AC: 4/4/20
Item No: 5.16

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI. NAVI MUMBAI

(AUTONOMOUS COLLEGE)

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

Program:

B.Sc. Microbiology Syllabus for T. Y. B. Sc. Microbiology

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

Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi
Autonomous College

Syllabus

Sr. No.	Heading	Particulars
1	Title of Course	T.Y.B.Sc. Microbiology
2	Eligibility for Admission	S.Y.B.Sc. (Microbiology) From a recognized university
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	New
9	To be implemented from Academic year	2020-2021

Preamble of the Syllabus

Bachelor of Science (B.Sc.) in Microbiology is an under graduation programme 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, 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: Medical, Pharmaceutical, and Industrial (Fermentation, Pollution Control), Air, Water, Food and Dairy, Agriculture (Plant Pathology and Soil Microbiology), Veterinary, Environmental (Ecology, Geomicrobiology).

Microbiological tools have been extensively used to study different life processes and are cutting edge technologies. There is a continual demand for trained microbiologists in the different work domains like – education, industry and research. Career opportunities for the graduate students are available in manufacturing industries and research institutes at technical levels apart from opportunities in academics.

The content of a syllabus should be such that it should maintain the continuity with the course content of higher secondary classes and act as a bridge to post graduate courses. 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 and Grading System and reflects the total credit, teaching hours and evaluation pattern.

Objectives of the Course: The important objectives of this course are as below-

- ✓ 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

Course Learning Outcome:

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

Semester V:
UGMB501: Microbial Genetics
Unit I: DNA Replication

1. Predict theoretical results of conservative and dispersive replication of DNA under Meselson and Stahl's experiment. [5]*
2. Illustrate the molecular mechanisms of DNA replication in Prokaryotic and Eukaryotic organisms.[3]*
3. Describe roles of all the enzymes and proteins involved in DNA replication.[2]*
4. Schematically represent replication events.[4]*
5. Compare and contrast between Prokaryotic and Eukaryotic DNA replication.[4]*
6. Apply the knowledge to solve higher order thinking questions

Unit II: Gene Expression and Regulation

7. Paraphrase the molecular mechanisms of Transcription & Translation in prokaryotic and eukaryotic organisms.[2]*
8. Describe roles of all the enzymes and proteins involved in Gene Expression and Regulation.[2]*
9. Diagrammatically explain various events of Gene Expression and Regulation.[4]*
10. Compare and contrast between prokaryotic and eukaryotic gene expression.[4]*
11. Forecast effect of Mutations on gene expression and regulation.[6]*

Unit III: Mutations and Repair

1. Infer effect of mutation on the phenotype.[5]*
2. Summarize molecular mechanisms of different types of Mutations and Repair systems.[2]*
3. Schematically/diagrammatically elaborate Repair mechanisms and action of Mutagenic agents.[4]*
4. Justify use of various methods of virus detection. [5]*
5. Compare & contrast between different types of Mutations and Repair mechanisms.[4]*

Unit IV: Natural Plasmids, Transposable Elements & Integrons, Genetic Research

1. Exemplify on types of plasmids, transposable elements, model organisms.[2]*
2. Prepare a flow chart of isolation of plasmids, transposition mechanism.[2]*

3. Compare & contrast between Composite and Non-composite Transposons, IS elements and Transposons.[4]*
4. Justify a strategy for setting up a Genetic experiment.[3]*

UGMBP501: Practical Based on Unit-I, II, III & IV of UGMB501

1. Study effect of UV light as an Mutagen.[3]*
2. Isolate and quantify Mutants in a population.[3]*
3. Perform Gradient Plate Technique.[3]*
4. Perform UV survival curve. [3]*
5. Study induction of Lac-operon. [3]*
6. Solve analytical problems on Genetics.[4]*

UGMB502: Medical Microbiology

Unit I: Bacterial Strategies for Evasion

1. Paraphrase attributes of microbial Pathogenicity & Disease progression [2]*
2. Compare & contrast between Exotoxin & Endotoxin produced by pathogenic microorganisms [4]*
3. Summarise Pathogenicity Islands [2]*
4. Forecast effects of virulence factors on host [6]*
5. Infer causative (Etiological) agent of the disease [5]*
6. Justify the role of Quality Control in accurate diagnosis [5]*

Unit II: Study of Few Diseases

1. Summarize cultural, morphological characteristics of Etiological agent to get diagnosis done accurately [2]*
2. Justify spread of Skin, Respiratory and Urinary tract infection & understanding clinical manifestation [5]*
3. Classify lesions of Leprosy[2]*
4. Predict the stages of infection [5]*
5. Monitor the Prophylactic Measures to minimize risk of infection [4]*
6. Research on MDR TB [4]*

Unit III: General Immunology

1. Distinguish the organs of Immune system based on their structure and function [4]*
2. Understand overall organisation of the Immune system [2]*
3. Determine the factors for an Antigen to become Immunogen [5]*
4. Construct structure of Antibody based on chemical and enzymatic method [6]*
5. Diagrammatically study the different types of Antibodies and their biological roles with occurrence [4]*

Unit IV: Activation of Immune Cells

1. Assess the Immune cells and their role in Immune system [5]*
2. Attribute the mechanism of B-Cells and T-cells in Humoral and Cell Mediated Immune Response respectively[4]*
3. Paraphrase how the collection of individual clones of Lymphocytes arises from rearrangement within two genetic loci: the Ig gene in B- Cells and the Antigen receptor in T-Cells [2]*

4. Justify the Clonal selection that allows for the expansion of a limited number of antigen recognizing lymphocytes in response to an specific antigen stimulus [5]*
5. Distinguish between the cells involved in Humoral response and Cell Mediated Immune Response [4]*

UGMBP502: Practical Based On Unit-I, II, III & IV of UGMB502

1. Perform rapid diagnosis of Tuberculosis and Leprosy [3]*
2. Select *Candida albicans* from other *Candida* species on chrome agar and evaluate Reynolds Braude phenomenon [5]*
3. Study the characteristics of standard cultures to make diagnosis from patient sample [3]*
4. Monitor live & dead lymphocyte by dye exclusion principle [4]*
5. Set up Quality Control measures in laboratory [6]*
6. Investigate the case studies of Epidemic infections, Emerging infections [4]*

UGMB503: Microbial Biochemistry I

Unit I: Biological Membranes & Transport

1. Appraise the Composition and Architecture of Membrane. [5]*
2. Construct a strategy of studying Solute Transport. [6]*
3. Distinguish between various types of Transport Mechanisms involved in the transport of essential nutrients in the metabolism of a cell. [4]*
4. Illustrate the Solute Uptake Model in the Prokaryotic cell. [3]*
5. Compare the role of exchange of metabolites between cells as the mode of communication and dissect the roles of Transporters in protein export and other processes. [5]*

Unit II: Bioenergetics & Quorum sensing

1. Distinguish between the structure and function of Electron & Hydrogen carriers in Mitochondria. [4]*
2. Illustrate and paraphrase complexes present in ETC of Mitochondria. [3]*
3. Discriminate the working mechanism of ATP Synthase and ATPase. [5]*
4. Appraise the functioning of Bacteriorhodopsin and its significance. [4]*
5. Evaluate the communication system in Non-bioluminescent bacteria (Quorum sensing). [5]*

Unit III: Methods of Studying Metabolism & Catabolism of Carbohydrates

1. Compare and analyze various experimental strategies required to study Metabolic Pathways. [4]*
2. Appraise elaborate working of Methanogens and its Catabolism. [4]*
3. Distinguish catabolism of Monosaccharide's, Disaccharides and Polysaccharides (Major and Minor pathways). [4]*
4. Dissect the regulation of EMP and TCA. [4]*
5. Measure the Energetics of glycolysis, TCA and ED pathway [5]*

Unit IV: Fermentative Pathway & Anabolism of Carbohydrates

1. Compare Homo-fermentative and Hetero-fermentative pathways that are present in the lactic acid bacterium pathway [5]*
2. Illustrate Bifidium and ED pathways. [3]*
3. Give the main idea of the fermentative pathways of Urea Metabolism. [2]*
4. Construct fermentative pathways that are present in microorganisms. [6]*
5. Construct anabolic pathways of carbohydrates. [6]*

