures.
Unit-II	Host defence and public health (Epidemiology of infectious diseases)	15 lectures.
Unit-III	Introduction to Physiological sampling, Diagnostic techniques and Vaccines	15 lectures.
UcC4Mi-3 Theory	**Advances Analytical Techniques, Soft Skills and Applications of Microbiology**	**2 Credits (45 Lectures)**
Unit-I	Introduction to Bioinformatics, Nano biotechnology, Biofilm and Biosensor	15 lectures.
Unit-II	Analytical Techniques: Chromatography, Spectroscopy and Basic centrifugation	15 lectures.
Unit-III	Research Fundamentals, Hypothesis Writing, Study designs, Report writing and presentation	15 lectures.
USc2MiP	**PRACTICALS**	**3 Credits**
	SECTION-1 **Introduction to Metabolism and Enzymology** (Practicals Based On Unit-I,II & III Of USC4 MI 1)	**1 Credit (45 Lectures)**
	SECTION-2 **Introduction to Medical Microbiology and immunology** (Practicals Based On Unit-I,II & III Of USC4 MI 2)	**1 Credit (45Lectures)**
	SECTION-3 **Advances Analytical Techniques, Soft Skills and Applications of Microbiology** .(Practicals Based On Unit-I,II & III Of USC4 MI 3)	**1 Credit (45 Lectures)**

PRACTICAL EXAMINATION PATTERN

(A) External (Semester end practical examination) :- 50 Marks Per Section
(Section-I based on course-1 **& Section-II based on course**-2)

Sr.No.	**Particulars**	**Marks**	**Total**
1.	**Laboratory work (Section-I + Section-II+ Section III)**	**30 + 30+30**	**= 90**
2.	**Report / Quiz**	**05 + 05+05**	**= 15**
3.	**Viva**	**05 + 05+05**	**= 15**
4.	**Assignment/ /Case study/**	**05 + 05 +05**	**= 15**
	Journal	**05 + 05+05**	**= 15**

PRACTICAL BOOK/JOURNAL

Semester III:

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.

The practical examination will be conducted in two days with 4.5 hrs of work each day.

Two examiners and one expert will be appointed from college for each batch by the principal / Head of the department.

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

Semester IV

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.

The practical examination will be conducted in two days with 4.5 hrs of work each day.

Two examiners and one expert will be appointed for each batch by the principal / Head of the department.

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

Overall Examination and Marks Distribution Pattern

Semester III

	Section I /paper I USc3Mi-1			Section II/Paper II USC3Mi-2			Section III/Paper III USc3Mi-3		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
Theory	25	75	100	25	75	100	25	75	100
Practicals	00	50	50	00	50	50	00	50	50

Semester IV

	Section I /paper I USc4Mi-1			Section II/Paper II USc4 Mi-2			Section III/Paper III USc4 Mi-3		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
Theory	25	75	100	25	75	100	25	75	100

Practicals	00	50	50	00	50	50	00	50	50

C.K.Thakur ACS College, New Panvel (Autonomous)

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Sem III Theory

Paper/ Unit	Title	Lecture/ Week	Total lectures
Paper I	**Estimation of Biomolecules and Introduction to Bioenergetics and Biostatistics**	**03**	**45**
U1	a) Extraction and analysis of Biomolecules		15
	b) Macromolecular composition of a microbial cell (Revision with Definition of atom, molecule, macromolecule, supramolecular, and biological application of each type of molecule.		01
	c) Methods of elemental analysis: i. Carbon: Manometer (Introduction) ii. Nitrogen: Micro Kjeldahl Method (Principle and Assembly) iii. Phosphorus: Fiske Subbarao Method (Principle and Procedure)		03
	d) Estimation of Proteins and amino acids i. Proteins by Biuret method ii. Protein estimation by Lowry's method iii. Amino acids by Ninhydrin method		03
	e) Estimation of Carbohydrates i. Total carbohydrates by Anthrone method ii. Total carbohydrates by Pheno-Sulphuric acid method iii. Reducing Sugars by DNSA method		03
	f) Extraction of Lipids by Soxhlet method (Principle and Assembly)		01
	g) General principles and extraction of nucleic acids i. RNA ii. DNA h) Estimation of Nucleic acids i. DNA by DPA method ii. RNA by Orcinol method		04
U2	Introduction to Bioenergetics, Thermodynamics and Biostatistics		15
	2.1 Introduction to Bioenergetics and Thermodynamics		**(10L)**
	a) Biological Energy Transformations Obey the Laws of Thermodynamics		01
	b) Gibbs free energy, Enthalpy, Entropy		01

	c) The Standard Free-Energy Change Is Directly Related to the Equilibrium Constant		02
	d) Standard Free-Energy Changes Are Additive		01
	e) Structure of ATP,		01
	f) phosphoryl group transfer and ATP,		01
	g) Types of energy–rich compounds,		01
	h) Assembly of Informational Macromolecules Requires Energy		02
	Introduction to Biostatistics		**(05)**
	a) Definition of terms: Biostatistics, Sample and Population, Types of sampling techniques		01
	b) **Data presentation:** Dot diagram, Bar diagram, Histogram, Frequency curve, pie diagram (Problems solving approach)		01
	c) **Central Tendency:** Definition, Notation, Formula and Problems: Mean, Median, Mode (Problems solving approach)		02
	d) Measures of Dispersion Definition, Notation and Formula of Variance, Standard Deviation and Standard Error (Problems solving approach)		01
U3	**Preparation of solutions and Biochemical Calculations**		**1**
	3.1 Various units of expressing and inter-converting concentration of solutions: molarity, moles, normality, osmolarity, molality, mole fraction 3.2 Bronsted Concept of conjugate acid –conjugate base pairs, ionization of solutions, pH, titration curves, buffers: preparation, action and their use in Biology 3.3 Henderson-Hasselbalch equation , buffer capacity, polyproteic acids, amphoteric salts, ionic strengths (problem solving under all heads)		**05** **05** **05**

Paper/ Unit	Title	Lecture/ Week	Total lectures
Paper II	**Introduction to fermentation technology and Applied Microbiology**	**03**	**(45)**
U1	**Introduction to fermentation Technology**		**(15)**
	A. Screening a. Primary screening- i. crowded plate technique ii. Auxanography iii. Enrichment culture techniques. iv. Use of indicator dye b. Secondary screening.		03
	B. Fermentation media a. Characteristics of ideal fermentation medium. b. Types of fermentation media c. Raw material i. Carbon source ii. Nitrogenous material iii. Growth factors iv. Precursors v. Buffers vi. Antifoam d. Media sterilization and contamination e. Screening for production media.		04
	C. Preparation of inoculum		01
	D. **Types of fermentation-** Aerobic, anaerobic, surface submerged, solid substrate, Batch, continuous.		04
	E. Fermenter design 1. Factors involve in fermenter design 2. Parts of fermenter a. Material used for fermenter b. Impeller, baffles, inoculum port, sparger, sampling point, pH control device, temperature control system, foam control device, bottom drainage system. 3. Fermenter configuration a. Batch fermenter **b.** Continuous fermenter		03
U2	Introduction to **Food and Dairy Microbiology**		**(15)**
	A. Important Microorganisms in Food Microbiology: General characteristics of the enlisted organisms to be studied wrt spoilage and transmission of infection/intoxication (no clinical features and structural details) a. Spoilage -causing microorganisms a. Yeast & Molds: Saccharomyces, *Aspergillus & Penicillium*		04

	b. Bacteria: *Bacillus, Clostridium, Flavobacterium, Pseudomonas* b. Food-borne Illness associated Microorganisms: Classification of Food-borne diseases (Schematic). Bacteria responsible for food -borne intoxication and infections- overview/tabulation. Examples of non-bacterial food-borne pathogens Details of : a) Staphylococcus food intoxication (organism, enterotoxin, incidence, foods involved, prevention of outbreaks) b) Salmonellosis (organism, source, incidence, foods involved, outbreak-conditions & prevention		
	B. General Principles of Food Preservation: a. Preservation using High temperature (including TDT, D, F, Z values, 12D concept), principle of canning b. Low temperature c. Drying d. Food preservatives (organic acids & their salts, Sugar & salt) e. Ionizing radiations		03
	C. Microbial flora of milk, normal and abnormal flora, their sources and changes induced them. Milk borne pathogens.		02
	D. Microbiological Quality of Milk & Milk Products: SPC, coliform count, LPC, thermophilic, psychrophilic counts and RPT (RRT, MBRT, DMC)		03
	E. Milk product- a) Butter, b) Cheese (types and production of cheddar cheese and cottage cheese), c) Yogurt (Types and production). d) Other milk products and names of organisms associated with them.		03
U3	**Fresh Water and Sewage Microbiology**	1	**(15)**
	A. Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes , marshes and bogs		3
	B. Potable water: Definition, water purification ,water quality standards and pathogens transmitted through water		2
	C. Microbiological analysis of water: Indicator organisms and their detection in water- Total Coliforms, Fecal Coliforms and *E. coli*, Fecal *Streptococci*, *Clostridium perfringens*		2
	D. Modern Waste Water treatment: Primary, Secondary and Tertiary Treatment		1
	E. The nature of wastewater and Monitoring of waste water treatment process(BOD,COD)		2
	F. Removal of Pathogens by Sewage treatment Processes.		1

	G. Oxidation Ponds and Septic tanks			1
	H. Sludge Processing			1
	I. Disposal of treated waste water and biosolids.			02
Paper/ Unit	**Title**	**Credits**	**Lecture/ Week**	**Total lectures**
Paper III	**Introduction to Microbial Genetics and Molecular Biology**	**02**		
U1	Nucleic acid chemistry, Electrophoresis and Sequencing		1	
	A. Nucleic Acid Structure DNA stores genetic information DNA molecules have distinctive base composition DNA is a double helix DNA can occur in different 3D forms DNA sequences adopt unusual structures Many RNAs have complex 3D structures			06
	B. Nucleic acid chemistry Denaturation of double helical DNA and RNA Nucleic acid from different species can form hybrids Nucleotides and nucleic acids undergo non enzymatic transformations, DNA methylation			06
	C. Separation of nucleic acids by Agarose gel electrophoresis			01
	D. DNA sequencing			02
U2	**Prokaryotic DNA replication, mutation and DNA repair mechanism**		**1**	
SHIFTED FROM USMB 501 UNIT 1	A. Historical perspective— conservative, dispersive, semi-conservative, Bidirectional and semi-discontinuous			04
	B. Prokaryotic DNA replication – Details of molecular mechanism Involved in Initiation, Elongation and Termination			04
SHIFTED FROM USMB 501 UNIT 3	C. Mutation-Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes			**01**
	D. Types of mutations: Point mutation, frameshift mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation			**01**
	E. DNA Repair 2.5.a. Mismatch repair, 2.5.b. Light repair			**05**

	2.5.c. Repair of alkylation damage 2.5.d. Base excision repair 2.5.e. Nucleotide excision repair 2.5.f. SOS repair			
U3	**Prokaryotic transcription and translation**		**1**	
SHIFTED FROM USMB 402 (2012-13)	Transcription ,Translation **A. RNA Synthesis** a. RNA Metabolism:DNA dependent synthesis of RNA RNApolymerase, Promoters, Regulation of transcription at various levels. b. Specific sequences signal termination of RNA synthesis. c. RNA polymerases in Eukaryotic cells. d. Protein factors required for RNA polymerase II. e. Inhibition of DNA dependent RNA polymerase f. RNA dependent synthesis of RNA			**(7 L)**
	B. Protein synthesis Stages of Protein synthesis:- a. Activation of amino acids b. Initiation c. Elongation d. Termination and release e. Folding and post translational processing			**(8L)**

Paper 1

1. Methods In Microbiology,Vol.5B,Ed.Norris & Ribbon,Academic Press
2. Lehninger:Principles Of Biochemistry,4th Ed.,D.Nelson & M.Cox,W.H.Freeman & Co.,New York 2005.
3. Outlines Of Biochemistry, 5/E,Conn P.Stumpf,G.Bruening & R.Doi,John Wiley & Sons,New York 1995.
4. Enzymes:Biochemistry,Biotechnology & Clinical Chemistry,T.Palmer,East West Press Ltd.,New Delhi2004.
5. An Introduction to Practical Biochemistry,David Plummer,3rd Edition(2003),Tata McGraw-Hill Publishing Co.Ltd.
6. Biochemical Methods,S.Sadasivam & A.Manickam,2nd Edition(1996),New Age International (P) Ltd.
7. Laboratory Manual in Biochemistry,J.Jayraman.
8. Fundamental of biostatistics Khan and khanum ,ukaaz publications, Hydrabad.
9. Biochemical calculation: 2nd edition, Irwin H.Segel.

