BANKURA UNIVERSITY

(West Bengal Act XIX of 2013- Bankura University Act, 2013)

Main Campus, Bankura Block-II, P.O.: Purandarpur, Dist.: Bankura, Pin- 722155, West Bengal

Office of the Secretary

Faculty Council for Undergraduate Studies

Ref: BKU/FCUG/295/2026 Date: 17/11/2026

NOTIFICATION

As directed, the undersigned is pleased to inform all concerned that Bankura University has initiated the process to implement New Curriculum and Credit Framework for Undergraduate Programme, UGC 2022 (as per NEP 2020) for 4-years Undergraduate programme with Microbiology as Major, Minor etc. from the academic session 2023-2024. The syllabus as framed / drafted and partially implemented deserves to be analysed after receiving feedback from different stakeholders. As an important corollary to the process, a workshop will be organized on the date mentioned herewith to get the feedback from the stakeholders. Present Students, Alumni, Guardians, Academicians and other stakeholders related to the specific programme/course are requested for their kind participation in the workshop and to present their views/ observations, etc. The stakeholders may go through the draft syllabus attached herewith and convey their observations to the office of the undersigned on ugsecretaryoffice@bankurauniv.ac.in within seven days from the date of publication of this notice.

Date: 24/11/2026

Time: 8 PM

Google Meet joining link: https://meet.google.com/pdc-drhb-nmk

Sd/-
Dr. Arindam Chakraborty
Secretary
Faculty Council for Undergraduate Studies

Ref: BKU/FCUG/295(6)/2026 Date: 17/11/2026

1. Registrar (Addl. Charge), Bankura University.
2. Dean (Officiating), Faculty Council of P.G. Studies in Arts, Science etc. Bankura University.
3. Chairperson / Convenor, Undergraduate Board of Studies in Microbiology, Bankura University with request for necessary action.
4. System Administrator, Bankura University with request to upload this in website.
5. Secretary, Hon'ble Vice Chancellor, Bankura University.
6. Guard File.

Sd/-
Dr. Arindam Chakraborty
Secretary
Faculty Council for Undergraduate Studies

SYLLABUS
UNDER NATIONAL EDUCATION POLICY
FOR
FOUR YEARS UNDER-GRADUATE COURSE IN
MICROBIOLOGY
(w.e.f. *2026-2027)*

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN: 722155

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1. INTRODUCTION

The National Education Policy (NEP) 2020 highlights that quality higher education must aim to develop good, thoughtful, well-rounded and creative individuals. The NEP recommends that "the undergraduate degree will be of either 3 or 4-year duration, with multiple exit options within this period, with appropriate certifications, e.g., a UG certificate after completing 1 year in a discipline or field including vocational and professional areas, or a UG diploma after 2 years of study, or a Bachelor's degree after a 3-year programme. The 4-year multidisciplinary Bachelor's programme, however, shall be the preferred option since it allows the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

In accordance with the NEP 2020, the UGC has formulated a new student-centric "Curriculum and Credit Framework for Undergraduate Programs (CCFUP)" incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options. This will facilitate students to pursue their career path by choosing the subject/field of their interest.

Therefore, the syllabus for Microbiology at undergraduate level framed in such a way that it gives the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Microbiology. The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject. The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Microbiology students select their minor courses Chemistry as compulsory and any one from the branch of Life Sciences disciplines. While the syllabus is in compliance with UGC model curriculum, it is necessary that Microbiology students should learn "Bioinformatics, Microbes in Sustainable Agriculture and Development & Instrumentation and Biotechniques" as one of the core courses rather than a selective while.

Also, it is been recommended that the Dissertation Work and Industrial Tour/ Institute visit is compulsory for all the students as per their respective semester curriculum.

LEARNING OUTCOME (LO)		
LO	**Summary**	**Description**
LO A:	Sound Domain Knowledge	Acquiring a strong, basic knowledge on origin, evolution and diversification in the applied field of Microbiology.
LO B:	Laboratory Skill	To develop good laboratory skills with latest advanced tools, sophisticated instruments and modern technologies to address emerging problems with scientific viewpoint.
LO C:	Team Work	To develop the spirit of teamwork, learn to harbor collaborative approach to explore new facts and facets of the subject.
LO D:	Academic and Scientific Endeavour	Students will gain cognitive development, innovative approach, technical maneuvering, entrepreneurship and managerial skills to set up a new start-up.
LO E:	Eco-friendly Approach	Futuristic approach to develop eco-friendly management practices to make socio-economic upliftment.
LO F:	Ethical Awareness	To develop ethical awareness among students regarding research & publications.
LO G:	Goal of life	To inculcate visions in students so that they can play a vital role for the advancement of the discipline in the greater benefits of the society.
LEARNING SPECIFIC OUTCOME (LSO)		
LSO	Summary	Description
LSO1:	Rational analysis	Develops fundamental concepts, rational thinking & analytical skill.
LSO2:	Soft Skill Proficiency	Develops communication skill, attitudes, leadership quality, ethical values and social awareness.
LSO3:	Environmental Consciousness	Increases eco-friendly consciousness, waste-management practices.
LSO4:	Hygiene practices	Builds up good habit of hygienic practices.
LSO5:	Scientific attitude	Inculcates research mind & approach to develop eco-friendly bio-products.
LSO6:	Resource management	Develops the knowledge & skill on natural & renewable resource management.
LSO7:	Dry lab practices	Develops ability of sequence analysis & structure prediction.
LSO8:	Awareness against infectious diseases	Develops Awareness against infectious & fatal diseases.
LSO9:	Ecological Awareness	Develops Ecological Awareness among students through Mushroom diversity study in different forest areas of the district.
LSO10:	Skill Development	Students will gain knowledge through different Hands-on-training program on Agro-economic activities.
LSO11:	Social Interaction	Develops Community link up through regular survey on Health & Nutritional parameters of local villagers.
LSO12:	Ethno-medicinal Practices	Develops knowledge on Ethno-medicinal Plants, their commercial usage & worldwide applications.

2. Scheme for NEP Curriculumin Microbiology (Major)

2.1. Credit Distribution across Courses

Category of Choice (Credit) / SEMESTER	Major (4) DSC	Major (4) DSE	Minor Stream (4)	Multidisci-plinary (3)	Skill Enhancement Courses [SEC] (3)	Ability Enhancement Courses [AEC] (2)	Value Added Courses (Common for all) (4)	Internship (2)	Research Project/ Dissertation (12)	Total Credit/ Number of Courses
I	1×4=4 S/MCB/101/MJC-1		1×4=4 S/MCB/102/MN-1	1×3=3 S/MCB/103/MD-1	1×3=3 S/MCB/104/SEC-1	1×2=2 ACS/105/AEC-1	1×4=4 ACS/106/VAC-1			20/6
II	1×4=4 S/MCB/201/MJC-2		1×4=4 S/MCB/202/MN-2	1×3=3 S/MCB/203/MD-2	1×3=3 S/MCB/204/SEC-2	1×2=2 ACS/205/AEC-2	1×4=4 ACS/206/VAC-2			20/6
CERTIFICATE (Total Credit)	8		8	6	6	4	8	4*(Additional) ACS/207/INT-1		40
III	2×4=8 S/MCB/301/MJC-3 S/MCB/302/MJC-4		1×4=4 S/MCB/303/MN-3	1×3=3 S/MCB/304/MD-3	1×3=3 S/MCB/305/SEC-3	1×2=2 ACS/306/AEC-3				20/6
IV	4×4=16 S/MCB/401/MJC-5 S/MCB/402/MJC-6 S/MCB/403/MJC-7 S/MCB/404/MJC-8		1×4=4 S/MCB/405/MN-4			1×2=2 ACS/406/AEC-4				20/6
DIPLOMA (Total Credit)	32		16	9	9	8	8	4*(Additional) ACS/407/INT-2		82
V	4×4=16 S/MCB/501/MJC-9 S/MCB/502/MJC-10 S/MCB/503/MJC-11 S/MCB/504/MJC-12		1×4=4 S/MCB/505/MN-5					1×2=2 ACS/506/INT-3		22/6
VI	4×4=16 S/MCB/601/MJC-13 S/MCB/602/MJC-14 S/MCB/603/MJC-15 S/MCB/604/MJC-16		1×4=4 S/MCB/605/MN-6							20/5
UG DEGREE (Total Credit)	16×4=64 64		24	9	9	8	8	2		124
VII	4×4=16 S/MCB/701/MJC-17 S/MCB/702/MJC-18 S/MCB/703/MJC-19 S/MCB/704/MJC-20		1×4=4 S/MCB/705/MN-7							20/5
VIII	4×4=16** S/MCB/801/MJC-21 S/MCB/802/MJC-22 S/MCB/803/MJC-23 S/MCB/804/MJC-24		1×4=4 S/MCB/805/MN-8							20/5
UG HONS. (Total Credit)	24×4=96 96		32	9	9	8	8	2		164
UG HONS. WITH RESEARCH (Total Credit)	21×4=84		32	9	9	8	8	2	12** S/MCB/806/RPD-1	

*Additional Summer Internship of 4 credit is mandatory for certificate and diploma courses.

**Honours students not undertaking research will do three courses for 12 credits for Major in lieu of a Research Project/ Dissertation and total four courses in Major in semester-VIII.
Honours with Research students will opt any one core course from available four courses in Major in Semester-VIII

2.2. Scheme for NEP based Curriculum in Microbiology (Major)

SEMESTER –I

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/101/MJC-1	Introduction to Microbiology and Microbial Diversity	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/102/MN-1	Introduction to Microbiology and Microbial Diversity (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 103 MD-1	Microbial Diagnosis in Health Clinics (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/104/SEC-1	Microbial Diagnosis in Health Clinics	3 (P)	10	40 (P 40)	50
ACS/105/ AEC-1	Communicative English	2	10	40	50
ACS/106/ VAC 1	ENVS	4	10	40	50
Total		**20**	**60**	**240**	**300**

SEMESTER –II

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/201/MJC- 2	Bacteriology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/202/MN- 2	Bacteriology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 203 MD-2	Microbiological Analysis of Air and Water (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/204/SEC- 2	Microbiological Analysis of Air and Water	3 (P)	10	40 (P 40)	50
ACS/205/ AEC-2	MIL-1(Bengali/Sanskrit/Santali)	2	10	40	50
ACS/206/ VAC 2	Any one of the following: A: Health and Wellness B: Understanding India: Indian Philosophical Traditions and Value Systems C: Basics of Indian Constitution D: Arts and Crafts of Bengal E: Historical Tourism in West Bengal	4	10	40	50
Total		**20**	**60**	**240**	**300**

SEMESTER –III

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/301/MJC-3	Biochemistry	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/302/MJC-4	Virology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/303/MN-3	Virology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/304 MD-3	Food Fermentation Techniques (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/305/SEC-3	Food Fermentation Techniques	3 (P)	10	40 (P 40)	50
ACS/306/ AEC-3	MIL-2(Bengali/Sanskrit/Santali)	2	10	40	50
Total		**20**	**60**	**240**	**300**

SEMESTER –IV

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/401/MJC-5	Microbial Physiology & Metabolism	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/402/MJC-6	Food & Dairy Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/403/MJC-7	Environmental Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/404/MJC-8	Bacterial Pathogenesis	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/405/MN- 4	Food & Dairy Microbiology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
Total		**22**	**60**	**240**	**300**