UGMBP503: Practical Based on Unit-I, II, III & IV of UGMB- 503

1. Assess the Iso-electric value of amino acids. [5]*
2. Compare Oxidative and Fermentative metabolism [5]*
3. Determine a qualitative and quantitative assay for the Phosphatase enzyme [5]*
4. Discriminate between Homo-fermentative and Hetero-fermentative microorganisms [5]*
5. Evaluate quantitatively Mitochondrial activity.[5]*

UGMBP504: Industrial Microbiology and Bioprocess Technology

Unit I: Upstream Processing- I

1. Apply knowledge of screening methods for isolating new industrial strains.[3]*
2. Illustrate the mechanisms of Strain Improvement.[3]*
3. Apply various preservation of microbial culture. [3]*
4. Distinguish between different methods of preservation [4]*
5. Set up Inoculum development process for industrial scale fermentations. [6] *

Unit II: Nutrition of Industrial Microorganisms and Sterilization Methods

1. Describe roles of various raw materials for fermentation media preparation. [2]*
2. Develop new fermentation media by applying knowledge of various raw materials currently used. [6] *
3. Compare and contrast between Heat sterilization and Filter sterilization. [4]*
4. Diagrammatically explain continuous and Batch sterilization process for sterilization of media. [4]*
5. Predict containment level and plan Aseptic operations. [5]*

Unit III: Fermentation Equipments and Control

1. Select type of Fermenter and construction material for a particular fermentation. [5]*
2. Diagrammatically explain various types of Fermenter used. [4]*
3. Justify use of various types of agitators and Spargers. [5]*
4. Relate importance of detection of variables and control. [4]*
5. Summarize scale up and scale down of fermentation. [2]*

Unit IV: Industrial Microbiology and Bioprocess Technology Traditional Fermentations

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

2. Set up product recovery plans for various fermentations[6]*
3. Construct outline of production plan for various fermentations[6]*
4. Give examples of various types of wine and state differences of in each. [2]*
5. Justify significance of SSF for Amylase production. [5]*

UGMBP504: Practical Based On Unit-I, II, III & IV of UGMB- 504

1. Determination of antibiotic spectrum of newly isolated Antibiotic/ Antibiotic producer. [5]*
2. Compare Amylase production between shake flask and solid substrate fermentation. [4]*
3. Screen new yeast strain and to develop Innoculum for wine production. [5]*
4. Apply chemical estimation methods to determine concentration of alcohol and sugar in prepared wine. [3]*
5. Isolate Carotenoid producers from natural sources[3]*

Semester VI:
UGMB601: rDNA Technology & Virology
Unit I: Gene Transfer Mechanisms & Recombination

1. Map genes by analysing data obtained with Transformation, Conjugation & Transduction experiments. [4]*
2. Illustrate the molecular mechanisms of Gene transfer mechanisms in bacteria and Recombination methods.[3]*
3. Diagrammatically represent Transformation, Transduction and Conjugation, as well as Homologous Recombination.[4]*
4. Compare & contrast between various Gene transfer mechanisms.[4]*
5. Solve analytical problems based of Gene transfer mechanisms.[5]*

Unit II: Recombinant DNA technology

1. Paraphrase methods of cloning and screening the clones.[2]*
2. Describe roles of cloning vectors and enzymes used in rDNA technology.[2]*
3. Diagrammatically explain mechanism of Cloning & screening.[4]*
4. Solve analytical problems on restriction mapping .[5]*
5. Summarize PCR and its variations, blotting techniques, FISH. [2]*

Unit III: Introduction to Virology

1. Infer that viral genomes show great variety.[5]*
2. Summarize viral genomes, enzymes and envelops.[2]*
3. Schematically/diagrammatically elaborate different structures of viruses.[4]*
4. Justify that viruses can be cultivated by variety of methods.[5]*
5. Design a Virosphere.[6] *

Unit IV: Advanced Virology

1. Exemplify on role of viruses in Cancer, Prions and Viroids.[2]*
2. Prepare a flow chart of life cycles of representative viruses from different classes.[4]*
3. Compare and contrast between different methods of virus visualization and enumeration.[4]*
4. Construct a diagrammatic representation of regulation of Lysogeny in Lambda phage.[4]*

UGMBP601: Practical Based on Unit-I, II, III & IV of UGMB601

1. Study enrichment and isolation of Coliphages.[3]*
2. Perform Artificial Transformation.[3]*
3. Isolate and detect genomic DNA of *E. coli*.[3]*
4. Isolate and detect Plasmids.[3]*
5. Perform Polymerase Chain Reaction[3]*
6. Solve analytical problems on Restriction mapping.[4]*

UGMB602: Medical microbiology

Unit I: Study of Few Diseases with Emphasis on Cultural Characteristics of Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention

1. Summarise the risk of Sexually Transmitted Infection, its transmission and prophylactic measures [2]*
2. Map spread of Polio and damage cause to CNS by use of diagrammatic representation of the infection [3]*
3. Compare and contrast between Sabin & Salk vaccine [4]*
4. Forecast clinical manifestation of full blown AIDS after patient shows AIDS related complex (ARC) [6]*
5. Distinguish between Bacterial and Viral Meningitis [4]*
6. Predict risk of Nosocomial infection in health care workers and enlisting Nosocomial infection [5]*

Unit II: Chemotherapy of Infectious Agents

1. Study attributes of ideal Chemotherapeutic agent to formulate the drug [2]*
2. Predict on effective Route of Drug Administration & maximize Bioavailability [5]*
3. Schematically & Diagrammatically understand effect of cell wall inhibitors [4]*
4. Classify antibiotic based on their mechanism of action [4]*
5. Suggest appropriate Chemotherapeutic drug & find out alternate drug of choice [4]*
6. Paraphrase drug resistance by describing ESBL, VRE, MRSA [2]*
7. Create awareness of drug misuse [6]*

Unit III: Immune Responses and Their Detection

1. Monitor the developmental phases from generation to activation of B-Cell and T-cell.[5]*
2. Investigate the role of antibody, produced by B-Cell, in T-Cell Mediated Cytotoxicity [4]*
3. Summarize the salient feature and nature of Antigen Antibody interaction [2]*
4. Manipulate the Antigen Antibody interactions for variety of Immunological assays [3]*
5. Choose appropriate Immunological Assays in diagnosing diseases [5]*

Unit IV: Vaccines, Immunohematology and Hypersensitivity

1. Monitor the development of vaccines based on Epitopes recognised by B-Cell and T-Cell. [5]*
2. Summarise the ABO blood group systems for Transfusions and Transplantation [2]*
3. Describe the Haemolytic Disease of new born due to Rh-factor Incompatibility [2]*
4. Justify the response of inappropriate immune response for Hypersensitive reactions [5]*
5. Paraphrase the four types of Hypersensitive reactions and their nature [2]*

UGMBP602: Practical Based on Unit-I, II, III & IV of UGMB602

1. Investigate the Malarial protozoan under microscope [4]*
2. Test the effect of antibiotics against the pathogens by Kirby Bauer method [4]*
3. Distinguish the blood groups based on ABO system [4]*
4. Study Rhesus factor incompatibility in diagnosis of haemolytic diseases [2]*
5. Prepare heat killed vaccine and check its sterility [6]*
6. Find out Bioavailability of an antibiotic in body fluids.