Paper2

1. Environmental Microbiology ,R. M. Maier,I.L.Pepper & C.P.Gerba (2010),Academic Press
2. A Textbook of Microbiology by RC Dubey and DK Maheshwari,Revised Edition(2013).
3. Introduction to Environmental Microbiology-By Barbara Kolawzan,Adamiak et al (2006)
4. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd,Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & HaII--S. J., 1997, "Principles of Fermentation,Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
6. Prescott and Dunn's ''Industrial Microbiology''.1982 4th Edition, McMillan Publishers
7. H. A. Modi, 2009. ''Fermentation Technology'' Vol 2, Pointer Publications, India
8. Industrial Microbiology. A.H.Patel. MacMillan. New Delhi. 1984.
9. Modern Food Microbiology. James Jay. 5th Ed,
10. Frazier and Westhoff ,Food Microbiology, Tata McGraw Hill, 4th Edition
11. Microbiology By Prescott, Harley, Klein's 7th Edn
12. Outlines Of Dairy Technology, Sukumar De,Oxford University Press

Paper 3

1. Lehninger: Principles Of Biochemistry,4th Ed., D. Nelson & M. Cox, W.H.Freeman & Co.,(LPE).
2. Prescott's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, (2011) 8th edition, McGraw-Hill International edition.
3. Prescott, Harley and Klein's Microbiology, Willey, Sherwood, Woolverton (2008) 7th edition, McGraw-Hill International edition
4. Brock Biology of Microorganisms, Madigan, Martinko, Dunlap and Clark (2009) 12th edition, Pearson Education

5. Peter J. Russell (2006), “Genetics-A molecular approach”, 2nd ed. 2

Practicals based on Sem III

Paper/Unit	S.N.	Title	Credits	Lecture/Week
Paper I		**Estimation of Biomolecules and Introduction to Bioenergetics and Biostatistics**	1	3
U1	1	Extraction of Lipids		
	2	Estimation of Proteins by Biuret method		
U2	3	Estimation of RNA		
	4	Estimation of Carbohydrates		
U3	5	Problems on thermodynamics		
	6	Use of Excel for determination of Mean, Standard Deviation, Standard error, Plotting of error bar graph.		
Paper II			1	3
U1	7	**Screening of antibiotic producer**		
	8	**Screening of organic acid producer**		
	9	Basic design and operation features of the bioreactor (Demonstration from Vlab.co.in)		
U2	10	Selective isolation of food spoilage organisms; Proteolytic, Lipolytic, amylase producing and coliforms.		
	11	Determination of TDT and TDT		
	12	MIC of Sugar and Salt tolerance		
	13	Dye reduction test: RRT, MBRT		
	14	Microbial quality of Milk: SPC, LPC, Thermophilic count, Pshychrophilic count, coliform count		
U3	15	MPN		
	16	Routine Microbial analysis of water: SPC		
	17	Determination of BOD, COD Visit to Effluent treatment plant.		
PIII			1	3
U1	18	Extraction of Nucleic Acids		
	19	Estimation of DNA		
	20	Separation and visualization of nucleic acids by Agarose gel electrophoresis		
U2				
	21	UV mutagenesis		
	22	Assignment on Various types of DNA mutation and Repair		
U3	23	Extraction of RNA		
	24	Estimation of Proteins by Lowry’s method		

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Sem IV **Theory**

Paper/Unit SEM IV	**Title**	**Lecture/ Week**	**Total lectures**
Paper I	**Introduction to Metabolism and Enzymology**		
U1	Introduction to metabolism	1	
	1a Introduction to metabolism, Metabolic pathways		03
	1b EMP pathway and TCA cycle		03
	1c Experimental approaches to study metabolism		04
	1d Thermodynamics of Phosphate compounds 1e Oxidation-reduction reactions 1f Thermodynamics of life		05
U2	Enzyme Kinetics	1	
	a. Introduction of Enzymes: • General properties of enzymes • How do enzymes accelerate reaction • Rate law for a simple catalysed reaction, Michaelis-Menten equation and it's derivation • Lineweaver Bruck plot • Classification of enzymes		6
	b. Overview of Coenzyme: • Coenzymes: Different types and reactions catalyzed by coenzymes (in tabular form) • Nicotinic acid: structure, occurrence & biochemical function		2
	c. Enzyme Kinetics: • Saturation kinetics • Effect of temperature and pH • Effect of Inhibitors- Reversible and irreversible, competitive, Non competitive and uncompetitive inhibitors Multisubstrate reactions- Ordered, Random and pingpong reactions • Allosteric effects in enzyme catalysed reactions- Koshland-Nemethy and Filmer model & Monod, Wyman and Changeux model		7
U3	Membrane Transport	1	
	A. Composition and architecture of membrane • Lipids and properties of phospholipid membranes • Integral & peripheral proteins & interactions with lipids • Permeability • Aquaporins • Mechanosensitive channels		02

	B. **Methods of studying solute transport** • Use of whole cells • Liposomes • Proteoliposomes **C. Solute transport across membrane** • Passive transport and facilitated diffusion by membrane proteins • Co-transport across plasma membrane - (Uniport, Antiport, Symport) • Active transport & electrochemical gradient • ATPases and transport (only Na-K ATPase) • Shock sensitive system – Role of binding proteins • Histidine uptake (Diagram and description) • Phosphotransferase system • Schematic representation of various membrane transport systems in bacteria. **D. Other examples of solute transport:** • Iron transport: A special problem • Assembly of proteins into membranes and protein export • Bacterial membrane fusion central to many biological processes		02 08 03

Paper/Unit	Title	Lecture/ Week	**Total lectures**
SEM IV Paper II	**Introduction to Medical Microbiology and immunology**	**03**	
U1	Common infectious diseases, Epidemiology and Public Health Awareness	01	(15)
SHIFTED FROM USMB 303 OPTION A	**Part A: Common infectious diseases**		**(10)**
	a. Skin Infections: Study of structure and functions of skin Study of skin infections caused by *Pseudomonas*, Acne & Measles		3
	b. Infections of Nervous system Study of structure and functions of nervous system Study of Tetanus & Rabies		2
	c. Infections of Respiratory systems Study of structure and function of respiratory system Study of pharyngitis, laryngitis, Sinusitis (learn terms only), Diphtheria and common cold		2
	d. Infections of Digestive system Study of structure and function of Digestive system		3

	Study of Typhoid fever, *E. coli* gastroenteritis, Hepatitis A, Rotavirus and Amoebiasis		
	Part B: Epidemiology and Public Health Awareness (5 Lectures)		
	e. The Epidemiology of Infectious Diseases and Their Control Epidemiological terminology: Epidemiology, sporadic diseases, endemic diseases, Hyperendemic Diseases, Epidemic Diseases, Index Case, Pandemic Disease, Outbreak		1
	f. The Spread of Infection: Reservoirs of infection - Human reservoir, Animal reservoir, non-living reservoir Transmission of Disease- Contact transmission, Vehicle Transmission and vectors		2
	g. Public Health Measures For Control Of Disease: Control directed against reservoir, Transmission of the pathogens. Immunisation, Quarantine, Surveillance and pathogen eradication		2
Practicals			
U2	Host defence and public health (Epidemiology of infectious diseases)	1	(15)
SHIFTED FROM USMB 402 UNIT 1			
	Innate immunity and immune system		**(11)**
	a. Classification of immune system (innate immunity & acquired immunity)		2
	b. Physical barriers in non specific innate resistance revision.Chemical barriers (Complement: principle & significance (no pathway), Cytokines: interferon, antimicrobialpeptides, bacteriocins		4
	c. Cells of immune sytem: Haematopoiesis,lymphocyctes, monocytes & macrophages, granulocytes, mast cells, dendritic cells & NK cells		2
	d.Phagocytosis & Inflammation		3
	Epidemiology of infectious diseases		**(4)**
	e.Tools of epidemiology, recognition of an infectious disease in population		2
	f. Spread of infection: Reservoirs and transmissions. Nosocomial infections: Micro organism in hospital, compromised host, chain of transmission, control of nosocomial infection.		2

U3	**Introduction to Physiological sampling, Diagnostic techniques and Vaccines**	**1**	**(15)**
	A. Introduction to Physiological sampling • Types of specimens • Sample collection • Processing • Transportation and storage		**04**
	B. Diagnostic techniques • Microscopic and Culturing techniques • Biochemical Identification • Molecular Biology Techniques (Western blotting, ELISA, PCR) • Immunological Tests (VDRL, Widal, SRID)		**08**
	C. Vaccines Active and Passive immunity Attenuated, Killed, Subunit vaccines		**03**

Paper/ Unit	Title	Credits	Lecture/ Week	**Total lectures**
Paper III SEM IV	Advances Analytical Techniques, Soft Skills and Applications of Microbiology	02		
U1	Introduction to Bioinformatics, Nano biotechnology, Biofilm and Biosensor		1	
	A. Introduction to Bioinformatics • Definition, aims, tasks and applications of Bioinformatics. • Database, tools and their uses - • Nucleic acid sequence databases- EMBL, DDBJ, GenBank, • Protein sequence databases-PIR, SWISS-PROT, TrEMBL • Different terminologies – Transcriptomics, Metabolomics, Pharmacogenomics, Phylogenetic tree, Annotation, • Sequence alignment—(global, local), FASTA, BLAST. • Genomics, Proteomics			05
	B. Nano biotechnology Introduction of Nano biotechnology & application in drug and gene delivery Types of nanomatrials- nanoparticles, nanocapsules, nanotubes, liposomes, nanogels, Dendrimers, Gold nanoparticles.(Definition and applications)			05
	C. Biofilms and biosensors with applications: Biosensors: Introduction, design, working and applications of biosensors Biofilms: Introduction of biofilms, Types of biofilms, Mechanism of formation of biofilms and applications of biofilms.			05
U2	Analytical Techniques: Chromatography, **Spectroscopy and Basic centrifugation**		1	
	A.Chromatography • Introduction to chromatography, • Types of chromatography o Paper chromatography: Principle, circular, ascending and descending Paper Chromatography, o Separation of amino acids by Paper Chromatography.			**08**

	○ Thin layer chromatography: principle, preparation of TLC plates, procedure for TLC, preparative TLC, 2D TLC [one paragraph], HPTLC-[1 page], Separation of sugars by TLC. • Column chromatography : Introduction & principle • Exclusion chromatography, gel chromatography			
	B. Spectroscopy • Properties of light • Beer's and Lambert's law • UV-visible spectroscopy ○ Principal ○ Working ○ Construction			04
	C. Centrifugation • Basic principles of sedimentation, • types of rotors, • Types of centrifuge and its applications. • Care, maintainance and safety aspects of centrifuges			03
U3	**Research Fundamentals, Hypothesis Writing, Study designs, Report writing and presentation**		**1**	
	A. Perception of Research Meaning of research P M Cook's definition of Research General characteristics of research Functions of research Specific characteristics of research Objectives of research Classification of research Steps of action research Characteristics of an investigator Difference between action research and fundamental research			**05**
	B. Hypothesis Writing			**02**
	C. Scientific Writing The research report Need of research report General format of research report Mechanics of report writing Writing research abstract: Need of an Abstract Format of an abstract and Characteristics of a good abstract Writing research papers: Format of a research paper, Advantages of a research paper			05
	D. Presentation skills (Poster and Oral)			**03**

References:

Paper 1

1. Lehninger: Principles Of Biochemistry,4th Ed., D. Nelson & M. Cox, W.H.Freeman & Co.,(LPE)
2. Principles of Biochemistry- G. Zubay, W.W. Parson, D.E.Vance. Wm.C.Brown Publishers.
3. Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th.
4. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
5. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford,University Press.
6. Rose, A.H. (1976) Chemical Microbiology, 3rdednButterworth-Heinemann

Paper 2

1. Microbiology, An Introduction by Tortora, Funke & Case 9th and 10th edition, Pearson education.
2. Bailey and Scott's Diagnostic Microbiology, 11th edition Publ: Mosby
3. Anantnarayan & Paniker's Textbook of Mocrobiology, 8th Ed.
4. Mackie and McCartney Practical medical microbiology 14th edition. Publ: Churchill Livingstone
5. Brock biology of microorganism by Michael T Madigan. & John M Martinco. Pearson education.
6. Presscot, Harley Klein. Mc Graw, Text Book of Microbiology, international edition, 7th Ed
7. Anantnarayan & Paniker's edtn 10th. University press
8. Kanai Mukherjee, Swarajit Ghosh 'Medical Laboratory Technology: Procedure manual for routine diagnostic tests, 3rd Edition.

Paper 3

1. Bionanotechnology - Andrew and Waqar, One Central Press Ltd, UK., November, 2014.
2. Text book of Biotechnology by R C Dubey. 4th edition
3. Current Research, Technology & Education Topics in Applied Microbiology & Microbial Biotechnology. A Mendez Vilas Edition
4. Periodicum Biologorum., Vol 109,, No 2, 2007. Characteristics and Significance of Microbial Biofilm Formation Biofilms Importance and Applications. Indian Journal of Biotechnology, Vol8, April 2009, pp159-169.
5. Research Methodology, Yogesh Kumar Singh, New age International Publisher
6. Instrumental Methods of chemical analysis, V.K. Ahluwalia, Ane Books Pvt.Ltd; 2015.
7. Principles & techniques of Biochemistry & Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006
8. Laboratory manual in Biochemistry- J. Jayaraman
9. Research Methodology, Yogesh Kumar Singh, New age International Publisher

Practicals based on Sem IV

Paper/Unit	S.N.	Title	Credits	Lecture/Week
Paper I			1	3
U1	1	Problems on Bioenergetics		
U2	2	Extracellular Production of enzyme - Demo		
	3	Effect of [S] on enzyme activity		
	4	Determination of Km and Vmax (MM and LB plot)		
	5	Effect of pH on enzyme activity		
	6	Effect of temperature on enzyme activity		
U3	7	Extraction of lipid (Demo)		
	8	Preparation of liposomes (Demo)		
Paper II U1	9	Isolation of Pseudomonas, Escherichia coli and S. typhi	1	3
	10	Permanent slides of Entamoeba histolytica		
	11	Assignment on: i. Normal flora of - skin/ respiratory system/ nervous system / digestive system, ii. Immunization programmes in India (role of CDC, WHO, ICMR, NICD, NAARI)		
U2	12	Differential staining: Blood staining		
	13	Pyocin typing		
	14	Phagocytosis (demonstration)		
U3	15	Acid fast staining		
	16	Metachromatic granules staining		
	17	VDRL and SRID		
	18	Isolation of pathogens on specific media XLD, SS agar, SIBA, Cetrimide agar		
	19	Biochemical tests IMViC, Sugar Fermentation, TSI, Oxidase, Catalase, Lysine decarboxylase, PPA, gelatinase		
PIII			1	3
U1	20	BLAST		
	21	Preparation of Silver Nano particles and study of its antimicrobial activity		
	22	Preparation and study of biofilm		
U2	23	Paper chromatography – amino acids separation		
	24	Thin layer chromatography –		

		carbohydrate separation		
	25	Column chromatography – separation of plant pigments		
	26	Sizing of yeast		
U3	27	Writing of report on (any 1) a. Isolation of spoilage causing microbes b. Isolation of pathogen from patient's sample c. Determination of efficiency of waste water treatment. 2. Isolation of photosynthetic/ N-fixing/ Sulphate reducing bacteria		

Modality of Assessment

Internal assessment

a) Theory 25 Marks

Sr.No.	Evaluation type	Marks
1	One class test (multiple choice questions/objective and subjective /long answers)	20
2	Active participation in routine class instructional deliveries(case studies/seminar/presentation)	05

B) External examination-75%

Semester End Theory Assessment -75% ` 75 marks

Duration – These examinations shall be of two and half hours duration.

