B.Sc. (Microbiology) Semester VI

Course Code	US06MAMIC01	Title of the Course	Immunology and Medical Microbiology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	The objectives of this course are to make students able to understand 1. Essence of fundamentals of immunology 2. Advances in Immunodiagnostics 3. Study of microbes that infect humans and the diseases they cause. 4. About Immunisation as an important contribution of microbiology to medicine. 5. Concepts of epidemiology and its impact on human life. 6. Diagnosis, prevention and treatment of various infectious diseases.

Course Content		
Unit	Description	Weightage* (%)
1	**Fundamentals of immunology** a) Central [Primary] lymphoid organs, Peripheral [Secondary] lymphoid organs, Cells of Lymphoreticular system. B Cell maturation, T Cell maturation, Null cells. b) Antigens: its types and properties c) Antibodies (Immunoglobulins): Definition, Structure, Function and Classes of Immunoglobulins. d) Primary and Secondary Antibody response. e) Cytokines and Acute Phase Proteins. f) Introduction to Monoclonal antibodies and their applications.	25
2.	**Immunodiagnostics** a) Antigen-Antibody Reactions: General Features, Measurement of Antigen and Antibody, b) Serological Reactions: i) Precipitation Reactions, Definition, Mechanism – Zone Phenomenon and Lattice Hypothesis. Applications- Precipitation in Liquid Medium. ii) Agglutination reactions- Definition, Applications-Slide agglutination test, Tube agglutination test, Passive agglutination test. c) Immunohematology-ABO and Rh blood group system d) Techniques in Clinical Immunology: Complement fixation test, ELISA, Western Blot, RIA, Immunofluorescence	25

3.	**Epidemiology and Health care associated infections** **A. Epidemiology** a) Epidemiological terminology b) The epidemiologist's tools c) Recognition of infectious disease in a population d) The infectious disease cycle e) Epidemiological markers **B. Health care associated infections** a) Common type of Health care associated infections, Sources and reservoirs of health care associated infection, b)Mode of transmission of Microorganisms, c) Measures to control infection in the health care setting **C. Emerging and re-emerging infections** Emerging and re-emerging infections , their Transmission form animals to humans, Zika virus disease, Drug resistance, Indian scenario of Emerging and re-emerging infections	25
4.	**Human microbe interactions** **A. Diseases** Study of following diseases with respect to causative agent, pathogenesis, symptoms and treatment : a) Airborne diseases: Tuberculosis b) Food and waterborne diseases: Typhoid c) Contagious diseases: AIDS d) Insect borne diseases: Malaria, Dengue e) Zoonoses: Anthrax **B. Vaccines** a) Concept of Herd immunity b) Adjuvant c) Vaccines: introduction and production. d) Types of vaccines: Traditional vaccines, Recombinant vaccine : Subunit vaccine, DNA Vaccine, Plant as edible subunit vaccine, Attenuated recombinant vaccine, Vector recombinant vaccine Delivery of antigen by bacteria.	25

Teaching-Learning Methodology	A blended learning experience that combines traditional practices and e learning is to be implemented to teach microbiological methods. Learning achievement can be evaluated by questions about microbiology case-based problems. Students' perceptions can be obtained by accessing questionnaire.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University External Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand Immune system , antigens and antibody
2.	Understand clinical microbiology reaction.
3.	Study the important concepts of epidemiology and human diseases
4.	Explain the importance of Immuno prophylaxis

Suggested References:	
Sr. No.	References
1.	Prescott, Healey and Klein, Microbiology, 7th and 10th Edition, Tata-McGraw Hill publications, Delhi.
2.	Ananthanarayan and Paniker's, Textbook of Microbiology,7th and 10th edition, Universities Press (India) Ltd, Hyderabad
3.	U. Satyanarayana, Biotechnology,1st Edition (Reprinted 2008), Books and Allied (P) Ltd. Kolkata

