S. P. Mandal's

Kankavli College, Kankavli

(Affiliated to University of Mumbai)

Department of Microbiology

SYLLABUS AND PROGRAMME / COURSE OUTCOMES

(B. Sc. F. Y. /S. Y. /T. Y.)

Academic Year 2021-2022

Sr. No	Program	Program code	Course code	Course Name (Title)
1.	**F. Y. B. Sc. (I sem)**	1S00141	USMB 101	Fundamentals of Microbiology
			USMB 102	Basic Techniques in Microbiology
			USMBP 01	Practical Based on USMB 101and USMB 102
2.	**F. Y. B. Sc. (II sem)**	1S00142	USMB 201	Basics of Microbiology
			USMB 202	Exploring Microbiology
			USMBP 02	Practical Based on USMB 201and USMB 202
3.	**S. Y. B. Sc. (III sem)**	1S00143	USMB 301	Microbial Diversity, Microbial Taxonomy & Instrumentation
			USMB 302	Environmental Microbiology
			USMB 303	Metabolism & Biology Of Macromolecules
			USMBP 03	Practical based on above three courses
4.	**S. Y. B. Sc. (IV sem)**	1S00144	USMB 401	Medical Microbiology & Immunology
			USMB 402	Industrial, Food & Dairy Microbiology
			USMB 403	Molecular Biology & Enzymology
			USMBP 04	Practical based on above three courses
5.	**T. Y. B. Sc. (V sem)**	1S00145	USMB 501	Microbial Genetics
			USMB 502	Medical Microbiology & Immunology :Part-I
			USMB 503	Microbial Biochemistry : Part I
			USMB 504	Bioprocess Technology & Environmental Microbiology.
			USMBP 05	Practical Based on USMB 501 and USMB 502
			USMBP 06	Practical Based on USMB 503 and USMB 504
6.	**T. Y. B. Sc. (VI sem)**	1S00146	USMB 601	r-dna Technology, Bioinformatics & Virology
			USMB 602	Medical Microbiology & Immunology: Part II
			USMB 603	Microbial Biochemistry : Part II
			USMB 604	Applied And Industrial Microbiology
			USMBP 07	Practical Based on USMB 601 and USMB 602
			USMBP 08	Practical Based on USMB 603 and USMB 604

SYLLABUS AND PROGRAMMME / COURSE OUTCOMES

S. P. Mandal's
KANKAVLI COLLEGE,KANKAVLI
(Affiliated to University of Mumbai)
Syllabus

Programme: B. Sc. F.Y. **Course: Microbiology**

Program Code:1S00141 and 1S00142 **Course Code:** USMB 101, 102 and USMB 201, 202

(As per the Credit Based Semester and Grading System with effect from the academic year 2016-17)

Year :2020-21 **Semester : I & II**

Programme Outcomes:

Continuous flow of information and latest advances in the subject imparted to the students. The syllabus have been upgraded in order to bridge the knowledge gap of the learner 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. The students after successful completion of B. Sc. Microbiology are able to understand the very nature of the subject and can apply the knowledge to overcome the problems and issues related to health, environment, pollution and other socioeconomic problems. The students are equipped with the problem solving ability and generate the innovative ideas to cope with any condition which affects the globe. The students are trained to take up the self-employment and by that way become job provider, entrepreneurs and not job seekers. They develop the ability to work collaboratively, can take up the higher studies provide the consultancies in the field of agriculture, may become academician, and take up the higher research.

Course Outcomes:

USMB-101 FUNDAMENTALS OF MICROBIOLOGY.

The concepts of Biosafety, Validation, Calibration and SOPs have been introduced to make the learners aware about:-

1. The biological hazards and safety measures
2. Importance of Validation and Calibration of Scientific equipment in industries and laboratories
3. Writing of SOPs for instruments and their importance at work. The unique chemistry of living systems results in large part from the remarkable and diverse properties of Bio macromolecules.
4. Macromolecules from each of the four major classes may act individually in a specific cellular process, whereas others associate with one another to form supramolecular structures.
5. All of these structures are involved in important cellular processes.
6. Since the arrival of information technology, biochemistry has evolved from an interdisciplinary role to becoming a core program for a new generation of interdisciplinary courses such as bioinformatics and computational biochemistry. Hence the module of macromolecules has been included in the revised syllabus to teach students the structure and function of biomolecules at an entry level with an objective to raise the student's awareness of the applicability of microcomputers in biochemistry as they go to the higher classes

USMB-102 BASIC TECHNIQUES IN MICROBIOLOGY

The concepts of Microscopy, staining, control of microorganisms, cultivation isolation and preservation is to make learners understand about the following

1. To understand the techniques about microscopy
2. Importance of microscopy in industries and laboratories
3. Study of control of microbes by physical and chemical agents
4. To study the Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors.
5. Revised syllabus to teach students the microscopy, control, objective to raise the student's awareness of the applicability of its knowledge as they go to the higher classes

Programme Specific Outcome (Semester II):

USMB-201 BASICS OF MICROBIOLOGY.

1. To study different groups of micro organisms
2. To study and understand the Classification, Morphological characteristics, cultivation, reproduction and significance of microbes
3. To study microbial growth and to understand and apply its application in breed count Petroff – Hausser counting chamber- Haemocytometer.
4. To study the methods of Counting viable non-culturable organisms
5. Revised syllabus to teach students the classification morphology, microbial growth count to raise the student's awareness of the applicability of its knowledge as they go to the higher classes

USMB-202 EXPLORING MICROBIOLOGY.

1. To study different types of microbial interactions and their interaction with human body
2. To understand and study Microbial associations with vascular plants
3. To study and understand the mechanism of Host defense against infection
4. To study the methods of Counting viable non-culturable organisms
5. Revised syllabus of Advance Techniques In Microbiology & Instrumentation is to teach students and raise the student's awareness of the applicability of its knowledge as they go to the higher classes

SYLLABUS

SEM-I

USMB-101 FUNDAMENTALS OF MICROBIOLOGY.

Unit-I 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 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 vesiclese. Nucleoid, Plasmids f. Bacterial endospores and their formation

---

Unit-II Eukaryotic Cell Structure

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.

Definitions of Lysosome, Endocytosis, Phagocytosis,Autophagy, Proteasomee. Eucaryotic ribosomesf. Mitochondriag. Chloroplastsh. Nucleus –Nuclear Structurei. External Cell Coverings: Cilia And Flagella j. ComparisonOf Prokaryotic And Eukaryotic Cells

2.2Biosafety 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.

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 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.

USMB-102 Theory BASIC TECHNIQUES IN MICROBIOLOGY.

Unit-I Microscopy & Staining

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)

Unit-II Control Of Microorganisms

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)

Unit-III Microbial Nutrition, Cultivation, Isolation& Preservation

3.1 Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors.**3.2** Nutritional types of microorganisms. **3.3** Types of Culture media with examples. **3.4** Isolation of microorganisms and pure culture techniques. **3.5** Preservation of microorganisms **3.6** Culture Collection Centres

USMBP-1: SECTION-1 : FUNDAMENTALS OF MICROBIOLOGY

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:
9. Assignment: Eukaryotic organelles

Unit-III

10. Qualitative detection :
11. Carbohydrates- Benedicts, Molisch's test.
12. Proteins, amino acids- Biuret, Ninhydrin.
13. Nucleic acid detection by DPA and Orcinol

SECTION-2 BASIC TECHNIQUES INMICROBIOLOGY.

Unit I

1. Parts of a microscope,
2. Micrometry
3. Dark field and Phase contrast : Demonstration
4. Monochrome and differential staining procedures, Gram staining& Negative Staining.

Unit II

5. Introduction to Laboratory equipments, disinfection & discarding techniques in laboratory
6. Methods of preparation of glassware for Sterilization (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)
7. Effect of UV Light, Desiccation, surface tension, Osmotic Pressure, heavy metals(Oligodynamic action)
8. Effect of dyes, phenolic compounds and chemotherapeutic agents(disc inhibition method)
9. Evaluation of Disinfectant by Coupon Method

Unit-III

10. Preparation of Culture Media:
a. Liquid medium(Nutrient Broth)
b. Solid Media(Nutrient agar,Sabourauds agar)
c. Preparation of slant ,butts & plates
11. Inoculation techniques and Study of Growth: a. Inoculation of Liquid Medium b. noculation 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)
12. Use of Differential & Selective Media: (MacConkey & Salt Mannitol Agar)
13. Determination of Optimum growth conditions: a)Temperature, b) pH
14. Methods of Preservation of culture

SEM II

USMB-201 Theory BASICS OF MICROBIOLOGY.

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

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

Unit-III Microbial Growth:

3.1a. Definition of growth, Mathematical Expression, Growth curve
b. Measurement of growth
c. Direct microscopic count – Breed's count, Petroff – Hausser counting 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

USMB-202 EXPLORING MICROBIOLOGY.

Unit-I Microbial Interactions:

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:

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. **2.2 Factors affecting infection:** Microbial factors: adherence, invasion, role of virulence factors in invasion, 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

3.1 Electron Microscope:TEM,SEM,
3.2 Contrast enhancement for electron microscope
3.3 Fluorescent Microscope, Confocal Microscope
3.4pH 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.

