GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University)
VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A^+ Grade

REGULATIONS AND SYLLABUS

OF

M.Sc. Microbiology

(w.e.f. 2021-22 admitted batch)

M.Sc. (Microbiology)

REGULATIONS*

(w.e.f. 2021-22 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 IInd 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.

"* To be changed as per 16th Academic Council Resolutions"

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.
- 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) Three mid semester examinations shall be conducted for 15 marks each. The performance in best two shall be taken into consideration. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Practicals	100	Continuous evaluation	60 marks for performance, regularity, record/ and case study. Weightage for each component shall be announced at the beginning of the semester. 40 marks (30 marks for experiment(s) and 10 marks for practical Viva-voce.) for the test conducted at the end of the Semester conducted by the concerned lab Teacher.
	Total	100		
3	Project work	200	Project evaluation	150 marks for evaluation of the project work dissertation submitted by the candidate. 50 marks are allocated for the project Viva-Voce. The project work evaluation and the Viva-Voce shall be conducted by one external examiner outside the University and the internal examiner appointed by the Head of the Department.

9. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

9.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations in April/May.

9.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during November/December

9.3 A student who has completed his/her period of study and still has "F" grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

10. PROMOTION TO THE NEXT YEAR OF STUDY

10.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 60% of the credits till the previous academic year.

10.2 Whenever there is a change in syllabus or curriculum he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue

his/her further studies

11. BETTERMENT OF GRADES

11.1 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 'n' (where 'n' is no.of semesters of the program) theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations.

11.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

12. REPEAT CONTINUOUS EVALUATION:

12.1 A student who has secured 'F' grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.2 A student who has secured 'F' grade in a practical course shall have to attend Special Instruction classes held during summer.

12.3 A student who has secured 'F' grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.4 The RCE will be conducted during summer vacation for both odd and even semester students. Student can register a maximum of 4 courses. Biometric attendance of these RCE classes has to be maintained. The maximum marks in RCE be limited to 50% of Continuous Evaluation marks. The RCE marks are considered for the examination held after RCE except for final semester students.

12.5 RCE for the students who completed course work can be conducted during the academic semester. The student can register a maximum of 4 courses at a time in slot of 4 weeks. Additional 4 courses can be registered in the next slot.

A student is allowed to Special Instruction Classes (RCE) 'only once' per course..

13. GRADING SYSTEM

13.1 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	-

13.2 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.

14. GRADE POINT AVERAGE

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

$$GPA = \frac{\Sigma [CxG]}{\Sigma C}$$

Where

C = number of credits for the course,

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

14.2 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.

14.3 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

Class	CGPA Required
First Class with Distinction	≥ 8.0*
First Class	≥ 6.5
Second Class	≥ 5.5
Pass Class	≥ 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.

15. ELIGIBILITY FOR AWARD OF THE M.Sc. DEGREE

15.1 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.

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

15.3 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.

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

16. 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.

MSc Microbiology

Program Educational Objectives

PEO 1. Provide knowledge and information to the students about the theory and laboratory skills in microbiology.

PEO 2. Train the students for attaining academic excellence in the field of microbiology.

PEO 3. To make students competent in Microbiology and allied areas through hands-on experience in basic tools and techniques.

PEO 4. To instill research and entrepreneurship ability in the students with strong ethics and communication skills.

PEO 5. To make students capable of integrating various aspects of microbiology in order to achieve holistic and societal development.

Program Outcomes:

Students will be able to:

1. Acquire, retain and apply the specialized concept and knowledge relevant to the plethora of microbiological fields.
2. Will gain knowledge about the basic principles of bacteriology, cell biology, molecular biology, virology, mycology, immunology, and parasitology, including the nature of pathogenic microorganisms, pathogenesis, laboratory diagnosis, transmission, prevention, and control of diseases common in the country.
3. They will also acquire laboratory safety knowledge and routine and specialized microbiological skills applicable to clinical research, including accurately reporting observations and analysis.
4. Apply and include the principles of microbiology in practical, real-world situations and problems.

Program Specific Outcomes:

1. Will implement basic principles of bacteriology, cell biology, molecular biology, virology, mycology, and immunology in real-world situations and problems.
2. Learn the detailed principles, procedures, and applications of various chromatographic and electrophoretic techniques for successfully purifying proteins to homogeneity.
3. Will apply the knowledge of various spectrophotometric methods to quantify the desired compound in the given solutions.