SEMESTER –V

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/501/MJC-9	Molecular Biology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/502/MJC-10	Fundamentals of Immunology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/503/MJC-11	Instrumentation and Biotechniques	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/504/MJC-12	Fungal, Protozoan and Viral Pathogenesis	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/505/MN- 5	Immunology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
ACS/506/INT-3	Internship (Compulsory)	2	10	40	50
Total		**22**	**60**	**240**	**300**

SEMESTER –VI

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/601/MJC-13	Microbial Genetics	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/602/MJC- 14	Extreme Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 603/MJC -15	Advanced Immunology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/604/MJC- 16	Recombinant DNA Technology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/605/MN- 6	Molecular Biology & Microbial Genetics (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
Total		**20**	**50**	**200**	**250**

SEMESTER –VII

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/701/MJC-17	Traditional & Industrial Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/702/MJC-18	Bioinformatics	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/703/MJC-19	Aquatic Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/704/MJC-20	Research Methodology	4 (P)	10	40 (T 25+P 15)	50
S/MCB/705/MN- 7	Industrial Microbiology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
Total		**20**	**50**	**200**	**250**

SEMESTER –VIII

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/801/MJC-21	Cell Biology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/802/MJC-22	Management of human microbial disease	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/803/MJC-23	Pharmaceutical Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/804/MJC-24	Microbes in Sustainable Agriculture and Development	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/805/MN- 8	Microbes in Sustainable Agriculture and Development (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/806/RPD-1	Research Project	12 (P)			150
Total		**20**	**50/20**	**200**	**250**

Question Pattern

MJC and MN papers (Theory F.M: 25 & Practical F.M: 15)

Theory	F.M: 25	Practical	F.M: 15
UNIT-I		1. Work out/Demonstration/Experiment:	10/7
1. Any five out of eight	1×5=5		
UNIT-II		2. Laboratory Record/ Field Report:	2/5
2. Any two out of four	5×2=10	3. Viva Voce:	3
UNIT-III			
3. Any one out of two	10×1=10		

SEC Papers (Practical F.M: 40)

Practical	F.M: 40
1.Work out/Interpretation/Identification:	12
2. Work out/ Demonstration:	8
3. Laboratory Record	5
4. Field Report:	10
5.Viva Voce:	5

Multidisciplinary Papers: (Theory F.M: 40)

Theory	F.M: 40
UNIT-I	
Any five out of eight	2×5=10
UNIT-II	
Any four out of six	5×4=20
UNIT-III	
Any one out of two	10×1=10

SEMESTER- I

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/101 /MJC-1	Introduction to Microbiology and Microbial Diversity	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/102 /MN-1	Introduction to Microbiology and Microbial Diversity (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 103 MD-1	Microbial Diagnosis in Health Clinics (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/104 /SEC-1	Microbial Diagnosis in Health Clinics	3 (P)	10	40 (P 40)	50
ACS/105/ AEC-1	Communicative English	2	10	40	50
ACS/106/ VAC 1	ENVS	4	10	40	50
Total		**20**	**60**	**240**	**300**

Major Course

MJC-1: Introduction to Microbiology and Microbial Diversity

Course Code: S/MCB/101/MJC-1 Credit: 4

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- The students will gain a holistic concept on history, development, scope and aspects of Microbiology. They will also learn about the contributions of Microbiologists.
- Students learn about the diversity of microbial world, kingdom and domain concept; features of dark field & phase contrast Microscope.
- Students will achieve knowledge on habitat, distribution, nutritional requirements, ultra-structure, thallus organization and aggregation of algae and fungi.
- Students will gain knowledge on General characteristics & Economic importance of Protozoa.
- Students will be made aware of biosafety protocols and laboratory management.

Unit 1 History and Development of Microbiology	**Lectures 8**
History, Development and Scope of microbiology Theory of Spontaneous generation, Germ theory of disease. Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology.	
Unit 2 Diversity of Microbial World	**Lectures 4**
Systems of classification: Basic idea about Haeckel and Whittaker's kingdom concept and domain concept of Carl Woese. Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain. General characteristics and representative members of different groups: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa). Acellular microorganisms (Viruses, Viroids, Prions).	
Unit 3 Basic Microscopy	**Lectures 4**
Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope.	
Unit 4 Phycology	**Lectures 10**
General characteristics of algae: occurrence, thallus organization, cell ultrastructure, pigments, flagella, eye spot, food reserves and vegetative, asexual and sexual reproduction. Economic importance of algae.	
Unit 5 Mycology	**Lectures 10**
General characteristics of fungi: habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation. Economic importance of fungi.	

Unit 6 Protozoa	Lectures 4
General characteristics of protozoa: Occurrence, cell ultra-structure, organs and appendages, nutrition, locomotion and economic importance.	

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition.
2. Madigan M T, Martinko J M, Dunlap P V and Clark D P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley J M, Sherwood L M and Woolverton C J. (2013) Prescott's Microbiology.9th Edition. McGraw-Hill International.
5. Atlas R M. (1997). Principles of Microbiology.2nd edition. W.M.T. Brown Publishers.
6. Pelczar M J,Chan ECS and Krieg NR.(1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Banerjee AK and Banerjee N (2006). Fundamentals of Microbiology and Immunology. New Central Book Agency (NCBA).

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Microbiology Laboratory Management and Biosafety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient Agar) for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven
6. Sterilization of heat sensitive material by filtration
7. Study of *Penicillium* using permanent mounts.
8. Study of *Chlamydomonas* using permanent Mounts.
9. Study of *Paramecium* using permanent mounts.

Minor Course

MN-1: Introduction to Microbiology and Microbial Diversity

Couse Code: S/MCB/102/MN-1 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- The students will gain a holistic concept on history, development, scope and aspects of Microbiology. They will also learn about the contributions of Microbiologists.
- Students learn about the diversity of microbial world, kingdom and domain concept; features of dark field & phase contrast Microscope.
- Students will achieve knowledge on habitat, distribution, nutritional requirements, ultra-structure, thallus organization and aggregation of algae and fungi.
- Students will gain knowledge on General characteristics & Economic importance of Protozoa.
- Students will be made aware of biosafety protocols and laboratory management.

Unit 1 History and Development of Microbiology	**Lectures 8**
History, Development and Scope of microbiology Theory of Spontaneous generation, Germ theory of disease. Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology.	
Unit 2 Diversity of Microbial World	**Lectures 4**
Systems of classification: Basic idea about Haeckel and Whittaker's kingdom concept and domain concept of Carl Woese. Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain. General characteristics and representative members of different groups: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa). Acellular microorganisms (Viruses, Viroids, Prions).	
Unit 3 Basic Microscopy	**Lectures 4**
Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope.	
Unit 4 Phycology	**Lectures 10**
General characteristics of algae: occurrence, thallus organization, cell ultrastructure, pigments, flagella, eye spot, food reserves and vegetative, asexual and sexual reproduction. Economic importance of algae.	
Unit 5 Mycology	**Lectures 10**
General characteristics of fungi: habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation. Economic importance of fungi.	

Unit 6 Protozoa	Lectures 4
General characteristics of protozoa: Occurrence, cell ultra-structure, organs and appendages, nutrition, locomotion and economic importance.	

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition.
2. Madigan M T, Martinko J M, Dunlap P V and Clark D P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley J M, Sherwood L M and Woolverton C J. (2013) Prescott's Microbiology.9th Edition. McGraw-Hill International.
5. Atlas R M. (1997). Principles of Microbiology.2nd edition. W.M.T. Brown Publishers.
6. Pelczar M J,Chan ECS and Krieg NR.(1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Banerjee AK and Banerjee N (2006). Fundamentals of Microbiology and Immunology. New Central Book Agency (NCBA).

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Microbiology Laboratory Management and Biosafety
2. To study the principle and applications of important instruments(autoclave, incubator, hot airoven, centrifuge, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media(Nutrient Broth and Nutrient Agar)for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven
6. Sterilization of heat sensitive material by filtration.
7. Study of *Penicillium* using permanent mounts.
8. Study of *Chlamydomonas* using permanent Mounts.
9. Study of *Paramecium* using permanent mounts.

Multidisciplinary Course

MD-1: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Course Code: S/MCB/ 103/MD-1 **Credit: 3**

(Theory: Lectures 30 /Marks 40)

Learning Outcome

- Students can have the knowledge about tools of diagnostic and detection methods different diseases.

Unit 1: Importance of Diagnosis of Diseases	**Lectures: 02**
Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease Associated clinical samples for diagnosis	
Unit 2: Collection of Clinical Samples	**Lectures: 04**
Collection of clinical samples(Sputum, Skin, Blood, Urine and Stool)with proper precautions Method of transport of clinical samples to the laboratory and storage	
Unit 3: Direct Microscopic Examination and Culture	**Lectures: 04**
Examination of sample by staining - Gram staining, Ziehl-Neelson staining, Giem sustaining Preparation and use of culture media-Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar.	
Unit 4: Serological and Molecular Methods	**Lectures: 06**
Serological Methods -Agglutination, ELISA, Immunofluorescence, Nucleic acid-based methods -PCR, Nucleic acid probes	
Unit 5: Detection of Pathogens	**Lectures: 04**
Typhoid, Dengue and HIV	
Unit 6:Testing for Antibiotic Sensitivity in Bacteria	**Lectures: 10**
General idea about resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin), Disc diffusion method & Minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/Streptomycin).	
Reference Books	

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. 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
3. Collee JG, Duguid JP, Fraser AG, Marmion BP(1989) Practical Medical Microbiology, 13th edition, Churchill Livingstone
4. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology

Skill Enhancement Course

SEC-1: MICROBIAL DIAGNOSIS IN HEALTH CLINICS (P)

Course Code: S/MCB/104/SEC-1 **Credits: 3**

(Practical: Lectures 30 /Marks 40)

Learning Outcome

- Students will gain knowledge and hands-on-training regarding diagnostic procedures in health clinics.

PRACTICAL	
Unit 1:	**Lectures: 06**
Collection of clinical samples (Sputum, Skin, Blood, Urine and Stool) with proper precautions	
Unit 2:	**Lectures: 04**
Method of transport and storage of clinical samples	
Unit 3:	**Lectures: 04**
Examination of sample by staining - Gram staining, Ziehl-Neelson staining	
Unit 4:	**Lectures: 06**
Preparation and use of culture media-Blood agar, Chocolate agar, TCBS Agar, MacConkey agar	
Unit 5:	**Lectures: 02**
Rapid Detection of Typhoid	
Unit 6:	**Lectures: 04**
Demonstration on resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin) using disc diffusion method	
Unit 7:	**Lectures: 04**
Demonstration on minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/ Streptomycin)	
Unit 8:	
Field study	

Reference Books

5. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
6. 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
7. Collee JG, Duguid JP, Fraser AG, Marmion BP(1989) Practical Medical Microbiology, 13th edition, Churchill Livingstone
8. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology

SEMESTER- II

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/201/ MJC-2	Bacteriology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/202/ MN-2	Bacteriology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 203 MD-2	Microbiological Analysis of Air and Water (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/204/ SEC-2	Microbiological Analysis of Air and Water	3 (P)	10	40 (P 40)	50
ACS/205/ AEC-2	MIL-1(Bengali/Sanskrit/Santali)	2	10	40	50
ACS/206/ VAC 2	Understanding India	4	10	40	50
	Total	**20**	**60**	**240**	**300**

Major Course

MJC 2: BACTERIOLOGY

Course Code: S/MCB/201/MJC-2 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students get a prominent knowledge on detailed cell organization, arrangement and other characteristic features of a bacterial cell.
- Students will learn about bacterial growth, nutrition, motility and reproduction processes.
- Students perform pure cultures techniques to isolate, study, identify and preserve bacterial strains.