USMBP-2: PRACTICALS: SECTION-1 BASICS OF MICROBIOLOGY.
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
9.Use of standard buffers for calibration and determination of pH of a given solution
10.Determination of λRmax & 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 Microbiology laboratory in a research Institute

SECTION-2 EXPLORING MICROBIOLOGY.
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 ƛRmax & 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 Microbiology laboratory in a research Institute

REFERENCES:

USMB 101 & USMB 201

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. International edition 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:
USMB 102& USMB 202

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.

: Question Paper Pattern :

(A) Semester End Theory Assessment - 100 Marks

i. Duration - These examinations shall be of 3 Hours duration.
ii. Theory question paper pattern:
1. There shall be four questions. On each unit there will be one question with 25 Marks each & fourth one will be based on all the three units with 25 Marks.
2. All questions shall be compulsory with internal choice within the questions.
Question 1 (Unit-I), Question 2 (Unit-II) & Question 3 (Unit-III) & Question 4 (combined units) will be of 50 Marks with internal options.
3. All Questions may be sub divided into sub questions of five marks objective questions and twenty marks of short or long questions of 5 to 10 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	40 + 40 =	80
2.	Journal	05 +05 =	10
3.	Viva	05 + 05 =	10

S.P.Mandal's
KANKAVLI COLLEGE,KANKAVLI
(Affiliated to University of Mumbai)

Syllabus

Programme: B. Sc. S. Y. **Course:** Microbiology
Program Code:1S00143 and 1S00144 **Course Code:** USMB301 to 303 and 401 to 403
(As per the Credit Based Semester and Grading System with effect from the academic year 2015-16)

Year : 2020-21 **Semester : III and IV**

Course Outcomes:

SEM III

USMB 301(Biomolecules and Microbial taxonomy)

1. Understand Macromolecular composition of a microbial cell, methods of elemental analysis, estimation of Proteins, amino acids, carbohydrates and nucleic acid.
2. Understand nucleic acid structure, chemistry, function of nucleotides and structure of chromosome.
3. Understand microbial taxonomy, Numerical Taxonomy, Methods of analysis used in classification: Phenotypic analysis (Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Fatty acid analysis), Amino acid sequencing, phylogenetic analysis.

USMB 302 (Environmental Microbiology)

1. Understand Air Microbiology, Sampling Devices for the Collection of Air Samples , Air Quality Standards
2. Understand fresh Water and Sewage Microbiology, water purification, water quality standards and pathogens transmitted through water, Modern Waste Water treatment.
3. Understand soil and Geo Microbiology, Terrestrial Environment, Methods of studying soil microorganisms, Biogeochemical Cycles.

USMB 303 (Introduction to Clinical Microbiology)

1. Understand Morphology and Physiology of Bacteria, Culture Methods, Culture Media and Bacterial Growth, Bacterial Taxonomy
2. Understand Common infectious diseases, Epidemiology and create awareness of Public health.
3. Understand Physical and chemical agents for Microbial Control.
4. Understand Recombinant DNA Technology, applications of Genetic Engineering and Bioinformatics databases.

SEM IV

USMB 401 (Metabolism & Basic Analytical Techniques)

1. Understand Metabolic pathways, Metabolic pathways.
2. Understand enzyme kinetics and concept of coenzyme.
3. Understand analytic techniques like chromatography, centrifugation and electrophoresis

USMB 402(Applied Microbiology)

1. Understand innate immunity and immune system, Epidemiology of infectious diseases.
2. Understand Food Microbiology, General Principles of Food Preservation, methods of microbial examination of foods.
3. Understand Pasteurization & Ultra-pasteurization, Fermented milk: Yogurt, cultured buttermilk and fermented milk in India, Microbiological Quality of Milk & Milk Products.

USMB 403 (Advances and Applications of Microbiology and Soft Skills)

1. Understand the concept of Nanobiotechnology, types of nanomaterials, and application in drug and gene delivery.
2. Understand application of Biosensors and biofilms.
3. Understand the Perception of Research, how to write scientific information, and learn to use biostatistical tests.
4. Understand different types of Biofertilizer, application of Biofertilizer.
5. Understand types of Biopesticides, formulations of Biopesticides.
6. Understand the principle of Bioremediation, factors affecting Bioremediation, advantages and disadvantages of Bioremediation

SYLLABUS

SEM-III

USMB301: Microbial Diversity, Microbial Taxonomy & Instrumentation

Unit I Biodiversity In Extreme Environments

1.1 Extreme Environments and their types with respect to the physical conditions which lead to microbial stress. (05L) a) Temperature based environments- Low and high temperature environments b) pH based environments- Acidic and alkaline environments, Acid mine drainage. c) Environments with high salt concentration. 1.2 Microbial Physiology of the extremophiles (05L) a) Examples of extremophiles in each environment with their morphology and cultural characteristics. b) Physiology of the extremophiles in each environment. c) Molecular adaptations of the extremophiles 1.3 Applications of extremophiles (05L) a) Applications of Acidophiles and Alkalophiles b) Applications of halophiles- in biotechnology and medicine c) Applications of psychrophiles in pharmaceuticals and environment. d)Applications of thermophiles and hyperthermophiles in enzymologys

Unit II Microbial Taxonomy

Microbial Taxonomy 2.1 Introduction to microbial Taxonomy (01L) 2.2 Taxonomic ranks (01L) 2.3 Techniques for determining Microbial Taxonomy and Phylogeny (05L) a)Microscopic & macroscopic morphology and biochemical characteristics,(b) Chemical Analysis,(c) Serological analysis,(d) Genetic & molecular analysis:-(i) RNA sequencing and finger printing,(ii) G+C

content,(iii) DNA sequencing,(iv) DNA-DNA hybridization 2.4 Phylogenetic Trees (02L) (a) Types,(b) Construction (an overview) 2.5 Numerical Taxonomy (03L) (a) Grouping by numerical methods of taxonomic units, (b) Phylogenetic inferencess 2.6 Bergey's Manual of Systematic Bacteriology (03L)

Unit III Instrumentation In Microbiology

3.1 Spectroscopic techniques: (03L) a) Visible and UV spectrophotometry i) Principles ii) Instrumentation iii) Applications 3.2 Electrophoretic techniques: a) General Principles (01L) b) Factors affecting electrophoresis (01L) c) Low voltage thin sheet & high voltage electrophoresis i) Materials (02L) ii) Apparatus and methods d) Gel electrophoresis (01L) i) Materials ii)Apparatus and methods 3.3 Chromatographic Techniques: (03L) a) General principles and techniques b) TLC c) Paper chromatography 3.4 Centrifugation techniques: (04L) a) Basic principles of sedimentation b) Types of centrifuges and their use (Give an overview) i) Small bench centrifuges ii) Large capacity refrigerated centrifuges iii) Small high speed refrigerated centrifuges iv) Continuous slow refrigerated centrifuges v) Preparative centrifuges vi) Analytical ultracentrifuges

USMB302 Environmental Microbiology

Unit I Air & Fresh Water Microbiology

1.1 Air Microbiology: (05 L) a) Origin, distribution, number and kinds of microorganisms in air , Factors affecting microbial survival in air b) Enumeration of microorganisms in air : Impingement in liquids ,Impaction on solids ,Filtration, Sedimentation ,Centrifugation ,Electrostatic Precipitation. c) Air borne pathogens and diseases, droplets and droplet nuclei d) Air sanitation-methods and application 1.2 Fresh water microbiology: (10 L) a) General: Hydrologic cycle, groups of natural waters, factors affecting kinds of microorganisms found in aquatic environments and nutrient cycles in aquatic environments b) Fresh Water environments and microorganisms found in Lakes , ponds, rivers, marshes, bogs and springs c) Potable water: Definition, water purification and pathogens transmitted through water. d) Microorganisms as indicators of water quality e) Bacteriological examination of water-sampling, routine analysis, SPC, membrane filter technique

Unit II Marine & Sewage Microbiology

2.1 Marine Microbiology: (05 L) a. Characteristics of marine environments b. Marine microbial characteristics and their importance c. Ecosystems of Deep sea Hydrothermal vents and Subterranean Water 2.2 Sewage Microbiology: (10 L) a. Types of waste water b. Characteristics of waste water c. Modern waste water treatment: Primary, Secondary and tertiary treatment. d. Removal of pathogens by sewage treatment Processes e. Sludge Processing f. Oxidation Ponds, Septic tanks g. Disposal of Solid Waste, Modern Sanitary Landfills, Composting

Unit III Soil & Geo Microbiology

3.1 Terrestrial environment: (03 L) a) Soil – Definition, composition, function ,Textural Triangle b) Types Of Soil microorganisms & their activities 3.2 Methods of studying soil microorganisms: (5L) Sampling , Cultural methods , Physiological methods , Immunological methods , NA based methods ,Radioisotope techniques 3.3 Biogeochemical Cycles : (05 L) Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle 3.4 Soil Bioremediation:

USMB303 Metabolism & Biology Of Macromolecules

Unit I Introduction To Metabolism & Enzymes

1.1 Nutrition of bacteria: (01 L) 1.2 Major & minor bioelements (01 L) 1.3 Survey of metabolism: (07 L) a) Participation of living organisms in carbon & oxygen cycle b) Nitrogen cycle in the biospherec c) Promotion of metabolic pathways by sequential enzyme systems d) Metabolism-Catabolism & Anabolism e) Catabolic pathways converge to a few end products f) Biosynthetic pathways diverge to yield many products g) Important differences between catabolic & anabolic pathways h) ATP as a carrier of energy from catabolic to anabolic reactions i) NADPH as a carrier of reducing power j) Cell metabolism-an economical tightly regulated process k) Secondary metabolism l) Compartmentalization of metabolic pathways in cells 1.4 Introduction to enzymes: (06L) a) General properties of enzymes b) How do enzymes accelerate reaction c) Rate law for a simple catalysed reaction, Michaelis-Menten equation and it's derivation d) Classification of enzymes

Unit II Principles Of Bioenergetics

Principles of Bioenergetics 2.1 Bioenergetics & thermodynamics: (06L) Energy transformations, thermodynamic quantities, standard – free energy, difference between ΔG &ΔGo' 2.2Structure of ATP, phosphoryl group transfer and (05L) ATP,Types of energy –rich compounds, multi-roles of ATP, inorganic phosphoryl group donor 2.3 Biochemical & chemical reactions, Biological oxidationreduction reaction

Unit III Estimation Of Biomolecules

3.1 Estimation of Biomolecules (15 L) a) Macromolecular composition of a microbial cell b) Methods of elemental analysis: Carbon by Slyke's method Nitrogen by Microkjelhdahl method. Phosphorus by Fiske-Subbarow method c) Estimation of Carbohydrates by Phenol and Anthrone method Estimation of Reducing Sugars by DNSA method Detection of Sugars by Aniline-Pthalate method d) Estimation of Proteins by Biuret method Estimation of Amino acids by Ninhydrin method e) Extraction of Lipids by Soxhlet method f) Extraction of Nucleic acids g) Estimation of Nucleic acids by DPA and Orcinol method

USMBP3 Practical based on above three courses

Section I

1) Enrichment and isolation of Thermophiles and Acidophiles from hot water springs of Vajreshwari/Pali 2) Enrichment and isolation of Psychrophiles from refrigerator swabs/ soil obtained from ice factories/cold storages
3) Enrichment and isolation of Halophiles from marine water
4) Construction of phylogenetic tree on the basis of given data
5) Identification of an organism using Bergey's Manual.(Characteristics to be given)
6) Isolating an organism from soil and identifying the same on the basis of "Classical Characteristics"(Bacillus spp.)
7) Paper Chromatography
8) TLC
9) Verification of Beer and Lambert's Law
10) Demonstration of Agarose gel electrophoresis

Section II

1.Enumeration of microorganisms in air and study its load after fumigation
2. Routine analysis of water 3. Rapid detection of E.coli by MUG technique-Demo

4. Visit to Sewage treatment plant
5. Microbiological analysis of waste water by SPC
6.Total Viable count of Soil Flora
7. Enrichment and isolation of Cellulose degraders ,Sulphate reducers and Phosphate solubilisers
8 Winogradsky Column

Section III

1.Problems on Thermodynamics/ Bioenergitics
2.Qualitative reactions of carbohydrates
3.Estimation of total carbohydrates by anthrone method
4.Estimation of reducing sugars by DNSA method
5.Qualitative reactions of amino acids & proteins
6.Estimation of proteins by biuret, Robinson Hogden method
7.Study of hydrolytic enzymes: Lipase, Casease, Amylase(Isolation)

References Course: USMB301

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. Prescott's Microbiology,8th edition,J.M.Willey,L.M.Sherwood&C.J.Woolverton,McGraw-Hill International Edition 4. General Microbiology,Stanier,4th edition 11
5. A biologist's guide to Principles and techniques of practical Biochemistry, 3rd edition, Wilson and Goulding
6. Practical Biochemistry (Principles & Techniques),Ed.Keith Wilson & John Walkar,5th Edition,Cambridge University Publication Course:

USMB302

1. Fundamental Principles of Bacteriology By A.H.Salle 7th edn, McGRAW-Hill Book Company
2. Prescott, Harley and Klein's Microbiology : 7th Edition ; Willey, Sherwood and Woolverton ,Mc Graw Hill International Edition
3. Microbiology,Michael J. Pelczar Jr., E.C.S. Chan ,Noel R. Krieg,5th Edition,McGraw Hill Education (India) Pvt.Ltd.
4. Microbiology:Application Based Aspproach,MichaelJ.Pelczar Jr.,E.C.S.Chan,Noel R.Krieg,1st Edition (2010),Tata McGraw Hill
5. Methods of studying soil microbial diversity, Journal of Microbiological Methods 58 (2004) 169 – 188 Jennifer L et al.
6.Introduction to Environmental Microbiology-By Barbara Kolawzan,Adamiak et al (2006)
7.Environmental Microbiology by R.M.Maier.I.L.Pepper&C.P.Gerba (2010),Academic Press

Course: **USMB303**

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,ConnP.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

SEM-IV

USMB401 Medical Microbiology & Immunology

Unit I Innate Immunity & Immune System

Innate Immunity & Immune System 1.1 Basic concepts in Immunology-Introduction (01L) 1.2 Principals of Innate & adaptive immunity-Primary, Secondary & Tertiary Barriers (02L) 1.3 Components of the immune system-Cells and organs of the immune system (03L) 1.4 Phagocytosis and inflammation-Mechanisms and link to immunity (03L) 1.5 Pattern recognition in innate immune system-PAMPs, PRRs, TLRs (03L) 1.6 The Complement System-Alternative and Lectin Pathways, evolution of Classical Pathway (03L)

Unit II Epidemiology Of Infectious Diseases

The Epidemiology of Infectious Disease: 2.1 Epidemiological Terminology : Epidemiology, sporadic disease, endemic disease, hyper endemic disease, epidemic disease, index case, pandemic disease, outbreak (01L) 2.2 Development of Disease (02L) 2.3 Epidemiological Methods (02L) 2.4 Patterns of infectious disease in a population (02L) 2.5 The spread of infection: a) Reservoirs of infection –human reservoirs, animal reservoirs, non-living reservoirs (01L) b) Transmission of disease- Contact transmission, Vehicle transmission, Vectors (01L) 2.6 Nosocomial Infections: Microorganisms in the hospital, compromised host, chain of transmission , control of nosocomial infections (02L) 2.7 Public Health Measures for the Control of Disease: Controls directed against the Reservoir, Controls Directed against Transmission of the Pathogen, Immunization, Quarantine, Surveillance, Pathogen Eradication (02L) 2.8 Emerging and Re-emerging Infectious Diseases (02L)

Unit III Diagnostic & Clinical Microbiology

Diagnostic And Clinical Microbiology 3.1 Overview of the Clinical Microbiology Laboratory: (01L) 3.2 Isolation of Pathogens from clinical specimens: (04L) a) Growth media and Culture b) Collection of specimens, handling and transport c) Types of specimens and their culture --- Blood, Urine, Faeces, sputum, Cerebrospinal fluid, pus, genital and culture of Anaerobes. 3.3 Identification of microorganisms from specimens: (02L) a) Microscopy b)Growth-Dependent Identification Methods 3.4 Rapid Methods of Identification3.5 Bacteriophage Typing (02L) 3.6 Molecular Methods and Analysis of Metabolic Products: (04L) a) Nucleic Acid –Based Detection Methods b) Gas liquid Chromatography c) Plasmid Fingerprinting

USMB402 Industrial, Food& Dairy Microbiology

Unit I Industrial Microbiology

Industrial Microbiology: 1.1 Strains of industrially important microorganisms: (04L) a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary screening. 1.2 Types of fermentations: (02L) a).Aerobic, b) Anaerobic and c) Solid state fermentations. 1.3 Types of fermentation processes: (02L) a. Surface and Submerged, b. Batch, continuous, fed-batch fermentation process 1.4 Media for industrial fermentations: (05L) a. Production and Inoculum media b. Media components :- Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers.[crude media-from Patel] 1.5 Inoculum development: (02L)

Unit II Food Microbiology

2.1Introduction: Significance, food as a substrate and sources: (01 L) 2.2 Microbial growth in foods: (02L) 2.3 Intrinsic and extrinsic factors: (01L) 2.4 General Principles of spoilage: Spoilage of fresh foods: fruits and vegetables, eggs, meat, poultry and seafood: (04L) 2.5General principles of food preservation (principle of each method and example of foods only): High temperature, low temperature, drying, radiations and food additives and preservatives (tabular representation), Asepsis with introduction to HACCP. Food borne diseases and intoxications: (04L) 2.6Methods of detection of microorganisms in food: overview of cultural, microscopic, physical, chemical and bioassay methods: (03L)

