Department of Microbiology, biotechnology and Food Technology
Bangalore University
Bengaluru-560056

Under-Graduate (UG) Program
B.Sc. Microbiology
Syllabus for V and VI semester

Framed According to the National Education Policy (NEP 2020)

(Effective from the Academic Year 2023-24)

BANGALORE UNIVERSITY

Department of Microbiology, Biotechnology & Food Technology

Jnana Bharathi Campus, Bengaluru -560 056

Proceedings of the Board of studies (UG)

A BOS meeting was held on 7th September, 2023 at 10.00 AM in the Department of Microbiology, Biotechnology and Food Technology, Bangalore University, Bengaluru-560056. The chairperson welcomed all the members of BOS (UG) and invited to discuss the revision and approval of B.Sc. Microbiology, Biotechnology and Food Technology syllabus of V and VI semester.

The members gone through the syllabus critically and approved with required corrections. The suggestions made by the all the members were incorporated. The meeting ended with vote of thanks by the Chairperson.

Members Present:

Sl. No.	Names	Members	Signature
1.	Prof. Thara Saraswathi K.T	Chairman	
2.	Dr. Geethanjali P.A	External Member	
3.	Dr. Raja Naik H	External Member	
4.	Dr. Kavyashree R	Member	
5.	Dr. D.C. Mohana	Member	

Programme Name	B.Sc. Discipline	Total Credits For The Program	Credits
Core	Biotechnology	Starting Year Of Implementation	2023-24

Program Outcomes:

At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.

PO2. Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance

PO3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.

PO4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.

PO5. Exploring the microbial world and analysing the specific benefits and challenges.

PO6. Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.

PO7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

PO8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.

PO9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.

PO10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.

PO11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyse outcomes by adopting scientific methods, thereby improving the employability.

PO12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

B.Sc. COURSE FOR BANGALORE UNIVERSITY FRAME WORK IN MICROBIOLOGY AS PER HIGHER EDUCATION COUNCIL GUIDELINES

(Two major Papers)

Semester & Course Category	Course Code	Course Title	Credits Assigned	Instructional Hours per week		Duration of Exam (Hrs.)	Marks		
				Theory	Practical		IA	Exam	Total
V Semester DSC MICROBIOLOGY MAJOR	MBL 105-I; DSC T5-I	Molecular Biology (Theory)	04	04	-	2½	40	60	100
	MBL 105-I; DSC P5-I	Molecular Biology (Practical)	02	-	04	04	25	25	50
	MBL 105-II; DSC T5-II	Food Microbiology (Theory)	04	04	-	2½	40	60	100
	MBL 105-II; DSC P5-II	Food Microbiology (Practical)	02	-	04	04	25	25	50
		Total	**12**				**130**	**170**	**300**
VI Semester DSC MICROBIOLOGY MAJOR	MBL 106-I; DSC T5-I	Immunology and Medical Microbiology (theory)	04	04	-	2½	40	60	100
	MBL 106-I; DSC P5-I	Immunology and Medical Microbiology (Practical)	02	-	04	04	25	25	50
	MBL 106-II; DSC T5-II	Microbial Genetic Engineering and Industrial Microbiology (theory)	04	04	-	2½	40	60	100
	MBL 106 II; DSC P5-II	Microbial Genetic Engineering and Industrial Microbiology (Practical)	02	-	04	04	25	25	50
		Total	**12**				**130**	**170**	**300**

Program Name	**BSc in MICROBIOLOGY**	Semester	**V**
Course Title	**MOLECULAR BIOLOGY (Theory)**		
Course Code:	**MBL 105-I; DSC T5-I**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of ESA/Exam	**2½ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course objective(s):

1. To learn the concepts of replication, transcription, translation, regulation of gene expression in Prokaryotes and Eukaryotes.
2. To learn about synthesis of protein
3. To provide knowledge about constitutive, inducible and repressible genes

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand concepts involved in replication, transcription, translation, regulation of gene expression in Prokaryotes and Eukaryotes.
CO2. Differentiate the process of replication, transcription, translation, regulation of gene expression in Prokaryotes and Eukaryotes.
CO3. Understand the genetic switch in Viruses (bacteriophages).
CO4. Compare and contrast housekeeping, constitutive, inducible and repressible genes
CO5. Outline regulatory mechanisms in Bacteria to control cellular processes