Unit 1 Cell organization	**Lectures: 10**
Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Differences between Eubacteria and archaebacteria. Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasmic inclusions. Endospore: Structure, formation, stages of sporulation.	
Unit 2 Bacteriological techniques	**Lectures: 6**
Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, cultivation of anaerobic bacteria, and accessing non-culturable bacteria.	
Unit 3 Growth and nutrition	**Lectures: 6**
Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched media and enrichment technique.	
Unit 4 Reproduction in Bacteria	**Lectures: 6**
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture. Mode of reproduction, logarithmic representation of bacterial populations, phases of growth,calculation of generation time and specific growth rate.	
Unit 5 Important archaeal and eubacterial groups	**Lectures:8**
Archaebacteria: General characteristics, suitable example and economic importance.	

Eubacteria: General characteristics with suitable example.

Non proteo-bacteria, Proteo-bacteria; Low G+C (Firmicutes), High G+C (Actinobacteria).

***Cyanobacteria*:** Introduction & economic importance.

Unit6 Culture preservation techniques **Lectures: 4**

Maintenance and Preservation / stocking of pure cultures
Short-term preservation methods: slant, stab, mineral oil, long-term preservation methods: lyophilization, cryopreservation

Reference Books

1. Atlas RM. (1997). Principles of Microbiology.2nd edition M. T. Brown Publishers.
2. BlackJG.(2008).Microbiology:PrinciplesandExplorations.7thedition.PrenticeHall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005).General Microbiology.5th edition McMillan.
7. Tortora GJ, Funke BR,and Case CL.(2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Simple staining
2. Negative Staining
3. Gram's staining
4. Isolation of pure cultures of bacteria from soil by spread plate method.
5. Isolation of pure cultures of bacteria from water by pour plate and streak plate method.
6. Preservation of bacterial cultures (slant and stab).
7. Isolation and enumeration of bacteria from air.
8. Bacterial Motility by hanging drop method

Minor Course

MN-2: BACTERIOLOGY

Course Code: S/MCB/202/MN-2 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students get a prominent knowledge on detailed cell organization, arrangement and other characteristic features of a bacterial cell.
- Students will learn about bacterial growth, nutrition, motility and reproduction processes.
- Students perform pure cultures techniques to isolate, study, identify and preserve bacterial strains.

Unit 1 Cell organization	**Lectures: 10**
Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Differences between Eubacteria and archaebacteria. Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasmic inclusions. Endospore: Structure, formation, stages of sporulation.	
Unit 2 Bacteriological techniques	**Lectures: 6**
Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, cultivation of anaerobic bacteria, and accessing non-culturable bacteria.	
Unit 3 Growth and nutrition	**Lectures: 6**
Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched media and enrichment technique.	
Unit 4 Reproduction in Bacteria	**Lectures: 6**
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture. Mode of reproduction, logarithmic representation of bacterial populations, phases of growth,calculation of generation time and specific growth rate.	
Unit 5 Important archaeal and eubacterial groups	**Lectures:8**
Archaebacteria: General characteristics, suitable example and economic importance.	

Eubacteria: General characteristics with suitable example.

Non proteo-bacteria, Proteo-bacteria; Low G+C (Firmicutes), High G+C (Actinobacteria).

***Cyanobacteria*:** Introduction & economic importance.

Unit6 Culture preservation techniques **Lectures: 4**

Maintenance and Preservation / stocking of pure cultures
Short-term preservation methods: slant, stab, mineral oil, long-term preservation methods: lyophilization, cryopreservation

Reference Books

1. Atlas RM. (1997). Principles of Microbiology.2nd edition M. T. Brown Publishers.
2. BlackJG.(2008).Microbiology:PrinciplesandExplorations.7thedition.PrenticeHall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005).General Microbiology.5th edition McMillan.
7. Tortora GJ, Funke BR,and Case CL.(2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. PearsonEducation Limited

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Simple staining
2. Negative Staining
3. Gram's staining
4. Isolation of pure cultures of bacteria from soil by spread plate method.
5. Isolation of pure cultures of bacteria from water by pour plate and streak plate method.
6. Preservation of bacterial cultures (slant and stab).
7. Isolation and enumeration of bacteria from air.
8. Bacterial Motility by hanging drop method

Multidisciplinary Course

MD-2: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (T)

Course Code: S/MCB/ 203/ MD-2 **Credit: 3**

(Theory: Lectures 30 /Marks 40)

Learning Outcome

- Students can have the knowledge and hands-on-training about microbiological analysis of air and water.

Unit 1 Aeromicrobiology	**Lectures: 06**
Bioaerosols, Airborne microorganisms (bacteria, Viruses, fungi, each from every category)and their Impact on human health, and environment, significance in food and pharma industries and operation theatres, allergens.	
Unit 2 Air Sample Collection and Analysis	**Lectures: 06**
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics	
Unit 3 Control Measures	**Lectures: 04**
Fate of Bioaerosols, inactivation mechanisms – HEPA filters, desiccation, Incineration	
Unit 4 Water Microbiology	**Lectures: 04**
Water borne pathogens, water borne diseases	
Unit 5 Microbiological Analysis of Water	**Lectures: 06**
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a)standard qualitative procedure: presumptive/MPN tests, confirmed and completed Tests for faecal coliforms (b)Membrane filter technique and (c) Presence/absence tests	
Unit 6 Control Measures	**Lectures: 04**
Precipitation, chemical disinfection, filtration, high temperature, UV light	

Reference Books

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water. A Laboratory Manual, CRC Press

2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

Skill Enhancement Course

SEC-2: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (P)

Course Code: S/MCB/204/SEC-2 **Credits: 3**

(Practical: Lectures 30 /Marks 40)

Learning Outcome

- Students can have the knowledge and hands-on-training about microbiological analysis of air and water.

PRACTICAL
Unit 1:
Bioaerosol sampling, growth on culture media and CFU counting
Unit 2:
Standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests of water potability
Unit 3:
Isolation and morphological characterization of bacteria from aquatic water
Unit 4:
Analysis of water sample by Membrane filter technique
Unit 5:
Demonstration on the function of UV light, HEPA filters, desiccation, Incineration, Precipitation, and filtration
Unit 6:
Field study

Reference Books

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water, A Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition,Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

SEMESTER- III

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/301/MJC-3	Biochemistry	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/302/MJC-4	Virology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/303/MN-3	Virology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/304 MD-3	Food Fermentation Techniques (For students of other discipline)	3 (T)	10	40 (T 40)	50
S/MCB/305/SEC-1	Food Fermentation Techniques	3 (P)	10	40 (P 40)	50
ACS/306/ AEC-3	MIL-2(Bengali/Sanskrit/Santali)	2	10	40	50
Total		**20**	**60**	**240**	**300**

Major Courses

MJC 3: BIOCHEMISTRY

Course Code: S/MCB/301/MJC-3 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- The students come to know about Bioenergetics.
- Students learn about properties, classification, stereo isomerism, Haworth projection of carbohydrates.
- Students learn about classification, structures and properties of fatty acids.
- Students gain knowledge on structures & Functions of proteins, Zwitterions.
- Students become capable of drawing Titration curve of amino acid.
- Students learn about Classification, Michaelis-Menten equation, induced fit hypothesis & mechanism of action of enzymes.

Unit 1 Physicochemical Properties of water	**Lectures 4**
Tetra-hedron structure of water molecule, physical properties, ionic product of water, pH & pK – their definition, relation to acids, bases & buffers in biological system. Electrostatic bond, hydrogen bond, hydrophobic bonds & Van der Wall's interactions.	
Unit 2 Bioenergetics	**Lectures 4**
First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenol pyruvate, ATP.	
Unit 3 Carbohydrates	**Lectures 6**
General properties, classification of carbohydrates, families of monosaccharides: structural concept of aldoses and ketoses, trioses, tetroses, pentoses, and hexoses (glucose and fructose). Stereo isomerism of monosaccharides, epimers and anomers of glucose, Mutarotation, optical isomerism. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms ofglucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan.	
Unit 4 Lipids	**Lectures 6**
Fatty acids: definition, types, structures and functions, essential fatty acids. Lipid: definition, nomenclature and classification (triacylglycerols, phosphoglycerides, phosphatidylethanolamine, phosphatidylcholine, sphingosine, ceramide, sphingomyelins, cerebrosides and gangliosides) with structures and properties. Functions of lipid. Introduction of lipid micelles, monolayers, bilayers.	

Unit 5 Proteins	Lectures 6
Amino acids: the building blocks of proteins. General formula of amino acid and concept of zwitterion. Classification, biochemical structure and notation of standard protein amino acids. Primary, Secondary, Tertiary and Quaternary structures of Protein.	
Unit 6. Enzymes	**Lectures 8**
Enzyme: Definition, properties; Apoenzyme, coenzyme and cofactors. Classification of enzymes; isozyme, ribozyme & abzyme Mechanism of action of enzymes: enzyme kinetics, Michaelis-Menten equation and their transformations, Km, Vmax and enzyme inhibition. Lock and key hypothesis, and Induced Fit hypothesis. Factors of enzyme activity: pH, temperature, substrate concentration, enzyme concentration, time.	
Unit 7. Vitamins and Nucleic Acids	**Lectures 6**
Classification and characteristics of with suitable examples, sources and importance. (Vitamin A, B, C, D,E & K). Purine and pyrimidine bases, nucleoside, nucleotide-structure, properties. Types of DNA and RNA.	

Reference Books

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone.
3. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.
4. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
5. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9th Ed.,McGrawHill.
6. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Concept of pH and buffers, preparation of buffers – phosphate and acetate buffer.
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars (DNS method).
3. Qualitative/Quantitative tests for proteins (Lowry method), amino acids (Ninhydrine), DNA (DPA) and RNA (Orcinol)
4. Qualitative assay of enzyme activity (alpha amylase).

MJC 4: Virology

Course Code: S/MCB/302/MJC-4 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students can have the knowledge about capsid symmetry, isolation, purification and cultivation of viruses.
- Students came to know about early and late proteins in maintaining lytic and lysogenic cycle of T4/T2 phage.
- Students will have a thorough understanding on structure, nucleic acid, replication and symptoms of viruses.
- Students will have a broad idea about oncogenic DNA and RNA viruses.
- Students will be acquainted with Gene expression & Gene therapy.