Unit III Dairy Microbiology

3.1 Milk- Definition ,composition,Sources of contamination of milk: (02L) 3.2 Pasteurization of milk-LTLT, HTST method: (03L) 3.3. Milk products:- production and spoilage of a Yoghurt (02L) b Butter (02L) c Cheese-Cheddar and Cottage cheese (02L) d Fermented milks (01L) 3.4. Quality control of milk s(03L) a. Rapid platform test b. Microbiological analysis of milk.:- SPC, Coliform count, LPC, Psychrophiles, Thermophilic count, DRT

USMB403 Molecular Biology & Enzymology

Unit I Nucleic Acid Chemistry & Structure

(F.Y.BSc: Revision of nucleic acid) 1.1 DNA can occur in different 3D forms,DNA sequences adopt unusual structures 1.2 Many RNAs have complex 3D structures 1.3 Nucleic acid chemistry 1.4 Denaturation of double helical DNA and RNA 1.5 Nucleic acid from different species can form hybrids 1.6 Nucleotides and nucleic acids undergo non enzymatic transformations,DNA methylation 1.7 Functions of nucleotides 1.8 Structures of chromosomes

Unit II Central Dogma, Genetic Code, Transcription & Translation In Prokaryotes

2.1 Pathways for transfer of genetic information: a) RNA biosynthesis, prokaryotic transcription apparatus, prokaryotic promoters, Initiation, elongation and termination of transcription (07 L) b) Translation: components of protein synthesis apparatus Genetic code, mRNA, Ribosomes, Protein synthesis

Unit III Enzymology

(Kinetics and purification of enzymes) 3.1 Enzymatically catalysed reactions exhibit saturation kinetics Effect of temperature and pH (07L) Effect of Inhibitors- Reversible and irreversible, competitive, Non competitive and uncompetitive inhibitors Allosteric effects in enzyme catalysed reactions Multisubstrate reactions- Ordered, Random and pingpong reactions Koshland-Nemethy and Filmer model Monod, wyman and Cahngux model 3.2 Coenzymes: Different types and reactions catalyzed by coenzymes (in tabular form), (04L) Water soluble coenzymes (NAD, Nicotinic acid) Fat soluble vitamins and their examples. 3.3 Working with proteins: (04L) Separation and purification of proteins Separation and characterization of proteins by electrophoresis Quantification of unseparated proteins

USMBP4 Practical based on above three courses

Section-I (Practicals based on USMB401)

1. Differential staining of Blood by the Field's staining method
2.Isolation of organisms from fomites:TableTops,FingerTips,Mobile Phones
3. Use of Selective and Differential Solid Media: Mac Conkeys agar, SS agar, XLD agar, TCBS agar, SIBA, Salt Mannitol agar, CLED agar, Hoyle's tellurite agar
4.Use of Biochemical Media/Tests for Identification of Pathogens: Carbohydrate fermentation, Indole test, Methy Red test,VoguesProskauer test, Citrate Utilization, Lysine Decarboxylase, Gelatin Liquefaction, Nitrate Reduction, Phenylalanine deaminase test, Urease test, TSI agar, Oxidase test, Catalase test, Bile solubility test, Coagulase test, Optochin test and Bacitracin test.
5. Rapid Identification of a Pathogen using a Kit: eg. The API 20 E system, Entero tube Multitest system (Demonstration)

Section-II (Practicals based on USMB402)

1. Isolation of antibiotic producers from soil.
2. Auxanography
3.Isolation of food spoilage agent
4.Determination of TDT and TDP
5.Determination of Salt and sugar tolerance Determination of MIC of a preservative
6. Visit to Food/Dairy industry
7. Rapid platform tests of raw and pasteurized milk.
8. Microbiological analysis of raw and pasteurized Milk. 9.Microbiological analysis of Butter, Chees

Section-III (Practicals based on USMB403)

1.Isolation of DNA from onion
2.Estimation of DNA by DPA method
3. Estimation of RNA by Orcinol method.
4.Enzyme production (Invertase)
5.Purification of enzyme: salt precipitation and desalting proteins by Dialysis
6.Determination of Km of Invertase (Lineweaver-Burke plot, MichaelisMenten graph)
7.Effect of variables on enzyme activity (Temp, pH, Enzyme concentration)

: Question Paper Pattern :

B) External examination - 75 % Marks Semester End Theory Assessment - 75% 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 15 marks.
2. All questions shall be compulsory with internal choice within the questions. Question 1(UnitI),Question 2 (Unit-II) & Question 3 (Unit-III) will be of 40 marks with internal options. Question 4 will be of 30 marks with internal options.
3. Questions 1,2 & 3 may be sub-divided into two sub-questions such as (a):-(i),(ii),(iii) & (iv) each carrying 06 marks(subjective type) AND (b):-(i),(ii),(iii),(iv),(v),(vi),(vii) & (viii) each carrying 02 marks (objective type) and the allocation of marks depends on the weightage of the

topic. Question 4 may be subdivided into sub questions a,b,c,d,e& f each carrying five marks (subjective type).

PRACTICAL EXAMINATION PATTERN

(A) Internal Examination:- There will not be any internal examination/ evaluation for practicals.

(B) External (Semester end practical examination) :- 50 Marks Per Section (Section-I based on course-1, Section-II based on course-2 & Section-III based on course-3)

Sr. No.	Particulars	Marks	Total
1.	Laboratory work	40+40+40 =	120
2.	Journal	05+05+05 =	15
3.	Viva	05+05+05=	15

S.P.Mandal's

KANKAVLI COLLEGE,KANKAVLI

(Affiliated to University of Mumbai)

SYLLABUS

Programme: B. Sc. T. Y. **Course:** Microbiology

Program Code:1S00145 and 1S00146

Course Code: USMB 501, USMB502, USMB503, USMB504 and USMB601, USMB602, USMB603, USMB604

(As per the Credit Based Semester and Grading System with effect from the academic year 2016-2017)

Year : 2020-21 **Semester : V and VI**

Course Outcome:

USMB-501(Microbial Genetics)

1. Understand the molecular mechanism involved in DNA replication
2. Understand how to identify and classify mutations in DNA followed by mechanism of DNA repair
3. Understand basic concepts of homologous recombination and genetic exchange among prokaryotes
4. Understand natural plasmids and transposons present in prokaryotes
5. Understand an account of prokaryotic gene structure and the mechanisms controlling gene expression

USMB-502 (Medical Microbiology &Immunology: Part-I)

(Medical Microbiology)

1. Give details of the virulence factors and other features of the pathogen
2. Correlate these virulence factors with the pathogenesis and clinical features of the disease
3. Comment on the mode of transmission, epidemiology and therefore modes of prophylaxis of these diseases
4. Given a few key clinical features, identify the likely causative agent.
5. Comment on the methods of diagnosis of the disease.

(Immunology)

6. Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens
7. Discuss the role of antigen in initiating the immune response
8. Correlate the structure & functions of immunoglobulin
9. Understand the importance of all the other entities involved i.e. T cells, B cells, NK cells, APCs, Cytokines, MHC, TCR, BCR, Co-receptors, Signaling pathways etc

USMB-503 (Microbial Biochemistry: Part-I)

1. Understand the architecture of the membrane and how solute is transported inside the cell.
2. Describe and explain the electron transport chains in prokaryotes and mitochondria and understand the mechanism of ATP synthesis

3. Explain bioluminescence mechanism and its significance
4. Discuss the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
5. Describe various other pathways which produce different end products.
6. Describe anabolic reactions in carbohydrate synthesis.
7. Apply the concepts of energetics and catabolism in biodegradation of various substrates.

USMB-504 (Bioprocess Technology & Environmental Microbiology)

1. Describe the applications of microbes and its strain improvement in Industrial Microbiology.
2. Apply kinetic formula to determine growth and productivity parameters of batch and continuous fermentations
3. Describe the design of bioreactors for different applications and its process parameters
4. Design media, growth conditions and techniques for producing and recovering different types of products of commercial value
5. Design an industrial process by keeping in view the strict guidelines for its recovery & disposal
6. Learner will be well –versed with the environmental aspects such as carbon credits & containment levels.
7. Learn to develop the corrective measures for dealing with the environmental pollution and its consequences.

SEM-VI

USMB-601(rDNA Technology, Bioinformatics & Virology)

1. Understand the basic concepts and techniques of recombinant DNA technology
2. Understand the basic concepts of Bioinformatics.
3. Understand the basic structure, classification, , enumeration, cultivation and life cycle of viruses
4. Understand the terms like cancer, prions, viriods and their mechanism
5. Understand regulation of lambda phage

USMB-602 (Medical Microbiology & Immunology: Part-II)

Medical Microbiology:

1. Give details of the virulence factors and other features of the pathogen
2. Correlate these virulence factors with the pathogenesis and clinical features of the disease
3. Comment on the mode of transmission, epidemiology and therefore modes of prophylaxis of these diseases
4. Given a few key clinical features, identify the likely causative agent

Immunology:

5. Understand the effector responses- Humoral Immunity & Cell Mediated Immunity and differentiate between them
6. Acquire an understanding of the role of immune system in disease: o Unregulated response resulting in Hypersensitivity
7. Understand the mechanism of Antigen-Antibody interaction & it's significance in diagnosis
8. Apply the concept of immunity to prevention of disease by development of vaccines

USMB-603 (Microbial Biochemistry: Part-II)

1. Understand the reactions involved in metabolism of lipids and hydrocarbons.
2. Describe and explain protein catabolism as well as anabolic processes in the cell.
3. Explain nucleic acid metabolism and recycling of nucleotides.
4. Discuss the mechanism of regulation with regards to allosteric proteins, gene expression as well as through other mechanisms like end product inhibition and covalent modification
   Describe prokaryotic photosynthesis with respect to photosynthetic pigments, photochemical apparatus and light and dark reactions
   Describe metabolism of inorganic compounds and Lithotrophy.

