

# VIVEKANANDHA

## COLLEGE OF ARTS AND SCIENCES FOR WOMEN

[AUTONOMOUS]

(Affiliated to Periyar University, Approved by AICTE & Accredited by NAAC)

Recognised under section 2(f) and 12(B) of UGC Act, 1956

ELAYAMPALAYAM, TIRUCHENGODE (Tk.), NAMAKKAL (Dt.).



## DEPARTMENT OF MICROBIOLOGY

M.Sc., APPLIED MICROBIOLOGY

SYLLABUS & REGULATIONS

[FOR CANDIDATES ADMITTED FROM 2020-2021  
ONWARDS UNDER AUTONOMOUS & CBCS PATTERN]

VIVEKANANDHA EDUCATIONAL INSTITUTIONS

Angammal Educational Trust

Elayampalayam, Tiruchengode (Tk.), Namakkal (Dt.)

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## **M.Sc., APPLIED MICROBIOLOGY**

### **1. SCOPE OF MICROBIOLOGY**

The Mission of the Department of Microbiology is to impart education and carry out research in various areas of Microbiology. There is an excellent combination of courses in both traditional microbiology and modern molecular biology. The facilities in the department are totally committed to provide highest quality of education for the rural students at Post-graduate and Research levels.

The world around us is full of organisms that are too small to be seen with the naked eye. These microbes live in a wide range of habitats from hot springs to the human body and the depths of the ocean. They affect each and every aspect of life on earth. Microbes have always affected our health, food and environment and they will play an important role in the big issues that we may face in the future: climate change, renewable energy resources; healthier lifestyles and controlling diseases.

Because microbes have such an effect on our lives, they are a major source of interest and employment to thousands of people. Microbiologists study microbes: where they occur, their survival strategies, how they can affect us and how we can exploit them. Before microbiologists can solve the problems caused by microbes, or exploit their amazing powers, they have to find out about the detailed workings of microbial cells. This basic knowledge of cell genetics, structure and function can then be used in applied microbiology as well as in other areas of biology.

Microbiology imparts knowledge about the importance of micro-organisms as experimental tools in basic research, biochemical and genetic studies. There is an increasing demand for trained microbiologists in pollution control organizations, food processing, pharmaceutical and fermentation industries, industrial effluent treatment plants and in various national and international research institutes.

### **2. SALIENT FEATURES**

- ❖ Course is specially designed for a higher level career placement.
- ❖ Special guest lecturers from industrialists will be arranged.
- ❖ Enables students to gain a professional degree
- ❖ Special industry orientations and training are parts of the degree course.
- ❖ Project work is included in the syllabus to enhance conceptual and deductive skills.

### **3. OBJECTIVES OF THE COURSE**

The specific objectives of the programme are:

- To equip the Postgraduate students with a sound knowledge of the fundamental principles involved in the study of microbiology.
- To produce graduates that would make impact in the diverse fields of human endeavor considering the ubiquitous nature of microorganism and the wide-ranging applications of the knowledge of microbiology.
- To provide focus for a career in various fields of Applied Science including Medicine, Pharmacy, Mining, Biotechnology, Industrial Production, Environmental Management, Agriculture and even the Computer industry.

### **4. CONDITIONS FOR ADMISSION**

#### **4.1 ELIGIBILITY CONDITIONS FOR ADMISSION**

Candidate who has passed the B.Sc., degree in any Life Sciences [Microbiology / Applied Microbiology/ Industrial Microbiology/ Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Animal Science/ Applied Animal Science and Animal Biotechnology/ Biochemistry/ Bioinformatics/ Biology/ Life Sciences/ Home Science/ Food Science and Nutrition/ BHMS/ BSMS/ BAMS/ BUMS/ Chemistry with Botany or Zoology as Allied Subjects of this University or any other University accepted by the Syndicate as equivalent there to shall be eligible for admission to M.Sc., Degree Course in Applied Microbiology.

## 5. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be eligible for the award of the degree only if she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed, earning 90 credits and fulfilled such conditions as have been prescribed therefore.

## 6. DURATION OF THE COURSE

The duration of the course is for two academic years consisting of four semesters.

## 7. EXAMINATIONS

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively.

## 8. SCHEME OF EXAMINATIONS

The scheme of examinations for different semesters shall be as follows:

Theory External marks	=	75
<b>Part A</b>	=	<b>20 Marks (01 x 20)</b>
<b>Part B</b>	=	<b>25 Marks (05 x 05)</b>
<b>Part C</b>	=	<b>30 Marks (03 x 10)</b>
Internal marks	=	25
<b>Total Marks</b>	=	<b>100</b>
<b>Time</b>	=	<b>3 Hrs.</b>

**The following procedure will be followed for Internal Marks**

**Theory - Internal Marks**

Theory best average of two tests	10 Marks
Attendance	5 Marks
Seminar	5 Marks
Assignment	5 Marks
<b>Total</b>	<b>25 Marks</b>

**Practical - Internal Marks**

Practical best average of two tests	25 Marks
Attendance	10 Marks
Observation Note	5 Marks
<b>Total</b>	<b>40 Marks</b>

**Project- Internal Marks**

Presentations [Two reviews 25+25]	50 Marks
Project Report	100 Marks
Viva - Voce	50 Marks
<b>Total</b>	<b>200 Marks</b>

**Break-up Details for Attendance**

<b>Below 75%</b>	<b>No Marks</b>
<b>76 to 80%</b>	<b>01 Marks</b>
<b>81 to 85%</b>	<b>02 Marks</b>
<b>86 to 90%</b>	<b>03 Marks</b>
<b>91 to 95%</b>	<b>04 Marks</b>
<b>96 to 100%</b>	<b>05 Marks</b>

## **9. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS**

- (i) Candidates shall register their names for the first semester examination after the admission in the PG courses.
- (ii) Candidates shall be permitted to proceed from the first semester up to the final semester irrespective of their failure in any of the semester examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) semester subjects.
- (iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time. Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the college from time to time.

## **10. PASSING MINIMUM**

- a) There shall be no Passing Minimum for Internal.
- b) For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
- c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
- d) Grading shall be based on overall marks obtained (Internal + External)

## **11. CLASSIFICATION OF SUCCESSFUL CANDIDATES**

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the first class. All other successful candidates shall be declared to have passed in second class. Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in

first class with distinction, provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the first appearance.

## 12. GRADING SYSTEM

The term grading system indicates a 7 point scale of evaluation of the performances of students in terms of marks obtained in the Internal and External examination, grade points and letter grade.

### SEVEN POINT SCALE (As per UGC notification, 1998)

GRADE	GRADE POINT	PERCENTAGE EQUIVALENT
'O'= Outstanding	5.50 – 6.00	75 – 100
'A'= Very Good	4.50 – 5.49	65 – 74
'B' = Good	3.50 – 4.49	55 – 64
'C'= Average	3.00 – 3.49	50 – 54
'D'= Below Average	1.50 – 2.99	35 – 49
'E'= Poor	0.50 – 1.49	25 – 34
'F'= Fail	0.00 – 0.49	00 – 24

## 13. RANKING

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction. Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the first appearance will not be eligible for ranking.

## 14. PATTERN OF QUESTION PAPER

PART A (Objective): Answer All the Questions **01 x 20 = 20 Marks**

PART B (200 words): Answer All the Questions (Internal choice) **05 x 05 = 25 Marks**

PART C (500 words): Answer All the Questions (Internal choice) **03 x 10 = 30 Marks**

## 15. PROCEDURE IN THE EVENT OF FAILURE

If a candidate fails in particular subjects, she may reappear for the examination in the concerned subject in subsequent semester and shall pass the examination.

## **16. COMMENCEMENT OF THESE REGULATIONS**

These regulations shall take effect from the academic year 2017-18 (i.e.,) for the students who are to be admitted to the first year of the course during the academic year 2017-18 and thereafter.

## **17. TRANSITORY PROVISION**

Candidates who were admitted to the PG course of Microbiology before 2018 – 2019 shall be permitted to appear for the examinations under those regulations for a period of two years i.e., upto and inclusive of the examination of Apr/May 2019. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

### **Vivekanandha College**

#### **VISION**

**To evolve into a centre of excellence in higher education through creative and innovative practices to secure social equity for women.**

#### **MISSION**

- 1. To provide sufficient learning infrastructure to the students to pursue their studies**
- 2. To provide good opportunity for higher education and conducive environment to the students to acquire education**
- 3. To provide high quality academic programme, training activities and research facilities**
- 4. To facilitate industry-institute interface**

#### **VISION**

Aspires to be a microbiologist committed to progress the quality of human lives by exploring environment, fighting with disease and to utilize microbes for healthy life.

#### **MISSION**

To educate the students to acquire the academic excellence with national and international recognition

To train the students to recognize, investigate and to resolve the myriad of microbiological problems affecting health and the environment through the programme designs

To contribute to the cutting edge in Microbiology by pursuing high quality research and other scholarly activities



To motivate the students to become a women entrepreneur by applying their knowledge in the field of microbiology

To establish as an expert resource within the geographical areas regarding all issues related to medical and environmental microbiology

### **M.Sc., APPLIED MICROBIOLOGY**

#### **PROGRAMME OUTCOME:**

The Master program builds consecutively on biological education and focus on research especially dedicated to the integration and consolidation of knowledge in microbiology. The course focuses on interaction between microbes, human disease and immunology that results in infectious disease and also dealt with the role of microbes in environment and ecology. To develop the technological advancement for current problem and to obtain reliable solutions through research activities.

#### **PROGRAMME SPECIFIC OUTCOME:**

1. To make the students to learn the in-depth concepts of microbiology to understand to complexity of microbiology and other biological system.
2. To explore the technique with laboratory components to obtain hands on experience to understand the application.
3. To develop the students to relate the conceptual knowledge and its application through research and scholarly activities.
4. To execute the knowledge, skills, ethics and values of microbiology into occupational pursuits.



**SCHEME OF CURRICULUM – M.Sc. in APPLIED MICROBIOLOGY**  
(For the candidates admitted during the academic year 2018-2019 onwards)

Sem	Subject code	Course	Subject title	Hrs/week	Credit	Int. marks	Ext. marks	Tot. marks
<b>I</b>	18P1AMB01	Core – I	General Microbiology	6	5	25	75	100
	18P1AMB02	Core – II	Microbial Physiology and Biochemistry	5	5	25	75	100
	18P1AMB03	Core – III	Immunology	5	5	25	75	100
	18P1AMBP01	Core Practical - I	Practical – I – General Microbiology	5	3	40	60	100
	18P1AMBP02	Core Practical - II	Practical – II – Microbial Physiology, Biochemistry & Immunology	5	3	40	60	100
	18P1AMBE01/ 18P1AMBE02	Elective – I	Should be selected from the list	4	4	25	75	100
			<b>Total</b>	<b>30</b>	<b>25</b>	<b>180</b>	<b>420</b>	<b>600</b>
<b>II</b>	18P2AMB04	Core – IV	Medical Bacteriology & Mycology	6	5	25	75	100
	18P2AMB05	Core – V	Microbial Genetics & Molecular Biology	5	5	25	75	100
	18P2AMB06	Core – VI	Food, Industrial and Pharmaceutical Microbiology	5	5	25	75	100
	18P2AMBP03	Core Practical- III	Practical – III – Medical Bacteriology & Mycology	5	3	40	60	100
	18P2AMBP04	Core Practical- IV	Practical – IV – Microbial Genetics, Molecular Biology, Food, Industrial and Pharmaceutical Microbiology	5	3	40	60	100
	18P2AMBE03/ 18P2AMBE 04	Elective – II	Should be selected from the list	4	4	25	75	100
			<b>Total</b>	<b>30</b>	<b>25</b>	<b>180</b>	<b>420</b>	<b>600</b>
<b>III</b>	18P3AMB07	Core – VII	Agricultural & Environmental Microbiology	5	5	25	75	100
	18P3AMB08	Core – VIII	Medical Virology & Parasitology	5	5	25	75	100

	18P3AMB09	Core – IX	Genetic Engineering: Concepts and applications	5	5	25	75	100
	18P3AMB05	Core Practical- V	Practical – V – Agricultural & Environmental Microbiology	5	3	40	60	100
	18P3AMB06	Core Practical- VI	Practical – VI – Medical Virology, Parasitology, Genetic Engineering & Gene Technology	5	3	40	60	100
	18P3AMBE05/06	Elective –III	Should be selected from the list	4	4	25	75	100
	18PHR01		Human rights	1	1	25	75	100
			<b>Total</b>	<b>30</b>	<b>26</b>	<b>205</b>	<b>495</b>	<b>700</b>
<b>IV</b>	18P4AMB010	Core – X	Research Methodology & Biostatistics	5	5	25	75	100
	18P4AMBE07/18P4AMBE 08	Elective – IV	Should be selected from the list	4	4	25	75	100
	18P4AMBPR01	Core – VII	Project work	10	5	50	150	200
	18P4BTED01	EDC	Plant and Animal cell culture techniques	2	1	25	75	100
				Project review	9	-	-	-
			<b>Total</b>	<b>30</b>	<b>15</b>	<b>125</b>	<b>375</b>	<b>500</b>
<b>Overall Total</b>				<b>120</b>	<b>91</b>	<b>625</b>	<b>1710</b>	<b>2400</b>

**Electives:**

**Semester I** – 1. Advanced techniques in Microbiology (18P1AMBE01)  
2. Microbial Quality control in Food & Pharmaceutical (18P1AMBE02)

**Semester II** – 1. Diagnostic Microbiology (18P2AMBE03)  
2. Poultry Microbiology (18P2AMBE04)

**Semester III** – 1. Genomics & Proteomics (18P3AMBE05)  
2. Microbial Fuel cell Technology & Nanotechnology (18P3AMBE06)

**Semester IV** – 1. Bioethics, Biosafety and IPR (18P4AMBE07)  
2. Entrepreneurship in Microbiology (18P4AMBE08)

**EXTRA DISCIPLINARY COURSE**

1. Medical laboratory technology (18P4AMBED3)

# SEMESTER I

## GENERAL MICROBIOLOGY

### Course Objectives:

- To study the early development of microbiology and to practice the microscopic and staining techniques
- To learn the microbial culture techniques and familiar with the bacterial taxonomy
- To acquire knowledge on algae, fungi and protozoa
- The microorganisms that grow at some extreme conditions were to be introduced

### Course Outcome:

CO1	The students could understand the origin of Microbiology field, Microscopy & Staining techniques
CO2	The art of cultivating the Microorganisms, storing methods and removal of pathogenic organisms were taught
CO3	The students could learn in detail about the Bacteria & Viruses
CO4	The students could learn in detail about the Fungi, Algae & Protozoa
CO5	The Adaptations & applications of the extremophiles were studied

### UNIT I – Basics in Microbiology

No. of Hours: 15

**History, Microscopy & Staining techniques:** History and scope of microbiology. Spontaneous and germ theory. Contribution of Leeuwenhoek – Robert Koch – Louis Pasteur – Edward Jenner. Microscopy: Principle and applications of Bright field, Dark field, Phase contrast, Confocal, SEM and TEM. Staining techniques: Simple, Differential staining - Gram staining, acid fast, Special staining - capsular, endospore, metachromatic and flagellar.

### UNIT II – Sterilization, Cultivation & Preservation methods

No. of Hours: 15

**Nutritional types of bacteria:** Sterilization and disinfection methods. Media preparation-Types of media. Aerobic and Anaerobic culture techniques. Pure culture techniques. Preservation of microbial culture. Phototrophs, autotrophs, chemotrophs, lithotrophs. Nutritional requirements of bacteria. Growth curve – batch, continuous and synchronous culture – factors influencing growth.

### UNIT III – Introduction to Bacteria & Viruses

No. of Hours: 15

**Bacteria:** Microbial Taxonomy - Definition and systematic, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach - Woese domain system.  
**Bacteria:** General characteristics & classification – Bergey's classification of systemic Bacteriology.

Modern approaches-Numerical taxonomy. **Virus:** General properties of virus – Baltimore classification of virus. Virions, Prions - Lytic and lysogenic cycle.

#### **UNIT IV – Introduction to Fungi, Algae & Protozoa**

**No. of Hours: 15**

**Fungi:** General characteristics & classification. General account on vegetative, asexual and sexual reproduction in fungi and yeasts. **Algae:** General characteristics & classification. Reproduction in algae. Symbiotic relationship of fungi: Lichens – Mycorrhiza. Economic importance of algae and fungi. **Protozoa:** General characteristics and classification of Protozoa.

#### **UNIT V– Introduction to Extremophiles**

**No. of Hours: 15**

**Extremophiles:** Definition and types. General characteristics of Arachea. Adaptations and applications of Thermophiles, Hyperthermophiles, Halophiles, Acidophiles, Alkalophiles, Mesophiles, Psychrophiles, Barophiles, Metal tolerant microbes, Sulfur reducing organisms and methanogens.

#### **Text Books**

1. Dubey, R.C. and Maheshwari, D.K., “**A Text Book of Microbiology**”, Revised Edition, S.Chand & Company Ltd., New Delhi, 2010.
2. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., “**Microbiology**”, Revised Edition, Tata Mc Graw Hill Publishers, New York, 2014.

#### **Reference Books**

1. Prescott, L.M., Harvey, J.P. and Klein, D.A., “**Microbiology**”, Ninth Edition, Wm. C. Brown Publications, Iowa. 2015.
2. Black, J.G., “**Microbiology: Principles and Explorations**”, Eighth Edition, John Wiley and Sons, Inc, New Jersey, 2012.
3. Sullia, S.B. and Santharam, S., “**General Microbiology**”, Oxford IBH Pub. Co., 2011.
4. Willey, J.M., Sherwood, L.M. and Woolverton, C.J., “**Prescott’s Microbiology**”, Eighth Edition, McGraw Hill, New York, 2015.
5. Tortora, J.G., Funke, R.B. and Case, C.L., “**Microbiology: An Introduction**”, Twelfth Edition, Pearson Education. Inc., San Francisco, 2016.

#### **Web Sources:**

1. <http://www.sheffcol.ac.uk/links/Science/Biology/Microbiology>
2. <http://www.microbiologyonline.org.uk/links.html>
3. <http://www.bact.wisc.edu/Microtextbook/index.php>
4. <http://www.bmb.leeds.ac.uk/mbiology/ug/ugteach/elect/elect.htm>
5. <http://www.microbeworld.org/>

## Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓



(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**

**GENERAL MICROBIOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Which of the following bacteria was not discovered by Robert Koch  
 a) *Bacillus anthracis*    b) *Mycobacterium tuberculosis*    c) *Salmonella typhi*    d) *Vibrio cholerae*
2. All of the following scientist supported the idea of “spontaneous generation” of animals except  
 a) Aristotle                      b) Francesco Redi                      c) John Needham                      d) Felix Archimede Pouchet
3. Which of following is the best suited to get the surface view of an object  
 a) SEM                              b) TEM                              c) Both A and B                      d) Compound microscope
4. Gram staining was developed by  
 a) French Microbiologist Louis Pasteur    b) Dutch lens maker Leeuwenhoek  
 c) Danish physician Christian Gram    d) Dutch physician Christian Gram
- 5) Name the type of bacteria which uses CO<sub>2</sub> as a sole source of carbon for growth  
 a) Organotrophs                      b) Heterotrophs                      c) Autotrophs                      d) Lithotrophs
- 6) Generation time of *Escherichia coli* is  
 a) 20 minutes                      b) 20 hours                      c) 20 days                      d) 200 hours
- 7) Which of the following method can be used to determine the number of bacteria quantitatively  
 a) Streak-plate                      b) Spread-plate                      c) Pour plate                      d) Pour-plate and spread plate
- 8) Which of the following is a Complex media for fungal growth  
 a) Nutrient broth                      b) Luria-Bertani media  
 c) Potato Dextrose Agar                      d) MacConkey Agar
- 9) 'Flagellum' is made up of -----  
 a) Sugars                              b) Lipids                              c) Polysaccharides                      d) Proteins
- 10) What is most distinguishing feature of mycoplasma?  
 a) Cell wall less                      b) Saprophyte                      c) Marine                      d) Ozone layer habitat
- 11) The protein coat of virus is called as  
 a) Nucleid                              b) Capsid                              c) Capsomere                      d) outer envelope
- 12) Outer viral 'proteins' also act as  
 a) Antibody                              b) Receptor                              c) Antigen                              d) Coat
- 13) Fungi can be stained by  
 a) Saffranin                              b) Lacto phenol cotton blue                      c) Glycerine                      d) Crystal violet
- 14) Which of the following is a colonial green algae  
 a) *Chlamydomonas*                      b) *Chlorella*                      c) *Volvox*                      d) *Spirogyra*
- 15) Laboratory diagnosis of *Entamoeba histolytica* depends on identification in the  
 a) Blood                              b) Urine                              c) Saliva                              d) Stool

- 16) African sleeping sickness is caused by which of the following protozoa  
a) *Entamoeba histolytica*      b) *Trypanosoma gambiense*  
c) *Leishmania donovani*      d) *Plasmodium vivax*
- 17) Mesophiles are group of bacteria that grow within the temperature range of  
a) 0-20°C      b) 25-40°C      c) 45-60 °C      d) more than 60°C
- 18) Which among the following is a non-sulfur purple bacteria  
a) *Rhodospirillum rubrum*      b) *Thiobacillus*      c) *Chromatium*      d) *Chlorobium*
- 19) Thermophiles are group of bacteria that grow within the temperature range of  
a) 0-20°C      b) 25-40°C      c) 50-70°C      d) more than 120°C
- 20) Which of the following gas is toxic to methanogenic bacteria  
a) Carbon      b) Sulphur      c) Nitrogen      d) Oxygen

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. (a). Explain about bright field microscope and its applications (**OR**)  
(b). write a short note on Robert Koch and Louis Pasteur.
22. (a). Explain in detail about aerobic and anaerobic culture techniques (**OR**)  
(b). Write a short note on preservation of microbial culture.
23. (a). Describe the economic importance of bacteria (**OR**)  
(b). Write a short note on virus classification.
24. (a). Give an account on Lichens and Mycorrhizae (**OR**)  
(b). Write the short notes on classification of Protozoa.
25. (a). Explain about the Acidophiles and Psychrophiles (**OR**)  
(b). Discuss in detail about the Sulfur reducing organisms and methanogens.

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Give a detailed account on History and scope of Microbiology.
27. Explain in detail Growth curve and factors influencing of growth curve.
28. Explain about lytic and lysogenic cycles of TMV, HIV and prions.
29. Discuss in detail about general characteristics and classification of Protozoa
30. Explain about types of extremophiles.

## MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

### Course Objective:

- To gain the knowledge on bioenergetics.
- To impart knowledge on carbohydrate anabolism and metabolism
- To impart the knowledge on respiratory metabolism.
- To know the knowledge on nitrogen cycle.
- To get the knowledge on enzyme

### Course Outcome:

CO1	The students can recognize the importance and types of photosynthesis and ATP formation
CO2	The students could learn the basic about buffers, pH, pigments and bonds between macromolecules
CO3	They can able to identify the assimilation patterns of Nitrogen
CO4	They could understand the different kinds of metabolic pathways
CO5	It will provide a good idea of using enzymes as biocatalysts

### UNIT I

No. of Hours: 15

**Principles of metabolism** – Catabolism-anabolism – autotrophy – oxygenic and anoxygenic photosynthesis – autotrophic generation of ATP; Fixation of CO<sub>2</sub> – Calvin cycle – C3-C4 pathway. Chemolithotrophy – sulphur – iron – hydrogen – nitrogen oxidations – luminescence.

### UNIT II

No. of Hours: 15

**Microbial metabolism** Embden Mayer Hoff pathway – Entner Doudroff pathway – glyoxlate pathway – Kreb's cycle – Electron Transport Chain and substrate level phosphorylation – reverse TCA cycle – gluconeogenesis – Pasteur effect; Fermentation of carbohydrates – homo and heterolactic fermentations.

### UNIT III

No. of Hours: 15

**Assimilation of nitrogen** – dinitrogen – nitrate nitrogen – Stickland reactions - Inorganic Nitrogen - Urease - assimilation of inorganic nitrogen - ammonia – synthesis of major amino acids – polyamines; synthesis of polysaccharides – peptidoglycan – biopolymers as cell components **UNIT IV**

No. of Hours: 15

**Basic aspects of bioenergetics** – entropy – enthalpy – electron carriers – artificial electron donors – inhibitors – uncouplers – energy bond – phosphorylation. Account on photosynthetic and accessory pigments – chlorophyll – bacteriochlorophyll – rhodopsin – carotenoids – phycobiliproteins.

**Enzymes as biocatalysts** – Enzyme classification, specificity, active site, activity unit, isoenzymes. Enzyme kinetics: Michaelis – Menton equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation. Vitamins and their role as coenzymes.

### Text Books

1. Caldwell, D. R. 1995. **Microbial Physiology and Metabolism**. Brown Publishers.
2. Moat, A. G and Foster, J. W. 1999. **Microbial Physiology**. Wiley.

### Reference Books

1. Stainer, R. Y., Ingharam, J. L., Wheelis, M. L., Painter, P. R. 1986. **General Microbiology**. Macmillan Education Ltd.
2. Brun, Y. V. and Shimkets, L. J. 2000. **Prokaryotic Development**. ASM Press.
3. Freeman, W. H. 2001. **Stryer Biochemistry**. 5<sup>th</sup> Edition.
4. Lehninger. 2000. **Principles of Biochemistry**. Nelson and Cox (Worth) Publishers.

### Web sources

1. [http://www.cuchd.in/elibrary/resource\\_library/University%20Institutes%20of%20Sciences/Fundamentals%20of%20Biochemistry/Chap-20.pdf](http://www.cuchd.in/elibrary/resource_library/University%20Institutes%20of%20Sciences/Fundamentals%20of%20Biochemistry/Chap-20.pdf)
2. <http://www.nios.ac.in/media/documents/dmlt/Biochemistry/Lesson-02.pdf>
3. [https://www.saddleback.edu/faculty/jzoval/mypptlectures/ch12\\_carbohydrates/lecture\\_notes\\_ch12\\_carbohydrates\\_current.pdf](https://www.saddleback.edu/faculty/jzoval/mypptlectures/ch12_carbohydrates/lecture_notes_ch12_carbohydrates_current.pdf)
4. <https://www.omicsonline.org/enzymes-biocatalyst-scholarly-open-access-journals.php>

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2	✓		✓	
CO3	✓		✓	✓
CO4	✓	✓	✓	✓
CO5	✓			

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**

**MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Organization of photosynthetic pigments into clusters is -----  
 a. photosynthesis    b. photosynthetic clusters    c. cluster arrangement    d. photo system
2. Chlorophylls are soluble in -----  
 a. organic solvents    b. inorganic solvents    c. organic solutes    d. inorganic solutes
3. Yellowing of plants is due to absence of -----  
 a. calcium    b. chlorophyll    c. magnesium    d. nitrogen
4. Phases of Calvin cycle involves -----  
 a. carbon fixation    b. reduction    c. regeneration    d. All of the Above
5. In photosynthesis carbon dioxide, light and water are -----  
 a. reactants    b. products    c. by-products    d. catalysts
6. There is a chemical link between anabolism and catabolism in form of -----  
 a. ADP    b. ATP    c. ATT    d. ASP
7. Reactions which are light-independent are termed as -----  
 a. light reactions    b. dark reactions    c. gaseous reactions    d. dull reactions
8. Splitting of water molecule releasing oxygen is called -----  
 a. photosynthesis    b. photolysis    c. photolytic    d. photophosphorylation
9. Exchange of gases between organism and environment is termed as -----  
 a. internal respiration    b. external respiration    c. respiration    d. acquired respiration
10. Alcoholic fermentation and Lactic acid fermentation are -----  
 a. aerobic    b. anaerobic    c. partially aerobic    d. partially anaerobic
11. End product of glycolysis is -----  
 a. glucose    b. pyruvic acid    c. citric acid    d. glycogen
12. Specialized molecule which traps high energy electron and electron carriers is -----  
 a. primary acceptor    b. electron acceptor    c. primary electron acceptor    d. electron acceptor
13. Where does oxidative phosphorylation take place?  
 a. Ribosomes    b. Nucleus    c. Mitochondria    d. Cell membrane
14. NADP is a cofactor used in -----

- a. Catabolic reactions      b. Anabolic reactions      c. Elimination reaction      d. Redox reactions
15. NADP<sup>+</sup> in its reduced form is -----  
 a. NAD      b. NADH      c. NADP      d. None
16. Saccharomyces translation means -----  
 a. Non sugars fungus      b. Non-sugar yeast      c. Sugar fungus      d. Sugar bacteria
17. The rate determining step of Michaelis- Menten kinetics is -----  
 a. the complex dissociation step to produce products      b. the complex formation step  
 c. the product formation step      d. None of these
18. The molecule which acts directly on an enzyme to lower its catalytic rate is -----  
 a. Repressor      b. Inhibitor      c. Modulator      d. Regulator
19. An example of a digestive hormone is -----  
 a. lipase      b. pepsin      c. amylase      d. gastrin
20. Plant absorbs nitrogen in the form of  
 a. Ammonia      b. Nitrate      c. Nitrite      d. All of the above

**PART – B (5 X 5 = 25 Marks)**

Answer **ALL** questions

All questions carry equal marks

21. (a). Explain about entropy & enthalpy (**OR**)  
 (b). write a short note on acid bases for pH and buffers.
22. (a). Explain in detail about Sulfur and iron oxidation (**OR**)  
 (b). Write a short note on luminisence.
23. (a). Describe the Electron transport chain (**OR**)  
 (b). Write a short note on reverse TCA cycle.
24. (a). Give an account on synthesis of polysacchraides (**OR**)  
 (b). Write the hyphae and yeast forms of fungi and their significance.
25. (a). Explain about the properties of enzyme (**OR**)  
 (b). Discuss in detail about the Kinetic analysis of allosteric enzymes.

**PART – C (3 X 10 = 30 Marks)**

Answer **ANY THREE** questions

All questions carry equal marks

26. Give a detailed account on Phosphorylation.
27. Explain in detail about the Oxygenic and anoxygenic photosynthesis.
28. Describe in detail about homolactic and heterolactic fermentation.
29. Discuss in detail about sporulation and morphogenesis.
30. Explain the role of vitamins as co enzymes.

## **IMMUNOLOGY**

### **Course Objectives:**

- To understand cells and organs of the immune system and host parasite relationship.
- To gain knowledge about antigens, major histocompatibility complex and immunoglobulins.
- To become familiar with *in vitro* and *in vivo* antigen-antibody reactions.
- To gain knowledge about & tumor and transplantation immunology.
- To understand hypersensitivity, autoimmune diseases and immunotherapy.

### **Course Outcome:**

<b>CO1</b>	The students could gain the knowledge about basics of immune responses and immunohematology
<b>CO2</b>	The students could learn about antigens, MHC and complement pathways
<b>CO3</b>	The antigen and antibody reaction were studied in detail.
<b>CO4</b>	The students could learn about tumour and transplantation immunology
<b>CO5</b>	Various types of hypersensitivity and autoimmune diseases and immunotherapy could be studied

### **UNIT I - Immune system and Immunity**

**No. of Hours: 15**

Historical background and scope of immunology- Blood cell formation, Apoptosis-Structure, composition and functions of cells and organs involved in immune system. Host parasite relationship. Immune responses – Innate, Acquired, Humoral and Cell Mediated Immunity. Immunohaematology – blood groups, transfusion and Rh incompatibilities.

### **UNIT II – Antigens and Antibody**

**No. of Hours: 15**

Antigens – types and properties, Haptens, Adjuvant and Super antigens. Immunoglobulin – classes and functions – Theories of antibody production. Antibody engineering: Chimeric and Humanized monoclonal antibodies. Major Histocompatibility Complex – structure and function of Class I, Class II and Class III molecules – antigen processing and presentation, T and B cell receptors – activation of T and B lymphocytes. Complement – Classical, Alternative and lectin pathways. Biological consequences of activation.

### **UNIT III - Antigen – antibody reactions**

**No. of Hours: 15**

Hypersensitivity – Type I. Anaphylaxis; Type II. Antibody dependent cell cytotoxicity; Type III. Immune complex mediated reactions; type IV. Cell mediated hypersensitivity. Organ specific and systemic autoimmune diseases.

### **UNIT IV –Tumor and transplantation Immunology**

**No. of Hours: 15**

Tumor immunology – tumour specific antigen – immune diagnosis of tumors. Transplantation immunology – GVH reactions – Mechanism of graft rejection. Lymphokines and cytokines. Oncogene and induction, Cancer immunotherapy. Vaccines - Active and passive immunization, vaccine schedule. Types of vaccine - whole organism vaccine, subunit vaccine, vaccine, DNA vaccine, recombinant vaccine, subunit vaccines and anti-idiotypic vaccine

## UNIT V – Immunotechniques

No. of Hours: 15

Antigen and Antibody reaction – salient features. *In vitro* methods – agglutination, precipitation, Flocculation and complement fixation, immunofluorescence, RIA, ELISA, *In vivo* methods: Skin tests and immune complex tissue demonstrations

### Text Books

1. Kindt TJ, Osborne BA and Goldsby RA (1993). **Kuby Immunology**. 6<sup>th</sup> Edition. W.H. Freeman and Company, New York.
2. Annadurai B (2008). **A Textbook of Immunology and Immunotechnology**. 1<sup>st</sup> Edition. S Chand & Co. Ltd., New Delhi.
3. Riott IM (1988). **Essentials of Immunology**, ELBS and Black Well Scientific Publishers, London.

### Reference Books

1. Paul WE (2012). **Fundamental Immunology**. 7<sup>th</sup> Edition. Lippincott Williams & Wilkins, Philadelphia.
2. Janeway CA, Travers P, Walport M and Shlomchik MJ (2001). **Immunobiology**. 5<sup>th</sup> Edition. Garland Science, New York.
3. Ananthanarayanan Rand Panicker CK (2005). **Text Book of Microbiology**. 8<sup>th</sup> Edition. Oriental Longman Publications, Hyderabad.
4. Rao CV (2012) **Immunology**. 2<sup>nd</sup> Edition, Narosa Publishing House Pvt. Ltd.

### Web sources:

1. <http://www-immuno.path.cam.ac.uk/-immuno/part1.html>
2. <http://www.Iclark.edu/-reiness/immuno/lectures.html>
3. <http://www.hhmi.org/biointeractive/immunology/lectures.html>

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2	✓		✓	✓
CO3	✓	✓	✓	✓
CO4	✓		✓	✓
CO5	✓	✓	✓	✓



(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.

**First Semester**  
**Applied Microbiology**

**IMMUNOLOGY**

**Time: Three hours**

**Maximum Marks: 75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

**1. The two types of immunity in humans are**

- a) Intrinsic & Extrinsic      b) Innate & Acquired      c) Overt & Covert      d) Internal & External

**2. Rh factor is named after**

- a) Monkey      b) Rat      c) Drosophila      d) Man

**3. Macrophages are derived from**

- a) Monocytes      b) Lymphocytes      c) Neutrophils      d) Basophils

**4. O blood group is universal donor because the blood has**

- a) Antigen A      b) Antigen B      c) Antigen A & B      d) No antigens

**5. IgM is structurally characterized as**

- a) Monometric      b) Bimetric      c) Pentameric      d) Tetrametric

**6. The specificity of an antibody is due to**

- a) Its valence      b) The heavy chains  
 c) The fc portion of the molecule      d) Variable portion of the heavy and light chain

**7. MHC class I molecules are primarily involved in**

- a) Recognition of glycolipid antigens      b) Resistance to fungi  
 c) Resistance to viruses      d) Activation of neutrophils

**8. The classical pathway is activated by a combination of**

- a) Bacteria, Antigen & Antibody      b) Complement, antigen & antibody  
 c) Antigen & antibody      d) Virus, antigen & antibody

**9. The VDRL test is an example for**

- a) Tube test      b) Ring test      c) Slide test      d) None of these

**10. The precipitation test is relatively less sensitive for the detection of**

- a) Antigens      b) Antibodies      c) Complement      d) Antigen-Antibody complexes

**11. Commercially available ELISA kits are used for the detection of**

- a) Hepatitis B surface antigen      b) Anti -HIV antibodies      c) Rota virus      d) All of these

**12. In 1959 radio immune assay was developed by**

- a) soloman      b) benson      c) Rosalyn      d) all of the above

**13. An example of a known oncogenic virus is**

- a) Herpes zoster      b) Epstein barr virus      c) HIV-2      d) *Proteus mirabilis*

**14. Cancer of B-lymphocytes is called**

- a) Sarcoma      b) Melanoma      c) Myeloma      d) Carcinoma

**15. Monoclonal antibodies recognize a single:**

- a) Antigen      b) Bacterium      c) Epitope      d) B-cells

**16. Cytokines are**

- a) Hormone like polypeptides      b) Carcinogens      c) Bacteria      d) Viruses

**17. Inflammation reaction is brought about by**

- a) Plasma cells      b) Macrophages      c) Mast cells      d) Adipose cells

**18. Which of the following binds to an Fc receptor on mast cells and basophils?**

- a) IgA      b) IgD      c) IgM      d) IgE

**19. A graft between members of the same species is termed an**

- a) Autograft      b) Allograft      c) Xenograft      d) Isograft

**20. The 1<sup>st</sup> production of live but non-virulent forms of chicken cholera bacillus was achieved by**

- a) Pasteur      b) Jenner      c) Sabin      d) Salk

**PART - B** ( $5 \times 5 = 25$  Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Describe the organs involved in immune system (**OR**)  
b) Discuss about the apoptosis.
22. a) Write short notes on Theories of antibody production (**OR**)  
b) Explain about the MHC.
23. a) Write short notes on Immunofluorescence (**OR**)  
b) Explain about RIA.
24. a) Discuss about the tumor specific antigens (**OR**)  
b) Give short notes on Mechanism of graft rejection.
25. a) Write short notes on DNA vaccines (**OR**)  
b) Discuss about the Type IV hypersensitivity reaction.

**PART - C** ( $3 \times 10 = 30$  Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Briefly explain about the Immunohaematology.
27. Explain about the Complement pathways.
28. Discuss the ELISA in detail.
29. Give a brief account on immune tolerance & immune suppression
30. Explain briefly about the hypersensitivity reactions.

### **PRACTICAL I - GENERAL MICROBIOLOGY**

#### **Course Objectives:**

- To learn the fundamental techniques in microbiology
- To gain experience with staining methods
- To be familiar with the methods of growing fungi and actinomycetes
- To understand the micrometry
- To learn the basics of preservation of microbes

#### **Course Outcome:**

<b>CO1</b>	The knowledge on pure culture isolation, cultivation and characterization are studied
<b>CO2</b>	The visualizing the morphology, size and movement of microbes are
<b>CO3</b>	Biochemical and control of microbial growth is determined
<b>CO4</b>	They could learn the preservation techniques to maintain the microbes
<b>CO5</b>	They could understand the micrometry

#### **1. Laboratory Techniques for isolation and cultural characterization of Microorganisms**

- Principles and methods of sterilization
- Preparation of culture media- Basal, differential, selective, enrichment, enriched, selective and transport media.
- Isolation of pure cultures using spread, pour and streak plate techniques

#### **2. Motility and cell measurement**

- Determination of bacterial motility - Hanging drop method and Wet mount slide method.
- Determination of bacterial cell size using Micrometry.

#### **3. Bacterial and Fungal Staining techniques**

- Preparation of bacterial smears
- Simple staining
- Differential staining - Gram staining and Acid fast staining (Ziehl neelsen method)
- Negative staining
- Lacto Phenol Cotton Blue and KOH Staining for fungi

- Special staining - Spore Stain (Malachite green)

#### **4. Cultivation of Microorganisms**

- Effect of temperature, UV, pH and disinfectants
- Effect of atmospheric oxygen on growth
- Anaerobic cultivation of microorganisms
- Bacterial growth curve and determination of generation time

#### **5. Biochemical tests for identification of bacteria**

- IMViC, Triple Sugar Iron Agar, Hydrogen Sulfide, Citrate utilization, Nitrate reduction, Catalase, Coagulase, Starch hydrolysis, Urease, Oxidase, Sugar fermentation, API system of bacterial analysis

#### **6. Isolation and characterization of cyanobacteria, actinomycetes and fungi.**

#### **Reference Books**

1. Aneja, K.R., 2003, “**Experiments in Microbiology and Plant Pathology**”, New Age Publications, New Delhi.
2. Arora, B and D.R. Arora, 2013, **Practical Microbiology**, CBS Publishers & distributors Pvt. Ltd, New Delhi.
3. Benson, J.H., 2001, “**Microbiological Applications: A Laboratory Manual in General Microbiology**”, Eighth Edition, McGraw-Hill, New York.
4. Cappuccino, J.G. and N. Sherman, 2005, “**Microbiology - A Laboratory Manual**”, Seventh Edition, Benjamin and Cummings Publications, San Francisco.
5. Dubey, R.C and D.K. Maheswari, 2005, “**Practical Microbiology**”, S. Chand and Company, New Delhi.
6. Gunasekaran, P., 2005, “**Laboratory Manual in Microbiology**”, New Age International (P) Ltd, New Delhi.
7. Kannan, N., 2003, “**Laboratory Manual in General Microbiology**”, Fourth Edition, Palani Paramount Publications, Palani.

8. Rajan, S and R. Selvi Christy, 2015, “**Experiments in Microbiology**”, Anjanaa Book House, Chennai.

### Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓

**PRACTICAL II – MICROBIAL PHYSIOLOGY, BIOCHEMISTRY & IMMUNOLOGY**

**Course Objectives:**

- To understand the bacterial growth curve and environmental factors
- To enhance knowledge about biochemical test
- To familiarize with serological test
- To gain knowledge about the detection of human blood group
- To comprehend the immunological test

**Course Outcome:**

CO1	The student should learn the quantification of carbohydrates, protein, urea, uric acid & chloride
CO2	They could be trained the immunological diagnostic techniques
CO3	They could know the antigen preparation & separation methodologies
CO4	They could learn the growth curve determination
CO5	They comprehend the estimation of biological samples

1. Effect of environmental conditions on bacterial growth.
2. Estimation of carbohydrates in a given solution by Anthrone method.
3. Estimation of sugars in biological samples.
4. Protein estimation by Lowry's
5. Analysis of urine for urea, glucose, uric acid and chloride.
6. Separation and preservation of serum and plasma.
7. Identification of human ABO blood group.
8. Latex agglutination test – RA test, CRP test, ASO test.
9. WIDAL slide and tube agglutination test.
10. Flocculation test – RPR test.
11. Immunodiffusion: Radial Immunodiffusion & Ouchterlony double diffusion.
12. Immunoelectrophoresis: Counter current & Rocket immunoelectrophoresis.

**References:**

1. Sambrook J and Russell DW (2001). **Molecular Cloning – A laboratory manual**. 3<sup>rd</sup> Edition. Cold Spring Laboratory Press, New York.
2. Surzycki S (2000). **Basic Techniques in Molecular Biology**. Springer-Verlag, New York.
3. Roitt IM (1988). **Essentials of Immunology**, ELBS and Black Well Scientific Publishers, London.
4. Kindt TJ, Goldsby RA, Osborne BA and Janis Kuby (2007). **Kuby Immunology**. WH Freeman and Company, New York.
5. Chapel H and Halbey M (1986). **Essentials of Clinical Immunology**. ELBS, London.
6. Weir DM, Steward J (1993). **Immunology**. 7<sup>th</sup> Edition. ELBS, London.

**Mapping**

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓

## **ADVANCED TECHNIQUES IN MICROBIOLOGY**

### **Course Objectives:**

- i) To gain the knowledge on Electrophoresis techniques
- ii) To get aware on Chromatographic methods
- iii) To impart the knowledge on Spectroscopy
- iv) To know the analytical methods of Hybridization techniques
- v) To get the knowledge on radioisotopic techniques

### **Course Outcome:**

<b>CO1</b>	They could know the extraction and isolation of DNA, RNA from bacterial source
<b>CO2</b>	They could able to separation the macromolecules like proteins by chromatography
<b>CO3</b>	To analyze and quantify the components using spectroscopy
<b>CO4</b>	They gained knowledge on the separation and preservation of macromolecules like nucleic acid, proteins with hybridization and blotting techniques
<b>CO5</b>	They could know to prepare the probes and its role as markers using radio labeled isotopes and biosensors

### **UNIT I - Electrophoresis**

**No. of Hours: 12**

Bio molecules and electron migration. Types and uses of Electrophoresis, Buffers and supportive media. Principle procedure, detection, quantification and applications of Gel electrophoresis – Native, SDS-PAGE and DISC-PAGE, PFEG, Isoelectric focusing, 2D gel electrophoresis.

### **UNIT II - Chromatographic techniques**

**No. of Hours: 14**

Basic principles and types. Principles, procedure and applications of Paper chromatography, Thin layer chromatography (TLC), Column chromatography (CC), Gas chromatography – Mass spectra MALDI, CELDI – TOF, High performance liquid chromatography (HPLC and HPTLC). Optimum performance laminar chromatography (OPLC).

### **UNIT III - Spectroscopy**

**No. of Hours: 12**

Basic principles – Molecular vibration and its types. Principles, procedure, interpretation and applications of Absorption spectroscopy – FTIR and NMR. Emission spectroscopy – Energy-dispersive X-ray spectroscopy and inductively coupled plasma Spectroscopy Scattering spectroscopy - Raman Spectroscopy. – Flow cytometry

### **UNIT IV - Molecular hybridization of nucleic acids**

**No. of Hours: 10**



Nucleotide probes and its types and labelling. Principle, procedure and application of Blotting techniques – Southern, Northern, Western and Dot blotting. DNA microarrays- steps involved in microarrays – types of DNA chips and its applications.