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
I Semester										
1	SMB 701	General Microbiology	PC	4	4	0	4	3	60	40
2	SMB 703	Cell Biology & Genetics	PC	4	4	0	4	3	60	40
3	SMB 705	Biomolecules	PC	4	4	0	4	3	60	40
4	SMB 707	Analytical Techniques & Biostatistics	PC	4	4	0	4	3	60	40
5	SSE 701/SSE 703	Skill Enhancement course*	AEC	2	0	3	3	3	--	100
6	SMB 721	Practicals-I: Microbiological Methods	PP	3	0	9	9	3	---	100
7	SMB 723	Practicals-II: Analytical Techniques	PP	3	0	9	9	3	---	100
		Total		24	16	21	37	--	240	460
*** Skill Enhancement course choose one of the following** 1. SSE 701: Basic computer concepts / 2. SSE 703: Information Technology Tools										
II Semester										
1	SMB 702	Microbial Physiology and Metabolism	PC	4	4	0	4	3	60	40
2	SMB 704	Food and Agricultural Microbiology	PC	4	4	0	4	3	60	40
3	SMB 706	Virology	PC	4	4	0	4	3	60	40
4	SMB 708	Molecular Biology and Genetic Engineering	PC	4	4	0	4	3	60	40
5	SAE 702	Professional communication skills	AEC	2	0	3	3	3	--	100

6	SMB 722	Practicals -III Microbial Physiology	PP	3	-	9	9	3	---	100
7	SMB 724	Practicals -IV Molecular Microbiology	PP	3	-	9	9	3	---	100
		Total		24	16	21	37	--	240	460
III Semester										
1	SMB 801	Immunology	PC	4	4	0	4	3	60	40
2	SMB 803	Ecology and Environmental Microbiology	PC	4	4	0	4	3	60	40
3	SMB 805	Medical Microbiology	PC	4	4	0	4	3	60	40
4	SMB 841	Microbial Genomics and Proteomics	GE-1	4	4	0	4	3	60	40
	SMB 843	Bioenergy and Biofuels								
	SMB 845	Dairy Technology								
	SMB 847	Microbial Biotechnology								
5	SOE XXX	Open elective	OE	3	3	0	3	3	60	40
6	SMB 821	Practicals-V: Diagnostic Microbiology	PP	3	0	9	9	3	---	100
7	SMB 823	Practicals -VI Immunology	PP	3	0	9	9	3	---	100
		Total		25	19	18	37	--	300	400
IV Semester										
1	SMB 802	Bioprocess Technology	PC	4	4	0	4	3	60	40
2	SMB 842	Marine Microbiology	GE -2	4	4	0	4	3	60	40
3	SMB 844	Plant Microbe Interactions								
4	SMB 846	Research methodology, statistics and Computer applications								
5	SMB 848	Bioethics and IPR								
6	SMB 822	Practicals-VII : Fermentation technology	PP	3	0	9	9	3	---	100
7	SMB 892	Project Work	PP	8	0	0	0	3	--	200
		Total		19	8	9	17	12	120	380

Open Elective Courses**.**

1. Management of Infectious Diseases (SOE 881)

M.Sc. (Microbiology) I SEMESTER

SMB 701: GENERAL MICROBIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course introduces the students to the basic concepts of microbiology, history and development of microbiology. Additionally, they learn about isolation identification classification of microorganisms. Introducing the subject to all the applied aspects of microbiology.

Course Objectives:

1. To introduce the subject of microbiology by its history, microscopy, aseptic techniques, sterilization, isolation of bacteria, study of morphological characters, identifying and classification of bacteria.
2. Preservation of microbes, staining techniques, understanding nutritional types of bacteria.
3. Detailed study of some clinically important bacteria
4. Microbiology of water, milk and microbial interactions in nature.

UNIT - I

History of microbiology, general characters of major groups of microorganisms, algae, fungi, protozoa, bacteria, virus, and archaea. 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.

Learning Outcomes:

By the end of this unit, the student will know about

- Contributions of eminent scientists to microbiology
- Microscopy and types of microscopes
- Classification of microorganisms and importance of Bergey's manual

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.