On-line resources to be used if available as reference material

(B. Sc.) (Microbiology) Semester- VI

Course Code	US06MAMIC02	Title of the Course	Fermentation Technology
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	To make the students familiar with: • The role of microorganisms in fermentation processes. • Fermentation media formulation and use of sterilization methods at industrial scale. • Different types of fermenters, their design and use of fermentation processes at a large scale. • Processes used for the recovery of different types of products. • To acquaint and sensitize students for conducting assays of various metabolites, to monitor quality parameters, to follow safety norms and GMP norms during different stages of manufacturing. • To sensitize the students about market potential of fermented products and fermentation economics. • To make students understand thoroughly regarding the intricacies of various fermentation processes with respect to primary and secondary metabolites.

Course Content		
Unit	Description	Weightage* (%)
1.	**Introduction to fermentation technology:** A. (a) Concept of fermentation technology (b) Range of processes and products (c) Industrially important microorganisms and their screening. Primary screening (antibiotic, organic acid, amylase and growth factor), significance of secondary screening and outline of fermentation process. B. (a) Inoculum development: Introduction and Criteria for ideal inoculums. (b)Ideal characters of media for industrial fermentation. Substrates for industrial fermentations (Carbon and Nitrogen Sources) (c) Role of precursors, inhibitors and inducers in fermentation medium. (d) Antifoams (e)Sterilization of air and media. (f) Scale up and scale down.	25

2.	**Fermenter design, type and control** (a) Methods of fermentation: Batch, Fed batch and Continuous, solid state fermentation (b) Industrial fermenter design (Criteria for the design, Basic functions, design of typical stirred tank fermenter) (c) Types of fermenter: Stirred tank and Air lift fermenter. (d) Components of fermenter and their uses: Impeller, Bearing Seals, Sparger and Baffles (e) Control of chemical and physical conditions: Temperature, pH and Foaming. (f) Introduction to mass transfer of oxygen: Introduction to oxygen transfer, methods for its determination: Sulphite Oxidation method, factors affecting KLa	25
3.	**Downstream processing of fermentation products** (a) Criteria for the selection of recovery process (b) Separation of cells by filtration and centrifugation (c) Techniques for the disruption of microbial cells (d) Liquid: Liquid extraction of fermentation products (e) Product purification by chromatographic techniques (f) Product concentration by precipitation, ultrafiltration and reverse osmosis (g) Finishing of product by drying and crystallization (h) Methods of Immobilization of microbial enzymes and cells	25
4.	**A. Assay and Quality control of fermentation products** a) Bioassay of fermentation product. b) Introduction to Quality assurance, Quality Control, Good Manufacturing Practice. c) Sterility testing and Endotoxin testing by LAL Test. d) Bio safety and Fermentation economics. **B. Fermentative production of specific microbial products** a) Microbial Biomass: Baker's Yeast b) Primary Metabolites: Ethanol and Citric acid. c) Secondary Metabolite: Penicillin d) Enzymes: Amylase	25

Teaching-Learning Methodology	The major teaching- learning consists of lectures and discussions (large group) in which the teacher makes a use of chalk and talk as well as power point presentation to introduce the learning objectives related to the basic concepts of the subject. These sessions incorporate space for participation and involvement of students through questions. The student's participation in laboratory on related theoretical concept is also required.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
3.	University External Examination	50%

Course Outcomes: Having completed this course, the learnerwill be able to:	
1.	Recognize the potential of microorganisms which can produce variety of economically viable products.
2.	Learn how microorganisms can be screened for production of various metabolites.
3.	Understand how inoculums for the industrial fermentations can be prepared and maintained.
4.	Appreciate the requirement of aseptic conditions and control of contaminations during the bioprocess.
5.	Understand on what basis cultivation methods are decided for a particular bioprocess.
6.	Know the types of bioreactor configurations available for bioprocesses and will also be able to learn importance of various important components which constitute various parts of bioreactor.
7.	Understand the need for monitoring and control of various essential bioprocess parameters.
8.	Learn various methods available for recovery and purification of fermentation products from the complex fermentation broth.