Contents	
UNIT 1: DNA Replication and Prokaryotic transcription **Introduction:** Central dogma of molecular biology, Structure and types of DNA and RNA, Gene, Genetic code. **DNA Replication:** Bacterial Cell cycle. Types of DNA replication- Rolling. Circle and theta model. Modes of DNA replication- Conservative, Semi- Conservative and dispersive. Steps in Initiation of replication, Enzymes in DNA replication, Replicon, OriC. Replication fork, replisome, Okazaki fragments, Termination of replication. **Prokaryotic Transcription:** Transcription bubble, Stages of transcription, Bacterial RNA polymerase - structure and mechanism, Recognition of promoters and DNA melting, Initiation, Elongation, Termination, Abortive, Transcription inhibitors.	**15 Hrs**
UNIT 2: Eukaryotic Transcription **RNA synthesis:** RNA polymerases in Eukaryotes- Types and Mechanism of RNA polymerase. Promoters, Transcription factors, basal apparatus, Enhancers, silencers. Initiation, elongation, termination. Transcription inhibitors. **RNA splicing and Processing**: mRNA capping, pre-mRNA splicing, snRNPs, spliceosome, types of splicing, polyadenylation, RNA maturation, Catalytic RNAs - auto splicing, ribozymes, RNA editing.	**15 Hrs**
UNIT 3: Translation **Introduction:** structure tRNA, rRNA and ribosome, charging of tRNA, differences between initiator tRNA and elongator tRNA. Steps in translation- Initiation, elongation, and termination. Role of initiation factors in bacterial translation, Formation of initiation complex, polypeptide, peptide bond formation, peptidyl transferase activity, translocation, termination. Differences between prokaryotic and eukaryotic translation. Regulation of translation. Post translational modifications of proteins. Protein maturation and secretion..	**15 Hrs**

UNIT 4: Regulation of gene expression in Prokaryotes and Acellular Microbes Regulatory mechanisms in bacteria- Positive and negative regulation. Operon concept, polycistronic mRNA. *lac* operon, trp operon, Catabolic repression and attenuation. Regulation of lytic & lysogenic life cycle in bacteriophage (λ page). Control of lytic cycle by regulatory proteins. **Regulation of gene expression in eukaryotes** Regulation through modification of gene structure- DNase I, histone, DNA methylation. Regulation through transcriptional activators, co-activators and repressors, enhancers and insulators.	**15 Hrs**

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1		3	1	2		2	1	1		
CO2	3	2		3	1	1		2				2
CO3	3	2		3	1	1		2	1			
CO4	3	1		3	1	2		1				
CO5	3	1		3	1	2		1				

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter (2015). Molecular Biology of the Cell. Garland Publishing, Inc., New York and London.
- Darnell, J. Lodish, H., Baltimore, D. (2003). Molecular Cell Biology. Scientific American Books Inc. NY.
- Garrett, R.H. and Gresham, C.M. (2010). Molecular aspects of Cell Biology, International 4th edition, Saunders College Pub.
- Karp, G. (2016). Cell and Molecular Biology concepts and experiments, 8th edition, John Wiley and Sons Inc. NY.
- Nelson, D.L., Cox, M.M. Lehninger. Principles of Biochemistry (2012). 6th edition Pub WH Freeman Co. NY,
- Old R.W., Primrose S.B., (2005) Principles of gene manipulation - An introduction to genetic engineering, Blackwell Scientific Publications. NY

Course Title	**MOLECULAR BIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MBL 105-I; DSC P5-I**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Study of semi-conservative replication of DNA through micrographs / schematic representations
2. Extraction of crude DNA from bacteria and yeast by phenol-chloroform method.
3. Determination of purity and quantity of DNA
4. Determination of DNA melting point and GC content
5. Extraction and visualization of plasmids from bacterial cultures
6. Extraction and visualization of genomic DNA from bacterial cultures
7. Measurement of β-galactosidase activity in stimulated and control cells of *E.coli*
8. β-galactosidase activity assay in Yeast
9. RNA extraction from yeast and visualization
10. Analysis of RNA quality and integrity
11. Determining nucleotide composition of RNA
12. Restriction enzyme digestion of DNA molecule - DNA fingerprinting
13. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25 Marks**

