

**GANDHI INSTITUTE OF SCIENCE  
(GITAM)**

**(Deemed to be University, Estd. u/s 3 of UGC Act 1956)**

**VISAKHAPATNAM \*HYDERABAD \*BENGALURU**

**Accredited by NAAC with 'A' Grade**



**REGULATIONS & SYLLABUS  
of  
Master of Science  
in  
(Microbiology)  
(W.e.f 2015-16 admitted batch)**

**Website: [www.gitam.edu](http://www.gitam.edu)**

# **M.Sc. (Microbiology)**

## **REGULATIONS**

**(w.e.f. 2015-16 admitted batch)**

### **1. ADMISSION**

1.1 Admission into M.Sc. in Microbiology program of GITAM University is governed by GITAM University admission regulations.

### **2. ELIGIBILITY CRITERIA**

2.1. A pass in B.Sc. with any two of the following subjects: Microbiology, Biochemistry, Biotechnology, Bioinformatics, Chemistry, Medical Lab. Technology, Genetics, Home science, Food and Nutrition, Zoology, Botany, Agriculture, Aqua Culture, Veterinary Sciences, Environmental Science and Mathematics, with a minimum aggregate of 50% marks or II<sup>nd</sup> division in degree or any other equivalent examination approved by GITAM University.

2.2. Admission into M.Sc. (Microbiology) will be based on an all India GITAM Science Admission Test (GSAT) conducted by GITAM University and the rule of reservation, wherever applicable.

### **3. CHOICE BASED CREDIT SYSTEM**

Choice Based Credit System (CBCS) is introduced with effect from the admitted batch of 2015-16 based on UGC guidelines in order to promote:

- Student centered learning
- Cafeteria approach
- Inter-disciplinary learning

Learning goals/ objectives and outcomes are specified leading to what a student should be able to do at the end of the program.

### **4. STRUCTURE OF THE PROGRAM**

4.1 The program consists of

- i) Foundation Course (compulsory) which gives general exposure to a student in communication and subject related area.

- ii) Core Courses (compulsory)
- iii) Discipline centric electives which
  - a) are supportive to the discipline
  - b) expand scope of the subject
  - c) provide inter disciplinary exposure
  - d) nurture the analytical skills
- iv) Open electives are of general nature either related or unrelated to the discipline.
- v) Practical Proficiency Courses: laboratory and project work

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each lecture / tutorial hour per week.
- One credit for two hours of practicals per week.
- Two credits for three (or more) hours of practicals per week
- Three credits for nine hours of practicals
- Eight credits for project

4.4 The curriculum of the M.Sc. program is designed to have a total of 95 credits for the award of M.Sc. degree.

## 5. **MEDIUM OF INSTRUCTION**

The medium of instruction (including examinations and project reports) shall be English.

## 6. **REGISTRATION**

Every student has to register himself/herself for each semester individually at the time specified by the Institute / University.

## **7. ATTENDANCE REQUIREMENTS**

7.1 A student is required to have a minimum of 75% attendance in all the courses put together in any semester, failing which he/she will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

7.2 However, the Vice Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine grounds and on payment of prescribed fee.

## **8. EVALUATION**

8.1. The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks).

8.2. A student has to secure an aggregate of 40% in the course in the two components put together, to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3. Practical/ Viva voce/ Seminar etc. are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

**Table 1: Assessment Procedure**

S. No.	Component Of Assessment	Marks Allotted	Type of Assessment	Scheme of Examination
1	Theory	40	Continuous evaluation	(i) Two mid semester examinations shall be conducted for 15 marks each. (ii) 5 marks are allocated for quiz. (iii) 5marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination Shall be for a maximum of 60 marks.
	Total	100		
2	Practical	40	Continuous evaluation	Forty (40) marks for continuous evaluation is distributed among the components: regularity, preparation for the practical, performance, submission of records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the Semester.
		60	Continuous evaluation	Sixty (60) marks for two tests of 30 marks each (one at the mid-term and the other towards the end of the Semester) conducted by the concerned lab teacher and another faculty member of the department who is not connected to the lab, as appointed by the HoD.
	Total	100		
3	Project work (IV semester)	200	Project evaluation	(i) 150 marks for evaluation of the project work dissertation submitted by the candidate. (ii) 50 marks are allocated for the project Viva-Voce. (iii) The project work evaluation and the Viva-Voce shall be conducted by one external examiner outside the University and the internal project work supervisor.

**9. REAPPEARANCE**

9.1 A student who has secured 'F' grade in a Theory course shall have to reappear at the subsequent semester end examinations held for that course.

9.1.1 A student who has secured 'F' grade in a Practical course shall have to attend Special Instruction Classes held during summer vacation.

9.1.2 A student who has secured ‘F’ Grade in Project work shall have to improve his/her report and reappear for Viva – voce at the time of Special Examination to be conducted in the summer vacation.

## **10. SPECIAL EXAMINATION**

A student who has completed his/her period of study and still has “F” grade in a maximum of three theory courses is eligible to appear for Special Examination normally held during summer vacation.

## **11. BETTERMENT OF GRADES**

A student who has secured only a pass or second class and desires to improve his/her class can appear for Betterment Examinations only in theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations. Betterment of Grades is permitted ‘only once’ immediately after completion of the program of study.

## **12. GRADING SYSTEM**

12.1 Based on the student performance during a given semester/trimester, a final letter grade will be awarded at the end of the trimester/semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

**Table 2: Grades & Grade Points**

S.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

12.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5 for a pass in the semester/trimester.

### 13. GRADE POINT AVERAGE

13.1 A Grade Point Average (GPA) for the semester/trimester will be calculated according to the formula:

$$\text{GPA} = \frac{\Sigma [ C \times G ]}{\Sigma C}$$

Where

C = number of credits for the course,

G = grade points obtained by the student in the course.

13.2 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, in all the semesters up to the particular point of time.

13.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

**Table 3: CGPA required for award of Class**

<b>Class</b>	<b>CGPA Required</b>
First Class with Distinction	$\geq 8.0^*$
First Class	$\geq 6.5$
Second Class	$\geq 5.5$
Pass Class	$\geq 5.0$

\* In addition to the required CGPA of 8.0 or more the student must have necessarily passed all the courses of every semester in first attempt.

### 14. ELIGIBILITY FOR AWARD OF THE M.Sc. DEGREE

14.1 Duration of the program: A student is ordinarily expected to complete M.Sc. program of four semesters in two years. However a student may complete the program in not more than four years including study period.

14.2 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

14.3 A student shall be eligible for award of the M.Sc. Degree if he / she fulfills all the following conditions.

- a) Registered and successfully completed all the courses and projects.
- b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.
- c) Has no dues to the Institute, hostels, Libraries, NCC / NSS etc, and
- d) No disciplinary action is pending against him / her.

14.4 The degree shall be awarded after approval by the Academic Council

#### **15. Discretionary Power:**

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.