Suggested References:	
Sr. No.	References
1.	Principles of Fermentation Technology, 2nd edition P.F. Stanbury, A. Whitaker and S.J. Hall.
2.	Fermentation Technology- VoI & Vol II – H.A. Modi.
3.	Industrial Microbiology. 1st edition, A.H. Patel.
4	Cruger's Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Crueger W and Crueger A.
5.	Biotechnology: The Biological Principles. Trevan M D, Boffey S, Goulding K H, and Standury S, (eds), (1987),Tata McGraw-Hill, New Delhi, India.

On-line resources to be used if available as reference material

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B.Sc. (Microbiology) Semester VI

Course Code	US06MAMIC03	Title of the Course	Microbiology Practical
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	• Students understand the biological assay of antibiotics and Pharmaceutical compounds. • Introduce basic principles and application of analytical techniques in clinical microbiology and Haematology for students. • To Identify Pure culture on the basis of various characteristics. • To gain concept of sterility testing of pharmaceutical products. • To recognize the potential of microorganisms which can produce variety of economically viable products, to learn how microorganisms can be screened for production of various metabolites and to understand how inoculums for the industrial fermentations can be prepared and maintained, exercises are designed accordingly.

Course Content : Practical based on core theory papers		
No	**Practical Section-1**	Weightage* (%)
1	Determination of human blood group: ABO and Rh systems.	
2.	Estimation of haemoglobin by Sahli's acid haematin method	
3.	Total count of leucocytes.	
4.	Differential count of leucocytes by Field's method	
5.	Estimation of blood sugar by Glucose oxidase / peroxidase method (GOD/POD)	
6.	Study ofantibiogram for a well isolated bacterium (using multidisc)	
7.	Isolation, cultivation and identification of gram-negative bacteria— a) Gram negative, lactose fermenter bacteria: *Escherichia coli*, *Enterobacter aerogens.* b) Gram negative lactose non fermenter bacteria: *Proteus vulgaris*, *Pseudomonas aeruginosa, Salmonella typhi*, *Salmonella paratyphi* A, *Salmonella paratyphi* B.	

	Practical section-2	
8	Ethanol Estimation.	
9.	Screening of Amylase producing bacteria from soil	
10.	Production and estimation of amylase enzyme.	
11.	Screening of Organic acid producing bacteria from soil.	
12	Screening of antibiotic producing bacteria by crowded plate technique	
13	Measurement of rate of aeration/ OTR by Sulphite oxidation method.	
14	Bioassay of Streptomycin.	
15	Sterility testing of a pharmaceutical product	

Teaching-Learning Methodology	By practical batches .Giving students concepts, guidance and demonstration to perform specific practical.

Evaluation Pattern		
Evaluation of practical at University level should be evaluated for minimum three exercises for performance, well documented certified Journal and a viva voce.		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination	50%
	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Journal, Attendance (As per CBCS R.6.8.3)	
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Apply the practical skill at pathological laboratories and pharmaceutical Industries.
2.	Aquatinted with routine laboratory techniques and tests used to analyze Blood and Serum samples.
3	Develop skill of isolating and screening of industrially important bacteria.
4.	Gain knowledge of basic characteristics of microbial cultures, which can be used to identify the disease-causing agent.
5	Conceptualize the importance of sterility for pharmaceutical products.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories
2.	Microbiology : A Practical Approach – Dr. Bhavesh Patel and Dr. Nandini Phanse
3.	Experimental Microbiology - Rakesh J.Patel & Kiran R. Patel, Volume I& II
4.	Medical laboratory technology by K L Mukherjee, published by Tata McGraw Hill, New Delhi
On-line resources to be used if available as reference material	

B.Sc. (Microbiology) Semester VI

Course Code	US06MIMIC01	Title of the Course	Bio- technology in environment and Agriculture
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	• The main objective is to ensure that the student develops a clear comprehension of the concepts of applied areas of bio-technology. The student will get knowledge of applications of enzymes and applications of biotechnology in the field of agriculture and environment.

