Government of Karnataka

Curriculum Framework for Undergraduate Programme in Colleges and Universities of Karnataka State

5th and 6th Semester Model Syllabus
for
B.Sc. in
MICROBIOLOGY

Submitted to

VICE CHAIRMAN
KARNATAKA STATE HIGHER EDUCATION COUNCIL
30, PRASANNA KUMAR BLOCK, BENGALURU CITY UNIVERSITY CAMPUS
BENGALURU, KARNATAKA – 560 009

Government of Karnataka

Model Curriculum

Program Name	**BSc in MICROBIOLOGY**	Semester	**V**
Course Title	**MOLECULAR BIOLOGY (Theory)**		
Course Code:	**MIC C9-T**	No. of Credits	**04**
Contact hours	**60 Hours(4 Hours per week)**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s) :

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 bacteria and Eukaryotes.

CO2. Differentiate the process of replication, transcription, translation, regulation of gene expression in bacteria and Eukaryotes.

CO3. Understand the genetic switch in 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. **DNA Replication :** Bacterial Cell cycle. Replicon. *OriC*. Bidirectional replication. Steps in Initiation of replication. DNA polymerases, Replication fork, replisome. Mechanism of DNA polymerase III in detail. Ligase. Eukaryotic DNA polymerases. Termination of replication. Extrachromosomal replicons. Replication of DNA strand with 5' end,linear end, replication of adenovirus and ϕ29 DNAs, rolling circle in replication of phage genomes, F plasmid,. Replication of ColE1 DNA. Replication of mtDNA, D loop. Replication of telomeres **Prokaryotic transcription:** Transcription bubble, Stages of transcription, Bacterial RNA polymerase - structure and mechanism, recognition of promoters and DNA melting, abortive initiation. Elongation, Termination, antitermination. Phage T7 RNA polymerase, alternative sigma factors - transcription of heat shock genes, phage SPO1 genes, sporulation in *Bacillus*. Stringent response in *E.coli*.	**15 Hrs**

UNIT 2 Transcription **Eukaryotic Transcription**: Eukaryotic RNA polymerases - RNA polymerase I, II, III. Mechanism of RNA polymerase in detail. Promoters, Transcription factors, basal apparatus, promoter clearance, elongation. Enhancers, silencers, termination. **RNA splicing and Processing**: mRNA capping, pre-mRNA splicing, lariat, snRNPs, spliceosome, autocatalytic splicing, alternative splicing, polyadenylation, tRNA splicing and maturation, production of rRNA, Catalytic RNAs - auto splicing, ribozymes, rinonuclease P,viroids and virusoids, RNA editing	**15 Hrs**
UNIT 3 Translation Genetic code, tRNA structure, charging of tRNA, differences between initiator tRNA and elongator tRNA, ribosome structure. Accuracy of translation. Stages of translation. Role of IFs in initiation of bacterial translation, Formation of initiation complex. Initiation of eukaryotic translation - Scanning model of mRNA, IRES, Role of eIFs. Elongation of polypeptide - EF-Tu, EF-G, peptide bond formation, peptidyl transferase activity, translocation, eEFs. Termination. Regulation of translation. Post translational modifications of proteins. Protein maturation and secretion - protein splicing,molecular chaperones. Protein translocation and secretion in bacteria	**15 Hrs**
UNIT 4 Regulation of gene Expression **Control of gene expression in prokaryotes** Regulatory mechanisms in bacteria. Positive and negative transcriptional control in bacteria. Operon concept, polycistronic mRNA. *lac* operon - negative inducible, allolactose,mutants of *lac* operon structure of *lac* repressor, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon.Regulation by lac repressor and CAP. *trp* operon regulation - repressor control & attenuator control. Arabinose operon - positive and negative transcriptional control by AraC. Riboswitch control of *rib* operon of *Bacillus subtilis*. Control of translation by riboswitches and small RNAs. Global regulatory mechanisms - *mal* regulon, two-component signal transduction systems.Regulation of lytic & lysogenic life cycle in bacteriophage λ. Control of lytic cycle by regulatory proteins - *cro* gene, *N* gene, lambda repressor - structure, DNA binding mechanism. Events in switch from lytic to lysogenic cycle. Maintenance of lysogeny. **Control of gene expression in eukaryotes** Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation. Regulation through transcriptional activators, Co-activators and repressors, enhancers and insulators. Regulation through RNA processing and degradation. Regulation through RNA interference	**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
Understand concepts involved in replication, transcription, translation, regulation of gene expression in bacteria and eukaryotes		√	√		√							√
Differentiate the process of replication, transcription, translation, regulation of gene expression in bacteria and eukaryotes		√	√		√							√
Understand the genetic switch in bacteriophages		√	√		√							√
Compare and contrast housekeeping, constitutive, inducible and repressible genes		√	√		√							√
Outline regulatorymechanisms in bacteria to control cellular processes		√	√		√							√