USMB-604 (Applied & Industrial Microbiology)

1. Understand the actual process involved in fermentations of important products.
2. To apply the knowledge of applications of animal and plant tissue culture techniques.
3. Learn the applications of enzymes in various fields.
4. Understand the working of important instruments used in biochemical analysis and also learn to analyze the results using statistical tools.
5. Learn the salient features of quality management and regulatory procedures.
6. Understand the commercial and economic aspects of applied microbiology.

SYLLABUS

SEM –V

USMB501 MICROBIAL GENETICS

Unit I DNA Replication

1.1. Historical perspective— conservative, dispersive, semi-conservative, Bidirectional and semidiscontinuous 1.2. Prokaryotic DNA replication – Details of molecular mechanism involved in Initiation, Elongation nd Termination 1.3. Enzymes and proteins associated with DNA replication-primase, helicase, topoisomerase, SSB, DNA polymerases, ligases, Ter and Tus proteins 1.4. Eukaryotic DNA replication-- Molecular details of DNA synthesis, replicating the ends of the chromosomes 1.5. Rolling circle mode of replication

Unit II Mutation And Repair

2.1. Mutation 2.1.a.Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes 2.1.b. Fluctuation test. 2.1.c. 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. 2.1.d. Causes of mutation: Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for – i. Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. ii. Physical mutagen iii. Biological mutagen (only examples) 2.1.e. Ames test 2.1.f. Detection of mutants 2.2. DNA Repair a. Mismatch repair, b. Light repair c. Repair of alkylation damage d. Base excision repair e. Nucleotide excision repair f. SOS repair

Unit III Homologous Recombination &Genetic Exchange

3.1. Gene transfer mechanisms in bacteria& homologous recombination 3.1.a. Transformation i. Introduction and History ii. Types of transformation in prokaryotes--Natural transformation in Streptococcus pneumoniae, Haemophilusinfluenzae, and Bacillus subtilis iii. Mapping of bacterial genes using transformation. iv. Problems based on transformation. 3.2.b. Conjugation i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sex factor iii. The conjugation machinery iv. Hfr strains, their formation and mechanism of conjugation v. F' factor, origin and behavior of F' strains, Sexduction. vi. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). vii. Problems based on conjugation 3.3.c.Transduction i. Introduction and discovery ii. Generalised transduction iii. Use of Generalised transduction for mapping genes iv. Specialised transduction v. Problems based on transduction 3.4. Recombination in bacteria 3.4.a. General/Homologous recombination i. Molecular mechanism ii. Holliday model of recombination b. Site –specific recombination

Unit IV Plasmids, Transposons & Operons

4.1.Plasmids a. Physical nature b.Detection and isolation of plasmids c. Plasmid incompatibility and Plasmid curing d. Cell to cell transfer of plasmids e. Types of plasmids i. Resistance Plasmids, ii. Plasmids encoding Toxins and other Virulence characteristics iii. col factor iv. Degradative plasmids

4.2.Transposable Elements in Prokaryotes a. Insertion sequences b. Transposons i. Types ii. Structure and properties iii. Mechanism of transposition iv. Transposon mutagenesis c. Integrons 4.3. Lac operon and problems on Lac operon Trp operon

USMB502 MEDICAL MICROBIOLOGY & IMMUNOLOGY : PART-I

Unit I Bacterial Strategies For Evasion And Study Of A Few Diseases

1A. Study of virulence mechanisms in bacteria 1.1. Identifying bacteria that cause disease 1.2. Genomics and bacterial pathogenicity 1.2.1. The clonal nature of bacterial pathogens 1.2.2. Mobile genetic elements 1.2.3. Pathogenicity islands 1.3. Bacterial virulence factors 1.3.1. Adherence factors 1.3.2. Invasion of host cells and tissues 1.3.3. Toxins 1.3.3.1. Exotoxins 1.3.3.2. Exotoxins associated with diarrhoeal diseases and food poisoning 1.3.3.3. LPS of gram negative bacteria 1.3.4. Enzymes 1.3.4.1. Tissue degrading enzymes 1.3.4.2. IgA1 proteases 1.3.5. Antiphagocytic factors 1.3.6. Intracellular pathogenicity 1.3.7. Antigenic heterogeneity 1.3.8. The requirement for iron 1.3.9. The role of biofilms1B. Study of A Few Infectious Diseases of the Respiratory Tract with Emphasis on Cultural Characteristics of the Aetiological Agent, Pathogenesis & clinical features, Laboratory Diagnosis And Prevention 1.1. S. pyogenes infections 1.2. Diphtheria 1.3. Common cold 1.4. Tuberculosis 1.5. Pneumonia caused by K .pneumoniae

Unit II Study Of A Few Diseases With Emphasis On Cultural Characteristics Of The Aetiological Agent, Pathogenesis, Laboratory Diagnosis And Prevention

2.1 Study of skin infections 2.1.1 Leprosy 2.1.2 Fungal infections- Oral Thrush 2.1.3 Pyogenic skin infections caused by Pseudomonas and S. aureus. 2.2 Study of gastrointestinal tract infections 2.2.1 Enteric fever- Salmonella 2.2.2 Shigellosis 2.2.3 Rotavirus diarrhoea 2.2.4 Dysentery due to Entamoebahistolytica 2.2.5 Infections due to Enteropathogenic E.coli strains 2.3 Study of urinary tract infections

Unit III General Immunology-I

3.1. Antigens 3.1.1.Immunogenicity versus antigenicity 3.1.2.Factors that influence immunogenicity – foreignness, molecular size, chemical composition, heterogenicity, ability to be processed and presented, contribution of the biological system to immunogenicity – genotype of the recipient, animal, immunogen dosage, route of administration and adjuvants 3.1.3.Epitopes / antigen determinants (only concepts) 3.1.4.Haptens and antigenicity 3.1.5.Immunogenicity of some natural substances – native globular proteins, polysaccharides, lipids, nucleic acids Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens 3.2. Immunoglobulins 3.2.1. Immunoglobulins – basic and fine structure 3.2.2.Immunoglobulin classes and biological activities 3.2.3.Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes 3.2.4.Immunoglobulin Superfamily3.2.5.Monoclonal antibodies, Production (Diagrammatically) & applications 3.3. T Cells, B cells and NK Cells 3.4. Antigen presenting cells Antigen presentation- professional and nonprofessional cells and processing pathways, (Cytosolic and Endocytic pathway)

Unit IV General Immunology-II

4.1. Cytokines 4.1.1. Properties and functions 4.1.2. Cytokines secreted by Th1 and Th2 cells 4.2. MHC complex and MHC molecules 4.2.1. Structure of class I, and class II molecules; class III

molecules 4.2.2. Peptide – MHC interaction 4.3. T cells 4.3.1. Receptors, structure (alpha-beta, gamma-delta TcR) 4.3.2. TcR-CD3 complex structure & functions. Accessory molecules. 4.3.3. Subsets of T cells (Th1, Th2, T reg) 4.3.4. T cell activation, Costimulatory molecules, T cell differentiation (memory & effector cell) 4.4. B cells 4.4.1. Receptors----structure & organization 4.4.2. B cell activation and differentiation – i)Thymus dependent and independent antigens, ii) B cell activating signals, iii) Role of Th cells in Humoral response, formation of T – B conjugates, CD40 / CD40L interaction, Th cell cytokine signals.