**Table 4 M.Sc. Microbiology  
(Scheme of Instruction)**

S.No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction			Total	Scheme of Examination		
					Hours per week		Duration in Hrs.		Maximum Marks		
					L/T	D/P			Sem. End Exam	Con. Eval	
<b>I Semester</b>											
1	SMB701	Microbiology	F	4	4	-	4	3	60	40	
2	SMB703	Cell Biology & Genetics	C	4	4	-	4	3	60	40	
3	SMB705	Biomolecules	C	4	4	-	4	3	60	40	
4	SMB707	Analytical Techniques & Biostatistics	C	4	4	-	4	3	60	40	
5	SMB721	Practicals-I: Microbiological Methods	C	3	-	12	12	4	--	100	
6	SMB723	Practicals -II: Analytical Techniques	C	3	-	12	12	4	---	100	
7	SMB791	Viva-Voce	C	1	-	-	-	3	--	50	
		<b>Total:</b>		23	16	24	40	23	240	410	
<b>II Semester</b>											
8	SMB702	Microbial Physiology and Metabolism	C	4	4	-	4	3	60	40	
9	SMB704	Food and Agricultural Microbiology	C	4	4	-	4	3	60	40	
10	SMB706	Virology	C	4	4	-	4	3	60	40	
11	SMB708	Molecular Biology	C	4	4	-	4	3	60	40	
12	SMB722	Practicals -III Microbial Physiology	C	3	-	12	12	4	--	100	
13	SMB724	Practicals -IV Molecular Microbiology	C	3	-	12	12	4	---	100	
14	SMB792	Viva-Voce	C	1	-	-	-	3	--	50	
15		OPEN ELECTIVE	E	3	3	-	3	3	60	40	
		Total Marks for II semester		26	19	24	43	26	300	450	

III Semester										
16	SMB801	Immunology	C	4	4	-	4	3	60	40
17	SMB803	Recombinant DNA Technology	C	4	4	-	4	3	60	40
18	SMB805	Medical Microbiology	C	4	4	-	4	3	60	40
19	SMB807	Ecology and Environmental Microbiology	C	4	4	-	4	3	60	40
20	SMB821	Practicals-V : Diagnostic Microbiology	C	3	-	12	12	4	--	100
21	SMB823	Practicals -VI Immunology	C	3	-	12	12	4	---	100
22	SMB891	Viva-Voce	C	1	-	-	-	3	--	50
23		OPEN ELECTIVE	E	3	3	-	3	3	60	40
		Total Marks for III semester		26	19	24	43	26	300	450
IV Semester										
24	SMB802	Bioprocess Technology	C	4	4	-	4	3	60	40
25	SMB842	Marine Microbiology	E	4	4	-	4	3	60	40
26	SMB844	Plant Microbe Interactions	E	4	4	-	4	3	60	40
27	SMB846	Microbial Biotechnology	E	4	4	-	4	3	60	40
28	SMB848	Bioethics and IPR	E	4	4	-	4	3	60	40
29	SMB822	Practicals-VII : Fermentation Technology	C	3	-	12	12	4	-	100
30	SMB892	Project	C	8	-	-	-	3	200	-
31	SMB894	Viva-Voce	C	1	-	-	-	-	-	50
		Total Marks for IV semester		20	8	12	20	13	320	230

**Open Electives offered:**

- 1) Basic Microbiology ( SOE 756)
- 2) Management of Infectious Diseases (SOE 867)

**M.Sc. (Microbiology) I SEMESTER**  
**Foundation Course**  
**SMB701: MICROBIOLOGY**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT - I**

Development and scope of Microbiology; Microscopy- light, fluorescent, confocal, phase contrast, and electron Microscope- SEM, TEM; Bacterial classification- Importance of Bergey's manual, Haeckel's, Whittaker's, Carl Woese's classifications, numerical taxonomy, molecular classification systems, phylogenetic trees.

**UNIT - II**

Sterilization- physical, chemical and radiation methods; Concept of containment facility; concept of pure culture, single cell isolation, enrichment culture techniques, maintenance of microbial cultures, preservation methods.

**UNIT – III**

Bacterial nutrition types; Types of media; Identification methods – nutritional, cultural, biochemical, antigenic and ecological. Microscopic identification: staining methods- simple, differential, structural and special staining. Bacterial reproduction and growth. Synchronous, batch and continuous cultures. Quantitative measurement of growth, factors affecting growth. Cultivation of aerobes and anaerobes. Toxic effects of oxygen.

**UNIT – IV**

Clinical Microbiology: general characteristics, morphology and pathogenesis of Bacteria-*Staphylococcus*, *Bacillus*, *Mycobacteria*, *Salmonella*, *Vibrio*, Fungi- *Candida*. Viruses: structure, Baltimore classification, and multiplication. Clinically important viruses *HIV*, *Hepatitis*, *Influenza*. Life cycle and biology of *Plasmodium* and *Entamoeba histolytica*.

**UNIT –V**

Microbial interactions-mutualism, protocooperation, commensalism, predation, parasitism and competition. General account and economic importance of algae and fungi, SCP-*Spirulina*, *Chlorella* and Mushrooms. Microbiology of water and milk.

## **RECOMMENDED BOOKS :**

1. Microbiology (5th edition) by Pelczar, Chan and Krieg.
2. General Microbiology (5th edition) by Stanier, Deudroff and Adelberg.
3. Bergey's Manual of Systematic Bacteriology (9th edition) volumes I to VI.
4. Brock Biology of Microorganism (9th edition) by Madigan, Martinko and Parker.
5. Introduction to Microbiology (2<sup>nd</sup> edition) by Ross.
6. Textbook of Microbiology (6<sup>th</sup> edition) by Ananthanarayan and C.K.J.Panikar
7. Medical Microbiology (26<sup>th</sup> edition) by Jawetz.
8. Microbial ecology: Fundamentals and applications (4<sup>th</sup> edition) by Atlas and Bartha.
9. Introductory Mycology ( 4<sup>th</sup> edition) by C.J. Alexopolus.
10. Principles of Microbiology (2<sup>nd</sup> edition) by R.M.Atlas.
11. Introductory Phycology by (1990) H.D. Kumar.
12. An Introduction to Mycology (1990) by R.S. Mehrothra and Aneja

**M.Sc. (Microbiology) I SEMESTER**  
**SMB703: CELL BIOLOGY AND GENETICS**

Hours per week: 4

Credits: 4

End Examination: 60 Marks

Sessionals: 40 Marks

**UNIT - I**

Organellar Biology: structure, function & biogenesis of chloroplast and mitochondria. Mesosomes, lysosomes and cytoskeletal system. Photosynthesis- oxygenic and anoxygenic: organization, apparatus, electron donors & acceptors, energetics. Biological oxidation, electron transport, oxidative phosphorylation. Nutrient transport mechanisms in bacteria.

**UNIT - II**

Cell-cell interaction. Signal transduction in eukaryotes: membrane receptors, protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, Cyclic nucleotides, G proteins.

**UNIT - III**

Centromeres and telomeres. Recombination at molecular level, heteroduplex analysis. C value paradox, C<sub>0</sub>t curves. Plasmids types-Col, F and R plasmids. Ti plasmid. Hybridization in yeast, control of mating type loci in yeast. Transposable elements, types of bacterial transposons, transposable elements in yeast and *Drosophila*.

**UNIT – IV**

Mechanisms of protein translocation across membranes in prokaryotes and eukaryotes, coated vesicles. Targeting sequences, protein export in bacteria, protein sorting at the membrane, single pass and multipass transmembrane helices

**UNIT - V**

Bacterial recombination: Bacterial conjugation, Transduction – Generalized and specialized transductions, Bacterial transformation. Tetrad analysis in eukaryotic microbes – *Neurospora* and yeast. Mapping of bacterial chromosome. Benzer's studies on r-II locus of T4 bacteriophage. Complementation test.

## **RECOMMENDED BOOKS:**

1. Molecular Biology of the Cell (5<sup>th</sup> edition) by B. Alberts *et. al.*
2. Molecular Cell Biology (6<sup>th</sup> edition) by H. Lodish *et. al.*
3. Cell and Molecular Biology (8<sup>th</sup> edition) by E.D.P.DeRobertis
4. The Cell: A molecular approach (6<sup>th</sup> edition). by G.M Cooper
5. Principles of Genetics (6<sup>th</sup> edition) by D.P.Snustad.
6. Genetics (3<sup>rd</sup> edition) by M.W. Strickberger.
7. Biochemistry of Signal Transduction and Regulation (5<sup>rd</sup> edition) by Gerhard Krauss.
8. Becker World of The cell (8<sup>th</sup> edition) by Jeffhardin *et.al*

**M.Sc. (Microbiology) I SEMESTER**  
**SMB705: BIOMOLECULES**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT-I**

Properties and importance of water, intra and intermolecular forces, non-covalent interactions- electrostatic, hydrogen bonding, Vander Waals interactions, hydrophobic and hydrophilic interactions. Disulphide bridges. pH, pK, acid base reactions and buffers.