Unit 1: Nature and Properties of Viruses	**Lectures 8**
Introduction: Discovery of viruses, nature and definition of viruses, general properties Concept of virusoids, and satellite viruses Structure of Viruses: Symmetry, enveloped and non-enveloped virus. Isolation, purification and cultivation of viruses. Viral taxonomy: Baltimore Classification and nomenclature of different groups of viruses.	
Unit 2: Bacteriophages	**Lectures 6**
Diversity, classification, lytic and lysogenic cycle of T4/T2 phage. Lysogenic to lytic switch over mechanism.	
Unit 3: Viral Transmission, Salient features of viral nucleic acids and	**Lectures 8**
Structure, transmission, replication, symptoms, preventive measures & treatment of: Adenovirus, Hepatitis B virus, Influenza virus, HIV, SARS-CoV-2.	
Unit 4: Viruses and Cancer	**Lectures 6**
Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses. Concepts of oncogenes and proto-oncogenes.	
Unit 5: Prevention & control of viral diseases	**Lectures 8**
Antiviral compounds and their mode of actions. Basic concept about Viral Vaccine.	
Unit 6: Applications of Virology	**Lectures 4**
Use of viral vectors in cloning and expression, Gene therapy, Phage therapy	

Reference Books

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study of the structure of important animal viruses (Rhabdo and Retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (TMV, Cucumber Mosaic Viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique

Minor Course

MN 3: Virology

Course Code: S/MCB/303/MN-3 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students can have the knowledge about capsid symmetry, isolation, purification and cultivation of viruses.
- Students came to know about early and late proteins in maintaining lytic and lysogenic cycle of T4/T2 phage.
- Students will have a thorough understanding on structure, nucleic acid, replication and symptoms of viruses.
- Students will have a broad idea about oncogenic DNA and RNA viruses.
- Students will be acquainted with Gene expression & Gene therapy.

Unit 1: Nature and Properties of Viruses	**Lectures 8**
Introduction: Discovery of viruses, nature and definition of viruses, general properties Concept of virusoids, and satellite viruses Structure of Viruses: Symmetry, enveloped and non-enveloped virus. Isolation, purification and cultivation of viruses. Viral taxonomy: Baltimore Classification and nomenclature of different groups of viruses.	
Unit 2: Bacteriophages	**Lectures 6**
Diversity, classification, lytic and lysogenic cycle of T4/T2 phage. Lysogenic to lytic switch over mechanism.	
Unit 3: Viral Transmission, Salient features of viral nucleic acids and	**Lectures 8**
Structure, transmission, replication, symptoms, preventive measures & treatment of: Adenovirus, Hepatitis B virus, Influenza virus, HIV, SARS-CoV-2.	
Unit 4: Viruses and Cancer	**Lectures 6**
Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses. Concepts of oncogenes and proto-oncogenes.	
Unit 5: Prevention & control of viral diseases	**Lectures 8**
Antiviral compounds and their mode of actions. Basic concept about Viral Vaccine.	
Unit 6: Applications of Virology	**Lectures 4**
Use of viral vectors in cloning and expression, Gene therapy, Phage therapy	

Reference Books

3. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

4. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

6. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

7. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

8. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study of the structure of important animal viruses (Rhabdo and Retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (TMV, Cucumber Mosaic Viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique

Multidisciplinary Course

MD-3: FOOD FERMENTATION TECHNIQUES

Course Code: S/MCB/ 304/MD-3 **Credit: 3**

(Theory: Lectures 30 /Marks 40)

Learning Outcome

- Students will study fermenting organisms from different foods
- Students will gain knowledge about different types of fermented foods and their health benefits

Unit 1: Fermented Foods	**Lectures: 04**
Definition, types, advantages and health benefits	
Unit 2: Milk Based Fermented Foods	**Lectures: 08**
Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process	
Unit 3: Grain Based Fermented Foods	**Lectures: 06**
Soy sauce, Bread, Idli and Dosa: Microorganisms and production process	
Unit 4: Vegetable Based Fermented Foods	**Lectures: 04**
Pickles, Sauerkraut: Microorganisms and production process	
Unit 5: Fermented Meat and Fish	**Lectures: 04**
Types, microorganisms involved, fermentation process	
Unit 6: Probiotic Foods	**Lectures: 04**
Definition, types, microorganisms and health benefits	
Reference Books	

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

Skill Enhancement Course

SEC-3: FOOD FERMENTATION TECHNIQUES (P)

Course Code: S/MCB/305/SEC-3 **Credits: 3**

(Practical: Lectures 30 /Marks 40)

Learning Outcome

- Students will study fermenting organisms from different foods
- Students will gain knowledge and hands-on-training on preparation of fermented foods

PRACTICAL
Unit 1:
Isolation and characterization of microorganisms from a fermented food
Unit 2:
Preparation of Milk-based fermented foods (Buttermilk, Dahi vada)
Unit 3:
Preparation of Grain-based fermented foods (Idli, Dosa)
Unit 4:
Preparation of vegetable-based fermented foods (Pickles, Sauerkraut)
Unit 5:
Isolation and characterization of microorganisms from a rotten food
Unit 6:
A visit to any food or beverage industry

Reference Books

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

SEMESTER- IV

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/401/MJC-5	Microbial Physiology & Metabolism	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/402/MJC-6	Food & Dairy Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/403/MJC-7	Environmental Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/404/MJC-8	Bacterial Pathogenesis	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/405/MN-4	Food & Dairy Microbiology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	10	40	50
Total		**22**	**60**	**240**	**300**

Major Courses

MJC 5: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Code: S/MCB/401/MJC-5 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with carbohydrate metabolism and electron transport system.
- Students can have brief idea about Passive and facilitated diffusion & Nutrient uptake procedure.
- Students will analysis effect of temperature, pH & NaCl on bacterial growth.

Unit 1 Microbial Growth and Effect of Environment	**Lectures 6**
Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy (Definition with example only) – Autotroph/Phototroph, heterotroph, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.	
Unit 2 Nutrient uptake and Transport	**Lectures 4**
Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport. Group translocation. Iron uptake.	
Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration	**Lectures 10**
Concept of aerobic respiration. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Glyoxylate cycle, TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation.	
Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation	**Lectures 8**
Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homo fermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.	
Unit 5 Chemolithotrophic and Phototrophic Metabolism	**Lectures 8**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic Photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria.	

Unit 6 Nitrogen Metabolism - an overview	Lectures 6

Introduction to biological nitrogen fixation.

Ammonia assimilation.

Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

Unit 7 Amino acid and Lipid Metabolism	Lectures 8

Endo- and exo-peptidase, Transamination, Deamination, Transmethylation and decarboxylation. General idea about biosynthesis of amino acid (Aromatic Amino acid family)

Beta-oxidation of even and odd number, saturated and unsaturated fatty acids

Reference Books

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study and plot the growth curve of *E. coli* by turbidometric methods. Calculations of generation time and specific growth rate
2. Effect of temperature and pH on growth of *E. coli*
3. Demonstration of the thermal death time and decimal reduction time of *E. coli.*
4. Demonstration of Di-auxic growth of *E. Coli*
5. Biochemical Tests: Catalase, Protease & Acid gas production

MJC 6: FOOD AND DAIRY MICROBIOLOGY

Course Code: S/MCB/402/MJC-6 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will study microbial spoilage of various foods, intrinsic and extrinsic factors of microbial activity.
- Students will gain knowledge on physical & chemical methods of food preservation.
- Students will have idea on beneficial role of gut probiotics, traditional fermented foods and their wide nutritional values.
- Students will study different food infections & intoxications.

Unit 1 Foods as a substrate for microorganisms	**Lectures: 6**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and Source of contamination of foods in general.	
Unit 2 Microbial spoilage of various foods	**Lectures: 6**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods	
Unit 3 Principles and methods of food preservation	**Lectures: 8**
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins	
Unit 4 Fermented foods	**Lectures: 8**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce.	
Unit 5 Probiotics	**Lectures: 8**
General concept on Probiotic, Prebiotic & Synbiotic, salient features, and health benefits Mode of action of probiotics, Common probiotic foods	
Unit 6 Food borne diseases (causative agents, foods involved, symptoms and preventive measures)	**Lectures: 10**
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella typhi*,*Yersinia enterocolitica* and *Campylobacter jejuni*	
Unit 7 Food sanitation and control	**Lectures: 4**
HACCP, Indices of food sanitary quality and sanitizers	

Reference Books

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CABInternational, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBSPublishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. MBRT of milk samples and their standard plate count.
2. Isolation of spoilage microorganisms from a rotten food sample.
3. Preparation of Curd.
4. Demonstration on Nutritional assessment of food product.
5. A survey on fermented foods available in the local market.

MJC 7: ENVIRONMENTAL MICROBIOLOGY

Course Code: SH/MCB/403/MJC-7 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will study microbial ecology & microbial interactions & impact of microorganisms in environment
- Students will gain advanced knowledge on Waste Management treatment.

Unit 1 Microorganisms and their Habitats	**Lectures: 8**
Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats, Atmosphere: Aero-microflora and dispersal of microbes, Animal Environment: Microbes in/on human body (Microbiomes) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.	
Unit 2 Microbial Interactions	**Lectures: 8**
Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, Predation, Microbe-Plant interaction: Symbiotic and non-symbiotic interactions, Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.	
Unit 3 Biogeochemical Cycling	**Lectures: 8**
Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin, Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction, Phosphorus cycle: Phosphate immobilization and solubilization, Sulphur cycle: Microbes involved in Sulphur cycle, Other elemental cycles: Iron.	
Unit 4 Waste Management	**Lectures: 8**
Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and Septic tank) and tertiary sewage treatment. Application of Anammox organisms in water purification.	
Unit 5 Microbial Bioremediation	**Lectures: 4**
Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.	
Unit 6 Water Potability	**Lectures: 4**
Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) Standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.	

Reference Books

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
7. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
8. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
9. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
10. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
2. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
3. Rapid detection of coliform bacteria in water.
4. Demonstration of BOD of waste water sample.
5. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase and protease) in soil.

MJC 8: BACTERIAL PATHOGENESIS

Course Code: SH/MCB/404/MJC-8 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students get a prominent knowledge on detailed cell organization, arrangement and other characteristic features of a bacterial cell.
- Students learn about Bacterial Pathogenesis.
- Students will learn about various antibiotics & their mode of action.

Unit 1 Introduction to Bacterial Pathogenesis	**Lectures: 8**
Basic concepts of infection and host-pathogen interactions, bacterial virulence factors, toxins (types, mechanisms of action, and their effects on the host).	
Unit 2 Mechanisms of Bacterial Pathogenesis	**Lectures: 8**
Adhesion factors involved in bacterial attachment, invasion strategies, host colonization, inflammatory response of host, tissue damage and disease progression, biofilm formation and quorum sensing.	
Unit 3 Bacterial Diseases	**Lectures: 18**
Causative agents, symptoms, mode of transmission, pathogenesis, treatment and control Respiratory disease: tuberculosis (*Mycobacterium tuberculosis*), pneumonia (*Streptococcus pneumoniae*) Gastrointestinal disease: Salmonellosis (*Salmonella typhi*), cholera (*Vibrio cholerae*) Sexually transmitted infections: Gonorrhea (*Neisseria gonorrhoeae*), syphilis (*Treponema pallidum*) Others: Urinary tract infections (*Escherichia coli*), Skin and soft tissue infection (*Staphylococcus aureus*), tetanus (*Clostridium tetani*)	
Unit 4 Antibiotics	**Lectures: 8**
Definition, classification of antibiotics based on their mechanism of action: Mechanisms of action of antibiotics: Cell wall inhibitors (beta-lactams), Protein synthesis inhibitors (tetracyclines), DNA synthesis inhibitors (quinolones), RNA synthesis inhibitors (rifamycins). Quorum quenching. Lantibiotics.	
Unit 5 Antibiotic Resistance	**Lectures: 8**
Overview of antibiotic resistance mechanisms, factors contributing to the emergence and spread of antibiotic resistance, strategies to combat antibiotic resistance.	