UGMB603: Microbial Biochemistry II

Unit I: Lipid Metabolism & Catabolism of Hydrocarbons

1. Distinguish the Lipids and mention its functions [4]*
2. Outline the role of lipases on Triglycerides / Tripalmitate [2]*
3. Appraise the role of catabolism of Aliphatic hydrocarbons [4]*
4. Construct the Catabolic pathways of Fatty acids and PHB [6]*
5. Construct the Anabolic pathways of Fatty acids and PHB [6]*

Unit II: Metabolism of Proteins and Nucleic Acids

1. Outline pathways involved in protein metabolism[2]*
2. Paraphrase protein folding, dynamics & structural evolution [2]*
3. Appraise amino acid degradation pathways[4]*
4. Illustrate Catabolism of Nucleotides[3]*
5. Illustrate Anabolism of Nucleotides[3]*

Unit III: Metabolic Regulation

1. Identify the terms involved in the regulation of metabolic pathways[2]*
2. Illustrate various patterns of Feedback inhibitions [3]*
3. Compare and differentiate between Allosteric and Covalent modifications using examples [5]*
4. Discriminate between Regulation of transcription by positive & negative control and evaluate the role of DNA Binding Proteins[5]*
5. Justify regulation of EMP and TCA cycle [5]*

Unit IV: Prokaryotic Photosynthesis & Inorganic Metabolism

1. Appraise the history of scientific endeavors in terms of research related to photosynthesis [4]*
2. Outline various processes related to Photosynthesis [2]*
3. Discriminate mechanisms of Light and Dark reactions which are part of Photosynthesis [5]*
4. Dissect inorganic metabolic pathways related to Nitrate & Sulphate Assimilation and Dissimilation [4]*
5. Account for the types of Lithotrophic organisms [2]*

UGMBP603: Practical Based On Unit-I, II, III & IV of UGMB603

1. Assess the working model of Lac-operon (Catabolite repression) by Diauxic growth curve technique [5]*
2. Measure proteins by Folin Lowry's method [5]*
3. Evaluate a qualitative and Quantitative Assay for Protease enzyme [5]*

4. Determine qualitative and Quantitative Assay for Lipase enzyme [5]*
5. Deduce if the organism is capable of metabolizing amino acids [5]*

UGMB604: Industrial Microbiology and Bioprocess Technology

Unit I: Down Stream Processing

1. Relate different methods of Product Recovery depending upon product type. [4]*
2. Illustrate principle behind Product Recovery[3]*
3. Categorise different methods of Product Recovery. [4]*
4. Diagrammatically/ schematically represent Effluent Treatment steps. [4]*
5. Compare and contrast between different methods of product recovery.[4]*
6. Choose correct method of recovery for a particular product. [5]*

Unit II: Advances in Bioprocess Technology

1. Formulate media for ATC and PTC. [6]*
2. Differentiate between ATC and PTC media[4]*
3. List all necessary requirements for doing ATC. [1]*
4. Define various types of Immobilization methods. [2]*
5. Set up Immobilised cells and enzymes. [6]*

Unit III: Quality Assurance, Quality Control, Instrumentation and Bioassay Modes of fermentation

1. Compare and contrast between QA and QC[4]*
2. Discuss various aspects of GMP. [2]*
3. Diagrammatically explain principle and working of Spectroscopes. [4]*
4. Differentiate between Turbidometric and Diffusion types of bioassay. [4]*
5. Exemplify various biological and physical indicators used for Sterility Assurance. [2]*
6. Design experiment for assessing Sterility in pharmaceutical product. [6]*

Unit IV: Industrial Fermentations

1. Prepare a flow chart for manufacturing process of Streptomycin, Vitamin B12, Glutamic acid, Mushroom and Vaccines. [4]*
2. Compare and contrast between different methods of virus Visualization and Enumeration. [4]*
3. Exemplify various substrates used for Mushroom cultivation. [2]*
4. Discuss importance of maintaining proper fermentation conditions. [2]*
5. Categorise Streptomycin and Vitamins as secondary and primary metabolites. [4]*

UGMBP604: Practical Based on Unit-I, II, III & IV of UGMB603

1. Perform agar diffusion type of Bioassay to determine concentration of Streptomycin and Vitamin B_{12}. [3]*
2. Set up Bioreactor column of immobilized yeast cells and detecting activity of immobilized cells. [6]*
3. Count viable and dead cells stained Trypan blue using Hemocytometer slide.[3]*
4. Prepare TAB vaccine[3]*
5. Estimate phenol from industrial effluent and also to calculate efficiency of effluent treatment plant in degrading phenol [5]*

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

Program Outcomes (POs)		
Learners are able to:		
PO-1	**Disciplinary Knowledge and Skills**	Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to applythese skills in the field of science, technology and its allied branches.
PO-2	**Communication and Presentation Skills**	Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	**Creativity and Critical Judgement**	Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	**Analytical Reasoning and Problem Solving**	Build critical and analytical attitude in handling the problems and situations.
PO-5	**Sense of Inquiry**	Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	**Use of Modern Tools**	Use various digital technologies to explore information/data forbusiness, scientific research and related purposes.
PO-7	**Research Skills**	Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	**Application of Knowledge**	Develop scientific outlook to create consciousness against the socialmyths and blind faith.
PO-9	**Moral and Ethical Reasoning**	Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	**Leadership and Teamwork**	Work cooperatively and lead proactively to achieve the goals ofthe organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.
PO-11	**Environment and Sustainability**	Create social awareness about environment and develop sustainabilityfor betterment of future.
PO-12	**Lifelong Learning**	Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)	
PSO1	**Understand the various aspects of microbial world and history of microbiology.**
PSO2	**Differentiate and classify different types of microorganism and its characteristics**
PSO3	**Distinguish between Prokaryotes and Eukaryotes with respective to their ultrastructure and functions**
PSO4	**Understand & differentiate the requirement of nutrients and environmental conditions for the growth of microorganisms**
PSO5	**Apply the knowledge of basic instrumentation, basic techniques in microbiology and control of microorganism**
PSO6	**Explain and describe types and functions of different biomolecules found in living cells**
PSO7	**Describe the aspects of microbial ecology and industrial microbiology**
PSO8	**Illustrate the basic immunology and medical microbiology**

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

Scheme of examination for Each Semester:

Continuous Internal Evaluation: 40 Marks (Common Test-20 Marks & 20 Marks for-

Assignment, Projects, Group discussion, Open book test, online test etc.) based on Unit III of each paper.

Semester End Examination: 60 Marks will be as follows -

I.	**Theory:** The Semester End Examination for theory course work will be conducted as per the following scheme.	
	Each theory paper shall be of two hours duration.	
	All questions are compulsory and will have internal options.	
	Q – I	Subject questions from Unit – I (having internal options.) 15M
	Q – II	Subjective questions from Unit – II (having internal options.) 15 M
	Q – III	Subjective questions from Unit – II (having internal options.) 15 M
	Q – IV	Objective type questions based on Unit I, II, III with equal weightage. 15 M
II.	**Practical**	The Semester End Examination for practical course work will be conducted as per the following scheme.

Sr. No.	**Particulars of Semester End Practical Examination**	**Marks%**
1	Laboratory Work	160
2	Journal	20
3	Viva	20
	TOTAL	**200**

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE VASHI
(AUTONOMOUS COLLEGE)

T.Y.B.Sc. Microbiology: Curriculum
SEMESTER V

Theory:

COURSE CODE	UNIT	TOPIC HEADINGS	Credits	L/ W
UGMB501.1 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	L/ W
UGMB502.1 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	L/ W
UGMB503.1 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**	**L/ W**
UGMB504.1 **Industrial Microbiology and Bioprocess Technology**	**Unit I**	**Screening For Productive Strains And Strain Improvements**	**4**	**4**
	Unit II	**Microorganisms And Sterilization Methods**		
	Unit III	**Fermentation Equipment And Control**		
	Unit IV	**Traditional Fermentations**		

COURSE CODE	**UNIT**	**TOPIC HEADINGS**	**Credits**	**L/ W**
UGECBT501 **Concepts in Biotechnology**	**Unit I**	**Importance of Biotechnology and Tools in Genetic Engineering**	**4**	**4**
	Unit II	**Techniques in Genetic Engineering**		
	Unit III	**Bioinformatics and IPR**		
	Unit IV	**Industrial Biotechnology**		

PRACTICAL:

COURSE CODE	PAPER	TOPIC HEADINGS	Credits	L/ W
UGMBP501.1	I	Microbial Genetics	6	16
	II	Medical Microbiology and Immunology		
	III	Microbial Biochemistry-I		
	IV	Industrial Microbiology and Bioprocess Technology		
UGECBTP05		Concepts in Biotechnology	2	4

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	L/ W
UGMB601.1 Microbial Genetics –II	Unit I	Gene Transfer Mechanisms & Recombination	4	4
	Unit II	Recombinant DNA technology		
	Unit III	Introduction to Virology		
	Unit IV	Advanced Virology		

