



Syllabus
Fourth Semester Courses in
BSc
Microbiology
(November 2024 onwards)

- **Core Courses:**

- USMIC5003CR1 DNA structure and replication
- USMIC5003CR1PR DNA structure and replication Practical
- USMIC5004CR1 Medical Microbiology and Epidemiology
- USMIC5004CR1PR Medical Microbiology and Epidemiology Practical

- **Evaluation and Assessment Guidelines**

APPROVED SYLLABUS



Shinde

PRINCIPAL
ST. XAVIER'S COLLEGE
(AUTONOMOUS)
MUMBAI - 400 001.

BSc in Microbiology		
Course Title: DNA structure and replication		
Course Code: USMIC5003CR1		
Credits 3: Theory (3) = 45 hr		
No.	Course Objectives	
1.	Introduce the molecular basis of heredity and the significance of the flow of genetic information.	
2.	Communicate the importance of non-chromosomal elements in genetic processes.	
3.	Explain the DNA replication processes in prokaryotes and eukaryotes.	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	Describe the flow of genetic information and its significance; discuss the molecular events and enzymatic machinery in prokaryotic and eukaryotic DNA replication.	Remember
2.	Explain the structure and organization of prokaryotic and eukaryotic chromosomes	Understand
3.	Elucidate bidirectional and unidirectional replication models; interpret results of classical experiments in genetics that illustrate the role of DNA in heredity	Apply
4.	Differentiate between eubacterial, archaeal and eukaryotic DNA replication	Analyze

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UNIT I	PROKARYOTIC AND EUKARYOTIC DNA STRUCTURE	(15)
A.	Ayurveda	(3)
	1. Science of Life, Genetics and Epigenetics	
	2. Prakriti and modern genomic research	
B.	Molecular basis of heredity	(2)
	1. Griffith's Experiment (1928) – Transforming principle	
	2. Avery-Macleod-McCarty Experiment (1944) – DNA as the carrier of genetic information	
	3. Hershey and Chase Experiment (1952) – DNA as hereditary material	
C.	Organization of DNA	(5)
	1. Watson and Crick's Model of DNA (1953) – 3-D model of the double helix	
	2. Rosalind Franklin and Maurice Wilkins (1953) – X-ray diffraction	
	3. Nucleic acid chemistry and forms of DNA – revision	
	4. Base composition studies - Chargaff's rule (1949)	
	5. Organization of genetic material – euchromatin and heterochromatin	
	6. Roles of histones and non-histone proteins	
	7. Chromosome packaging, circularity, and the phenomenon of supercoiling	
	8. Structures of condensed chromatin, nucleosomes, centromeres, kinetochores, and telomeres	
D.	Central Dogma of Life	(1)
	The flow of genetic information and its significance in the biological processes governing life	
E.	Genetic Elements	(2)
	Non-chromosomal genetic elements -Viruses, plasmids, and transposable elements	
F.	Differences in Chromosomal Structure	(1)
	Variations in the chromosomal structure of eubacteria, archaea, and eukaryotes	
G.	Exploring genomics	(1)



Introduction to Bioinformatics

UNIT II	MOLECULAR MECHANISMS OF PROKARYOTIC DNA REPLICATION	(15)
A.	Unveiling DNA Replication	(4)
	1. Semi-conservative nature of DNA replication and inheritance of genetic information - Meselson and Stahl experiment (1958)	
	2. Bidirectional model of DNA replication in <i>E. coli</i> - J Cairns experiments (1963)	
B.	Prokaryotic DNA Replication	(11)
	1. Initiation, Elongation and Termination	
	2. Enzymology	
	3. Theta and Sigma Models of Replication	
	4. Multiforked replication	
UNIT III	MOLECULAR MECHANISMS OF DNA REPLICATION IN EUKARYOTES	(15)
A.	DNA Synthesis in Eukaryotes	(10)
	1. Initiation, Elongation and Termination	
	2. Enzymology	
	3. Linear DNA end replication problem	
	4. Replication of Telomeres	
B.	Nucleosomes	(3)
	1. Synthesis of Nucleosomes	
	2. Disassembly and reassembly of DNA	
C.	Differences between eubacteria, archaea, and eukaryotic DNA replication	(2)

References:

1. Attwood, T. K., Parry-Smith, D. J., & Phukan, S. (1999). *Introduction to bioinformatics*. Pearson Education.
2. Klug W.S., Cummings M.R., Spencer CA, Palladino MA, (2015), *Concepts of Genetics*. (11th edition), Pearson Publications