**UNIT-II**

Classification of carbohydrates, structure and properties of monosaccharides (glucose and fructose) disaccharides (sucrose and lactose), polysaccharides (starch and cellulose) and glycosaminoglycans (chondroitin sulfate and keratan sulfate).

**UNIT-III**

Classification, structure and properties of amino acids, essential and nonessential amino acids. Protein isolation and purification. Primary structure of protein- determination of amino acid composition and sequence. Secondary structure- $\alpha$ -helix,  $\beta$ -pleated sheet, collagen triple helix, Ramachandran's plot,  $\beta$ -bends and structural motifs. Tertiary and quaternary structures. Solid phase peptide synthesis.

**UNIT-IV**

Classification, structure, properties and functions of fatty acids, triglycerides, phospholipids, sphingolipids, cholesterol and eicosanoids. Structure and functions of vitamins, heme and chlorophyll.

**UNIT-V**

Structure and properties of nucleic acids. Different forms of DNA-A, B, Z. Circular DNA and DNA supercoiling. Different types of RNA- mRNA and non coding RNA – tRNA, rRNA, scRNA, snRNA and siRNA.

## **RECOMMENDED BOOKS:**

1. Lehninger Principles of Biochemistry (6<sup>th</sup> edition) by D. Nelson and Cox.
2. Biochemistry (6<sup>th</sup> edition) by L.Stryer
3. Biochemistry (4<sup>th</sup> edition) by D.Voet and J.G.Voet.
4. Biochemistry (3<sup>rd</sup> edition) by U.Satyanarayana.
5. Biochemistry (3<sup>rd</sup> edition) by Mathews *et. al.*
6. Harper's Biochemistry (28<sup>th</sup> edition) by R. K. Murray *et. al.*
7. Biochemistry (2<sup>nd</sup> edition) by D. Rawn.



**M.Sc. (Microbiology) I SEMESTER**  
**SMB707: ANALYTICAL TECHNIQUES AND BIOSTATISTICS**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT-I**

Principles and applications of chromatographic techniques: paper chromatography, thin layer chromatography, gel filtration, ion-exchange chromatography, affinity chromatography, GC, GC-MS and HPLC.

**UNIT-II**

Principles and concepts of electrophoretic techniques: native PAGE, SDS – PAGE, agarose gel electrophoresis, capillary electrophoresis, isoelectric focusing, two dimensional, pulse field and diagonal electrophoresis.

**UNIT-III**

Principles and applications of UV-visible, Raman, infrared, ORD, CD, NMR, ESR, fluorescence spectroscopy. X-ray diffraction. Principles and applications of preparative and analytical ultracentrifuges.

**UNIT-IV**

Radioactive and non-radioactive tracer techniques and their applications in biological sciences. Detection and measurement of radioactivity. Principles of electrochemical techniques – operation and applications of pH, oxygen, ion-selective and gas sensing electrodes. Biosensors – principle, design and applications.

**UNIT-V**

Scientific data description, tabulation and graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Types of errors and level of significance. Tests of significance - F and *t* -tests, chi-square tests, ANOVA. Simple linear regression and correlation.

## **RECOMMENDED BOOKS:**

1. Principles and Techniques of Biochemistry and Molecular Biology ( 7<sup>th</sup> edition ) by K. Wilson and J. Walker.
2. A Biologists guide to Principles and Techniques of Practical Biochemistry (3<sup>rd</sup> edition) by.B.D.Williams.
3. Biophysical Chemistry: Principles and Techniques (2010) by Upadhyay, Upadhyay and Nath.
4. Biostatistics (2<sup>nd</sup> edition) by P.K. Arora and P.K. Malhal
5. Fundamentals of Biostatistics (1994) by Khan and Khanum.
6. Fundamentals of Applied Statistics (10<sup>th</sup> edition ) by S.C.Gupta and V.K. Kapoor.
7. Physical Chemistry ( 9<sup>th</sup> edition ) by P.W. Atkins and W.H. Freeman.
8. An introduction to biostatistics (2<sup>nd</sup> edition) by N. Gurumani.
9. Basic Concepts in Statistics (2009) by K.S. Kushwaha and R. Kumar.

**M.Sc. (Microbiology) I SEMESTER**  
**SMB721: MICROBIOLOGICAL METHODS**

Hours per week: 12

End Examination: 60 Marks

Credits: 3

Sessionals: 40 Marks

1. Microscopy- Microscope and its operation- components, microscope adjustments- light sources- microscopic measurements- calibration.
2. Isolation methods – Pour plate, Streak plate and Spread plate techniques.
3. Maintenance of microbial cultures.
4. Staining methods – Gram’s staining. Capsule staining. Acid-fast staining by Ziehl-Neelsen’s method, spore staining. Negative staining.
5. Detection of motility by hanging drop method.
6. Selective and indicator media – Crystal violet blood agar, Salt nutrient agar, Mannitol salt agar,
7. Growth curves, Bacterial growth measurement, Dry weight and turbidometric methods, viable count by spread plate method, colony count.
8. Metabolic (Biochemical) tests – Catalase and Oxidase tests. IMViC, starch hydrolysis; H<sub>2</sub>S production.
9. Isolation & Identification of known & unknown bacteria.
10. Isolation and culturing of fungi.
11. Microbiological quality testing of milk (MBRT test).

## **RECOMMENDED BOOKS:**

1. Laboratory Experiments in Microbiology (2007) by G. Reddy *et. al.*
2. Laboratory Manual of Microbiology and Biotechnology (2014) by K.R. Aneja.
3. Microbiology - Practical Manual (3<sup>rd</sup> edition) by S.M. Reddy and S.R. Reddy.
4. Microbiology – A Laboratory Manual (10<sup>th</sup> edition) by J.G. Cappuccino and N. Sherman.
5. Laboratory Manual in Microbiology (2007) by P. Gunashekar,
6. Laboratory Manual in General Microbiology (2002) by N. Kannan.

**M.Sc. (Microbiology) I SEMESTER**  
**SMB723: ANALYTICAL TECHNIQUES**

Hours per week: 12  
Credits: 3

End Examination: 60 Marks  
Sessionals: 40 Marks

1. Qualitative tests of carbohydrates, lipids, amino acids, proteins & nucleic acids.
2. Estimation of reducing sugar-Anthrone method
3. Estimation of sugar by titration method –Benedict’s method
4. Estimation of amino acids by Ninhydrin method.
5. Determination of pKa and pI values of amino acids.
6. Quantitation of glycine by formol titration
7. Absorption spectrum of proteins and quantification by uv spectroscopy.
8. Paper Chromatography of amino acids.
9. Thin Layer chromatographic separation of amino acids
10. Determination of saponification value of fats
11. Determination of iodine number of oils
12. Determination of acid value of fats
13. Demonstration of HPLC and GC

## **RECOMMENDED BOOKS:**

1. Introductory Practical Biochemistry (2<sup>nd</sup> edition) by S.K. Sawhney and Randhir Singh.
2. Principles and Techniques of Practical Biochemistry (7<sup>th</sup> edition) by K. Wilson and J. Walker, Cambridge University Press.
3. An Introduction to Practical Biochemistry (3<sup>rd</sup> edition) by D.T. Plummer.
4. Practical Biochemistry – A Basic Course ( 2<sup>nd</sup> edition) by A. Rameshwar.
5. Laboratory Manual in Biochemistry ( 2<sup>nd</sup> edition) by Jayaraman.
6. Experimental Biochemistry (3<sup>rd</sup> edition) by B. S. Rao and V. Deshpande.
7. Text Book of Practical Biochemistry (2002) by Rashmi Joshi and Manju Saraswat.