Course Code	UNIT	TOPIC HEADINGS	Credits	L/ W
UGMB602.1 Medical Microbiology and Immunology -II	Unit I	Medical Microbiology II	4	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**	**L/ W**
UGMB603.1 Microbial Biochemistry -II	**Unit I**	**Lipid Metabolism & Catabolism of Hydrocarbons**	**4**	**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**	**L/ W**
UGMB604.1 Bioprocess Technology: – II	**Unit I**	**Downstream Processing**	**4**	**4**
	Unit II	**Advances in Bioprocess Technology**		
	Unit III	**Quality Assurance, Quality Control, Instrumentation and Bioassay**		
	Unit IV	**Industrial Fermentations**		

COURSE CODE	**UNIT**	**TOPIC HEADINGS**	**Credits**	**L/ W**
UGECBT601 Applied Biotechnology	**Unit I**	**Agricultural biotechnology**	**4**	**4**
	Unit II	**Methodology in Animal and Plant Biotechnology**		

	Unit III	**Environmental Biotechnology**		
	Unit IV	**Health Care Biotechnology**		

PRACTICAL:

COURSE CODE	PAPER	TOPIC HEADINGS	Credits	L/ W
UGMBP601.1	**I**	**Microbial Genetics -II**	**6**	**16**
	II	**Medical Microbiology and Immunology -II**		
	III	**Microbial Biochemistry-II**		
	IV	**Bioprocess Technology: – II**		
UGECBTP06		**Applied Biotechnology**	**2**	**4**

Rayat Shikhan Santha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI, NAVI
MUMBAI Department of Microbiology
T.Y.B.Sc. Microbiology: Curriculum
Revised for choice Based Credit & Grading System
To be implemented from the academic year 2020-2021

UGMB501.1: Microbial Genetics - I

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Illustrate the molecular mechanisms of DNA replication in Prokaryotic and Eukaryotic organisms.[3]*
CO2. Compare and contrast between Prokaryotic and Eukaryotic DNA replication.[4]*
CO3. Describe roles of all the enzymes and proteins involved in Gene Expression and Regulation.[2]*
CO4. Compare and contrast between prokaryotic and eukaryotic gene expression. [4]*
CO5. Schematically/diagrammatically elaborate Repair mechanisms and action of Mutagenic agents.[4]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	0	1	2	3	1	1	2	0	0	0	0
CO2	2	0	1	1	2	1	1	2	0	0	0	0
CO3	2	0	2	2	2	2	3	3	0	0	0	0
CO4	2	0	1	1	2	1	1	2	0	0	0	0
CO5	0	0	3	3	2	1	2	2	0	0	0	0
CO6	3	0	2	3	3	2	3	3	0	2	1	0

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

SEMESTER V Paper I		
Course Code	**Title**	**Credits**
UGMB 501.1	**Microbial Genetics - I**	**4 Credits (60 Lectures)**

Unit I	**DNA Replication** 1.1 Three models of DNA Replication 1.2 Semiconservative Replication in prokaryotes: The Meselson and Stahl Experiment 1.3 DNA replication in Prokaryotes- with special reference to *E. coli* a. The J. Cairn Experiment b. Molecular Mechanism of DNA replication 1.4 Enzymology of DNA replication a. Helicases, DNA polymerases, ligase, topoisomerases. b. SSB proteins, Tus proteins 1.5 Rolling Circle replication 1.6 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	**(15 Notional Hours)**
Unit II	**Gene Expression and Regulation**	**(15 Notional Hours)**
	2.1 The transcription process 2.2 Transcription in bacteria- Initiation, Elongation & Termination 2.3Transcription 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 2.4 Translation a. tRNA b. Ribosomes	

	c. Initiation of Translation d. Elongation of the polypeptide chain e. Termination of Translation f. Protein sorting **2.5** Regulation of gene expression in bacteria **a)** *Lac* operon of *E. coli*- Jacob and Monod's operon model, Positive control, molecular details of regulation	
Unit III	**Mutations and Repair**	**(15 Notional Hours)**
	3.1 Classification of Mutations: a. Based on molecular change b. Based on phenotypic effects c. Based on location 3.2 The Fluctuation Test 3.3 Spontaneous Mutations: a. Replication errors b. Tautomeric shifts c. Depurination & deamination d. Oxidative damage e. Transposable elements 3.4 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 3.5 Reverting mutations, Suppression, Pleiotropic mutations, mutator genes 3.6 Detecting mutations: a. Visible mutants b. Nutritional mutants c. Conditional mutants d. Resistance mutants 3.7 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	
Unit IV	**Natural Plasmids, Transposable elements & Integrons, Genetic Research**	**(15 Notional Hours)**
	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 plasmids, Degradative plasmids, Ti plasmids, plasmids encoding toxins & virulence 4.2 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 4.3 Integrons- Role in antibiotic resistance 4.4 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

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 McGraw 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

UGMB502.1: Medical Microbiology and Immunology -I

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Paraphrase attributes of microbial Pathogenicity & Disease progression [2]*

CO2. Justify the role of Quality Control in accurate diagnosis [5]*

CO3. Summarize cultural, morphological characteristics of Etiological agent to get diagnosis done accurately [2]*

CO4. Infer causative (Etiological) agent of the disease [5]*

CO5. Understand overall organization of the Immune system [2]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	3	2	1	0	0	0	0	0	0	0	0
CO2	3	3	2	2	1	0	1	2	0	0	0	2
CO3	3	3	2	1	1	1	0	1	0	0	0	1
CO4	3	3	3	2	2	1	0	3	0	0	0	1
CO5	3	3	1	1	2	1	1	2	0	0	0	1

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.
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SEMESTER V Paper II		
Course Code	**Title**	**Credits**
UGMB502.1	**Medical Microbiology and Immunology -I**	**4 Credits (60 Lectures)**
Unit I	**1.1 Attributes of microbial pathogenicity** **a.** Entry and Adherence **1.2 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.** **1.4 Corollaries of microbial pathogenicity** a. Exotoxins b. Ras inhibitor and other toxin affecting host cell trafficking and signal transduction pathways **1.5 Membrane active exotoxin**	**(15 Notional Hours)**

	a. Enzymes **1.6 Bacterial Strategies for Evasion** **1.7 Study of virulence mechanisms in bacteria** a. Pathogenicity islands b. Bacterial virulence factors c. Adherence factors d. Invasion of host cells and tissues **1.8 Toxins** a. Exotoxins b. Exotoxins associated with diarrheal diseasesand food poisoning c. LPS of gram negative bacteria **1.9 Enzymes** a. Tissue degrading enzymes - IgA1 proteases **1.10 Antiphagocytic factors** **1.11 Intracellular pathogenicity** a. Antigenic heterogeneity. The requirement for iron **1.12 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)** **2.1 Skin Infections:** a. Pathogenesis of mucocutaneous lesion (Only diagram) b. Skin manifestations of systemic infections caused by bacteria and fungi. **2.2 Upper Respiratory Tractinfection:** a.Common cold b.Parotitis c.Leprosy d.Fungal (Candidiasis) e. Viral (Herpex Simplex, Measles, Chicken pox) f. Cutaneous dermatophytes **2.3 Lower Respiratory Tract infection:** a. Influenza b. Tuberculosis c. Whooping cough	**(15 Notional Hours)**