USMB503 MICROBIAL BIOCHEMISTRY : PART- I

Unit I Biological Membranes & Transport

1.1 Composition and architecture of membrane 1.1.1. Lipids 1.1.2. Integral & peripheral proteins & interactions with lipids 1.1.3. Permeability and outer membrane- a barrier 1.1.4. Aquaporins 1.1.5. Mechanosensitive channels 1.2 Methods of studying solute transport 1.2.1. Using whole cells 1.2.2. Using Liposomes 1.2.3. Using Proteoliposome 1.3 Solute transport across membrane 1.3.1. Passive transport facilitated by membrane proteins. 1.3.2. Transporters grouped into Superfamilies 1.3.3. Co transport across plasma membrane (Uniport, Antiport, Symport) 1.3.4. Active transport & electrochemical gradient 1.3.5. Ion gradient provides energy for secondary activetransporteg. Lactose transport 1.3.6. ATPases and transport 1.3.7. ABC transporters e.g. Histidine transport 1.3.8. Shock sensitive system – Role of binding proteins e.g. Maltose uptake 1.3.9. Phosphotransferase system 1.3.10.Schematic representation of various Membrane transport mechanisms in E. coli 1.4 Other examples of solute transport- 1.4.1. Iron transport : A special problem 1.4.2. Bacterial protein export 1.4.3. Bacterial membrane fusion central to many biological processes

Unit II Bioenergetics & Bioluminescence

2.1. Biochemical mechanism of generating ATPSubstrate level, Oxidative, and Photo Phosphorylation 2.2 Electron transport chain 2.2.1. Universal Electron acceptors that transfer electrons to ETC. 2.2.2. Carriers in ETC i. Hydrogen carriers – Flavoproteins, Quinones ii. Electron carriers – Iron sulphur proteins, Cytochromes 2.2.3. Mitochondrial ETC i. Biochemical anatomy of mitochondria ii. Complexes in Mitochondrial ETC iii.Schematic representation of Mitochondrial ETC 2.3 Prokaryotic ETC 2.3.1. Organization of electron carriers in bacteria 2.3.2. Generalised electron transport pathway in bacteria 2.3.3. Different terminal oxidases 2.3.4. Branched bacterial ETC 2.3.5. Pattern of electron flow in E. coli - aerobic and anaerobic 2.3.6. Pattern of electron flow inAzotobactervinelandii 2.4. ATP synthesis 2.4.1. Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential 2.4.2. Free energy released during electron transfer from NADH to O2. 2.4.3. Chemiosmotic theory 2.4.4. Structure & function of Mitochondrial ATP synthase (No Kinetics) 2.4.5. Mechanism by Rotational catalysis 2.4.6. Structure of bacterial ATP synthase 2.4.7. Inhibitors of ETC, Inhibitors of ATPase, Uncouplers, Ionophores 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, Significance, Function as proton pump, 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

Unit III Methods Of Studying Metabolism Equipment And Control:

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 i. Pulse labeling ii. Assay & study of radiorespirometry – to differentiate EMP & ED 3.1.5. Use of biochemical mutants. 3.1.6. Sequential induction technique 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 pathwaysi. Glycolysis (EMP) ii.HMP Pathway & Significance of the pathway iii. ED pathway, iv. TCA cycle & Significance of the cycle v. Anaplerotic reactions vi. Glyoxylate bypass, vii. Incomplete TCA in anaerobic bacteria 3.3 Amphibolic role of EMP and TCA cycle 3.4 Energetics of Glycolysis, ED and TCA pathway – Balance sheet only(No efficiency calculation)

Unit IV Fermentative Pathway& Anabolism Of Carbohydrates

4.1 Fermentative pathways (With structures and enzymes) 4.1.1. Lactic acid fermentation – i. Homofermentors ii. Heterofermentors iii. Bifidobacterium pathway (Schematic) 4.1.2. Alcohol fermentation i. by ED pathway in bacteria ii. by EMP in yeasts 4.2 Other modes of fermentations in microorganisms 4.2.1. Mixed acid, 4.2.2. Butanediol 4.2.3. Butyric acid 4.2.4. Butanol-acetone 4.2.5. Propionic acid (Acrylate pathway and succinate propionate pathway) 4.3 Anabolism of Carbohydrates 4.3.1. General pattern of metabolism leading to synthesis of a cell from Glucose 4.3.2. Gluconeogenesis (Mitochondrial aspect not included) 4.3.3. Biosynthesis of Glycogen 4.3.4. Biosynthesis of Peptidoglycan

USMB504 BIOPROCESS TECHNOLOGY & ENVIRONMENTAL MICROBIOLOGY.
Unit I Upstream Processing
1.1 Strain Improvement of industrial microorganisms Selection of induced mutants Selection of mutants with altered permeability Isolation of mutants not producing Feed Back Inhibitors or Feed Back repressors (All Methods –Only one example) Use of auxotrophs for production of primary metabolites. Example aspartate family. Isolation of mutants that do not recognize the presence of inhibitors & repressors with example (Gradient plate –Lysine) Isolation of auxotrophic mutants example-(PenicillinDavies technique &Minaturized tech) Isolation of induced mutants for secondary metabolites. Isolation of resistant mutants. Isolation of revertant mutants. 1.2 Sterilization Introduction. Media sterilization (Concept of nabla factor), Design of batch sterilization. Methods of batch sterilization,- Design of continuous sterilization, Methods – Heat

Unit II Fermenter Equipment And Control:

2.1.Design of fermenter Scale Up, Basic functions of fermenter,- Aseptic operation & containment ,Body construction, Aeration and agitation:Agitators, Stirrer glands & bearing, Mechanical seals(Names & Functions ,no diagrams), Magnetic Drive, - Baffles, Sparger: porous, orifice; nozzle; combined. Achievement & maintenance of ascetic condition,Valves / Steam traps - function in general & examples. Types of fermenters:Acetator, Cavitator, Tower fermenter, Cylindro conical, Air lift – outer loop / inner loop, Deep jet, Cyclone column, Packed tower (generator), Rotating disc, Bubble cap. 2.2 Instrumentation & Control of variables Introduction, Types of sensors, Sensing & Control of- pH, temp, Dissolved oxygen, Flow measurement &control, Pressure, Inlet / Exit gas analysis, Foam sensing, Oxygen

Unit III Downstream Processing & Environmental Aspects

3.1.Downstream processing Recovery & Purification of fermentation products Introduction, Precipitation, Filtration - theory, filter-aids, batch filters(Plate and frame filters), continuous filters.(Rotary vaccum),Centrifugation : flocculating agent, range of centrifuges - Basket, tubular

bowl. Cell disruption: Physico-chemical. Liquid – Liquid extraction, Solvent recovery, Chromatography –Ion exchange & Adsorption Membrane processes – Ultrafiltration, reverse osmosis, liquid membranes. Drying, Crystallization, Whole broth processing. 3.2 .Environmental aspects 3.2.1 Effluent treatment 3.2.2. Carbon Credits - Environmental Degradation issues and challenges

Unit IV Traditional Industrial Fermentations : Part-I

4.1. Beer –Ale and Lager 4.2. Wine –Red and white & Champagne 4.3. Vinegar (acetator& Generator) 4.4. Alcohol from molasses 4.5. Baker's yeast 4.6. Fungal amylase by solid substrate fermentation

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. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
4. Isolation and detection of plasmid DNA.
5. Preparation of competent cells and transformation
6. Diauxic Growth and beta galactosidase assay

Course code: USMBP05 [Practicals Based on USMB502, Credits -1.5, Lectures-60, Notional Periods-15]
1. Illustration of the role of plasmids in antibiotic resistance through curing of the plasmid
2. Study of iron sequestration- siderophore production in Pseudomonas spp.
3. Determination of mannose resistant haemagglutination as an indication for presence of P fimbriae in uropathogenic E.coli strains.
4. Acid fast staining of M. tuberculosis.
5. To determine SLO and SLS activity of S .pyogenes
6. Serological identification of enteropathogenic E.coli
7. Identification of isolates obtained from nasal swabs, skin swab, pus, sputum, stool and urine by morphological, cultural and biochemical properties.
8. Antigen Preparation: O & H antigen preparation of Salmonella. Confirmation by slide agglutination

[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. Detection of organic acids by TLC
5. Study of Home and Heterofermentation
6. Isolation and detection of Mitochondria
7. Glucose detection by GOD/POD
8. Galactose transport in yeasts

Course code: USMBP06 [Practicals Based on USMB504,Credits -1.5,Lectures- 60, Notional Periods-15]
1. Alcohol tolerance for yeast.

2. Sugar tolerance for yeast.
3. Alcohol fermentation.-Efficiency of fermentation
4. Chemical estimation –Sugar by Cole's
5. Chemical estimation –Alcohol
6. Gradient plate technique for analogue resistant mutants.
7. Production of amylase- detection, shake flask or solid substrate cultivation and stimation. (Qualitative)

Semester V:Text Books and Reference Books

USMB501: Text books

1. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., 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 ed., Macmillan worth Publishers.
5. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th ed., 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 edn. Mc Graw Hill international edition.
9. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing
10. Snustad, Simmons, "Principles of genetics", 3rd edn. John Wiley & sons, Inc.