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Sterilization methods
- Pure culture techniques
- Preservation of microorganisms

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Discriminate Nutritional types of bacteria
- Understand Bacterial growth curve
- Learn Microscopic identification

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.*

Learning Outcomes:

By the end of this unit, the student will be able to understand

- General characteristics and pathogenesis of clinically important bacteria
- General characteristics and pathogenesis of clinically important viruses
- General characteristics and pathogenesis of clinically important protozoans

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.

Learning out comes:

By the end of this unit, the student will be able to comprehend

- Positive and negative microbial interactions

- General characters and economic importance of algae and fungi
- Microbiology of water and milk

Course Outcomes:

After completion of the course, the student will

1. Study the history of Microbiology, microscopy, aseptic techniques, sterilization,

2. Understand about the isolation of bacteria, study of morphological characters, identifying and classification of bacteria.

3. Know the preservation of microbes, staining techniques, understanding nutritional types of bacteria.

4. Make a detailed study of some clinically important bacteria

5. Understand the Microbiology of water, milk, and microbial interactions in nature.

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^{nd} edition) by Ross.
6. Textbook of Microbiology (6^{th} edition) by Ananthanarayan and C.K.J.Panikar
7. Medical Microbiology (26^{th} edition) by Jawetz.
8. Microbial ecology: Fundamentals and applications (4^{th} edition) by Atlas and Bartha.
9. Introductory Mycology (4^{th} edition) by C.J. Alexopolus.
10. Principles of Microbiology (2^{nd} 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

SMB 703: CELL BIOLOGY AND GENETICS

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

Cell biology and genetics provides the proper knowledge about organellar biology, cell – cell interactions organization and bacterial genetics and recombination.

Course Objectives:

Course provides the knowledge regarding

- Organellar Biology and cell-cell interactions
- Cell transduction and translation
- Bacterial genetics and recombination methods

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.

Learning Outcomes:

By the end of this unit, the student will be able to exhibit Clear knowledge about

- Organellar biology, photosynthesis
- Biological oxidation and 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.

Learning Outcomes:

By the end of this unit, the student will be able to understand and explain

- Cell to cell interaction
- Signal transduction pathways in eukaryotes

UNIT - III

Centromeres and telomeres. Recombination at molecular level, heteroduplex analysis. C value paradox, C0t curves. Plasmids types-Col, F and R plasmids, Ti plasmid. Hybridization in yeast, control of mating type loci in yeast. Transposable elements. Mutations – Types of mutations, molecular basis of mutations, physical and chemical mutagens, screening and analysis of mutants, transposons.

Learning Outcomes:

By the end of this unit, the student will acquire a knowledge of

- centromeres and telomeres
- Recombination at molecular level
- Hybridization in yeast
- Mutations

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

Learning Outcomes:

By the end of this unit, the student will be able to understand and explain

- Mechanism of protein translocation in prokaryotes and eukaryotes
- Protein export in bacteria, 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.

Learning Outcomes:

By the end of this unit, the student will acquire knowledge of

- bacterial recombination and transformation
- Mapping of bacterial chromosome

Course Outcomes

After completion of the course, the student will

1. Gain knowledge about organellar Biology and cell-cell interactions

2. Understand cell transduction and translation

3. Know about bacterial genetics and recombination methods

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) I SEMESTER

SMB 705: BIOMOLECULES

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course will familiarize the students with certain fundamental aspects of biochemistry viz. the various forces operating in nature, the principles and importance of pH and buffers in biological systems and the structures an functions of various biomolecules such as carbohydrates, lipids, proteins and nucleic acids. Learning the structure and functions of these biomolecules will pave way for further learning in forthcoming semester wherein the metabolism of these biomolecules shall be explored.

Course Objectives:

- To familiarize students with fundamentals forces of attraction operating in living systems
- To appreciate the importance of pH and buffers in living systems
- To learn the chemical structures and functions of carbohydrates, proteins, lipids and nucleic acids
- To learn the structure and function of various water soluble and fat soluble vitamins
- To understand the structure and functions of important porphyrins

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.

Learning Outcomes:

After completion of this unit the student will be able to

- Differentiate different types of forces of attraction
- Understand pH and application of 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).