Theory question paper pattern:-

1. There shall be four questions. Three questions each of 20 marks and one question for 15 marks. On each unit there will be one questions & fourth one will be based on all the three units.
2. All question shall be compulsory with internal choice within the questions. Question number 1, 2 & 3 will be of 39 – 40 marks and question no. 4 will be 30 marks with internal options.
3. Questions may be subdivided into subquestions.
4. The allocation of marks depends on the weightage of the topic.

Practical Examination pattern

Semester III:

Course : USc3 Mi P	Total
Section -I	50 Marks
Section –II	50 Marks
Section -III	50 Marks

Semester IV:

Course : USc4 Mi P	Total
Section -I	50 Marks
Section –II	50 Marks
Section -III	50 Marks

Overall examination pattern

	Section I /paper I			Section II/Paper II			Section III/Paper III		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
Theory	25	75	100	25	75	100	25	75	100
Practicals	00	50	50	00	50	50	00	50	50

Practical examination –Semester III	
USc3 Mi P	
Section -I	50 Marks
Section –II	50 Marks
Section -III	50 Marks
Practical examination –Semester IV	
USc4 Mi P	
Section -I	50 Marks
Section –II	50 Marks
Section -III	50 Marks

External examination pattern

Semester –III

USc3 Mi P

Sr.no.	**Section - I**	Marks
1	Chemical assay (Estimation of Proteins /RNA /Carbohydrate)	20
2	Qualitative test	10
	Biostatics problem/ Problems on thermodynamics/Quiz	05
3	Assignment/Report	05

	Section- II	
1	Major techniques (Determination of TDT and TDT/MIC of Sugar and Salt tolerance/Microbial quality of Milk: SPC, LPC, Thermophilic count, Psychrophilic count, coliform count/MPN/Routine Microbial analysis of water: SPC.)	20
2	Minor techniques (antibiotic producer/ organic acid producer/isolation of food spoilage organisms; Proteolytic, Lipolytic, amylase producing and coliforms/ Dye reduction test: RRT, MBRT/ Determination of BOD, COD)	10
3	Assignment/Report	05
4	quiz	05

	Section- III	
1	Major techniques (Estimation of DNA / Estimation of Proteins by Lowry's method /Separation and visualization of nucleic acids by Agarose gel electrophoresis)	20
2	Minor techniques –(Extraction of Nucleic Acids/ / Extraction of RNA/UV mutagenesis)	10
3	Assignment on Various types of DNA mutation and Repair	05
4	Quiz	05

Semester –IV

USc4 Mi P

Sr.no.	Section - I	Marks
1	Major techniques (Effect of [S] on enzyme activity Determination of Km and Vmax (MM and LB plot) Effect of pH on enzyme activity Effect of temperature on enzyme activity)	30
2	Problem/quiz	05
3	Assignment/Report	05
	Section II	
1	Major techniques (Biochemical tests IMViC, Sugar Fermentation, TSI, Oxidase, Catalase, Lysine decarboxylase, PPA, gelatinase/ Acid fast staining).	20
2	Minor Techniques (Isolation of *Pseudomonas, Escherichia coli* and *S. typhi* / Differential staining: Blood staining/ Metachromatic granules staining/ Isolation of pathogens on specific media XLD, SS agar, SIBA, Cetrimide agar/ Permanent slides of *Entamoeba histolytica*/ VDRL and SRID.)	10
3	Assignment on: i. Normal flora of - skin/ respiratory system/ nervous system / digestive system, ii. Immunization programs in India (role of CDC, WHO, ICMR, NICD, NAARI)	05
4	Quiz/Report	05
	Section III	
1	Major techniques (Preparation of Silver Nano particles and study of its antimicrobial activity/ Thin layer chromatography – carbohydrate separation/Column chromatography – separation of plant pigments	20
2	Minor techniques (Preparation and study of biofilm/ Paper chromatography – amino acids separation/ Sizing of yeast/ Isolation of photosynthetic/ N-fixing/ Sulphate reducing bacteria	10
3	Report	05
4	Assignment/quiz	05

Class: S. Y. B. Sc. Microbiology

Syllabus Revision: 2019-20 **Syllabus Implementation: 2020-2021**

Course Outcome

Semester III

Paper I:

Learners will

- Benefits in learning the estimation of biomolecules required for research purpose
- Understand the concepts of bioenergetics, thermodynamics and basics of biostatistics
- Understand the biochemical calculations for the preparation of solutions

Paper II:

Learners will

- Benefits in understanding the technology and microbiology involved in fermentation
- Understand the microbiology of food, milk, fresh water and sewage

Paper III:

Learners will

- Understand the nucleic acid chemistry, separation of nucleic acid using electrophoresis and its sequencing are the basic insights in molecular biology
- Understand the DNA replication in prokaryotes, mutations in genetic material and the repair mechanisms adapted by prokaryotes
- Understand the insights into the central dogma of life process namely transcription and translation

Semester IV

Paper I:

Learners will

- Understand the concepts/basics under metabolism
- Understand the kinetic studies of enzymes in metabolism process
- Benefits in understanding the transport of molecules across the biological membranes

Paper II:

Learners will

- Benefits in understanding common infectious diseases, epidemiology and associated public health awareness in relation to diseases
- Understand the host defense mechanisms adapted by humans

· Understand the medical microbiology techniques like physiological sampling and the diagnosis of infectious diseases as well as the role of vaccines

Paper III:

Learners will

· Understand the role of bioinformatics, nano biotechnology, biofilm and biosensors

· Understand the analytical techniques used in education, industries and research institutes

· Benefits the learners in understanding the research fundamentals

AC Item No.

UNIVERSITY OF MUMBAI

Revised Syllabus for T.Y.B.Sc.
Program: B.Sc.
Course: Microbiology (USMB)

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

PREAMBLE

The Choice Based Credit system was introduced by Mumbai University from 2016 - 2017. The process was initiated by restructuring the F.Y.B.Sc. syllabus and the paper pattern according to the CBCS pattern and its implementation in the same year i.e. 2016 - 17.

This was followed by revision of S.Y.B.Sc. syllabus and paper pattern in the year 2017 - 2018.

The revised S.Y.B.Sc. syllabus gave an opportunity to the Microbiology students to opt for Paper III of any subject other than Microbiology. Likewise S.Y.B.Sc. students of other subjects could opt for Microbiology Paper III. This gave them the option to choose from diversity of applied sciences.

In continuation with this, the T.Y.B.Sc. syllabus is being revised in the year 2018 - 2019. The existing paper pattern will also be accordingly revised.

Keeping in tune with the revised syllabus, the committee has ensured that there is a continuous flow of information and latest advances in the subject imparted to the students. Hence some of the modules of the earlier syllabus have been upgraded, while some new modules have been added to the syllabus in order to bridge the knowledge gap of the learner from S.Y.B.Sc. to T.Y.B.Sc.

The syllabus is aimed at equipping the students with basic knowledge in various branches of Microbiology such as Microbial Genetics, Molecular Biology, Virology, Medical Microbiology, Immunology, Microbial Biochemistry and Industrial Microbiology. Additionally, it also makes students aware of interdisciplinary sciences such as Bioinformatics and Bioinstrumentation.

In all, the students offering Microbiology as a single major subject that is Six units pattern, will study eight courses of theory and practicals compulsory during Semester V and Semester VI together, while students opting for double major subject that is Three units pattern, will have four courses of theory and practicals compulsory during Semester V and Semester VI together.

The courses for six units will comprise of the following:

1) USMB 501 and USMB 601
2) USMB 502 and USMB 602
3) USMB 503 and USMB 603
4) USMB 504 and USMB 604

The courses for three units will comprise of the following:

1) USMB 501 and USMB 601
2) USMB 502 and USMB 602

The approach towards designing this syllabus has been to retain the classic concepts of Microbiology as well as keeping abreast with the latest discoveries in Microbiology and other interdisciplinary fields.

In conclusion, the revised syllabus aims at inculcating a spirit of learning and kindling curiosity towards the subject in the minds of learners, resulting in their pursuit of higher education in Microbiology.

T.Y.B.Sc. MICROBIOLOGY THEORY

(SEMESTER V)

COURSE CODE	TITLE	CREDITS AND LECTURES / SEM
USMB501	**Microbial Genetics**	**2.5 Credits (60 Lectures)**
Unit I	DNA Replication	15 Lectures
Unit II	Transcription, Genetic Code & Translation	15 Lectures
Unit III	Mutation and Repair	15 Lectures
Unit IV	Genetic Exchange & Homologous Recombination	15 Lectures
USMB502	**Medical Microbiology & Immunology: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Bacterial Strategies for Evasion and Study of a Few Diseases	15 Lectures
Unit II	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological agent, Pathogenesis, Laboratory Diagnosis and Prevention.	15 Lectures
Unit III	General Immunology - I	15 Lectures
Unit IV	General Immunology - II	15 Lectures
USMB503	**Microbial Biochemistry: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Biological Membranes & Transport	15 Lectures
Unit II	Bioenergetics & Bioluminescence	15 Lectures
Unit III	Methods of Studying Metabolism & Catabolism of Carbohydrates	15 Lectures
Unit IV	Fermentative Pathway & Anabolism of Carbohydrates	15 Lectures

USMB504	**Bioprocess Technology: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Upstream Processing - I	15 Lectures
Unit II	Upstream Processing - II	15 Lectures
Unit III	Fermentation Modes, Equipments and Instruments	15 Lectures
Unit IV	Traditional Industrial Fermentations	15 Lectures

N.B.

I. Each theory period shall be of 48 minutes duration. Theory component shall have 240 instructional periods plus 240 notional periods per semester which is equal to 384 learning hours. For theory component the value of One Credit is equal to 38.40 learning hours.

II. Each practical period shall be of 48 minutes duration. Practical component shall have 240 instructional periods plus 60 notional periods per semester which is equal to 240 learning hours. For practical component the value of One Credit is equal to 40 learning hours.

T.Y.B.SC. MICROBIOLOGY THEORY (SEMESTER V)

MICROBIAL GENETICS (USMB-501)

LEARNING OBJECTIVES

Microbial Genetics (USMB-501) is a course in Genetics for T.Y.B.Sc. undergraduate students in Semester V that deals with various concepts of Genetics.

The learning objectives include the following:

1. **DNA Replication:** The learner will understand the events occurring in both Prokaryotic and Eukaryotic DNA replication, with a focus on the involvement of Proteins and Enzymes at the cellular level. The topic will also include the assembly of Eukaryotic chromosome.
2. **Transcription, Genetic Code and Translation:** This module aims at the learner understanding the basis of gene expression and the Central Dogma and the molecular basis of protein synthesis in Prokaryotes and Eukaryotes. The module deals with the structure and properties of different forms of RNA, maturation of RNA and RNA splicing.
3. **Mutation and DNA repair:** The molecular basis and types of mutation, their cause, effect and DNA repair is studied. The basic concepts related to molecular biology are explained.
4. **Genetic exchange:** This module includes the study of various mechanisms of gene transfer in bacteria. It also provides insight into the mechanisms of genetic recombination. The module deals with the Genetics of bacteria and bacteriophages, development of new strains and genetic mapping.
5. **Practicals**
   The laboratory techniques and experiments based on these topics will give students hands on competence in fundamental molecular biology experiments.

LEARNING OUTCOMES:

- **DNA Replication**: The learner will understand the sequence of events, mechanism, enzymes and proteins involved in replication of DNA in prokaryotes and eukaryotes.
- **Transcription, Genetic Code and Translation:** The student will know the central dogma of biology its two-step transcription and translation, maturation of RNA.
- **Mutation and DNA repair**: The learner will know the concept of mutation, its types, causes and their effects. This module will also make them understand types of mutagens, damage to DNA due to mutagenesis, various mechanisms of DNA repair.
- **Genetic exchange**: The student shall understand the various mechanisms of gene transfer in bacteria and genetic recombination.
- **Practicals**: The students will acquire skill to perform the laboratory techniques and experiments based on the above topics.