**M.Sc. (Microbiology) II SEMESTER**  
**SMB702: MICROBIAL PHYSIOLOGY AND METABOLISM**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT - I**

Carbohydrate metabolism in microbes: Embden- Meyerhof- Parnas pathway, Pasteur effect, Warburg effect, Entner-Doudoroff (ED) pathway, C2-C4 split Pathway, Krebs' cycle- amphibolic nature and anapleurotic reactions. Glyoxylate cycle, hexose monophosphate shunt (HMP), gluconeogenesis, synthesis of peptidoglycans and glycoproteins. Electron transport chain. Fermentations – biochemical mechanisms of lactic acid, ethanol, butanol and citric acid fermentations.

**UNIT - II**

Metabolism of amino acids - Biosynthesis and catabolism of aromatic amino acids by microbes. Protein metabolism- assimilation of inorganic nitrogen and sulphur. Biochemistry of nitrogen fixation, Chemolithotrophy- sulphur, iron, hydrogen, nitrogen oxidizing bacteria, nitrate and sulphate respiration, methanogenesis. Catabolism of amino acids, transamination, decarboxylation and oxidative deamination. Porphyrin biosynthesis and catabolism.

**UNIT - III**

Lipid metabolism- Biosynthesis of triacylglycerol, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Biosynthesis and catabolism of purine and pyrimidine nucleotides, salvage pathways. Biosynthesis of deoxyribonucleotides- regulation of nucleotide synthesis.

**UNIT - IV**

Outlines of enzyme classification, nomenclature, assay of enzymes and kinetics of enzyme catalyzed reactions – Michaelis – Menten equation, determination of  $K_m$ ,  $V_{max}$  and  $k_{cat}$  values. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes

## **UNIT - V**

Enzyme inhibitors, competitive and noncompetitive inhibition. Active site determination. Mechanism of action of ribonuclease, lysozyme and chymotrypsin. Isoenzymes, regulatory enzymes – covalent modification, zymogen activation, allosteric enzymes – ATCase.

### **RECOMMENDED BOOKS:**

1. Biochemistry (4<sup>th</sup> edition) by D.Voet and J.G.Voet.
2. Biochemistry (3<sup>rd</sup> edition) by U. Satyanarayana.
3. General Microbiology (5th edition) by R. Stanier.
4. Microbial physiology (4<sup>th</sup> edition) by Moat and Foster.
5. Lehninger Principles of Biochemistry (6<sup>th</sup> edition) by D. Nelson and Cox.
6. Biochemistry (6<sup>th</sup> edition) by L. Stryer.
7. Bacterial metabolism ( 2<sup>nd</sup> edition) by Doelle.



**M.Sc. (Microbiology) II SEMESTER**  
**SMB704: FOOD AND AGRICULTURAL MICROBIOLOGY**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT - I**

Food fermentations and microbial foods: fermented foods - preparation of yogurt: *Streptococcus* species, *Lactobacillus bulgaricus*; manufacture of cheese- *Pencillium roqueforti*. Fermented soybean products. Microorganisms as food: single cell protein (bacteria, yeast, algae and fungi). Genetically modified foods.

**UNIT - II**

Contamination and spoilage: water activity, intrinsic and extrinsic factors, normal flora and microbial spoilage of fresh foods- grains, fruits, vegetables, milk, meat, eggs, fish and canned foods. Microbiological examination of foods. Food poisoning- mycotoxins and bacterial toxins.

**UNIT - III**

Food preservation and asepsis, pasteurization of milk, refrigeration and freezing, dehydration, osmotic pressure, chemicals - organic acids, nitrates, nitrites & cresols; radiation - UV light, gamma irradiation.

**UNIT - IV**

Soil environment - soil profile. Physico-chemical conditions, sampling techniques, role of microorganisms in organic matter decomposition (cellulose, hemicellulose, lignins), biogeochemical cycles – nitrogen cycle, sulphur and phosphorous cycles. Rhizosphere, biochelators (siderophores).

**UNIT - V**

Biofertilizers - Introduction, nitrogen fixing microbes- *Rhizobium*, *Azotobacter*, *Azospirillum*, *Azolla-Anabena* symbiosis, blue-green algae, Phosphate solubilizing microorganisms. Mycorrhiza. Biopesticides - *Bacillus thuringiensis*, *Pseudomonas syringae* and *Beauveria bassiana*.

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**RECOMMENDED BOOKS:**

1. Food Microbiology (4<sup>th</sup> edition) by W. Frazier.
2. Soil Microbiology (4<sup>th</sup> edition) by N. S. Subba Rao.
3. Agricultural Microbiology (2006) by P.K. Biswas.
4. Food Microbiology (3<sup>rd</sup> edition) by M.R. Adams.
5. Basic Food Microbiology (2<sup>nd</sup> edition) by G. I. Banwart.
6. Soil Microbiology (2<sup>nd</sup> edition) by A. Martin
7. Environmental Soil Science (3<sup>rd</sup> edition) K. H. Tan.
8. Introduction To Soil and Agricultural Microbiology (2004) G. Prabhakaran.

## **M.Sc. (Microbiology) II SEMESTER**

### **SMB706: VIROLOGY**

Hours per week: 4

Credits: 4

End Examination: 60 Marks

Sessionals: 40 Marks

#### **UNIT - I**

Viruses: structure- capsid, nucleic acids, Sub-viral agents Viroids, Prions. Classification ICTV and Baltimore classifications. TMV, T2 bacteriophage, and Influenza, new emerging viruses

#### **UNIT - II**

Biochemical characteristics. Antigenic nature of viruses. Cultivation and assay of viruses : embryonated eggs, primary and secondary cell cultures, suspension and monolayer cell cultures, organs cultures, experimental animals. Inactivation of viruses.

#### **UNIT - III**

DNA and RNA viral genomes- linear, circular, double and single stranded, positive and negative sense of RNA genomes, mono-, bi-, tri and multipartite genome. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses.

#### **UNIT - IV**

Virus – host interactions : latent infection, cytopathic effects of viral infections, Host defense against viral infections, innate and adaptive immune response to viruses. Viral routes of entry, host specificity and tissue tropism. Virus spread in the body. Mechanism of viral persistence

#### **UNIT - V**

Vertical and horizontal transmission of viruses in animals and plants. Vectors - arthropod, non - arthropod. Multiple host infections, viral zoonosis. Virus ecology and epidemiology – Epidemiological concepts. Virus maintenance in communities- wild and domestic animals.

## **RECOMMENDED BOOKS:**

1. Basic Virology (3<sup>rd</sup> edition) by Wagner and Hewelett.
2. Microbiology (5th edition) Pelczar, Chan and Krieg.
3. Principles of Virology (3<sup>rd</sup> edition) by S.J. Flint *et. al.*
2. Introduction to Modern Virology (6<sup>th</sup> edition) Dimmock *et. al.*
3. Principles of Molecular Virology (5<sup>th</sup> edition) by A. Cann.
4. Medical Virology ( 4<sup>th</sup> edition) by D.O. White and F.J. Fenner.
5. Plant Virology (5<sup>th</sup> edition) by R. Hull. .
6. Fundamental Virology ( 6<sup>th</sup> edition) by D.M.Knipe and P.M.Howley.

**M.Sc. (Microbiology) II SEMESTER**  
**SMB708: MOLECULAR BIOLOGY**

Hours per week: 4

Credits: 4

End Examination: 60 Marks

Sessionals: 40 Marks

**UNIT - I**

Nature of genetic material, organization of genetic material in prokaryotes and eukaryotes. Fine structure of the gene. Different kinds of genes- split genes, overlapping genes. Gene amplification and polytene chromosomes, Lampbrush chromosomes,

**UNIT - II**

Prokaryotic DNA replication- enzymes involved and mechanism. Transcription in prokaryotes: mechanism of transcription- initiation, elongation and termination. Types of RNA polymerases and promoter-polymerase interactions. Transcriptional factors. Post transcriptional modifications: Processing of mRNA, tRNA and rRNA.

