Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi [Autonomous College]

Syllabus (CBCGS Pattern)

Sr. No.	Heading	Particulars
1	Title of Course	T.Y.B.Sc. Microbiology
2	Eligibility for Admission	S.Y.B.Sc. Microbiology [of recognized Boards]
3	Passing Marks	40%
4	Ordinances/Regulations (if any)	-
5	No. of Years/Semesters	One year/Two semester
6	Level	U.G.
7	Pattern	Semester
8	Status	Revised
9	Implemented from Academic year	2020-2021

AC-04/04/2020
Item No-5.16

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE VASHI

(AUTONOMOUS COLLEGE)

Sector-15- A, Vashi, Navi Mumbai - 400 703

Syllabus for T.Y.B.Sc. Microbiology

Program: B.Sc. Microbiology

Course: Microbiology

(Choice Based Credit, Grading and Semester System with effect from the academic year 2020-2021)

Preamble

Bachelor of Science (B.Sc.) in Microbiology is an under graduate program of Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Autonomous College]

Microbiology is a branch of science that studies microorganisms such as bacteria, protozoa, algae, fungi, bacteria, viruses, etc. These studies integrate cytology, physiology, ecology, genetics and molecular biology, evolution, taxonomy and systematics with a focus on microorganisms.

The relevance and applications of microorganisms to the surrounding environment including human life and Mother Nature becomes part of this branch. Since inception of this branch of science, Microbiology has remained a field of active research and ever expanding in all possible directions; broadly categorized as pure and applied science.

Different branches of Pure Microbiology based on taxonomy are Bacteriology, Mycology, Protozoology and Parasitology, Phycology and Virology; with considerable overlap between these specific branches over each other and also with other disciplines of life sciences, like Biochemistry, Botany, Zoology, Cell Biology, Biotechnology, Nanotechnology, Bioinformatics, etc.

Areas in the applied Microbial Sciences can be identified as: Genetics, Medical, Immunology, Biochemistry, Biotechnology, Pharmaceutical, Industrial (Fermentation, Pollution Control), Air, Water, Food and Dairy, Agriculture (Plant Pathology and Soil Microbiology), Veterinary, Environmental (Ecology, Geomicrobiology); and the technological aspects of these areas.

Microbiological tools have been extensively used to study different life processes and are cutting edge technologies. There is a continual demand for microbiologists in the work force – education, industry and research. Career opportunities for the graduate students are available in manufacturing industry and research institutes at technical level. The content of a syllabus should be such that it maintains continuity with the course content of higher secondary class and post graduate course. The present curriculum is made keeping this in mind and is an effort to impart fundamental

knowledge of the subject needed at this level. The curriculum is designed as per the guidelines for Choice Based Credit System and reflects the total credit, teaching hours and evaluation pattern.

Objectives of the Course:

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

Program Outcomes (POs)

PO-1	**Disciplinary Knowledge:** (i) Acquire the knowledge with facts and figures related to various subjects in pure sciences such as Physics, Chemistry, Mathematics,Microbiology and Computer Science; and Biotechnology, Information Technology and itsother fields related to the program. (ii) Understand the basic concepts, fundamental principles, theoretical formulations and experimental findings and the scientific theories related to various scientific phenomena and their relevance in the day-to-day life.
PO-2	**Communication Skills:**Develope various communication skills such as reading, listening and speaking skills etc., which we will help in expressing ideas and views clearly and effectively.
PO-3	**Critical Thinking:** Think creatively to propose novel ideas in explaining the scientific data, facts and figures related to science and technology.
PO-4	**Analytical Reasoning and Problem Solving:**Identify, describe, formulate, interpret, analyze the data systematically and solve theoretical and numerical problems in the diverse areas of science and technology and provide alternate solutions to the problems.
PO-5	**Sense of Inquiry:**Curious for asking relevant questions like why and how for better understanding of the basic concepts, fundamental principles, scientific theories and applications related to the study.
PO-6	**Use of Modern Tools:**Use of modern tools, equipments, instrumentation and laboratory techniques to design and perform the experiments and write the programs in different languages (software).
PO-7	**Research Skills:** Ability to search for, find, collect, analyze, interpret and evaluate information/data that is relevant to the subjects related to science and technology being studied.
PO-8	**Application of Knowledge:** Develop scientific outlook with respect to the subjects related to science and technology and also participate in various social and cultural activities.
PO-9	**Ethical Awareness:** Imbibe ethical and social values in personal and social life leading to cultured and civilized personality.
PO-10	**Teamwork:** Work effectively within the groups and individuals, participate and take initiative for various field-based situations related to science, technology and society at large.
PO-11	**Environment and Sustainability:** Understand how development in science and technology and interdisciplinary subjects are taking place for protecting our environment and sustainable developments.
PO-12	**Lifelong Learning:** Ability of self-driven to explore, learn and gain knowledge and new skills to improve the quality of life and sense of self-worth by paying attention to the ideas and goals throughout the life.

Program Specific Outcomes [PSO's]: UG

PSO_1: Understand the various aspects of microbial world and history of microbiology

PSO_2: Differentiate and classify different types of microorganism and its characteristics

PSO_3: Distinguish between Prokaryotes and Eukaryotes with respective to their ultra-structure and functions

PSO_4: Understand & differentiate the requirement of nutrients and environmental conditions for the growth of microorganisms

PSO_5: Apply the knowledge of basic instrumentation, basic techniques in microbiology and control of microorganism

PSO_6: Explain and describe types and functions of different biomolecules found in living cells

PSO_7: Describe the aspects of microbial ecology and industrial microbiology

PSO_8: Illustrate the basic immunology and medical microbiology

T.Y.B.Sc. Microbiology: Curriculum
Revised for Credit Based Semester & Grading System
To be implemented from the academic year 2020-2021
SEMESTER V

Theory:

COURSE CODE	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB501 Microbial Genetics -I	Unit I	DNA Replication	4	4
	Unit II	Gene Expression and Regulation		
	Unit III	Mutations and Repair		
	Unit IV	Natural Plasmids, Transposable elements & Integrons, Genetic Research		

COURSE CODE	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB502 Medical Microbiology and Immunology I	Unit I	Medical Microbiology	4	4
	Unit II	Study of diseases		
	Unit III	General Immunology		
	Unit IV	Activation of Immune cells		

COURSE CODE	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB503 Microbial Biochemistry-I	Unit I	Biological Membranes & Transport	4	4
	Unit II	Bioenergetics & Quorum Sensing		
	Unit III	Methods of Studying Metabolism & Catabolism of Carbohydrates		
	Unit IV	Fermentative Pathway & Anabolism of Carbohydrates		

COURSE CODE	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB504 Industrial Microbiology and Bioprocess Technology	Unit I	Screening For Productive Strains And Strain Improvements	4	4
	Unit II	Nutrition Of Industrial Microorganisms And Sterilization Methods		
	Unit III	Fermentation Equipment And Control		
	Unit IV	Traditional Fermentations		

PRACTICAL:

COURSE CODE	PAPER	TOPIC HEADINGS	Credits	NH/ week
UGMBP501	I	Microbial Genetics	6	16
	II	Medical Microbiology and Immunology		
	III	Microbial Biochemistry-I		
	IV	Industrial Microbiology and Bioprocess Technology		