USMB501:Reference books:

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

USMB502:Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd Edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education

USMB502: Reference books / Internet references:

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

USMB503 :Text books:

1. Stanier, R. Y.,M. Doudoroff andE. 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, 3rdednButterworth-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, 4thedn. Pearson
9. Wilson and Walker , 4thedn

USMB503 : Reference books:

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

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. &HaII--S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press
4. H. A. Modi, (2009). ''Fermentation Technology'' Vols 1 & 2, Pointer Publications, India
5. OkaforNakuda (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
6. Environmental degradation : issues and challenges by Shitole and Sable, Global research publication (2012)

USMB504 : Reference books

1. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
2. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th Edition, McMillan Publishers

SYLLABUS

SEM VI

USMB601 RDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY 2.5 (60 LECTURES)

Unit I RECOMBINANT DNA TECHNOLOGY 15 lectures

1.1. Branches of Genetics 1.1.a. Transmission genetics 1.1.1.b. Molecular genetics 1.1.c. Population genetics 1.1.d. Quantitative genetics 1.2. Model Organisms 1.2.a. Characteristics of a model organism 1.2.b. Examples of model organisms used in study 1.2.c. Examples of studies undertaken using prokaryotic and eukaryotic model organisms 1.3. Basic steps in Gene Cloning. 1.4. Cutting and joining DNA molecules--Restriction and modification systems, restriction endonucleases, DNA ligases 1.5. Vectors 1.5.a. Plasmids as cloning vectors. The plasmid vectors, pBR322 vector 1.5.b. Cloning genes into pBR322 1.5.c. Phage as cloning vectors, cloning genes into phage vector 1.5.d. Cosmids 1.5.e. Shuttle vectors 1.5.f. YAC 1.6.g.BAC 1.6. Methods of transformation 1.7.Screening and selection methods for identification and isolation of recombinant cells

Unit II BASIC TECHNIQUES & BIOINFORMATICS 15 lectures

2.1. Basic techniques 2.1.a. Southern, Northern and Western blotting. 2.1.b. Autoradiography (explain the term) 2.2.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,genetherapy,Genetic engineering of plants and animals. 2.3. PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) 2.4. Bioinformatics 2.4.a. Introduction i. Definition, aims, tasks and applications of Bioinformatics. ii. Database, tools and their uses - ¬ Importance, Types and classification of databases ¬ Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. ¬ Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databasesSCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. 2.4.b. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, 2.4.c. Sequence alignment-- global v/s local alignment, FASTA, BLAST. 2.4.d. Genomics- structural, functional and comparative genomics. 2.4.e. Proteomics- structural and functional proteomics.

Unit III BASIC VIROLOGY 15 lectures

3.1. Viral architecture3.1.a. Capsid, viral genome and envelope 3.1.b. Structure of TMV, T4, Influenza virus, HIV. 15 4 15 3.2. Viral classification 3.3. The viral replication cycle- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. 3.4. Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods:Equipment required for animal cell culture,Isolation of animal tissue

Unit IV ADVANCED VIROLOGY 15 lectures

4.1. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail 4.2. Visualization and enumeration of virus particles 4.2.a. Measurement of infectious units i. Plaque assay ii. Fluorescent

focus assay iii. Infectious center assay iv. Transformation assay v. Endpoint dilution assay. 4.2.b. Measurement of virus particles and their components i. Electron microscopy ii. Atomic force microscopy iii. Haemagglutination iv. Measurement of viral enzyme activity. 4.3. Regulation of lytic and lysogenic pathway of lambda phage 4.4. Role of viruses in cancer: Imp definations,charaeteristics of cancer cell,cancer multi step process,Homan DNA tumor viruses-EBV,Kaposis sarcoma virus,Hepatitis B and C virus,Papiloma Virus. 4.5. Prions and viroids

USMB602 MEDICAL MICROBIOLOGY & IMMUNOLOGY : PART II 2.5 (60 LECTURES)

Unit I STUDY OF A FEW DISEASES WITH EMPHASIS ON CULTURAL CHARACTERISTICS OF THE AETIOLOGICAL AGENT, PATHOGENESIS, LABORATORY DIAGNOSIS AND PREVENTION.

1.1 Study of vector-borne infections Malaria 1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea 1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Meningococcal meningitis
Unit II CHEMOTHERAPY OF INFECTIOUS AGENTS 15 lectures
2.1.1 Attributes of an ideal chemotherapeutic agent and related definitions 2.1.2 Selection and testing of antibiotics for bacterial isolates by Kirby-Bauer method 2.2 Mode of action of antibiotics on2.2.1 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) 2.3.1 List of common antibiotics used for treating viral, fungal and parasitic diseases. 2.3.2 New antibiotics 2.4 Mechanisms of drug resistance- Its evolution, pathways and origin

Unit III HUMORAL RESPONSE,CELL MEDIATED EFFECTOR RESPONSE, ANTIGEN-ANTIBOBY REACTIONS 15 lectures

3.1. Humoral Response 3.1.1.Induction of Humoral response, Primary and secondary responses 3.1.2.Germinal centers and antigen induced B cell differentiation 3.1.3.Affinity maturation and somatic hyper mutation, Ig diversity, class switching 3.1.4.Generation of plasma cells and memory cells 3.2. Cell mediated effector response 3.2.1.Generation and target destruction by Cytotoxic T cells. 3.2.2.Killing mechanism of NK cells. 3.2.3.Antibody dependent cell cytotoxicity (ADCC) 3.3. Antigen-Antibody reactions Precipitation, agglutination, passive agglutination, agglutination inhibition, Radioimmunoassay (RIA), Enzyme immunoassays (EIA), Immunofluorescence, western blot technique

Unit IV VACCINES, IMMUNOHAEMATOLOGY, HYPERSENSITIVITY 15 lectures

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, Failures in vaccination 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. 4.3. Hypersensitivity 4.3.1. Coombs and Gells classification 4.3.2. Type I to Type IV hypersensitivity, Mechanism and manifestation

USMB603 MICROBIAL BIOCHEMISTRY : PART II 2.5 (60 LECTURES)

Unit I LIPID METABOLISM & CATABOLISM OF HYDROCARBONS. 15 lectures

1.1 General introduction to Lipids 1.1.1. Lipids and their functions 1.1.2. Action of lipases on triglycerides /tripalmitate 1.1.3. Phospholipids and their properties 1.1.4. Common phosphoglycerides in bacteria 1.2 Catabolism of Lipids 1.2.1.Oxidation of saturated fatty acid - β oxidation pathway - Energetics of β oxidation of Palmitic acid 1.2.2. Oxidation of propionic acid. 1.2.3. Degradation of poly beta hydroxy butyrate 1.3 Anabolism of Lipids 1.3.1. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) 1.3.2. Biosynthesis ofphosphoglycerides in bacteria 1.3.3. Biosynthesis of PHB 1.4 Catabolism of aliphatic hydrocarbons 1.4.1. Oxidation of saturated aliphatic hydrocarbon (n-alkane) 1.4.2. Omega oxidation pathwayi) Pathway inCorynebacteriumand yeast ii) Pathway inPseudomonas

Unit II METABOLISM OF PROTEINS AND NUCLEIC ACIDS. 15 lectures

2.1 Protein catabolism 2.1.1. Enzymatic degradation of proteins 2.1.2. Metabolic fate of amino acids (schematic only) 2.1.3. Metabolism of single amino acids – i. Deamination reactions ii. Decarboxylation iii. Transamination 2.1.4. Fermentation of single amino acid - Glutamic acid by Clostridium glutamicum 2.1.5.Fermentation of pair of amino acids - Stickland reaction 2.2 Anabolism of Proteins 2.2.1. Schematic representation of amino acid families 2.2.2. Synthesis of amino acids of Aspartate family 2.3 Nucleic acid Catabolism 2.3.1. Degradation of purine nucleotides up to uric acid formation 2.3.2. Recycling of purine and pyrimidine nucleotides by salvage pathway 2.4 Anabolism of Nucleic Acids 2.4.1. Metabolic origin of atoms in purine and pyrimidine ring. 2.4.2. Biosynthesis of pyrimidine nucleotides. 2.4.3. Biosynthesis of purine nucleotides. 2.4.4. Formation of deoxyribonucleotides. 2.4.5. Synthesis of nucleotide diphosphates and triphosphates. 2.4.6. Role of nucleotides (high energy triphosphates)

Unit III METABOLIC REGULATION 15 lectures

3.1Overview and major modes of regulation Examples of cellular control mechanism acting at various levels of metabolism (tabulation only) 3.2 Allosteric proteins 3.2.1. Definition 3.2.2. Allosteric enzymes - Role of allostericenzymes using ATCase as example (no kinetic study) 3.2.3.Regulatory allosteric proteins i. Interaction of proteins with DNA ii. Structure of DNA Binding proteins iii. Examples - Lac repressor, Trp repressor, CAP protein iv.Definition and examples of alarmones 3.3 Regulation of gene expression (Transcription) 3.3.1. Introduction to operon model 3.3.2. Common patterns of regulation of transcription - General concept of positive and negative regulation of operons i. Lac operon - Mechanism of regulation - Induction - Catabolite repression ii. Trp operon - End Product Repression - Attenuation 3.3.3. Regulation of gene expression i. Multiple Sigma Factors ii. Riboswitches 3.4 Regulation of enzyme activity (Post translational regulation) 3.4.1. End-Product Inhibition and Mechanism of End Product Inhibition in branched pathways with examples i. Isofunctional enzymes ii. Concerted feedback inhibition iii. Sequential feedback inhibition iv. Cumulative Feedback inhibition v. Combined activation and inhibition 3.4.2. Covalent modification of enzymes i. General examples without structures ii. Monocyclic cascade &interconvertable enzyme definition iii. Glutamine synthetase system of E.coli 3.4.3. Regulation by proteolytic cleavage 3.5 Regulation of EMP and TCA (Schematic and Role of Pryruvate dehydrogenase Complex)

Unit IV PROKARYOTIC PHOTOSYNTHESIS & INORGANIC METABOLISM 15 lectures

4.1 Prokaryotic photosynthesis 4.1.1. Early studies on photosynthesis i. Light and dark reactions ii. Bacterial photosynthesis iii. Hill reaction 4.1.2. Phototrophic prokaryotes -Oxygenic, Anoxygenicphototrophs examples only 4.1.3. Photosynthetic pigments 4.1.4. Location of photochemical apparatus 4.1.5. Photophosphorylation 4.1.6. Light reactions in i. Purple photosynthetic bacteria ii. Green sulphur bacteria iii. Cyanobacteria (with details) 4.1.7. Dark reaction i. Calvin Benson cycle ii. Reductive TCA 4.2 Inorganic Metabolism 4.2.1. Assimilatory pathways- i. Assimilation of nitrate, ii. Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase iii. Biological nitrogen fixation (Mechanism for N2 fixation and protection of nitrogenase) iv. Assimilation of sulphate 4.2.2. Dissimilatory pathways- i. Nitrate as an electron acceptor (Denitrification in Paracoccusdenitrificans) ii. Sulphate as an electron acceptor 4.2.3. Lithotrophy– Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron.