**UNIT - III**

Translation in prokaryotes: genetic code, translational machinery, mechanism of initiation, elongation and termination. Regulation of translation, co and post translational modifications.

**UNIT - IV**

Regulation of gene expression in prokaryotes and eukaryotes- the operon concept, negative & positive control and attenuation. Lac and Trp operons. Role of enhancers, cis-trans elements, DNA methylation and chromatin remodeling in gene expression. Environmental regulation of gene expression. RNA and gene silencing.

**UNIT - V**

Mutations – Types of mutations, molecular basis of mutations, physical and chemical mutagens, carcinogens, Site directed mutagenesis, mutational hot spots, Reversion, screening and analysis of mutants.

## **RECOMMENDED BOOKS:**

1. Molecular Biology (2004) by David Frefielder.
2. Molbio (2005) by Avinash and K. Upadhyay.
3. Genes IX by B. Lewin.
4. Cell and Molecular Biology (8<sup>th</sup> edition) by E.D.P. De Robertis.
5. DNA Science (2<sup>nd</sup> edition) by D. Micklos.
6. Molecular Biology of the Gene ( 7<sup>th</sup> edition) by J.D. Watson *et. al.*
7. Molecular Biology (2011) by R. F. Weaver.

**M.Sc. (Microbiology) II SEMESTER**  
**SMB722: MICROBIAL PHYSIOLOGY**

Hours per week: 12  
Credits: 3

End Examination: 60 Marks  
Sessionals: 40 Marks

1. Estimation of proteins by Bradford method.
2. Estimation of DNA by diphenylamine method.
3. Estimation of RNA by orcinol method.
4. Estimation of organic and inorganic phosphates by Fiske Subbarow's method
5. Estimation of ammoniacal nitrogen and nitrates
6. Estimation of DO, BOD and COD.
7. Production and Assay of microbial enzymes – Amylase and protease
8. Enzyme Kinetics: (any one of the above enzymes):
  - a) Effect of substrate and enzyme concentration on enzyme activity;  
Determination of  $K_M$  and  $V_{max}$  values.
  - b) Effect of pH, temperature and inhibitors on enzyme activity.
9. Enzyme and Whole cell immobilization.

## **RECOMMENDED BOOKS:**

1. Experimental Biochemistry (3<sup>rd</sup> edition) by B. S. Rao and V. Deshpande.
2. Introductory Practical Biochemistry (2<sup>nd</sup> edition) by S.K. Sawhney and R. Singh.
3. Principles and Techniques of Practical Biochemistry (7<sup>th</sup> edition) by K. Wilson and J. Walker.
4. Laboratory Manual in Biochemistry ( 2<sup>nd</sup> edition) by Jayaraman.
5. Text Book of Practical Biochemistry (2002) by R. Joshi and M. Saraswat.
6. Laboratory Manual in Biochemistry by Jayaraman.
7. Experimental Biochemistry by B. S. Rao and V. Deshpande.



**M.Sc. (Microbiology) II SEMESTER**  
**SMB724: MOLECULAR MICROBIOLOGY**

Hours per week: 12  
Credits: 3

End Examination: 60 Marks  
Sessionals: 40 Marks

1. UV survival curve of bacteria
2. Repair mechanism of damage caused by UV radiation
3. Protoplast preparation and regeneration
4. DNA extraction from Fungi, yeast, Bacteria, Blood, Plants.
5. Plasmid DNA preparation from bacteria, microalgae.
6. Determination of T<sub>m</sub> of different DNA samples
7. Restriction and ligation of DNA
8. Transformation
9. Southern hybridization
10. DNA finger printing (RAPD)
11. Conjugation reaction
12. Complementation test in bacteria.
13. Bacterial conjugation

**RECOMMENDED BOOKS :**

1. Genetic Engineering: Principles and Practice (2015) by S. Mitra
2. Molecular Cloning (1989) J. Sambrook *et. al.*
3. Microbiology – A Laboratory Manual ( 10<sup>th</sup> edition) by J.G. Cappuccino and N. Sherman.
4. Methods in Molecular Biotechnology: Experimental Analysis (2010) by V. Gomase *et. al.*

**M.Sc. (Microbiology) III SEMESTER**  
**SMB 801: IMMUNOLOGY**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT - I**

Innate immunity, adaptive immunity, cells involved in immune system – T-lymphocytes, B- lymphocytes, monocytes, macrophages, APC, Neutrophils, mast cells, lymphoid system, Thymus, bone marrow, spleen, lymph nodes, clonal selection of lymphocytes, immunological memory. Humoral and cell-mediated immunity.

**UNIT - II**

Nature of antigens; antibody structure, classification and functions, primary and secondary immune response; Antibody diversity. Antigen-Antibody reactions; precipitation, agglutination, neutralisation, Opsonisation. and important immunological diagnostic tests- ELISA, RIA, immuno blot, Immunodiffusion, immunofluorescence, Immunoelectrophoresis, Complement fixation test (CFT).

**UNIT - III**

Ontogeny of B and T lymphocytes, T and B cell interactions, cytokines, lymphocyte-mediated cytotoxicity (CTL). Antibody-dependent cell-mediated cytotoxicity. The complement system. classical and alternate complement pathways.

**UNIT - IV**

Major Histocompatibility Complex (MHC), class I, II & III MHC molecules, peptide MHC interaction, Human leucocyte antigen (HLA) restriction, processing and presentation of antigens, Transplantation immunity- graft rejection. Tumor immunology, immunological tolerance and immunosuppression. Immune response to infectious diseases.

**UNIT - V**

Hypersensitive reactions, Autoimmunity. Immunodeficiency diseases - Primary immunodeficiency diseases due to B-cell and T-cell and combined defects (hypogammaglobulinemia, thymic aplasia, SCID). Secondary immunodeficiency

(acquired). Hybridoma techniques (MAB) and Immunotherapy, types and principles of immunization.

**Recommended books:**

1. Kuby Immunology (7<sup>th</sup> edition) by J. Owen and J. Punt
2. Elements of Immunology (2009) by F. H. Khan.
3. Immunology and Immunotechnology (2006) by A.K. Chakravarty
4. Introduction to Immunology (2006) by C.V.Rao.
5. Cellular and Molecular Immunology (2014) by A. K. Abbas *et. al*
6. Roitt's Essential Immunology (2011) by P.J. Delves
7. Janeway's Immunobiology (2011) by K. Murphy
8. Fundamentals of Immunology (7<sup>th</sup> edition) by W.E. Paul.
9. Advanced immunology (2000) by R. Fernandez-Botran

## **M.Sc. (Microbiology) III SEMESTER**

### **SMB803: RECOMBINANT DNA TECHNOLOGY**

Hours per week: 4

End Examination: 60 Marks

Credits: 4

Sessionals: 40 Marks

#### **UNIT - I**

Enzymes in rDNA technology: Restriction enzymes, Reverse Transcriptase, Terminal Transferases, T4 Polynucleotide Kinases & Alkaline phosphatases, DNA ligases, nucleases, DNA polymerases, RNase H. Blotting techniques. PCR- Principle, types and applications.

#### **UNIT - II**

Cloning vectors and their applications: Plasmids- pBR 322, pUC; Phages – Lambda and M13 vectors, cosmids, phagemids, SV40. Expression.Vectors, artificial chromosomes.

#### **UNIT - III**

Gene isolation, Cloning of genes, introduction of cloned genes, Screening and selection of clones, expression of cloned genes. cDNA and construction of genomic / gene (cDNA) libraries. Probes: types, synthesis and applications.

#### **UNIT - IV**

Isolation of nucleic acids: Technique of DNA and plasmid isolation, RNA. DNA sequencing- Maxam Gilbert's method & Sanger's method, Automated sequencing. Genome sequencing and physical mapping, restriction mapping, DNA foot printing, chromosome walking. Protein sequencing.

