MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL
(Formerly West Bengal University of Technology)
Syllabus of B. Sc in Microbiology
(Effective from 2023-24 Academic Sessions)

THIRD SEMESTER

Course Name: Molecular Biology

Mode: Offline Credits: 5(3+2)

BMMC 3201 & BMMC 3291

Aim of the Course: The aim is to achieve basic knowledge about DNA structure, replication, Transcription, DNA damage and repair as well as regulation and gene expression and gene cloning.

Course Objectives: The course is aimed to build knowledge in fundamentals of molecular biology and the underlying mechanisms of it. To impart basic knowledge about DNA structure, replication, Transcription and DNA damage and repair as well as regulation and gene expression. It also considers different applications of molecular techniques. To acquaint students with the procedure of gene cloning with important enzymes and vectors.

Sl	**Graduate attributes**	**Mapped modules**
CO1	The student will get an introduction to the discipline of molecular biology with details of DNA structure and replication	**M1**
CO2	The students will get a clear concept on DNA damage, repair, non-homologous and homologous recombination	M2
CO3	The student shall get a concept of Transcription mechanism and RNA processing	**M3**
CO4	To acquaint students with the details about concepts of Regulation of gene expression and translation	**M4**
CO5	The student shall be master to know the procedure to clone a gene with important enzymes and vectors	**M5**

Learning Outcome/Skills: To impart basic knowledge about the following

- Details of DNA structure
- Mechanism of DNA replication
- DNA damage and their repair mechanisms
- Mechanism of non-homologous recombination
- Mechanism of homologous recombination

- Mechanism of Transcription
- Mechanism of RNA processing
- Regulation of gene expression
- Mechanism of translation Gene cloning

Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	DNA structure and replication	**8**	**18**	**1,2,3**	**NA**
M2	DNA damage, repair, non-homologous and homologous recombination	**10**	**22**	**1,2,3,4**	**NA**
M3	Transcription mechanism and RNA processing	**8**	**18**	**1,2,3,4**	**NA**
M4	Regulation of gene expression and translation	**8**	**18**	**1,2,3,4**	**NA**
M5	How to clone a gene	**11**	**24**	**1,2,3,4**	**NA**
Total Theory		**45**	**100**		
Practical		**30**			
	TOTAL	**75**			

Detailed Syllabus

Module 1:

DNA structure and replication

DNA as genetic material, structure of DNA, Types of DNA, Replication of DNA in prokaryotes and Eukaryotes, Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

(Total Hours:8)

Module 2:

DNA damage, repair, non-homologous and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo-reactivation, base excision repair, nucleotide excision repair, mismatches repair, translation synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

(Total Hours:10)

Module 3:

Transcription and RNA processing

RNA structure and types of RNA, Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

(Total Hours:8)

Module 4:

Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

(Total Hours:8)

Module 5:

How to clone a gene

What is clone, overview of the procedure, Gene library, hybridization Cutting and Joining DNA- Restriction Endonucleases, Ligation, Alkaline phosphate, Modification of Restriction fragment ends, and Other ways of joining DNA molecules. Plasmid vectors, Vectors based on the lambda bacteriophage, cosmids, M13 vectors, Expression vectors, Vectors for cloning and expression in Eukaryotic cells, Super vectors- YACs and BACs

(**Total Hours:10)**

PRACTICAL

BMMC 3291

Paper Name-Lab on Molecular Biology

(Whereverwetlabexperimentsarenotpossibletheprinciplesandconceptscanbedemonstratedthroughany other material or medium including videos/virtual labs etc.)

Credit:2

Total Hours:30

1. Preparation of buffers and solutions for molecular biology experiments
2. DNA isolation from Cabbage leaves/ goat liver/Human blood and Microbes
3. Plasmid DNA isolation
4. Agarose gel Electrophoresis of genomic DNA and plasmid DNA
5. Preparation of restriction digestion of DNA samples
6. Gel Documentation and photography

Suggested Readings:

1. Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

Paper Name: Clinical and Pharmaceutical Microbiology Credits: 5(3T+2P)

BMMC 3202 & BMMC 3292

Aim of the Course: Clinical and Pharmaceutical Microbiologyis a subdiscipline of microbiology dealing with the study of microorganisms (bacteria fungi, viruses and parasites,) capable of infecting and causing diseases in humans.Rapid diagnosis of pathogens is important for initiating effective antibiotic administration and improving the outcomes of treatment.