MICROBIAL GENETICS (USMB-501): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: DNA Replication	**15 L**	**15**
1.1. Historical perspective - Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication.	**3 L**	
1.2. Prokaryotic DNA replication - Details of molecular mechanisms involved in Initiation, Elongation and Termination	**4 L**	
1.3. Enzymes and proteins associated with DNA replication- Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, Ter and Tus proteins.	**3 L**	
1.4. Eukaryotic DNA replication - Molecular details of DNA synthesis, replicating the ends of the chromosomes assembling newly replicated DNA into nulcleosomes**.**	**4 L**	
1.5. Rolling circle mode of DNA replication	**1 L**	
Unit II: Transcription, Genetic Code and Translation	**15 L**	**15**
2.1 Central Dogma: An Overview, Transcription process, Transcription in bacteria - Initiation of transcription at promoters, elongation of an RNA chain, termination of an RNA chain	**3 L**	
2.2 Transcription in Eukaryotes - Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing	**5 L**	
2.3 Genetic code - Nature of genetic code and characteristics of genetic code.	**2 L**	
2.4 Translation process - Transfer RNA, structure of tRNA, tRNA genes, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA , Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell.	**5 L** **1 L**	
Unit III: Transcription, Genetic Code and Translation	**15 L**	**15**
3.1 Mutation 3.1.1 **Terminology:** alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes	**1 L**	

3.1.2 **Fluctuation test.**	**1 L**	
3.1.3 **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.	**3 L**	
3.1.4 **Causes of mutation:** Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for: 3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. 3.1.4.2 Physical mutagen 3.1.4.3 Biological mutagen (only examples)	**4 L**	
3.1.5 **Ames test**	**1 L**	
3.1.6 **Detection of mutants**	**1 L**	
3.2 DNA Repair 3.2.1 Mismatch repair, 3.2.2 Light repair 3.2.3 Repair of alkylation damage 3.2.4 Base excision repair 3.2.5 Nucleotide excision repair 3.2.6 SOS repair	**4 L**	
Unit IV: Genetic Exchange & Homologous Recombination	**15 L**	**15**
4.1 Genetic analysis of Bacteria	**1 L**	
4.2 Gene transfer mechanisms in bacteria 4.2.1 Transformation 4.2.1.1 Introduction and History 4.2.1.2 Types of transformation in prokaryotes--Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis*. 4.2.1.3 Mapping of bacterial genes using transformation. 4.2.1.4 Problems based on transformation.	**3 L**	
4.2.2 Conjugation 4.2.2.1 Discovery of conjugation in bacteria 4.2.2.2 Properties of F plasmid/Sex factor 4.2.2.3 The conjugation machinery 4.2.2.4 Hfr strains, their formation and mechanism of conjugation 4.2.2.5 F' factor, origin and behavior of F' strains,	**5 L**	

	Sexduction. 4.2.2.6 Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). 4.2.2.7 Problems based on conjugation		
4.2.3	Transduction 4.2.3.1 Introduction and discovery 4.2.3.2 Generalized transduction 4.2.3.3 Use of Generalized transduction for mapping genes 4.2.3.4 Specialized transduction 4.2.3.5 Problems based on transduction	**3 L**	
4.3	**Recombination in bacteria** 4.3.1 General/Homologous recombination 4.3.2 Molecular basis of recombination 4.3.3 Holliday model of recombination (Single strand DNA break model only) 4.3.4 Enzymes required for recombination 4.3.5 Site –specific recombination	**3 L**	

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART-I (USMB-502)

LEARNING OBJECTIVES

The course in medical microbiology has been designed to help students to build on the basic information regarding host defense mechanisms that they have gained in S.Y.B.Sc. It has been designed to highlight the most important areas of medical microbiology i.e. etiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases

The students have achieved a basic understanding of Innate Immunity and Host Defense mechanisms in their lower classes and Immunology that forms an integral part of Medical Microbiology has been designed to help understand the ability of our immune system to defend against invading pathogens in a logical fashion. This includes our ability to defend against microorganisms by understanding the concepts of Humoral and Cellular Immunity (innate immunity); if we react excessively, what price we pay (hypersensitivity); and very importantly, how we can prevent pathogens from infecting us (vaccination).

LEARNING OUTCOMES: The students should be able to

- Give details of the virulence factors and other features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, and therefore modes of prophylaxis of these diseases
- Comment on the methods of diagnosis of the disease.

- Conceptualize how the adaptive immune responses coordinate to fight invading pathogens and the organs and tissue involved
- Discuss the role of antigen in initiating the immune response
- Correlate the structure & functions of immunoglobulin
- Understand the importance of cytokines, MHC, APCs, Cytokines, and the role in adaptive immunity.
- Understand the various antigen –antibody reactions

MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART I

(USMB-502): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Bacterial Strategies for Evasion and Study of a Few Diseases	**15 L**	**15**
1.1. Study of virulence mechanisms in bacteria 1.1.1. Pathogenicity islands 1.1.2. Bacterial virulence factors 1.1.2.1. Adherence factors 1.1.2.2. Invasion of host cells and tissues 1.1.3. Toxins 1.1.3.1. Exotoxins 1.1.3.2. Exotoxins associated with diarrhoeal diseases and food poisoning 1.1.3.3. LPS of gram negative bacteria 1.1.4. Enzymes 1.1.4.1. Tissue degrading enzymes 1.1.4.2. IgA1 proteases 1.1.5. Antiphagocytic factors 1.1.6. Intracellular pathogenicity 1.1.7. Antigenic heterogeneity 1.1.8. The requirement for iron	**5 L**	
1.2. Study of A Few Infectious Diseases of the Respiratory Tract (wrt. Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only) 1.2.1. *S. pyogenes* infections 1.2.2. Influenza 1.2.3. Tuberculosis 1.2.4. Pneumonia caused by *K .pneumoniae*	**8 L**	
1.3. Study of urinary tract infections	**2L**	

Unit II: Study of few diseases (wrt. Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)		**15 L**	**15**
2.1	**Study of skin infections**	**7 L**	
2.1.1	Pyogenic skin infections caused by *Pseudomonas* and *S. aureus*		
2.1.2	Leprosy		
2.1.3	Fungal infections- Candidiasis		
2.1.4	Viral Infections- Herpes simplex		
2.2	**Study of gastrointestinal tract infections**	**8 L**	
2.2.1	Infections due to Enteropathogenic *E.coli* strains		
2.2.2	Enteric fever- *Salmonella*		
2.2.3	Shigellosis		
2.2.4	Rotavirus diarrhoea		
2.2.5	Dysentery due to *Entamoeba histolytica*		
Unit III: General Immunology – I		**15 L**	**15**
3.1.	**Organs and tissues of the immune system:**	**4 L**	
3.1.1	Primary lymphoid organs - structure and function of Thymus and Bone marrow		
3.1.2	Secondary lymphoid organs – structure and function of Spleen**,** Lymph node**,** Mucosa associated lymphoid tissues, Bronchus associated lymphoid tissue, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue		
3.2	**Antigens**	**5 L**	
3.2.1	Immunogenicity versus antigenicity: Concepts - Immunogenicity, Immunogen, Antigencity, Antigen, Haptens. Haptens as valuable research and diagnostic tools		
3.2.2	Factors that influence immunogenicity - Foreignness, Molecular size, Chemical composition, Heterogeneity, Susceptibility of antigen to be processed and presented, Contribution of the biological system to immunogenicity Genotype of the recipient, Immunogen dosage, Route of administration		
3.2.3	Adjuvants		
3.2.4	Epitopes / antigen determinants - General concept, Characteristic properties of B - cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells		
3.2.5	Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens		
3.3	**Immunoglobulins**	**6 L**	
3.3.1	Immunoglobulins – basic structure of Immunoglobulins, heterodimer; types of heavy and light chains; constant and		

		variable regions, Immunoblobulin domains-hinge region. Basic concepts - hypervariable region, complementarity - determining regions (CDRs), framework regions (FRs) and their importance.		
	3.3.2	Immunoglobulin classes and biological activities - Immunogloublin G, Immunogloublin M, Immunogloublin A, Immunogloublin E, Immunogloublin D, (including diagrams)		
	3.3.3	Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes**.**		
	3.3.4	Immunoglobulin Superfamily		
		Unit IV: General Immunology – II	**15 L**	**15**
4.1	**Cytokines**		**2 L**	
	4.1.1	Concepts - cytokines, lymphokines, monokines, interleukines, chemokines.		
	4.1.2	Properties of cytokines		
	4.1.3	Attributes of cytokines		
	4.1.4	Biological functions of cytokines		
4.2	**Major histocompatibility complex**		**3 L**	
	4.2.1	Introduction		
	4.2.2	Three major classes of MHC encoded molecules		
	4.2.3	The basic structure and functions of Class I and Class II MHC Molecules		
	4.2.4	Peptide binding by Class I and Class II MHC molecule		
4.3	**Antigen presenting cells**		**3 L**	
	4.3.1	Types of APC's		
	4.3.2	Endogenous antigens: The cytosolic pathway		
	4.3.3	Exogenous antigens: The endocytic pathway		
4.4	**Antigen Antibody reactions**		**7 L**	
	4.4.1	Precipitation reaction - Immunoelectrophoresis		
	4.4.2	Agglutination reactions - haeme-agglutination, bacterial agglutination, passive agglutination, agglutination inhibition.		
	4.4.3	Radioimmunoassay (RIA),		
	4.4.4	Enzyme Linked Immunosorbent Assay - indirect, competitive and sandwich ELISA		
	4.4.5	Immunofluorescence- Direct and indirect.		
	4.4.6	Western blotting.		

MICROBIAL BIOCHEMISTRY: PART-I (USMB-503)

LEARNING OBJECTIVES

This course is designed for T.Y.B.Sc. students who choose to major in Microbiology. Biochemistry is the branch of science that explores the chemical processes that take place inside all living things, from bacteria to plants and animals. It is a laboratory based science that brings together biology and chemistry, by using chemical knowledge and techniques to help understand and solve biological problems. Microbial physiology is best understood with knowledge of biochemistry. The course thus focuses on the need to study uptake, various intermediary metabolic processes and methods to study metabolism both invitro as well as invivo. The course is designed to expose students to carbohydrate metabolism as also understand the principles of energy generation by different physiological groups of organisms. The advanced area of bioenergetics unfolds the universal mechanisms of energy generation by using electron transport systems and gaining knowledge of energy conservation. The student is also learning anabolic processes through concepts of biosynthesis, and polymerization namely glycogen and peptidoglycan biosynthesis.

LEARNING OUTCOMES: The students should be able to

- Understand the architecture of the membrane and how solute is transported inside the cell.
- Describe and explain the electron transport chains in prokaryotes and mitochondria and understand the mechanism of ATP synthesis.
- Explain bioluminescence mechanism and its significance
- Discuss the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
- Describe various other pathways which produce different end products.
- Describe anabolic reactions in carbohydrate synthesis.
- Apply the concepts of energetics and catabolism in biodegradation of various substrates.

MICROBIAL BIOCHEMISTRY: PART-I:

(USMB-503): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Biological Membranes & Transport	**15 L**	**15**
1.1 Composition and architecture of membrane 1.1.1 Lipids and properties of phospholipid membranes 1.1.2 Integral & peripheral proteins & interactions with lipids 1.1.3 Permeability	**2 L**	

1.1.4 Aquaporins 1.1.5 Mechanosensitive channels			
1.2 Methods of studying solute transport 1.2.1 Use of whole cells 1.2.2 Liposomes 1.2.3 Proteoliposomes		**2 L**	
1.3 Solute transport across membrane 1.3.1 Passive transport and facilitated diffusion by membrane proteins 1.3.2 Co-transport across plasma membrane - (Uniport, Antiport, Symport) 1.3.3 Active transport & electrochemical gradient 1.3.4 Ion gradient provides energy for secondary active transport 1.3.4.1 Lactose transport 1.3.5 ATPases and transport (only Na-K ATPase) 1.3.6 Shock sensitive system – Role of binding proteins 1.3.6.1 Maltose uptake (Diagram and description) 1.3.6.2 Histidine uptake (Diagram and description) 1.3.7 Phosphotransferase system 1.3.8 Schematic representation of various membrane transport systems in bacteria.		**8 L**	
1.4 Other examples of solute transport: 1.4.1 Iron transport: A special problem 1.4.2 Assembly of proteins into membranes and protein export 1.4.3 Bacterial membrane fusion central to many biological processes		**3 L**	
Unit II: Bioenergetics & Bioluminescence		**15 L**	**15**
2.1 Biochemical mechanism of generating ATP: Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation		**1 L**	
2.2 Electron transport chain 2.2.1 Universal Electron acceptors that transfer electrons to E.T.C. 2.2.2 Carriers in E.T.C. 2.2.2.1 Hydrogen carriers – Flavoproteins, Quinones 2.2.2.2 Electron carriers – Iron Sulphur proteins, Cytochromes. 2.2.3 Mitochondrial ETC 2.2.3.1 Biochemical anatomy of mitochondria 2.2.3.2 Complexes in Mitochondrial ETC 2.2.3.3 Schematic representation of Mitochondrial ETC**.**		**3 L**	
2.3 Prokaryotic ETC 2.3.1 Organization of electron carriers in bacteria 2.3.1.1 Generalized electron transport pathway in		**3 L**	

	bacteria 2.3.1.2 Different terminal oxidases 2.3.2 Branched bacterial ETC 2.3.3 Pattern of electron flow in *E. coli* - aerobic and anaerobic 2.3.4 Pattern of electron flow in *Azotobacter vinelandii*		
2.4	**ATP synthesis** 2.4.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) 2.4.2 Free energy released during electron transfer from NADH to O_2 2.4.3 Chemiosmotic theory (only explanation) 2.4.4 Structure & function of Mitochondrial ATP synthase 2.4.5 Structure of bacterial ATP synthase 2.4.6 Mechanism by Rotational catalysis 2.4.7 Inhibitors of ETC, ATPase and uncouplers	**3 L**	
2.5	**Other modes of generation of electrochemical energy** 2.5.1 ATP hydrolysis 2.5.2 Oxalate formate exchange 2.5.3 End product efflux, Definition**,** Lactate efflux 2.5.4 Bacteriorhodopsin: - Definition, function as proton pump and significance	**2 L**	
2.6	**Bioluminescence** 2.6.1 Brief survey of bioluminescent systems 2.6.2 Biochemistry of light emission 2.6.3 Schematic diagram 2.6.4 Significance / Application	**3 L**	
	Unit III: Studying Metabolism & Catabolism of Carbohydrates	**15 L**	**15**
3.1	**Experimental Analysis of metabolism** 3.1.1 Goals of the study 3.1.2 Levels of organization at which metabolism is studied 3.1.3 Metabolic probes. 3.1.4 Use of radioisotopes in biochemistry 3.1.4.1 Pulse labeling 3.1.4.2 Assay and study of radiorespirometry to differentiate EMP & ED 3.1.5 Use of biochemical mutants 3.1.6 Sequential induction	**3 L**	
3.2	**Catabolism of Carbohydrates** 3.2.1 Breakdown of polysaccharides – Glycogen, Starch, Cellulose 3.2.2 Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose. 3.2.3 Utilization of monosaccharides - Fructose, Galactose 3.2.4 Major pathways – (with structure and enzymes)	**10 L**	

3.2.4.1 Glycolysis (EMP) 3.2.4.2 HMP Pathway - Significance of the pathway 3.2.4.3 ED pathway 3.2.4.4 TCA cycle - Action of PDH, Significance of TCA 3.2.4.5 Incomplete TCA in anaerobic bacteria 3.2.4.6 Anaplerotic reactions 3.2.4.7 Glyoxylate bypass		
3.3	**Amphibolic role of EMP; Amphibolic role of TCA cycle**	**1 L**	
3.4	**Energetics of Glycolysis, TCA and ED pathway** – Balance sheet only. Format as in Lehninger (2.5 ATP/NADH and 1.5 ATP / $FADH_2$) (Based on this format make balance sheet for Glycolysis - Lactic acid and Alcohol fermentation and for ED pathway)	**1 L**	
Unit IV: Fermentative Pathways & Anabolism of Carbohydrates		**15 L**	**15**
4.1	**Fermentative pathways** (with structures and enzymes) 4.1.1 Lactic acid fermentation 4.1.1.1 Homofermentation 4.1.1.2 Heterofermentation 4.1.2 Bifidum pathway 4.1.3 Alcohol fermentation 4.1.3.1 By ED pathway in bacteria 4.1.3.2 By EMP in yeasts	**4 L**	
4.2	**Other modes of fermentation in microorganisms** 4.2.1 Mixed acid 4.2.2 Butanediol 4.2.3 Butyric acid 4.2.4 Acetone-Butanol 4.2.5 Propionic acid (Acrylate and succinate propionate pathway)	**5 L**	
4.3	**Anabolism of Carbohydrates** 4.3.1 General pattern of metabolism leading to synthesis of a cell from glucose 4.3.2 Sugar nucleotides 4.3.3 Gluconeogenesis (only bacterial) 4.3.4 Biosynthesis of glycogen 4.3.5 Biosynthesis of Peptidoglycan	**6 L**	

BIOPROCESS TECHNOLOGY: PART-I (USMB-504)

LEARNING OBJECTIVES

Bioprocess Technology I 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 & 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 and enzymes.