#### **UNIT - V**

DNA microarray – types of supports, probe attachment, whole genome analysis, SNPs, DNA chips. Protein microarrays. Advantages and disadvantages of DNA & protein microarray. Transgenic plants and animals. Gene therapy. Bioethics.

## **RECOMMENDED BOOKS :**

1. Principles of Gene Manipulations and Genomics (2009) by S. B. Primrose and R. Twyman.
2. Molecular Biotechnology: Principles and applications of Recombinant DNA (2010) by B. R. Glick et. al.
3. Gene Cloning: An Introduction (1995) by T.A. Brown.
4. Recombinant DNA (1992) by J. Watson,
5. Genetic Engineering: Principles and Practice (2015) by Sandhya Mitra.
6. Molecular Cloning (1989) J. Sambrook et. al.
7. An introduction to Genetic Engineering (3<sup>rd</sup> edition) D. Nicholl.

**M.Sc. (Microbiology) III SEMESTER**  
**SMB805: MEDICAL MICROBIOLOGY**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT - I**

Normal microbial flora of human body. Mechanism of bacterial adhesion, establishment, spread, tissue damage and anti-phagocytic factors, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Antigenic variation and virulence.

**UNIT - II**

Classification of pathogenic bacteria. *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Corynebacteria*, *Bacillus*, *Clostridium*, non spore forming anaerobes, organisms belonging to enterobacteriaceae-*E.coli*, *Salmonella*; *Vibrios*, *Yersinia*; *Haemophilus*; *Bordetella*, *Brucella*, *Mycobacteria*, *Spirochaetes*, *Actionomycetes*, *Rickettsiae*, *TRIC agents and LGV*, *Mycoplasma*.

**UNIT - III**

Morphology, pathogenesis and laboratory diagnosis of pathogenic fungi: *Aspergillus*, *Penicillium*, *Rhinosporidium*. *Rhizopus*, *Blastomyces* and *Microsporium*. Antifungal agents. Parasitology of *Entamoeba histolytica*, *Leishmania donovani*, *Trypanosoma gambiense*, *Plasmodium spp.* Helminthic infections: *Taenia solium*, *Ascaris lumbricoides*, *Enterobius vermicularis*, *Wucheraria bancrofti*.

**UNIT - IV**

Infections caused by Pox viruses, herpes virus, adeno viruses, picorna viruses, orthomyxo viruses, paramyxo viruses, arboviruses, rhabdo viruses, hepatitis viruses, oncogenic viruses, human immuno deficiency virus (AIDS).

**UNIT - V**

Laboratory control of antimicrobial therapy: various methods of drug susceptibility testing, antibiotic assay in body fluids, various mechanisms and sites of action of antibiotics, available vaccines and schedules, nosocomial infections, diagnosis and control.

## **RECOMMENDED BOOKS :**

1. Textbook of Microbiology (6<sup>th</sup> edition) by Ananthanarayan and C.K.J.Paniker.
2. Textbook of Medical Parasitology (2013) by S.C.Panija.
3. Textbook of Medical Parasitology (6<sup>th</sup> edition) by C.K.J Paniker.
4. Medical Microbiology (26<sup>th</sup> edition) by Jawetz *et. al.*
5. Medical Microbiology (26<sup>th</sup> edition) by Melnick and Adelberg
6. Medical Microbiology (16<sup>th</sup> edition) by D. Greenwood *et. al.*
7. Medical Microbiology (7<sup>th</sup> edition) by P. R.Murray *et. al.*

**SMB807: ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY**

Hours per week: 4

End Examination: 60 Marks

Credits: 4

Sessionals: 40 Marks

**UNIT - I**

Concepts of Ecology- Biotic components and their interactions, energy flow, physical, abiotic factors and their interaction, food chains, food webs, ecological pyramids, trophic levels. Growth in closed and open environments.

**UNIT - II**

Microbial ecology-scope, positive and negative microbial interactions in populations, kinetics of microbial interactions, Microbial community development, r and k strategies, Extremophiles. Species diversity indices. Biofilms.

**UNIT - III**

Aerobiology-Droplet nuclei, aerosol, air spora, air sampling principles and techniques. Air borne transmission of microbes

Aquatic microbiology-fresh water, marine habitats. zonation of water ecosystems, upwelling, eutrophication. Potability of water - Microbial assessment of water quality, water purification, major water borne diseases and their control measures.

**UNIT - IV**

Pollution and waste treatment-, hydrogen sulphide, CO, NH<sub>3</sub>, nitrogen oxides, Acid rain. microbial production of methyl mercury

Wastes- solid and liquid, solid waste treatment- saccharification, gasification, composting, liquid waste - DO, COD, BOD, primary, secondary, tertiary treatment – trickling filter, activated sludge, oxidation pond.

**UNIT - V**

Bioremediation: Microbial degradation of oil spills, pesticides and detergents, bioaccumulation of metals and detoxification, GEMS and their impact. Biodeterioration of paper, leather, wood, textiles, metal corrosion and prevention.



## **RECOMMENDED BOOKS:**

1. Microbial Ecology: Fundamentals and Applications (4<sup>th</sup> edition) by Atlas and Bartha.
2. Textbook of Environmental Biotechnology (2007) by P.K. Mohapatra.
3. Manual of Environmental Microbiology (3<sup>rd</sup> edition) by C, J, Hurst.
4. Environmental Microbiology (2<sup>nd</sup> edition) by R. Mitchell
5. Environmental Microbiology (2<sup>nd</sup> edition) by Maier *et. al.*
6. Fundamentals of Ecology (5<sup>th</sup> edition) E.P. Odum.
7. Industrial and Environmental Biotechnology (2001) by Ahmed Nuzhat.

**M.Sc. (Microbiology) III SEMESTER**  
**SMB 821: DIAGNOSTIC MICROBIOLOGY**

Hours per week: 12

End Examination: 60 Marks

Credits: 3

Sessionals: 40 Marks

1. Preparation of different media used in diagnostic microbiology.
2. Laboratory examination of sputum: collection of sputum. Microbiological examination of sputum for pus cells and predominant bacteria. Ziehl-Neelsen staining to detect AFB, culturing the specimen.
3. Collection of throat swabs – culturing the specimen.
4. Laboratory examination of pus and skin specimens for *staphylococcus aureus*, *streptococcus pyogenes* and *Pseudomonas aeruginosa*.
5. Examination of urine for pathogenic microorganisms –collection of urine, microscopic examination of urine, comparison of normal specimen with urinary tract infection sample.
6. Urine cultures, single colonies, seeding in peptone water and Christensen's urea medium, blood agar, nutrient agar and Mac Conkey plate cultures.
7. Isolation of pathogenic fungi –Filamentous fungi, yeasts, yeast like fungi and dimorphic fungi. *Aspergillus niger*, *Nocardia*, *Candida albicans*.
8. Medical parasitology – *E. histolytica*, *G. lamblia*, *Trypanosoma*, *Leishmania* and *Plasmodium* (Permanent Slide Observation)
9. Permanent slide observation of helminthes.
10. Serological Tests- Hemoglobin estimation, RBC Count, WBC Count, bleeding time, clotting time, erythrocyte sedimentation rate (ESR).

## **RECOMMENDED BOOKS :**

1. Practical Medical Microbiology ( 1996) by Mackie and Mc. Cartney.
2. Practical Medical Microbiology Vol-II b (12<sup>th</sup> edition) Cruichshank *et. al.*
3. Microbiology – A Laboratory Manual ( 10<sup>th</sup> edition) by J.G. Cappuccino and N.Sherman
4. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation (4<sup>th</sup> edition) by K. R. Aneja.
5. Laboratory Manual in Microbiology (10<sup>th</sup> edition) by Alcamo.