### UNIT V – Radio isotopic techniques

No. of Hours: 12

Radioactive labelling, principle and application of tracer techniques, Half life of isotopes, detection and measurement of radioactivity – ionization chamber, proportional chamber, GM and Scintillation counters, autoradiography and its applications. Dosimetry. Biosensors: Definition and types. Principle, preparation methods and applications.

#### Text books

1. Upadhyay, A., Upadhyay, K., and Nath, N. (2016). **Biophysical Chemistry**. Himalaya Publishing House.
2. Boyer, R. F., (2001). **Modern experimental Biology**. 3<sup>rd</sup> Edition, Hope College
3. Miller, J. (1998). **Chromatography: Concepts and Contrasts**. John Wiley and Sons. Inc., New York.

#### Reference books

1. D.A. Skoog, F. J. Holler, S. R. Crouch. (2016). **Instrumental methods of analysis**. 7<sup>th</sup> Edition.
2. H.H. Willard, L.L. Merritt Jr. and others. (1986). **Instrumental Methods of Analysis**. 6<sup>th</sup> Edition. CBS Publishers and Distributors.
3. B.B. Straughan and S. Walker (1976) **Spectroscopy**. Volume 1. Chapman & Hall, London.
4. Chapman and Hall. **Gel Electrophoresis of Proteins- A Practical Approach by Hanes**.
5. Cotterill, R. M. J. (2002). **Biophysics: An Introduction**. John Wiley & Sons, England.
6. Nölting, B. (2006). **Methods in modern biophysics**. Second Edition. Springer, Germany.

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CO1	✓	✓	✓	✓
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CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓
CO5	✓	✓	✓	✓

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 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**

**ADVANCED TECHNIQUES IN MICROBIOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Electrophoresis was developed by -----  
 a) Tswett                                      b) Tsvedberg                                      c) Tiselius                                      d) Sanger
2. Which of the following factors does not influence electrophoretic mobility?  
 a) Molecular weight    b) Shape of molecule    c) Size of molecule    d) Stereochemistry of molecule
3. Each nucleotide is a composite molecule formed by -----  
 a) base- sugar- phosphate                      b) base- sugar- OH                      c) sugar-phosphate                      d) base sugar phosphate
4. Proteins can be visualized directly in gels by  
 a) staining them with the dye                      b) using electron microscope only  
 c) measuring their molecular weight                      d) none of these
5. In a native PAGE, proteins are separated on the basis of  
 a) net negative charge    b) net charge and size    c) net positive charges size    d) net positive charge
6. The most common type of gel used for DNA separation is a  
 a) Agar                      b) Polyacrylamide                      c) Agarose                      d) all the above
- 7 In thin layer chromatography, the stationary phase is made of --- and the mobile phase is made of --  
 -  
 a) Solid, liquid                      b) Liquid, liquid                      c) Liquid, gas                      d) Solid, gas
8. In SDS-PAGE, separation is based on  
 a) AGE                      b) PFGE                      c) 2D PAGE                      d) SDS-PAGE
9. The speed of migration of ions in an electric field depends on  
 a) magnitude of charge and mass of molecules    b) magnitude of charge and shape of molecules  
 c) Shape and size of molecule                      d) Magnitude of charge shape and mass of molecule
10. Western blotting is the technique for the detection of  
 a) specific DNA in a sample                      b) specific RNA in a sample  
 c) specific protein in a sample                      d) specific glycolipid in a sample
11. In electrophoresis, DNA will migrate towards  
 a) positive electrode cathode                      b) anode or negative electrode  
 c) cathode or negative electrode                      d) anode or positive electrode
12. The GC trace obtained after an experiment is called a  
 a) chromatograph                      b) chromatogram                      c) chromatophore                      d) graph

13. Which of the following is not used for detection in GC?  
 a) Infrared spectroscopy      b) NMR      c) Flame ionisation      d) Electrical conductivity
14. Probe is a -----  
 a) protein for detecting a specific DNA molecule  
 b) short piece of labelled DNA which are complementary to the nucleic acid strand to be detected  
 c) short piece of labelled DNA or RNA which are complementary to the nucleic acid strand to be detected  
 d) none of these
14. Which of the following is not used for detection in GC?  
 a) Infrared spectroscopy      b) NMR      c) Flame ionisation      d) Electrical conductivity
15. Which of the following is not an IR vibrational mode?  
 a) Stretching      b) Scissoring      c) Rocking      d) Rolling
16. In genome southern blotting can be used to identify  
 A) Sequences      b) Number of sequences      c) DNA fragments      d) RNA sequence
17. Lambert's law states that the intensity of light decreases with respect to \_\_\_\_\_  
 a) Concentration      b) Distance      c) Composition      d) Volume
18. In mass spectrometer, the ion currents are measured using which of the following?  
 a) Scintillation counter      b) Ion counter      c) Electrometer tube      d) Electric fields
19. Polyacrylamide gel is usually used for  
 a) proteins      b) DNA      c) both A and B      d) Vitamins
20. Isotopes have similar -----  
 a) Chemical properties      b) physical properties      c) number of neutrons      d) mass numbers

**PART - B** ( $5 \times 5 = 25$  Marks)  
 Answer **ALL** the Questions  
 All questions carry equal marks

21. a) Write the short notes on Immune electrophoresis (OR)  
 b) Describe about buffers and supportive media.
22. a) Write about the principles of HPLC (OR)  
 b) Briefly write about the thin layer chromatography.
23. a) Describe about the applications Absorption spectroscopy (OR)  
 b) Briefly write about Raman spectroscopy.
24. a) Write about types of Nucleotide probes (OR)  
 b) Describe about Southern Blotting technique.
25. a) Write down the principle of Radioactive labeling (OR)  
 b) Describe about Dosimetry.

**PART - C** ( $3 \times 10 = 30$  Marks)  
 Answer **ANY THREE** the Questions  
 All questions carry equal marks

26. Write about the principles and applications of Gel electrophoresis.
27. Briefly explain about Column chromatography.
28. Explain about Molecular vibration and its types.
29. Briefly discuss about Dot blotting technique.
30. Explain about Ionization chamber.

## **MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL**

### **Course Objective:**

- i) To study the microbiological laboratory practices and biosafety methods
- ii) To check the quality of food and pharmaceutical products
- iii) To detect the presence of pathogen in food and water
- iv) To demonstrate the quality of milk, spoilage and preservation
- v) To get the knowledge on food safety procedures.

### **Course Outcome:**

<b>CO1</b>	They could learn the microbiological practices and biosafety in laboratories
<b>CO2</b>	They could with Standards of food and pharmaceutical products
<b>CO3</b>	They could able to analyze the presence of pathogens in food and water
<b>CO4</b>	They comprehend with the determination of quality in milk
<b>CO5</b>	They got an knowledge on food safety procedures and organization

### **UNIT - I**

**Total No. of hours: 12**

Good laboratory practices (GLP), Good Microbiological Practices (GMP). Quality policy, quality objectives of food processing company, Standard Operating Procedures, Work instructions, Good Handling Practices (GHP) & GMP checklist.

### **UNIT-II**

**Total No. of hours: 12**

Importance and significance of microorganisms in food safety -Food and Drug Administration (FDA) and its regulation - Factors affecting the growth of micro organisms in food - intrinsic (pH, moisture, oxidation-reduction potential and nutrient content) and extrinsic (Temperature, relative humidity, gases and microbial activities).

### **UNIT - III**

**Total No. of hours: 12**

Determination of micro organisms and their products in food: sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods- direct microscopic observation, culture enumeration and isolation methods.

### **UNIT - IV**

**Total No. of hours: 12**

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods.

Microbiological quality standards of food, control and inspection, Enforcement and Govt. Regulatory practices and policies. FSSAI, FDA, EPA, HACCP, ISI, Detection of various methods of food toxicity, Hazard analysis criteria control points (HACCP) system for food safety, HACCP principle and applications.

**Text books:**

1. Rajesh Bhatia (2000). **Quality Assurance in Microbiology**. CBS publishers and Distributors Pvt. Ltd., New Delhi.
2. Adams M.R and Moss M.O (2008). **Food Microbiology**, 2<sup>nd</sup> Edition, Royal Society of Chemistry.
3. Frazier W.C and Westhoff D.C (2013). **Food Microbiology**, 5<sup>th</sup> edition, Tat McGraw Education, New Delhi.

**Reference books:**

1. Mandal S.K (2007). **Total Quality Management - Principles and Practice**. 1<sup>st</sup> Edition. Vikas Publishing House Pvt. Ltd, Noida.
2. James M Jay, Martin J Loessner and David A Golden (2006). **Modern Food Microbiology**, 7<sup>th</sup> edition, Springer Science and Business Media, New York.
3. Richard K. Robinson (2005). **Dairy Microbiology Hand book: The Microbiology of Milk and Milk Products**, 3<sup>rd</sup> edition, John Wiley and Sons, New York.
4. Baird RM, Hodges NA and Denyer SP (2005). **Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices**, Taylor and Francis Inc.

**Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓	✓	✓	✓
CO4	✓	✓	✓	✓
CO5	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Microbiology**

**MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL**

**Time: Three hours**

**Maximum Marks: 75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

- 1) Good work practices include -----
  - a. Smelling and tasting chemicals
  - b. Not washing hands before and after lab
  - c. Confining long hair and loose clothing
  - d. Using damaged equipment and glassware
- 2) To prevent the contamination of microscopes and surrounding areas disinfect/clean used slides, prepared by student, with -----
  - a. 70% ethanol and lens paper
  - b. Acetone and lens paper
  - c. 5% methylene blue and lens paper
  - d. Water and lens paper
- 3) Which of the following is best to sterilize heat labile solutions?
  - a. Dry heat
  - b. Autoclave
  - c. Membrane filtration
  - d. Pasteurization
- 4) The time required to kill 90% of the microorganisms in a sample at a specific temperature is the --  
 -----
  - a. Decimal reduction time
  - b. Thermal death point
  - c. F value
  - d. D value
- 5) Which of the following method is used for viable count of a culture?
  - a. Direct microscopic count
  - b. Plate count method
  - c. Membrane filter count
  - d. Plate count method and membrane filter count
- 6) Removal and killing of all microorganisms is known as -----
  - a. Destruction
  - b. Sterilization
  - c. Pasteurization
  - d. Removal
- 7) Identify the correct definition of an antiseptic.
  - a. Chemicals that kill or prevent infection and damage living tissues
  - b. Chemicals that kill or prevent infection without damaging living tissues
  - c. Chemicals that can only kill or prevent infection on non-living tissues
  - d. Chemicals that can only kill or prevent infection on animal housing
- 8) Which of the following is an indirect method for measuring bacterial growth?
  - a. Cell count
  - b. Cell mass
  - c. Cell activity
  - d. Both cell mass and cell activity
- 9) Mac-Conkey medium is an example of -----
  - a. Transport medium
  - b. Enrichment medium
  - c. Differential medium
  - d. All of these
- 10) Saboraud medium is used to selectively isolate -----
  - a. Coliform bacteria
  - b. Gram positive bacteria
  - c. Yeasts
  - d. Acid fast organisms
- 11) Which water is used for hand washing in change room of pharmaceutical manufacturing plant?
  - a. Potable water
  - b. Sterile water
  - c. Purified water
  - d. Soap water
- 12) Peptone water and nutrient broth are -----
  - a. Selective media
  - b. Enriched media
  - c. Basal media
  - d. None of these
- 13) What is the most important reason for poor udder health?
  - a. Weather
  - b. Mastitis
  - c. Udder conformation
  - d. Producer knowledge

- 14) The pasteurized Milk Ordinance regulates what?  
 a. Grade A milk      b. Manufacturing grade milk      c. Grade B milk      d. Grade C milk
- 15) Which of the following is not a cause of coliform mastitis?  
 a. Cracked or split inflations      b. Milking too soon after calving  
 c. Using excessive water in washing udders      d. Slightly damp, warm bedding
- 16) The \_\_\_\_\_ test is used to detect if milk has been pasteurized properly.  
 a. Lipase      b. Coliform      c. Standard Plate Count      d. Phosphatase
- 17) What does HACCP stand for?  
 a. Hazard Analysis and Critical Control Point      b. Hazard and Critical Control Point  
 c. Health Analysis and Critical Control Point      d. Hazard and Critical Cooking Point
- 18) How many principles are there in a HACCP system?  
 a. Four      b. Seven      c. Eighteen      d. Ten
19. F.P.O stands for -----  
 a. Fruit Production Operation      b. Fruit Product Order  
 c. Flavour Production Office      d. Fruit Procurement Order
20. The AGMARK standard is set by -----  
 a. Central Committee for Food Surveillance      b. Central Committee for Food Standards  
 c. Directorate of Marketing and Inspection      d. Bureau of Indian Standard

**PART - B** ( $5 \times 5 = 25$  Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a. Write the quality policy and quality objectives of food processing company. **(OR)**  
 b. How can you discard the biohazardous waste by using incineration?
22. a. What is disinfectant and write about their standardization procedure. **(OR)**  
 b. Write about the limulus lysate test.
23. a. How can assess the quality of chemicals used in pharmaceutical testing? **(OR)**  
 b. Write about the enrichment culture technique.
24. a. Explain briefly the microflora present in milk. **(OR)**  
 b. Write about the principle and procedure for Resazurin assay.
25. a. Write about the microbial standards for different food and water. **(OR)**  
 b. Explain briefly about AGMARK.

**PART - C** ( $3 \times 10 = 30$  Marks)

Answer **any three** the Questions

All questions carry equal marks

26. Explain in detail about the Good Microbiological Practices.
27. How can you check the sterility of the pharmaceutical products?
28. Explain in detail about the different types of water used in pharmaceutical industry.
29. What are the different types of milk borne diseases?
30. Explain in detail about the principles and flow diagrams of HACCP.

# SEMESTER II



## MEDICAL BACTERIOLOGY AND MYCOLOGY

### Course Objectives:

- To study the pathogenesis, laboratory diagnosis and antimicrobial sensitivity testing.
- To gain knowledge about the diseases caused by Gram positive and Gram negative cocci.
- To impart knowledge on the diseases caused by Gram positive bacilli and Gram negative bacilli.
- To understand the fungal classification, diagnosis, cultivation and antifungal agents.
- To study the superficial, cutaneous, sub cutaneous, systemic and opportunistic mycoses.

### Course Outcome:

CO1	They could be able to identify and examine the bacterial and fungal pathogens of clinical importance
CO2	Could comprehend the scientific method as it is used for classification of bacteria and fungi
CO3	Students could learn the morphology, life cycle, symptoms, diagnosis and treatment method for some important bacterial and fungal pathogens
CO4	They could be aware about the antibacterial and antifungal agents and their mode of action
CO5	They could acquire knowledge on fungi and its diseases in human

### UNIT I - Introduction to Medical Bacteriology

No. of Hours:15

Normal microbial flora of human body – Infection – Types, Source, Modes of Transmission, Mechanism of bacterial pathogenesis – Laboratory diagnosis of infectious diseases – Antibiotic Sensitivity Test, Antibacterial drugs - mechanism of action and resistance.

### UNIT II -Gram Positive bacterial pathogen

No. of Hours:15

Morphology, pathogenesis, symptoms and laboratory diagnosis of *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Corynebacterium diphtheriae*, *Bacillus anthracis*, *Clostridium* sp - *Clostridium perfringens* and *Clostridium tetani* *Mycobacterium* sp - *Mycobacterium tuberculosis* and *Mycobacterium leprae*.

### UNIT III - Gram Negative bacterial pathogen and cellular parasite

No. of Hours:15

Morphology, pathogenesis, symptoms and laboratory diagnosis of *Neisseria gonorrhoeae*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus* species, *Salmonella typhi*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Vibrio cholerae* and Spirochetes – *Treponema pallidum* and *Leptospira*. Obligate intra cellular parasites – *Mycoplasma pneumoniae*, *Chlamydia* and *Rickettsia*.

## UNIT IV - General Mycology

No. of Hours:15

Classification of medically important fungi – Laboratory diagnosis of fungal diseases – Collection and examination of fungal specimens – Isolation and identification of fungi – Staining of fungi – KOH, LCB, PAS, H&E, GMS – Cultivation of fungi - Antifungal drugs – Antifungal susceptibility test.

## UNIT V - Fungal Pathogens Hours:15

No. of

Classification of Mycoses based on infection- Brief account on pathogenesis, symptoms and laboratory diagnosis of *Tinea nigra*, White and Black Piedra, Coccidiomycoses, Dermatophytoses, Mycetoma, Histoplasmosis, Cryptococcosis, Candidiasis and Aspergillosis. Mycotoxicoses..

### Text Books

1. Arti Kapil (2013). **Ananthanarayan & Jayaram Paniker's Text book of Microbiology**. 9<sup>th</sup> edition, Orient Longman Limited, Chennai.
2. Jagdish Chander (2012). **Text book of Medical Mycology**. 3<sup>rd</sup> edition. Mehta Publishers, New Delhi.

### Reference Books

1. Jawetz E and JL Melnic (2001). **Medical Microbiology**, 22<sup>nd</sup> edition, Tata McGraw-Hill, New Delhi.
2. David Greenwood CB and Richard (2002). **Medical Microbiology**. 22<sup>nd</sup> edition, Tata McGraw-Hill, New Delhi.
3. Monica Cheesbrough (2003). **District Laboratory Practice in Tropical Countries**. Part 1 and 2. Low-Price edition, Cambridge University Press.
4. Chakraborty P (2003). **A Text book of Microbiology**. 2<sup>nd</sup> edition, Published by New Central Book Agency (P) Ltd., Kolkata.

### Web sources:

1. [http:// www.bact.wisc.edu/bact330](http://www.bact.wisc.edu/bact330)
2. [http:// www-micro.msb.le.ac.uk/224](http://www-micro.msb.le.ac.uk/224)
3. [http:// www.cellsalive.com/ecoli.htm](http://www.cellsalive.com/ecoli.htm)
4. [http:// www.bact.wise.edu/microtextbook/](http://www.bact.wise.edu/microtextbook/)
5. [http:// www. Pitt.edu/-super1/lecture/lec4771/](http://www.Pitt.edu/-super1/lecture/lec4771/)
6. [http:// www.textbook of bacteriology.net/](http://www.textbookofbacteriology.net/)

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**Second Semester**  
**Applied Microbiology**

**MEDICAL BACTERIOLOGY AND MYCOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

- Which of the following microorganism produces colicins in intestine?  
 a. *E. coli*      b. *B. subtilis*      c. *Clostridium botulinum*      d. *Streptococcus salivarius*
- Lactobacillus is a human pathogen that is also part of normal flora and found in  
 a. Colon      b. Mouth      c. Genital Tract of female      d. All of above
- Metachromatic granules can be stained as follows except:  
 a. Ponder' stain      b. Albert stain      c. Gram stain      d. Neisser's stain
- The disease transmitted by tick  
 a. Rocky mountain fever      b. Endemic fever      c. Both A&B      d. None of the above
- Treponema pallidum* is -----  
 a. Spirochatae      b. Vibrio      c. Mycoplasma      d. Acid fast bacilli
- Ascoli's thermoprecipitation test is used for ----  
 a. Streptococci      b. Staphylococci      c. Anthrax      d. *Clostridium difficile*
- Lepra bacilli are best cultivated in -----  
 a. Armadila      b. Mouse foot pad      c. Guinea pig      d. Rabbit
- Staphylococcus* commonly inhabits -----  
 a. Nose      b. Skin      c. Throat      d. Groin
- Transport medium for *Vibrio cholerae* is -----  
 a. VR medium      b. Blood agar      c. Tellurite broth      d. Alkaline bile salt agar
- Bartholin cyst is caused by -----  
 a. *T. pallidum*      b. LGV      c. Gonococci      d. *Haemophilus ducryi*
- Elberth Gaffky bacillus is -----  
 a. *Salmonella*      b. *Shigella*      c. Streptococci      d. Streptobacillus
- Dark field microscopy is useful to identify -----  
 a. Spirochaetes      b. Mycoplasma      c. Chlamydia      d. Rickettsiae
- Hyphal wall consists of microfibrils composed of \_\_\_\_\_  
 a. hemicellulose or chitin      b. Cellulose      c. lipids      d. proteins
- What do the term dimorphic mean?  
 a. Bisexual      b. Unisexual      c. Exists in two forms      d. Exists in single form
- Which stain is used to study fungal morphology in tissue sections?  
 a. Periodic acid-Schiff      b. Alizarin Red      c. Masson's Trichrome      d. Von Kossa
- Nystatin belongs to which class of antifungal drugs  
 a. Allylamines      b. Polynes      c. Echinocandis      d. Thiocarbamate

17. Which of the following is not the characteristic of histoplasmosis?  
 a. Person to person transmission      b. Specific geographic distribution  
 c. Yeasts in tissue                      d. mycelial phase in the soil
18. Causative agent for 'ringworm' is -----  
 a. Epidermatophyton              b. Tinea nigra              c. Mycetoma              d. Histoplasma
19. Tinea pedis' is scientific name of a foot disease that is commonly called as  
 a. Athlete's foot              b. Ringworm              c. Skin rash              d. Skin infection
20. Which one is considered as class one carcinogen?  
 a. Aflatoxin              b. Ergotoxin              c. Fumonisin              d. Ochratoxin

**PART - B** (5 × 5 = 25 Marks)  
 Answer **ALL** the Questions  
 All questions carry equal marks

21. a) What are the types of infections? (OR)  
 b) Briefly explain the antibacterial susceptibility testing.
22. a) What are the virulence factors involved in Staphylococcal infections? (OR)  
 b) Discuss the different types of anthrax.
23. a) Write a note on different kinds of diarrhea caused by *E.coli* (OR)  
 b) Describe about cholera and its diagnosis.
24. a) Explain about classification of medically important fungi (OR)  
 b) Write a short note on systemic mycosis.
25. a) Explain about Tinea nigra (OR)  
 b) Write a short note on Histoplasmosis.

**PART - C** (3 × 10 = 30 Marks)  
 Answer **ANY THREE** the Questions  
 All questions carry equal marks

26. Explain in detail the normal flora of the human's different anatomical sites.
27. Write a detailed note on morphology, virulence factors and pathogenicity of *Clostridium perfringens*.
28. Write the pathogenesis and laboratory diagnosis of Syphilis.
29. Explain about Antifungal susceptibility test.
30. Write a short note on Candidiasis and cryptococcosis.