	2.4 Urinary Tract infections a.Acquisition and Etiology b.Predisposing factors c. Pathogenesis and clinical manifestations d. Lab diagnosis. e. Prevention and treatment **2.5 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** **3.1 Organs 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 **3.2 Antigens** a. Immunogenicity versus antigenicity b.Factors that influence immunogenicity – foreignness, molecular size, chemical, composition, heterogenicity, ability to be processed and presented, contribution of thebiological system to immunogenicity – genotypeof the recipient, animal, immunogen dosage, routeof 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- heterophileantigens, isophile antigens, sequestered antigens,super antigens, bacterial and viral antigens 3.3 **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 - Immunoglobulin G, Immunoglobulin M, Immunoglobulin A, Immunoglobulin E, Immunoglobulin D, (including diagrams)	**(15 Notional Hours)**

	d. Immunoglobulin Superfamily e. Monoclonal antibodies	
Unit IV	**Activation of Immune cells** **4.1: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, formationof T – B conjugates, CD40 / CD40L interaction,Th cell cytokine signals. **4.2: 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) **4.3:MHC complex and MHC molecules** a. The basic structure and functions of Class I and Class II MHC Molecules. b. Peptide-MHC interaction. **4.4:Cytokines** a. Concept b. Properties c. Attributes of cytokines d. Biological functions of cytokines **4.5: Complement System** a. Functions and components of complement b. Complement Activation—classical, alternative and lectin pathway c. Biological consequences of complement activation	**(15 Notional Hours)**

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 TexasMedical 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, CapitalPublishing Company
12. Fahim Khan, Elements of Immunology, Pearson Education

UGMB503.1: Microbial Biochemistry - I

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Compare the role of exchange of metabolites between cells as the mode of communication and dissect the roles of Transporters in protein export and other processes. [5]*
CO2. Evaluate the communication system in Non-bioluminescent bacteria (Quorum sensing). [5]
CO3. Give the main idea of the fermentative pathways of Urea Metabolism. [2]*
CO4. Compare Homo-fermentative and Hetero-fermentative pathways that are present in the lactic acid bacterium pathway [5]*
CO5. Construct fermentative pathways that are present in microorganisms. [6]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	0	0	0	2	0	3	0	0	0	0
CO2	1	0	0	2	0	0	0	3	0	0	0	0
CO3	1	0	0	2	0	0	0	3	0	0	0	0
CO4		0	2	3	0	0	0	1	0	0	0	0
CO5	1	0	0	2	0	0	0	3	0	0	0	0
CO6	1	0	0	3	0	0	1	2	0	0	0	0

***In CO PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

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SEMESTER V Paper III		
Course Code	**Title**	**Credits**
UGMB503.1	**Microbial Biochemistry - I**	**4 Credits (60 Lectures)**
Unit I	**1.1 Composition and architecture of membrane** a. Integral & peripheral proteins & interactions with lipids b. Permeability	**(15 Notional Hours)**

	c. Aquaporins d. Mechanosensitive channels **1.2 Methods of studying solute transport** a. Use of whole cells b. Liposomes c. Proteoliposomes **1.3 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. **1.4 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 **1.5 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** **2.1 Biochemical mechanism of generating ATP:** a. Substrate-LevelPhosphorylation, b. Oxidative Phosphorylation c. Photophosphorylation **2.2 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.	**(15 Notional Hours)**

	c. Mitochondrial ETC i. Biochemical anatomy of mitochondria ii.Complexes in Mitochondrial ETC iii. Schematic representation of Mitochondrial ETC **2.3 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* **2.4 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 **2.5 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 **2.6 Quorum Sensing:** **Quorum Sensing:** System similar LuxR/LuxI in non-luminescent bacteria	
Unit III	**Methods of Studying Metabolism & Catabolism of Carbohydrates** **3.1 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	**(15 Notional Hours)**

	differentiate EMP & ED e. Use of biochemical mutants f. Sequential induction **3.2 Catabolism of Carbohydrates** a. Breakdown of polysaccharides – Glycogen, Starch, Cellulose b. Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose. c. Utilization of monosaccharides - Fructose, Galactose 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 **3.3 Amphibolic role of EMP; Amphibolic role of TCA cycle** **3.4 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** **4.1 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	**(15 Notional Hours)**

	the Second Urea Nitrogen atom iv. Argininosuccinase v. Arginase e. Glyoxylate pathway **4.2 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) **4.3 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

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.

UGMB504.1: Industrial Microbiology and Bioprocess Technology I

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Illustrate the mechanisms of Strain Improvement & Apply various preservation of microbial culture .[3]*

CO2. Describe roles of various raw materials for fermentation media preparation. [2]*

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

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

CO5. Set up product recovery plans for various fermentations[6]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	2	2	0	3	3	1	0	0	2	1
CO2	1	0	2	3	0	2	2	1	0	0	1	0
CO3	1	0	3	1	0	0	0	1	0	0	0	0
CO4	1	0	2	3	0	3	1	2	0	0	1	0
CO5	3	0	1	1	0	1	1	3	0	0	1	0

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

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SEMESTER V Paper IV		
Course Code	**Title**	**Credits**
UGMB 504.1	**Industrial Microbiology and Bioprocess Technology I**	**4 Credits (60 Lectures)**
Unit I	**Upstream processing** **1.1 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. **1.2 Strain Improvement.** 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. **1.3Preservation 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 **1.4The development of inocula for industrial fermentations**	**(15 Notional Hours)**

	a. Development of inocula for unicellular bacterial process b. Development of inocula for mycelia process	
Unit II	**Nutrition Of Industrial Microorganisms And Sterilization Methods** 2.1 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 **2.2 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 f. Sterilization of the Feeds g. Sterilization of the liquid wastes **2.3 Filter Sterilization** a. Filter sterilization of fermentation media b. Filter sterilization of air c. Filter sterilization of fermenter exhaustair. **2.4 Achievement of aseptic conditions** Aseptic operation & containment	**(15 Notional Hours)**
Unit III	**Fermentation Equipments And Control** **3.1 Design of fermenter** a. Basic functions of fermenter,- b. Aeration and agitation: Agitators, Stirrer glands & bearing, Baffles c. Mechanical seals(Names & Functions ,no diagrams), Magnetic Drive d. Sparger: porous, orifice; nozzle; combined e. Achievement & maintenance of ascetic condition, Valves / Steam traps – Function in general & examples. **3.2 Types of fermenters:** Acetator, Cavitator, Tower fermenter, Cylindroconical, Air lift fermenter – outer loop / inner loop, Deep jet, Cyclone column, Packed tower (generator), Rotating disc, Bubble cap. **3.3 Instrumentation & Control of Variables** Introduction, Types of sensors, Sensing & Control of pH, temp, Dissolved oxygen, Flow measurement &	**(15 Notional Hours)**

	control, Pressure, Inlet / Exit gas analysis, Foam sensing, Oxygen **3.4 Scale up and scale down of fermentation**	
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, champagne, sherry, examples of aroma compounds of wine, types and examples of wine **4.2Vinegar (acetic acid):** Introduction, biosynthesis, production using generator, production using submerged fermenter, recovery**.** **4.2 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. **4.4 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 **4.5 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) **4.6 Production of Carotenoids.** Introduction and production of Beta carotene.	**(15 Notional Hours)**

Reference books

1. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
3. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
4. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
5. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science
6. 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

UGECBT501: Concepts in Biotechnology

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1:Correlate between Modern and Traditional Biotechnology. [2] *
CO2:Illustrate the cloning and selection process for Cloned genes.[3] *
CO3:Differentiate various branches of Bioinformatics [4]*
CO4:Understand aspects of industrial production of Cheese, Yoghurt, Biopolymers, Ascorbic acid and Indigo [2]*
CO5:Solve analytical problems in Bioinformatics [4]*
CO6: Set up Immobilization of Saccharomyces cerevisiae using sodium alginate and perform Invertase assay [6]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	0	1	1	0	2	3	1	0	1	1
CO2	3	0	2	2	1	1	2	3	2	1	1	1
CO3	1	2	1	3	1	3	2	2	1	1	0	0
CO4	3	0	3	1	1	0	2	3	0	2	2	1
CO5	1	0	2	2	1	3	2	1	0	0	0	1
CO6	1	0	0	2	2	0	3	2	0	0	2	1

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

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SEMESTER V Paper I		
Course Code	**Title**	**Credits**
UGECBT501	**Concepts in Biotechnology**	**4 Credits (60 Lectures)**
Unit I	**Importance of Biotechnology and Tools in Genetic Engineering** 1.1 History of Biotechnology – Traditional and Modern Biotechnology. Biotechnology as an interdisciplinary area, Global impact and current excitements in Biotechnology. 1.2 (Health care,Agriculture, environment,	(15 Notional Hours)