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	

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Model Curriculum

Course Title	**MOLECULAR BIOLOGY (Practical)**	Practical Credits	**02**
Course Code	**MIC C10-P**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Micropipeting: Moving Very Small Volumes Very Accurately
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Extraction of crude DNA from bacteria and yeast by phenol/chloroform method.
4. Determination of purity and quantity of DNA
5. Determination of DNA melting point and GC content
6. Extraction and visualization of plasmids from bacterial cultures
7. Extraction and visualization of genomic DNA from bacterial cultures
8. Measurement of β-galactosidase activity in stimulated and control cells of *E.coli*
9. β-galactosidase Activity Assay in Yeast
10. DNA extraction from agarose gel
11. RNA extraction and visualization from yeast.
12. Analysis of RNA quality and integrity
13. Determining nucleotide composition of RNA
14. Restriction enzyme digestion of DNA molecule - DNA fingerprinting
15. 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 guidelines are compulsory	

References	
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2	Lewin's Genes XII. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick. Jones and Bartlett Learning.2017
3	James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular Biology of the Gene, 7th edition. 2017
4	Freifelder's Essentials of MOLECULAR BIOLOGY. George M Malacinski, 4th ed. 2015
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7	Alberts Bruce , Johnson A , Lewis J , Raff M , Roberts K, Walter P (2014) Molecular Biology of the Cell. 5th Edition, Taylor and Francis. New York, USA.
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9	Allison A. Elizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey
10	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.
11	Bloch KD; Grossmann B (1995). Digestion of DNA with Restriction Endonucleases. https://doi.org/10.1002/0471142727.mb0301s31
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13	Elkins K M (2013). DNA Extraction Forensic DNA Biology.
14	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.
15	Johnson M (2019). RNA extraction, Synatom Research, Princeton, New Jersey, United States. DOI//dx.doi.org/10.13070/mm.en.2.201.
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18	Sambrook JF, Russell DW (2001). Molecular Cloning: a Laboratory Manual. 3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
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20	Surzycki S (2000). Basic techniques in molecular biology. Springer.
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Model Curriculum

Program Name	**B.Sc. in MICROBIOLOGY**	Semester	**V**
Course Title	**MICROBIAL GENETICS (Theory)**		
Course Code:	**MIC C11-T**	No. of Credits	**03**
Contact hours	**45 Hours(3 Hours per week)**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s) :

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

CO1 Understand the fundamental molecular principles of genetics
CO2 Understand relationship between phenotype and genotype in genetic traits;
CO3 Knowledge on the basis of genetic mapping in bacteria, linkage analysis in fungi.

Contents	
Mendel's principles of inheritance: Special features of pea plants as an ideal system to study genetics and Mendel's cross breeding experimental approach to prove genetic principles. Principles of dominance and Segregation; phenotype, genotype, traits controlled by genes, existence of alleles (dominant and recessive), segregation of alleles during the formation of gametes, aggregation of alleles during fertilization, monohybrid (single character) cross, F1 and F2 generation, heterozygous, homozygous, test cross to test genotype of F1 plants. Principle of independent assortment; Dihybrid (two characters) cross, pattern of assortment of alleles. Chromosomal basis of inheritance; chromosome number, haploid (n), diploid (2n). Chromosomal theory of Heredity; Experimental evidence linking the inheritance of genes to chromosomes, Chromosomes as arrays of genes, Chromosomal basis of Mendel's principles of segregation and independent assortment.	**15 Hrs**
Historical developments of DNA as a genetic material; Griffith experiment of Transformation,Proof that genetic information stored in DNA, Enzymatic approach to prove DNA mediates transformation by A very, MacLeod and McCarty, Hershey and Chase experiment to prove DNA carries the genetic information in T2 bacteriophage. RNA stores the genetic information in some viruses, viroids and prions. Structure of Watson Crick model of DNA, Plasmid DNA. Mechanism of DNA replication, enzymes involved in replication. Organization of genes in viruses, prokaryotes and eukaryotes, mitochondria and chloroplast.	**15 Hrs**
Genetics of Viruses Structure and life cycle of Bacteriophage T4 and Lambda, lytic and lysogenic cycle of bacteriophage. Genetics of Bacteria; Structure and life cycle of bacteria *E. coli* Mutant genes in bacteria, mutants blocked in their ability to utilize specific energy sources, mutants unable to synthesize an essential metabolite, mutants resistant to antibiotics. Mechanism of genetic exchange in bacteria, Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Natural and artificial methods of transformation. Bacterial Conjugation: U-tube experiment to prove physical contact between bacteria is essential for gene transfer, properties of the F plasmid, F^+ x F^- conjugation, sexduction F′x F^- conjugation, Hfr x F^- conjugation, Gene mapping in bacteria by conjugation. Transduction: Generalized and specialized transduction, plasmids and episomes. Genetics of Fungi: life cycle of Yeast and Neurospora, Terad analysis, unordered tetrad analysis in yeast, ordered tetrad analysis in Neurospora, two point and three point test cross, detecting linkage and mapping genes in yeast and neurospora.	**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
Understand the fundamental molecular principles of genetics		√		√			√					
Understand relationship between phenotype and genotype in genetic traits;		√					√				√	
Knowledge on the basis of genetic mapping in bacteria, linkage analysis in fungi.		√					√					√