UGMB501 Microbial Genetics – I

Course Outcome: Paper I

By the end of the course, a student should develop the ability to

CO1: Describe roles of all the enzymes and proteins involved in DNA replication.[2]*

CO2: Compare and contrast between Prokaryotic and Eukaryotic DNA replication.[4]*

CO3: Forecast effect of Mutations on gene expression and regulation.[6]*

CO4: Compare & contrast between Composite and Non-composite Transposons, IS elements and Transposons.[4]*

CO5: Solve analytical problems on Genetics.[4]*

CO6: Perform mutation experiments by UV survival curve and identify it by performing Gradient Plate Technique. [3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER V Paper I		
Course Code	**Title**	**Credits**
UGMB501	**Microbial Genetics - I**	**4 Credits (60 Lectures)**
Unit I	**DNA Replication** Three models of DNA Replication Semiconservative Replication in prokaryotes: The Meselson and Stahl Experiment	**(15 Notional Hours)**

	DNA replication in Prokaryotes- with special reference to *E. coli* a. The J. Cairn Experiment b. Molecular Mechanism of DNA replication Enzymology of DNA replication- a. Helicases, DNA polymerases, ligase, topoisomerases. b. SSB proteins, Tus proteins Rolling Circle replication DNA replication in Eukaryotes- with special reference to *Saccharomyces cerevisiae* a. Semiconservative replication in eukaryotes- The Taylor, Woods & Hughes experiment b. Replicons c. Initiation of replication d. Eukaryotic replication enzymes e. Replicating the ends of chromosomes f. Assembling the newly replicated DNA	
Unit II	**Gene Expression and Regulation** 2.1 The transcription process 2.2 Transcription in bacteria- Initiation, Elongation & Termination 2.3 Transcription in eukaryotes a. Eukaryotic RNA Polymerases b. Transcription by RNA Polymerase II c. The structure and production of eukaryotic mRNAs d. Splicing mechanisms- Self- splicing introns, The spliceosome e. RNA editing Translation a. tRNA b. Ribosomes c. Initiation of Translation d. Elongation of the polypeptide chain e. Termination of Translation f. Protein sorting Regulation of gene expression in bacteria **a)** *Lac* operon of *E. coli*- Jacob and Monod's operon model, Positive control, molecular details of regulation	**(15 Notional Hours)**

Unit III	**Mutations and Repair** Classification of Mutations: a. Based on molecular change b. Based on phenotypic effects c. Based on location The Fluctuation Test Spontaneous Mutations: a. Replication errors b. Tautomeric shifts c. Depurination & deamination d. Oxidative damage e. Transposable elements Induced Mutations: a. Base analogs b. Base- modifying agents c. Intercalating agents d. Adduct-Forming agents e. Radiations- Ultraviolet light, Ionizing radiations f. The Ames test Reverting mutations, Suppression, Pleiotropic mutations, mutator genes Detecting mutations: a. Visible mutants b. Nutritional mutants c. Conditional mutants d. Resistance mutants DNA repair mechanisms a. Direct reversal repair- Proofreading, Photoreactivation, repair of alkylation damage b. Excision repair- Base excision repair, Nucleotide excision repair, Methyl-directed mismatch repair, SOS repair c. Double strand break repair in eukaryotes	**(15 Notional Hours)**
Unit IV	**Natural Plasmids, Transposable elements & Integrons, Genetic Research** 4.1 Natural Plasmids i. Physical nature of plasmids ii. Detection and isolation of plasmids iii. Replication of plasmids iv. Plasmid copy number v. Plasmid incompatibility vi. Plasmid amplification vii. Types of plasmids- R- plasmids, F-plasmid, Col	**(15 Notional Hours)**

	plasmids, Degradative plasmids, Ti plasmids, plasmids encoding toxins & virulence Transposable elements a. General features of transposable elements b. Transposable elements in bacteria- Insertion sequences, transposons [Composite & Non-composite] c. IS elements & transposons in plasmids d. Bacteriophage μ *e.* Transposable elements in yeast- *Ty* f. The transposition machinery g. The transposition reaction- Replicative and non-replicative transposition h. The fate of the donor site i. Target immunity j. Transposons as molecular tools k. Retroposons l. Retrotransposons Integrons- Role in antibiotic resistance Basic Concepts in Genetic Research a. The sub-disciplines of genetics b. Basic and applied research c. Genetic databases & maps d. Organisms for genetics research- Characteristics, examples, representative studies using prokaryotic and eukaryotic organisms	

References for UGMB501

1. Peter J. Russell (2010), "Genetics-A molecular approach", 3rd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman and company.
3. M.Madigan, J.Martinko, J.Parkar, (2012), "Brock Biology of microorganisms", 13th ed., Pearson Education International.
4. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
5. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing
6. Robert Weaver, (2008), "Molecular biology", , 3rd edn. Mc Graw Hill international edition.
7. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th ed, Blackwell Publishing
8. Snustad, Simmons, "Principles of genetics", 3rd edn. John Wiley & sons, Inc.
9. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edn. ASM press.

10. Benjamin Lewin, (9 th edition), “Genes IX”, , Jones and Bartlett publishers.
11. JD Watson, “Molecular biology of the gene”, 5th edn.

Practical based on UGMB501

Course code: UGMBP05/I

[Credits -1.5, Notional Hours- 60]

1. UV survival curve – determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis
3. Gradient Plate Technique
4. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
5. Bacterial gene induction with reference to lac operon.
6. Genetics problems

UGMB502- Medical Microbiology and Immunology -I

Course Outcome: Paper II

By the end of the course, a student should develop the ability to

CO1: Justify the role of Quality Control in accurate diagnosis [5]*

CO2: Justify spread of Skin, Respiratory and Urinary tract infection & understanding clinical manifestation [5]*

CO3: Monitor the Prophylactic Measures to minimize risk of infection [4]*

CO4: Distinguish the organs of Immune system based on their structure and function [4]*

CO5: Attribute the mechanism of B-Cells and T-cells in Humoral and Cell Mediated Immune Response respectively [4]*

CO6: Study the characteristics of standard cultures to make diagnosis from patient sample [3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER V Paper II		
Course Code	**Title**	**Credits**
UGMB502	**Medical Microbiology and Immunology -I**	**4 Credits (60 Lectures)**
Unit I	**Attributes of microbial pathogenicity -** a. Entry and Adherence **Strategy for survival** a. Avoid,Circumvent,Subvert b. Manipulate normal host defences, getting into host cells,avoiding intracellular pitfalls **1.2 Establishment-overcoming host immune system.** **Corollaries of microbial pathogenicity** a. Exotoxins- b. Ras inhibitor and other toxin affecting host cell trafficking and signal transduction pathways **Membrane active exotoxin** a. Enzymes	**(15 Notional Hours)**