	CRISPR/Cas9), Biodiversity and its preservation. 1.3 Tools in Genetic Engineering a. Basic requirements: Electrophoresis, agarose gel b. Electrophoresis, Pulse field gel electrophoresis (PFGE), SDS-PAGE,2Dgel electrophoresis. c. b. Spectrophotometry, Matrix assisted laser desorption ionization (MALDI), Surface enhanced laser desorption ionization (SELDI), Electrospray ionization (ESI), Random amplified polymerase DNA (RAPD), Probes. d. Genome mapping: genome maps, molecular markers, Restriction fragment length polymorphism (RFLP) variable number tandem repeats (VNTR), chromosome jumping, chromosome walking,DNA amplification Finger Printing (DAF). e. Blotting Techniques: Southern, Northern and Western blotting. DNA sequencing, ELISA, RIA, Nick translation and in situ Hybridization.	
Unit II	**Techniques in Genetic Engineering** 2.1. Cutting and joining of DNA: Exonucleases, Endonucleases, Restriction Endonucleases (TypeI,II,III). Examples of some enzymes – DNA ligases, Alkaline Phosphatases, DNA polymerases, Use of Linkers and Adaptors. 2.2. Cloning Vectors: Properties of good vector, Cloning and Expression vectors. *E. coli*	(15 Notional Hours)
	vectors–Plasmid, Cosmid, Phagmid, Bacteriophage vectors. Vectors for other bacteria, Shuttle vectors, Yeast vectors,Vectors for animals and plants. 2.3. Steps in gene cloning: Isolation of desired gene, cDNA library, Genomic library, Chemical synthesis of gene. Gene amplification by PCR, Introduction of vector into suitable bacterial host (various transformation methods), Selection of recombinant clones, selection of clones containing recombinant vector, selection of clones containing specific DNA inserts, colony hybridization test.	

Unit III	**Bioinformatics and IPR** 3.1 Bioinformatics a. Introduction b. Definition, aims, tasks and applications of Bioinformatics. c. Database, tools and their uses – d. Importance, Types and classification of databases e. Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. f. Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. g. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, h. Sequence alignment-- global v/s local alignment, FASTA, BLAST. i. Genomics- structural, functional and comparative genomics. j. Proteomics- structural and functional proteomics. 3.2 Introduction to IPR: Genesis, Role of WTO and TRIPS a. Overview of patent system b. Requirements for patentability c. Patent Categories d. Preliminary steps for patent applications e. Patent Procedures for biotech and microbiological products 3.3 Legal, Social and ethical aspects of Biotechnology. Patent Laws, Bioethics.	(15 Notional Hours)
Unit IV	**Industrial Biotechnology** 4.1 Exploitation of Microorganisms to produce primary and secondary metabolites: Amino acids (lysine), Vitamin B12 4.2 Synthesis of Novel Antibiotics – Engineering polykatid antibiotics, peptide antibiotics 4.3 Biotransformation of Steroids. 4.4 Bioreactors - Major types, solid–state fermentation, Immobilization techniques, Downstream processing, Enzyme extraction and Purification.(Amylases and proteases) 4.5 Production of SCP – Yeast, Spirulina, Mushroom 4.6 Production of Biopolymers – biogums, biopolysaccharides, bioplastic. 4.7 Synthesis of small biological molecules: synthesis of	(15 Notional Hours)

	L- ascorbic acid and Indigo. 4.8 Protein engineering: Engineering disulfide bonds, improving stability in other ways, changing binding site specificity, Biomaterial design relies on protein engineering	

Reference

a. Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 3rd Edition.

b. B. D. Singh. Biotechnology. Kalyani Publishers.

c. S. N. Jogdand. Advances in Biotechnology. 2005. 5t Edition.

d. S. B. Primrose. Modern Biotechnology 1989. Blackwell Scientific Publ.
e. Primrose and others. Principles of Gene manipulations. 6th edition. 2004 Blackwell Science.
f. Aluizino Borent and others. Understanding Biotechnology. 2004 Pearson Education.
g. James Watson and Others. Recombinant DNA. 2001. Scientific American Books.
h. S. Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house
i. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd edition, OxfordUniver
j. Biotechnology- Applying the Genetic Revolution by David P. Clark and Nanette J. Pazdernik

. Biosimilar drug product development by Laszlo Endrenyi & Dr. Paul Declerck & Shein-Chung Chow (volume 216)

Course Learning Outcome: By the end of the practical course, a student should develop the ability to,

CO1. Justify a strategy for setting up a Genetic experiment. [3]*
CO2. Learn the infections of Skin, Respiratory and Urinary tract, understanding clinical Manifestation and apply methods of diagnosis [5]*
CO3. Compare and analyze various experimental strategies required to study metabolic pathways. [4]*
CO4. Determine antibiotic spectrum. [5]*
CO5. Formulate production methods for enzyme, bioplastics.[6*]

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	1	1	1	3	2	3	1	0	1	1
CO2	3	0	1	2	1	3	2	3	2	1	1	1
CO3	1	1	2	3	1	2	2	2	1	1	0	0
CO4	2	0	1	3	2	2	2	2	0	2	2	1
CO5	2	2	3	3	2	3	2	3	0	0	0	1

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate

there is no correlation in respective CO and PO.
(All Results have to be done with proof unless otherwise stated)

Practical based on UGMB501.1

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

Practical based on UGMB502.1

[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 Chrome agar
3. Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonella typhi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus* 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.

Practical based on UGMB503.1 [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

Practical based on UGMB504.1 [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.

   3.1 Alcohol and Sugar Tolerance of yeast for wine production

   3.2 Preparation of yeast inoculum

   3.3 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

Practical Syllabus Based on UGECBTP05 Course Code:UGECBTP05/I

[Credits: 1.5, Notional hours: 60]

1. Quantitation of DNA and Protein using U.V absorption
2. PAGE for proteins.
3. Western blot technique (Demo)
4. Production of Microbial polysaccharide and determination of yield.
5. Production of SCP (Yeast) and its quantitative estimation
6. Production of Biogum.(biopolysaccharide) and its qualitative estimation
7. Production of bioplastic (PHB)
8. Immobilization of *Saccharomyces cerevisiae* using alginate and invertase assay.
9. Production, Purification and Estimation of Amylase /Protease.
10. Bioinformatics practical: Online Practical

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

b. Visiting & exploring various databases mentioned in syllabus and

i. Using BLAST and FASTA for sequence analysis

ii. 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.s evolution of a specific protein in bacteria,

predicting function of unknown protein from a new organism based on its homology)

iii. Six frame translation of given nucleotide sequence

iv. Restriction analysis of given nucleotide sequence

v. Pair-wise alignment and multiple alignment of a given protein sequences

vi. Formation of phylogenetic tree

UGMB601.1: Genetics & Virology

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Illustrate the molecular mechanisms of Gene transfer mechanisms in bacteria and Recombination methods.[3]*
CO2. Describe roles of cloning vectors and enzymes used in rDNA technology.[2]* as well as Diagrammatically explain mechanism of Cloning & screening.[4]*
CO3. Schematically/diagrammatically elaborate different structures of viruses.[4]* **CO4.**Justify that viruses can be cultivated by variety of methods.[5]*
CO5. Compare and contrast between different methods of virus visualization and enumeration.[4]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	1	0	0	2	0	2	3	0	0	0	0
CO2	3	1	2	2	3	2	3	1	0	0	0	0
CO3	3		2	3	2	0	1	2	0	0	0	0
CO4	2	1	0	0	2	0	0	0	0	0	0	0
CO5	3	1	1	1	2	2	1	1	0	0	0	0

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

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SEMESTER VI Paper I		
Course Code	**Title**	**Credits**
UGMB601.1	**Genetics & Virology**	**4 Credits (60 Lectures)**
Unit I	**Gene Transfer Mechanisms & Recombination** **1.1 Gene transfer mechanisms in bacteria** **a. Transformation** i. Discovery of transformation bacteria ii. Natural transformation in *Bacillus subtilis, Haemophilus influenzae* iii. Artificial Transformation iv. 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 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 inbacteria 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	**(15 Notional Hours)**

	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 **2.4 Finding a specific clone in a library** a. Screening a cDNA library b. Screening a genomic library c. Identifying genes by complementation of mutations d. Identifying genes using heterologous probes e. Identifying genes using oligonucleotide probes **2.5 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 **2.6 Polymerase Chain Reaction** a. Basic steps b. Advantages and limitations of PCR c. Applications of PCR d. Reverse Transcription- PCR e. Real-time PCR	**(15 Notional Hours)**
Unit III	**Introduction to Virology** **3.1 Historical Perspective** a. Important milestones in developing	**(15 Notional Hours)**

	virology b. Discovery of emerging viruses in 21st century **3.2 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 **3.3 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 **3.4 Cultivation of Viruses** a. Cultivation of Bacterial viruses b. Cultivation of Animal viruses- Embryonated 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**	**(15 Notional Hours)**

	and HIV **4.3 Regulation of lytic and lysogenic pathway of lambda phage** **4.2 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**	

References for UGMB601.1

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.