Learning Outcomes:

After completion of this unit the student will be able to

- Classify carbohydrates

- Identify structures of various carbohydrates
- Appreciate the functions of different carbohydrates

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-α-helix, β-pleated sheet, collagen triple helix, Ramachandran's plot, β-bends and structural motifs. Tertiary and quaternary structures. Solid phase peptide synthesis

Learning Outcomes:

After completion of this unit the student will be able to

- Classify amino acids based on structure and dietary requirement
- Elucidate isolation and purification of proteins
- Identify the hierarchy of protein structure
- Appreciate the 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.

Learning Outcomes:

After completion of this unit the student will be able to

- Distinguish different types of lipids
- Appreciate their role in day to day life
- Relate different vitamins with their functions
- Relate structure of porphyrins with their functions

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.

Learning Outcomes:

After completion of this unit the student will be able to

- Differentiate different forms of DNA based on structure
- Differentiate different types of RNA
- Explain the importance of sc RNA, sn RNA and si RNA.

Course Outcomes:

After completion of the course, the student will

1. Be familiarized with fundamentals forces of attraction operating in living systems
2. Appreciate the importance of pH and buffers in living systems
3. learn the chemical structures and functions of carbohydrates, proteins, lipids, and nucleic acids
4. Understand the structure and function of various water soluble and fat-soluble vitamins
5. Gain knowledge regarding the structure and functions of important porphyrins

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) I SEMESTER

SMB 707: ANALYTICAL TECHNIQUES AND BIOSTATISTICS

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This paper gives student an idea about principles and procedures in performing different chromatographic techniques like in purifying the proteins to homogeneity, testing the purity levels by different electrophoretic techniques, and quantitating the same by spectrophotometric methods. This paper also gives you brief idea about the different radioactive methods for measurement of radioactivity, electrochemical methods in determining the pH of the solution, and about importance of biosensors. This course also helps to quantitate the scientific data, importance of statistics and application of various statistical methods, importantly, standard deviation, correlation, and regression related to bioanalytical techniques.

Course Objectives:

- To understand the detailed principles, procedures and applications of various chromatographic techniques for example in learning the purification of proteins by using ion exchange and affinity chromatography, and molecular weight determination by size exclusion chromatography.
- To learn the principles, procedures and applications of various electrophoretic techniques, importantly knowing the difference between SDS and native PAGE, and isoelectric focussing.
- To study the principles, procedures and applications of various spectrophotometric methods especially in quantitation of desired compound in the given solutions.
- To know the principles, procedures and applications of radioactive methods for measurement of radioactivity, electrochemical methods, and biosensors.
- To focus on the usage of different statistical methods learned with respect to bioanalytical techniques perspectives.

UNIT-I

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

Learning Outcomes:

By the end of this Unit, the student

- will be able to understand the detailed principles, procedures and applications of various chromatographic techniques.
- shall imbibe the basics of isolation of proteins to the purification of the proteins to homogeneity, and especially with the usage of high end chromatography columns, and purification procedures.
- will also be trained with the prerequisites for making recombinant protein for ease in purification of proteins with tags such as his-tag etc.
- will get to know about the identification of carbohydrates and amino acids by techniques like paper and thin layer chromatography

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.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Understand the principles, components, and applications of various electrophoretic techniques.
- Know the difference between SDS-PAGE and native PAGE techniques with respect to proteins
- Learn agarose gel electrophoresis and know molecular biology techniques like PCR and molecular cloning
- Visualize the purity of proteins those are purified to homogeneity using various chromatography columns.

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.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Know the principles, components, and applications of various spectrometry techniques.
- Utilize of UV-visible spectrophotometer to know the concentrations of the solutions.
- Importance of Circular Dichroism in understanding the folding of proteins after expression and purification
- Understand the importance of techniques such as XRD for retrieving the structure of the protein with high resolution.

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.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Gain knowledge on various radioactive and stable isotopes, tracer techniques, and about biosensors and their applications in many industries.
- Know the instruments used for measurement of radioactivity
- Know the working of pH electrode etc.

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.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Analyze the scientific data, importance of statistics and application of various statistical approaches for knowing the significance of data obtained after laboratory experiments
- Know the formulae for Standard deviation, correlation, and regression methods, and usage of these calculations and retrieved values with respect to bioanalytical techniques.