3. Nelson, D. L., Cox, M. M., & Lehninger, A. L. (2013). *Lehninger principles of biochemistry* (6. edition, international ed). Freeman.
4. Pierce, B. A. (2020). *Genetics: A conceptual approach* (7th edition). Macmillan International, Higher Education.
5. Russell, P. J. (2009). *iGenetics: A molecular approach* (3rd edition, international ed). Cummings.
6. Watson, J. D. (Ed.). (2014). *Molecular biology of the gene* (7th ed., student ed). Pearson.
7. Willey, J. M., Prescott, L. M., Sandman, K. M., & Wood, D. H. (2020). *Prescott's microbiology* (11th edition). McGraw-Hill Education.

Evaluation (Theory, USMIC5003CR1): Total marks per course – 100

Formative Assessment for Learning

(continuous internal assessment - CIA to improve learning).

CIA - 40 marks

CIA 1: Written test - 20 marks.

CIA 2: Test / Assignment / Presentations / Infographics / Quiz / as prescribed - 20 marks.

Summative Assessment of Learning

(focus on outcomes, quantitative data for outcomes of instruction)

End Semester Examination - 60 marks

One question from each unit for 20 marks, with internal choice.

Total marks per question with choice 25 - 30 marks.

Distribution of Bloom's Taxonomy levels for the course assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	15-20%	20-30%	20-30%	20-30%	-	-

APPROVED SYLLABUS



BSc in Microbiology		
Course Title: DNA structure and replication Practical		
Course Code: USMIC5003CR1PR		
Credits 1: Practical (1) Number of hours: 30		
No.	Course Objectives	
1.	Familiarize students with the basic laboratory tools used in molecular biology	
2.	Introduce basic methods in genomic and plasmid DNA isolation	
3.	Facilitate the use of bioinformatics	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	Isolate genomic DNA and plasmid DNA from various biological sources	Apply
2.	Demonstrate basic expertise in handling laboratory equipment used in molecular biology	Apply
3.	Navigate nucleotide databases and apply basic bioinformatic tools to analyze nucleotides	Apply
4.	Demonstrate the presence of DNA using agarose gel electrophoresis and quantify using a spectrophotometer	Analyze

S. No. Name of Practical

1. Isolation of genomic DNA from *E. coli*
2. Isolation of pUC 18
3. Quantification of DNA using UV-Vis spectrophotometer
4. Agarose gel electrophoresis
5. Sucrose density gradient centrifugation
6. Bioinformatics - nucleotide databases

References:

1. Aneja, K. R. (2014). *Laboratory manual of microbiology and biotechnology*. Scientific International.
2. Hemalatha R & Govil S. (2018). *Life Science Protocol Manual*. Department of Biotechnology.
3. Green, M. R., & Sambrook, J. (2012). *Molecular cloning: A laboratory manual* (4th ed.). Cold Spring Harbor Laboratory Press.



Evaluation (Practical, USMIC5003CR1PR): Total marks practical course - 50
CIA - 20 marks

End Semester Practical Examination - 30 marks.

Continuous practical evaluation will be done on the basis on the completion of the hands-on practical sessions

Distribution of Bloom's Taxonomy levels for the practical assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	-	20-30%	30-45%	25-35%	-	-

APPROVED SYLLABUS



BSc in Microbiology		
Course Title: Medical Microbiology and Epidemiology		
Course Code: USMIC5004CR1		
Credits 3: Theory (3) = 45 hr		
No.	Course Objectives	
1.	Introduce determinants of infections and pathogenesis of infectious diseases	
2.	Explain the diagnostic process	
3.	Facilitate the identification of core epidemiologic functions	
4.	Explain primary applications of epidemiology in public health practice	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	List pathogenic agents, portals of entry, exit of pathogens, and stages of disease; define basic terms in medical microbiology and epidemiology	Remember
2.	Describe stages of disease; classify diseases based on occurrence, severity and extent of host involvement	Understand
3.	Identify etiological agents based on cultural and biochemical properties; plot epidemic curve; investigate outbreaks	Apply
4.	Measure risk based on epidemiological data	Analyze
5.	Compare bacterial and viral diseases with respect to pathogenesis and diagnosis	Evaluate