**M.Sc. (Microbiology) III SEMESTER**  
**SMB 823: IMMUNOLOGY**

Hours per week: 12  
Credits: 3

End Examination: 60 Marks  
Sessionals: 40 Marks

1. Separation of Serum - Immuno electrophoresis.
2. Ouchterlony double diffusion.
3. Radial immunodiffusion.
4. Immunoprecipitation and precipitin curve.
5. ELISA.
6. Western blotting.
7. Various agglutination reactions : Blood grouping, Rh typing,
8. VDRL
9. WIDAL
10. Agglutination inhibition test.
11. Separation and characterization of serum and lymphocytes from blood

**RECOMMENDED BOOKS:**

1. Practical Immunology (1989 ) by Hudson
2. Practical Immunology (2002) by Hay.
3. Manual of Clinical Immunology (1986) by Rose and Friedman.
4. Immunochemistry in Practice (1996) by Johnstone and Thrope.

**M.Sc. (Microbiology) IV SEMESTER**  
**SMB802: BIOPROCESS TECHNOLOGY**

Hours per week: 4

End Examination: 60 Marks

Credits: 4

Sessionals: 40 Marks

**UNIT - I**

Introduction to fermentation processes, Industrially important microorganisms – isolation and screening methods – primary and secondary. Strain improvement. Auxotrophic mutants.

**UNIT – II**

Design of fermentor, types of fermentors, maintenance of aseptic conditions, instrumentation control, physical and chemical sensors, control of physical parameters; computer applications in fermentation technology, fermentation economics.

**UNIT - III**

Industrial media formulation. Substrates for fermentation – carbon & nitrogen sources, antifoams, inoculum media. Inoculum development. Microbial growth kinetics- Batch culture, continuous culture, fed batch culture and dual or multiple fermentations. Solid state, surface, submerged fermentations, scale up.

**UNIT - IV**

Industrial production- production of ethyl alcohol, beer and wine. Industrial production of enzymes -proteases, amylases; organic acids – lactic and citric acid; Vitamins (Riboflavin, Vitamin B<sub>12</sub>) and antibiotics – penicillin, tetracycline.

**UNIT – V**

Products from genetically modified organisms–insulin, growth factors and interferons. Immobilization of enzymes-adsorption, covalent binding, entrapment, membrane confinement. Downstream processing-recovery and purification of microbial products

## **RECOMMENDED BOOKS:**

1. Industrial Microbiology (1984) by A.H. Patel
2. Prescott & Dunn's Industrial Microbiology (2004) by G. Reed.
3. Solid State Fermentation In Biotechnology (2009) by Ashok Pandey.
4. Industrial Microbiology (2002) by Waites.
5. Biotechnology: A Text Book Of Industrial Microbiology (1991) by Cruger and Cruger.
6. Principles Of Fermentation Technology (2008) by Stanbury
7. Microbial Technology: Microbial Processes Vol II (2009) by H. J. Peppler.

**M.Sc. (Microbiology) IV SEMESTER**  
**SMB842: MARINE MICROBIOLOGY**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT- I**

Stratification in marine environment, marine microbial habitats- water column, sediments, coastal ecosystems, salt marshes, mangroves and estuarine ecosystems. Microbial loop, marine microbial community.

**UNIT- II**

Metabolic diversity and the importance of microbial communities. Energy-yielding processes: phototrophy and primary productivity, fermentation, respiration, methanogenesis, nitrogen fixation, nitrification and denitrification. Specific nutrients needed for growth- macronutrients, micronutrients and trace elements.

**UNIT- III**

Marine Extremophiles-survival at extreme environments, starvation, adaptive mechanisms in thermophilic, alkalophilic, barophilic and psychrophilic microorganisms. Marine microbial interactions- positive and negative interactions.

**UNIT- IV**

Marine Microbial Diseases -Marine food borne pathogens & Water borne pathogens– pathogenicity, spread prophylaxis and treatment - *Aeromonas*, *Vibrio*, *Salmonella*, *Pseudomonas*, *Leptospira*, *corynebacterium* and algal toxins.

**UNIT- V**

Production and applications of marine microbial products– pigments (Astaxanthin,  $\beta$  carotene), enzymes, antibiotics, polysaccharide, secondary metabolites, bioluminescence and sea food preservation methods. Marine algal blooms and control.

## **REFERENCE BOOKS:**

1. Microbiology (2005) L.M. Prescott *et. al.*
2. Marine Microbiology: Ecology and Applications (2<sup>nd</sup> edition) by C. Munn.
3. Marine Microbiology (2005) by J. H. Paul.
4. Microbiology: Principles and Explorations ( 7<sup>th</sup> edition) by J. G. Black.
5. Ocean and Health: Pathogens in the marine environment (2006) by S. Belkin and R. R. Colwell
6. Bioactive Marine Natural Products (2005) D.S. Bhakuni and D.S. Rawat.



**M.Sc. (Microbiology) IV SEMESTER**  
**SMB 844: PLANT MICROBE INTERACTIONS**

Hours per week: 4

End Examination: 60 Marks

Credits: 4

Sessionals: 40 Marks

**UNIT- I**

Plant diseases (epidemic, endemic and recurrent), infective agents - introduction to plant pathogenic fungi, bacteria, nematodes and viruses. Economic importance of plant diseases.

**UNIT-II**

Host-microbe interactions: mode of infection (soil, seed, water or air borne), Infection process - fungi, bacteria, nematodes and viruses, host parasite specificity, physiological and biochemical changes induced by plant pathogens.

**UNIT- III**

Etiology, infection and disease cycle of important plant pathogens of Indian crops- Bacteria (soft rot), Viral (mosaic), fungal (rots, rusts, smuts and mildews). Diseases of edible fungi. Survival mechanisms of plant pathogens.

**UNIT-IV**

Molecular mechanisms underlying variation in plant pathogens. Systemic and local acquired resistance. Molecular approaches to plant disease diagnosis and management.

**UNIT- V**

Integrated plant disease management (radiation therapy of seeds, management of plant pathogens, chemical, bio control agents, mulching). Biofertilizers: PGPR. VAM, symbiotic and free living nitrogen fixers. Phosphate solubilizers.

## **REFERENCE BOOKS**

1. Roger Hull. (4th Edition) Matthew's Plant Virology.
2. Microbial Biotechnology: Fundamentals of Applied Microbiology ( 2<sup>nd</sup> edition) A. N. Glazer. and H. Nikaido.
3. Biological Control of Plant Diseases (2007) by Chincholkar and Mukherjee.
4. Natural Enemies: An Introduction to Biological Control (2004) by A. Hajek.
5. Plant Pathology (2014) by P.D Sharma.
6. Plant Physiology (4<sup>th</sup> edition) by Salisbury and Ross.

**M.Sc. (Microbiology) IV SEMESTER**  
**SMB846: MICROBIAL BIOTECHNOLOGY**

Hours per week: 4

End Examination: 60 Marks

Credits: 4

Sessionals: 40 Marks

**UNIT- I**

Bacteria, algae and fungi as biofertilizers- cyanobacteria, PGPR, Phosphate solubilizing microbes, symbiotic and non symbiotic nitrogen fixers, marine algae, mycorrhizae.

**UNIT-II**

Biocontrol- biopesticides, antagonism, siderophore production, microbial toxins, mycoparasitism, entomopathogenic fungi. Specific examples-*Bacillus thuringiensis*. *Pseudomonas syringae*, *Beauveria bassiana*, *Trichoderma viride*, NPV.

**UNIT-III**

Biofuels from microbial biomass - H<sub>2</sub> production, methane, ethanol, biodiesel, butanol, biofuels from wastes, bioelectricity- microbial fuel cell. PHB, biosensors.

**UNIT-IV**

Single cell proteins, *Spirulina*, mushroom- button, oyster. Yeast, probiotics, prebiotics, applications of SCP, food additives and animal feed.

**UNIT- V**

Bioremediation of terrestrial, marine, fresh water pollutants, sewage treatment, heavy metal pollution, biosorption, biodegradation – superbug, biotransformation, microbial leaching, carbon sequestration.