Course Outcomes:

After completion of the course, the student will

1. Understand the detailed principles, procedures and applications of various chromatographic techniques
2. Learn the principles, procedure, and applications of various electrophoretic techniques.
3. Learn the principles, procedure, and applications of various spectrophotometric methods.
4. Know the principles, procedure, and applications of radioactive methods.
5. Focus on the usage of different statistical methods learned with respect to bioanalytical techniques perspectives.

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) I SEMESTER

SSE 701: BASIC COMPUTER CONCEPTS

Hours per week: 3 Sessionals: 100 Marks

Credits: 2

Preamble:

The course gives an understanding about the characteristics and classification of computers, various components of computer along with different operating systems that are available. It gives a hands on training on the packages MS-Word, MS-Power Point and MS-Excel. The course also comprehends AI tools.

Basics of Computers: Definition of a Computer - Characteristics and Applications of Computers – Block Diagram of a Digital Computer – Classification of Computers based on size and working – Central Processing Unit – I/O Devices, Primary, Auxiliary and Cache Memory – Memory Devices. Software, Hardware, Firmware and People ware – Definition and Types of Operating System – Functions of an Operating System – MS-DOS –MS Windows, UNIX. Introduction to AI tools.

MS-Word

Features of MS-Word – MS-Word Window Components – Creating, Editing, ormatting and Printing of Documents – Headers and Footers – Insert/Draw Tables, Table Auto format – Page Borders and Shading – Inserting Symbols, Shapes, Word Art, Page Numbers, Equations – Spelling and Grammar – Thesaurus – Mail Merge.

MS-PowerPoint

Features of PowerPoint – Creating a Blank Presentation - Creating a Presentation using a Template - Inserting and Deleting Slides in a Presentation – Adding Clip Art/Pictures -Inserting Other Objects, Audio, Video- Resizing and Scaling of an Object –Slide Transition – Custom Animation.

MS-Excel

Overview of Excel features – Creating a new worksheet, Selecting cells, Entering and editing Text, Numbers, Formulae, Referencing cells – Inserting Rows/Columns –Changing column widths and row heights, auto format, changing font sizes, colors, shading.

Reference Books:

1. Fundamentals of Computers by V.RajaRaman, PHI Learning Pvt. Ltd, 2010.

2. Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh andFaithe Wempen, Wiley Publications, 2010.

Learning Outcomes:

By the end of this course, the student will be able to

- understand fundamental hardware components that make up a computer's hardware and the role of each of these components
- Understand the difference between an operating system and an application program, and what each is used for in a computer.
- Acquire knowledge about AI tools.
- Create a document in Microsoft Word with formatting that complies with the APA guidelines.
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number.
- Create a presentation in Microsoft PowerPoint that is interactive and legible content

Course Outcomes:

After completion of the course, the student will

1. Develop knowledge on the basics of computers
2. know about the features of MS-WORD, Editing, ormatting and Printing of Documents
3. Make a power point presentation
4. Overview MS-Excel

M.Sc. (Microbiology) I SEMESTER

SSE 703: INFORMATION TECHNOLOGY TOOLS

Hours per week: 3 Sessionals: 100 Marks

Credits: 2

Preamble:

The course enables the student to understand networking concepts related to Internet and introduce the social Networking sites and working of Email. It gives orientation of Block Chain technology. It give hands on training in SPSS, R Programming and creation of simple HTML documents.

Introduction to Internet: Networking Concepts, Data Communication –Types of Networking, Internet and its Services, Internet Addressing –Internet Applications–Computer Viruses and its types – Browser –Types of Browsers.

Internet applications: Using Internet Explorer, Standard Internet Explorer Buttons, Entering a Web Site Address, Searching the Internet– Introduction to Social Networking: twitter, tumblr, Linkedin, facebook, flickr, skype, yahoo!, google+, youtube, WhatsApp, etc.

E-mail : Definition of E-mail, Advantages and Disadvantages,User Ids, Passwords, Email Addresses, Domain Names, Mailers, Message Components, Message Composition, Mail Management, Email Inner Workings.

WWW-Web Applications, Web Terminologies, Web Browsers, URL–Components of URL, Searching WWW –Search Engines and Examples.