Reference Books

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J.Prentice Hall International, Inc.
4. PelczarJr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

PRACTICAL

LECTURES: 30 **Marks: 15**

List of Practical

1. Identification and characterization: *E. coli*, *Salmonella*, *Staphylococcus*, *Bacillus* on the basis of morphological and Gram characteristics
2. Endospore & Acid Fast Staining
3. Identification of pathogenic bacteria through blood and chocolate agar media
4. Demonstration of routine and microscopic examination of urine sample.
5. Perform antibacterial sensitivity by disc-diffusion method.
6. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

Minor Course

MN-4: FOOD AND DAIRY MICROBIOLOGY

Course Code: S/MCB/405/MN-4 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will study microbial spoilage of various foods, intrinsic and extrinsic factors of microbial activity.
- Students will gain knowledge on physical & chemical methods of food preservation.
- Students will have idea on beneficial role of gut probiotics, traditional fermented foods and their wide nutritional values.
- Students will study different food infections & intoxications.

Unit 1 Foods as a substrate for microorganisms **Lectures: 08**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and Source of contamination of foods in general.
Unit 2 Microbial spoilage of various foods **Lectures:08**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods
Unit 3 Principles and methods of food preservation **Lectures: 08**
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins
Unit 4 Fermented foods **Lectures: 06**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce.
Unit 5 Probiotics **Lectures: 04**
General concept, salient features, and health benefits Mode of action of probiotics, Common probiotic foods
Unit 6 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) Lectures: 10
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella typhi*, *Yersinia enterocolitica* and *Campylobacter jejuni*
Unit 7 Food sanitation and control **Lectures: 06**
HACCP, Indices of food sanitary quality and sanitizers

Reference Books

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International(P)Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors,Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation.CABInternational, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-HillPublishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional,
7. London.
8. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBSPublishers and Distributors, Delhi, India.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. PearsonEducation.

PRACTICAL

Lectures: 30 **Marks: 15**

List of Practical

1. MBRT of milk samples.
2. Isolation of spoilage microorganisms from a rotten food sample.
3. Preparation of Curd.
4. Demonstration on Nutritional assessment of food product.
5. A survey on fermented foods available in the local market.

SEMESTER- V

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/501/MJC-9	Molecular Biology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/502/MJC-10	Fundamentals of Immunology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/503/MJC-11	Instrumentation and Biotechniques	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/504/MJC-12	Fungal, Protozoan and Viral Pathogenesis	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/505/MN- 5	Immunology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
ACS/506/INT-3	Internship (Compulsory)	2	10	40	50
Total		**22**	**60**	**240**	**300**

Major Courses

MJC 9: MOLECULAR BIOLOGY

Course Code: S/MCB/501/MJC-9 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will have an overall knowledge about replication, transcription,post transcriptional processing and translation of prokaryotes and eukaryotes.
- Students will learn about regulation of gene expression

Unit 1 Structures of DNA and RNA / Genetic Material	**Lectures: 06**
DNA Structure: Watson and Crick- historic perspective, DNA structure, and Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of Genome: Prokaryotes (*E. coli*), Viruses (DNA virus-SV40, RNA virus-HIV), Eukaryotes (S. cerevisiae). RNA Structure, Organelle DNA – mitochondria and chloroplast DNA.	
Unit 2 Replication of DNA (Prokaryotes and Eukaryotes)	**Lectures: 10**
Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, Θ (theta) mode of replication, Mismatch and excision repair	
Unit 3 Transcription in Prokaryotes and Eukaryotes	**Lectures: 08**
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general transcription factors.	
Unit 4 Post-Transcriptional Processing	**Lectures: 08**
Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, its significance in brief.	
Unit 5 Translation (Prokaryotes and Eukaryotes)	**Lectures: 10**
Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryotes.	
Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes	**Lectures: 08**
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.	

Reference Books

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the 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.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Estimation of purity of DNA & RNA sample through spectrophotometer.
4. Isolation of genomic DNA from *E. coli*
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

MJC 10: FUNDAMENTALS OF IMMUNOLOGY

Course Code: S/MCB/502/MJC-10 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will have fundamental concept on innate & adaptive immunity, immune cells and organs.
- Students will have concept on epitopes, adjuvants, haptens, MHC.
- Students will have knowledge on types, structure, and functions of antibodies.

Unit 1: Introduction	**Lectures: 06**
Contributions of following scientists to the development of field of immunology: Edward Jenner, Louis Pasteur, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, Emil von Behring , MacFarlane Burnet and Rodney Porter.	
Unit 2: Immune Cells and Organs	**Lectures: 06**
Structure, Functions and Properties of: Immune Cells –B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen	
Unit 3: Antigens	**Lectures: 08**
Characteristics of an antigen T-dependent and T-independent antigens Concept of Epitopes, Adjuvants, Haptens, Carrier	
Unit 4: Antibodies	**Lectures: 08**
Types, Structure, and Functions of antibodies Production and Clinical uses of Monoclonal antibodies	
Unit 5: Antigen-Antibody Interactions	**Lectures: 06**
Principles, types and applications of Precipitation and Agglutination reactions.	
Unit 6: Major Histocompatibility Complex	**Lectures: 08**
Organization of MHC locus (Mice & Human) Structure and Functions of MHC I molecule Structure and Functions of MHC II molecule	
Unit 7: Generation of Immune Response	**Lectures: 08**
Fundamental concept of Innate and Adaptive immunity Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC)	

Reference Books

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
2. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
3. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Determination of human blood groups.
2. Separation of serum from the blood sample.
3. Demonstration of immunoelectrophoresis.
4. Demonstration of immunodiffusion by Ouchterlony method.
5. Institute Visit.

MJC 11: INSTRUMENTATION & BIOTECHNIQUES

Course Code: S/MCB/503/MJC-11 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with sophisticated instruments and Biotechniques.
- .Students will learn about various chromatographic techniques.

Unit 1 Microscopy	**Lectures: 10**
Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.	
Unit 2 Chromatography	**Lectures: 14**
Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.	
Unit 3 Electrophoresis	**Lectures: 10**
Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, and Agarose gel electrophoresis.	
Unit 4 Spectrophotometry	**Lectures: 08**
Principle and use of study of absorption spectra of biomolecules. Basic instrumentations & analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.	
Unit 5 Centrifugation	**Lectures: 08**
Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, principle and application of differential centrifugation, density gradient Centrifugation and ultracentrifugation.	

Reference Books :

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H.Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition.ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Ray diagrams of Fluorescence Microscopy
2. Ray diagrams of Phase Contrast Microscopy
3. Separation of mixtures by paper & Thin layer chromatography
4. Study of bacterial colony by Stereomicroscope
5. Separation of components of a given mixture using centrifuge
6. Qualitative & quantitative estimation of biomolecules (any one) by Spectrophotometer.

MJC 12: FUNGAL, PROTOZOAN AND VIRAL PATHOGENESIS

Course Code: S/MCB/504/MJC-12 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will learn about various types of fungal, Protozoan and viral diseases.
- Students can have brief idea about pathogenesis, Transmission, symptoms and their mode of infection.
- Students will learn about different antimicrobial agents and their mode of action.

Unit 1: Fungal diseases	**Lectures: 10**
Brief description of mycoses Transmission, symptoms and prevention of Cutaneous mycoses: Tinea pedis (Athlete's foot) & Systemic mycoses: Histoplasmosis, opportunistic mycoses: Candidiasis.	
Unit 2: Protozoan disease	**Lectures: 08**
Mode of transmission, Symptoms, prophylaxis and control of following diseases: Malaria, Kala-azar.	
Unit 3: Viral diseases	**Lectures: 08**
Salient features, mode of transmission, symptoms, prophylaxis and control of following diseases: Ebola, Dengue, Chikungunya, Japanese Encephalitis.	
Unit 4: Antimicrobial agents	**Lectures: 14**
General characteristics and mode of action Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Anti-Protozoal medicine: Chloroquine phosphate, Liposomal amphotericin B.	
Unit 5: Host pathogen interaction	**Lectures: 10**
Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.	

Reference Books

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. 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
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology, 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology, 9th edition, McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition, Pearson International Edition

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical
1. Isolation and morphological characterization of fungi from garden soil.
2. Study of composition and use of important culture media: Sabouraud Dextrose Agar, Potato Dextrose Agar, Czapek-Dox Agar.
3. Fungal mounting
4. Study of various stages of malarial parasite from micrograph.
5. Study of the structure of important animal viruses (EBOLA and MONKEY POX) using electron micrograph.

Minor Course

MN-5: IMMUNOLOGY

Course Code: S/MCB/505/MN-5 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will have fundamental concept on innate & adaptive immunity, immune cells and organs.
- Students will have concept on epitopes, adjuvants, haptens, MHC.
- Students will have knowledge on types, structure, and functions of antibodies.

Unit 1: Introduction	**Lectures: 08**
Contributions of following scientists to the development of field of immunology: Edward Jenner, Louis Pasteur, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet and Rodney Porter.	
Unit 2: Immune Cells and Organs	**Lectures: 08**
Structure, Functions and Properties of: Immune Cells –B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen	
Unit 3: Antigens	**Lectures: 08**
Characteristics of an antigen T-dependent and T-independent antigens Concept of Epitopes, Adjuvants, Haptens, Carrier	
Unit 4: Antibodies	**Lectures: 06**
Types, Structure, and Functions of antibodies Production and Clinical uses of Monoclonal antibodies	
Unit 5: Antigen-Antibody Interactions	**Lectures: 06**
Principles, types and applications of Precipitation and Agglutination reactions.	
Unit 6: Major Histocompatibility Complex	**Lectures: 06**
Organization of MHC locus (Mice & Human) Structure and Functions of MHC I molecule Structure and Functions of MHC II molecule	
Unit 7: Generation of Immune Response	**Lectures: 08**
Fundamental concept of Innate and Adaptive immunity Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC)	

Reference Books

- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and
- Company, New York.
- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Determination of human blood groups
2. Separation of serum from the blood sample
3. Demonstration of immunoelectrophoresis
4. Demonstration of immunodiffusion by Ouchterlony method

SEMESTER- VI

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/601/MJC-13	Microbial Genetics	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/602/MJC- 14	Extreme Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/ 603/MJC -15	Advanced Immunology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/604/MJC- 16	Recombinant DNA Technology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/605/MN- 6	Molecular Biology & Microbial Genetics (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
Total		**20**	**50**	**200**	**250**

Major Courses

MJC 13: MICROBIAL GENETICS

Course Code: S/MCB/601/MJC-13 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students can have brief idea about different genome organization.
- Students will get to know about different genetic exchange mechanisms.

Unit 1 Genome Organization and Mutations	**Lectures: 10**
Genome organization of *E. coli* Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes	
Unit 2 Plasmids	**Lectures: 10**
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids	
Unit 3 Mechanisms of Genetic Exchange	**Lectures: 12**
Transformation - Discovery, mechanism, Identification of recombinants Conjugation - Discovery, mechanism, Hfr and F' strains Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping By recombination and co-transduction of markers	
Unit 4 Phage Genetics	**Lectures: 08**
Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda	
Unit 5 Transposable elements	**Lectures: 10**
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition Uses of transposons and transposition	

Reference Books

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, Benjamin Cummings

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
2. Isolation of Plasmid DNA from *E. coli*
3. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
4. Demonstration of Bacterial Conjugation
5. Demonstration of bacterial transformation and transduction
6. Demonstration on Ames Test

MJC 14: EXTREME MICROBIOLOGY

Course Code: S/MCB/602/MJC-14 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will get to know about wonders of the microbial world.
- Students can have brief idea about different extremophiles and their characteristics.
- Students will learn about the microbes present in space and marine environment.