	Bacterial Strategies for Evasion **Study of virulence mechanisms in bacteria** a. Pathogenicity islands b. Bacterial virulence factors c. Adherence factors d. Invasion of host cells and tissues **Toxins** a. Exotoxins b. Exotoxins associated with diarrheal diseases and food poisoning c. LPS of gram negative bacteria **Enzymes** a. Tissue degrading enzymes - IgA1 proteases **Antiphagocytic factors** **Intracellular pathogenicity** a. Antigenic heterogeneity. The requirement for iron **Typical diagnostic cycle –** a. Specimen collection(direct and indirect, samples from normal flora sites, specimen for viral diagnosis, patient preparation, special instruction, transportation to lab., storage before processing, primary plating media, direct examination, Comments) b. Transport, Direct examination, microscopy c. Culture, isolation of viruses & detection, cytology & histology d. Serological identification, molecular biology techniques. e. Q.C. in diagnostics	
Unit II	**Study of diseases (Anatomy, Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)** **Skin Infections:** a. Pathogenesis of mucocutaneous lesion (Only diagram) b. Skin manifestations of systemic infections caused by bacteria and fungi.	**(15 Notional Hours)**

	Upper Respiratory Tract infection: a. Common cold b. Parotitis c. Leprosy d. Fungal (Candidiasis) e. Viral (Herpex Simplex, Measles, Chicken pox) f. Cutaneous dermatophytes **Lower Respiratory Tract infection:** a. Influenza b. Tuberculosis c. Whooping cough **2.4 Urinary Tract infections** a. Acquisition and Etiology b. Predisposing factors c. Pathogenesis and clinical manifestations d. Lab diagnosis. e. Prevention and treatment **Gastrointestinal tract infections**: (Gastroenteritis, Diarrhea, Dysentery, Enterocolitis) a. Schematics of Gastrointestinal tract b. Shigellosis c. Cholera *d.* Food poisoning- *Staphylococcus* e. Rotavirus diarrhea f. Dysentery due to *Entamoeba histolytica*- detail g. Hepatitis A	
Unit III	**General Immunology -I** **3.1Organs and tissues of the immune system:** a.Primary lymphoid organs - structure and function of Thymus and Bone marrow b. Secondary lymphoid organs – structure and function of Spleen**,** Lymph node**,** Mucosa associated lymphoid tissues, Bronchus associated lymphoid tissue, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue **: Antigens** a. Immunogenicity versus antigenicity b. Factors that influence immunogenicity – foreignness, molecular size, chemical, composition, heterogenicity, ability to be processed and presented, contribution of the	**(15 Notional Hours)**

	biological system to immunogenicity – genotype of the recipient, animal, immunogen dosage, route of administration and adjuvants c. Epitopes / antigen determinants (only concepts) d. Haptens and antigenicity e. Immunogenicity of some natural substances – Native globular proteins, polysaccharides, lipids, nucleic acids. f. Types of antigen- heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens **Antibodies:** a. Immunoglobulin: Basic Structure in detail b. Basic concepts - hypervariable region, complementarity -determining regions (CDRs), framework regions (FRs) and their importance. c. Immunoglobulin classes and biological activities - Immunogloublin G, Immunogloublin M, Immunogloublin A, Immunogloublin E, Immunogloublin D, (including diagrams) d. Immunoglobulin Superfamily e. Monoclonal antibodies	
Unit IV	**Activation of Immune cells** **: B cells:** a. Receptors--- structure & organization b. B cell activation and differentiation – c. Thymus dependent and independent antigens d. B cell activating signals e. Role of Th cells in Humoral response, formation of T – B conjugates, CD40 / CD40L interaction, Th cell cytokine signals. **: T cells:** a. Receptors, structure (alpha-beta, gamma-delta , TcR) b. TcR-CD3 complex structure & functions. c. Accessory molecules d. Subsets of T cells (Th1, Th2, T reg) e. T cell activation, Costimulatory molecules, T cell differentiation (memory & effector cell) **: MHC complex and MHC molecules** a. The basic structure and functions of Class I and	**(15 Notional Hours)**

	Class II MHC Molecules. b. Peptide-MHC interaction. **: Cytokines** a. Concept b. Properties c. Attributes of cytokines d. Biological functions of cytokines **: Complement System** a. Functions and components of complement b. Complement Activation—classical, alternative and lectin pathway c. Biological consequences of complement activation	

References for UGMB502

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthnarayan and Panicker's, Textbook of Microbiology, 10th edition
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthnarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Medical Microbiology edited by Samuel Baron. Fourth edition. (University of Texas Medical Branch of Galvesion
6. Sherries, John C, Ed, Medical Microbiology: an Introduction to infectious diseases.
7. Elsevier Publication IInd edition.
8. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael. Cedric Mims, Medical microbiology, 3rd edition
9. Bailey and Scott's Diagnostic microbiology, 12th edition
10. Kuby Immunology, 6th Edition, W H Freeman and Company
11. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
12. Fahim Khan, Elements of Immunology, Pearson Education

Practical based on UGMB502

[UGMBP05/II]

[Total Credits 1.5, Notional Hours 60]

1. Acid fast staining.
2. Identification of *Candida* species using the germ tube test and growth on Chrom agar
3. Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonalla typhi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aurous*
4. Identification of isolates obtained from Swab, pus, sputum, stool and urine by morphological, cultural and biochemical properties.
5. Rapid identification techniques [Demonstration of Vitek 2]
6. Antigen Preparation: O & H antigen preparation of *Salmonella*. Confirmation by slide agglutination
7. Separation of lymphocytes and their staining
8. Quality control in laboratory
9. Case studies on Epidemics.

UGMB503- Microbial Biochemistry – I

Course Outcome: Paper III

By the end of the course, a student should develop the ability to

CO1: Distinguish between various types of Transport Mechanisms involved in the transport of essential nutrients in the metabolism of a cell. [4]*

CO2: Illustrate and paraphrase complexes present in ETC of Mitochondria. [3]*

CO3: Measure the Energetics of glycolysis, TCA and ED pathway [5]*

CO4: Construct fermentative pathways that are present in microorganisms. [6]*

CO5: Determine a qualitative and quantitative assay for the Phosphatase enzyme [5]*

CO6: Discriminate between Homo-fermentative and Hetero-fermentative microorganisms [5]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER V Paper III		
Course Code	**Title**	**Credits**
UGMB503	**Microbial Biochemistry - I**	**4 Credits (60 Lectures)**
Unit I	**Composition and architecture of membrane** a. Integral & peripheral proteins & interactions with lipids b. Permeability c. Aquaporins d. Mechanosensitive channels **Methods of studying solute transport** a. Use of whole cells b. Liposomes c. Proteoliposomes **Solute transport across membrane** a. Active transport & electrochemical gradient b. Ion gradient provides energy for secondary active transport c. Lactose transport d. ATPases and transport (only Na-K ATPase) e. Shock sensitive system – Role of binding proteins f. Phosphotransferase system g. Schematic representation of various membrane transport systems in bacteria.	**(15 Notional Hours)**