Block Chain technology: What is Block Chain, Blockchain Architecture, How Block chain Transaction Works? Why do we need Blockchain? Block chain versions, Block chain Variants, Block chain Use Cases, Important Real-Life Use Cases of Block chain Bitcoin cryptocurrency: Most Popular Application of Block chain, Block chain vs. Shared Database, Myths about Block chain, Limitations of Block chain technology.

SPSS : SPSS Commands, Descriptive Statistics, Hypothesis Testing, Test of Difference, Analysis of Variance- One Way ANOVA, Non Parametric Tests, Correlation Analysis, Regression Analysis.

R Programming: Becoming familiar with R, Working with Objects, Introduction to Graphical Analysis.

HTML: WEB Terminology, Structure of HTML Document, HTML – Head and Body tags, Semantic tags- HR- Heading, Font, Image & Anchor tags, Different Types of Lists using Tags, Table Tags, Image Formats – Creation of Simple HTML Documents.

Reference Books:

- In-line/On-line : Fundamentals of the Internet and the World Wide Web by Raymond Greenlaw and Ellen Hepp, 2nd Edition, TMH.
- Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, WileyPublications.

Course Outcomes:

By the end of this course, the student will be able to

- Understand the basic networking concepts, types of networks, Internet Explorer and www.
- Outline the Block chain architecture, Bitcoin Crypto currency and Limitations of Block Chain.
- Choose different statistical tests to be performed on the data sets.
- Demonstrate the R programming with simple graphs.
- Make use of commands to structure HTML document.

M.Sc. (Microbiology) I SEMESTER

SMB 721: MICROBIOLOGICAL METHODS

Hours per week: 8

Credits: 3 Sessionals: 100 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_2S 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 Mannual of Microbiology and Biotechnology (2014) by K.R. Aneja.
3. Microbiology - Practical Manual (3^{rd} edition) by S.M. Reddy and S.R. Reddy.
4. Microbiology – A Laboratory Manual (10^{th} edition) by J.G. Cappuccino and M. Sherman.
5. Laboratory Manual in Microbiology (2007) by P. Gunashekaran,
6. Laboratory Manual in General Microbiology (2002) by N. Kannan.

Course Outcomes:

After the completion of the above experiments the students will be able to perform

- Isolation of various microorganisms (bacteria, fungi) from different sources (water, soil, food)
- Identification of physiological characteristics such as gram, capsule, spore and flagella by

microscopic techniques

- Identification of the biochemical characteristics of the bacteria
- Preparation of various types of media for culturing of microorganism
- Test of microbial quality of milk

M.Sc. (Microbiology) I SEMESTER

SMB 723: ANALYTICAL TECHNIQUES

Hours per week: 8

Credits: 3 Sessionals: 100 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^{nd} edition) by S.K. Sawhney and Randhir Singh.
2. Principles and Techniques of Practical Biochemistry (7^{th} edition) by K. Wilson and J. Walker, Cambridge University Press.
3. An Introduction to Practical Biochemistry (3^{rd} edition) by D.T. Plummer.
4. Practical Biochemistry – A Basic Course (2^{nd} edition) by A. Rameshwar.
5. Laboratory Manual in Biochemistry (2^{nd} edition) by Jayaraman.
6. Experimental Biochemistry (3^{rd} edition) by B. S. Rao and V. Deshpande.
7. Text Book of Practical Biochemistry (2002) by Rashmi Joshi and Manju Saraswat.

Course Outcomes:

After the completion of the above experiments the students will be able to

- Identify different biomolecules
- Quantify different biomolecules
- Determine the isoelectric point of amino acids

- Separate amino acids by different chromatographic techniques
- Characterise quality of lipids by titrimetric methods
- Understand the working and applications of HPLC and GC

M.Sc. (Microbiology) II SEMESTER

SMB702: MICROBIAL PHYSIOLOGY AND METABOLISM

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

The various metabolic pathways operating in the biological system are not only interesting but also important. This course is an extrapolation of the paper explored in the first semester wherein the students learnt the structures of various biomolecules. This paper gives an in depth understanding of metabolism of carbohydrates, lipids, proteins and nucleotides in microorganisms and their regulation. The course also throws light on enzymes and their action. The basic mechanisms remain the same in higher animals also with minor variations. Hence studying this course helps one standardize their diet and lead a healthy life.