UGMB602.1: Medical Microbiology and Immunology -II

Course Learning Outcome: 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. Classify antibiotic based on their mechanism of action & Suggest appropriate chemotherapeutic drug & find out alternate drug of choice [4]*

CO3. Study attributes of ideal chemotherapeutic agent to formulate the drug [2]*

CO4. Predict on effective Route of Drug Administration & maximize Bioavailability [5]*

CO5. Investigate the role of antibody, produced by B-Cell, in T-Cell Mediated Cytotoxicity [4]*

CO6. Justify the response of inappropriate immune response for Hypersensitive reactions [5]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	0	0	0	0	0	2	2	0	1	0
CO2	1	1	3	1	0	0	1	2	0	0	1	0
CO3	2	2	2		0	0	0	3	0	0	0	0
CO4	2	0	2	3	0	3	2	3	0	0	0	0
CO5	1	0	2	3	1	0	2	3	1	1	1	0
CO6	1	0	0	2	0	0	0	1	2	0	0	0

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

SEMESTER VI Paper II		
Course Code	**Title**	**Credits**
UGMB602.1	**Medical Microbiology and Immunology -II**	**4 Credits (60 Lectures)**
Unit I	**Medical Microbiology II** **1.1Study of vector-borne infections** – Malaria **1.2 Sexually transmitted infectious diseases**: a. AIDS b. Gonorrhea c. Human Papilloma virus d. Genital Herpes **1.3 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 (pathogen, clinical features,mortality,sequelae) d. Study pathogenesis of viral encephalitis (only diagram) **1.4 Health care associated infections (overview)**	**(15 Notional Hours)**

	a. Risk factors. Common infecting organisms and measures to prevent nosocomial infections) b. Health associatesUTI,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** **2.1Chemotherapy of Infectious Agents** a. Attributes of an ideal chemotherapeutic agent i. Selective toxicity ii. Bioavailability of drug iii. Routes of drug administration iv. LD50 v. MBC **2.2 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 d. **Protozoa:** Metronidazole, Mepacrine) **2.3 Resistance to antibiotics:** a. Development of antibiotic resistance (e.g	**(15 Notional Hours)**

	ESBL, VRE, MRSA) b. Reasons and Mechanisms of drug resistance c. Use and misuse antibiotics **2.4 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 **2.5 Use of antibiotics in combination**	
Unit III	**Immune Responses And Their Detection** **3.1: 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. **3.2 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) **3.3: 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** **4.1 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	**(15 Notional Hours)**

	4.2 Immuno-hematology 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. Hemolytic disease of new born g. Coombs test. **4.3: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

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

UGMB603.1: Microbial Biochemistry - II

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Distinguish the Lipids and mention its functions [4]*
CO2. Outline pathways involved in protein metabolism[2]*
CO3. Discriminate between Regulation of transcription by positive & negative control and evaluate the role of DNA Binding Proteins[5]*
CO4. Compare and differentiate between Allosteric and Covalent modifications using examples [5]*
CO5. Discriminate mechanisms of Light and Dark reactions which are part of Photosynthesis [5]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	1	1	0	1	1	0	2	0	0	0	0
CO2	0	0	3	3	0	0	0	0	0	0	2	0
CO3	3	0	3	0	0	0	0	0	0	0	0	0
CO4	1	0	3	3	0	0	0	0	0	0	0	0
CO5	1	0	3	3	0	0	0	0	0	0	2	0

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO
(All Results have to be done with proof unless otherwise stated).

SEMESTER VI Paper III		
Course Code	**Title**	**Credits**
UGMB603.1	**Microbial Biochemistry - II**	**4 Credits (60 Lectures)**
Unit I	**Lipid Metabolism & Catabolism of Hydrocarbons** **1.1 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 **1.2 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 methyl citrate pathway d) PHB as a food reserve and its degradation	**(15 Notional Hours)**

	1.3 Anabolism of Fatty Acids & Lipids a) Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b) Biosynthesis of phosphoglycerides in bacteria c) Biosynthesis of PHB **1.4 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** **1 Protein metabolism: Protein folding, ynamics** a) Protein Folding: Theory and xperiment 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) **2.2 Anabolism of amino acids** a) Schematic representation of amino acid families **b)** Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) **2.3 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 **2.4 Catabolism of Nucleotides** a) Degradation of purine nucleotides up to uric acid formation b) Salvage pathway for purine and pyrimidine nucleotides **2.5 Biosynthesis of nucleotides** a) Biosynthesis of pyrimidine nucleotides b) Biosynthesis of purine nucleotides **c)** Biosynthesis of deoxyribonucleotides	
Unit III	**Metabolic Regulation** **3.1 Definition of terms and major modes of regulation 3.2 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 **3.3 DNA binding proteins and regulation of transcription by positive & negative control** a) DNA binding proteins b) Negative control of transcription: Repression and Induction	**(15 Notional Hours)**

	c) Positive control of transcription: Maltose catabolism in *E. coli* d) Ara operon *e)* Trp operon **3.4 Global regulatory mechanisms** a) Global control & catabolite repression b) Stringent response **3.5 Regulation of EMP and TCA cycle -** (Schematic and Regulation of Pyruvate dehydrogenase Complex)	
Unit IV	**Prokaryotic Photosynthesis & Inorganic Metabolism** **4.1 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 **4.2 Light reactions in:** a) Purple photosynthetic bacteria b) Green Sulphur bacteria c) Cyanobacteria (with details) **4.3 Dark reaction** a) Calvin Benson cycle b) Reductive TCA cycle **4.4 Inorganic Metabolism** a) 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)	**(15 Notional Hours)**

	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 UGMB603.1

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.

UGMB604.1: Industrial Microbiology and Bioprocess Technology II

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Choose the correct method of recovery for a particular product. [5]*
CO2. Categories different methods of Product Recovery, Compare and contrast between different methods of product recovery [4]*
CO3. Set up Immobilized cells and enzymes. [6]*
CO4. Exemplify various biological and physical indicators used for Sterility Assurance. [2]*
CO5. Discuss the importance of maintaining proper fermentation conditions. [2]*
CO6. Design experiment for assessing Sterility in pharmaceutical products. [6]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	0	0	0	0	0	2	0	0	3	1
CO2	1	0	0	3	0	0	0	0	0	0	2	3
CO3	1	0	0	1	0	0	0	0	0	0	0	0
CO4	0	0	3	0	0	0	0	2	0	0	1	0
CO5	0	0	3	0	0	0	0	2	0	0	0	1
CO6	1	0	2	0	0	1	0	2	2	0	0	1

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

SEMESTER VI Paper IV		
Course Code	**Title**	**Credits**
UGMB604.1	**Industrial Microbiology and Bioprocess Technology II**	**4 Credits (60 Lectures)**
Unit I	**Down Stream Processing- I** **1.1 Recovery and purification of Fermentation products** a. Introduction b. Removal of solid materials. c. Foam separation d. Precipitation e. Filtration- Theory of filtration, Batch filters, Continuous filters f. Centrifugations- Cell aggregation and flocculation and Ranges of centrifugations. g. Cell Disruption h. Liquid-Liquid Extraction i. Solvent Recovery j. Chromatographic techniques k. Membrane Processes l. Drying m. Crystallization n. Whole Broth Processing **1.2 Effluent treatment –** Introduction, Dissolved	**(15 Notional Hours)**