Unit 1: Extremophiles	**Lectures: 10**
Brief introduction to extremophiles, diversity, occurrence and their importance in environment. Extremophile Biota and categories, evolutionary history and genetic makeup. Utility in Biotechnology.	
Unit 2: Characteristics and classification of Extremophiles	**Lectures: 10**
Types of extremophiles based on their habitat: Environmental variables- Temperature, Radiation, Pressure, Salinity, pH, Oxygen tension, Chemicals (Methane, Metals etc.),	
Unit 3: Physiology and metabolism of extremophiles	**Lectures: 12**
Physiological versatility, Stress Response, Modified anabolic pathways. (Carbohydrates, lipids), cellular structural & molecular adaptations, Modifications in tRNA and rRNA structure. Novel 7S rRNA. Signature sequences	
Unit 4: Marine Microbiology	**Lectures: 08**
Introduction to oceanography: Microbes in deep-sea hydrothermal vents and deep hypersaline anoxic basins. Quorum sensing and luminescent bacteria, bioactive compounds from marine microorganisms	
Unit 5: Space Microbiology	**Lectures: 10**
Occurrence, diversity of microbial life in space under gravitational force, Applications of Micro-organisms in Space.	

Reference Books

1. Extremophiles by Johri B.N. 2000. Springer Verlag. , New York
2. Microbial Diversity by Colwd , D. 1999, Academic Press.
3. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.
4. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
5. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by M.S. Da Costa, J.C. Duarate, R.A. D. Williams. Elsevier Applied Science, London.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Isolation of thermophiles from hot water spring.
2. Studies on halophiles isolated from seawater [Pigmentation and Salt tolerance].
3. Studies on alkaliphiles isolated from lonar water/sea water.
4. Biogenic methane production using different wastes.
5. Study of bacterial cultures from metal sulfides or rock coal or acid mine waters.

MJC 15: ADVANCED IMMUNOLOGY

Course Code: S/MCB/603/MJC-15 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with advance immunological techniques.
- Students can have brief idea about different immunization and hypersensitive reactions.
- Students will learn about different diseases and immune response against it. .

Unit 1: Complement System	**Lectures: 10**
Components of the Complement system Complement Activation pathways (Classical, Alternative and Lectin pathways) Biological consequences of complement Activation	
Unit 2: Immunization	**Lectures: 08**
Immunization: Types & functions. Characteristics and functions of Active and Passive Immunization	
Unit 3: Cytokines	**Lectures: 08**
Properties, types & functions	
Unit 4: Hypersensitive reactions	**Lectures: 06**
Definitions, types and mechanisms	
Unit 5: Immune response to infectious diseases	**Lectures: 06**
Immune response to viral (Influenza), bacterial (*Corynebacterium diphtheriae*), protozoan (*Plasmodium*) infections.	
Unit 5: Autoimmunity	**Lectures: 06**
General concepts Organ-specific autoimmune diseases (Hashimoto's thyroiditis, Graves' disease) Systematic autoimmune diseases (Systemic Lupus Erythematosus, Multiple sclerosis)	
Unit 6: Immunological Techniques	**Lectures: 06**
Immunoelectrophoresis, ELISA, RIA, ELISPOT, Immunofluorescence, Immunoelectron microscopy	

Reference Books

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Perform Total Leukocyte Count of the given blood sample.
2. Study of serum bactericidal activity (demonstration).
3. Determination of Lysozyme activity (demonstration).
4. Perform DOT ELISA technique.

MJC 16: RECOMBINANT DNA TECHNOLOGY

Course Code: S/MCB/604/MJC-16 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with different cloning techniques.
- Students can have brief idea about advanced genetic engineering techniques.
- Students will learn about different applications of RDT in Industry.

Unit 1 Introduction to Genetic Engineering	**Lectures: 04**
Milestones in genetic engineering and biotechnology	
Unit 2 Molecular Cloning- Tools and Strategies	**Lectures: 08**
Restriction endonuclease in genetic engineering; Definition and function of restriction site, linkers, adaptors, DNA Modifying enzymes: Topoisomerase, DNA ligase, Terminal deoxy nucleotidyl transferase, kinases, phosphatase Definition and Properties of following Cloning Vectors: pBR322, pUC8, Bacteriophage lambda, Phagemid, M13, Cosmids, BACs and YACs vectors, expression vectors (Plasmid & Mammalian SV40-based)	
Unit 3 Methods in Molecular Cloning	**Lectures: 10**
Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery Agarose gel electrophoresis, Southern and Northern blotting, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting	
Unit 4 DNA Amplification and DNA sequencing	**Lectures: 10**
Basic concept of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing	
Unit 5 Construction and Screening of Genomic and cDNA libraries	**Lectures: 08**
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization And colony PCR, Chromosome walking and chromosome jumping	
Unit 6 Applications of Recombinant DNA Technology	**Lectures: 10**
Products of recombinant DNA technology: Insulin, hGH, Antisense molecules, Bt transgenic - cotton, brinjal , Gene therapy, Recombinant vaccines,(Hepatitis B) protein engineering and site directed mutagenesis	

Reference Books

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Demonstration of bacterial Transformation by standard method.
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
3. Ligation of DNA fragments.
4. Interpretation of sequencing gel Electropherogram.
5. Demonstration of amplification of DNA by PCR
6. Demonstration of Southern blotting.

Minor Course

MN-6: MOLECULAR BIOLOGY & MICROBIAL GENETICS

Course Code: S/MCB/605/MN-6 **Credit: 4**

(Theory: Lectures 50/Marks 25)

Learning Outcome

- Students will learn about different molecular processes like DNA & RNA replication.
- Students will get acquainted with molecular techniques.
- Students will get idea about prokaryotic genetics through practical experiments.

Unit 1 Genome Organization and Replication of DNA (Prokaryotes and Eukaryotes) **Lectures: 08**
DNA Structure: Watson and Crick- historic perspective, DNA structure, and Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase. Models of DNA replication: rolling circle, θ (theta) mode of replication
Unit 2 Transcription & Post-Transcriptional Processing in Prokaryotes and Eukaryotes **Lectures: 06**
Concept of Gene & operon (operator & promoter) RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general transcription factors. , Concept of introns and exons, RNA splicing, spliceosome, Polyadenylation and capping,
Unit 3 Translation (Prokaryotes and Eukaryotes) **Lectures: 08**
Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryote.
Unit 4 Regulation of gene Expression in Prokaryotes and Eukaryotes **Lectures: 06**
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp*operons, Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.
Unit 5 Mutation & DNA repair in Prokaryotes and Eukaryotes **Lectures: 08**
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes. Mismatch and excision repair.
Unit 6 Mechanisms of Genetic Exchange in Prokaryotes **Lectures: 06**
Discovery & mechanism of Transformation and Conjugation, Hfr and F' strains. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates.
Unit 7 Plasmids & Transposable elements **Lectures: 08**
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti & Degradative plasmids. Host range, partitioning, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing. Transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition

Reference Books

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the 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,
3. Pearson Benjamin Cummings Publishing, San Francisco
4. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
6. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
7. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
8. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study the effect of physical (UV) mutagens on bacterial cells
2. Isolation of genomic DNA from *E. coli*
3. Isolation of Plasmid DNA from *E. coli*
4. Visualization of Genomic and plasmid DNA through Agarose gel electrophoresis.
5. Demonstration of Bacterial Conjugation
6. Demonstration of bacterial transformation and transduction

SEMESTER- VII

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/701/MJC-17	Traditional & Industrial Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/702/MJC-18	Bioinformatics	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/703/MJC-19	Aquatic Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/704/MJC-20	Research Methodology	4 (P)	10	40 (T 25+P 15)	50
S/MCB/705/MN- 7	Industrial Microbiology (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
Total		**20**	**50**	**200**	**250**

Major Courses

MJC 17: TRADITIONAL & INDUSTRIAL MICROBIOLOGY

Course Code: S/MCB/701/MJC-17 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students can have brief idea about Indian Knowledge System and traditional Microbial practices.
- Students will learn about industrially important bioprocess and can have basic idea about large scale production.
- Students will be acquainted with different fermentation process and techniques

Unit 1 Introduction to Indian Knowledge System (IKS) and traditional microbiology. Lectures: 06
Concept and scope of Indian Knowledge System (IKS). Traditional knowledge of microorganisms in Indian culture and daily life. Historical use of microbes in fermented foods, medicine, and agriculture. Relevance of traditional microbiological practices in modern science and sustainability.
Unit 2 Traditional Microbiological Practices. Lectures: 08
Role of microorganisms in traditional **fermented foods** (curd, idli, dosa, pickles). **Ayurvedic medicine preparations** (Asava, Arishta). **agricultural practices** (biofertilizers, composting, Panchagavya). Food preservatives (Lepana)
Unit 3 Isolation of industrially important microbial strains and fermentation media Lectures: 08
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn steep Liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.
Unit 4 Types of fermentation processes, bio-reactors and measurement of fermentation parameters Lectures: 10
Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of Bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters pH, temperature, dissolved oxygen, foaming and aeration.
Unit 5 Microbial production of industrial products & Down-stream processing Lectures: 12
Ethanol, penicillin, Enzyme (amylase), Vitamin B12,Wine & beer Downstream processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.
Unit 6 Enzyme immobilization Lectures: 06
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase)

Reference Books
1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited 2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA 3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell 4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company 5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. 6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical
1. Isolation & purification of Amylase (enzyme) & Ethanol (alcohol) producing bacteria or Fungi. 2. Study of different parts of fermenter. 3. Demonstration of Microbial fermentations for the production and estimation (qualitative and quantitative) of: Amylase (enzyme) & Ethanol (alcohol). 4. Demonstration of antibiotic Production by *Penicillium*. 5. Visit to an Industry (Pharma/ beverage/ food).

MJC 18: BIOINFORMATICS

Course Code: S/MCB/702/MJC-18 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be Use bioinformatics databases and tools to retrieve and manage biological sequence data.
- Perform basic sequence analysis such as alignment and similarity search of DNA and proteins.
- Interpret genomic and proteomic data for biological and research applications.