Formative Assessment as per UNIVERSITY guidelines are compulsory

References

- Allison A. Elizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons Hoboken,New Jersey
- Aranda PS, LaJoie DM, Jorcyk C L (2012). Bleach Gel: A Simple Agarose Gel for Analyzing RNA Quality. Electrophoresis. 33(2): 366–369. Doi: 10.1002/elps .201100335.
- Bloch KD; Grossmann B (1995). Digestion of DNA with Restriction Endonucleases.
- Elkins K M (2013). DNA Extraction Forensic DNA Biology.
- Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A.Smith, Kevin Struhl (2003). Current Protocols in Molecular Biology. John Wiley & Sons, New York, United States.
- Lewis M. Agarose gel electrophoresis (basic method). Department of Pathology, University of Liverpool.
- Sambrook JF, Russell DW (2001). Molecular Cloning: a Laboratory Manual. 3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
- Struhl K, Seidman J G, Moore D D, Kingston RE, Brent R, Ausubel FM, Smith JA. (2002). hort Protocols in Molecular Biology: A Compendium of Methods from Current Protocols in Molecular Biology. John Wiley & Sons Inc., New York, United States

Program Name	**BSc in Microbiology**	Semester	**V**
Course Title	**FOOD MICROBIOLOGY (Theory)**		
Course Code:	**MBL 105-II; DSC T5-II**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of ESA /Exam	**2½ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course objective(s):

1. To learn the microbes in food and the quality testing of food.
2. To learn about methods of spoilage of food and the diseases associated with it
3. T o gain knowledge regarding the preservation and food safety protocols

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. To understand the association of microbes in food and the quality testing of food
CO2. To understand the preservation and food safety protocols
CO3. To understand the methods of spoilage of food and the diseases associated with it
CO4. To learn the properties of milk and the types of preservation of milk.
CO5. To learn the types of fermented food and dairy products and its significance

CONTENTS	**45 Hrs**
Unit 1: Microbes and Food Introduction, Food as a substrate for microorganisms- Intrinsic and extrinsic parameters affecting the growth of microbes. Types of microorganisms in food- Moulds, yeasts and bacteria. **Food borne infections and intoxications-** Causative organism, mode of entry, symptoms, Treatment and control of *Staphylococcal food poisoning, Botulism, Salmonellosis, Brucellosis, Listeriosis.* General account of Mycotoxins and Phycotoxins. **Fermented Food:** Fermented vegetable- sauerkraut, pickles. Meat- sausage. Beverages- kombucha. Sourdough. Microbes as food- SCP, SCO. Nutraceuticals and Symbionts.	15 hrs
Unit 2: Food Spoilage and Preservation **Food Spoilage:** Principles of food spoilage, Sources of food contamination, Types of food spoilage. Spoilage of Meat, Poultry, Fish and Sea foods. Spoilage of cereals, fruits and vegetables. Spoilage of canned food. **Preservation:** Principles of food Preservation. Methods of preservation- Physical (temperature, Drying, irradiation), chemical (Class I and Class II) and Bio preservation. Canning. Food additives. Food Packaging- Types of packaging materials, properties and benefits.	15hrs
Unit 3: Dairy Microbiology **Introduction:** History of white revolution. Properties and nutritional value of milk. Types of milk- dried, liquid, condensed. **Microorganisms in milk:** Normal and contaminant microflora in milk, pathogenic microbes in milk. Starter culture and its types. Sources of contamination of milk. Microbiological analysis of milk- Rapid platform tests (organoleptic, COB, alcohol, Phosphatase, DMC, sedimentation tests) and reductase tests. SPC. Preservation of milk- Pasteurization. Dehydration, sterilization. Packing of milk and dairy products. **Fermentation in milk**: Lactic acid, gassy fermentation, souring, ropiness. **Dairy products:** Cheese- Types and production (Cheddar), Tofu, Yoghurt, Acidophilus milk. Prebiotics, Probiotics.	15 hrs