	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** **2.1 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 cellfusion, valuable products. **2.2 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 **2.3Immobilized 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** **3.1 Quality assurance, quality control and GMP** a. Definitions, Chemical and pharmaceutical 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** **3.3Instrumentation: Principles, working and**	**(15 Notional Hours)**

	application of a. Spectrophotometry: b. UV, Visible c. IR d. AAS & AES e. Flame photometry f. Fluorimetry **3.4. Bio-assay** a. Introduction b. Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic	
Unit IV	**Industrial Fermentations** **4.1 Aminoglycoside: Streptomycin:** Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery. **4.2 Vitamin B_{12}:** Occurrence and economic significance, structure, biosynthesis, production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas,* recovery. **4.3 Glutamic acid:** Production strains, biosynthesis, effect of permeability on production, conditions of manufacturing, production process and recovery. **4.4 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 **4.5 Vaccine production:** Bacterial vaccine(TAB Vaccine) and Viral vaccine(Polio Vaccine)	**(15 Notional Hours)**

Reference for UGMB604.1 :

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. H. K. Das., "Textbook of Biotechnology", 2nd and 3rdedition.
4. A textbook of biotechnology R. C. Dubey 4 th edition.S. Chand.
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 ofIndustrial
8. Microbiology, 2nd Edition, Panima Publishing Corporation, NewDelhi.
9. Prescott and Dunn's "Industrial Microbiology''(1982), 4thEdition,McMillan Publishers.
10. Veerakumari L. "Bioinstrumentation", MJP Publisher
11. Pharmaceutical Microbiology, Hugo and Russell, 7th edition, Blackwell Science.

UGECBT601: Applied Biotechnology

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1: Explain the application of microbes as Biofertilizers [2]*
CO2: Justify the use of bacteria and their natural system for the delivery of genes. [4]*
CO3: Apply the principles of gene manipulation for bioremediation of Xenobiotics. [4]*
CO4: Construct a diagrammatic representation on disease diagnosis and drug designing. [5] *
CO5: Produce Nanoparticles by chemical & microbial methods. [6]*
CO6: Isolate and cultivate Azotobacter, Rhizobium, Phosphatesolubilizers and prepare Biofertilizers. [6]*

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	2	1	1	1	2	0	1	3	0	2	3	1
CO2	2	0	2	2	1	0	2	3	1	0	1	1
CO3	3	1	2	2	1	1	3	3	0	1	2	1
CO4	2	0	2	3	1	3	3	2	1	0	0	1
CO5	1	0	1	2	3	0	1	3	0	0	1	2
CO6	3	0	2	1	1	0	2	3	2	1	3	2

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

SEMESTER VI Paper IV		
Course Code	**Title**	**Credits**
UGECBT601	**Applied Biotechnology**	**4 Credits (60 Lectures)**
Unit I	**Agricultural biotechnology** **1.1 Biofertilizer, Biopesticides** **1.2 Development of Insect, pathogen and herbicide resistant plants:** Development of stress and senescence tolerant plants, genetic manipulation of flower pigments, Modification of plant nutrient content, Modification of food plant taste and appearance, plants as bioreactors .**1.3 Application of transgenic animals, animal bioreactors, molecular farming (pharming), cloning livestock by nuclear transfe**r.	**(15 Notional Hours)**

Unit II	**Methodology in Animal and Plant Biotechnology** **2.1. Animal cell cultures** – Principles of mammalian cell culture, establishment of cell line. Continuous cell lines. Media and equipment for animal cell culture. Hybridoma technology. In vitro fertilization and embryo transfer, animal cloning. **2.2. Transgenic animals**, transfection methods, embryonic stem cell transfer, targeted gene transfer, detection of transgenic and trans gene transfer. **2.3. Plant tissue cell and organ culture-** regeneration of plants, plant breeding – recombinant and nonrecombinant approaches, germ plasm bank. **2.4. Genetic engineering of plants:** Agrobacterium mediated gene transfer, Agro infection and direct gene transfer methods, integration, using the $C_{RE}/l_{OX}P$ System,inheritance analysis and confirmation of transgenic plants.	**(15 Notional Hours)**
Unit III	**Environmental Biotechnology** **3.1** Culture enrichment for environmental samples,Biological fuel generation, sources of biomass, ethanol and methane from biomass. Hydrogen production, petroleum prospecting, enhanced oil recovery. **3.2** Bioremediation: Methods, bioremediation of hydrocarbons, dyes, paper and pulp industry, heavy metals, xenobiotics. **3.3** Biofilters, bioaugmentation, vermicomposting and bioleaching, biosensors and biochips.	**(15 Notional Hours)**

Unit IV	**Health Care Biotechnology** 4.1 Disease **prevention** – vaccines: conventional vaccines, purified antigen vaccines, recombinant vaccines. DNA vaccines, synthetic vaccines. 4.2 **Disease Diagnosis** – Probes, monoclonal antibodies and detection of genetic diseases. 4.3 **Disease treatment** – Products from non-recombinant and recombinant organisms., interferons, growth factors, antisense nucleotides as therapeutic agents, monoclonal antibodies. 4.4 Drug designing, pharmacogenomics, drug delivery and targeting, Biosimilar, artificial tissue / organ, gene therapy, enzyme therapy and replacement, therapeutic proteins and blood products 4.5 **Nanoparticles in cancer therapy:** Detection of viruses by Nanowires, Controlled denaturation of DNA by Gold nanoparticles, controlled change of Proteinand shape by DNA	**(15 Notional Hours)**

References

1. Biotechnology- Applying the Genetic Revolution by David P. Clark and Nanette J. Pazdernik
2. BiosimilaR Drug Product Development by Laszlo Endrenyi & Dr. Paul Declerck & Shein-Chung Chow (volume 216)
3. Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 3rd Edition.
4. B. D. Singh. Biotechnology. Kalyani Publishers.
5. S. N. Jogdand. Advances in Biotechnology. 2005. 5t Edition.
6. S. B. Primrose. Modern Biotechnology 1989. Blackwell Scientific Publ.
7. Primrose and others. Principles of Gene manipulations. 6th edition. 2004 Blackwell Science.
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9. James Watson and Others. Recombinant DNA. 2001. Scientific American Books.

Course Learning Outcome: By the end of the practical course, a student should develop the ability to,

CO1. Learn molecular biology techniques and apply in the molecular biology field [2]*

CO2. Categorise appropriate antibiotic against infection [6]*

CO3. Detect metabolic products formed in the reaction. [3]*
CO4. Determine the potency of pharmaceutical product. [5]*
CO5. Preparation of Biopesticide.[6]

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	2	3	1	3	2	3	1	2	2	1
CO2	1	1	1	1	2	2	2	3	1	0	2	1
CO3	1	0	0	2	1	2	2	3	2	1	2	1
CO4	1	0	1	1	1	1	2	2	1	0	0	1
CO5	2	1	3	2	2	2	3	3	0	1	1	2

***In CO – PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-'indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Practical Syllabus Based on UGMB601.1

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)

Practical Syllabus Based on UGMB602.1 Course Code: UGMBP06/II

[Credits: 1.5, Notional hours: 60]

1. Detection of malaria 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 Radial immunodiffusuion.
12. Visit to blood bank and preparation of visit report

Practical Syllabus Based on UGMB603.1 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

Practical Syllabus Based on UGMB604.1 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 injectables.
6. Preparation of TAB vaccine.
7. Estimation of phenol.
8. Industrial Visit

Practical Syllabus Based on UGECBTP06 Course Code: UGECBTP06/I

[Credits: 1.5, Notional hours: 60

1. Demonstration of cell fusion.
2. Isolation and cultivation of Azotobacter, Rhizobium, Phosphate solubilizers and preparation of biofertilizers.
3. Production of Biopesticides (*Bacillus thuringiensis*)
4. Plant Tissue culture (callus formation)
5. Production of Nanoparticle – chemical & microbial methods.
6. Preparation of Vermicompost.
7. Isolation of dye degraders.
8. Animal Tissue culture (Demonstration