## MICROBIAL GENETICS AND MOLECULAR BIOLOGY

**SEMESTER – II**  
**18P2AMB05**  
**Credits – 5**

**CORE – V**  
**Total Number of Hours: 75**  
**5 Hours/ Week**

### Course Objectives:

- To gain the knowledge about the structure of nucleic acid
- To understand the basic mechanisms of replication, transcription, and translation
- To understand the genetic consequences and molecular mechanisms of several prokaryotic and eukaryotic gene regulation systems
- To understand the structure and organization of the prokaryotic and eukaryotic chromosomes

### Course Outcome:

<b>CO1</b>	They students could learn the genetic material and its structure
<b>CO2</b>	Could obtain basic knowledge of replication, DNA repair mechanism
<b>CO3</b>	They could acquire knowledge on prokaryotic and eukaryotic molecular mechanism of gene regulation systems
<b>CO4</b>	They could differentiate the prokaryotic and eukaryotic structure and organization of chromosomes
<b>CO5</b>	They could obtain knowledge on vector and gene transfer mechanisms

### UNIT I - Genetic material DNA and RNA

**No. of Hours: 15**

Evidences for DNA as the genetic material – Watson and Crick model – Physical and chemical properties of DNA, Types and forms of DNA – Law of DNA constancy and C value paradox – RNA as genetic material – Structure, types and functions of RNA. Prokaryotic Genome: *E. coli* chromosome – nucleosome. Eukaryotic genome organization: Structure of chromatin, chromosome, centromere, and telomere. Genome organization in Virus

### UNIT II - DNA replication and Repair mechanisms

**No. of Hours: 15**

DNA replication – Evidence for semi-conservative replication - DNA replication mechanism, enzymology of DNA replication – bidirectional and rolling circle replication –Prokaryotic & eukaryotic DNA polymerases, Types & function - Inhibitors of DNA replication – DNA recombination – Models - Role of Rec A in homologous recombination - DNA repair mechanism – photo reactivation, excision repair, SOS repair, mismatch repair, recombination repair and glycosylase system.

### UNIT III – Transcription and Translation

**No. of Hours: 15**

Transcription – Structure and function of RNA polymerase. Mechanism of transcription – steps involved. Post transcriptional modifications – RNA processing: Capping, polyadenylation, splicing – Genetic code – Salient features – Wobble hypothesis. Translation – direction of protein synthesis – Ribosomes and their organization – Initiation of translation: SD sequence, initiator tRNA –

Elongation of translation, translocation and termination mechanisms. Post – translational modification. Gene regulation in bacteria – *lac*, *trp* and *ara* operons.

#### **UNIT IV – Mutagenesis**

**No. of Hours: 15**

Mutation – Types of mutation – Mutagens - Molecular basis of mutation – Spontaneous mutations; Luria and Delbruck experiment, Newcombe experiments. Induced mutation; DNA damages – Deamination of bases, alkylation, damage due to reactive oxygen, UV induced damage. Detection and isolation of mutants, mutant selection – Beadle & Tatum experiment: detection of nutritional mutants in *Neurospora*. Carcinogenicity testing.

#### **UNIT V – Plasmid and Gene transfer mechanisms**

**No. of Hours: 15**

Plasmid Biology – types and properties – compatibility, replication, control of copy number and plasmid segregation– episomes. Gene transfer in bacteria – Conjugation: Discovery, types -  $F^+ \times F^-$ ,  $F'$ , Hfr. Transformation – evidence and mechanism. Transduction – Lytic and lysogenic cycle of phage – Generalized and specialized transduction. Insertion sequences – mechanism of transposition, complex and compound transposons – T10, T5 and retroposon & composite.

#### **Text Books**

1. Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM. (1998). **Molecular Biology of the Gene**. The Benjamin/Cummings publishing company.
2. Freifelder D. (2012). **Molecular Biology**, 2<sup>nd</sup> edition, Narosa Publishing Home.
3. R.S. Old and S.B. Primrose. (2001). **Principles of Gene Manipulation**, 6<sup>th</sup> Ed., Black well Scientific Publications, London.

#### **Reference Books**

1. Maloy SR, Cronan Jr. JE and Freifelder D. (1994). **Microbial Genetics**. Jones and Bartlett Publishers.
2. Friedberg EC, Walker GC, and Siede W. (2006). **DNA repair and Mutagenesis**, 2<sup>nd</sup> edition, ASM press.
3. Gardner EJ, Simmons MJ and Snustad DP, (2006). **Principles of Genetics**, 8<sup>th</sup> edition, John Wiley and Sons.
4. Singer M and Berg P. (1991). **Genes and Genomes**. University Science Books.

#### **Web sources:**

1. [www.en.wikipedia.org/wiki/Microbial\\_genetics](http://www.en.wikipedia.org/wiki/Microbial_genetics)
2. [www.microbiologyprocedure.com/genetics/microbial-genetics/microbial-genetics.htm](http://www.microbiologyprocedure.com/genetics/microbial-genetics/microbial-genetics.htm)
3. [www.bestwebbuys.com/Microbiology-N\\_10038066-books.html](http://www.bestwebbuys.com/Microbiology-N_10038066-books.html)
4. [www.en.wikipedia.org/wiki/Molecular\\_biology](http://www.en.wikipedia.org/wiki/Molecular_biology)
5. [www.web-books.com/MoBio/](http://www.web-books.com/MoBio/)

**Mapping**

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓		✓	✓
<b>CO2</b>		✓	✓	
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)

18P2AMB05

M.Sc., DEGREE EXAMINATIONS

----- / ----- 2018.

Second Semester

Microbiology

**MICROBIAL GENETICS AND MOLECULAR BIOLOGY**

**Time: Three hours**

**Maximum Marks: 75**

**PART - A (1 x 20 =20 Marks)**

**Answer all the questions**

1. DNA is the genetic material in
  - a) Viruses, prokaryote and eukaryote
  - b) prokaryote and eukaryote
  - c) Only in eukaryotes
  - d) in some viruses, prokaryotes and eukaryotes
2. Z-DNA have a
  - a) Double helical nature
  - b) Zig-Zag appearance
  - c) uracil base
  - d) single stranded nature
3. AUG is -----
  - a) Stop codon
  - b) Start Codon
  - c) Intermediate
  - d) Valine
4. When the B DNA is slightly dehydrated in the laboratory it takes on
  - a) Negative supercoils
  - b) Positive supercoils
  - c) Z conformation
  - d) A conformation
5. An endonuclease is an enzyme that hydrolyzes
  - a) A nucleotide from only the 3' end of an oligonucleotide
  - b) A nucleotide from either terminal of an oligonucleotide
  - c) A phosphodiester bond located in the interior of a polynucleotide
  - d) A bond only in the specific sequence of nucleotides
6. Eukaryotes differ from prokaryote in mechanism of DNA replication due to
  - a) Use of DNA primer rather than RNA primer
  - b) Different enzyme for synthesis of lagging and leading strand
  - c) Discontinuous rather than semi-discontinuous replication
  - d) Unidirectional rather than semi-discontinuous replication
7. Which of the following enzymes remove supercoiling in replicating DNA ahead of the replication fork?
  - a) DNA polymerases
  - b) Helicases
  - c) Primases
  - d) Topoisomerases
8. Semi conservative replication of DNA was first demonstrated in
  - a) *E. coli*
  - b) *S. pneumoniae*
  - c) *S. typhimurium*
  - d) *D. melanogaster*
9. True replication of DNA is possible due to
  - a) Hydrogen bonding
  - b) Phosphate backbone
  - c) Complementary base pairing rule
  - d) None of the above
10. Which is the largest among the followings?
  - a) Nucleotide
  - b) Nitrogenous base
  - c) Phosphate
  - d) Carbon
11. The enzyme required for transcription is
  - a) Restriction enzymes
  - b) DNA polymerase
  - c) RNA polymerase
  - d) RNase
12. What is the main function of tRNA in relation to protein synthesis?
  - a) Inhibits protein synthesis
  - b) Proof reading
  - c) Identifies amino acids and transport them to ribosomes
  - d) all of these
13. Transcription is the transfer of genetic information from
  - a) DNA to RNA
  - b) tRNA to mRNA
  - c) DNA to mRNA
  - d) mRNA to tRNA



14. The enzyme involved in amino acid activation is  
a) ATP synthetase                      b) aminoacyl tRNA synthetase  
c) aminoacyl mRNA synthetase   d) aminoacyl rRNA synthetase
15. Which is the energy rich molecule required for initiation of translation  
a) ATP                      b) GTP                      c) CTP                      d) AMP
16. X rays causes mutation by  
a) Deletion    b) transition                      c) transversion                      d) base substitution
17. Gene mutation occurs at the time of  
a) DNA repair    b) DNA replication                      c) Cell division                      d) RNA transcription
18. The transfer of genes from one cell to another by a bacteriophage is known as  
a) Recombination    b) Conjugation                      c) Transduction                      d) Transformation
19. The transfer of naked DNA from one cell to another is referred to as \_\_\_\_\_  
a) Transduction    b) Lysogeny                      c) Transformation                      d) Conjugation
20. F plasmid is often used in conjugation. The correct statement is?  
a) The F plasmid encodes the factor which is transferred from one cell to another  
b) The factor encoded by the F plasmid is called as Filamentous (F) factor  
c) It is transferred from one cell to another by filament  
d) The bacteria must belong to same species to carry out the conjugation

**PART – B (5 X 5 =25)**

**Answer all the questions**

21. a) Write the short notes C value paradox **(OR)**  
b) Describe about genome organization in yeast.
22. a) Write about the semi conservative replication **(OR)**  
b) Briefly write about the DNA polymerase.
23. a) Describe about the Wobble hypothesis **(OR)**  
b) Briefly write about lac operon.
24. a) Write about types of Luria & Delbruck experiment **(OR)**  
b) Describe about Carcinogenicity test.
25. a) Write down the Conjugation **(OR)**  
b) Describe about types of plasmid.

**PART – C (3 X 10 = 30)**

**Answer any three questions**

26. Write about the Watson & Crick model of DNA.
27. Briefly explain about enzymes involved in replication process.
28. Explain about Translation mechanism.
29. Briefly discuss about nutritional mutant detection in Neurospora.
30. Explain about gene transfer mechanism.

## **FOOD, INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY**

### **Course Objectives**

To enable the students to

- understand the principles of food preservation and spoilage
- learn the food and milk borne diseases
- aware the Government regulatory practices and policies
- be familiar with the upstream and downstream processes
- know standards in pharmaceuticals sterilization

### **Course Outcome:**

<b>CO1</b>	They could understand the principles of food preservation and spoilage techniques
<b>CO2</b>	They could obtain food and milk borne diseases
<b>CO3</b>	Could comprehend the knowledge on Government Regulatory Practices and Policies
<b>CO4</b>	They could familiar with the industrial production of some products
<b>CO5</b>	Could gather the pharmaceutical sterilization and its standards

### **UNIT I - Microbiology of food**

**No. of Hours: 15**

Food Microbiology: Micro-organisms and their importance in food microbiology–molds, yeast, bacteria, general features and classification, principles of food preservation, asepsis, control of microorganisms (anaerobic conditions, high temperature, low temperature, drying), factors influencing microbial growth in food–extrinsic and intrinsic factors - Contamination of foods.

### **UNIT II - Fermented food products and standards**

**No. of Hours: 15**

Fermented food – Bread. Oriented foods – Soy Sauce. Fermented drink – kombucha. Fermented vegetables– sauerkraut. Quality assurance - Microbiological quality standards of food. Government regulatory practices and policies. NABL, FDA, EPA, HACCP, ISI and FSSAI. Food safety, safety of dairy products, control and hazards.

### **UNIT III - Bioprocess technology**

**No. of Hours: 15**

Introduction to bioprocess - historical developments - fermentor designing, Components & types. Industrially important strains – screening, strain improvement, Inoculum development. Upstream processing – media formulation & sterilization. Downstream processing – Recovery & purification of extracellular & intracellular products. Fermentation economics – Application of computer in fermentation technology.

## Unit – IV Microbial products

No. of Hours: 15

Microbial production technology – Antibiotics –penicillin & streptomycin, organic acids – citric acid, vitamins – B12, enzymes – amylase, alcoholic beverages - beer and wine. Single cell protein. Microbial transformations: steroids and alkaloids production. Vaccines – synthetic peptide vaccines & multivalent subunit vaccines. Hormones - Insulin and Somatostatin.

## Unit – V Pharmaceutical Sterilization Techniques and its Standards

No. of Hours: 15

Microbial spoilage of pharmaceutical products and their sterilization – sterile injectables – non injectables – ophthalmic preparations and implants. Quality assurance and quality management in pharmaceuticals – ISO, WHO and US certification. Sterilization control and sterility testing -heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization.

### Text Books

1. Frazier, W.C. and D.C. Westhoff, (2008), “**Food Microbiology**”, Sixth Edition, Tata McGraw Hill Publications Co. Ltd., New Delhi.
2. Adams, M.R. and M.O. Moss, (2007), “**Food Microbiology**”, New Age International (P) Ltd., New Delhi.
3. Patel, A.H., (2003), “**Industrial Microbiology**”, Eighth Edition, McMillan Publishers, New Delhi.

### Reference Books

1. Mukhopadhyay, S.N., (2010), “**Process Biotechnology fundamentals**”, Third Edition, Viva Books, Chennai.
2. Modi, H.A., (2007), “**Dairy Microbiology**”, First Edition, Sheetal printers, Jaipur.
3. Bamforth, C. W., (2005), “**Food, Fermentation and Microorganisms**”, Blackwell Science Ltd., London.
4. **Pharmaceutical Microbiology**, W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
5. **Analytical Microbiology** - Edt by Frederick Kavanagh Volume I & II. Academic Press New York. Fernandes, R., (2009), “**Microbiology Handbook - Dairy Products**”, Leatherhead Food International Ltd, London.
6. Jain, N., Singh, V., and A. Sharma, (2011), “**Instant Notes in food Biotechnology**”, CBS. Publishers and Distributors Pvt. Ltd. New Delhi.

### Web sources:

1. <http://www.microbes.info>
2. <http://www.fsis.usda.gov/>
3. <http://www.cdc.gov/>
4. <http://web.indstate.edu/thcme/mwking/>
5. <http://lifesciences.asu.edu/text/classesbk.html>

## Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

**M.Sc., DEGREE EXAMINATIONS**

----- / ----- 2018.

**Second Semester**

**Microbiology**

**FOOD, INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY**

**Time: Three hours**

**Maximum Marks: 75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. The target microorganism in canning is  
a. *Clostridium botulinum*    b. *Streptococcus thermophilus*    c. PA 3679    d. *Lactobacillus bulgaricus*
2. Pasteurization is the heat treatment designed primarily to kill  
a. Vegetable forms of microorganisms    b. All form of microorganisms    c. Spore    d. None of above
3. In spore forming bacteria maximum resistance occurs at pH  
a. 4    b. 5    c. 6    d. 7
4. The time required to kill microorganism at a given lethal temperature is known as  
a. Z value    b. D value    c. C value    d. F value
5. *Clostridium botulinum* is  
a. Bacteria    b. Mold    c. Yeast    d. Virus
6. Thermophiles grows at  
a. 8 to 45°C    b. 25 to 30°C    c. 0 to 20°C    d. 50-60°C
7. Lactic acid bacteria include  
a. *Lactococcus lactis*    b. *Lactococcus cremoris*    c. *Bifidobacterium*    d. All above
8. Shredded cabbage is the starting product for which of the following fermented food?  
a. Sauerkraut    b. Pickles    c. Green olives    d. Sausage
9. Auxanography is employed to screen  
a. amino acid producers    b. amylase producers    c. cellulose producer    d. organic acid producers
10. Lyophilization is otherwise known as  
a. freeze drying    b. refrigeration    c. cold sterilization    d. appertization
11. The main source of commercial starch is  
a. tapioca    b. grapes    c. sulfite waste liquor    d. vegetable oils
12. Corn steep liquor is a  
a. carbon source    b. nitrogen source    c. hydrocarbon    d. cellulosic material
13. Type of yeast used for wine fermentation is  
a. *Saccharomyces cerevisiae*    b. *Streptococcus thermophilus*  
c. *Acetobacter acceti*    d. *Clostridium botulinum*
14. Citric acid is  
a. an acidulant    b. chelating agent    c. sequestering agent    d. all the above
15. The linkage between starch molecules is attacked by  
a. amylase    b. protease    c. lipase    d. cellulase

16. Vitamin B<sub>12</sub> is otherwise known as  
a. cyanocobalamine      b. riboflavin      c. ascorbic acid      d. niacin
17. Cold sterilization is  
a. refrigeration      b. radiation      c. filtration      d. pasteurization
18. Cobalt 60 is used in  
a. x rays      b. gamma rays      c. UV rays      d. β-rays
19. HEPA filter is used to filter  
a. air      b. injectables      c. ophthalmic solutions      d. tablets
20. Lipopolysaccharide act as  
a. exotoxin      b. endotoxin      c. neurotoxin      d. cytotoxin

**PART - B** (5 × 5 = 25 Marks)  
Answer **ALL** the Questions  
All questions carry equal marks

21. a) Describe about Mycotoxins (**OR**)  
b) Discuss about the food preservation using drying.
22. a) Write short notes on HACCP (**OR**)  
b) Explain about the FDA regulations
23. a) Write short notes on fermentation economics (**OR**)  
b) Explain about primary screening
24. a) Discuss about the citric acid production (**OR**)  
b) Give short notes on penicillin production
25. a) Write short notes on D value and Z value (**OR**)  
b) Discuss about filter sterilization of pharmaceutical products.

**PART - C** (3 × 10 = 30 Marks)  
Answer **ANY THREE** the Questions  
All questions carry equal marks

26. Briefly explain about food borne diseases.
27. Explain about soy sauce production.
28. Discuss the downstream process in detail.
29. Give a brief account on synthetic peptide vaccines & multivalent subunit vaccines
30. Explain briefly about quality assurance and quality management in pharmaceuticals.

### PRACTICAL - III MEDICAL BACTERIOLOGY AND MYCOLOGY

#### Course Objectives:

- To learn the microscopic techniques
- To gain experience with staining methods
- To be familiar with the methods of growing the bacteria
- To understand the identification methods of yeast
- To gain the basic knowledge cultivation of fungi

#### Course Outcome:

CO1	The students could understand the origin of Microbiology field, Microscopy & Staining techniques
CO2	To be aware of processing of clinical specimen
CO3	To enhance the knowledge about cultivation and identification of fungal
CO4	To comprehend the isolation and identification of yeast
CO5	The students adequate knowledge about clinical pathogens

#### 1. Processing of clinical specimen, Isolation, Identification and AntibioGram of unknown Bacterial pathogens in specimens.

*Staphylococcus* spp., *Streptococcus* spp., *Bacillus* spp., *Escherichia* spp., *Klebsiella* spp., *Proteus* spp., *Salmonella* spp., *Shigella* spp., *Pseudomonas* spp., *Vibrio* spp.,

#### 2. Isolation and Identification of Fungal Specimens

- (a) Direct Microscopy – KOH and Lacto phenol cotton blue mount
- (b) Slide culture technique

#### 3. Isolation and Identification of Yeast – Germ tube, Gram staining and Negative staining

*Candida* spp., *Cryptococcus* spp.

#### 4. Cultivation and identification of fungal pathogens from clinical specimens

Dermatophytes, *Aspergillus* spp.

#### Reference Books

1. Aneja, K.R., (2003), “**Experiments in Microbiology and Plant Pathology**”, New Age Publications, New Delhi.
2. Arora, B and D.R. Arora, (2013), **Practical Microbiology** CBS Publishers & distributors Pvt. Ltd, New Delhi.

3. Benson, J.H., (2001), “**Microbiological Applications: A Laboratory Manual in General Microbiology**”, Eighth Edition, McGraw-Hill, New York.
4. Cappuccino, J.G. and N. Sherman, (2005), “**Microbiology - A Laboratory Manual**”, Seventh Edition, Benjamin and Cummings Publications, San Francisco.
5. Gunasekaran, P., (2005), “**Laboratory Manual in Microbiology**”, New Age International (P) Ltd, New Delhi.

### Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓



**PRACTICAL IV – MICROBIAL GENETICS, MOLECULAR BIOLOGY, FOOD INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY**

**Course Objectives:**

- To learn about molecular techniques
- To understand the Bacterial Transformation mechanisms
- To be aware of Enumeration of microorganisms in food samples
- To adequate knowledge about mutagens
- To study about industrial product derived from microbes

**Course Outcome:**

<b>CO1</b>	To isolate, estimate and visualize the genetic material from bacterial cells
<b>CO2</b>	To impart knowledge on physical and chemical mutagens
<b>CO3</b>	To gain knowledge of the milk quality
<b>CO4</b>	To obtain the industrial production aspects with some commercial products
<b>CO5</b>	To gain knowledge of sterility test of food products

- 1) Isolation of chromosomal and plasmid DNA from bacteria and visualization of DNA by Agarose gel Electrophoresis
- 2) Quantitative estimation of DNA by diphenylamine test.
- 3) Effect of UV radiations to study the survival pattern of *E. coli*
- 4) Study the effect of chemical mutagens on bacterial cells.
- 5) Isolation of antibiotic resistant mutant by gradient plate technique.
- 6) Isolation of coli phage from sewage.
- 7) Demonstration of Bacterial Transformation, conjugation and transduction
- 8) Enumeration of bacteria and fungi in food samples- vegetables and fruits.
- 9) Isolation of fungi from spoiled bread
- 10) Qualitative testing of milk by MBRT (Methylene Blue Reduction Test) & Resazurin test
- 11) Counting of bacteria in milk by breed count method
- 12) Wine production using grape juice and estimation of total acidity, volatile acidity and ethanol from wine
- 13) Sterility control by LAL test

**Reference Books**

1. Benson, J.H., (2001), “**Microbiological Applications: A Laboratory Manual in General Microbiology**”, Eighth Edition, McGraw-Hill, New York.
2. Cappuccino, J.G. and N. Sherman, (2005), “**Microbiology - A Laboratory Manual**”, Seventh Edition, Benjamin and Cummings Publications, San Francisco.
3. Gunasekaran, P., (2005), “**Laboratory Manual in Microbiology**”, New Age International (P) Ltd, New Delhi.
4. Kannan, N., (2003), “**Laboratory Manual in General Microbiology**”, Fourth Edition, Palani Paramount Publications, Palani.

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

## **DIAGNOSTIC MICROBIOLOGY**

### **Course Objectives:**

- To gain the knowledge on microbial sample collection
- To get aware on microbial pathogenicity
- To impart the knowledge on clinical epidemiology
- To know the analytical methods on clinical microbiology

### **Course Outcome:**

<b>CO1</b>	They could impact knowledge on microbial sample collection
<b>CO2</b>	could study the pathogenicity of microorganisms with relevant to dose
<b>CO3</b>	They could able to aware the molecular epidemiology of microorganisms
<b>CO4</b>	They could able to gain knowledge of diagnostic techniques of microorganisms
<b>CO5</b>	To comprehend with the study of diagnostic technique of parasites

### **UNIT I**

**No. of Hours: 12**

**Microbiological samples:** Sample collection, transport, processing and testing methods of – Blood, Urine, Stool, Sputum, Skin scrapings, Body fluids – CSF, Pleural, peritoneal & pericardial fluid, Bronchoalveolar lavage fluid, hydatid cyst fluid, Synovial fluid.