	Membrane channels & pumps: a. The Transport of Molecules Across a Membrane May Be Active or Passive b. A Family of Membrane Proteins Uses ATP Hydrolysis to Pump Ions Across membrane c. Secondary Transporters Use One Concentration Gradient to Power the Formation of Another d. Specific Channels Can Rapidly Transport Ions Across Membranes e. Gap Junctions Allow Ions and Small Molecules to Flow between Communicating Cell f. ABC transporters use ATP to drive the Active site of a wide variety of Substrates **Other examples of solute transport:** a. Iron transport: A special problem b. Assembly of proteins into membranes and protein export	
Unit II	**Bioenergetics & Quorum Sensing** **Biochemical mechanism of generating ATP:** a. Substrate-Level Phosphorylation, b. Oxidative Phosphorylation c. Photophosphorylation **Electron transport chain** a. Universal Electron acceptors that transfer electrons to E.T.C. b. Carriers in E.T.C. i. Hydrogen carriers – Flavoproteins, Quinones ii.Electron carriers – Iron Sulphur proteins, Cytochromes. c. Mitochondrial ETC i. Biochemical anatomy of mitochondria ii.Complexes in Mitochondrial ETC iii. Schematic representation of Mitochondrial ETC **Prokaryotic ETC** a. Organization of electron carriers in bacteria i. Generalized electron transport pathway in bacteria ii.Different terminal oxidases b. Branched bacterial ETC c. Pattern of electron flow in E. coli - aerobic and anaerobic *d.* Pattern of electron flow in Azotobacter vinelandi*i*	**(15 Notional Hours)**

	ATP synthesis a. Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) b. Free energy released during electron transfer from NADH to O2 c. Chemiosmotic theory (only explanation) d. Structure & function of Mitochondrial ATP synthase e. Structure & function of bacterial ATP synthase f. Mechanism by Rotational catalysis g. Inhibitors of ETC, ATPase and uncouplers **Other modes of generation of electrochemical energy** a. ATP hydrolysis b. Oxalate formate exchange c. End product efflux, Definition**,** Lactate efflux d. Bacteriorhodopsin: - Definition, function as proton pump and significance **Quorum Sensing:** **Quorum Sensing:** System similar LuxR/LuxI in non-luminescent bacteria	
Unit III	**Methods of Studying Metabolism & Catabolism of Carbohydrates** **Experimental Analysis of metabolism** a. Goals of the study b. Levels of organization at which metabolism is studied c. Metabolic probes. d. Use of radioisotopes in biochemistry i. Pulse labeling ii. Assay and study of radiorespirometry to differentiate EMP & ED e. Use of biochemical mutants f. Sequential induction **Catabolism of Carbohydrates** a. Breakdown of polysaccharides – Glycogen, Starch, Cellulose b. Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose. c. Utilization of monosaccharides - Fructose, Galactose	**(15 Notional Hours)**

	d. Major pathways – (with structure and enzymes) i. ED pathway ii. Incomplete TCA in anaerobic bacteria iii. Anaplerotic reactions iv. Glyoxylate bypass e. **Methylotrophs**: Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts. f. **Methanogenesis** from H2, CO2, CH3OH, HCOOH, methylamines, energy coupling and biosynthesis in methanogenic bacteria g. **Cynogens and cynotrophs**: cynogenesis and cynide degradation **Amphibolic role of EMP; Amphibolic role of TCA cycle** **Energetics of Glycolysis, TCA and ED pathway** – Balance sheet only. (2.5 ATP/NADH and 1.5 ATP /FADH2) (Based on this format make balance sheet for Glycolysis -Lactic acid and Alcohol fermentation and for ED pathway)	
Unit IV	**Fermentative Pathway & Anabolism of Carbohydrates** **Fermentative pathways** (with structures and enzymes) a. Lactic acid fermentation i. Homofermentation ii. Heterofermentation b. Bifidum pathway c. Alcohol fermentation i. By ED pathway in bacteria d. Urea Cycle: i. Carbamoyl Phosphate Synthetase: Acquisition of the First Urea Nitrogen atom ii. Ornithine Transcarbamoylase iii. Argininosuccinate Synthetase: Acquisition of the Second Urea Nitrogen atom iv. Argininosuccinase v. Arginase	**(15 Notional Hours)**

	e. Glyoxylate pathway **Other modes of fermentation in microorganisms** a. Mixed acid b. Butanediol c. Butyric acid d. Acetone-Butanol e. Propionic acid (Acrylate and succinate propionate pathway) **Anabolism of Carbohydrates** a. General pattern of metabolism leading to synthesis of a cell b. from glucose c. Sugar nucleotides d. Gluconeogenesis (only bacterial) e. Biosynthesis of glycogen f. Biosynthesis of Peptidoglycan	

References for UGMB503

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, th edition, 1987. John Wiley &Sons. New York.
3. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition W. H. Freeman and Company
6. Rose, A.H. (1976) Chemical Microbiology, 3rd edition. Butterworth-Heinemann
7. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
8. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
9. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.

Reference Books:

1. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
2. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer
3. Principles of Biochemistry, Lehninger, International edition Seventh edition
4. Biochemistry by Donald Voet, Judith Voet: Forth edition
5. Biochemistry by Berg J., John Tymoczko, Lubert Stryer Fifth edition

Practical based on UGMB503

[UGMBP05/III]
[Total Credits 1.5, Notional Hours 60]

1. Study of oxidative and fermentative metabolism
2. Qualitative and Quantitative assay of Phosphatase
3. Study of Homo – Heterofermentations
4. Isolation and detection of Mitochondria
5. Glucose detection by GOD/POD
6. Enrichment and isolation and identification of Methylobacterium
7. Determination of the isoelectric point of the given protein or determination of pKa value of amino acid
8. Estimation of polyphenols/tannins by FC reagent
9. Effect of pH on enzyme activity
10. Estimation of Uric acid

UGMB504- Industrial Microbiology and Bioprocess Technology-I

Course Outcome: Paper IV

By the end of the course, a student should develop the ability to

CO1: Apply knowledge of screening methods for isolating new industrial strains.[3]*

CO2: Set up Inoculum development process for industrial scale fermentations. [6] *

CO3: Diagrammatically explain continuous and Batch sterilization process for sterilization of media. [4]*

CO4: Relate importance of detection of variables and control. [4]*

CO5: Prepare a flow chart of Wine, Vinegar, Baker's yeast and Microbial enzyme production. [4]*

CO6: Apply chemical estimation methods to determine concentration of alcohol and sugar in prepared wine. [3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER V Paper IV		
Course Code	**Title**	**Credits**
UGMB504	**Industrial Microbiology and Bioprocess Technology - I**	**4 Credits (60 Lectures)**
Unit I	**Upstream Processing** **Screening for productive strains and Strain Improvements.** a. Source of Microorganisms used in bioprocess b. Literature search and culture collection supply. c. Isolation *de novo* of microorganisms producing metabolites of economic importance. d. Enrichment with the substrate utilized by the microorganisms being sought. e. Enrichment with toxic analogues of the substrate utilized by the microorganisms being sought. f. Testing microbial metabolites for bioactive activity. **Strain Improvement.**	**(15 Notional Hours)**