Industrial microbiology becomes an important application based paper covering microbial fermentations. Thus, it becomes a laboratory to market scenario where the entire products reach. The learner is provided with the details of productions of important traditional fermentation products like wine, beer, vinegar and enzymes.

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 both the science and business aspects to be achievable to make a viable product and enhance their entrepreneur skills.

LEARNING OUTCOMES: The students should be able to

- Describe the applications of microbes and its strain improvement in Industrial Microbiology.
- Apply kinetic formula to determine growth and productivity parameters of batch continuous, fed batch and solid substrate fermentations
- Describe the design of bioreactors for different applications and its process parameters
- Design media, growth conditions and techniques for producing and recovering different types of products of commercial value.
- Learner will be well –versed with the containment and levels of containment.

BIOPROCESS TECHNOLOGY: PART-I

(USMB-504): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Upstream Processing – I	**15 L**	**15**
1.1 Introduction 1.1.1 An introduction to fermentation processes 1.1.2 The range of fermentation processes 1.1.3 The Component parts of a fermentation process	**3 L**	
1.2 Screening methods 1.2.1 Primary and secondary screening	**3 L**	

	1.2.2 High throughput screening methods		
1.3	**Strain improvement** 1.3.1 The improvement of industrial microorganisms 1.3.2 The selection of induced mutants synthesizing improved levels of primary metabolites 1.3.3 The isolation of induced mutants producing improved yields of secondary metabolites. 1.3.4 The improvement of strains by modifying properties other than the yield of product	**6 L**	
1.4	**Preservation of cultures** 1.4.1 Preservation of industrially important organisms 1.4.2 Quality control of preserved stock 1.4.2.1. Key Criteria's 1.4.2.2. Development of a master culture bank (MCB) 1.4.2.3. Variability test to ensure reproducibility of the MCB	**3 L**	
	Unit II: Upstream Processing – II	**15 L**	**15**
2.1	**Fermentation media formulation and raw materials** 2.1.1 Media formulation 2.1.2 Raw materials for fermentation media	**4 L**	
2.3	**The development of inocula for industrial fermentations** 2.2.1 Introduction 2.2.2 Development of inocula for unicellular bacterial process 2.2.3 Development of inocula for mycelial process	**3 L**	
2.3	**Sterilization and achievement of aseptic conditions** 2.3.1 Introduction 2.3.2 Medium sterilization (concept of nabla factor) 2.3.3 Methods of batch sterilization 2.3.4 The design of continuous sterilization process 2.3.5 Sterilization of the Fermenter 2.3.6 Sterilization of the Feeds 2.3.7 Sterilization of the liquid wastes 2.3.8 Filter Sterilization 2.3.8.1 Filter sterilization of fermentation media, 2.3.8.2 Filter sterilization of air 2.3.8.3 Filter sterilization of fermenter exhaust air 2.3.9 Achievement of aseptic conditions	**6 L**	
2.4	**Scale up and scale down of fermentation**	**2 L**	
	Unit III: Fermentation Modes, Equipments and Instruments	**15 L**	**15**
3.1	**Modes of fermentation** 3.1.1 Batch, continuous and fed batch fermentation 3.1.2 Solid substrate fermentation	**3 L**	

3.2	**Design of fermenter** 3.2.1 Basic functions 3.2.2 Aseptic operation & Containment 3.2.3 Body construction 3.2.4 Agitator (impeller) – function, types, mechanical seal and magnetic drive 3.2.5 Baffles 3.2.6 The aeration system (sparger) - function and types 3.2.7 Valves (Globe, piston & needle) 3.2.8 Steam traps 3.2.9 Examples of fermenters - Stirred Tank Reactor, Air Lift, Deep Jet, Photobioreactor	**7 L**	
3.3	**Instrumentation and control** 3.3.1 Introduction to sensors and its types 3.3.2 Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis.	**5 L**	
	Unit IV: Traditional Fermentations	**15 L**	**15**
4.1	**Wine – Red, White, Champagne and Sherry:** Alcoholic fermentation, composition of grape juice, Sulphur dioxide addition, factors affecting wine fermentation, examples and role of yeasts involved in fermentation, malolactic fermentation, technological aspects of wine making- red, white, champagne, sherry, examples of aroma compounds of wine, types and examples of wine	**3 L**	
4.2	**Beer – Ale and Lager:** Elements of brewing process, process details, use of cylindro-conical vessel, primary fermentation, continuous fermentation, aging and finishing, yeasts involved in fermentation.	**3 L**	
4.3	**Alcohol from Molasses:** Introduction, biosynthesis of ethanol, production process- preparation of nutrient solution, fermentation, recovery by distillation**.**	**2 L**	
4.4	**Vinegar (acetic acid):** Introduction, biosynthesis, production using generator, production using submerged fermenter, recovery**.**	**3 L**	
4.5	**Baker's yeast:** Outline of production, yeast strains and their properties, factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature, preparation of substrate, fermentation, harvesting of yeast cells, production of compressed and active dry yeast.	**2 L**	
4.6	**Fungal amylase production:** $\propto$ amylase- production from bacteria and fungi, β amylase and glucoamylase, concentration and purification.	**2 L**	

T.Y.B.Sc. MICROBIOLOGY PRACTICALS (SEMESTER-V)

Course Code: USMBP05

[Practicals Based on USMB501, Credits -1.5, Lectures- 60, Notional Periods-15]

1. UV survival curve – determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis
3. Gradient plate technique (dye resistant mutant)
4. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
5. Isolation and detection of plasmid DNA.

Course Code: USMBP05

[Practicals Based on USMB502, Credits -1.5, Lectures-60, Notional Periods-15]

1. Acid fast staining.
2. Identification of *Candida* species using the germ tube test and growth on Chrom agar
3. To determine SLO and SLS activity of *S .pyogenes*
4. Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonalla typhi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus*
5. Identification of isolates obtained from pus, sputum, stool and urine by morphological, cultural and biochemical properties.
6. Antigen Preparation: O & H antigen preparation of Salmonella. Confirmation by slide agglutination

Course Code: USMBP06

[Practicals Based on USMB503; Credits-1.5, Lectures- 60, Notional Periods-15]

1. Isolation and study of Bioluminescent organisms
2. Study of oxidative and fermentative metabolism
3. Qualitative and Quantitative assay of Phosphatase
4. Study of Homo - Heterofermentations
5. Isolation and detection of Mitochondria
6. Glucose detection by GOD/POD

Course Code: USMBP06

[Practicals Based on USMB504, Credits -1.5, Lectures- 60, Notional Periods-15]

1. Alcohol Fermentation
   - 1.1. Preparation and standardization of yeast inoculums for alcohol fermentation
   - 1.2. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation.

2. Determine the alcohol tolerance for yeast.
3. Determine the sugar tolerance for yeast.
4. Chemical estimation of sugar by Cole's ferricyanide method
5. Chemical estimation of alcohol
6. Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative).
7. Primary screening for antibiotic producers using Wilkin's agar overlay method.
8. Determination of antibiotic spectrum using agar strip / streak method.
9. Industrial Visit

TEXT BOOKS AND REFERENCE BOOKS

(SEMESTER V)

Course Code: USMB501

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. D,.Nelson and M.Cox, (2005), "Lehninger's Principles of biochemistry", 4th edition, Macmillan worth Publishers.
5. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
6. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
7. Prescott, Harley and Klein, "Microbiology", 7th edition Mc Graw Hill international edition.
8. Robert Weaver, "Molecular biology", 3rd edition. Mc Graw Hill international edition.
9. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing
10. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.

Reference books:

1. Benjamin Lewin, "Genes IX", Jones and Bartlett publishers.
2. JD Watson, "Molecular biology of the gene", 5th edition.

Course Code: USMB502

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd Edition, Capital Publishing Company
7. Fahim Khan, Elements of Immunology, Pearson Education

Reference books / Internet references:

1. Kuby Immunology, 7th edition, W H Freeman and Company
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th8th edition
3. Baron Samuel , Medical Microbiology, 4th edition
4. http://www.ncbi.nlm.nih.gov/books/NBK7627/
5. http://www.macmillanlearning.com/catalog/static/whf/kuby/

Course Code: USMB503

Text books:

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. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition, W. H. Freeman and Company
6. Rose, A.H. (1976) Chemical Microbiology, 3rd edition. Butterworth-Heinemann
7. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
8. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
9. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.

Reference books:

1. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
2. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer

Course Code: USMB504

Text books

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
5. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
6. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
8. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
9. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th edition, McMillan Publishers

Reference books

1. R. C. Dubey, 2005 A Textbook of ''Biotechnology'' S. Chand and Company, New Delhi.
2. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 & 2, Pointer Publications, India
3. Practical Fermentation Technology by Brian Mcneil & Linda M. Harvey (2008).

T.Y.B.Sc. MICROBIOLOGY THEORY

(SEMESTER VI)

COURSE CODE	TITLE	CREDITS AND LECTURES / SEM
USMB601	**rDNA Technology, Bioinformatics & Virology**	**2.5 Credits (60 Lectures)**
Unit I	Recombinant DNA Technology	15 Lectures
Unit II	Applications of rDNA Technology & Bioinformatics	15 Lectures
Unit III	Regulation & Basic Virology	15 Lectures
Unit IV	Advanced Virology	15 Lectures
USMB602	**Medical Microbiology & Immunology: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	15 Lectures
Unit II	Chemotherapy of Infectious Agents	15 Lectures
Unit III	Immunology - I	15 Lectures
Unit IV	Immunology – II	15 Lectures
USMB603	**Microbial Biochemistry: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Lipid Metabolism & Catabolism of Hydrocarbons	15 Lectures
Unit II	Metabolism of Proteins and Nucleic Acids.	15 Lectures
Unit III	Metabolic Regulation	15 Lectures
Unit IV	Prokaryotic Photosynthesis & Inorganic Metabolism	15 Lectures
USMB604	**Bioprocess Technology: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Downstream Processing	15 Lectures
Unit II	Advances in Bioprocess Technology	15 Lectures
Unit III	Quality Assurance, Quality Control, Instrumentation and Bioassay	15 Lectures
Unit IV	Industrial Fermentations	15 Lectures

T.Y.B.SC. MICROBIOLOGY THEORY (SEMESTER V)

rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY (USMB-601)

LEARNING OBJECTIVES

rDNA technology, Bioinformatics and Virology, USMB 601 is a course for T.Y.B.Sc. in Semester VI Microbiology students which deal with the following:

1. **The rDNA technology:** This module deals with the basic steps in gene cloning, vectors, model organisms, methods of transformation and screening and identification of recombinant cells.
2. **Application of rDNA technology and Bioinformatics:** This module will empower the student to understand the basic techniques in Recombinant DNA technology along with their applications. Bioinformatics is the basic tool in understanding Cells at the genomic and proteomic levels. Inclusion of Bioinformatics in this module will empower the learner with insilico analytical techniques.
3. **Gene Regulation and Basic Virology:** This module will make the students understand the genetic basis of regulation and operon control through the involvement of regulatory proteins. The study of Basic Virology will emphasise on the structure, classification and general modes of replication of viruses.
4. **Advanced Virology:** This module deals with basic structure and life cycle of different viruses and cultivation of viruses. It also comprises of basic study on Prions, Viriods and viruses causing cancer.