### **UNIT II**

**No. of Hours: 12**

**Microbial pathogenicity:** Pathogenicity and virulence - Colonization, toxins, plasmids, enzymes, invasiveness and communicability. Quantitative measures of virulence – minimal lethal dose (MLD), LD50, ID50, TCID50. Facultative / obligate intracellular pathogens.

### **UNIT III**

**No. of Hours: 12**

**Molecular microbial epidemiology:** Biochemical and Immunological tools – biotyping, serotyping, phage typing, protein profiling, multilocus enzyme electrophoresis (MLEE); Molecular typing: RFLP (ribotyping, IS based), RAPD, 16S-23S IGS, ARDRA, rep (REP, ERIC, BOX)-PCR, PFGE, AFLP, MLST, MVLST, VNTR, SNP.

### **UNIT IV**

**No. of Hours: 12**

**Clinical Bacteriology & Mycolgy:** Laboratory diagnosis of pyogenic infection, Leprosy, Tuberculosis, URTI, LRTI, Enteric fever, Bacillary dysentery, Diarrhoeal diseases, Urinary tract infection and Meningitis. Candidiasis, Cryptococcosis, Histoplasmosis.

## UNIT V

Amoebic dysentery, Kalazar, Ascariasis, Filariasis, Taeniasis, Enterobiasis, Hepatitis, Viral diarrhea and AIDS.

### Text Books

1. Jawetz, Melnick, & Adelberg's (2004). **Medical Microbiology by Brooks GF, Butel JS, Morse SA**,  
Melnick JL, Jawetz E, Adelberg EA. 23<sup>rd</sup> edition. Lange Publication.
2. Cossart P, Boquet P, Normark S, Rappuoli R. (2005). **Cellular Microbiology**. 2<sup>nd</sup> edition.  
American Society for Microbiology Press.
3. Salyers AA and Whitt DD eds. **Bacterial Pathogenesis: A molecular approach**. (2002).  
American  
Society for Microbiology Press, Washington, DC USA.

### Reference Books

1. Hacker J and Dorbindt U. (2006). **Pathogenomics: Genome analysis of pathogenic microbes**.  
Ed.  
Wiley-VCH.
2. Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ. (2004).  
**Molecular Microbiology: Diagnostic Principles and Practice**. American Society for  
Microbiology Press.
3. Nelson KE, Williams CM, Graham NMH. (2001). **Infectious Disease Epidemiology: Theory  
and  
Practice**. An Aspen Publication.

### Web sources

1. [http:// www.microbiologyonline.org.uk/sgmprac.htm](http://www.microbiologyonline.org.uk/sgmprac.htm)
2. [http:// www.cvm.uiuc.edu/vdl/AppenA\\_man.html](http://www.cvm.uiuc.edu/vdl/AppenA_man.html)
3. [http:// www.microbes.info/resources/education\\_and learning](http://www.microbes.info/resources/education_and_learning)
4. <http://infohost.nmt.edu/-nmtlib/subj/boil.html>
5. [http:// www.hoflink.com/%7Ehouse/microbio.html](http://www.hoflink.com/%7Ehouse/microbio.html)

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**Second Semester**  
**Applied Microbiology**

**DIAGNOSTIC MICROBIOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

**1. Presence of urine sample in deep yellow colour is because of**

- a) Haematuria                      b) Myoglobinuria                      c) Dehydration                      d) Alkaptonuria

**2. Sputum sample for tuberculosis is collected for -----**

- a) Two consecutive days                      b) Three consecutive days  
 c) Four consecutive days                      d) One day

**3. In adult, the CSF sample is collected between ...lumbar vertebra**

- a) 3<sup>rd</sup> and 4<sup>th</sup>                      b) 4<sup>th</sup> and 5<sup>th</sup>                      c) 6<sup>th</sup> and 7<sup>th</sup>                      d) 7<sup>th</sup> and 8<sup>th</sup>

**4. Neurotoxins are produced by.....**

- a) Gram -ve                      b) Gram +ve                      c) Gram variables                      d) Above all

**5. TCID50 used to detect**

- a) Infectivity of virus                      b) Infectivity of bacteria                      c) Cytotoxicity                      d) Malignancy

**6. Enzyme which causes damage in connective tissue is -----**

- a) Bacterial kinases                      b) Hyaluronidase                      c) Coagulases                      d) Proteases

**7. Which of the following is a type of enterotoxin?**

- a) Vibrio enterotoxin                      b) SSSS toxin                      c) Diphtheria toxin                      d) Streptolysin

**8. Bile pigments detected by which of the following test?**

- a) Benzidine test                      b) Fouchet's test                      c) Hay's test                      b) Ehrlich's test

**9. Which of the following parasite can bore through intact skin**

- a) Nectator americanus                      b) *wuchereria bancrofti*                      c) *Taenia solium*                      d) None of the above

**10. Which of the following organism infects through inhalation?**

- a) *Streptococcus pyogenes*                      b) *Streptococcus pneumoniae*                      c) *Staphylococcus aureus*                      d) All of the above

**11. Which of the following is an example for capsulated bacteria?**

- a) *Streptococcus pneumoniae*                      b) *Klebsiella pneumoniae*                      c) *Hemophilus influenzae*                      d) All of the above

**12. What is the function of leucocidins enzyme?**

- a) Destruction of RBC                      b) Destruction of WBC                      c) Destruction of platelets                      d) Destruction of cancer cells

**13. Toxemia is the condition of .....**

- a) Toxicity in tissue                      b) Toxicity in blood                      c) Toxicity in CSF                      d) Toxicity in Serum

**14. Toxic Shock Syndrome Toxin (TSS) is produced by.....**

- a) *Streptococcus pneumoniae*                      b) *Streptococcus pyogenes*  
 c) *Staphylococcus aureus*                        d) *Klebsiella pneumoniae*
15. Massive muscle spasms is caused by.....
- a) Diphtheria Toxin    b) Hemolysin        c) Tetanus Toxin        d) Streptolysin O
16. VR Transport Media is used for.....
- a) *E.coli*            b) *S. typhi*            c) *V. cholerae*                      d) *S. flexneri*
17. Black water fever is caused by
- a) *Plasmodium falciparum*    b) *Trypanosoma brucei*        c) *Leishmania donovani*        d) None of the above
18. In which of the following body fluid, HIV is not present?
- a) Semen                      b) Breast milk                      c) Sweat                      d) Blood
19. The head of *Taenia solium* has..... mouths
- a) 1                      b) A pair                      c) 4                      d) 3
20. BCG Vaccine more effective to control TB in .....
- a) Children                      b) Adults                      c) Both A and B                      d) No control

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a. Explain the sample collection and processing of CSF (OR)  
 b. Explain sputum collection and processing and testing.
22. a. Write on TCID<sub>50</sub> (OR)  
 b. Give account on LD<sub>50</sub>.
23. a. Give introduction and application of FAME analysis (OR)  
 b. Write a brief notes on RAPD.
24. a. Write on infection & Symptoms of Bacillary dysentery (OR)  
 b. Explain clinical conditions caused by *Candida albicans*.
25. a. Give introduction to filariasis and explain pathogenesis and Clinical manifestation of *Wuchereria bancrofti* (OR)  
 b. Write on hepatitis.

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Write in detail on collection and processing and testing of blood and urine.
27. Give introduction on virulence, colonization, invasiveness and write function of toxins and enzymes.
28. Write in detail on PFGE.
29. Explain the pathogenesis, clinical symptoms of enteric fever.
30. Explain infection by HIV and clinical manifestation of AIDS.

## **POULTRY MICROBIOLOGY**

### **Course Objectives:**

- To gain the knowledge on poultry and its products
- To improve knowledge about the growth of chickens
- To impart the knowledge entrepreneurship in poultry field
- To know the disease profile of chickens

### **Course Outcome:**

<b>CO1</b>	The students could able to study about the poultry farm and its types
<b>CO2</b>	Could impart the knowledge on the nutraceutical value of poultry feeds
<b>CO3</b>	They could be aware of principles of disease prevention management
<b>CO4</b>	They gained the benefits of the students more conscious about viral disease
<b>CO5</b>	They could improve the entrepreneurship opportunities

### **UNIT I - House and Cage**

**No. of Hours: 12**

Types of poultry houses. Different types of rearing – advantages and disadvantages Brooding: Types of brooders; preparation of shed to receive chicks. Classification of poultry with respect to production characters. Cage management – Different types; Advantages and disadvantages.

### **UNIT II - Nutrition Value of poultry production**

**No. of Hours: 12**

Classification of nutrients – Factors influencing nutrient requirements – feed consumption, Nutrient requirements and feed formulations. Feeding systems — Additives, pre and probiotics - supplements. Nutritional and metabolic disorder – Rickets, Osteomalacia, Vitamin A deficiency, Vitamin E deficiency.

### **UNIT III - Poultry judging**

**No. of Hours: 12**

Formation of egg in fowl - Egg structure – Physical and chemical composition. Bio-security and principles of disease prevention management. Health care for common poultry diseases –Principles of poultry medication. Poultry waste management, pollution, disposal of hatchery waste

### **UNIT IV - Viral disease**

**No. of Hours: 12**

Newcastle disease – fowl pox – EDS -76 (egg drop syndrome) – Infectious bursal diseases (Gumboro diseases) – Infectious bronchitis – Infectious Laryngo tranchitis – Inclusion body hepatitis – Avian encephalomyelitis – Reo viral arthritis – Marek's disease – Avian lymphoid leukosis.

### **UNIT V - Bacterial, fungal and protozoan diseases**

**No. of Hours: 12**

Salmonellosis – Avian coliform infection – Staphylococci – Avian tuberculosis – Infectious coryza – Avian streptococcal infection – Avian pasteruellosis, Psittacosis. Parasitic and Fungal diseases — Coccidiosis.– *Ascardia galli*, Tape worms. External parasites - Fowl ticks, Lice, Mites. Fungal diseases. Aspergillosis and aflatoxicosis.

### Text Books

1. Mahajan Naresh, (2015). **Poultry Nutrition and Management**. 1<sup>st</sup> Edition. Anmol Publications Pvt. Ltd., New Delhi.
2. Wiseman. J, and Garnsworthy. P. C., (1999). **Recent Development in Poultry Nutrition**.
3. Titus Harry. W and Fritz James. C (1971). **The Scientific Feeding of Chickens**. 5<sup>th</sup> Edition.

### Reference Books

1. F. Jordan, M. Pattison, D. Alexander and T. Faragher. (2001). **Poultry diseases**. W.B Saunders London.
2. B. W. Calrek (1997). **Diseases of poultry**. 10<sup>th</sup> Ed., Iowa state university. Ames, Iowa. USA.
3. Reena Kandwal, (2013). **Nutrient Requirements of Poultry**. 3<sup>rd</sup> Edition.
4. Bell D. Donald and Weaver D. William Jr., (2007). **Commercial Chicken Meat and Egg Production**. 5<sup>th</sup> Edition. Springer India Pvt. Ltd., Noida.
5. Reddy Ramasubba V., and Bhosale T. Dinesh, (2004). **Handbook of Poultry Nutrition**. 1<sup>st</sup> Edition. International Book Distribution Co., Lucknow, India.

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓



**(For the candidates admitted from 2018 - 19 onwards)**  
**M.Sc., DEGREE EXAMINATIONS**  
----- / ----- **2018.**  
**First Semester**  
**Applied Microbiology**

**POULTRY MICROBIOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Grower house
  - a. rear egg type chick
  - b. 18 weeks of age
  - c. Egg type birds
  - d. Male and female
2. Super intensive system has been considered as
  - a. Management system
  - b. Cage system
  - c. Deep litter
  - d. Open system
3. Allowing poultry to eat as much as they want is called
  - a. Diet
  - b. Feed intake
  - c. Ad libium
  - d. None of these
4. House orientation
  - a. Location
  - b. Site
  - c. Direction
  - d. Size
5. The overhang of the roof should not be .....feet
  - a. 3.5
  - b. Above 4
  - c. Less than 3.5
  - d. None of this
6. N. Chicken originated from a certain places is called
  - a. Breeds
  - b. Variety
  - c. Class
  - d. Strain
7. Carbohydrates are the
  - a. Trace elements
  - b. Organic compounds
  - c. Amino acids
  - d. None of these
8. The optimum nutrient of poultry is called
  - a. Diet
  - b. Feed intake
  - c. Consumption
  - d. Feed system
9. The air cell must not exceed 1/8 inch in depth that is ..... type of egg
  - a. Grade AA
  - b. Grade A
  - c. Grade B
  - d. Grade C
10. Egg consists of ..... major parts
  - a. 4
  - b. 2
  - c. 3
  - d.1
11. It is the glycoprotein
  - a. Avidin
  - b. Ovomucin
  - c. Lysozyme
  - d. Ovamucoid
12. Power can be generated by following method
  - a. Composting
  - b. Rendering
  - c. Anaeribic digestion
  - d. A&B
13. The vaccine administered into the embryo is called.....vaccination
  - a. In ovo
  - b. Intramuscular
  - c. Ocular
  - d. Nasal
14. Fowl pox produced
  - a. Lesions
  - b. Loss of feather
  - c. Wart like lesions
  - d. None of this
15. New castle disease is a type of
  - a. Bronchitis
  - b. Quail bronchitis
  - c. Fungal disease
  - d. Pneumoencephalitis
16. Highly pathogenic Newcastle disease is called
  - a. Lentogenic
  - b. Mesogenic
  - c. Velogenic
  - d. Phytogenic
17. Symptoms of infectious bronchitis
  - a. Temperature
  - b. Weight loss
  - c. Feed taking
  - d. Cold

18. Mycotic pneumonia is caused by  
a. Mycoplasma      b. Pox virus      c. *Aspergillus*      d. *Candida*
19. Incubation period of Lymphoid Leukosis  
a. 10 days      b. 1 year      c. 1 month      d. 4 months
20. Necrotic enteritis is otherwise called as  
a. Clostridia      b. EDS-76      c. Necrosis      d. Trauma

**PART - B** ( $5 \times 5 = 25$  Marks)  
Answer **ALL** the Questions  
All questions carry equal marks

21. a. Give the account and types of poultry houses. (OR)  
b. Shortly describe the preparation of shed to receive the chicks.
22. a. Write about the food additives. (OR)  
b. Write the short notes on Phase feeding system.
23. a. Explain the physical composition of egg. (OR)  
b. Shortly describe the poultry biosecurity.
24. a. Give the short notes on the egg drop syndrome. (OR)  
b. Explain the gumboro disease.
25. a. Write about the infectious coryza. (OR)  
b. Shortly explain the avian pasterullosis.

**PART - C** ( $3 \times 10 = 30$  Marks)  
Answer **ANY THREE** the Questions  
All questions carry equal marks

26. Briefly explain about poultry rearing.
27. Briefly describe the classification of poultry nutrition.
28. Briefly explain about Vitamin A & E deficiency.
29. Give the essay notes on Marek's disease.
30. Briefly answered for poultry coccidiosis.

# SEMESTER III

**AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY**

**Course Objectives**

To enable the students to

- study the soil microbial distribution, interaction and their significance
- learn the microbial diseases of crops and to understand the production of biofertilizer and biopesticides
- be familiar with airborne microbes
- be aware of potable and waste water treatment system and disposal
- acquire knowledge on microbial action in the environment

**Course Outcome:**

<b>CO1</b>	Gain knowledge on basis of soil environment, microbial distribution in soil and the interaction between soil and microbes
<b>CO2</b>	Understand the interaction of microbes with plants, the various diseases in plants and the preparation of various biofertilizers, biopesticides and bioherbicides
<b>CO3</b>	Get information on microbial load in air, air sampling devices and the types of airborne diseases and its control measures
<b>CO4</b>	Gain knowledge on waterborne diseases, waste water treatment and its disposal
<b>CO5</b>	Understand the various microbial actions in different aspects viz., bioenergy, biodiesel, biogas, etc.

**UNIT - I Soil Microbiology**

**No. of Hours: 15**

Soil formation. Physical and chemical characteristics of soil. Soil atmosphere-water, pH and temperature. Role of microorganisms in humus formation. Microbial degradation of cellulose. Distribution of bacteria, actinomycetes, fungi, algae, protozoa and virus in soil. Microbial interaction-mutualism, amensalism, commensalisms, protocooperation, predation, parasitism and competition. Biogeochemical Cycles- C, N, P, and S.

**UNIT - II Microbial Interactions**

**No. of Hours: 15**

Plant microbial interaction – phyllosphere and rhizosphere. N<sub>2</sub> fixation and phosphate solubilisation (symbiotic and free living) - genetics of N<sub>2</sub> fixation. Actinorrhizae and Mycorrhizal associations. Plant diseases – Blast of Rice, Angular Leaf Spot of Cotton (Black Arm of Cotton), Powdery Mildew of Cucurbits, Black or Stem Rust of Wheat, TMV. Biofertilizers types and methods of application – *Rhizobium*, *Azotobacter*, *Azospirillum* and Cyanobacteria. Biopesticides: bacterial, fungal and viral. Microbial nematicides and herbicides.

**UNIT - III Aerobiology**

**No. of Hours: 15**

Composition of air – aerial environment – microbial propagules in air- Indoor and Outdoor flora of air. Seasonal and diurnal periodicities of airspora. Air sampling techniques: Settle under gravity, Centrifugal action, Filtration, Impingement and Electrostatic Precipitation. Significance of air flora. Hazards of laboratory techniques. Airborne diseases and its control measures.

#### **UNIT - IV Aquatic Microbiology**

**No. of Hours: 15**

Microbiology of water - Indicator microorganisms - Detection of water borne pathogens – sewers swab method – membrane filter techniques – multiple tube fermentation test. DO, BOD and COD. Impact of eutrophication. Sewage - Physical, chemical and biological treatment process– Membrane technology - RO treatment – oxidation. Disinfection and disposal of treated sewage: Irrigation, composting and land filling.

#### **UNIT- V Microbial Remediation**

**No. of Hours: 15**

Biofilm formation and biocorrosion of water distribution system, Bioremediation and bioaugmentation of toxic and recalcitrant chemicals. Bioenergy - Biodiesel & biogas. Bioplastics, Biofilters and Bioscrubbers. Bioconcrete. Microbial enhanced oil recovery – Biosurfactants. Bioleaching of metals - Copper, Uranium and Gold. Bioaccumulation of heavy metals by microbes. Biodeterioration of paint, textile and leather.

#### **Text Books**

1. Rangaswami, G. and D.J. Bagyaraj, (2001). “**Agricultural Microbiology**”, 2<sup>nd</sup> Edition, Prentice-Hall of Private Limited, New Delhi.
2. Subbarao, N.S., (2001). “**Recent Advances in Biological Nitrogen Fixation**”, Oxford and IBH, New Delhi.
3. Subbarao, N.S., (1995). “**Soil Microorganisms and Plant Growth**”, 4<sup>th</sup> Edition, Oxford and IBH, New Delhi.

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1. Agrios, G.N., (2005). “**Plant Pathology**”, Elsevier Academic Press, Burlington.
2. Paul, A., (2014). “**Soil Microbiology, Ecology and Biochemistry**”, Fourth Edition, Academic Press Inc., New York.
3. Lowenfels, J. and W. Lewis, (2010). “**Teaming with Microbes: The Organic Gardener's Guide to the Soil Food Web**”, Timber Press, Portland.
4. Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. and D.A. Zuberer, (2005). “**Principles and applications of soil microbiology**”, Second Edition, Pearson, London.
5. Barton, L.L. and Northup, D.E., (2011). “**Microbial Ecology**”, John Wiley & Sons, Inc., New Jersey.
6. Lebaron, P., Matheron, R., Normand, P. and Sime-Ngando, T., (2015). “**Environmental Microbiology: Fundamentals and Applications**”, Springer, New York.

7. Mitchell, R. and Gu, J.D., (2010). “**Environmental Microbiology**”, 2<sup>nd</sup> Edition, John Wiley & Sons, Inc., New Jersey.
8. Pepper, I.L., Gerba, C.P. and Gentry, T.J, (2015). “**Environmental Microbiology**”, 3<sup>rd</sup> Edition, Elsevier, New York.
9. Ronald, A.M. and Bhartha, R., (2000). “**Microbial Ecology**”, 4<sup>th</sup> Edition. Benjiman/Cummings Publications, California.

### Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

**(For the candidates admitted from 2018 - 19 onwards)**  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**Third Semester**  
**Applied Microbiology**

**AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A (20 × 1 = 20 Marks)**

Answer **ALL** the Questions

All questions carry equal marks

1. Which of these has the smallest size of particles?  
 a) Sand            b) Silt            c) Clay            d) Gravel
2. Water logging can be expected in soil which is rich in  
 a) sand            b) clay            c) silt            d) humus
3. What is loss of topsoil from wind and water?  
 a) Eutrophication            b) Soil erosion            c) Desertification            d) Urbanization
4. In process of photosynthesis energy from sunlight is trapped by  
 a) Roots            b) Stomata            c) Chlorophyll            d) Mesophyll
5. The use of living microorganism to degrade environmental pollutants is called  
 a) Microremediation            b) Nanoremediation            c) Bioremediation            d) All of these
6. The association which involves the exchange of nutrients between two species is referred as -----  
 --  
 a) Mutualism            b) Syntrophism            c) Commensalism            d) Antagonism
7. Which of the following organisms are known to grow on the surfaces of freshly exposed rocks?  
 a) Green algae            b) Diatoms            c) Cyanobacteria            d) Yeast
8. Microorganisms secrete an enzyme which helps in digestion of cellulose known as  
 a) Cellulose            b) Catalase            c) Sucrose            d) Pepsin
9. Cellulose is highly insoluble in water and is not digested in digestive tract of  
 a) Human            b) birds            c) Protozoa            d) Insects
10. An association between two individuals or populations where both are benefitted and where neither can survive without the other is -----  
 a) Competition            b) Commensalism            c) Mutualism            d) Protocoperation
11. *Pencillium* does not swallow the growth of bacterium *Staphylococcus* which relationship is called  
 a) Commensalism            b) Predation            c) Amensalism            d) Mutualism
12. The process of extracting metals from ore bearing rocks is called  
 a) Bioextraction            b) Microbial extraction            c) Biofiltration            d) Bioleaching
13. Mycorrhizae is associated with the following  
 a) Formation of root nodules            b) Hyphae penetrating the soil  
 c) Found mostly in lower plants            d) Soil erosion
14. The xanthophyte walls are typically of -----  
 a) Chitin            b) Cellulose            c) Cellulose and pectin            d) Starch
15. In *Chlamydomonas* the most common method of sexual reproduction is  
 a) Isogamy            b) Heterogamy            c) Oogamy            d) Spore formation

16. Organic farming is the technique of raising crops through uses of?  
a) Manures            b) Biofertilizers            c) Resistant varieties            d) All of these
17. *Azolla* is used as biofertilizer as it has  
a) *Rhizobium*            b) *Cyanobacteria*            c) *Mycorrhiza*            d) large quantity of humus
18. Which of the following compounds are required for growth of saprophytic bacteria and fungi?  
a) Organic compounds            b) Nitrates            c) Phosphates            d) Mercury
19. Which of the following bacterium is called as the superbug that could clean up oil spills?  
a) *Bacillus subtilis*            b) *Pseudomonas putida*  
c) *Pseudomonas denitrificans*            d) *Bacillus denitrificans*
20. Which of the following microbe is widely used in the removal of industrial wastes  
a) *Trichoderma* sp            b) *Aspergillus niger*            c) *Pseudomonas putida*            d) All of these

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions  
All questions carry equal marks

21. a) Explain the Role of microorganisms in composting and humus formation (**OR**)  
b) Write short note on mutualism and amensalism.
22. a) Write about the plant disease – red rot of sugar cane (**OR**)  
b) Explain about the microbial herbicides.
23. a) Write a short note on indoor and outdoor flora of air (**OR**)  
b) Briefly explain the significance of air flora.
24. a) Write a short note on membrane filter technique (**OR**)  
b) Explain in detail about BOD and COD.
25. a) Write a short note on microbial fuel cells (**OR**)  
b) Explain in detailed about super bug.