.

USMB604 APPLIED AND INDUSTRIAL MICROBIOLOGY 2.5 CREDITS (60 LECTURES)

Unit I TRADITIONAL INDUSTRIAL FERMENTATIONS – PART 2 15 lectures

1.1. Penicillin& Semisynthetic Penicillin 1.2. Vitamin B12 from Propionibacterium& Pseudomonas 1.3. Glutamic Acid (direct) 1.4. Citric acid 1.5 Mushroom

Unit II ADVANCES IN BIOPROCESSES TECHNOLOGY: 15 lectures

2.1 Animal Cell Cultivation and applications Animal Cell Lines, Methods of cultivation and establishment of cell lines, Animal cell culture fermenters, Large scale cultivation procedures 2.2. Plant Tissue Culture Methods of cultivation of organ culture, callus culture and cell suspension culture, Application in Agriculture (Disease resistant plants, virus free plants) Horticulture (Micropropagation) Industry (secondary metabolites production),Transgenic plant (Insect resistant plants) 2.3 Enzyme Technology Enzyme Immobilization methods, Applications in therapeutic uses, Analytical uses and Industrial uses

Unit III BIOINSTRUMENTATION & BIOSTATISTICS 15 lectures

3.1. Bioinstrumentation – Principles, working and applications of: 3.1.1 Spectrophotometry (I. R) 3.1.2Atomic absorption (AAS) & Atomic Emission (Flame photometry) 3.1.3 Radioisotopes and autoradiography 3.1.4 Microbiological Assays 3.2Biostatistics Introduction to Biostatistics Sample and Population Data presentation: Dot diagram, Bar diagram, Histogram, Frequency curve. Central Tendency: Mean, Median, Mode Summation, notations. Standard Deviation, Variance, Q-Test, t test and F-test.

Unit IV QUALITY ASSURANCE & REGULATORY PRACTICES 15 lectures

4.1 Intellectual Property Rights: Introduction to Intellectual Property Genesis of IPR - GATT, WTO, TRIPS, The World Intellectual Property Rights Organization (WIPO) Types of Intellectual Property – Patents, Copyright, Trademark, Trade secret Plant varieties protection act, Designs, Geographical Indications Indian Patent office sitehttp://www.ipindia.nic.in/ 4.2 QA,QC,GMP : Definitions-Manufacture, Quality, Quality Control, In-Process Control, Quality Assurance, Good Manufacturing Practices. Chemicals, Pharmaceuticals, Chemicals &Pharmaceutical production The five variables, In process Items, Finished Products, Labels and Labeling, Packaging materials Documentation, Regulations, Control of Microbial contamination during manufacture, Premises and contamination

control ,Manufacture of sterile products, Clean and Aseptic Area Important publications related to QA 4.3 Sterilization Control and Sterility Assurance: Bio-burden determinations Environmental monitoring Sterilization Monitors – Physical, Chemical and Biological indicators Sterility Testing

T.Y.B.Sc.MicrobiologyPracticals (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 UVVIS.
2. Enrichment of coliphages, phage assay (pilot & proper).
3. Restriction digestion of lambda phage /any plasmid DNA
4. Amplification of DNA by PCR and confirmation of it by gel electrophoresis [Demo.]
5. Western Blot.(Demo)
6. Bioinformatics practical 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
7. Animal cell culture (demo) Documentation, Regulations, Control of Microbial contamination during manufacture, Premises and contamination control ,Manufacture of sterile products, Clean and Aseptic Area Important publications related to QA 4.3 Sterilization Control and Sterility Assurance: Bio-burden determinations Environmental monitoring Sterilization Monitors – Physical, Chemical and Biological indicators Sterility Testing 04

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

1. Acid fast staining of M. leprae
2. Identification of Candida species using the germ tube test and growth on Chrom agar
3. Demonstration of malarial parasite in blood films
4. Selection and testing of antibiotics using the Kirby-Bauer method
5. Determination of MBC of an antibiotic.
6. Blood grouping – Direct & Reverse typing
7. Coomb's Direct test
8. Determination of Isoagglutinin titer
9. Demonstration experiments- Widal, VDRL

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

1. To study catabolite repression by diauxic growth curve.
2. Protein estimation by Lowry's method
3. Estimation of uric acid
4. Qualitative and Quantitative assay of Protease
5. Qualitative and Quantitative assay of Lipase
6. Study of Hill reaction
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. Immobilization of yeast cells for invertase activity- making of beads, Determination of activity and count by haemocytometer.
4. Carrot explant culture.
5. Sterility testing of water for injection or DPT vaccine.
6. Chemical estimation of Penicillin 7. Biostatistics problem

Semester-VI : Text Books & Reference Books

USMB 601: Text books:

1. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., 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 ed., 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 edn. Mc Graw Hill international edition.
11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th ed, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd Edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edn. John Wiley & sons, Inc.
14. A textbook of biotechnology R.C.Dubey 4 th ed.S.Chand.

Reference books:

1. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edn. 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 edn.

USMB602 :TEXT BOOKS:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd Edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education

REFERENCES:

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

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. Salle, A.J. Fundamental Principles of Bacteriology, 7thedn McGraw Hill Book Co.
7. Cohen, G.N. (2011). Microbial Biochemistry. 2ndedn, Springer
8. Madigan, M.T. and J.M. Martinko 2006. 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, 5thednW. H. Freeman and Company

USMB 604 : TEXT BOOKS

1. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Stanbury P. F., Whitaker A. &HaII--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Crueger W. and Crueger A. 2000 "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
4. R. C. Dubey, 2005 A Textbook of ''Biotechnology'' S. Chand and Company, New Delhi
5. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 & 2, Pointer Publications, India
6. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th Edition, McMillan Publishers
7. Research Methodology: Methods and Techniques By C. R. Kothari, New Age International, 2004

REFERENCE BOOKS:

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Principles and application of Statistics in Biosciences byDrD.V.Kamat (2012),Manan Prakashan

: Question Paper Pattern :

Modality Of Assessment
Assessment pattern for theory

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 25% marks in the first component
& by conducting the Semester End Examinations with 75% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment - 25% **25 marks**
a) Theory : **25 marks**

Sr No	Evaluation type	Marks
1.	One class Test* 20articulation, leadership qualities demonstrated through	20
2.	Active participation in routine class instructional deliveries 05 Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

Question Paper Pattern for Periodical Class Test for Courses at UG Programmes Written Class Test (20 Marks)

1.	Match the Column / Fill in the Blanks / Multiple Choice Questions (½ Marks each)	05
2.	Answer in One or Two Lines (Concept based Questions) (1 Marks each)	05
3.	Answer in Brief (Attempt Any Two of the Three) (5 Marks each)	10

Semester End Theory Assessment - 75% **75 marks**
1. Duration - These examinations shall be of **2.5 hours** duration.
2. Theory question paper pattern :-
i. There shall be **five questions** each of **15** marks **(30 marks with internal option)**
ii. On each unit there will be one question & fifth question will be based on entire syllabus.
iii. All questions shall be **compulsory** with internal choice within the questions.
iv. Questions may be sub divided into sub questions as **a, b, c, d, e & f** etc & the allocation of marks depends on the weightage of the topic.

Practical Examination Pattern:

(A)Internal Examination:- There will not be any internal examination/ evaluation for practicals.

(B) External (Semester end practical examination)

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

Overall Examination and Marks Distribution Pattern
Semester V

Course	USMB 501			USMB 502			USMB 503			USMB 504			Grand Total
--	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	--
Theory	25	75	100	25	75	100	25	75	100	25	75	100	**400**
Pract.	--	50	50	--	50	50	--	50	50	--	50	50	**200**

Overall Examination and Marks Distribution Pattern
Semester VI

Course	USMB 601			USMB 602			USMB 603			USMB 604			Grand Total
--	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	--
Theory	25	75	100	25	75	100	25	75	100	25	75	100	**400**
Pract.	--	50	50	--	50	50	--	50	50	--	50	50	**200**