LEARNING OUTCOMES:

- **r DNA technology:** This module will make the student understand the methods to construct recombinant DNA molecules, also know the tools required like vectors, restriction enzymes etc.
- **Application of rDNA technology and Bioinformatics**: The learner will know about applications of r DNA technology, through bioinformatics the student will understand the use of databases and software tools for understanding biological data.
- **Gene Regulation and Basic Virology:** The student will know about gene expression in prokaryotes, operon as a unit of gene regulation, regulation of gene expression in prokaryotes and bacteriophages. The student will also understand about general structure, life cycle and classification of viruses.
- **Advanced Virology:** The learner will understand the basic structure and life cycle of different viruses and their cultivation. The student will get basic knowledge on Prions, Viriods and viruses causing cancer.
- **Practicals**: The students will acquire skill to perform the laboratory techniques and experiments based on the above topics. The students will understand computational biology and insilico analytical techniques.

rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY

(USMB-601): DETAIL SYLLABUS

Title		Lectures / Semester	Notional Periods
Unit I: Recombinant DNA Technology		**15 L**	**15**
1.1	**Branches of Genetics** 1.1.1 Transmission genetics 1.1.2 Molecular genetics 1.1.3 Population genetics 1.1.4 Quantitative genetics	**1 L**	
1.2	**Model Organisms** 1.2.1 Characteristics of a model organism 1.2.2 Examples of model organisms used in study 1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms	**2 L**	
1.3	**Plasmids** 1.3.1 Physical nature 1.3.2 Detection and isolation of plasmids 1.3.3 Plasmid incompatibility and Plasmid curing 1.3.4 Cell to cell transfer of plasmids 1.3.5 Types of plasmids 1.3.6 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Colfactor, Degradative plasmids	**2 L**	
1.4	**Transposable Elements in Prokaryotes** 1.4.1 Insertion sequences 1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition, Integrons	**2 L**	
1.5	**Basic steps in Gene Cloning.**	**1 L**	
1.6	**Cutting and joining DNA molecules** - Restriction and modification systems, restriction endonucleases, DNA ligases	**3 L**	
1.7	**Vectors** 1.7.1 Plasmids as cloning vectors. plasmid vectors, pBR322 vector 1.7.2 Cloning genes into pBR322 1.7.3 Phage as cloning vectors, cloning genes into phage vector 1.7.4 Cosmids 1.7.5 Shuttle vectors 1.7.6 YAC 1.7.7 BAC	**3 L**	
1.8	**Methods of transformation**	**1 L**	

	Unit II: Applications of rDNA Technology & Bioinformatics	**15 L**	**15**
2.1	**PCR**- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)	**2 L**	
2.2	**Basic techniques** 2.2.1 Southern, Northern and Western blotting. 2.2.2 Autoradiography (explain the term	**2 L**	
2.3	**Screening and selection methods for identification and isolation of recombinant cells**	**2 L**	
2.4	**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.	**4 L**	
2.5	**Bioinformatics** 2.5.1 Introduction 2.5.2 Definition, aims, tasks and applications of Bioinformatics. 2.5.3 Database, tools and their uses – 2.5.3.1 Importance, Types and classification of databases 2.5.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. 2.5.3.3 Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. 2.5.4 Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics- structural, functional and comparative genomics, Proteomics - structural and functional proteomics, Sequence alignment - global v/s local alignment, FASTA, BLAST (Different types of BLAST)	**5 L**	
	Unit III: Regulation & Basic Virology	**15 L**	**15**
3.1	**A) Lac operon and problems on Lac operon** **B) Trp operon**	**7 L**	
3.2	**Regulation of lytic and lysogenic pathway of lambda phage**	**3 L**	
3.3	**Viral architecture -** Capsid, viral genome and envelope	**2 L**	
3.4	**Viral classification (Baltimore classification)**	**1 L**	
3.5	**Viral replication cycle** - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release.	**2 L**	

	Unit IV: Advanced Virology	**15 L**	**15**
4.1	Structure of TMV, T4, Influenza virus, HIV. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail**.**	**5 L**	
4.2	**Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue	**3 L**	
4.3	**Visualization and enumeration of virus particles** 4.3.1 Measurement of infectious units 4.3.1.1 Plaque assay 4.3.1.2 Fluorescent focus assay 4.3.1.3 Infectious center assay 4.3.1.4 Transformation assay 4.3.1.5 Endpoint dilution assay. 4.3.2 Measurement of virus particles and their components 4.3.2.1 Electron microscopy 4.3.2.2 Atomic force microscopy 4.3.2.3 Haemagglutination 4.3.2.4 Measurement of viral enzyme activity.	**3 L**	
4.4	**Role of viruses in cancer:** Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus.	**2 L**	
4.5	**Prions:** Defination, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis	**1 L**	
4.6	**Viroids**	**1 L**	

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART - II

(USMB-602)

LEARNING OBJECTIVES

Medical microbiology encompasses the etiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are most common to humans through which the students build on the basic information regarding host defense mechanisms that they have gained in S.Y.B.Sc. an separate unit o chemotherapy that are available for infectious agent and the misuse of antibiotic in generation of multiple resistance strains

Immunology is an integral part of Medical Microbiology and this course is designed for T.Y.B.Sc. Microbiology students on the assumption that the students have achieved a basic understanding of Innate Immunity and Host Defense mechanisms. The course has been designed to help understand the ability of our immune system to defend against invading

pathogens in a logical fashion. This includes our innate ability to defend against microorganisms (innate immunity); should this first line of defense fail, how we can fight infections (acquired immunity); if we react excessively, what price we pay (hypersensitivity); the role of immunoheamatology in blood transfusion and very importantly, can we prevent pathogens from infecting us (vaccination).

LEARNING OUTCOMES:

- Give details of the virulence factors and morphological and cultural features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, and modes of prophylaxis of these diseases
- Given a few key clinical features, identify the likely causative agent.
- Comment on the methods of diagnosis of the disease.
- Understand the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral & Cell Mediated Immunity Acquire an understanding of the role of immune system in disease:
- Understand the activation of complement system
- Apply the concept of immunity to prevention of disease by development of vaccines

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART - II

(USMB-602): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	**15 L**	**15**
1.1 Study of vector-borne infections - Malaria	**2 L**	
1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea	**8 L**	
1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Meningococcal meningitis	**5 L**	

	Unit II: Chemotherapy of Infectious Agents	**15 L**	**15**
2.1	**Attributes of an ideal chemotherapeutic agent** - Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc.	**2 L**	
2.2	**Mode of action of antibiotics on-** 2.2.1 Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems) 2.2.2 Cell Membrane (Polymyxin and Imidazole) 2.2.3 Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) 2.2.4 Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn) 2.2.5 Enzyme inhibitors (Sulfa drugs, Trimethoprim)	**8 L**	
2.3	**List of common antibiotics** - used for treating viral, fungal and parasitic diseases.	**1 L**	
2.4	**Mechanisms of drug resistance** - Its evolution, pathways and origin for ESBL, VRE, MRSA	**3 L**	
2.5	(i) Selection and testing of antibiotics for bacterial isolates by Kirby-Bauer method (ii) Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains	**2 L**	
	Unit III: Immunology – I	**15 L**	**15**
3.1	**T cells** 3.1.1 T Cell Receptor-structure (alpha-beta, gamma-delta TCR) 3.1.2 TCR-CD_3 complex - structure and functions. Accessory molecules 3.1.3 T cell activation 3.1.3.1 TCR mediated signaling – Overview 3.1.3.2 Costimulatory signals 3.1.3.3 Superantigens induced T cell activation 3.1.4 T cell differentiation (Memory and Effector cells)	**4 L**	
3.2	**Cell mediated effector response** 3.2.1 General properties of effector T cells 3.2.2 Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway 3.2.3 Killing mechanism of NK cells 3.2.4 Antibody mediated cell cytotoxicity (ADCC)	**3 L**	
3.3	**B cells** 3.3.1 B cell receptor and co-receptor-structure and function 3.3.2 B cell activation and Differentiation 3.3.2.1 Thymus dependant and independent antigens	**4 L**	

	3.3.2.2 Signal transduction pathway activated by BCR-overview 3.3.2.3 Role T_H cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, T_H cells cytokine signals		
3.4	**Humoral Response** 3.4.1 Primary and secondary responses 3.4.2 In vivo sites for induction of Humoral response 3.4.3 Germinal centers and antigen induced B cell Differentiation 3.4.3.1 Cellular events within germinal centers- Overview 3.4.3.2 Affinity maturation, somatic hyper-mutation and class switching 3.4.3.3 Generation of plasma cells and memory cells	**4 L**	
	Unit IV: Immunology – II	**15 L**	**15**
4.1	**Vaccines** 4.1.1 Active and passive immunization 4.1.2 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines 4.1.3 Use of adjuvants in vaccine 4.1.4 New vaccine strategies 4.1.5 Ideal vaccine 4.1.6 Route of vaccine administration, Vaccination schedule	**7 L**	
4.2	**Immunohaematology** 4.2.1 Human blood group systems, ABO, secretors and non secretors, Bombay Blood group. Rhesus system and list of other blood group systems 4.2.2 Haemolytic disease of new born, Coombs test.	**3 L**	
4.3	**Complement System** 4.3.1 Functions and components of complement 4.3.2 Complement Activation—classical, alternative and lectin pathway 4.3.3 Biological consequences of complement activation	**3 L**	
4.4	**Monoclonal Antibodies** 4.4.1 Production and clinical uses	**2 L**	

MICROBIAL BIOCHEMISTRY: PART-II

(USMB-603)

LEARNING OBJECTIVES

Having studied many aspects of microbial physiology in the earlier semester, contents of this semester is designed to understand how myriad organic compounds such as lipids, carbohydrates, proteins and nucleic acids can be utilized by the living cells. These life mechanisms also reveal how biomolecules are synthesized. Since all biosynthetic pathways are denovo or salvage, the vital regulatory role played by enzymes is understood. Various levels and mechanisms of regulation are dealt to make the learner aware of coordinated mechanisms of metabolism in the living cell. Photosynthesis is studied to understand the diversity in mechanism of its electron transfer, pigments and localization of photosynthetic apparatus, although the energy conservation mechanism is not different. Microorganisms are diverse with respect to their metabolism and the field of lithotrophy explains how some universal inorganic compounds can be used to make constituents of cell biomass yet others use them as electron acceptors or reduced compounds as source of energy.

LEARNING OUTCOMES: At the end of the course in Microbial Biochemistry; USMB 603, the learner will have an understanding of the following metabolic process and their significance.

- Metabolism of Lipids, Fatty acids, Nucleotides and Amino acids
- Catabolism of Protein and aliphatic hydrocarbons
- Regulation of metabolic process at various levels
- Photosynthesis
- Metabolism of inorganic molecules with special reference to nitrate and sulfate
- Biological Nitrogen fixation
- Lithotrophy

At the end of the course the learner will also acquire the following practical skills

- Screening of microorganisms producing lipase, PHB and protease
- Detection of activity of enzymes which play an important role in amino acid and nitrate metabolism
- Quantitative detection of important metabolic products such as protein and uric acid.
- Quantitative detection of an important metabolic enzymes- protease

MICROBIAL BIOCHEMISTRY: PART-II:

(USMB-603): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Lipid Metabolism & Catabolism of Hydrocarbons	**15 L**	**15**
1.1 Introduction to Lipids 1.1.1 Lipids –Definition, classification & functions 1.1.2 Types and role of fatty acids found in bacteria 1.1.3 Common phosphoglycerides in bacteria 1.1.4 Action of lipases on triglycerides /tripalmitate	**2 L**	
1.2 Catabolism of Fatty Acids and PHB 1.2.1 Oxidation of saturated fatty acid by β oxidation pathway 1.2.2 Energetics of β oxidation of Palmitic acid 1.2.3 Oxidation of propionyl CoA by acrylyl- CoA pathway and methylcitrate pathway 1.2.4 PHB as a food reserve and its degradation	**5 L**	
1.3 Anabolism of Fatty Acids & Lipids 1.3.1 Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) 1.3.2 Biosynthesis of phosphoglycerides in bacteria 1.3.3 Biosynthesis of PHB	**6 L**	
1.4 Catabolism of aliphatic hydrocarbons 1.4.1 Organisms degrading aliphatic hydrocarbons 1.4.2 Hydrocarbon uptake mechanisms 1.4.3 Omega oxidation pathway- 1.4.3.1 Pathway in *Corynebacterium* and yeast 1.4.3.2 Pathway in *Pseudomonas*	**2 L**	
Unit II: Metabolism of Proteins and Nucleic Acids	**15 L**	**15**
2.1 Protein / amino acid catabolism 2.1.1 Enzymatic degradation of proteins 2.1.2 General reactions of amino acids catalyzed by 2.1.2.1 Amino acid decarboxylases 2.1.2.2 Amino acid deaminases 2.1.2.3 Amino acid transaminases 2.1.2.4 Amino acid racemases 2.1.3 Metabolic fate of amino acids - Glucogenic and ketogenic amino acids 2.1.4 Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum* 2.1.5 Fermentation of pair of amino acids -Stickland reaction (include enzymes)	**6 L**	

2.2	**Anabolism of amino acids** 2.2.1 Schematic representation of amino acid families 2.2.2 Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine)	**2 L**	
2.3	**Catabolism of Nucleotides** 2.3.1 Degradation of purine nucleotides up to uric acid formation 2.3.2 Salvage pathway for purine and pyrimidine nucleotides	**3 L**	
2.4	**Biosynthesis of nucleotides** 2.4.1 Nomenclature and structure of nucleotides 2.4.2 Role of nucleotides (high energy triphosphates) 2.4.3 Biosynthesis of pyrimidine nucleotides 2.4.4 Biosynthesis of purine nucleotides 2.4.5 Biosynthesis of deoxyribonucleotides	**4 L**	
	Unit III: Metabolic Regulation	**15 L**	**15**
3.1	**Definition of terms and major modes of regulation**	**2 L**	
3.2	**Regulation of enzyme activity** 3.2.1 Noncovalent enzyme inhibition 3.2.1.1 Allosteric enzymes and feedback inhibition 3.2.1.2 Patterns of FBI, combined activation and inhibition 3.2.2 Covalent modification of enzymes 3.2.2.1 Monocyclic cascades 3.2.2.2 Examples of covalent modification(without structures) 3.2.2.3 Regulation of Glutamine synthetase	**5 L**	
3.3	**DNA binding proteins and regulation of transcription by positive & negative control** 3.3.1 DNA binding proteins 3.3.2 Negative control of transcription: Repression and Induction 3.3.3 Positive control of transcription: Maltose catabolism in *E. coli*	**4 L**	
3.4	**Global regulatory mechanisms** 3.4.1 Global control & catabolite repression 3.4.2 Stringent response	**2 L**	
3.5	**Regulation of EMP and TCA cycle -** (Schematic and Regulation of Pryruvate dehydrogenase Complex)	**2 L**	
	Unit IV: Prokaryotic Photosynthesis & Inorganic Metabolism	**15 L**	**15**
4.1	**Photosynthesis** 4.1.1 Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) 4.1.2 Photosynthetic pigments 4.1.3 Location of photochemical apparatus 4.1.4 Photochemical generation of reductant	**4 L**	

4.2 Light reactions in: 4.2.1 Purple photosynthetic bacteria 4.2.2 Green sulphur bacteria 4.2.3 Cyanobacteria (with details)	**3 L**	
4.3 Dark reaction 4.3.1 Calvin Benson cycle 4.3.2 Reductive TCA cycle	**2 L**	
4.4 Inorganic Metabolism 4.4.1 Assimilatory pathways: 4.4.1.1 Assimilation of nitrate, 4.4.1.2 Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase 4.4.1.3 Biological nitrogen fixation (Mechanism for N_2 fixation and protection of nitrogenase) 4.4.1.4 Assimilation of sulphate 4.4.2 Dissimilatory pathways: 4.4.2.1 Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*) 4.4.2.2 Sulphate as an electron acceptor	**5 L**	
4.5 Lithotrophy–Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron.	**1 L**	

BIOPROCESS TECHNOLOGY: PART-II (USMB-604)

LEARNING OBJECTIVES

Bioprocess Technology II is designed to develop the learner's ability to study the techniques use in the downstream process used for the final product and industrial effluent treatment.