Course Objectives: The course is aimed to provide the focus on bacteriology and virology. Introduction to bacteriology includes the properties of bacteria, both as a normal flora and as a pathogen. One can learn more about pathogens, virulence factors, genetics and pathogenicity. This course will provide the host defense mechanism which is resisted by the pathogen. The course willexplain the role of epidemiology in the field of public health.The course outcome will provide how infectious disease can occur in different parts of human body and learns more about selected pathogenic microorganisms. One will learn about diagnostics in medical microbiology, with a focus on bacteriology,mycology and virology. This includes culture identification, diagnostic laboratory technology withbiochemical serological and molecular analysis. Furthermore, the other important areas in medical microbiology such as infection control, antimicrobial strategies as well as drug resistances determination of bacteria and reference systems are also included in the course.
Upon completion of the course the students will gather basic knowledge about the pathogenic microorganisms, mode of infection ,symptoms , causative agent identification and their control.
Moreover they canhelp doctors and other public health officials with diagnosing the pathogen related to the illnesses and developing treatments to prevent or cure diseases.

Sl	Graduate attributes	Mapped modules
CO1	The students will get acquainted with natural habitats the microbes over human body that constitute the body's normal flora or microbiota have infected the body, but they seldom cause disease unless they invade a part of the body where they do not normally reside and/or the host becomes immunocompromised. .	M1
CO2	The overall goal of this module is to better understand the total picture of infectious diseases in terms of host-infectious agent interaction virulence factors and microbial resistance against the defense mechanisms of human body.	M2

CO3	The general objective of the core teaching program in epidemiology is to introduce students to the principles and methods of epidemiologic research in order to enable them to design, conduct, analyze, and interpret epidemiologic research.	M3
CO4	The students will become aware of the significant role microorganisms in different parts of human body. Once they invade the host cell, they disrupt or damage the normal cellular activities. This leads to diseases on a larger scale. This part of the course will also focus on mechanisms of microbial pathogenesis symptoms of the disease and prescribed treatments.	M4
CO5	All students will gather the basic knowledge to interpret and correlate clinical and laboratory data so that clinical manifestations of diseases can be explained.	M5
CO6	The students will be able to understand the principles of chemotherapy and the development of antibiotics based on their target sites of action .They would also gain knowledge about their different routes of administration , dosage forms and the categorization of different antibiotics based on their structure and mode of action.	M6
CO7	This part of the course will provide students to aquire comprehend knowledge regarding the assay methods for analyzing various antimicrobial agents.Once antimicrobial resistance or susceptibility results become available, the treatment regimens for each patient can be developed by healthcare providers. By the knowledge of the mechanisms of drug resistance in bacteria the students will get acquainted with the fact of antimicrobial resistance which is an increasingly pressing global concern .	M7

Learning Outcome/ Skills:

Students should acquire a specialized knowledge in the field of Medical Microbiology. The students should demonstrate fundamental knowledge about thenormal as well as beneficial microbial community and harmful microbial community over human body. They should acquire knowledge about types of pathogenic determinants of microbes and their effect in human body. They should explain the scientific technologies to detect the infectious agent.More-over students should be able to develop better understanding to manage the infection and application of proper drug to manage the disease.

Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Gathering the Knowledge about the microorganisms that prevent transient pathogenic organisms from colonizing the skin surface , The	8	10%	1,2	NA

	normal gut microbiota imparts specific function in host nutrient metabolism				
M2	Idea about the pathogens that avoid host immune system and cause illness to humans in a variety of different ways. They can damage tissues or cells by producing toxins as they replicate. While some pathogens cause mild problems, others can be life threatening	7	15%	1,2	NA
M3	An advanced understanding of epidemiological theory and it's role and contribution in health-related disciplines.	9	10%	1,2,4	NA
M4	Knowledge about the pathogenicity ,symptoms and remedy of diseasecausing microorganisms include bacteria, fungi viruses, protozoa.	8	30%	1,2	NA
M5	Ability to collect the pathological specimen and to handle all laboratory instruments, and identify the etiological agent.	6	15%	3,4	NA
M6	Knowledge about antimicrobials and their mode of actions	7	10%	1,2,3	NA
M7	Identification of most appropriate antibiotic selection for particular procedures		10%	4,5,6	
Total Theory		45	100		
Practical		30			
	TOTAL	75			

Detailed Syllabus CREDITS: 3

Module 1: Normal microflora of the human body:

Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract (the gut microflora), urogenital tract.**No. of Hours: 2**