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UNIT I	INTRODUCTION TO INFECTIOUS DISEASES AND MICROBIAL VIRULENCE	(15)
A.	History of infectious diseases	(1)
B.	Human microbial interactions	(2)
	1. Beneficial interactions – microbiota/ microbiome	
	2. Harmful microbial interactions - Infectious agents – bacteria, fungi, protozoa, viruses, prions	
C.	Germ theory of disease – Koch’s postulates	(1)
D.	Infectious disease cycle – an overview	(2)
	1. the causative agent	
	2. source or reservoir of the pathogen	
	3. modes of transmission	
	4. portals of entry	
	5. infectious dose	
	6. portals of exit	
E.	Development of Disease	(1)
	Stages of Disease – incubation period, prodromal period, period of illness, period of decline, period of convalescence	
F.	Classifying Infectious Diseases	(2)
	1. Occurrence – sporadic, endemic, epidemic, pandemic	
	2. Severity or duration of disease – acute, chronic, sub-acute, latent	
	3. Extent of host involvement – local infection, systemic infection, focal infection etc.	
G.	Microbial mechanisms of pathogenicity	(4)
	1. Adherence	
	2. Penetration of host defense	
	3. Damage to host cells	
	4. Role of virulence factors – toxins, enzymes, antigenic variation etc.	
H.	Emerging and re-emerging infections	(1)
I.	Nosocomial infections	(1)



UNIT II	HUMAN PATHOGENIC MICROBES: CHARACTERISTICS AND PATHOGENESIS	(15)
A.	<i>Staphylococcus aureus, Pseudomonas</i>	(6)
B.	SARS CoV2	(3)
C.	<i>Plasmodium spp</i>	(3)
D.	<i>Candida spp</i>	(3)
UNIT III	EPIDEMIOLOGY	(15)
A.	History	(1)
B.	Basic principles of epidemiology	(4)
	1. Core epidemiologic functions	
	2. Case definition	
	3. Descriptive epidemiology	
	4. Analytic epidemiology	
	5. Epidemic patterns	
C.	Statistics and common measures in epidemiology	(6)
	1. Organizing data	
	2. Types of variables	
	3. Frequency distribution	
	4. Measures of central location and spread	
	5. Measures of risk	
D.	Public health surveillance	(2)
	1. Purpose and characteristics	
	2. Role of GIS, CDC and WHO	
E.	Outbreak investigation	(2)

References:

1. Ananthanarayan, R., Paniker, C.K.J. (2022). *Ananthanarayan and Paniker's Textbook of Microbiology* (R. Kanungo, & S. Saxena, Eds.; 12th Edition). Universities Press.
2. Chess, B. (2024). *Talaro's foundations in microbiology* (12th edition). McGraw Hill LLC.
3. Chess, B., & Talaro, K. P. (2021). *Talaro's Foundations in microbiology* (11th edition). McGraw.



4. Dicker, R. C. (2006). *Principles of epidemiology in public health practice; an introduction to applied epidemiology and biostatistics* (3rd edition). CDC.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2019). *Brock biology of microorganisms* (15th edition, global edition). Pearson.
6. Willey, J. M., Prescott, L. M., Sandman, K. M., & Wood, D. H. (2020). *Prescott's microbiology* (11th edition). McGraw-Hill Education.
7. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). *Prescott's microbiology* (12th edition, international student edition). McGraw Hill.

Evaluation (Theory, USMIC5004CR1): Total marks per course – 100

Formative Assessment for Learning

(continuous internal assessment - CIA to improve learning).

CIA - 40 marks

CIA 1: Written test - 20 marks.

CIA 2: Written assignment - 20 marks.

Summative Assessment of Learning

(focus on outcomes, quantitative data for outcomes of instruction)

End Semester Examination - 60 marks

One question from each unit for 20 marks, with internal choice.

Total marks per question with choice 25 - 30 marks.

Distribution of Bloom's Taxonomy levels for the course assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	15-20%	15-25%	20-35%	20-30%	5-10%	-

APPROVED SYLLABUS



BSc in Microbiology		
Course Title: Medical Microbiology and Epidemiology Practical		
Course Code: USMIC5004CR1PR		
Credits 1: Practical (1) Number of hours: 30		
No.	Course Objectives	
1.	Explain the role and significance of the microbiota in human health.	
2.	Equip students with the skills to identify <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i> from pathological samples using morphological, cultural, and biochemical characteristics	
3.	Familiarize students with the significance and detection of virulence factors of pathogens	
4.	Explain the role of fomites in the transmission of infectious diseases.	
5.	Show permanent slides of malarial parasites and learn to identify <i>Candida</i> species based on morphological and biochemical characteristics.	
6.	Facilitate the analysis of epidemiological data using statistical methods.	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	Isolate normal microbiota of selected body sites such as skin, oral cavity	Apply
2.	Isolate and identify <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i> and show the presence of their major virulence factors	Apply
3.	Perform the germ tube test to identify <i>Candida</i> species.	Analyze
4.	Employ appropriate statistical tests to analyze epidemiological data.	Analyze, Evaluate