Course Content		
Unit	Description	Weightage* (%)
1.	1. Introduction to biotechnology 2. Agricultural biotechnology: a) Biofertilizers, b) Bioinsecticides c) Plant tissue culture d) genetically modified/transgenic plants	50%
2.	Environmental biotechnology: a) Bioremediation b) Biofuels c) bioleaching d) MEOR e) Bio sensors	50%

Teaching-Learning Methodology	The teaching- learning process will consist of lectures (large group) in which the teacher will use aids such chalk and talk as well as make power point presentation to introduce the topics encompassing the basic concepts of the subject. Video lectures of NPTEL and BISAG.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3) Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Describe the role of microorganisms in Biodegradation and Bioleaching.
2.	Understand Concept of Bioremediation.
3.	Learn synthesis of Biofertilizers and use of Bioinsectides in agriculture.
4.	Get acquainted with various biosensors and application of Biofuels.

Suggested References:	
Sr. No.	References
1.	Atlas R M, (1997), Principles of Microbiology. 2nd edn., Wm. C. Brown Pub, Iowa, USA.
3.	Biotechnology – B.D.Singh, B.Sc edition, Kalyani publishers 3rd revised and enlarged reprint- 2008
4.	Trevan M D, Boffey S, Goulding K H and Standury S, (eds), (1987). Biotechnology: The Biological Principles, Tata McGraw-Hill, New Delhi. India
5.	Prescott L, Harley J P, and Klein D A, Microbiology, 7th and8thedition. Wm C.Brown - McGraw Hill, Dubuque, IA ltd.
6	Biotechnology by U. Satyanarayan
7	A Textbook of Biotechnology – R.C.Dubey
On-line resources to be used if available as reference material	
Lectures and notes of NPTEL	

B.Sc. (Microbiology) Semester VI

Course Code	US06MIMIC02	Title of the Course	Microbiology Practical
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	• The main objective is to ensure that the student develops a clear comprehension of the concepts of applied areas of bio-technology. The student of biotechnology in the field of agriculture and environment.

Course Content		
Unit	Description	Weightage* (%)
1.	Study of soil microbes morphology and cultivation: bacteria, fungi	100%
2	Cultivation and study of Nitrogen fixing bacteria: Rhizobia	
3	Morphology study of Rhizobia from root nodules by Gram staining	
4	Cultivation and study of nitrogen fixing bacteria Azotobacter from soil	
5	Study of phosphate solubilising bacteria.	
6	Demonstration study of bio sensors available in market	
7	Visit to a Plant tissue culture centre / biogas plant/ biofertilizer production unit.	

Teaching-Learning Methodology	• By briefing them with the theoretical aspects as well as providing them with the protocol (Aim, Requirements and Procedure) of the experiment to be performed using chalk and duster as well as power point presentation. • Students are trained for microscope observations and its handling. • Demonstrations of the practical are also carried out and care is taken for aseptic handling and skill development for microbiological work in the laboratory. • Possibility of various results and their interpretation can also be discussed.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Will be able to understand cultivation and characterization of microorganisms that are important in agriculture and can be exploited as bio fertilizers
2.	Visit to Plant tissue culture centre/ biogas plant/ bio fertilizer production unit make them realization of actual applicability of biotechnology.

Suggested References:	
Sr. No.	References
1.	Practical protocols and guidelines given in laboratories
2.	Microbiology : A Practical Approach – Dr Bhavesh Patel and Dr Nandini Phanse
3	Experimental Microbiology - Rakesh J.Patel & Kiran R. Patel, Volume I& II

On-line resources to be used if available as reference material
Lectures and notes of NPTEL.

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