Module 2:Mechanism of Bacterial Pathogenicity

Types of bacterial pathogens, Transmission of infection,Entry of pathogens into the host, , Infection, Invasion Opportunistic infections, Mechanism of bacterial pathogenicity - colonization and growth, Virulence, Virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins, Pathophysiologic effects of LPS. Avoidance of host defense mechanisms - Ability to resist innate and adaptive immune system. Ability to induce autoimmune response, damage to host cell.**No. of Hours: 8**

Module 3: Epidemiology

Principles of epidemiology, Current epidemics (AIDS,Nosocomical infections, Acute respiratory Syndrome,) Measures for prevention of epidemics –Global health consideration, Biological warfare and biological weapons.**No. of Hours: 5**

Module 4:Microbial diseases (Etiology, parts effected and treatment)

Bacterial diseases : Respiratory disease – (Tuberculosis, Pneumonia) ,

Gastrointestinal disease - *E.coli* infections ,*Cholera, Salmonella* , Sexually transmitted diseases (Syphilis , Gonorrhoea), Urinary tract infection by *E.coli, Klebsiella and Proteus*,

Skin and superficial infections *(S.aureus*).

Fungal disease : Cutaneous mycoses: Tinea pedis (Athlete's foot) ,Systemic mycoses: Histoplasmosis ,Opportunistic mycoses: Candidiasis.

Viral disease: Polio,Hepatitis, Herpes Dengue, Chicken Pox AIDS,Influenza. SARS, Swine flu

Parasitic (protozoan) disease- Malaria, Kala-azar, Amoebaiosis.

No. of Hours: 14

Module 5:Sample collection, transport and Laboratory diagnosis of infectious diseasesNo. of Hours: 5

Collection of patient's sample.transport and culturing of clinical samples, Steps in the laboratory diagnosis process, specimen collection and transport (pre test) processing of the samples in culture media, staining, the lab- microscopic examination and identifications, principles of different diagnostic methods (ELISA,Immunofluorescence, Agglutination based tests,Complement fixation,

PCR, DNA probes). Quality control in clinical microbiology laboratory.**No. of Hours: 8**

Module 6:Principles Of Drugs, Route of administration and Mode of actions.

History of Chemotherapy- Paul Ehrlich contributions, Definition of Bacteriostatic and bactericidal agents,

Antibiotics - types of antibiotics and their classification, Target sites of drug action on bacteria. Route of administration, combined/mixed multi drug therapy, Mode of action of important drugs/antibiotics : Cell wall inhibitors (Betalactam – eg. Penicillin), membrane inhibitors (Bacitracin, Polymyxins), Streptomycin,Tetracyclin (protein synthesis inhibitor)Fluoroquinolones, Rifampicin(nucleic acid inhibitor), Sulfonamides and trimethoprim (antimetabolite)

antifungal antibiotics (Nystatin, Amphotericin B)

Antiviral agents – (Acyclovir, Azidothymidine). **No. of Hours: 4**

Module 7: **Antimicrobial assay and Drug Resistance**

Anti microbiological assay techniques and their importance : sensitivity of bacteria using Kirby-Bauer test and well diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution Method. The clinical basis of drug resistance, Mechanisms of Drug resistance in bacteria.**No. of Hours: 4**

Clinical and Pharmaceutical Microbiology (PRACTICAL) CREDITS: 2

BMMC-3292TOTAL HOURS: 30

1. Study of normal bacterial flora of skin by swab method.
2. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
3. Study symptoms of the diseases with the help of photographs: Dermatomycoses (ring worms), Athlete's foot
4. Study symptoms of the diseases with the help of photographs: Polio, herpes, chicken pox, AIDS (candidiasis),
5. Study of various stages of malarial parasite in RBCs using permanent mounts.
6.. Study of composition and use of important differential media for identification of bacteria: EMB

Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS

7. Perform antibacterial sensitivity by Kirby-Bauer method
8. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. Universities Press (India) Pvt. Ltd.; **Twelfth edition** (28 February 2022); Universities Press (India) Pvt. Ltd.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A.15th edition (2013)

3. Jawetz, Melnick andAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

4. Essentials of Medical Microbiology By Apurba S Sastry (2023) .Edition:4th Revised Reprint.Publisher:JAYPEE BROTHERS

5. Willey JM, Sherwood LM, and Woolverton CJ. (2018) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

6.. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2020). Brock Biology of Microorganisms. 15th edition. Pearson International Edition