Bioprocess technology II becomes an important application based paper covering microbial fermentations as well as applying the techniques of molecular biology to enzyme technology, animal tissue culture as well as plant tissue culture. Thus, it becomes a laboratory to market scenario where the entire products reach. The learner is provided with the details of productions of important products like antibiotics, vitamins, organic acid, amino acids and mushrooms along with the analysis techniques using various instruments and bioassays.

The learner is expected to learn the need of 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 both the science and business aspects to be achievable to make a viable product and enhance their enterpreunial skills.

LEARNING OUTCOMES:

- Understand the actual process involved in fermentations of important products.
- To apply the knowledge of applications of animal and plant tissue culture techniques.
- Learn the applications of immobilized enzymes in various fields.
- Understand the working of important instruments used in biochemical analysis and bioassay.
- Learn the salient features of quality management and regulatory procedures.

At the end of the course the learner will also acquire the following practical skills

- Techniques involved in running a bioassay, immobilization of cells & sterility testing
- Preliminary techniques in animal & plant tissue culture.

BIOPROCESS TECHNOLOGY: PART-II

(USMB-504): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Downstream Processing	**15 L**	**15**
1.1 Recovery and purification 1.1.1 Introduction 1.1.2 Methods of DSP: Precipitation, Filtration, Centrifugation, Cell Disruption, Liquid-Liquid Extraction, Solvent Recovery, Chromatography, Membrane Processes, Drying, Crystallization, Whole Broth Processing	**10 L**	
1.2 Effluent treatment – Introduction, Dissolved oxygen concentration as indicator of water quality, The strength of fermentation effluents, Treatment process (Physical, chemical and biological)	**5 L**	
Unit II: Advances in Bioprocess Technology	**15 L**	**15**
2.1 Animal biotechnology 2.1.1 Primary cell culture and established cell lines 2.1.2 Basic principles 2.1.3 Growth media 2.1.4 Cell viability 2.1.5 Scale up of cultured cells and tissue 2.1.6 Applications of cell culture: Vaccines, somatic cell fusion, valuable products.	**5 L**	
2.2 Plant tissue culture 2.2.1 Introduction	**5 L**	

2.2.2 Requirements for in vitro culture, Methods of plant cell and tissue culture 2.2.3 Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropogation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization**.** 2.2.4 Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance, micropropogation, secondary metabolites from cell culture, transgenic plants for crop improvement **2.3 Immobilized enzyme and cells** 2.3.1 Introduction and Definitions 2.3.2 Methods 2.3.3 Immobilized Enzyme Reactors 2.3.4 Applications	**5 L**	
Unit III: Quality Assurance, Quality Control, Instrumentation and Bioassay	**15 L**	**15**
3.1 Quality assurance and quality control 3.1.1 Definitions, Chemical and pharmaceutical products 3.1.2 Variables of batch process 3.1.3 Q.A and Q.C wrt.- Raw materials, method of manufacturing, in process items, finished products, label and labeling, packaging materials 3.1.4 Control of microbial contamination during manufacturing	**4 L**	
3.2 Sterilization control and assurance	**2 L**	
3.3 Instrumentation: Principles, working and application of 3.3.1 Spectrophotometry: UV, Visible & IR 3.3.2 AAS & AES (Flame photometry)	**3 L**	
3.4 Bioassay 3.4.1 Introduction 3.4.2 Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic	**3 L**	
3.5 Intellectual property rights 3.5.1 Genesis, Role of WTO and TRIPS 3.5.2 Overview of patent system 3.5.3 Requirements for patentability 3.5.4 Patent Categories 3.5.5 Preliminary steps for patent applications 3.5.6 Patent Procedures 3.5.7 For biotech and microbiological products	**3 L**	

	Unit IV: Industrial Fermentations	**15 L**	**15**
4.1	**Penicillin and semisynthetic penicillins:** Introduction, biosynthesis and regulation, strain development, production methods. Semisynthetic penicillins: Examples, production, advantages	**3 L**	
4.2	**Aminoglycoside: Streptomycin:** Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery.	**3 L**	
4.3	**Vitamin B $_{12}$:** Occurrence and economic significance,structure, biosynthesis, production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas,* recovery.	**2 L**	
4.4	**Citric acid:** Introduction, strains used for production, biosynthesis, nutrient media, production processes- surface and submerged, product recovery.	**3 L**	
4.5	**Glutamic acid:** Production strains, biosynthesis, effect of permeability on production, conditions of manufacturing, production process and recovery.	**2 L**	
4.6	**Mushroom cultivation (Agaricus):** Edible mushroom species, preparation of substrate- composting- phase I and phase II, Factors affecting composting, preparation of spawn, casing, induction of fruiting body formation, harvesting	**2 L**	

T.Y.B.Sc. MICROBIOLOGY PRACTICALS (SEMESTER-VI)

Course Code: USMBP07

[Practicals Based on USMB601, Credits -1.5, Lectures- 60, Notional Periods-15]

1. Isolation of genomic DNA of *E. coli* and measurement of its concentration by UV-VIS.
2. Enrichment of coliphages, phage assay (pilot & proper).
3. Restriction digestion of lambda phage /any plasmid DNA (Demo)
4. Beta galactosidase assay
5. Bioinformatics practicals

   On Line Practical

   i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained

   ii. Visiting & exploring various databases mentioned in syllabus and

      a. Using BLAST and FASTA for sequence analysis

      b. 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)

c. Six frame translation of given nucleotide sequence
d. Restriction analysis of given nucleotide sequence
e. Pair-wise alignment and multiple alignment of a given protein sequences
f. Formation of phylogenetic tree

6. Animal cell culture (Demo)

Course Code: USMBP07
[Practicals Based on USMB602, Credits -1.5, Lectures-60, Notional Periods-15]

1. Demonstration of malarial parasite in blood films (Demo)
2. Selection and testing of antibiotics using the Kirby-Bauer method
3. Determination of MBC of an antibiotic.
4. Blood grouping – Direct & Reverse typing
5. Coomb's Direct test
6. Determination of Isoagglutinin titer
7. Demonstration experiments - Widal, VDRL

Course Code: USMBP08
[Practicals Based on USMB603; Credits-1.5, Lectures- 60, Notional Periods-15]

1. Detection of PHB producing bacteria
2. To study catabolite repression by diauxic growth curve.
3. Protein estimation by Lowry's method
4. Estimation of uric acid
5. Qualitative and Quantitative assay of Protease
6. Qualitative detection of Lipase
7. Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity
8. Study of Lithotrophs – Nitrosification and Nitrification

Course Code: USMBP08
[Practicals Based on USMB604, Credits -1.5, Lectures- 60, Notional Periods-15]

1. Bioassay of an antibiotic (Ampicillin / Penicillin)
2. Bioassay of Cyanocobalamin.
3. Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count.
4. Plant tissue culture – Callus culture (Demo).
5. Sterility testing of injectable.
6. Chemical estimation of Penicillin
7. Estimation of phenol.
8. Industrial Visit

TEXT BOOKS AND REFERENCE BOOKS

(SEMESTER VI)

Course Code: USMB601

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
7. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
8. Teri Shors,.(2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
10. Robert Weaver, (2008), "Molecular biology", 3rd edition, Mc Graw Hill international edition.
11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th edition, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd Edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.
14. A textbook of biotechnology R.C.Dubey 4 th edition. S.Chand.

Reference books:

1. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edition. ASM press.
2. T. K. Attwood & D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education
3. Benjamin Lewin, (9 th edition), "Genes IX", Jones and Bartlett publishers.
4. JD Watson, "Molecular biology of the gene", 5th edition.

Course Code: USMB602

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017

3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria Dannessa Delost 2015
6. Prescott's microbiology 10th edition 2017
7. Kuby Immunology,4th and 6th edition, W H Freeman and Company
8. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
9. Fahim Khan, Elements of Immunology, Pearson Education

Reference books / Internet references:

1. Baron Samuel , Medical Microbiology, 4th edition
http://www.ncbi.nlm.nih.gov/books/NBK7627/
2. Kuby Immunology, 7th Edition, W H Freeman and Company
http://www.macmillanlearning.com/catalog/static/whf/kuby/

Course Code: USMB603

Text books:

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. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry, 4th edition, W. H. Freeman and Company.
6. G. Moat, J.W. Foster, M,P. Spector.(2002), Microbial Physiology, 4th edition, WILEY-LISS
7. Madigan, M.T. and J.M. Martinko2006. [11th edition] Brock Biology of Microorganisms. Pearson Prentice Hall.

Reference books:

1. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
3. Principles of Biochemistry, Lehninger, 5th edition, W. H. Freeman and Company

Course Code: USMB604

Text books

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd Edition (2017) "Principles of Fermentation Technology"
4. H. K. Das., "Text book of Biotechnology", 2nd and 3rd edition.
5. A textbook of biotechnology R.C.Dubey 4 th edition. S.Chand.
6. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India
7. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
8. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
9. Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
10. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th Edition, McMillan Publishers.
11. Veerakumari L. "Bioinstrumentation", MJP Publisher
12. Pharmaceutical Microbiology, Hugo and Russell, 7th edition, Blackwell Science.

Reference books

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Williams, Bryan L; Wilson, 2nd edition." A Biologist's guide to principles and techniques of practical biochemistry" Baltimore: University Park Press, 1981.
3. Wilson, Keith, 1936-; Goulding, Kenneth H, 3rd edition., A Biologist's guide to principles and techniques of practical biochemistry" London ; Baltimore : E. Arnold, 1986.
4. Wilson and Walker, "Principles and techniques of practical biochemistry" 5th edition.

Modality of Assessment
Assessment pattern for theory

Scheme of Examination

The learner's Performance shall be assessed by conducting the Semester End Examinations with 100% marks

Semester End Theory Assessment - 100% **100 marks**

1. Duration - These examinations shall be of **3 hours** duration.
2. Theory question paper pattern :-
   i. There shall be **five questions** each of **20** marks (with internal options)
   ii. Question one will be based on unit one, question two on unit two, question three on unit three and question four on unit four. Question five will have questions from all four units of the syllabus.
   iii. Each of the main questions one to four will be subdivided into two sub-questions "A" and "B". Sub-question "A" will have four questions (of 6 marks each) out of which any two will be attempted. Total marks allotted to sub-question "A" will be 12 marks. Sub-question "B" will be 'Do as directed (attempt eight out of twelve)'. Each question in Sub-question "B" will be of one mark each. Total marks allotted to "B" sub-question will be 8 marks. Main question five will have six questions (of 5 marks each) out of which any four will be attempted, total 20 marks.
   iv. All questions shall be **compulsory** with internal choice within the questions.
   v. The allocation of marks will depend on the weightage of the topic.

Passing Standard:

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course and 40% marks in **Semester End Examination (i.e. 40 out of 100) separately**, to pass the course and **minimum of Grade E** in each project, wherever applicable, to pass a particular semester.

Practical Examination Pattern:

External (Semester end practical examination):-

Sr.No.	Particulars/ paper	Marks
1.	Laboratory work	40
2.	Journal	05
3.	Viva	05

Semester V:

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 the Head of the Department / Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Semester VI

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 the Head of the Department/ Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course code	Practical Syllabus	Credits & lectures
USMBP05	Based on USMB501 and USMB502 of Semester V	Credits 3 (8 periods/week) = 120 periods/semester
USMBP06	Based on USMB503 and USMB504 of Semester V	Credits 3 (8 periods/week) = 120 periods/semester

Semester V

Course	USMB-501	USMB-502	USMB-503	USMB-504	Grand Total
Theory	**100**	**100**	**100**	**100**	**400**
Practicals	**50**	**50**	**50**	**50**	**200**

Semester VI

Course	USMB-601	USMB-602	USMB-603	USMB-604	Grand Total
Theory	**100**	**100**	**100**	**100**	**400**
Practicals	**50**	**50**	**50**	**50**	**200**

T.Y.B.Sc. Microbiology Practicals: Semester-V

Course code	Practical Syllabus	Credits & lectures
USMBP05	Based on USMB501 and USMB502 of Semester V	Credits 3 (8 periods/week) = 120 periods/semester
USMBP06	Based on USMB503 and USMB504 of Semester V	Credits 3 (8 periods/week) = 120 periods/semester

T.Y.B.Sc. Microbiology Practicals: Semester-VI

Course code	Practical Syllabus	Credits & lectures
USMBP07	Based on USMB601 and USMB602 of Semester VI	Credits 3 (8 periods/week) = 120 periods/semester
USMBP08	Based on USMB603 and USMB604 of Semester VI	Credits 3 (8 periods/week) = 120 periods/semester

COURSE WISE CREDIT ASSIGNMENT UNDER THE FACULTY OF SCIENCE

Program: B.Sc.
Course: Microbiology (USMB)

Course wise credit assignments under the faculty of science Type of Courses / Credits Assigned	**First Year (Credit x No. of Courses)**		**Second Year (Credit x No. of Courses)**		**Third Year (Credit x No. of Courses)**		**Total Credit Value**
	First Semester	**Second Semester**	**Third Semester**	**Fourth Semester**	**Fifth Semester**	**Sixth Semester**	
Core Courses (Theory)	04x03	04x03	06x02	06x02	2.5x04	2.5x04	68
Core Courses (Practicals)	02x03	02x03	03x02	03x02	1.5x04	1.5x04	36
Foundation course	02x01	02x01	02x01	02x01			08
Applied Component Courses (Theory)					02x01	02x01	04
Applied Component Courses (Practical)					02x01	02x01	04
Total	**20**	**20**	**20**	**20**	**20**	**20**	**120**

Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR
ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL
(AUTONOMOUS)

Re-accredited 'A^{+}' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: B.Sc.