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions  
All questions carry equal marks

26. Write a detailed account on different Microbial interactions.
27. Write an essay about Mycorrhizal association.
28. Explain in detail about air sampling techniques.
29. Write an essay on sewage and effluent treatment.
30. Explain in detailed about bioleaching of metals.



## MEDICAL VIROLOGY AND PARASITOLOGY

### Course Objectives

- To gain knowledge about general properties of viruses.
- To understand the diseases caused by arthropod borne and rodent borne viruses.
- To gain knowledge about the diseases caused by pox, adeno, herpes and hepatitis viruses.
- To understand protozoan diseases.
- To gain knowledge about diseases caused by helminthes.

### Course Outcome:

CO1	The students could understand the basic concepts in medical virology
CO2	Could gain the knowledge on arthropod and rodent borne viral infections
CO3	Could get information on viral diseases, preparation and their schedule of vaccine
CO4	They could understand the basic concepts in medical parasitology and few protozoan diseases and its control
CO5	Could understand the concepts in helminthes diseases and its control

### UNIT - I

No. of Hours: 15

Introduction and Historical perspective of medical virology - General Properties of viruses and virus multiplication. Baltimore classification viruses. Collection, transport and processing of clinical samples for the viral infection diagnosis by serological and molecular techniques. – Methods of cultivation of viruses Antiviral agents, Vaccines – immunization schedule and Interferons.

### UNIT - II

No. of Hours: 15

**Poxviridae:** *Othropoxviruses* – *Variola*, *Vaccinia* and *Cowpox virus*. **Herpesviridae:** *Human herpes viruses - type 1 to 8*. **Adenoviridae:** *Human adeno viruses*. **Papillomaviridae:** - *Human papilloma viruses*. **Picornaviridae:** *Enterovirus - Polio virus, Coxsackie A viruses (CA) and Coxsackie B viruses*. **Rhabdoviridae:** – *Lyssavirus - Rabies virus*. **Hepatitis viruses:** A, B, C, D and E. **Orthomyxoviridae:** *Influenza A – Spanish flu, Asian flu, Hong Kong flu* and recent epidemic.

### UNIT - III

No. of Hours: 15

**Paramyxoviridae:** *Morbillivirus – Measles; Orthorubulavirus – Mumps and Henipavirus - Nipahvirus*. **Matonaviridae:** *Rubivirus - Rubella virus - German measles*. **Togoviridae:** *Alphavirus – Chickungunya virus, O' nyong nyong virus and Ross river virus*. **Flaviviridae:** *flavivirus – Yellow fever, KFD virus, Dengue and Zika virus*. **Filoviridae:** *Ebola and Marburg virus*. **Coronaviridae:** *Betacoronavirus – SARS-CoV, MERS-CoV and SARS-CoV-2*. **Retirovidae:** *Lentivirus - Human*

*Immunodeficiency virus.*

#### UNIT – IV

No. of Hours: 15

**Introduction to medical parasitology:** Host - parasite interactions, classification of medically important parasites. **Intestinal protozoans:** *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum* and *Balantidium coli*. **Blood and tissue protozoa:** *Trypanosoma brucei* and *cruzi*; *Leishmania donovani*, *tropica* and *braziliensis*; *Plasmodium falciparum*, *ovale*, *malariae* and *vivax*; *Trichomonas vaginalis*; *Toxoplasma gondii*.

#### UNIT – V

No. of Hours: 15

**Intestinal helminths:** *Ascaris lumbricoides* (roundworm), *Taenia solium* and *saginata* (Tapeworm), *Enterobius vermicularis* (Pinworm), *Trichiuris trichiuria* (whipworm), *Ancylostoma duodenale*, and *Necator americanus* (hookworms). **Liver flukes:** *Fasciola hepatica* and *buski*. **Lung fluke:** *Paragonimus westermani*. **Blood fluke:** *Schistosoma haematobium* and *japonicum*. **Microfilaria:** *Wuchereria bancrofti*. Laboratory techniques in Parasitology. Concentration methods - Examination of faeces for ova and cysts. Blood smear examination for parasites. Cultivation of protozoans

#### Text Books

1. Saravanan P (2006). **Virology**. 1<sup>st</sup> Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai.
2. Arti Kapil (2013). **Ananthanarayan and Paniker's Text Book of Microbiology**. 9<sup>th</sup> Edition, Orient Blackswan Private Limited.
3. Chakraborty P (2015). **A Text Book of Microbiology**. New Central Book Agency (P) Ltd., Kolkata.
4. Subhash Chandra Parija (2004). **Text Book of Medical Parasitology**. 2nd Edition, All India Publishers and Distributors, New Delhi.

#### Reference Books

1. Dimmock NJ and Primrose SB (1994). **Introduction to Modern Virology**. 4<sup>th</sup> Edition, Blackwell scientific Publications, Oxford.
2. Jawetz, Melnick and Adelberg, (2010). **Medical Microbiology** (25<sup>th</sup> edition) McGraw Hill Publications.
3. Flint JS and Skalka AM, Enquist LW and Racaniello VR (2015). **Principles of Virology**. 4<sup>rd</sup> Edition, ASM Press, New York.
4. Chatterjee KD (2009). **Medical Parasitology**. 13<sup>th</sup> Edition, CBS Publishers and Distributors Pvt Ltd., New Delhi.

## Mapping

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

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**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**Third Semester**  
**Applied Microbiology**

**MEDICAL VIROLOGY AND PARASITOLOGY**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Viruses range in size from -----  
 a. 1-100 nm    b. 25-300 nm    c. 10-100 µm    d. 400-1000 nm
2. Which of the following virus contains haemagglutinin spikes?  
 a. Enterovirus    b. Influenza virus    c. VZV    d. None of the above
3. Which of the following virus is arthropod born virus?  
 a. HIV    b. HSV    c. Dengue    d. Hepatitis
4. Virus growth in cell culture identified by -----  
 a. CPE    b. Light microscope    c. ELISA    d. Granules
5. How soon do symptoms typically appear after a person is infected with the rabies virus?  
 a. 48 hours    b. 1 week    c. 1 month    d. 1 year
6. The influenza virus is mainly controlled in special "risk" sectors by:  
 a. Hygiene    b. Vaccination    c. Antiviral drugs    d. Humanised monoclonal antibodies
7. Which of the following is a morphological characteristic of the paramyxoviruses?  
 a. Fragile viruses often visualised with RNA spewing from the inside    b. Elongate viruses  
 c. Icosahedral viruses with envelope    d. Very large viruses
8. Lassa and Ebola are emergent viruses in W. Africa. What is their origin?  
 a. Humans    b. Primates    c. Fruit bats    d. Pigs
9. What is a reactivation of chickenpox in adults?  
 a. Measles    b. Shingles    c. Warts    d. Impetigo
10. The adenovirus virion has which unique structural feature?  
 a. Icosahedron    b. Icosahedron with slender fibres  
 c. 'Complex' structure not yet fully explored    d. Flexuous lipid containing structure
11. The following diseases are associated with Epstein-Barr virus infection, except -----  
 a. Infectious mononucleosis    b. *Epidermodysplasia verruciformis*  
 c. Nasopharyngeal carcinoma    d. Oral hairy leukoplakia
12. Which is the best choice today for her immunoprophylaxis of hepatitis A?  
 a. A dose of hepatitis A vaccine  
 b. A dose of IM immunoglobulin and a dose of hepatitis A vaccine  
 c. A dose of IM immunoglobulin  
 d. First dose of hepatitis A vaccine today and a booster dose the day before she leaves
13. African sleeping sickness is caused by which of the following protozoa?  
 a. *Entamoeba histolytica*    b. *Trypanosoma gambiense*

- c. *Leishmania donovani*                      d. *Plasmodium vivax*
14. In malaria, the form of plasmodia that is transmitted from mosquito to human is the -----  
 a. Sporozoite                      b. Gametocyte                      c. Merozoite                      d. Hypnozoite
15. Which of the following agent is used to prevent Malaria  
 a. Mebendazole                      b. Chloroquine                      c. Inactivated vaccine                      d. Zinc table
16. A patient experiences persistent diarrhea, abdominal pain and weight loss. Which of the following is a likely diagnosis?  
 a. visceral leishmaniasis                      b. amebic encephalitis                      c. Chagas' disease                      d. None of these
17. Host of *Taenia solium*  
 a. Pigs                      b. Humans                      c. Both                      d. None
18. How does a Scistosome normally enter in to the body?  
 a. Through the skin                      b. Through drinking water                      c. Through the urethra                      d. Through the nose
19. The common name for *Ascaris lumbricoides* is -----  
 a. Roundworm                      b. Hookworm                      c. Whipworm                      d. Threadworm
20. Difference in appearance from *Necatoris* that mouth has 4 teeth on front and smaller pair of teeth in back of buccal cavity -----  
 a. *Ancylostoma duodenale* vs *Necator mericanus*                      b. teeth of *Ancylostoma duodenale*  
 c. *Necator mericanus* adult                      d. dog hookworm infestation of human

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a. Give brief introduction on vaccines and its types (OR)  
 b. Explain interferon and its function in viral infection.
22. a. Write pathogenesis of Dengue Virus (OR)  
 b. Explain clinical manifestation of Chikungunya virus
23. a. Give introduction to Adeno virus and clinical features. (OR)  
 b. Give account on immunization schedule.
24. a. General characteristics of Parasites (OR)  
 b. Describe the clinical manifestation of *Plasmodium* species
25. a. Explain flotation technique (OR)  
 b. Explain sedimentation technique

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Explain in details on antiviral agents.
27. Give detailed account on polio virus infection.
28. Give introduction to viral vaccines, types and preparation.
29. Explain infection caused by *Giardia intestinalis*.
30. Explain pathogenesis and clinical features of *Wuchereria bancrofti*.

## GENETIC ENGINEERING – CONCEPTS AND APPLICATIONS

### Course Objectives

To enable the students to

- i) acquire knowledge on DNA modifying enzymes
- ii) understand the molecular biology of vectors
- iii) be familiar with the cloning techniques
- iv) understand the concept of transgenic technology
- v) learn the applications of genetic engineering

### Course Outcome:

<b>CO1</b>	The students familiar with molecular techniques
<b>CO2</b>	To be aware of Enzymology of Genetic Engineering
<b>CO3</b>	To improve the knowledge about Cloning strategies
<b>CO4</b>	To get knowledge about advanced molecular techniques
<b>CO5</b>	To achieve knowledge about gene biotechnology

### UNIT – I Concepts on Gene biotechnology

**No. of Hours: 15**

History and Scope. Enzymology of Genetic Engineering – restriction enzyme: Types and properties. DNA modifying enzymes: Ligase, kinase, phosphatase, S<sub>1</sub> Nuclease, exonuclease, terminal transferase, Rnases, DNA Polymerase enzymes (*Taq*, *Pfu*, T4 DNA polymerase) and reverse transcriptase.

### UNIT – II Cloning Vectors

**No. of Hours: 15**

Types and properties of vector. Plasmid vector: pBR<sup>322</sup>, pUC19 and Ti plasmids. Phage vectors:  $\lambda$  and M13 vectors. Cosmid and phasmid vectors. Expression vector and shuttle vector. Artificial chromosomes: YAC, BAC, PAC and HAC.

### UNIT – III Gene Cloning strategies

**No. of Hours: 15**

Cloning strategies - Host selection, vector selection and target selection. Genomic libraries and cDNA libraries. Library screening: nucleic acid hybridization, immunological and screening by function. Gene transfer techniques: physical, chemical and biological transfer techniques. Expression of cloned genes: minicel, maxicel, fused and unfused.

### UNIT – IV Transgenics and its applications

**No. of Hours: 15**

Transgenic and gene knockout technologies: targeted gene replacement, gene augmentation and gene silencing. DNA sequencing: enzymatic, chemical and pyro sequencing. PCR - Types and applications. RAPD, RFLP and AFLP.

**Regulation in gene biotechnology** - Development of transgenic plant for disease resistant, herbicide tolerance, nutritional quality (Gold Rice). Transgenic animal for Disease resistant

**UNIT – V Applications of Genetic engineering****No. of Hours: 15**

Medicine (production of Hormone: insulin, somatostatin and somatotropin interferon and recombinant vaccines). Environment-(Biosensor: Structure and function. Biochips). Genetically Modified Organism: *Pseudomonas putida* (super bug).

**Reference Books**

1. Brown, T.A., “**Gene Cloning and DNA Analysis: An Introduction**”, Sixth Edition, Wiley-Blackwell Publishing Ltd., Oxford, 2010.
2. Cooper, G.M. and Hausman R.E., “**The Cell: A Molecular Approach**”, Fifth Edition, Sinauer Associates Inc., New York, 2009.
3. Dale, J.W. and Park, S.F., “**Molecular Genetics of Bacteria**”, Fourth Edition, John Wiley & Sons Ltd., Chichester, 2004.
4. Dale, J.W., Schantz von M. and Plant, M., “**From Genes to Genomes: Concepts and Applications of DNA Technology**”, Third Edition, John Wiley & Sons Ltd., Chichester, 2012.
5. Dubey, R.C., “**A Text Book of Biotechnology**”, S. Chand and Company, New Delhi, 2000.
6. Freifelder, D, “**Molecular Biology**”, Narosa Publishing House, New Delhi, 1991.
7. Glick, B.R. and *Pasternak, J.J.*, “**Molecular Biotechnology**”, A.S.M. Press, London, 2001.
8. Karp, G., “**Cell and Molecular Biology: Concepts and Experiments**”, Sixth Edition, John Wiley & Sons Inc., New York, 2010.
9. Primrose, S.B. and Twyman, R.M., “**Principles of Gene Manipulation and Genomics**”, Seventh Edition, Blackwell Science Publishing, Oxford, 2006.

**Mapping**

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**

**GENETIC ENGINEERING – CONCEPTS AND APPLICATIONS**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

- 1. Which of the following enzyme is used to synthesize DNA using an mRNA template**  
 a) Taq polymerase    b) Alkaline phosphatase    c) Reverse transcriptase    d) Nuclease
- 2. Which of the following enzyme is used to cut the DNA molecule**  
 a) Restriction endonuclease    b) DNA ligase    c) Ribonuclease H    d) S1 Nuclease
- 3. Which of the following enzyme is used to join the DNA molecule**  
 a) DNA ligase    b) Exonuclease    c) Endonuclease    d) Phosphatase
- 4. Which of the following enzymes commonly used in rDNA technology**  
 a) Type I    b) Type II    c) Type III    d) Type IV
- 5. Which is an example of a simplest vector (in terms of size)?**  
 a) 2 micron circle    b) Bacteriophage    c) Plasmid    d) YAC
- 6. Bolivar and Rodriguez constructed which vector?**  
 a) Yip7    b) R6-5    c) pUC8    d) Pbr322
- 7. Which antibiotic resistance is present in pBR322?**  
 a) Ampicillin    b) Kanamycin    c) Lactase    d) Gentamycin
- 8. What is the copy number of the pUC8 plasmid vector?**  
 a) 5-10    b) 50-100    c) 100-200    d) 500-700
- 9. In which stage of genetic engineering a probe is used?**  
 a) Cleaving DNA    b) Recombining DNA    c) Cloning    d) Screening
- 10. Vector and insert are mixed, ligated and packaged and introduced into the host by**  
 a) transformation    b) transduction    c) infection    d) transformation and infection
- 11. The first genomic libraries were cloned in -----**  
 a) Plasmid    b) Bacteria    c) Human    d) Plants
- 12. A genomic library is a collection of -----**  
 a) Genes    b) Proteins    c) Vectors    d) Recombinants
- 13. Chain-termination is a type of -----**  
 a) Sequencing    b) Vector generation    c) Antibiotic production    d) Gene manipulation
- 14. What is the main enzyme component of Sanger sequencing?**  
 a) Helicase    b) Polymerase    c) Nuclease    d) Gyrase



**15. If two successive PCR are carried out, it is called as -----**

- a) Touch-down PCR      b) Hot-start PCR      c) Combined PCR      d) Nested PCR

**16. Polymerase used for PCR is extracted from -----**

- a) *Escherichia coli*      b) *Homo sapiens*      c) *Thermus aquaticus*      d) *Saccharomyces cerevisiae*

**17. Which of the following is the genetically engineered insulin?**

- a) Humulin      b) Rumulin      c) H-insulin      d) R-insulin

**18. The subunit vaccine for hepatitis B is created against ----**

- a) Surface protein      b) Core protein      c) Genome      d) Whole virus

**19. Which of the following bacterium is called superbug that clean up the spil?**

- a) *Bacillus subtilis*      b) *Pseudomonas putida*      c) *Pseudomonas denitrificans*      d) *Bacillus amyloliquifaciens*

**20. The human growth hormone for the first time wasgenetically isolated by?**

- a) Benting and best      b) Ross      c) Pasteur      d) Goeddel

**PART - B** ( $5 \times 5 = 25$  Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Describe about the DNA ligase (or)  
b) Discuss about the DNA polymerase enzyme.
22. a) Write short notes on pBR322(or)  
b) Explain about the cosmid vectors.
23. a) Write short notes on cDNA library (or)  
b) Explain about the cloning strategies.
24. a) Discuss about the RAPD (or)  
b) Give short notes on Pyrosequencing.
25. a) Write short notes on biochips (or)  
b) Discuss about the insulin production.

**PART - C** ( $3 \times 10 = 30$  Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Briefly explain about the restriction enzymes.
27. Explain about the bacteriophage vectors
28. Discuss the Construction of genomic library.
29. Give a brief account on PCR & its types
30. Explain briefly about the applications of genetic engineering.

### **PRACTICAL - V AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY**

#### **Course Objectives:**

To enable the students to

- study the soil microbial distribution, interaction and their possible utility
- learn the mass production of *Azolla* and Mycorrhizae
- be familiar with nitrogen fixing bacteria
- be aware of waste quality analysis
- acquire knowledge on isolation of microbes from soil samples

#### **Course Outcome:**

<b>CO1</b>	The students understanding the isolation of microbes from rhizosphere soil
<b>CO2</b>	To be aware of environmental microbiology
<b>CO3</b>	To enhance the knowledge about agricultural microbiology
<b>CO4</b>	To get knowledge on water quality analysis
<b>CO5</b>	To achieve knowledge about agricultural and environmental microbiology

1. Isolation of bacteria, fungi and *Actinobacteria* from rhizosphere soil
2. Isolation of *Rhizobium* sp from root nodule
3. Isolation and culturing of *Azotobacter* sp
4. Isolation and culturing of *Azospirillum* sp
5. Isolation of Cyanobacteria from paddy field
6. Isolation of phosphate solubilizing bacteria from soil
7. AM Staining
8. *Azolla* sp cultivation (Demonstration)
9. Isolation of cellulose degrading bacteria from compost
10. Water Quality Analysis: BOD, COD
11. Water analysis by MPN technique
12. Water analysis by Membrane filter technique
13. Microbial assessment of air quality using air sampler

#### **Reference Books**

1. Aneja, K.R., “**Experiments in Microbiology and Plant Pathology**”, New Age Publications, New Delhi, 2003.
2. Benson, J.H., “**Microbiological Applications: A Laboratory Manual in General Microbiology**”, Eighth Edition, McGraw-Hill, New York, 2001.
3. Cappuccino, J.G. and Sherman, N., “**Microbiology - A Laboratory Manual**”, Eleventh Edition, Benjamin and Cummings Publications, San Francisco, 2017.
4. Dubay, R.C. and Maheswari, D.K., “**Practical Microbiology**”, New Age Publications, New Delhi, 2002.
5. Kannan, N., “**Laboratory Manual in General Microbiology**”, Fourth Edition, Palani Paramount

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

## **PRACTICAL - VI MEDICAL VIROLOGY, PARASITOLOGY AND GENETIC ENGINEERING**

### **Course Objectives:**

- To gain knowledge about medical microbiology
- To be aware of the cultivation of viruses
- To gain knowledge about the serological test
- To identification of parasites
- To gain knowledge about isolation of plasmid DNA from bacteria

### **Course Outcome:**

<b>CO1</b>	The students understanding the medical microbiology especially for virology
<b>CO2</b>	To be aware of genetic engineering techniques
<b>CO3</b>	To gain knowledge about cultivation of virus
<b>CO4</b>	The student gain more knowledge about parasites
<b>CO5</b>	To be aware of serological test

### **1. Cultivation of viruses**

- Egg inoculation methods (all routes)
- Animal tissue culture (demonstration)

### **2. Serological tests: Serodiagnosis of various viral diseases.**

- ELISA – HBV and HIV.
- Complement fixation test.
- Haemagglutination and Haemagglutination Inhibition Test.