Unit 4: Food Standards and quality control: **Quality testing of food**- Rapid microbiological methods. Examination of fecal contamination. **Food sanitation and control -** Good Hygiene practices, GLP, GMP (Waste treatment disposal methods), HACCP and Food control agencies and their regulation. Bacterial indicator organisms in food contamination. Food Safety –risk and hazards, Food Safety Laws and Regulations- BIS, FSSAI, Codex Alimentarius.	**15 hrs**

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3			2		2		3				
CO2	3			2		1	2					
CO3	3			2		2						
CO4	3			2		3				1		1
CO5	3			2		1		3				1

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

Course Title	**FOOD MICROBIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MBL 105-II; DSC P5-II**	Contact Hours	**4HRS/WEEK**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**
Practical Content			

1. Isolation of bacteria and fungi from spoilt fruits and vegetables
2. Isolation of bacteria and fungi from fermented food and stored/ preserved food.
3. Reductase tests-MBRT/Resazurin/phosphatase
4. Estimation of Titrable acidity in milk.
5. Fat estimation – Gerber's method
6. Bacterial examination by SPC, DMC
7. Estimation of lactose in milk
8. Production of yoghurt
9. Study of food borne pathogens- *Staphylococcus, Salmonella, Aspergillus, Clostridium*
10. Study of significant microbes in Food and Dairy- *Lactobacillus, Streptococcus, Penicillium, Rhizopus*
11. Microbiological analysis of water
12. Study of leavening properties of yeast
13. To study the normal flora of egg and fish
14. Wine preparation

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

References

- Adams, M.R and Moss, MO. 1995. Food Microbiology. The Royal Society of Chemistry,Cambridge.
- James. M. Jay, 1992, Modern food microbiology 4ed.
- Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata McGraw Hill Publishing Company Limited, New Delhi, India.
- Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals. Frontiers, ASM Press.
- Garbutt J. (1997). Essentials of Food Microbiology, Armold- International Students edition, London. 8. Marriott N. G. and Gravani R. B. (2006).
- Principles of Food Sanitation, Food Science text Series, Springer International, New York, USA.
- ThomasJ., Matthews,Karl; Kniel, Kalmia E (2017), Food Microbiology: An Introduction, American Society for (ASM).
- Deak T. and Beuchat L. R. (1996). Hand Book of Food Spoilage Yeasts, CRC Press, New York.

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)**		
Course Code:	**MBL106-I; DSC T6-I**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of ESA /Exam	**2½ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course objective(s):

1. To learn various immune mechanisms
2. To learn about pathogenic bacterial infections, symptoms, diagnosis and treatment process.
3. T o gain knowledge regarding the Immunological techniques and sero diagnosis of infectious diseases

Course Outcomes (COs): After the successful completion of the course, the student will be able to:
CO1: To gain a preliminary understanding about various immune mechanisms.
CO2: To familiarize with Immunological techniques and serodiagnosis of infectious diseases
CO3: To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process.
CO4: To understand pathogenic viral infections, symptoms, diagnosis and treatment process.
CO5: To understand pathogenic fungal infections, symptoms, diagnosis and treatment process.

Contents	60 Hrs
UNIT I: Host and microbe interaction **Normal microflora of the human body:** Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract **Host pathogen interaction:** Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers andtheir types, Opportunistic infections, Nosocomial infections. Transmission of infection. **Bacterial diseases:** Symptoms, mode of transmission, prophylaxis and control of Respiratory diseases: *Haemophilus influenzae, Mycobacterium tuberculosis*; Gastrointestinal diseases: *Salmonella typhi*, *Vibrio cholera*; Others: *Bacillus anthracis, Clostridium tetani*.	**15 hrs.**
UNIT II: **Medical Virology, Parasitology and Mycology** Symptoms, mode of transmission, prophylaxis and control of Hepatitis, Rabies, Dengue, AIDS, Corona, Influenza, Chikungunya; Protozoan diseases: Malaria; Fungal infections- Pedis (Athlete's foot), Candidiasis. **Antimicrobial agents:** General characteristics and mode of action of antibacterial agents: Inhibitor of Cell wall, Cell membrane, Nucleic acid and Protein synthesis; Inhibitor of metabolism. Mechanism of action of Amphotericin B, Cephalosporin, Penicillin, Tetracyclin, Griseofulvin Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance microbes.	**15 Hrs**
UNIT-III: Introduction to Immunology Historical perspective of immunology; Immunity; Natural (active and passive) and artificial (active and passive) with example, Innate and acquired, Humoral and cell mediated. Cells and organs of immune system: Hematopoiesis, cytokines, properties and functions of B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoid organs; Bone marrow and Thymus. Secondary lymphoid organs; Spleen and Lymphnods.	**15 Hrs**