	a. Selection from naturally occurring variants. b. Manipulation of the genome of industrial microorganisms. c. Genome manipulations not involving foreign DNA or bases: Conventional mutation. d. Strain improvement methods involving foreign DNA or bases. **Preservation of cultures** a. Preservation of industrially important organisms b. Quality control of preserved stock -Key Criteria's c. Development of a master culture bank (MCB) d. Variability test to ensure reproducibility of the MCB **1.4 The development of inocula for industrial fermentations** a. Development of inocula for unicellular bacterial process b. Development of inocula for mycelial process	
Unit II	**Nutrition Of Industrial Microorganisms And Sterilization Methods** The basic nutrient requirements of Industrial media. a. Criteria for the choice of raw material used in industrial media. b. Some raw material used in compounding Industrial media. c. Growth factors and Water. d. Some potential sources of components in Industrial media- Carbohydrate and Protein sources. e. The use of plant waste material in Industrial media-Starch ,Cellulose, hemi-cellulose and lignin f. Difference between Inoculum development media and production media **Sterilization** a. Introduction: The basis of loss by Contaminants. b. Medium sterilization (concept of nabla factor) c. Methods of batch sterilization d. The design of continuous sterilization process e. Sterilization of the Fermenter	**(15 Notional Hours)**

	f. Sterilization of the Feeds g. Sterilization of the liquid wastes **Filter Sterilization** a. Filter sterilization of fermentation media b. Filter sterilization of air c. Filter sterilization of fermenter exhaust air. **Achievement of aseptic conditions** Aseptic operation & containment	
Unit III	**Fermention Equipments And Control** **3.1 Design of fermenter** Basic functions of fermenter,- Aeration and agitation: Agitators, Stirrer glands & bearing, Baffles Mechanical seals(Names & Functions ,no diagrams), Magnetic Drive Sparger: porous, orifice; nozzle; combined e. Achievement & maintenance of ascetic condition, Valves / Steam traps – Function in general & examples. **Types of fermenters:** Acetator, Cavitator, Tower fermenter, Cylindro conical, Air lift fermenter – outer loop / inner loop, Deep jet, Cyclone column, Packed tower (generator), Rotating disc, Bubble cap. **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 **Scale up and scale down of fermentation**	**(15 Notional Hours)**
Unit IV	**TRADITIONAL FERMENTATIONS** **4.1 Wine – Red & White:** Alcoholic fermentation, composition of grape juice, Sulphur dioxide addition, factors affecting wine fermentation, examples and role of yeasts involved in fermentation, malolactic fermentation, technological aspects of wine making- red, white,	**(15 Notional Hours)**

	champagne, sherry, examples of aroma compounds of wine, types and examples of wine **Vinegar (acetic acid):** Introduction, biosynthesis, production using generator, production using submerged fermenter, recovery. **Baker's yeast:** Outline of production, yeast strains and their properties, factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature, preparation of substrate, fermentation, harvesting of yeast cells, production of compressed and active dry yeast. **Microbial transformation of steroids and Sterols** a. Uses of steroids and sterols as sex hormones, corticosteroids, saponins , heterocyclic steroids b. Types of microbial steroids transformations. **Production of Microbial Enzymes** a. Introduction, development of new enzymes, Fermentation process, recovery and finishing, specifications, regulations and applications. b. Example: production of Amylase by Bacteria (Submerged) and by Fungi (SSF) **Production of Carotenoids.** Introduction and production of Beta carotene	

Note: 1) Green Color: Topics related to Local/National/Regional & global development needs
2) Blue Color: Topics related to Employability/Entrepreneurship/Skill Development
3) Yellow Color: Topics related to professional ethics, gender, human values, Environment & Sustainability

Text Books and References for : UGMB504

Text books:

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"

4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
5. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
6. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
8. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
9. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th edition, McMillan Publishers

Reference books

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

Practical based on UGMB504

[UGMBP05/IV]
[Total Credits 1.5, Notional Hours 60]

1. Determination of antibiotic spectrum using agar strip and streak method.
2. Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative).
3. Wine production from apple.
   Alcohol and Sugar Tolerance of yeast for wine production
   Preparation of yeast innoculum
   Sugar Estimation and Alcohol estimation
4. Vinegar production from red wine.
5. "Sirka" production and study of its microflora
6. Isolation of Carotenoid producers from natural sources
7. Industrial Visit

T.Y.B.Sc. Microbiology: Curriculum
Revised for Credit Based Semester & Grading System
To be implemented from the academic year 2020-2021
SEMESTER VI

Theory:

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB601 Microbial Genetics -II	Unit I	Gene Transfer Mechanisms & Recombination	3	4
	Unit II	Recombinant DNA technology		
	Unit III	Introduction to Virology		
	Unit IV	Advanced Virology		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB602 Medical Microbiology and Immunology -II	Unit I	Medical Mircobiology II	3	4
	Unit II	Chemotherapy of Infectious agents		
	Unit III	Immune responses and their detection		
	Unit IV	Vaccines, Immuno-hematology and Hypersensitivity		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ week
UGMB603 Microbial Biochemistry -II	Unit I	Lipid Metabolism & Catabolism of Hydrocarbons	3	4
	Unit II	Metabolism of Proteins and Nucleic Acids		
	Unit III	Metabolic Regulation		
	Unit IV	Prokaryotic Photosynthesis & Inorganic		

		Metabolism		
Course Code	**UNIT**	**TOPIC HEADINGS**	**Credits**	**NH/ week**
UGMB604 Bioprocess Technology: – II	**Unit I**	**Downstream Processing**	**3**	**4**
	Unit II	**Advances in Bioprocess Technology**		
	Unit III	**Quality Assurance, Quality Control, Instrumentation and Bioassay**		
	Unit IV	**Industrial Fermentations**		

PRACTICAL:

COURSE CODE	**PAPER**	**TOPIC HEADINGS**	**Credits**	**NH/ week**
UGMBP601	**I**	**Microbial Genetics -II**	**6**	**16**
	II	**Medical Microbiology and Immunology -II**		
	III	**Microbial Biochemistry-II**		
	IV	**Bioprocess Technology: – II**		

UGMB601- Genetics & Virology

Course Outcome: Paper I

By the end of the course, a student should develop the ability to

CO1: Diagrammatically represent Transformation, Transduction and Conjugation, as well as Homologous Recombination.[4]*

CO2: Paraphrase methods of cloning and screening the clones.[2]*

CO3: Solve analytical problems on restriction mapping .[5]*

CO4: Summarize viral genomes, enzymes and envelops.[2]*

CO5: Compare and contrast between different methods of virus visualization and enumeration.[4]*

CO6: Study enrichment and isolation of Coliphages.[3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER VI Paper I		
Course Code	**Title**	**Credits**
UGMB601	**Genetics & Virology**	**4 Credits (60 Lectures)**
Unit I	**Gene Transfer Mechanisms & Recombination** **1.1 Gene transfer mechanisms in bacteria** **a. Transformation** bacteria Natural transformation in *Bacillus subtilis, Haemophilus influenzae* Artificial Transformation Transformation as a genetic tool: gene mapping v. Transformation as a molecular tool vi. Problems based on transformation. **b. Conjugation** i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sex factor iii. The conjugation machinery iv. Transfer of DNA v. Surface exclusion vi. Formation of Hfr and transfer of DNA vii. Genetic uses of Hfr strains- mapping of genes viii. Formation of F- prime and transfer of DNA	**(15 Notional Hours)**