### **3. Identification of parasites:**

- Sedimentation & Flotation techniques
- Saline, KOH and Iodine wet mount

**4.** Isolation of genomic DNA from bacterial cells and quantification by UV spectrophotometer

**5.** Isolation of plasmid DNA from bacterial cells and separation by agarose gel electrophoresis.

**6.** Melting point determination of bacterial DNA.

**7.** Single and Double Restriction enzyme digestion of plasmid DNA.

**8.** Determination of Molecular weight of proteins by SDS PAGE.

**9.** Bacterial transformation and blue white selection assay.

## Reference Manuals

1. Dubey RC and Maheshwari DK (2012). **Practical Microbiology**. 3rd Edition. S. Chand & Company Ltd., New Delhi.
2. Aneja KR (2010). **Experiments in Microbiology, Plant pathology and Biotechnology**. 4<sup>th</sup> Edition, New age International publishers, Chennai.
3. Chaitanya KV (2013). **Cell and Molecular Biology: A Lab Manual**. Prentice Hall India Learning Pvt Ltd.
4. Vennison SJ (2010). **Laboratory Manual for Genetic Engineering**. 1<sup>st</sup> Edition, Prentice Hall India Learning Pvt Ltd.
5. Palanivelu P (2009). **Analytical Biochemistry and Separation Techniques**. 4<sup>th</sup> Edition. Twenty First Century Publications.

## Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

## **GENOMICS AND PROTEOMICS**

### **Course Objectives**

To enable the students to

- i) be familiar with the concepts of genomics
- ii) learn the techniques of genome sequencing
- iii) acquire knowledge on proteomic methods
- iv) understand the principle of mass spectrometry
- v) be familiar with the applications of genomics and proteomics

### **Course Outcome:**

<b>CO1</b>	The students could know the basic concepts of genomics and proteomics
<b>CO2</b>	To gain the knowledge about molecular identification techniques
<b>CO3</b>	To obtain knowledge on proteomics techniques
<b>CO4</b>	To understand the working principle of mass spectrometry
<b>CO5</b>	To be proverbial with genomics and proteomics and its application

### **UNIT – I Genomics**

**No. of Hours: 12**

Basic concepts and scope of genomics. Genome, Genomics and Omics. Genome diversity: taxonomy and significance of genomes – bacteria, yeast, *Homo sapiens*, etc.

### **UNIT – II Genome sequencing**

**No. of Hours: 12**

Hierarchical sequencing and whole genome shotgun sequencing. Genome annotation. Expressional analysis: Parallel analysis of gene expression- cDNA microarray, Long oligonucleotide microarray, Short oligonucleotide microarray and SAGE.

### **UNIT – III Proteomics**

**No. of Hours: 12**

Introduction and scope of proteomics. Types of proteomics. Techniques involved proteomics study- Protein separation: Single dimensional and two dimensional gel electrophoresis - Detection of protein spots in gel: Organic dye staining, silver staining and fluorescent staining and image analysis.

### **UNIT – IV Proteomic tools**

**No. of Hours: 12**

Gel spot visualization and picking. Tryptic digestion of protein and peptide fingerprinting. Mass spectrometry: Ion source (MALDI) - analyzer (ToF) and detector. Genetic mapping- DNA markers - RFLPs, SSLPs and SNPs

### **UNIT – V Application of genomics and Proteomics**

**No. of Hours: 12**

Embryogenomics - Cancer genomics –Pharmacogenomics - Metabolomics. Personalised medicine. Computational approaches to Phenomics. Phylogenomics. Applications of proteome analysis: Protein-

protein interaction (Two hybrid interaction screening) - Protein engineering - Protein chips and functional proteomics.

### Reference Books

1. Brown, T.A., “**Gene cloning and DNA analysis: An Introduction**” Sixth Edition, Wiley-Blackwell Publishing Ltd., London, 2010.
2. Gibson, G. and Muse, S.V., “**A primer of Genome Science**”, Second Edition, Sinauer Associates Inc., Massachusetts, 2004.
3. Hoffman, E.D. and Stroobant, V., “**Mass Spectrometry-Principles and applications**”, Third Edition, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, 2007.
4. Liebler, D.C. and Yates, J.R., “**Introduction to Proteomics-Tools for the New Biology**”, Humana Press, Totowa, 2002.
5. Mishra, N.C., “**Introduction to Proteomics: Principles and Applications**”, First Edition, John Wiley & Sons, Inc. New Jersey, 2011.
6. Primrose, S.B. and Twyman, R.M., “**Principle of Gene Manipulation and Genomics**”, Seventh Edition, Black Well Publishing Company, Oxford. 2012.
7. Rehm, H., “**Protein Biochemistry and Proteomics**”, First Edition, Elsevier Academic Press., Burlington, 2006.
8. Starkey, M. and Elaswarapu, R., “**Genomics: Essential Methods**” John Wiley & Sons, Ltd. West Sussex. 2011.
9. Veenstra, T.D. and Yates, J.R., “**Proteomics for biological Discovery**”, First Edition, A John Wiley & Sons, Inc. New Jersey, 2006.
10. Westermeier, R. and Naven, T., “**Proteomics in Practice: A laboratory Manual of Proteome Analysis**”. Wiley-VCH, Darmstadt, 2002.

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

18P3AMBE05

**(For the candidates admitted from 2018 - 19 onwards)**  
**M.Sc., DEGREE EXAMINATIONS**  
----- / ----- **2018.**  
**Third Semester**  
**Applied Microbiology**

**GENOMICS AND PROTEOMICS**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. The effects of protein on an entire organism is described in -----  
a) Phenotypic function    b) Cellular function    c) Molecular function    d) Structural genomics
2. Sequencing of genomic DNA is included in -----  
a) Phenotypic function    b) Cellular function    c) Molecular function    d) Structural genomics
3. Genes of same species, similarly related to each other are -----  
a) Ortholog                b) Synteny                c) Paralog                d) Microarray
4. The precise biochemical activity of a protein is described in  
a) Phenotypic function    b) Cellular function    c) Molecular function    d) Structural genomics
5. International Human Genome project was initiated by  
a) National Institute of Health (NIH)                                b) Celera genomics  
c) US Department of Energy (DoE)                                d) NOH and US DoE
6. Genomics introduced  
a) Thomas Roder                b) craig venter                c) Thomas cech                d) None of these
7. One of the following is not a gene expression database?  
a) fly view                b) GenBank                c) Body map                d) None of these
8. Which DNA is restricted to making a genomic library?  
a) Genomic                b) Plasmid                c) Phage                d) Plant
9. Gene mapping provides useful information about chance of -----  
a) inheritance of disorders                b) inheritance of genes  
c) inheritance of recessive gene                d) inheritance of dominant gene
10. Methods used to identify locus of gene and distances between genes are called as -----  
a) gene localization                b) gene linkage                c) gene pooled                d) gene mapping
11. How many potential open reading frames are present in a DNA sequence?  
a) One                b) Three                c) Six                d) More than Six
12. Secondary structure of RNA molecules -----  
a) depends on complementary base pairing  
b) is generated by covalent bonding between sections of the RNA molecule  
c) can be described as interactions between portions of the backbone of the molecule  
d) does not have an impact on function of the molecule
13. Structure of 'mitochondrial' DNA, considered as -----  
a) Linear                b) Double helix                c) Ladder like                d) Circular
14. Study of functions and structure of genome is called:  
a) Genetics                b) Genomics                c) Hereditary                d) Inheritance



15. Which of the following are known as helix breakers?  
 a) Proline and glycine                      b) Isoleucine and leucine                      c) Valine                      d) Threonine
16. Unfolding of a protein can be termed as -----  
 a) Renaturation                      b) Denaturation                      c) Oxidation                      d) Reduction
17. What are the following is not a factor responsible for denaturation of proteins?  
 a) pH change                      b) Organic solvents                      c) Heat                      d) Charge
18. The first protein sequenced by Frederick Sanger -----  
 a) Haemoglobin                      b) myoglobin                      c) insulin                      d) mysoin
19. Which of these amino acids are not optically active?  
 a) Cysteine                      b) Lysine                      c) Arginine                      d) Glycine
20. How is the secondary structure of a protein stabilized?  
 a) Van der wall forces                      b) Hydrogen bonding                      c) Covalent bond                      d) Hydrophobic bond

**PART - B** ( $5 \times 5 = 25$  Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Explain the prokaryotic genome (**OR**)  
 b) Write short note on genomic mapping.
22. a) Write about the genome annotation (**OR**)  
 b) Explain about the cDNA microarray.
23. a) Write a short note on application of protein arrays (**OR**)  
 b) Briefly explain the organic dye staining.
24. a) Write a short note on mass spectrometry (**OR**)  
 b) Explain in detail about ToF.
25. a) Write a short note on application of genomics and proteomics (**OR**)

**PART - C** ( $3 \times 10 = 30$  Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Write a detailed account on genome project.
27. Write an essay about parallel analysis of gene expression.
28. Explain in detail about protein separation methods.
29. Write an essay on proteomic tools.
30. Explain in detailed about embryogenomics.

## **MICROBIAL FUEL CELL TECHNOLOGY AND NANOTECHNOLOGY**

### **Course Objectives**

To enable the students to

- i. acquire the knowledge on nanotechnology
- ii. learn the methods of nanoparticle synthesis
- iii. study the applications of nanotechnology
- iv. know the microbial fuel cell technology and its types
- v. understand the mechanism of microbial fuel cell

### **Course Outcome:**

<b>CO1</b>	The students gain knowledge about nanotechnology
<b>CO2</b>	To be aware of nanotechnology and its applications
<b>CO3</b>	To obtain knowledge on microbial fuel cell technology
<b>CO4</b>	To be aware of nanoparticle characterization
<b>CO5</b>	To understating the mechanism of microbial fuel cell technology

### **UNIT – I**

Microbial fuel cell - Definition and history. Types of MFC- mediator microbial fuel cell, free microbial fuel cell, microbial electrolysis cell, soil based microbial fuel cell-designing of microbial fuel cell-materials used for construction of MFC.

### **UNIT – II**

Fuel cell reaction kinetics - electrode kinetics, over voltages, Tafel equation, charge transfer reaction, exchange currents, electro catalyses - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte. Applications- power generation, and water treatment.

### **UNIT – III**

History and scope of nanotechnology. Techniques used in nanotechnology: Bottom-up techniques - top down approaches. Methods of nanoparticle synthesis- Physical methods (ball milling and laser ablation) - chemical methods (sol-gel methods and microwave synthesis) – Biological methods (bacteria, fungi and plants).

### **UNIT – IV**

Nanoparticle characterization, UV Spectrophotometer, XRD, FTIR, EDAX, SEM, TEM and DLS. Antimicrobial activity of nanoparticles-mechanism of activity. Nanodrug delivery - liposomes, dendrimers, polymeric micelles, nanocapsules, nanotubes- advantages of nanodrug delivery.

## UNIT –V

Nanotechnology in agriculture. Nanotechnology in food industry. Nanotechnology in textiles. Environmental risks of nanoparticles. Ethical considerations in the advance of nanotechnology. IPR in nanotechnology.

### References:

1. Fuel Cell Systems Explained, J. Larminie and A. Dicks (John Wiley & Sons, 2003, USA)
2. Fuel Cell Fundamentals, R. O'Hayre, S-W. Cha, W. Colella, F. B. Prinz (John Wiley and Sons, 2005, USA)
3. Fuel Cell Engines, M. M. Mench (John Wiley and Sons, 2008, USA)
4. Fuel Cells: From Fundamental to Applications, S. Srinivasan (Springer, 2006, USA)
5. Principles of Fuel Cells, X. Li (CRC Press, 2005, USA)
6. Fuel Cells: Principles and Applications, B. Viswanathan and M. A. Scibioh (Universities Press, 2006, India)
7. PEM Fuel Cells: Theory and practice, F. Barbir (Elsevier Academic Press, 2005, USA)
8. High-Temperature Solid Oxide Fuel Cells: Fundamental, Design and Applications, S. C. Singhal, K. Kendall (Elsevier Science, 2004, USA)
9. Transport Phenomena in Fuel cells, Ed. B. Sunden and M. Faghri (WIT Press, 2005, UK)
10. Fundamentals of Electrochemistry, V. S. Bagotsky (John Wiley & Sons, 2006, USA)

### Additional Reading:

1. M.M. MENCH, Fuel Cell Engines, Wiley, 2008.
2. M.T .M. Koper (ed.), Fuel Cell Catalysis, Wiley, 2009.
3. J.O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer 1998.
4. Larminie J., Dick A., Fuel Cell Systems Explained, 2nd Ed. Wiley, 2003.

### Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)  
M.Sc., DEGREE EXAMINATIONS  
----- / ----- 2018.  
Third Semester  
Applied Microbiology

**MICROBIAL FUEL CELL AND NANOTECHNOLOGY**

**Time: Three hours**

**Maximum Marks:**

**75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. A fuel cell is used to convert chemical energy into -----  
a) Mechanical energy      b) Solar energy      c) Electrical energy      d) Potential energy
2. Select the incorrect statement from the following option.  
a) Fuel cells have high efficiency  
b) The noise levels of fuel cells are high  
c) The emission levels of fuel cells are far below the permissible limits  
d) Fuel cells are modular
3. \_\_\_\_\_ and suitable catalyst are required to promote high rate of electrode processes.  
a) Lower temperature      b) Higher temperature      c) Moderate temperature      d) Very low temperature
4. Fuel cells are free from vibrations, heat transfer and thermal pollution.  
a) True      b) False
5. A stable interface between solid \_\_\_\_\_ liquid \_\_\_\_\_ and gaseous \_\_\_\_\_ promotes high rate of electrode processes.  
a) Fuel, electrolyte, electrode      b) Electrode, fuel, electrolyte  
c) Electrode, electrolyte, fuel      d) Fuel, electrode, electrolyte
6. Which of the following is not an example of a fuel cell?  
a) Hydrogen-oxygen cell      b) Methyl-oxygen-alcohol cell  
c) Propane-oxygen cell      d) Hexanone-oxygen cell
7. The electrolytic solution used in a hydrogen-oxygen fuel cell is  
a) 75% KOH solution      b) 25% KOH solution      c) 75% NaOH solution      d) 25% NaOH solution
8. The standard emf of the hydrogen-oxygen fuel cell is  
a) 1.23 V      b) 2.54 V      c) 3.96 V      d) 0.58 V
9. The residual product discharged by the hydrogen-oxygen cell is  
a) Hydrogen peroxide      b) Alcohol      c) Water      d) Potassium permanganate
10. Hydrogen-oxygen fuel cell can produce drinking water of potable quality.  
a) True      b) False
11. In standard hydrogen electrode, concentration of hydrogen is \_\_\_\_\_  
a) 0M      b) 0.5M      c) 1M      d) 1.5M
12. The temperature maintained in the standard hydrogen electrode is \_\_\_\_\_  
a) 22°C      b) 23°C      c) 24°C      d) 25°C

13. The emf of the standard hydrogen electrode is \_\_\_\_\_  
 a) 0V                      b) 1V                      c) 2V                      d) 3V
14. Which of the following is the correct equation?  
 a)  $E = E^{\circ} [(2.303RT)/nF] \log_{10} [H^+]$                       b)  $E = E^{\circ} + [(2.303RT)/nF] \log_{10} [H^+]$   
 c)  $E = E^{\circ} - [(2.303RT)/nF] \log_{10} [H^+]$                       d)  $E = E^{\circ} / [(2.303RT)/nF] \log_{10} [H^+]$
15. If the standard hydrogen electrode is used as the reduction electrode, then the emf is given by \_\_\_\_\_  
 a)  $E_{red} = -E^{\circ} + (5/n) \log_{10} [H^+]$                       b)  $E_{red} = -E^{\circ} - (0.0591/n) \log_{10} [H^+]$   
 c)  $E_{red} = E^{\circ} + (0.0591/n) \log_{10} [H^+]$                       d)  $E_{red} = -E^{\circ} + (0.0591/n) \log_{10} [H^+]$
16. In standard calomel electrode, for saturated KCL solution, electrode potential is \_\_\_\_\_  
 a) 0.897V                      b) 0.456V                      c) 0.3512V                      d) 0.2415V
17. For 1N KCL standard reduction potential in the calomel electrode is \_\_\_\_\_  
 a) 0.28V                      b) 0.25V                      c) 0.5V                      d) 1V
18. The calomel electrode is only used as \_\_\_\_\_  
 a) Oxidising electrode    b) Reducing electrode    c) Depends on the half cell    d) Cannot be said
19. \_\_\_\_\_ is the device used to measure the emf of the cell.  
 a) Voltmeter                      b) Potentiometer                      c) Ammeter                      d) Multimeter
20. The emf of the Weston standard cell is \_\_\_\_\_ at 20°C.  
 a) 16.7989V                      b) 5.2572V                      c) 1.0183V                      d) 0V

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Write a short note on Microbial fuel cell (Or)  
 b) Write the type Microbial fuel cell.
22. a) Application power generation and biosensor (Or)  
 b) Briefly narrate the history of Nanotechnology.
23. a) Write a short note on energy production microbes (Or)  
 b) Discuss about scope of Nanotechnology.
24. a) Explain TEM sample preparation methods (Or)  
 b) Factor affecting microbial fuel cell performance.
25. a) Explain application microbial fuel technology in power generation (Or)  
 b) Nanotechnology in Agriculture.

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Explain in detail the types of Microbial Fuel Cell.
27. Explain the catabolic pathway involved in energy production from microbes.
28. What is difference between TEM and SEM? How can one make the sample SEM for solid and liquid sample?
29. Discuss and detail Nano drug delivery.
30. Write different method of nano particle synthesis. Give a suitable example.

# SEMESTER IV

## **RESEARCH METHODOLOGY AND BIOSTATISTICS**

### **Course Objectives**

To enable the students to

- i) understand the about basics in research
- ii) understand the mechanism Advanced techniques in microbiology
- iii) acquire the knowledge about separation techniques
- iv) learn the methods of basic statistics
- v) provide them knowledge in big data analysis

### **Course Outcome:**

<b>CO1</b>	The students gain knowledge on research methodology
<b>CO2</b>	To be aware of advanced techniques in microbiology
<b>CO3</b>	The students obtain the knowledge on separation techniques
<b>CO4</b>	To enhance knowledge about biostatistics
<b>CO5</b>	To provide them knowledge on data analysis

### **UNIT - I** **15**

**No. of Hours:**

Introduction – importance - identification of research areas. Review of Literature- Research design and experimentation-Preparation of research report - Hypothecation of research. Guidelines for preparing an article -ISSN, ISBN impact factor, citation index, h-index, I-index, Google scholar, Scopus.

### **UNIT - II**

**No. of Hours: 15**

Microscopy – TEM, SEM, AFM, Electrophoresis, PCR, RAPD, RFLP and AFLP. Immuno-assays: SRID, ELISA, RIA, Western Blotting, Immunofluorescens and their application. Histochemical studies. Thesis writing

### **UNIT- III**

**No. of Hours: 15**

Analytical Techniques-Centrifugation. Chromatography techniques - Column, Gas and High Pressure Liquid Chromatography, Spectrophotometer techniques - NMR, Atomic Adsorption and Mass Spectroscopy. GM counter and Scintillation Counter and X-ray diffraction. Fluorimetry. Radio isotope techniques.

**UNIT- IV****No. of Hours:****15**

Basic definitions and applications. Measures of central tendency: Mean, Median, Mode. Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation.

**UNIT - V****No. of Hours: 15**

Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Frequency distributions, Probability curve, Measures of central tendency, Variability, z-scores, Correlation-regression, ANOVA, one and two way classification. Statistical tools –SPSS, CCD with RSM. Computers in biological research-methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

**Reference Books**

1. Gurumnani, N., (2006). **Research methodology for biological sciences** (1<sup>st</sup> Edition). MJP Pubsihers. A unit of Tamilnadu Book House, Chennai.
2. Bajpai, S. (Ed.), (2006). **Biological instrumentation and methodology**. Chand & Company Ltd., New Delhi,
3. Jeffrey A. W. and L. S.Myra, (2002). **Statistics for the Life Sciences** (3<sup>rd</sup> Edition). Prentice Hall.
4. **Essentials of Immunology by Riott I.M.** 1998. ELBS, Blackwell Scientific Publishers, London.
5. Glick, B.R. and J.J.Pasternack, (1998). **Molecular Biotechnology** (2<sup>nd</sup> Edition). ASM Press, Washington, DC.
6. Webster, J.G., (2004). **Bioinstrumentation**. Student Edition. John Wiley and Sons, Ltd.
7. Glantz, S.A., (2001). **Primer of Biostatistics**. McGraw-Hill.
8. Rosner, B., (1999). **Fundamentals of Biostatistics**. Duxbury Press.
9. Motulsky, H., (1995) **Intuitive Biostatistics**. Oxford University Press.

**Web sources**

<http://www.math.yorku.ca/scs/statResource.html#> General  
<http://www.jegsworks.com/Lessons/index.html>  
<http://www.bettycjung.net/statsites.html>  
<http://www.biostat.harvard.edu/links/>  
<http://www.ped.mod.utah.edu/genpedscrr/Epibio.html>.

**Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓
CO4	✓	✓		✓
CO5	✓		✓	✓



(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**

**RESEARCH METHODOLOGY AND BIOSTATICS**

**Time: Three hours**  
**75**

**Maximum Marks:**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. The main concept behind doing research is to
  - a. study and explore knowledge
  - b. start with a predefined and clear-cut objectives
  - c. get new ideas
  - d. define clear objectives.
2. For any study should question the validity and reliability of
  - a. the sample procedure
  - b. the questionnaire
  - c. the interviewing process
  - d. all the above
3. Which of the following is used in electron microscope?
  - a. electron beams
  - b. magnetic fields
  - c. light waves
  - d. electron beams and magnetic fields
4. Which of the following is a mismatch?
  - a. Polymerase – Taq polymerase
  - b. Template – double stranded DNA
  - c. Primer – oligonucleotide
  - d. Synthesis – 5' to 3' direction
5. Polymerase used for PCR is extracted from \_\_\_\_\_
  - a. *Escherichia coli*
  - b. *Homo sapiens*
  - c. *Thermus aquaticus*
  - d. *Saccharomyces cerevisiae*
6. Polymorphism in RAPD is observed because \_\_\_\_\_
  - a. DNA used is from different chromosomes of same species
  - b. DNA used is from same chromosomes of same species
  - c. DNA used is from different chromosomes of different species
  - d. DNA used is from complementary chromosomes of same species
7. The inheritance pattern of RAPD is \_\_\_\_\_
  - A) Dominant
  - B) Recessive
  - C) Codominant
  - D) Random
8. The direct ELISA test requires
  - A) known antigen
  - B) complement
  - C) patient antibody
  - D) known antibody
9. At what speed do you centrifuge blood?
  - A) 2200-2500 RPM
  - B) 3000-3200 RPM
  - C) 1000-1500 RPM
  - D) 4000 RPM
10. Which of the following is not a type of centrifugation?
  - A) Hydro cyclone
  - B) Tubular centrifuge
  - C) Microfiltration
  - D) Disk stack
11. Which of the following is used in uranium enrichment?
  - A) Tubular centrifuge
  - B) Disk-stack centrifuge
  - C) Gas centrifuge
  - D) Zippe-type centrifuge
12. Chromatography is used to separate

- A) Solution    B) mixtures    C) molecules    D) atoms
13. Mean, Median and Mode are -----  
 A) Measures of deviation                      B) Ways of sampling  
 C) Measures of control tendency    D) None of the above
14. A common test in research demands much priority on  
 A) Reliability    B) Useability    C) Objectivity    D) All of the above
15. In the process of conducting research 'Formulation of Hypothesis' is followed by  
 A) Statement of Objectives                      B) Analysis of Data  
 C) Selection of Research Tools    D) Collection of Data
16. How is stochastic equation of information solved?  
 A) By statistical rules                              B) By dynamic rules  
 C) By statistical and dynamic rules              D) None of these
17. "Controlled Group" is a term used in..... .  
 A) Survey research    B) Historical research    C) Experimental research    D) Descriptive research
18. Which of the following is not a "Graphic representation"?  
 A) Pie Chart    B) Bar Chart    C) Table    D) Histogram
19. A set of rules that govern overall data communications system is popularly known as.....  
 A) Protocol    B) Agreement    C) Pact    D) Memorandum
20. Questionnaire is a -----  
 A) Research method                      B) Measurement technique  
 C) Tool for data collection              D) Data analysis technique

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Write a short note on identification of research areas? OR  
 b) Write a short note on histogram and pie diagram?
22. a) Write a short note on electrophoresis? OR  
 b) Write a short note on RAPD?
23. a) Write a short note on fluorimetry? OR  
 b) Write a short note on NMR?
24. a) Write a short note on Types of data? OR  
 b) Write a short note on methods of data presentation?
25. a) Write a short note on Chi square T test and F test? OR  
 b) Write a short note on Anova?