S. No. Name of Practical

1. Study of normal microbiota
2. Study of virulence factors of *S aureus*, *Pseudomonas*
3. Transmission of diseases: role of fomites
4. Identification of bacterial etiological agent (*S aureus*, *Pseudomonas*) from samples using morphological, cultural, and biochemical characteristics
5. Malarial parasite – permanent slides
6. *Candida* – Germ tube



7. Statistics in epidemiology

References:

1. Ananthanarayan, R., Paniker, C.K.J. (2022). *Ananthanarayan and Paniker's Textbook of Microbiology* (R. Kanungo, & S. Saxena, Eds.; 12th Edition). Universities Press.
2. Aneja, K. R. (2014). *Laboratory manual of microbiology and biotechnology*. Scientific International.
3. Cappuccino, J. G., & Sherman, N. (2014). *Microbiology: A laboratory manual* (10th edition). Pearson.
4. Dicker, R. C. (2006). *Principles of epidemiology in public health practice; an introduction to applied epidemiology and biostatistics* (3rd edition). CDC.

Evaluation (Practical, USMIC5004CR1PR): Total marks practical course - 50

CIA - 20 marks

End Semester Practical Examination - 30 marks.

Continuous practical evaluation will be done on the basis on the completion of the hands-on practical sessions

Distribution of Bloom's Taxonomy levels for the practical assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	-	-	35-45%	35-45%	5-15%	-

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Syllabus

Fourth Semester Courses in

BSc

Microbiology

(November 2024 onwards)

- **Minor Courses:**
 - USMIC5002MN1 Introduction to Infectious Diseases and Chemotherapy
 - USMIC5002MN1PR Introduction to Infectious Diseases and Chemotherapy Practical
- **Evaluation and Assessment Guidelines**

APPROVED SYLLABUS



BSc in Microbiology		
Course Title: Introduction to infectious diseases and chemotherapy		
Course Code: USMIC5002MN1		
Credits 3: Theory (3) = 45 hr		
No.	Course Objectives	
1.	Introduce determinants of infections and pathogenesis of infectious diseases	
2.	Equip students with an understanding of the diagnostic process	
3.	Explain the basic principles of chemotherapy - mechanisms of action of different classes of antibiotics, clinical relevance of antibiotic susceptibility testing and principles of antibiotic resistance	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	List pathogenic agents, portals of entry, exit of pathogens, and stages of disease; define basic terms in medical microbiology and epidemiology	Remember
2.	Describe stages of disease; classify diseases based on occurrence, severity and extent of host involvement; discuss the mode of action of different classes of antimicrobial agents	Understand
3.	Identify etiological agents based on cultural and biochemical properties	Apply
4.	Compare and contrast mechanisms of action of antibiotics and methods of antimicrobial susceptibility testing	Analyze

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UNIT I	MICROBIAL VIRULENCE AND DEVELOPMENT OF DISEASE	(15)
A.	History of infectious diseases	(1)
B.	Human microbial interactions	(2)
	1. Beneficial interactions – microbiota/ microbiome	
	2. Harmful microbial interactions - Infectious agents – bacteria, fungi, protozoa, viruses, prions	
C.	Germ theory of disease – Koch’s postulates	(1)
D.	Infectious disease cycle – an overview	(2)
	1. the causative agent	
	2. source or reservoir of the pathogen	
	3. modes of transmission	
	4. portals of entry	
	5. infectious dose	
	6. portals of exit	
E.	Development of Disease	(1)
	Stages of Disease- incubation period, prodromal period, period of illness, period of decline, period of convalescence	
F.	Classifying Infectious Diseases	(2)
	1. Occurrence- sporadic, endemic, epidemic, pandemic	
	2. Severity or duration of disease- acute, chronic, sub-acute, latent	
	3. Extent of host involvement-local infection, systemic infection, focal infection etc.	
G.	Microbial mechanisms of pathogenicity	(4)
	1. Adherence	
	2. Penetration of host defense	
	3. Damage to host cells	
	4. Role of virulence factors – toxins, enzymes, antigenic variation etc.	
H.	Emerging and re-emerging infections	(1)
I.	Nosocomial infections	(1)