	ix. Genetic uses of F-primes - mapping of genes x. Conjugation from prokaryotes to eukaryotes xi. Problems based on conjugation **c. Transduction** i. Discovery of transduction in bacteria ii. Generalized transduction- P1 as a model iii. Two-factor crosses to determine gene linkage iv. Three- factor crosses to map the order of genes v. Strain construction vi. Localized mutagenesis vii. Specialized transduction- lambda phage as a model viii. Making merodiploids with specialized transducing phage ix. Problems based on transduction **d. Recombination in bacteria** i. Models of Homologous recombination ii. Holliday model of recombination iii. Enzymes & proteins involved in recombination iv. Site –specific recombination- e.g. lambda phage v. Illegitimate recombination	
Unit II	**Recombinant DNA technology** **2.1 DNA Cloning- Basic steps** **2.2 Restriction enzymes** **2.3 Cloning vectors** a. Plasmids b. Bacteriophages c. Artificial chromosomes d. Shuttle Vectors e. Expression vectors f. Cosmids g. Phagmids h. PCR cloning vectors i. Transcribable vectors **2.4 Methods of transformation of host cell** **2.5 DNA Libraries** a. Genomic Libraries b. Chromosomal Libraries c. cDNA libraries **Finding a specific clone in a library** a. Screening a cDNA library	**(15 Notional Hours)**

	b. Screening a genomic library c. Identifying genes by complementation of mutations d. Identifying genes using heterologous probes e. Identifying genes using oligonucleotide probes **Molecular Techniques for analysis of DNA** a. Restriction mapping b. Southern Blot Analysis of sequences of genome c. Northern Blot Analysis of RNA d. Fluorescent *in situ* hybridization **Polymerase Chain Reaction** a. Basic steps b. Advantages and limitations of PCR c. Applications of PCR d. Reverse Transcription- PCR e. Real-time PCR	
Unit III	**Introduction to Virology** **Historical Perspective** a. Important milestones in developing virology b. Discovery of emerging viruses in 21st century **Viral Architecture** a. Properties viruses b. Viral structure and morphology- Capsid, genome, envelope, Viral enzymes c. Structural details of T4, TMV, HIV & Influenza virus d. Viruses that challenge the definition- Giruses, Virophages **Viral Taxonomy & Nomenclature** a. Classification on the basis of diseases b. Classification on the basis of host organisms c. Classification on the basis of virus morphology d. Classification on the basis of nucleic acids e. Baltimore classification f. Virosphere g. Viral Nomenclature **Cultivation of Viruses** a. Cultivation of Bacterial viruses b. Cultivation of Animal viruses- Embryonated	**(15 Notional Hours)**

	eggs, Tissue culture, Animals **c.** Cultivation of Plant viruses	
Unit IV	**Advanced Virology** **4.1 Visualization and enumeration of virus particles** a. Measurement of infectious units i. Plaque assay ii. Fluorescent focus assay iii. Infectious center assay iv. Transformation assay v. Endpoint dilution assay. b. Measurement of virus particles and their components i. Electron microscopy ii. Hemagglutination assay iii. Measurement of viral enzyme activity. c. Serological methods i. Virus neutralization assay ii. Immunostaining iii. Immunoblotting iv. Immunoprecipitation v. ELISA vi. PCR vii. Microarray technology **4.2 Life cycle of T4 phage, TMV, Influenza Virus and HIV** **4.3 Regulation of lytic and lysogenic pathway of lambda phage** **4.3 Role of viruses in cancer:** Important definitions, characteristics of cancerous cells, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus, RNA tumor viruses **4.5. Prions and viroids:**	**(15 Notional Hours)**

References for UGMB601

1. Peter J. Russell (2010), "Genetics-A molecular approach", 3rd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman and company.
3. M. Madigan, J. Martinko, J. Parkar, (2012), "Brock Biology of microorganisms", 13th ed., Pearson Education International.
4. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
5. Edward Wagner and Martinez Hewlett, (2008) "Basic Virology", 3rd edition, Blackwell Publishing
6. Teri Shors, (2009) , "Understanding viruses", Jones and Bartlett publishers.
7. Robert Weaver, (2008), "Molecular biology", , 3rd edn. Mc Graw Hill international edition.
8. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th ed, Blackwell Publishing
9. Snustad, Simmons, "Principles of genetics", 3rd edn. John Wiley & sons, Inc.
10. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edn. ASM press.
11. Benjamin Lewin, (9th edition), "Genes IX", , Jones and Bartlett publishers.
12. J.D. Watson, "Molecular biology of the gene", 5th edition.

Practical Syllabus Based on UGMB601

Course Code: UGMBP06/I

[Credits: 1.5, Notional hours: 60]

1. Isolation of genomic DNA of *E. coli*
2. Gel Electrophoresis of DNA
3. Elution of DNA from Gel
4. Isolation of plasmid DNA by alkaline lysis method.
5. Preparation of competent cells and transformation
6. Enrichment of coliphages, phage assay (pilot & proper).
7. Restriction digestion mapping [Problem solving]
8. Polymerase Chain Reaction
9. Animal cell culture (Demonstration)

UGMB602-Medical Microbiology and Immunology -II

Course Outcome: Paper II

By the end of the course, a student should develop the ability to

CO1: Predict risk of Nosocomial infection in health care workers and enlisting Nosocomial infection [5]*

CO2: Suggest appropriate Chemotherapeutic drug & find out alternate drug of choice [4]*

CO3: Summarise the ABO blood group systems for Transfusions and Transplantation [2]*

CO4: Analyse Antigen Antibody interactions for variety of Immunological assays [4]*

CO5: Test the effect of antibiotics against the pathogens by Kirby Bauer method [4]*

CO6: Distinguish the blood groups based on ABO system [4]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER VI Paper II		
Course Code	**Title**	**Credits**
UGMB602	**Medical Microbiology and Immunology -II**	**4 Credits (60 Lectures)**
Unit I	**Medical Microbiology II** **Study of vector-borne infections** – Malaria **Sexually transmitted infectious diseases**: a. AIDS b. Gonorrhea c. Human Papilloma virus d. Genital Herpes **Central Nervous system infectious diseases:** a. Cerebro Spinal Fluid changes during CNS infections (only tabular information) b. Polio(detail) c. Meningococcal meningitis(short) - Tabular information on bacterial and viral meningitis	**(15 Notional Hours)**

	(pathogen, clinical features, mortality, sequelae) d. Study pathogenesis of viral encephalitis (only diagram) **1.4 Health care associated infections (overview)** a. Risk factors. Common infecting organisms and measures to prevent nosocomial infections) b. Health associates UTI, bacteremia, pneumonia, wound, hepatitis B, C, tetanus, gastroenteritis c. Sources and reservoirs of health-care associated infections-self,cross,environmental sources d. Measures to control, standard precautions-hand hygiene, personal protective equipment, injection safety, environmental cleaning, medical equipment, respiratory hygiene/cough etiquette, precautions in Operation Theatre e. Post-exposure control **1.5 List of new infectious diseases recognized since 1977**	
Unit II	**Chemotherapy of Infectious agents** **2.1 Chemotherapy of Infectious Agents** ttributes of an ideal chemotherapeutic agent i. Selective toxicity ii. Bioavailability of drug iii. Routes of drug administration iv. LD50 v. MBC **Mode of action of antibiotics:** **a. Bacteria:** i. Cell wall: Beta lactams [1st to 6th Generation- e.g. Meropenem, Imipenem, Piperacillin], Cycloserine Cephalosporins, Bacitracin ii. Cell membrane (Polymyxin, Monensin) iii. Protein synthesis (Streptomycin, Tetracycline,Chloramphenicol) iv. Nucleic acids (Nalidixic acid, Rifamycin, Quinolones) v. Enzyme inhibitors (Trimethoprim, Sulfa drugs) **b. Fungi:** Griseofulvin, Nystatin, Amphotericin B, Anidulafungin **c. Viruses:** Acyclovir, Zidovudine, Oseltamivir	**(15 Notional Hours)**