UNIT IV: Antigen and Antibody reaction	15 Hrs
Antigen: Immunogenicity and antigenicity, Epitopes, B and T cell epitopes, Haptens, Properties and Chemical nature of antigen. **Antibody**: Basic structure of antibody, light and heavy chain, variable and constant region, hinge region, Fab and Fc. Structure and functions of different types of antibodies (IgM, IgG, IgA, IgE, and IgD). Antibody dependent cell mediated cytotoxicity (ADCC). Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. Monoclonal antibody production by hybridoma technology **Principles and applications of antigen-antibody interactions:** Definition of affinity and avidity. Immunoprecipitation; Radial (Mancini) and double (Ouchterlony) immunodiffusion. Agglutination reactions: Hemagglutination and Bacterial agglutination. Enzyme linked immune-sorbent assay (ELISA). Hypersensitivity reactions: Definition , classification and mechanism.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	2			1		2		2				
CO2	2			1		2		2				
CO3	2			2		1					1	
CO4	2			1			1				1	
CO5	2			1		1	1				1	

Pedagogy： Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10 Marks
Class Test	10 Marks
Debate/Quiz/Assignment	10 Marks
Seminar	10 Marks
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

Course Title	IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Practical)		Practical Credits	2
Course Code	MBL 106-I; DSC P6-I		Contact Hours	4Hours/week
Formative Assessment	25 Marks	Summative Assessment		25 Marks

Practical Content

1. Identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease and catalase tests
2. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Antibacterial sensitivity test
5. Study of symptoms of the diseases with the help of photographs: Hepatitis, AIDS, Corona, Influenza, Pedis (Athlete's foot), Candidiasis
6. Study of various stages of Malarial parasite in RBCs using permanent mounts.
7. Identification of human blood groups.
8. Perform Total Leukocyte Count of the given blood sample.
9. Perform total and differential Leukocyte Count of the given blood sample.
10. Separate serum from the blood sample (demonstration).
11. Perform immunodiffusion by Ouchterlony/Radial diffusion method.
12. Perform DOT ELISA.
13. Perform immunoelectrophoresis.

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Attendance	05 Marks
Records	05 Marks
Performance	05 Marks
Test	10 Marks
Total	**25 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References

- Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
- Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
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- Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14thedition. Pearson International Edition
- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th editionSaunders Publication, Philadelphia.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Murphy K, Travers.P,Walport M. (2008).Janeway's Immunobiology.7th edition Garland Science,Publishers,New York.
- Peakman.M.and Vergani D. (2009).Basic and Clinical Immunology,2nd edition Churchill,Livingstone Publishers, Edinberg.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**MICROBIAL GENETIC ENGINEERING AND INDUSTRIAL MICROBIOLOGY(Theory)**		
Course Code:	**MBL 106-II; DSC T6-II**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of ESA /Exam	**2½ hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course objective(s):

1. To learn the concepts and terminology in genetic engineering
2. To learn about principles involved in manipulating genes and DNA
3. T o gain knowledge regarding the importance of industrially important microbes and acquire the knowledge of the production of value-added products

CO1 : To acquire knowledge on the concepts and terminology in genetic engineering

CO2 : To learn about principles involved in manipulating genes and DNA

CO3 **:** Familiar with various cloning strategies in prokaryotes

CO4 : Learn techniques in genetic engineering

CO5 : To have awareness of IPR, the social and the ethical issues concerning cloning by genetic engineering

Unit 1: Introduction to Microbial Genetic Engineering **15 Hrs**

Historical prospectives: Definition of genetic engineering, milestones in genetic engineering, scope of genetic engineering.