UNIT II	HUMAN PATHOGENIC MICROBES: CHARACTERISTICS AND PATHOGENESIS	(15)
A.	<i>Staphylococcus aureus, Listeria monocytogenes</i>	(4)
B.	Influenza virus	(4)
C.	<i>Plasmodium spp</i>	(4)
D.	<i>Candida spp</i>	(3)
UNIT III	CHEMOTHERAPY	(15)
A.	History	(1)
B.	Principal groups of antibacterial agents and mechanism of action	(4)
	1. Cell Wall Inhibitors	
	2. Inhibitors of Protein Synthesis	
	3. Inhibitors of Nucleic Acid Synthesis	
	4. Cell Membrane Disruptors	
	5. Antimetabolites	
C.	Anti-mycobacterial, antifungal, antiviral, antiprotozoal drugs	(3)
D.	Selection and testing	(2)
E.	Drug Resistance: Origin, Mechanisms and Transmission	(3)
F.	Principles of Ayurveda	(2)

References:

1. Ananthanarayan, R., Paniker, C.K.J. (2022). *Ananthanarayan and Paniker's Textbook of Microbiology* (R. Kanungo, & S. Saxena, Eds.; 12th Edition). Universities Press.
2. Chess, B. (2024). *Talaro's foundations in microbiology* (12th edition). McGraw Hill LLC.
3. Chess, B., & Talaro, K. P. (2021). *Talaro's Foundations in microbiology* (11th edition). McGraw.
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2019). *Brock biology of microorganisms* (15th edition, global edition). Pearson.
5. Willey, J. M., Prescott, L. M., Sandman, K. M., & Wood, D. H. (2020). *Prescott's microbiology* (11th edition). McGraw-Hill Education.
6. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). *Prescott's microbiology* (12th edition, international student edition). McGraw Hill.



Evaluation (Theory, USMIC5002MN1): Total marks per course – 100

Formative Assessment for Learning

(continuous internal assessment - CIA to improve learning).

CIA - 40 marks

CIA 1: Written test - 20 marks.

CIA 2: Written assignment - 20 marks.

Summative Assessment of Learning

(focus on outcomes, quantitative data for outcomes of instruction)

End Semester Examination - 60 marks

One question from each unit for 20 marks, with internal choice.

Total marks per question with choice 25 - 30 marks.

Distribution of Bloom's Taxonomy levels for the course assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	20-25%	25-30%	30-35%	20-25%	-	-

APPROVED SYLLABUS



BSc in Microbiology		
Course Title: Introduction to infectious diseases and chemotherapy Practical		
Course Code: USMIC5002MN1PR		
Credits 1: Practical (1) Number of hours: 30		
No.	Course Objectives	
1.	Introduce the role and significance of microbiota in human health.	
2.	Facilitate the identification of <i>Salmonella typhi</i> based on morphological, cultural, and biochemical characteristics and the virulence factors of <i>Staphylococcus aureus</i>	
3.	Explain the role of fomites in the transmission of infectious diseases.	
4.	Explain Kirby Bauer's method for antibacterial susceptibility testing	
CO	Course Outcomes On completing the course, the learner will be able to	Bloom's Taxonomy Level (BT level)
1.	Isolate normal flora of selected body sites such as skin, oral cavity	Apply
2.	Isolate and identify <i>Salmonella typhi</i>	Apply
3.	Demonstrate major virulence factors of <i>Staphylococcus aureus</i>	Apply
4.	Perform antibacterial susceptibility testing and recommend appropriate therapeutic agent	Analyze, Evaluate

S. No. Name of Practical

1. Study of normal microbiota
2. Study of virulence factors of *S. aureus*
3. Transmission of diseases: role of fomites
4. Identification of bacterial etiological agent (*S. typhi*) from samples using morphological, cultural, and biochemical characteristics
5. AST – Kirby Bauer's method

References:

1. Aneja, K. R. (2014). *Laboratory manual of microbiology and biotechnology*. Scientific International.
2. Cappuccino, J. G., & Sherman, N. (2014). *Microbiology: A laboratory manual* (10th edition). Pearson.



Evaluation (Practical, USMIC5002MN1PR): Total marks practical course - 50

CIA - 20 marks

End Semester Practical Examination - 30 marks.

Continuous practical evaluation will be done on the basis on the completion of the hands-on practical sessions

Distribution of Bloom's Taxonomy levels for the practical assessment

Learning Levels	Remember	Understand	Apply	Analyze	Evaluate	Create
Percentage	-	10-20%	30-40%	30-40%	5-10%	-

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