Unit 1 Fundamentals of Computer and Bioinformatics	**Lectures: 06**
Fundamentals of computers and software systems: Types of computers, Operating Systems & Computer Networks. Introduction to Linux OS. Database Management System. Introduction to Bioinformatics: definition, scope and applications in biological research. Types of biological data: DNA, RNA, protein sequences and structural data.	
Unit 2 Introduction to Biological Databases	**Lectures: 12**
Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB	
Unit 3 Sequence Alignments, Phylogeny and Phylogenetic trees	**Lectures: 12**
Local and Global Sequence alignment, pairwise and multiple sequence alignment.Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood	
Unit 4 Genomics, Transcriptomics & Proteomics	**Lectures: 10**
Genome, transcriptome, proteome, 2-D gel electrophoresis, MALDI-TOF spectroscopy Genetic mapping tools, DNA markers - RFLPs. Physical mapping - Restriction mapping, Fluorescent in situ hybridization, Radiation hybrid and Sequence tagged site mapping. Next Generation Sequencing (NGS), DNA micro array,	
Unit 5 Protein Structure Predictions	**Lectures: 10**
Hierarchy of protein structure - primary, secondary and tertiary structures, Protein modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot Rational drug design: structure and ligand based. Concept of ADMET	

Reference Books

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Introduction to bioinformatics databases: NCBI, EMBL, DDBJ, Swiss-prot, PDB
2. Sequence retrieval using BLAST
3. Sequence alignment & phylogenetic analysis using various online based tools Emboss & clustal W
4. Retrieval of Genomic/Gene Data from different Databases/tools.
5. Protein structure prediction: primary structure analysis, secondary & tertiary structure prediction
6. Molecular visualization of proteins using Jmol or PyMol
7. Protein Docking : Binding pocket identification , Ligand preparation & Docking by CB Dock

MJC 19: AQUATIC MICROBIOLOGY

Course Code: S/MCB/703/MJC-19 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Understand the diversity and ecological roles of microorganisms in aquatic ecosystems.
- Analyze microbial interactions and nutrient cycling in freshwater and marine environments.
- Apply microbiological techniques to assess water quality and aquatic microbial populations.

Unit 1: Aquatic Biomes	**Lectures: 08**
Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone.	
Unit 2: Aquaculture pathogen	**Lectures: 08**
Microbiology of drinking-water Water-borne pathogens Pathogenic marine bacteria Role of microbes in marine fouling	
Unit 3: Physico-chemical Characteristics	**Lectures: 08**
Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases. Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous).	
Unit 4: Aquatic pollution	**Lectures: 08**
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication.	
Unit 5: Fish pathology	**Lectures: 10**
Microbiology and fish pathology, control of aquaculture diseases, fish immunology, Pathogenic human viruses in coastal waters. Public health risk.	
Unit 6: Aquaculture engineering	**Lectures: 08**
Definition, mode of actions and applications of Probiotics and prebiotics in aquaculture. Applications of biotechnology in the diagnosis and control of diseases. Blue economy.	

Reference Books

1. "Water Microbiology: Bacterial Pathogens and Water" by Elsevier Science; 1st Edition (2004) by Duncan Mara and Nigel Horan.
2. "Water Quality and Treatment: A Handbook of Community Water Supplies" by American Water Works Association; 6th Edition (2011) by American Water Works Association.
3. "Waterborne Pathogens: Detection Methods and Applications" by Wiley-Blackwell; 1st Edition (2013) by Valeria Campos, Anicet R. Blanch, and M. Dolors Balagué.
4. "Water and Health: Volume 7" by World Health Organization (WHO); 1st Edition (2011) by World Health Organization.
5. "Water and Public Health: The Johns Hopkins Series in Environmental Toxicology" by Johns Hopkins University Press; 1st Edition (1999) by Mark D. Sobsey and Joan B. Rose.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Determine the amount of pH, Dissolved Oxygen, Transparency and TDS of water.
2. Study of instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
3. Study of fish pathogens.
4. Determination of Total Viable Bacterial Count from a given water sample.
5. Isolation and study of gut flora from fish intestine.
6. A Report on a visit to a Sewage treatment plant/Marine bio- reserve/Fisheries Institute/freshwater ecosystem.

MJC 20: RESEARCH METHODOLOGY

Course Code: S/MCB/703/MJC-20 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be able to formulate research questions, objectives, and design appropriate research methodologies.
- Students will learn different methods of data collection and apply basic statistical tools for analyzing research data.
- Students will develop the ability to prepare research reports, dissertations, and present scientific findings effectively.

Unit 1: Fundamental of Research	**Lectures: 06**
Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the research – Concept, Construct, Definition. Purpose of research, Classification of research, Fundamentals of research methods, Problem Identification: Hypothesis – type of Hypothesis.	
Unit 2: Research Design	**Lectures: 06**
Definition – essentials and types of research design – errors and types of errors in research design. Research problem: Analysing the research problem – problem statement formulation – formulation of hypothesis.	
Unit 3: Literature Review	**Lectures: 06**
Literature review: purpose, sources, and importance - literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives.	
Unit 4: Research Ethics and Plagiarism	**Lectures: 08**
Ethics: the concepts. Code of Ethics in Research – Ethics and Research Process – Importance of Ethics in Research. Ethical issues to consider relating to the researcher, misuse of information. Plagiarism – concept and regulations, detection tools. Research report writing and report format. Turnitin, Urkund and other open-source software tools.	
Unit 5: Computer Application in Research:	**Lectures: 08**
Introduction to MS Excel, Using Formulas and Functions, Features for Statistical Data Analysis, Generating Charts/Graphs, Introduction to MS Word, Features and Functions, Writing Report in MS Word, Introduction to Open Office. Creating Presentations in MS Power Point.	
Unit 6: Advanced Research Techniques	**Lectures: 06**
Web based literature search tools. Retrieval & Exploration of Data through advanced database, Exploration of Google scholar and PubMed Central. Bibliography Management (Zotero/Mendeley). Research index: Database indexing, h-index, g index, i10 index.	
Unit 7: Basic Statistics & Statistical tools in Research	**Lectures: 10**
Frequency, Measures of Central Tendency, Dispersion, Regression and Interpretation of Results. Digital Documentation, basic concept of Statistical tools (SPSS & ANOVA), Application of tools in writing a Paper, Thesis, Report, Bibliography.	

Reference Books

(1) Cooper, D.R., Schindler, P.S. and Sun, J., 2006. Business research methods (Vol. 9). New York: McGraw-Hill Irwin.
(2) Creswell, J.W. and Creswell, J.D., 2017. Research design: Qualitative, quantitative, and mixed methods approach. Sage publications.
(3) Kothari, C.R., 2004. Research methodology: Methods and techniques. New Age International.
(4) Krishnaswamy, K.N., 2006. Management Research Methodology: Integration of Principles, Methods and Techniques. Pearson Education India.
(5) Sekaran, U. and Bougie, R., 2016. Research methods for business: A skill building approach. John Wiley & Sons.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Search scientific articles from databases (Google Scholar, PubMed) and prepare a Poster Presentation using tools.
2. Demonstration of plagiarism detection tools.
3. Journal Club: Prepare a power point presentation using MS Power point and present it.
4. Demonstration on SPSS.
5. Perform Graphical representation on data: bar graphs, pie charts, and line graphs using Excel.

Minor Course

MN-7: INDUSTRIAL MICROBIOLOGY

Course Code: S/MCB/705/MN-7 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students can have brief idea about different bioreactors and Bioprocess reactions.
- Students will learn about industrially important bioprocess and can have basic idea about large scale production.
- Students will be acquainted with different fermentation process and techniques

Unit 1 Introduction to industrial microbiology **Lectures: 04**
Brief history and developments in industrial microbiology
Unit 2 Isolation of industrially important microbial strains and fermentation media Lectures: 10
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.
Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters Lectures: 10
Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of Bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters pH, temperature, dissolved oxygen, foaming and aeration.
Unit 4 Down-stream processing Lectures: 08
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.
Unit 5 Microbial production of industrial products (micro-organisms involved, media,fermentation conditions, downstream processing and uses) Lectures: 10
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease) Wine, beer
Unit 6 Enzyme immobilization Lectures: 08
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase)

Reference Books

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Isolation & purification of Amylase (enzyme) & Ethanol (alcohol) producing bacteria or Fungi.
2. Study of different parts of fermenter.
3. Demonstration of Microbial fermentations for the production and estimation (qualitative and quantitative) of: Amylase (enzyme) & Ethanol (alcohol).
4. Demonstration of antibiotic Production by *Penicillium*.

SEMESTER- VIII

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
S/MCB/801/MJC-21	Cell Biology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/802/MJC-22	Pharmaceutical Microbiology	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/803/MJC-23	Microbes in Sustainable Agriculture and Development	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/804/MJC-24	Infectious Disease	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/805/MN- 8	Microbes in Sustainable Agriculture and Development (For students of other discipline)	4 (T +P)	10	40 (T 25+P 15)	50
S/MCB/806/RPD-1	Research Project*	12 (P)			150
Total		**20**	**50/ 20**	**200**	**250**

* Honours students who do not undertake a research project or dissertation shall complete three Major courses carrying a total of 12 credits in lieu of the Research Project, thereby completing a total of four Major courses in Semester VIII.

** Students pursuing Honours with Research shall select any one of the four available core courses under the Major discipline in Semester VIII.

Major Courses

MJC 21: CELL BIOLOGY

Course Code: S/MCB/801/MJC-21 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will learn about the structure & organization of cell, protein sorting and transport.
- Students will know about different cell signalling pathways & their interconnections.
- Students will learn about advanced & core scientific research areas like regulation of programmed cell death, development of cancer, Stem cells.

Unit 1 Structure and organization of Cell	**No. of Hours: 8**
Cell Organization – Eukaryotic and prokaryotic Plasma membrane: Structure and transport of small molecules Nucleus, Mitochondria, chloroplasts and peroxisomes	
Unit 2 Protein Sorting and Transport	**No. of Hours: 8**
Ribosomes Endoplasmic Reticulum – Structure and Functions Golgi Apparatus – Organization, protein glycosylation, and Functions Lysosomes	
Unit 3 Cell Signalling	**No. of Hours: 12**
Fundamental concept of cell signalling molecules: Steroid hormones and the nuclear receptor superfamily Nitric Oxide and Carbon Monoxide Neurotransmitters Peptide Hormones and Growth Factors Eicosanoids Plant Hormone mediated cell signalling process Modes of Cell-to-Cell Signalling	
Unit 4 Cell Surface Receptors	**No. of Hours: 8**
Function of cell surface receptors: G Protein-Coupled Receptors Receptor Protein-Tyrosine Kinases Cytokine Receptors and Non-Receptor Protein-Tyrosine Kinases Receptors Linked to Other Enzymatic Activities	
Unit 5 Signal transduction	**No. of Hours: 8**
Cyclic AMP pathway Cyclic GMP pathway MAP Kinase pathway	
Unit 6 Cell Cycle & its regulation	**No. of Hours: 6**

Basic concept of cell cycle
Regulation of Programmed cell death
Cancer: General properties
p53 gene product
Stem cells: General properties & types

Reference Books

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley &Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Microscopic observation of a representative plant cell (*Allium cepa*/ *Ficus benghalensis*).
2. Microscopic observation of epithelial cells.
3. Study of the structure of cell organelles through electron micrographs: Lysosome, Chloroplast, Endoplasmic Reticulum, Golgi Apparatus, Nucleus, Mitochondria.
4. Identification of different stages of Mitosis (permanent slides/ photographs).
5. Identification of different stages of Meiosis (permanent slides/ photographs).