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Explain about the guidelines for preparing articles?
27. Detailed account on SEM, TEM and AFM?
28. Explain in detail about HPLC?
29. Detailed account on Mean, Median and Mode?
30. Detailed account on SPSS and RSM?

**SEMESTER – IV**  
**18P4AMBE07**  
**Credits - 4**

**ELECTIVE - IV**  
**Total Number of Hours: 60**  
**4 Hours/ Week**

## **BIOETHICS, BIOSAFETY AND IPR**

### **Course Objectives:**

The students will able to

- i) gain awareness about Intellectual Property Rights (IPRs) to protect their ideas
- ii) devise business strategies by taking account of IPRs
- iii) to assists in technology upgradation and enhancing competitiveness.
- iv) acquire adequate knowledge in the use of genetically modified organisms and its effect on human health
- v) gain more insights into the regulatory affairs.

### **Course Outcome:**

<b>CO1</b>	The students gain knowledge on Intellectual Property Rights
<b>CO2</b>	To gain awareness about biosafety
<b>CO3</b>	To be aware of Regulation of national and international guidelines of Biosafety
<b>CO4</b>	To gain knowledge on bioethics
<b>CO5</b>	To students gain knowledge about bioethics and biosafety

### **Unit – I: Biosafety**

Biosafety – Introduction. Different levels of biosafety. Guidelines for Recombinant DNA Research Activities in Microorganisms. Good Laboratory Practices (GLP). Containments – Types. Basic Laboratory and Maximum Containment microbiology Laboratory research.

### **Unit – II: Bioethics**

Bioethics - Definition – Principles of Bio ethics – General Issues Related to Environmental release of Genetically Modified Microorganisms. Ethical Issues Related to the use of Animal as Models for Microbial Diseases - Animal ethics Norms in India - Licensing of Animal House - Ethical Clearance Norms for Conducting Studies on Human Subjects. Ethical Issues Related to Research in Embryonic Stem Cell Cloning.

### **Unit – III: IPR - Types and Functions**

Introduction to Intellectual Property - IPR - Definition - Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, IP as a factor in R&D; IPs of relevance to Microbiology / Biotechnology and few Case Studies WTO - Definition - Functions - Forms of IPR Protection.

### **Unit – IV: Agreements and treaties**

Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & Recent Amendments.

### **Unit – V: Types and Applications of Patents**

Basics of Patents and Concept of Prior Art IPR & edits. Introduction to Patents; Types of Patent Applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and Complete; Process of Patenting, Indian and International Agencies Involved in IPR & Patenting, Global Scenario of Patents and India's Position, Patenting of biological material, GLP, GMP.

#### Text books

1. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)
2. Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
3. Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)

#### Reference Books

1. Narayan, P., Patent Law, Eastern Law House (1975).
2. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
3. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

#### Books Recommended:

1. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN-1555811804, 9781555811808.
2. Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
3. Law and Strategy of biotechnological patents by Sibley. Butterworth publication. (2007) ISBN: 075069440, 9780750694445.
4. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
5. Intellectual Property Right- Wattal- Oxford Publication House. (1997) ISBN: 0195905024.
6. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
7. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
8. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
9. B.D. Singh. Biotechnology expanding horizons.
10. H.K. Das. Text book of biotechnology 3rd edition.

### **Mapping**

<b>CO/PSO</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>
<b>CO1</b>	✓	✓	✓	✓
<b>CO2</b>		✓	✓	✓
<b>CO3</b>	✓		✓	✓
<b>CO4</b>	✓	✓		✓
<b>CO5</b>	✓		✓	✓

(For the candidates admitted from 2018 - 19 onwards)

**M.Sc., DEGREE EXAMINATIONS**

----- / ----- 2018.

**Fourth Semester**

**Applied Microbiology**

**BIOETHICS, BIOSAFETY AND IPR**

**Time: Three hours**

**Maximum Marks:**

**75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. What agency provides guidance on laboratory design for increasing Biosafety levels?
  - a. IATA – Dangerous Goods Regulations
  - b. DOT – 49CFR
  - c. CDC/NIH – BMBL
  - d. WHO
2. What agency regulates the transport of all hazardous materials within the United States?
  - a. IATA
  - b. DOT
  - c. CDC
  - d. NIH
3. The JSC Biosafety Review Board (BRB) reviews ground-based research, payloads, and flight operations for Biosafety concerns.
  - a. True
  - b. False
4. How often does the JSC biosafety inspection of laboratories occur?
  - a. 3 months
  - b. 6 months
  - c. Once a year
  - d. Every 2 years
5. Genetically modified materials – recombinant DNA must be approved for use by the BRB using which form?
  - a. JSC 713
  - b. JSC 1161
  - c. JSC 644
  - b. Approval is not required
6. Risk of exposure can vary with the amount of infectious material used, therefore, CDC/NIH BMBL
  - a. Recommends different procedures be used based on amounts/manipulation being performed
  - b. Recommends that you always use the highest Biosafety level
  - c. Recommends you contact the WHO for further information
  - d. None of the above
7. It is recommended by the CDC/NIH that Biosafety Level 2 laboratories have -
  - a. Physical Containment equipment (Biosafety Cabinet)
  - b. Limited access, unidirectional airflow, and physical containment equipment (Biosafety cabinet)
  - c. A and B, plus respiratory protection
  - d. None of these are recommended for BSL-2
8. When should you wash your hands?
  - a. After removing gloves
  - b. After a spill
  - c. Before leaving the laboratory
  - d. All of the above
9. To aid in Biosecurity, an inventory of all microorganisms in-use at JSC is maintained by the BRB.
  - a. True
  - b. False
10. Eye protection should always be worn when there is a chance for aerosol production?
  - a. True
  - b. False
11. Biosafety cabinets are among the most effective and most commonly used \_\_\_\_\_ containment devices when working with infectious agents
  - a. Primary
  - b. Secondary
  - c. Tertiary
  - d. Quaternary
12. The HEPA filters in a BSC filter particulates to size \_\_\_\_\_ and are \_\_\_\_\_ efficient.

- a. 0.01 $\mu$ m, 85%      b. 0.3 $\mu$ m, 99.97%      c. 0.1 $\mu$ m, 95.9%      d. 3.0 $\mu$ m, 90%
13. What % of air is re-circulated in a Class II B1 Biosafety Cabinet?  
a. 70      b. 30      c. 100      d. 50
14. When working in a Biosafety cabinet, what area of the cabinet should samples be placed in for the best protection?  
a. Back      b. Middle      c. Front      d. Sides
15. A clean bench protects the samples only, not the laboratory worker.  
a. True      b. False
16. If it is not moved or repaired, how often are BSC re-certified in JSC labs?  
a. 3 months      b. 6 months      c. Every year      d. Every 2 years
17. Gloves, broken glass and absorbent materials from a spill should be placed in the appropriate biomedical waste container.  
a. True      b. False
18. Biohazard waste containers should be open \_\_\_\_\_.  
a. At all times      b. Only when actively adding waste to them  
c. When they are placed outside for storage      d. None of these
19. Close-calls, mishaps and illnesses with fever should all be reported to your supervisor when working with Blood borne pathogens and infectious agents.  
a. True      b. False
20. Biosafety training at JSC is required every two years.  
a. True      b. False

**PART - B** (5 × 5 = 25 Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a. Write short notes on safety, responsibility and rights (OR)  
b. Social and ethical issue in Biotechnology.
22. a. Write short notes on WTO (or)  
b. Write to safety procedure in laboratory.
23. a. Explain the farmer rights (or)  
b. Write short notes on Intellectual property rights
24. a. Write detailed note on Copyrights and its scope (OR)  
b. Write a short note on Geographical indications and their objectives
25. a. Write a short note on Non -patentable inventions in India (OR)  
b. Scope for protection of new plant varieties in India.

**PART - C** (3 × 10 = 30 Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Why biosafety is an important issue in transgenic research? Explain various biosafety guidelines at national level for research involving DNA molecules.
27. Write detailed note on following: a. Ethical issues in biotechnology research.  
b. Socioeconomic impact of biotechnology products.
28. What do you mean by IPRs? Describe different types of IPRs available under various legislations in India for protection of intellectual property.
29. Define term 'patent'. Describe the criteria for grant of patents related to biotechnology inventions in India.
30. Write a detailed note on minimum standards laid down under TRIPs agreement for different types of IP Protection.

## **ENTREPRENEURSHIP IN MICROBIOLOGY**

### **Course Objectives**

To enable the students to

- i) understand the fundamental concepts of entrepreneurship
- ii) comprehend the procedure in starting an entrepreneurial career
- iii) keep abreast of the institutional support in the field of entrepreneurship
- iv) know the role of microbes in environmental management
- v) learn the applications of microbiology

### **Course Outcome:**

<b>CO1</b>	The students enhanced self well group for entrepreneurship
<b>CO2</b>	To gain knowledge about microbiology and its applications
<b>CO3</b>	To be aware of Institutions and schemes of Government of India
<b>CO4</b>	To obtain knowledge about Skills for entrepreneur
<b>CO5</b>	To obtain knowledge on Composting of domestic, agricultural and industrial wastes

### **UNIT - I Introduction to Entrepreneurship**

**No. of Hours: 12**

Entrepreneurship: evolution concepts of entrepreneur – entrepreneurship: Definitions-Meaning-characteristics- types of entrepreneurs- qualities- functions of an entrepreneur. Development – need – role of source, talent and spirit – Process of entrepreneurship to socio-economic gains. Starting a business: Forms of ownership - Product selection - licensing procedures.

### **UNIT – II Project Generation**

**No. of Hours: 12**

Project analysis: Idea generation – sources of idea generation – Trade fairs and Exhibitions- Project identification and selection – classification – project formulation – project appraisal - feasibility analysis- market, production, technical and social.

### **UNIT – III Financial Assistance**

**No. of Hours: 12**

Institutions and schemes of Government of India. Schemes and Programmes, Department of Science and Technology schemes, nationalized banks- other financial institutions - support for entrepreneurs: APEDA, DIC, TIIC, SISI, NABARD and commercial banks. Entrepreneurial development programmes.

### **UNIT – IV Entrepreneurial skills**

**No. of Hours: 12**



Skills for entrepreneur – communication skills, problem solving skills; Business plan development; Market need – Market research, SWOT analysis, identifying competitors. Financial plan – Financial support for business, business insurance, Marketing – mix-product, distribution, price, promotion and market goal setting.

### UNIT – V **Biology in Entrepreneurship**

**No. of Hours: 12**

Composting of domestic, agricultural and industrial wastes. Vermicomposting, Spirulina and mushroom cultivation (brief account only). Production of teaching kits (plasmid DNA isolation, electrophoresis) and diagnostic kits (Widal test kit and ABO blood grouping kit). Designing and execution of clinical laboratory, quality control lab and research laboratory.

#### **Text Book**

1. Study material prepared by the Department of Microbiology.

#### **Reference Books**

1. Bhatia, B.S. and G.S. Batra, 2003, “**Entrepreneurship and small business management**”, Deep and Deep Publications, New Delhi.
2. Desai, V., 2001, “**Dynamics of Entrepreneurial Development and Management**”, Fourth Edition, Himalaya Publishing House Mumbai.
3. Gordon, E. and K. Natarajan, 2009, “**Entrepreneur Development**”, Third Edition, Himalaya Publishing House, Mumbai.
4. Gupta, C.B. and N.P. Srinivasan, 2003, “**Entrepreneurial Development**”, Reprint, Sultan Chand and Sons, New Delhi.
5. Hisrich, D.R., 2008, “**Entrepreneurship**”, Sixth Edition, Tata McGraw Hill Private Limited, New Delhi.
6. Mohanty, S.K., 2005, “**Fundamentals of Entrepreneurship**”, Sixth Edition, Prentice Hall India Private Limited, New Delhi.
7. Nagendra, S., 2008, “**Entrepreneurship and Management**”, Sanguine technical Publishers, New Delhi.
8. Naidu, V.V.R., 2008, “**Management and Entrepreneurship**”, I.K. International Pvt. Ltd, New Delhi.
9. Saxena, S., 2015, “**Applied Microbiology**”, Springer, New York.

#### **Web Sources**

1. [www.ucc.ie/en/ProspectiveStudents/Admissions/programmes/DocumentFile\\_en.pdf](http://www.ucc.ie/en/ProspectiveStudents/Admissions/programmes/DocumentFile_en.pdf), 41238, en.pdf
2. [www.orgs.tigweb.org/33065](http://www.orgs.tigweb.org/33065)
3. [www.womensjoblist.com/resumes/18143-Microbiologist.html](http://www.womensjoblist.com/resumes/18143-Microbiologist.html)
4. [www.entretchforum.org/mm\\_May19\\_2009.htm](http://www.entretchforum.org/mm_May19_2009.htm)
5. [www.linkedin.com/pub/dir/george/hlass](http://www.linkedin.com/pub/dir/george/hlass).

#### **Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	✓	✓	✓	✓
CO2		✓	✓	✓
CO3	✓		✓	✓

CO4	✓	✓		✓
CO5	✓		✓	✓

18P4AMBE08

(For the candidates admitted from 2018 - 19 onwards)  
**M.Sc., DEGREE EXAMINATIONS**  
 ----- / ----- 2018.  
**First Semester**  
**Applied Microbiology**  
**ENTREPRENEURSHIP IN MICROBIOLOGY**

**Time: Three hours**

**Maximum Marks:**

**75**

**PART - A** (20 × 1 = 20 Marks)

Answer **ALL** the Questions

All questions carry equal marks

1. Why should an entrepreneur do a feasibility study for starting a new venture?
  - a) To identify possible sources of funds
  - b) To see if there are possible barriers to success
  - c) To estimate the expected sales
  - d) To explore potential customers
2. A women entrepreneur is supposed to have a minimum financial interest in share capital of entrepreneur's enterprise
  - a) 35 per cent
  - b) 51 per cent
  - c) 25 per cent
  - d) None of the above
3. The ways entrepreneurial makes decision
  - a) Entrepreneurial domain
  - b) Reverse brain storming
  - c) Heuristics
  - d) None of the two mentioned
4. International entrepreneurship is
  - a) Licensing
  - b) Exporting
  - c) Both A and B
  - d) None of the two mentioned
5. Members of distribution channels are excellent sources for new ideas because
  - a) They are familiar with the needs of the market
  - b) They earn a handsome profit from new business
  - c) They do not bother if entrepreneur bears a loss
  - d) They have well-developed sales force
6. Sales promotions are thought to make consumer purchase decisions
  - a) More satisfying
  - b) Simpler
  - c) Less satisfying
  - d) More complex
7. The main reason why organizations use exhibitions is to
  - a) Create publicity opportunities
  - b) Have a competitive presence
  - c) Make sales
  - d) Develop relationships
8. How many feasibility studies are conducted in requirement analysis?
  - a) Two
  - b) Three
  - c) Four
  - d) None of the mentioned
9. Small Industry Development Organization (SIDO) was established in the year of
  - a) 1954
  - b) 1967
  - c) 1964
  - d) 1974
10. Which one of the following Central Government Policy is to provide handholding support and assistance to the potential first generation entrepreneurs?
  - a) Rajiv Gandhi Udyami Mitra Yojana (RGUMY)
  - b) Micro and Small Enterprises- Cluster Development Programme (MSE-CDP)
  - c) Assistance to States for Developing Export Infrastructure and Other Allied Activities (ASIDE)
  - d) Scheme for Technology Upgradation Fund
11. Which one of the following is signed MOU with the Ministry of Micro, Small and Medium Enterprises (MSME) in India for operating a programme to encourage and assist women entrepreneurs
  - a) The Oriental Bank of Commerce
  - b) Dena Bank

c) Punjab and Sind Bank of India

d) Saraswat Cooperative Bank

12. Which one of the following scheme is provided by AXIS bank

a) Priyadarshini Yojana b) Mahila Vikas Nidhi Scheme c) Smart Privilege d) Udyagini Scheme

13. Which of the following SWOT elements are internal factors for a business?

a) Strengths and Weaknesses b) Opportunities and Threats

c) Strengths and Opportunities d) Weaknesses and Threats

14. Mesophiles are group of bacteria that grow within the temperature range of

a) 0-20 degree Celsius b) 25-40 degree Celsius

c) 45-60 degree Celsius d) more than 60 degree Celsius

15. What is the optimum pH for the growth of most of the microbes in composting pile

a) 5-9 b) 6.5-7.5 c) 2-3.5 d) 9-9.5

16. Vermicompost is biofertilizer which is rich in

(a) Phosphorus (b) Calcium (c) Nitrogen (d) All of the above

17. The colour of the body in earthworm is brown due to the presence of

a) blood b) haemoglobin c) haemocyanine d) prophyrin

18. Which one of the following C:N ratio is leads to under utilization of N and the excess may be released into atmosphere as ammonia

a) Greater than 40:1 b) Less than 20:1 c) 20:20 d) None of the above

19. Isolation of genomic DNA follows the same principles as that of obtaining plasmid from E. coli. Which of the following is not included in it?

a) Cell lysis b) Removal of proteins

c) Removal of chromosomal DNA d) Dissolving plasmid in water

20. Cell lysis is carried out by which substance?

a) Lysozyme and detergents b) Water c) Sugar solution d) Suphuric Acid

**PART - B** ( $5 \times 5 = 25$  Marks)

Answer **ALL** the Questions

All questions carry equal marks

21. a) Write about type of entrepreneur (OR)

b) Write short notes on characteristics of entrepreneurship.

22. a) Elaborate on methods of project identification and selection (OR)

b) Give a brief account on project formulation.

23. a) Explain the Government initiatives (OR)

b) Detail about the nationalized banks

24. a) Write about Skills of entrepreneur (OR)

b) Explain about marketing methods

25. a) How can you assess the quality of clinical laboratory? (OR)

b) Write a short note on Spirulina cultivation.

**PART - C** ( $3 \times 10 = 30$  Marks)

Answer **ANY THREE** the Questions

All questions carry equal marks

26. Explain the role of entrepreneurship in economic development

27. Give a detailed note on feasibility analysis.

28. Write in detail the government initiatives to support bioentrepreneurs.

29. Write in detail the negotiation skills and SWOT analysis.

30. Give a detailed account on Plasmid DNA isolation and Widal test kit production.

**SEMESTER – IV**  
**18P4AMBED01**  
**Credits - 2**

**Extra Disciplinary Course – I**  
**Total Number of Hours: 30**  
**2 Hours/ Week**

## **MEDICAL LABORATORY TECHNIQUES**

### **OBJECTIVES**

To enable the students to

- i. understand the fundamental concepts of laboratory
- ii. comprehend the procedure inoculation and preservation methods
- iii. To study the blood composition and grouping
- iv. To gain knowledge on clinical specimens
- v. learn the antibody - antigen reactions

### **UNIT - I**

**No. of Hours: 6**

Basic lab principles and procedures in lab accidents - lab safety rules and regulations - Preparation of glasswares - Sterilization - principles and methods - quality control in sterilization

### **UNIT - II**

**No. of Hours: 6**

Inoculation methods and preservation of cultures - Staining techniques and methods - lab methods of diagnosing fungal infections - microscopy- KOH and LCB mount.

### **UNIT - III**

**No. of Hours: 6**

Introduction - Blood composition and component preparation - Anticoagulant - complete blood count - ABO & Rh blood group system - Blood grouping - Rh type compatibility - Transfusion reaction.

### **UNIT - IV**

**No. of Hours: 6**

Clinical specimens - Urine, Blood, faeces, CSF - Concentration techniques in stool - examination of blood and malaria - identification of bacteria by biochemical test.

### **UNIT - V**

**No. of Hours: 6**

Antigen-Antibody reactions - diagnosis of infectious diseases- precipitation, agglutination, immunofluorescence - Immunoelectrophoresis - RIA, ELISA, HAT - Immunoblotting technique - Western blot.

### **TEXT BOOKS**

1. Mukerjee KL and Ghosh S (2010). **Medical Laboratory Technology: Procedure Manual for Routine Diagnostic Tests**. Volume 1. 2<sup>nd</sup> Edition. Tata McGraw Hill Education Pvt Ltd., New Delhi.

2. Chakraborty P (2015). **A Text Book of Microbiology**. 2<sup>nd</sup> Edition, Published by New Central Book Agency (P) Ltd., Kolkata.
3. Sood R (2006). **Textbook of Medical Laboratory Technology**, Jaypee Brothers Publishers, New Delhi.
4. Dubey RC and Maheswari DK (2013). **A Text Book of Microbiology**, 3<sup>rd</sup> Edition. S. Chand Publishing, New Delhi.

#### **REFERENCE BOOKS**

1. Arti Kapil (2013). **Ananthanarayan and Paniker's Text Book of Microbiology**, 9<sup>th</sup> Edition, Orient Blackswan Private Limited.
2. Godkar PB and Godkar DP (2008). **Text Book of Medical Laboratory Technology**, 2<sup>nd</sup> Edition, Bhalani Publishing House, New Delhi.
3. Cheesbrough M (2006). **District Laboratory Practice in Tropical Countries**, Part 1 & 2. 2<sup>nd</sup> Edition, Cambridge University Press, Cambridge.
4. Bhatia Rand Ichhpujani RL (2004). **Essentials of Medical Microbiology**. 3<sup>rd</sup> Edition, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.