## **REFERENCE BOOKS:**

1. Microbial Biotechnology: Fundamentals of Applied Microbiology (2<sup>nd</sup> edition) A. N. Glazer. and H. Nikaido
2. Basic Biotechnology (3rd edition) by C. Ratledge and B. Kristiansen.
3. Manual of Industrial Microbiology and Biotechnology (2010) by R. H. Baltz *et al.*
4. Molecular Biotechnology (2004) by B. R. Glick and J. J. Pasternak.
5. Applied Microbiology (2015) by S. Saxena.
6. Basic and Applied Aspects of Biopesticides (2014) by K. S. Raj.
7. Handbook of Microbial Biofertilizers (2006) by M. Rai.
8. Bioenergy: Biomass to Biofuels (2014) by A. Dahia.

**M.Sc. (Microbiology) IV SEMESTER**  
**SMB848: BIOETHICS AND IPR**

Hours per week: 4  
Credits: 4

End Examination: 60 Marks  
Sessionals: 40 Marks

**UNIT-I**

Bioethics, ethical issues in genetic engineering, patenting human genes, cloning, genetic testing & screening. Stem cell research. Biotechnology & social responsibility; Public acceptance issue in Biotechnology.

**UNIT-II**

Biosafety and risk assessment, framework of biosafety regulation in India; DBT guidelines on biosafety in conducting research in biology / biotechnology. GM foods. Regulations of Genetically modified Organisms in India. Cartagena Protocol on biosafety; Bioterrorism.

**UNIT-III**

Hazard assessment, release of genetically modified organisms in environment; biosafety in laboratory, laboratory associated infections and other hazards; level of biosafety, prudent biosafety practices in laboratory.

**UNIT-IV**

Concept of intellectual property rights (IPR) and protection (IPP). Biotechnology and IPR-rationale of patent in research and scientific innovations, requirements for patentability-patentable subject matter, novelty, invention in biotechnological research, industrial applicability, patent documentation.

**UNIT-V**

Categories of biotechnological patents, examples of patents granted. concerns over biotechnology patents, International conventions; patenting living organisms; biodiversity & farmer's rights; patent owners rights and duties.

## REFERENCE BOOKS:

1. Principles of cloning (2002) J. Cibelli *et. al.*
2. Ethics In Engineering (2004), M.W. Martin and R. Schinzinger.
3. Biosafety Issues Related To Transgenic Crops, DBT Guidelines, Biotech Consortium India Limited, New Delhi.
4. Biotechnology and Intellectual Property Rights: Legal and Social Implications (2015) by K. K. Singh
5. Bioethics and Biosafety In Biotechnology (2007) by V.Sreekrishna.
6. Bioethics and Biosafety (2008) by M. K. Sateesh.

**M.Sc. (Microbiology) IV SEMESTER**  
**SMB822: FERMENTATION TECHNOLOGY**

Hours per week: 12  
Credits: 3

End Examination: 60 Marks  
Sessionals: 40 Marks

1. Screening for amylase production.
2. Screening for organic acid production by crowded plate technique
3. Screening of antibiotic producing microorganisms.
4. Production of antibiotics by fermentation.
5. Production of citric acid by *Aspergillus niger*.
6. Production of glutamic acid by fermentation.
7. Isolation of yeasts from grapes.
8. Production of Wine
9. Production & Estimation of Ethanol
10. Isolation of air-borne micro flora.
11. Isolation of *Rhizobium*, *Azotobacter* from soil.
12. Microbiological assay and determination of MIC of antibiotics.

**RECOMMENDED BOOKS:**

1. Manual of Industrial Microbiology and Biotechnology (2010) by R. H. Baltz, *et. al.*
2. Experiments In Microbiology, Plant Pathology, Tissue Culture & Mushroom Production Technology by Aneja.
3. Manual Of Environmental Microbiology (3<sup>rd</sup> edition) by C. J. Hurst.
4. Practical manual on Fermentation Technology (2012) by S. Kulandaivelu and S. Janardanan.
5. Environmental Microbiology: A Laboratory manual (2005) by Pepler *et. al.*

**OPEN ELECTIVE**  
**SOE 756: BASIC MICROBIOLOGY**  
**( II semester)**

Hours per week: 3

Credits: 3

End Examination: 60 Marks

Sessionals: 40 Marks

**UNIT- I**

Important Microorganisms- bacteria, fungi, viruses, protozoa; cultivation of microorganisms- types of media. Bacterial growth and reproduction. Sterilization.

**UNIT- II**

Microbial ecology- basic components of ecology-food chain, food webs, ecological pyramids, prey predator relationship; microbial interaction- commensalism, neutralism, symbiosis, mutualism, antagonism and parasitism. Biofertilizer and biopesticides

**UNIT- III**

Medical microbiology-mechanism of infection, bacterial, viral and fungal diseases. Antibiotics

Immunology-innate and acquired immunity, antigen, antibody, Ag-Ab reactions, vaccines, allergy.

**UNIT- IV**

Food microbiology - food spoilage and preservation, food borne diseases, production of yoghurt, wine. Mushroom cultivation. Genetically modified foods.

**UNIT- V**

Industrial microbiology- fermentor-design and types of fermentors, production of vitamin B<sub>12</sub>, amylase. Bioremediation, biotransformation, biogas.



## RECOMMENDED BOOKS :

1. Microbiology (5th edition) by Pelczar *et. al.*
2. General Microbiology (5th edition) by Stanier.
3. Bergey's Manual of Systematic Bacteriology (9th edition) volumes I to VI.
4. Brock Biology of Microorganism (9th edition) by Madigan *et. al.*
5. Introduction to Microbiology (2<sup>nd</sup> edition) by Ross.
6. Textbook of Microbiology by Ananthanarayan and C.K.J.Panikar.
7. Medical Microbiology (26<sup>th</sup> edition) by Jawetz.
8. Microbial Ecology: Fundamentals and Applications (4<sup>th</sup> edition) Atlas and Bartha.
9. Introductory Mycology ( 4<sup>th</sup> edition) by C.J. Alexopolus.
10. Principles of Microbiology (2<sup>nd</sup> edition) by R.M.Atlas.
11. Introductory Phycology by (1990) H.D. Kumar.
12. An Introduction to Mycology (1990) by R.S. Mehrothra and Aneja

**OPEN ELECTIVE**  
**SOE 867: MANAGEMENT OF INFECTIOUS DISEASES**  
**(III semester)**

Hours per week: 3

End Examination: 60 Marks

Credits: 3

Sessionals: 40 Marks

**UNIT- I**

Potability of water, water disinfection, Indicator organisms. Water borne diseases- bacterial and viral (cholera, typhoid, poliomyelitis, hepatitis).

**UNIT- II**

Food borne infections- food poisoning and food intoxication-algal, bacterial and fungal toxins, milk borne pathogens. Food preservation.

**UNIT- III**

Air borne infections- mechanism of infection and spread. Tuberculosis, chicken pox, influenza. Prevention and control

**UNIT- IV**

Antibiotics- narrow spectrum, broad spectrum, sensitivity and resistance, mode of action of penicillin, streptomycin and chloramphenicol.

**UNIT- V**

Vaccines- principle and types- live attenuated and killed vaccines, toxoids. DNA vaccine. Recombinant vaccines, vaccination schedule. Vaccinoprophylaxis of cervical cancer.

## **RECOMMENDED BOOKS :**

1. Textbook of Microbiology (6<sup>th</sup> edition) by Ananthanarayan and C.K.J. Paniker.
2. Textbook of Medical Parasitology (2013) by S.C. Panija.
3. Textbook of Medical Parasitology (6<sup>th</sup> edition) by C.K.J. Paniker.
4. Medical Microbiology (26<sup>th</sup> edition) by Jawetz *et. al.*
5. Medical Microbiology (26<sup>th</sup> edition) by Melnick and Adelberg
6. Medical Microbiology (16<sup>th</sup> edition) by D. Greenwood *et. al.*
7. Medical Microbiology (7<sup>th</sup> edition) by P. R.Murray *et. al.*