	d. **Protozoa:**Metronidazole, Mepacrine) **Resistance to antibiotics:** a. Development of antibiotic resistance (e.g. ESBL, VRE, MRSA) b. Reasons and Mechanisms of drug resistance c. Use and misuse antibiotics **Selection and testing of antibiotics for bacterial isolates by Kirby-Bauer method** a. Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains b. Suceptiblity tests- MBC,Serum bacterial assay **Use of antibiotics in combination**	
Unit III	**Immune Responses And Their Detection** **: Humoral Response** a. Introduction of Humoral response, Primary and secondary responses b. Germinal centres and antigen induced B cell Differentiation c. Affinity maturation and somatic hyper mutation, Ig diversity, class switching d. Generation of plasma cells and memory cells. **Cell mediated effector response** a. Generation and target destruction by Cytotoxic T cells. b. Killing mechanism of NK cells. c. Antibody dependent cell cytotoxicity (ADCC) **: Antigen Antibody interactions** a. Precipitation reaction – Immunoelectrophoresis b. Agglutination reactions - haeme-agglutination, bacterial agglutination, passive agglutination, agglutination inhibition c. Radioimmunoassay (RIA) d. Enzyme Linked Immunosorbent Assay - indirect, competitive and sandwich ELIS e. Immunofluorescence- Direct and indirect. f. Western blotting. g. Complement fixation test	**(15 Notional Hours)**
Unit IV	**Vaccines, Immuno-hematology and Hypersensitivity**	**(15 Notional Hours)**

	: Vaccines a. Active and passive immunization b. Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines c. Use of adjuvants in vaccine d. New vaccine strategies. e. Ideal vaccine **: Immuno-haematology** a. Human blood group systems b. ABO system c. Secretors and non secretors d. Bombay Blood group. e. Rhesus system and list of other blood group system. f. Haemolytic disease of new born g. Coombs test. **: Hypersensitivity** a. Coombs and Gell's classification (Table) b. IgE mediated (Type I) hypersensitivity c. Antibody mediated cytotoxic (Type II) hypersensitivity d. Immune complex mediated (Type IV) hypersensitivity e. Delayed type (Type IV) hypersensitivity	

References for UGMB602

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition, Lange publication
2. Ananthnarayan and Panicker's, Textbook of Microbiology, 10th editio2017
3. Cedric Mims, Medical microbiology,3rd edition
4. Ananthnarayan and Panicker's, Textbook of Microbiology, 9th editionAnanthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria Dannessa Delost 2015

6. Prescott's microbiology 10th edition 2017
7. Kuby Immunology,4th and 6th edition, W H Freeman and Company
8. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital

Practical Syllabus Based on UGMB602

Course Code: UGMBP06/II

[Credits: 1.5, Notional hours: 60]

1. Detection of malarial parasite in blood films.
2. Selection and testing of antibiotics using the Kirby-Bauer method
3. Determination of MBC of an antibiotic.
4. Antibiotic assay in body fluids
5. Blood grouping – Direct & Reverse typing, Major-minor cross match,
6. Coomb's direct test, Calculation of hematological indices
7. Serum protein separation by electrophoresis
8. Determination of Isoagglutinin titer
9. Demonstration experiments - Widal
10. ELISA (Qualitative)
11. Single Radialimmunodiffusuion.
12. Visit to blood bank and preparation of visit report

UGMB603-Microbial Biochemistry – II

Course Outcome: Paper III

By the end of the course, a student should develop the ability to

CO1: Distinguish the Lipids and mention its functions [4]*

CO2: Illustrate Catabolism and Anabolism of Nucleotides and Amino acids [3]*

CO3: Identify the terms involved in the regulation of metabolic pathways[2]*

CO4: Discriminate between Regulation of transcription by positive & negative control and evaluate the role of DNA Binding Proteins[5]*

CO5: Discriminate mechanisms of Light and Dark reactions which are part of Photosynthesis [5]*

CO6: Measure proteins by Folin Lowry's method [5]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER VI Paper III		
Course Code	**Title**	**Credits**
UGMB603	**Microbial Biochemistry - II**	**4 Credits (60 Lectures)**
Unit I	**Lipid Metabolism & Catabolism of Hydrocarbons** **Introduction to Lipids** a) Lipids –Definition, classification & functions b) Types and role of fatty acids found in bacteria c) Common phosphoglycerides in bacteria d) Action of lipases on triglycerides /tripalmitate **Catabolism of Fatty Acids and PHB** a) Oxidation of saturated fatty acid by β oxidation pathway b) Energetics of β oxidation of Palmitic acid c) Oxidation of propionyl CoA by acrylyl- CoA pathway and methylcitrate pathway d) PHB as a food reserve and its degradation **Anabolism of Fatty Acids & Lipids**	**(15 Notional Hours)**

	a) Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b) Biosynthesis of phosphoglycerides in bacteria c) Biosynthesis of PHB **Catabolism of aliphatic hydrocarbons** a) Organisms degrading aliphatic hydrocarbons b) Hydrocarbon uptake mechanisms c) Omega oxidation pathway- i. Pathway in *Corynebacterium* and yeast *ii.* Pathway in *Pseudomonas*	
Unit II	**Metabolism of Proteins and Nucleic Acids** **Protein metabolism: Protein folding, Dynamics** a) Protein Folding: Theory and Experiment b) Folding Accessory Proteins c) Enzymatic degradation of proteins d) General reactions of amino acids catalyzed by i. Amino acid decarboxylases ii. Amino acid deaminases iii. Amino acid transaminases iv. Amino acid racemases e) Metabolic fate of amino acids - Glucogenic and ketogenic amino acids f) Fermentation of pair of amino acids -Stickland reaction(include enzymes) **Anabolism of amino acids** a) Schematic representation of amino acid families b) Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) **Catabolism of Amino Acids** Degradation of Amino acids to:	**(15 Notional Hours)**

	a) Pyruvic acid b) Acetyl Co-A c) α- Ketoglutarate d) Succinyl Co-A **Catabolism of Nucleotides** a) Degradation of purine nucleotides up to uric acid formation b) Salvage pathway for purine and pyrimidine nucleotides **Biosynthesis of nucleotides** a) Biosynthesis of pyrimidine nucleotides b) Biosynthesis of purine nucleotides c) Biosynthesis of deoxyribonucleotides	
Unit III	**Metabolic Regulation** **Definition of terms and major modes of regulation** **Regulation of enzyme activity** a) Noncovalent enzyme inhibition i. Allosteric enzymes and feedback inhibition ii. Patterns of FBI, combined activation and inhibition b) 3.2.2 Covalent modification of enzymes i. Monocyclic cascades ii. Examples of covalent modification(without structures) iii. Regulation of Glutamine synthetase c) Regulation of Multienzyme complexes and multifunctional enzymes, specific eg: Blood coagulation cascade **DNA binding proteins and regulation of transcription by positive & negative control** a) DNA binding proteins b) Negative control of transcription: Repression and	**(15 Notional Hours)**