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	

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Model Curriculum

Course Title	**MOLECULAR GENETICS (Practical)**	Practical Credits	**02**
Course Code	**MIC C12-P**	Contact Hours	**4 Hours/ week**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

	Practicals - List of experiments
1	Isolation of bacteria/fungal DNA
2	Isolation of Coliphages from sewage
3	Bacterial survival against UV-radiation
4	Isolation of antibiotic resistant mutant by gradient plate method
5	Isolation and characterization of petite mutant in yeast
6	Induction of mutation in yeast and bacteria by chemicals / radiation
7	Replica plating technique
8	Bacterial plasmid isolation
9	Restriction digestion of DNA
10	Ligation
11	Bacterial transformation
12	Bacterial conjugation

MICROBIAL GENETICS

Course Objectives:

The objectives of this course are to introduce students to:

- Basics of genetics and classical genetics covering prokaryotic and eukaryotic domains.
- Classical concepts of Mendelian genetics, recombination in bacteria and fungi.

Student Learning Outcomes:

At the end of the course, students should be able to:

- Describe fundamental molecular principles of genetics;
- Understand relationship between phenotype and genotype in human genetic traits;
- Evaluate the basics of genetic mapping in bacteria, linkage analysis in fungi.

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 :

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2. Molecular Genetics of Bacteria by J. W. Dale. 1994. John Wiley and Sons.
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5. Gene VII by Lewin Oxford University Press. 2000.
6. Bacterial and Bacteriophage Genetics. 4th Editions by Birge.
7. Microbial Genetics by Frefielder. 4th Edition.
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Model curriculum for VI semester

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Model Curriculum

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)**		
Course Code:	**MIC C15-T**	No. of Credits	**4**
Contact hours	**60 Hours(4 hours per week)**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Common to the Course Programme at Entry Level
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 bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process

Contents	60 Hrs
UNIT-I Normal microflora of the human body and host pathogen 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 and their types, Opportunistic infections, Nosocomial infections. Transmissionof infection, Pathophysiologic effects of LPS. Sample collection, transport and diagnosis. Clinical Microbiology Medical Bacteriology The following diseases in detailwith Symptoms, mode of transmission, prophylaxis and control respiratory diseases: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi*, *Vibrio cholerae*, Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani,(10 hrs)*	**15 hrs.**
UNIT-II	**15 Hrs**
Medical Virology, parasitology and Mycology The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Corona, Influenza, swine flu, Ebola, Chikungunya, Japanese Encephalitis Protozoan diseases: Malaria, Kala-azar, Entamoeba Fungal infections- Cutaneous mycoses: Tinea, pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis(10 Hrs) Antimicrobial agents: General characteristics and mode of action Antibacterial agents: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine . Antibiotic resistance, MDR, XDR, MRSA, NDM-1 5hrs	

UNIT-III	**15 Hrs**
Historical perspective of immunology; Edward Jenner, Luis Pasteur, attenuation. Immunity; Natural (active and passive) and artificial (active and passive) with example, Innate and acquired, Humoral and cell mediated. Early theories to explain the formation and specificity of antibody; Selective, instructional and clonal selection. 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 Lymphnodes.	
UNIT-IV **Antigen**: Immunogenicity and antigenicity, epitopes, haptens. Properties of antigen contribute to immunogenicity; Chemical nature (proteins, carbohydrates, lipids and nucleic acids), degree of foreignness, molecular weight, chemical composition and complexity, degradability. Adjuvants (alum, freunds incomplete and complete) and their importance. B and T cell epitopes. **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 mediated effector functions; opsonization, complement activation and antibody dependent cell mediated cytotoxicity (ADCC). Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. Monoclonal antibody production by hybridoma technology **10hrs** Principles and applications of antigen-antibody interactions: Definition of affinity and avidity. Immunoprecipitation; Radial (Mancini) and double (Ouchterlony) immunodiffusion. Agglutination reactions: Hemagglutination, Bacterial agglutination, passive agglutination, and agglutination inhibition. Enzyme linked immune-sorbent assay (ELISA): Direct, indirect, sandwich and competitive ELISA. Radioimmunoassay (RIA). Immunofluorescence. Complement system: Functions of complement components, Complement activation by classical, alternative and lectin pathway to develop membrane attack complex (MAC). Complement mediated opsonization, complement fixation test. Hypersensitive reactions: Classification, Humoral Immunity mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH). **5 Hrs**	**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**	**1**	**12**	**13**	**14**	**15**
To gain a preliminary understanding about various immune mechanisms.	√														
To familiarize with Immunological techniques and serodiagnosis of infectious diseases		√	√							√					
To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process	√			√						√					
To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process	√				√	√				√					