MJC 22: PHARMACEUTICAL MICROBIOLOGY

Course Code: S/MCB/802/MJC-22 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with carbohydrate metabolism and electron transport system.
- Students can have brief idea about Passive and facilitated diffusion & Nutrient uptake procedure.
-

Unit 1: Antibiotics and Synthetic antimicrobial agents: **No. of Hours:12**
Source, structure & Mode of action: Antibacterial Antibiotics- β-lactam, aminoglycosides, tetracyclines, macrolides Antifungal antibiotics - Griseofulvin Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics Synthetic antibiotics - Sulphonamides; Chloramphenicol; Quinolone.
Unit 2: Drug Resistance: **No. of Hours: 8**
Study of resistance of microbes to antimicrobial agents. Current issues of MDR/XDR (ESKAPE) microbial strains. Alternative strategies to overcome drug resistance.
Unit 3: Microbial contamination of pharmaceuticals and its analysis: **No. of Hours: 10**
General idea about Microbial contamination of pharmaceuticals, Product recalls, microbial limit standards. Preservation of microbial product: Type of Preservatives. The test methods for evaluation of formulations such as Preservative Efficacy Testing and Stability of Drugs & Stability Testing.
Unit 4: Microbiological Control and Risk Management: **No. of Hours: 10**
Microbiological control: Risk Assessment, Disinfectants: Factors in Choice and Use of Disinfectants. Qualification of Disinfectants Test Methods and Validation of disinfectants.
Unit 5: Regulatory Aspects of Pharmaceuticals: **No. of Hours: 10**
Quality assurance and Quality control of microbial contaminants in pharmaceutical industries with respect to FDA and WHO (GMP and GLP). Their maintenance and requirement criteria as per Indian Pharmacopeia.

Reference Books

1. Hugo and Russell's Pharmaceutical Microbiology — Stephen P. Denyer, Norman A. Hodges, and Sean P. Gorman. Wiley-Blackwell.
2. Pharmaceutical Microbiology — William B. Hugo and Andrew D. Russell. Blackwell Scientific Publications.
3. Pharmaceutical Microbiology: Principles and Applications — A. K. Jain. (For pharmaceutical microbiology and quality control topics, check the edition and publisher available to your institution.)
4. Good Manufacturing Practices for Pharmaceuticals — Sydney H. Willig, Murray M. Tuckerman, and William S. Hitchings. Marcel Dekker.
5. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems — Loyd V. Allen Jr., Howard C. Ansel, and Nicholas G. Popovich. Wolters Kluwer

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Assessment of the microbial load of a pharmaceutical product by the viable plate count method.
2. Determination of the susceptibility of bacterial isolates to different antibiotics.
3. Study of Sterility testing of pharmaceuticals.
4. Determination of the phenol coefficient of a disinfectant.
5. Study of the antimicrobial activity of selected antibiotics by the agar disc diffusion method.

MJC 23: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

Course Code: S/MCB/803/MJC-23 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- To understand the role of beneficial microorganisms in sustainable agriculture, including biofertilizers, biopesticides, and nutrient cycling.
- To explain the applications of microbes in improving soil fertility, enhancing crop productivity, and promoting environmentally sustainable agricultural practices.

Unit 1 Soil Microbiology	**No. of Hours: 6**
Soil as Microbial Habitat Diversity and distribution of microorganisms in soil	
Unit 2 Mineralization of Organic & Inorganic Matter in Soil	**No. of Hours: 8**
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium	
Unit 3 Microbial Activity in Soil and Green House Gases	**No. of Hours: 6**
Carbon dioxide, methane – production and control	
Unit 4 Microbial Control of Soil Borne Plant Pathogens	**No. of Hours: 6**
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial Plant pathogens, Insects, Weeds	
Unit 5 Biofertilization, Phytostimulation, Bioinsecticides	**No. of Hours: 10**
General concept of Biofertilizers. Isolation, mass multiplication & application of Phosphate solubilizing Microorganism. Nitrogen fixing Microorganism (*Rhizobium* and *Azotobacter*). Bioinsecticides*: Bacillus thuringiensis*, NPV	
Unit 6 Secondary Agriculture Biotechnology	**No. of Hours: 6**
Biomanure, biogas, biofuels – Principle, advantages, applications and processing parameters	
Unit 7 GM crops	**No. of Hours: 8**
Advantages, limitations, social and environmental aspects of Bt crops, golden rice, frost resistant plants.	

Reference Books
1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego, 2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi. 3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASMPress, 4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA 5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition,

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical
1. Study of microflora of different types of soils: Rhizosphere & Barren soil
2. Isolation and characteristics of *Rhizobium* from leguminous plant
3. Demonstration on design & mechanism of biogas plant
4. Isolation of cellulose/starch - degrading microorganisms
5. Isolation of phosphate solubilizing microorganisms

MJC 24: INFECTIOUS DISEASE

Course Code: S/MCB/804/MJC-24 **Credit:4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- To understand the causes, modes of transmission, symptoms, and prevention of infectious diseases.
- To explain the role of pathogens, host immunity, and public health measures in controlling the spread of infectious diseases.

Unit 1 – Introduction to Epidemiology	**No. of Hours: 12**
Definition, scope, and history of epidemiology. Basic concepts: incidence, prevalence, morbidity, mortality, case fatality rate. Types of epidemiological studies: descriptive, analytical, and experimental. Epidemiological triad (agent–host–environment). Emerging and re-emerging infectious diseases – global perspective.	
Unit 2 – Disease Transmission & Dynamics	**No. of Hours: 10**
Modes of transmission: direct, indirect, airborne, vector-borne, zoonotic. Chain of infection and breaking the chain. Reservoirs of infection in humans, animals, and the environment. Dynamics of disease occurrence: endemic, epidemic, pandemic, sporadic. Mathematical models in epidemiology (basic reproduction number R_0, herd immunity concept).	
Unit 3 – Public Health Microbiology & Surveillance	**No. of Hours: 8**
Structure and role of public health systems (WHO, CDC, ICMR, NCDC). Microbiological aspects of public health: water, food, and air quality monitoring. Surveillance systems: passive, active, sentinel, syndromic surveillance. Laboratory role in disease detection and reporting. AMR (antimicrobial resistance) surveillance.	
Unit 4 – Outbreak Investigation & Control Measures	**No. of Hours: 10**
Steps of outbreak investigation. Case definition and contact tracing. Laboratory support in outbreak investigations (sample collection, transport, analysis). Vaccination programs and immunization schedules. Public health interventions: quarantine, isolation, chemoprophylaxis, sanitation.	
Unit 5 – Epidemiology of Selected Infectious Diseases	**No. of Hours: 10**
Nipah, Brain eating amoeba, Mucor mycoses,Bordetella pertussis Nosocomial infections and infection control practices. Role of microbiologists in disaster management and bioterrorism preparedness.	

Reference Books
1. Ryan, K.J., & Ray, C.G. (2014). *Sherris Medical Microbiology*. McGraw-Hill. 2. Nelson, K.E., & Williams, C.M. (2014). *Infectious Disease Epidemiology: Theory and Practice*. Jones & Bartlett Learning. 3. Park, K. (2021). *Preventive and Social Medicine*. Banarsidas Bhanot Publishers. 4. Jawetz, E., Melnick, J.L., & Adelberg, E.A. (2022). *Medical Microbiology*. McGraw-Hill. 5. WHO Technical Reports & Surveillance Guidelines – https://www.who.int

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical
1. **Epidemiological Data Analysis** Calculation of incidence, prevalence, morbidity, and mortality rates using sample datasets. Epidemic curve plotting and interpretation. 2. **Food Microbiology for Public Health** Isolation of foodborne pathogens (e.g., *E. coli*, *Salmonella*) from food samples. Detection of contamination by standard microbiological methods. 3. **Statistical analysis of epidemiological data** Using online databases for disease tracking (e.g., WHO, CDC). Data visualization using spreadsheet tools.

Minor Course

MN-8: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

Course Code: S/MCB/805/MN-8 **Credit: 4**

(Theory: Lectures 50 /Marks 25)

Learning Outcome

- Students will be acquainted with carbohydrate metabolism and electron transport system.
- Students can have brief idea about Passive and facilitated diffusion & Nutrient uptake procedure.
-

Unit 1 Soil Microbiology	**No. of Hours: 6**
Soil as Microbial Habitat Diversity and distribution of microorganisms in soil	
Unit 2 Mineralization of Organic & Inorganic Matter in Soil	**No. of Hours: 8**
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium	
Unit 3 Microbial Activity in Soil and Green House Gases	**No. of Hours: 6**
Carbon dioxide, methane – production and control	
Unit 4 Microbial Control of Soil Borne Plant Pathogens	**No. of Hours: 6**
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial Plant pathogens, Insects, Weeds	
Unit 5 Biofertilization, Phytostimulation, Bioinsecticides	**No. of Hours: 10**
General concept of Biofertilizers. Isolation, mass multiplication & application of Phosphate solubilizing Microorganism. Nitrogen fixing Microorganism (*Rhizobium* and *Azotobacter*). Bioinsecticides*: Bacillus thuringiensis*, NPV	
Unit 6 Secondary Agriculture Biotechnology	**No. of Hours: 6**
Biomanure, biogas, biofuels – Principle, advantages, applications and processing parameters	
Unit 7 GM crops	**No. of Hours: 8**
Advantages, limitations, social and environmental aspects of Bt crops, golden rice, frost resistant plants.	

Reference Books

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego, 2. Singh RS.(1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
2. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASMPress,
3. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4thedition. Benjamin/Cummings Science Publishing, USA
4. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition,

PRACTI CAL

Lectures: 30 **Marks: 15**

List of Practical

1. Study of microflora of different types of soils: Rhizosphere & Barren soil
2. Isolation and characteristics of *Rhizobium* from leguminous plant
3. Demonstration on design & mechanism of biogas plant
4. Isolation of cellulose/starch - degrading microorganisms
5. Isolation of phosphate solubilizing microorganisms

RESEARCH PROJECT

RPD 1: RESERCH PROJECT

Course Code: S/MCB/806/RPD-1 **Credit:12**

- **Learning Outcome**:
  - Students will develop the ability to conduct literature reviews, undertake research, and analyse and interpret research findings.
  - The course will enhance their subject knowledge, scientific aptitude, and research skills, thereby providing a foundation for advanced studies and future research.

Guidelines

. 1. Students enrolled in the Honours with Research Programme shall opt for one of the four available core courses under the Major discipline in Semester VIII, as prescribed by the University.
2. The course shall focus on research project work or a dissertation to be undertaken by students under the supervision of a faculty member of the college, in accordance with the rules and regulations prescribed by the University.
3. Each student shall select a research topic in consultation with the assigned supervisor. The topic may be chosen from any field of Microbiology or from an interdisciplinary area relevant to the discipline.
4. Each supervisor shall guide a maximum of ten students, subject to the applicable University regulations.
5. The dissertation or project report shall include the following components:
   - Title Page: Dissertation title and student details
   - Certificate from the supervisor/guide
   - Declaration by the student
   - Acknowledgement
   - Preface
   - Table of content
   - List of Table and Figures (if required)
   - List of abbreviations
   - Review of Literature
   - Objectives of the study
   - Materials and Methods/Methodology
   - Results and Discussion
   - Conclusion
   - References

OR
in accordance with the format prescribed by the University.

6. Each student shall submit three (03) copies of the completed project report to the college following the prescribed submission guidelines.

7. The research project shall be evaluated in accordance with the assessment guidelines prescribed by the University.

Evaluation Scheme
The research project shall carry a total of **150 marks (12 credits),** distributed as follows:

Assessment Component	Marks
Project Report	100
Presentation	30
Interaction	20
Total	**150**