Tools in Microbial Genetic Engineering: Mode of action and applications of restriction enzymes, DNA polymerases, methylases, Terminal deoxynucleotidyl transferase, Kinases, Phosphatases and DNA ligases in genetic engineering.

Cloning Vectors: Definition, uses and properties of Plasmid vectors: pBR and pUC series. Bacteriophage lambda, cosmids.

Cloning host- Cloning in *Escherichia coli* and *Saccharomyces cerevisiae*. Gene Library: Construction of cDNA library, genomic library.

Unit 2: Techniques and applications in Microbial Genetic Engineering **15 Hrs**

Isolation and Detection of DNA: Isolation of DNA, restriction digestion and ligation of DNA, Agarose gel electrophoresis, Blotting techniques- Southern blotting, DNA microarray analysis. PCR techniques and applications. DNA transfer methods: Microinjection, Electroporation and Liposome mediated DNA transfer. Identification and selection of recombinants.

Recombinant microorganisms: Application of recombinant microorganisms in basic research, industry, medicine, agriculture, environment. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines. Biological, ethical and social issues of gene cloning and IPR.

Unit 3: Introduction to Industrial microbiology **15 Hrs**

Scope and concepts; Criteria for selection of industrially important microbes. Fermentor: Basic features; design and components of a typical Fermentor; Sterilization of fermentor, Control of air, temperature, pH, foaming and feed. Fermentation media: Strategies for media formulation; Natural and synthetic media; Role of buffers, precursors, inhibitors, inducers and micronutrients. Types of fermentation process: Submerged fermentation, Surface fermentation and Solid state fermentation (Koji)

Unit-4: Downstream processing and Microbial products **15Hrs**

Objectives and significance of downstream processing: Overview of steps in product extraction and purification, Biomass separation- Filtration and centrifugation; cell disruption- Physical, chemical and biological methods; Product extraction, purification, recovery and product testing.

Industrial production of microbial products: Antibiotics (Penicillin), Enzymes (Amylase), anti-cholesterol compounds (lovastatin), anti-cancerous compounds (curcumin), hormones (Insulin).

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes(POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1												
CO2				3			1					
CO3			1	3	2		1			2		1
CO4				3	1	1	3			3		2
CO5			1									3

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40 Marks**
Formative Assessment as per guidelines are compulsory	

Course Title	**MICROBIAL GENETIC ENGINEERING AND INDUSTRIAL MICROBIOLOGY (Practical)**		Practical Credits	**02**
Course Code	**MBL 106-II; DSC P6-II**		Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment		**25 Marks**
Practical Content				

1. Induction of mutations in bacteria by physicochemical methods.
2. Preparation of competent cells and demonstration of bacterial transformation.
3. Digestion of DNA by restriction enzymes.
4. Demonstration of ligation of DNA fragments.
5. Preparation of master and replica plates.
6. Demonstration of amplification of DNA by PCR.
7. Demonstration of Southern blotting.
8. Study of recombinant products-insulin.
9. Demonstration of a basic fermentor
10. Production and estimation of amylase by solid substrate fermentation
11. Production and estimation of amylase by submerged fermentation
12. Production and estimation of Penicillin
13. Demonstration of Downstream techniques namely centrifugation, microfiltration technique and cell disruption by sonicator/enzyme (photoghaphs, flow charts)

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25 Marks**
Formative Assessment as per guidelines are compulsory	

References

- Arindam Kuilaand Vinay Sharma (2018) Principles and Applications of Fermentation Technology,Wiley.
- Casida L E.J.R. (2016) Industrial Microbiology, 2nd edition, New Age International Publisher.
- Crueger W&A Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology.Edited by K.R. Aneja. Panima Publishing Corporation.
- Michael, J.W., Neil L. Morgan (2013) Industrial microbiology : an Introduction. Blackwell science
- Nduka Okafor,Benedict Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2nd Edition :CRC Press Publishers
- Stanbury P.F., W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevierpublication
- Alexander N. Glazer, Hiroshi Nikaido (2014), Microbial Biotechnology: Fundamental of applied Microbiology, 2nd Edition, Cambridge University Press