Revised Syllabus of T.Y.B.Sc. (Applied Component Biotechnology) Microbiology

Choice Based Credit, Grading and Semester System

w.e.f. Academic Year 2020-21

PREAMBLE OF THE SYLLABUS

With the introduction of Academic autonomy by the esteemed Changu Kana Thakur Arts, Commerce and Science College, New Panvel from the academic year 2019-2020, the existing syllabus of T.Y.B.Sc. (Applied Component Biotechnology) Microbiology is restructured according to the CBCS pattern for its implementation from 2019-2020. This syllabus is prepared to make students more skilled in the applied aspects of microbiology and biotechnology. The new and updated syllabus is based on interdisciplinary approach with vigour and depth. The contents have been drawn to accommodate the widening horizons of the microbial techniques. It reflects the changing needs of the students, pertaining to the fields of Plant biotechnology, Bioremediation, Animal Biotechnology, Industrial biotechnology, Marine Biotechnology, Bioenergy, Healthcare biotechnology and Molecular Techniques. The well-organized curricula including basic as well as advanced concepts in the Microbiology shall inspire the students for pursuing higher studies in Microbiology and for becoming an entrepreneur and also enable students to get employed in the Microbiology subject based industries.

OBJECTIVES TO BE ACHIEVED:-

- To enrich students' knowledge and train them in the microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate sense of scientific responsibilities and social and environment awareness.
- To enhance the employability of learners.
- To help students build-up a progressive and successful care

T. Y. B. Sc.
Choice Based credit system
Biotechnology (Applied Component) Syllabus for B. Sc degree in Microbiology
(To be implemented from the academic year 2020-2021)
Semester V

Introduction to Biotechnology				
		Semester V		
Course code	**Unit**	**Topic**	**Credits**	**Lectures/ Week**
USc5Mi5	I	Basic Techniques in biotechnology	2	4
	II	Bioremediation in Biotechnology		
	III	Animal Biotechnology		
	IV	Industrial and Marine Biotechnology		
USc5Mi PAC		Practical Based on USc5Mi5	2	4

SEMESTER VI

Applied Biotechnology				
		Semester VI		
Course code	**Unit**	**Topic**	**Credits**	**Lectures/ Week**
USc6Mi5	I	Role of Biotechnology in Society	2	4
	II	Bioenergy and Biofuels		
	III	Plant Biotechnology		
	IV	Healthcare Biotechnology		
USc6 Mi PAC		Practical based on USc6Mi5	2	4

N.B.

I. Each theory period shall be of 48 minutes duration. Theory component shall have 60 instructional periods plus 60 notional periods per semester which is equal to 96 learning hours. For theory component the value of one credit is equal to 48 learning hours.

II. Each practical period shall be of 48 minutes duration. Practical component shall have 60 instructional periods plus 15 notional periods per semester which is equal to 60 learning hours. For Practical component the value of one credit is equal to 30 learning hours.

LEARNING OBJECTIVES:

Topics included in this semester aim:

- To revise and impart to the students, knowledge of the basic techniques of biotechnology with respect to gene cloning and cloning vectors.
- To give the students an overview of bioremediation of soil, water and the different methods of using genetically engineered microbes and plants.
- To provide a basic insight into the methods of generating transgenic animals and study their applications.
- To give an insight into the role of microorganisms in industrial and marine biotechnology.

Learning outcome:

- Students will become competent by gaining knowledge of bioremediation, industrial production and animal biotechnology which will enhance their chances for employment and for further education.
- The students will acquire knowledge to carry out techniques in biotechnology and will understand the applications of transgenic animals and the methods used for obtaining transgenic animals.

	Introduction to Biotechnology **Course code :** USc5Mi5 (2 Credits)		
	Semester V		
Unit	**Topic**	**Lec/ topic**	**Lecture/ Sem**
I	**Basic Techniques in Biotechnology** Biophysical techniques A. Principle and application of 1. Electrophoretic techniques: Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis, 2-D, PFGE 2. Spectrophotometric Techniques (Principle, Ray diagram, Applications): UV/Visible, AAS, NMR, ESR, X-ray diffraction B. Molecular Techniques: a. DNA sequencing methods b. Microarray c. GISH and FISH	05 06 04	15L
II	**Bioremediation in Biotechnology :** 2.1 Introduction and Types of reaction in Bioremediation. 2.2 Biodegradation of pesticides and herbicide 2.3Bioremediation of contaminated soil and waste water. 2.4Bioremediation using genetically engineered microbes(GEM) 2.5Higher plants in Bioremediation : Phytoremediation 2.6Transgenic plants for phytoremediation 2.7 Bioremediation market	02 03 02 02 02 02 02	15L
III	**Animal Biotechnology :** **3.1 Transgenic Mice** : Methodology: The retroviral Vector method, The DNA microinjection method, The engineering embryonic stem cell method, Genetic modification with the Cre-lox P recombination system , RNA interference, , Transgenesis with high capacity vectors. **3.2 Transgenic mice applications**: Transgenic disease models: Alzheimer disease, Using Transgenic mice as test systems, Conditional regulation of transgene expression, Conditional control of cell death.	07 08	15L
IV	**Industrial and Marine Biotechnology:** **4.1 Industrial Biotechnology**: • Synthesis of Novel Antibiotics – Engineering polykatid antibiotics, peptide antibiotics • Production of SCP – Yeast, Spirulina, Mushroom • Production of Biopolymers – Biogums, Biopolysaccharides, Bioplastic. **4.2** 4.2 **Marine Biotechnology:** • Bio-prospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms • Methods for Microbial Bio-prospecting in Marine Environments. Biotechnological Potential of Marine Microbes • Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges • Marine Bio-resources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids, Cosmetics from Marine Sources, Marine Drugs, Marine Microbial Enzymes, Marine Drugs as Pharmaceuticals.	7 L 8L	15L

References:

- Banwell, C.N. and McCash, E.M., 2012, *Fundamentals of Molecular Spectroscopy*, 4th Ed., New Delhi, Tata McGraw Hill Education Pvt. Ltd.
- Upadhyay, Upadhyay and Nath, 2012, *Biophysical Chemistry: Principles and Techniques*, Mumbai, Himalaya Publishing House
- *Analytical Chemistry by Open Learning Series*, 2008, New York, John Wiley and Sons.
- Braun R. , Introduction to Instrumental Analysis, New York, McGarw Hill Book Company
- Skoog, Holler and Nieman, Principles of Instrumental Analysis, 5th Ed. Australia, Thomson Brock/Cole
- Elements of Biotechnology: 2009 PK Gupta, Rastogi Publications Edition 2nd ,
- Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition.
- Primrose and others. Principles of Gene manipulations. 7th edition. 2004 Blackwell Science.
- Peter J. Russell 2006, "Genetics-A molecular approach", 3rd edition.
- R. C. Bubey. A Texy book of Biotechnology. 2006 S. Chand and Company Ltd.
- B. D. Singh. Biotechnology. Kalyani Publishers.
- Prescott and Dunn's „"Industrial Microbiology"""1982 4th Edition, McMillan Publishers
- Marine biotechnology in the twenty-first century-Problems, promise, and products, National academy press •

PRACTICALS BASED ON USc5Mi PAC

1. Gel electrophoresis of DNA
2. Isolation of genomic DNA (bacterial / yeast or onion)
3. Enrichment and isolation of Sulphate reducing bacteria
4. Isolation and identification of *Bacillus thuringenesis*
5. Determination of COD and BOD of sewage sample /Industrial Effluent
6. Production of Biopesticide
7. Production of Microbial polysaccharide and determination of yield.
8. Cultivation of Edible mushroom
9. Isolation of marine microbial flora

SEMESTER VI

LEARNING OBJECTIVES:

- Aims at imparting knowledge on recent trends in plant and healthcare biotechnology.
- Aims at highlighting the significance of bioenergy and biofuel
- Create awareness of the importance of Biotechnology in society

LEARNING OUTCOME:

- Students will be trained to address issues of Bioenergy and Bio fuels
- They will be skilled to respond to issues related to genetic engineering in plant biotechnology.
- The learner will be able to comprehend details of the role of biotechnology in society

	Applied Biotechnology Course code : USc6Mi5 Credits 02		
	Semester VI		
Unit	**Topic**	**Lec/ topic**	**Lecture /sem**
I	**Role of Biotechnology in Society** 1.1 Benefits of Biotechnology. 1.2 ELSI of Biotechnology 1.3 Recombinant therapeutic product for human healthcare 1.4 Genetic modification and food consumption 1.5Recombinant food and religious beliefs 1.6 Are Genetically Modified Food is safe? 1.7 Release of genetically engineered organisms 1.8Application of Human genetic r-DNA research 1.9Human embryonic stem cell research 1.10 Organ cloning 1.11 Biotechnology and the developing countries 1.12 Patenting Biotechnology Invention	15	15L
II	**Bioenergy and Biofuel** **2.1Bioenergy** a) Energy consumption Worldwide b) Energy consumption in India c) Solid biomass resources and dedicated energy crops d) Greenhouse gases and Kyoto protocol e) Bioenergy for Sustainable Development **2.2Biofuel** a) Liquid biofuels: Bio-diesel, Bio-ethanol, Bio-oils b) Gaseous Biofuels: Biogas, Bio hydrogen c) Fossil fuels: The nonrenewable sources of energy d) Renewable and C-Neutral bioenergy e) Biomass production and its utilization for bioenergy 2.3 **Benefits and problems** a) - in production and use of biofuels	07L 07L 01L	15L

III	**Plant Biotechnology** **3.1 Genetic engineering of Plants** a) Plant transformation with Ti plasmids of *A.tumefaciens*, b) Ti plasmid derived vector systems, c) physical methods of transferring genes to plants. **3.2Uses of genetically engineered plants**: a) To overcome Biotic and abiotic stress: b) Insect resistance: Increasing expression of the *B.thuringiensis* protoxin, other strategies for protecting plants against insects, c) preventing the development of *Bacillus thuringeinsis* resistant insects, d) Herbicide resistant plants e) Oxidative stress, f) Salt and drought stress, g) Modification of plant nutritional content: Vitamin A	 06L 09L	15L
IV	**Healthcare Biotechnology** a) Branches within healthcare biotechnology b) Animal and human health care c) Genetic Counseling d) Forensic medicine	 03 04 04 04	15L

References:

- Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition.
- Bioenergy and biofuels: Ozcan Konur, CRC Press, Edition 1st 2018
- Elements of Biotechnology, 2009 P K Gupta, Second Revised Edition , Rastogi Publications .
- Vault Career guide to Biotechnology (E-Book)
- Biotechnology 2004 U. Satyanarayana , Books and Allied (P) Ltd.

PRACTICALS BASED ON USc6Mi PAC

1. Test for reducing sugars.
2. Bioethanol production from biomass.
3. Isolation of Cellulase producing microorganisms and determination of Cellulase activity
4. Plant tissue culture Callus formation.
5. Immobilization of *Sacchromyces cerevisiae* using alginate and invertase assay
6. Visit to PTC and ATC Facility
7. Case Studies

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XXXXX

Modality of Assessment

Internal assessment

a) Theory 25 Marks

No.	Evaluation type	Marks
1	One class test (multiple choice questions/objective and subjective /long answers)	20
2	Active participation in routine class instructional deliveries(case studies/seminar/presentation)	05

B) External examination-75%

Semester End Theory Assessment -75% ` 75 marks

Duration – These examinations shall be of two and half hours duration.

Theory question paper pattern:-

1. There shall be five questions of 15 marks each.
2. On each unit there will be one questions & fifth question will be based on all the four units.
3. All questions shall be compulsory with internal choice within the questions.
4. All questions will be of 30 marks with internal options.
5. Questions 1, 2, 3, and 4 will be subdivided into a) Subjective question (2 out of 4) for 10 marks and b) Objective questions (5 out of 10) for 5 Marks.
6. Question no. 5 will be subjective (3 out of 6) for 15 marks.
7. The allocation of marks depends on the weightage of the topic.

Practical Examination pattern

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.

The practical examination will be conducted in one day with 6 hrs of work or in two days with 3 hrs of work each day.

One examiner and one expert will be appointed from college for each batch by the principal / Head of the department.

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

Semester V:

Course : USc5 Mi PAC	Marks Assigned
Lab work Major practical (30 Marks) Minor Practical (20 Marks)	50
Assignment on Bio-pesticide production	10
Case study on Mushroom cultivation	10
Quiz	10
Viva-voce	10
Journal	10
Total Marks	100

Semester VI:

Course : USc6 Mi PAC	Marks Assigned
Lab work Major practical (30 Marks) Minor Practical (20 Marks)	50
Visit Report	10
Case study Report	10
Quiz	10
Viva-voce	10
Journal	10
Total Marks	100