	Induction *c)* Positive control of transcription: Maltose catabolism in *E. coli* *d)* Ara operon *e)* Trp operon **Global regulatory mechanisms** a) Global control & catabolite repression b) Stringent response **Regulation of EMP and TCA cycle -** (Schematic and Regulation of Pyruvate dehydrogenase Complex)	
Unit IV	**Prokaryotic Photosynthesis & Inorganic Metabolism** **Photosynthesis** a) Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) b) Photosynthetic pigments c) Location of photochemical apparatus d) Photochemical generation of reductant **Light reactions in:** a) Purple photosynthetic bacteria b) Green Sulphur bacteria c) Cyanobacteria (with details) **Dark reaction** a) Calvin Benson cycle b) Reductive TCA cycle **Inorganic Metabolism** a) Assimilatory pathways: i. Assimilation of nitrate, ii. Ammonia fixation – Glutamate dehydrogenase,	**(15 Notional Hours)**

	Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase iii. Biological nitrogen fixation (Mechanism for N2 fixation and protection of nitrogenase) iv. Assimilation of sulphate b) Dissimilatory pathways: i. Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*) ii. Sulphate as an electron acceptor **4.5 Lithotrophy**–Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron	

Reference for UGMB603

Text books

1. Principles of Biochemistry, Lehninger, International edition Seventh edition
2. Donald Voet, Judith Voet: Forth edition
3. Berg J., John Tymoczko, Lubert Stryer Fifth edition.]
4. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
5. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry,5th edition, 1987. John Wiley & Sons. New York.
6. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
7. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
8. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry, 4th edition, W. H. Freeman and Company.
9. G. Moat, J.W. Foster, M,P. Spector.(2002), Microbial Physiology, 4th edition, WILEYLISS
10. Madigan, M.T. and J.M. Martinko2006. [11th edition] Brock Biology of Micro-organisms. Pearson Prentice Hall.

Reference books:

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

Practical Syllabus Based on UGMB603

Course Code: UGMBP06/III

[Credits: 1.5, Notional hours: 60]

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

UGMB604- Industrial Microbiology and Bioprocess Technology-II

Course Outcome: Paper IV

By the end of the course, a student should develop the ability to

CO1: Diagrammatically/ schematically represent Effluent Treatment steps. [4]*

CO2: Choose correct method of recovery for a particular product. [5]*

CO3: Differentiate between ATC and PTC media [4]*

CO4: Exemplify various biological and physical indicators used for Sterility Assurance. [2]*

CO5: Prepare a flow chart for manufacturing process of Streptomycin, Vitamin B12, Glutamic acid, Mushroom and Vaccines. [4]*

CO6: Perform agar diffusion type of Bioassay to determine concentration of Streptomycin and Vitamin B_{12}. [3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER VI Paper IV		
Course Code	**Title**	**Credits**
UGMB604	**Industrial Microbiology and Bioprocess Technology - II**	**4 Credits (60 Lectures)**
Unit I	**Down Stream Processing- I** **Recovery and purification of Fermentation products** a. Introduction b. Removal of solid materials. c. Foam separation Precipitation Filtration- Theory of filtration, Batch filters, Continuous filters flocculation and Ranges of centrifugations. Cell Disruption Liquid-Liquid Extraction	**(15 Notional Hours)**

	i. Solvent Recovery j. Chromatographic techniques k. Membrane Processes Drying Crystallization Whole Broth Processing **1.2 Effluent treatment –** Introduction, Dissolved oxygen concentration as indicator of water quality, The strength of fermentation effluents, Treatment process (Physical, chemical and biological)	
Unit II	**Advances in Bioprocess Technology-II** **Animal biotechnology** Primary cell culture and established cell lines Basic principles, Growth media, Cell viability Scale up of cultured cells and tissue Applications of cell culture: Vaccines, somatic cell fusion, valuable products. **Plant Biotechnology** :Introduction Requirements for in vitro culture, Methods of plant cell and tissue culture Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropogation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization. Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance, micropropogation, secondary metabolites from cell culture, transgenic plants for crop improvement **Immobilized enzyme and cells** Introduction and Definitions Methods, Immobilized Enzyme Reactors, Applications	**(15 Notional Hours)**
Unit III	**Quality Assurance, Quality Control, Instrumentation and Bioassay Modes of fermentation** **Quality assurance, quality control and GMP** a. Definitions, Chemical and pharmaceutical	**(15 Notional Hours)**

	products and Variables of batch process b. Q.A and Q.C wrt.- Raw materials, method of manufacturing, in process items, finished products, label and labelling, packaging materials c. Control of microbial contamination during manufacturing d. Good Manufacturing Practices **3. 2. Sterilization control and assurance** **Instrumentation: Principles, working and application of** a. Spectrophotometry: b. UV, Visible c. IR d. AAS & AES e. Flame photometry f. Fluorimetry **Bio-assay** a. Introduction b. Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic	
Unit IV	**Industrial Fermentations** **Aminoglycoside: Streptomycin:** Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery. **Vitamin B_{12}:** Occurrence and economic significance, structure, biosynthesis, production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas*, recovery. **Glutamic acid:** Production strains, biosynthesis, effect of permeability on production, conditions of	**(15 Notional Hours)**

	manufacturing, production process and recovery. **Mushroom cultivation (Agaricus):** Edible mushroom species, preparation of substrate-composting- phase I and phase II, Factors affecting composting, preparation of spawn, casing, induction of fruiting body formation, harvesting **Vaccine production:** Bacterial vaccine (TAB Vaccine) and Viral vaccine(Polio Vaccine)	

Note: 1) Green Color: Topics related to Local/National/Regional & global development needs
2) Blue Color: Topics related to Employability/Entrepreneurship/Skill Development
3) Yellow Color: Topics related to professional ethics, gender, human values, Environment & Sustainability

Reference for UGMB604

Text books

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

Reference books

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Williams, Bryan L; Wilson, 2nd edition." A Biologist's guide to principles and techniques of practical biochemistry" Baltimore: University Park Press, 1981.

3. Wilson, Keith, 1936-; Goulding, Kenneth H, 3rd edition., A Biologist's guide to principles and techniques of practical biochemistry" London ; Baltimore : E. Arnold, 1986.
4. Wilson and Walker, "Principles and techniques of practical biochemistry" 5th edition

Practical Syllabus Based on UGMB604

Course Code: UGMBP06/IV

[Credits: 1.5, Notional hours: 60]

1. Bioassay of an antibiotic (Streptomycin)
2. Bioassay of Vitamin B12 (Cyanocobalamin).
3. Perform immobilization of yeast cells for invertase activity - making of beads, determination of activity and viable count by haemocytometer.
4. Plant tissue culture – Callus culture
5. Sterility testing of inject able.
6. Preparation of TAB vaccine.
7. Estimation of phenol.
8. Industrial Visit