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 guidelines are compulsory	

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Model Curriculum

Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Practical)**	Practical Credits	**2**
Course Code	**MIC C16-P**	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, Staphylococcu Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitratereduction, urease production and catalase tests
2	Study of composition and use of important differential media for identification of pathogenicbacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3	Study of bacterial flora of skin by swab method
4	Perform antibacterial sensitivity by Kirby-Bauer method
5	Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox,HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
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 Differential Leukocyte Count of the given blood sample.**
10	Separate serum from the blood sample (demonstration).
11	Perform immunodiffusion by Ouchterlony 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 guidelines are compulsory	

REFERENCES

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Model Curriculum

Program Name	**BSc in Microbiology**	Semester	**VI**
Course Title	**MICROBIAL GENETIC ENGINEERING (Theory)**		
Course Code:	**MIC C17-T**	No. of Credits	**3**
Contact hours	**45 Hours(3 Hours per week)**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Common to the Course Programme at Entry Level

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

MICROBIAL GENETIC ENGINEERING	**45Hrs**
Unit 1: Introduction to Microbial Genetic Engineering	**15 Hrs**

Historical prospectives: Definition of genetic engineering, milestones in genetic engineering, prospects and problems of genetic engineering.

Tools in Microbial Genetic Engineering: Restriction modification systems- Types, Mode of action, nomenclature, applications of restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases, methylases, Terminal deoxynucleotidyl transferase, kinases and phosphatases and DNA ligases.

Unit 2: Cloning vectors, DNA transfer methods and identification of recombinants	**15 Hrs**

Cloning Vectors: Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: pBR and pUC series. Bacteriophage lambda, cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors: Baculovirus based vectors, mammalian SV40-based expression vectors.

Cloning host- Cloning in *Escherichia coli*, cloning in *Saccharomyces cerevisiae*, cloning in GRAS microorganism. Gene Library: Construction of cDNA library, genomic library. DNA transfer methods: Microinjection, Biolistic, Electroporation, Calcium phosphate and Liposome mediated DNA transfer. Identification and selection of recombinants: DNA hybridisation, blue white selection, antibiotic selection, colony and plaque hybridization.

Unit 3: 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, Northern blotting, dot blot, DNA microarray analysis, Western blotting. DNA sequencing- Sanger's method. PCR techniques and applications.

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, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines. Biological, ethical and social issues of gene cloning and IPR.

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**	**13**	**14**	**15**
To acquire knowledge on the concepts and terminology in genetic engineering	√					√									
To learn about principles involved in manipulating genes and DNA	√		√						√						
Familiar with various cloning strategies in prokaryotes									√	√					
Learn techniques in genetic engineering						√						√			
To have awareness of IPR, the social and the ethical issues concerning cloning by genetic engineering										√					

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	

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Model Curriculum

Course Title	**MICROBIAL GENETIC ENGINEERING (Practical)**		Practical Credits	**02**
Course Code	**MIC C18-P**	Contact Hours	**4 Hours/ week**	
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**	
Practical Content				

Practical: Microbial Genetic Engineering

Preparation of buffers-TE, TAE and Lysis buffer.
Isolation of plasmid DNA from *Escherichia coli.*
Estimation of DNA by DPA method.
Demonstration of estimation of DNA by spectrophotometric method.
Resolution and visualization of DNA by agarose gel electrophoresis.
Induction of mutations in bacteria by UV light.
Preparation of competent cells and demonstration of bacterial transformation.
Demonstration of bacterial transformation and calculation of transformation efficiency.
Digestion of DNA with restriction enzymes.
Demonstration of ligation of DNA fragments.
Preparation of master and replica plates.
Designing of primers for DNA amplification.
Demonstration of amplification of DNA by PCR.
Demonstration of Southern blotting.
Study of recombinant products-as per theory syllabus.

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	

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1	Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
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3	Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
4	Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
5	Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
6	Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
7	Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.