Course Objectives:

- To understand the metabolism and regulation of carbohydrates under aerobic and anaerobic conditions
- To learn pathways exclusively found in microbes and their importance
- To explore metabolism of proteins, lipids and nucleotides
- To understand the mechanism of enzymes, enzyme kinetics and their applications
- To learn the importance of different types of enzyme inhibitions

UNIT - I

Carbohydrate metabolism in microbes: Embden- Meyerhof- Paranas pathway, Pasteur effect, Warburg effect, Entner-Doudoroff (ED) pathway, C2-C4 split Pathway, Kreb's 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.

Learning Outcomes:

After the completion of this unit the student will be able to

- Elucidate the carbohydrate metabolism and the associated energy yield
- Understand different fermentation pathways

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Appreciate the mechanism of amino acid metabolism
- Explain the importance of chemolithotrophy in nature
- Explain the mechanism of porphyrin metabolism

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand lipid metabolism
- Understand nucleotide metabolism

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Classify enzymes based on their functions
- Appreciate enzyme kinetics and mechanism of action
- Standardize conditions for optimum enzyme activity

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the importance of enzyme inhibition
- Appreciate the mechanism of action of specific enzymes
- Distinguish functioning of allosteric enzymes form normal enzymes

Course Outcomes:

After the completion of the course, the students will be able to

1. Understand the metabolism and regulation of carbohydrates
2. Learn pathways exclusively found in microbes and their importance
3. Explore metabolism of proteins, lipids and nucleotides
4. Understand about enzymes, kinetics and their applications
5. Learn the importance of enzyme inhibitions

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) II SEMESTER

SMB 704: FOOD AND AGRICULTURAL MICROBIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

The course not only throws light on traditional fermented foods but also introduces the students to the new concepts in preparations of new fermented foods. The basic concepts on food spoilage and latest methods of food preservation are included . The course also introduces them to the soil microbiology, biogeochemical cycles, Biofertilizers and Biopesticides.

Course Objectives:

- Impart knowledge on traditional foods, preparation of fermented foods and genetically modified foods
- Imparting knowledge in spoilage of foods, prevention of spoilage and preservation methods.
- Teach basic concepts of soil structure and nitrogen phosphorous Sulphur cycles
- Teach degradation of lignocellulosic compounds.
- Provide knowledge in Biofertilizers and Biopesticides.

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). Probiotics and prebiotics; Genetically modified foods.

Learning Outcomes:

By the end of this unit, the student will be able to know

- Concepts of fermented foods
- Usage of microbes as food and fodder
- Genetically modified foods-advantages and disadvantages, scenario of GM foods in India .

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.

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Spoilage of foods-possible contamination and prevention
- Microbiological examination of foods
- Food poisoning

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.

Learning Outcomes:

By the end of this unit, the student will be able to understand and differentiate

- Food preservation methods
- Pasteurization of milk
- Radiation of foods

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).

Learning Outcomes:

By the end of this unit, the student will be able to comprehend

- Detailed soil profile, sampling of soil for testing
- Organic matter decomposition
- Biogeochemical cycles

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, NPV*.

Learning Outcomes:

By the end of this unit, the student will be able to have

- Knowledge on growth of Biofertilizers
- Knowledge on phosphate solubilizing bacteria
- Knowledge on Biopesticides

Course Outcomes:

After the completion of the course, the students will be able to

1. Gain knowledge on traditional foods, preparation of fermented foods and genetically modified foods
2. Impart knowledge in spoilage of foods, prevention of spoilage and preservation methods.
3. Learn basic concepts of soil structure and nitrogen phosphorous Sulphur cycles
4. Know about the degradation of lignocellulosic compounds, Biofertilizers and Biopesticides

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) II SEMESTER

SMB 706: VIROLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course makes the student to understand about the structure and life cycle of viruses as well as viral evolution. This also illustrates the mechanisms of host immune responses to viral infections. Additionally it details the pathogenesis of viral infections and epidemiology of infection.

Course Objectives:

- To provide knowledge about distinctive characteristics of viruses.
- To learn about biological, chemical and physical properties of viruses.
- To provide the knowledge about principles of viral taxonomy.
- To provide the basic knowledge about structure of viruses and their replicative cycle.
- To provide basic knowledge about viral genetic variability and the principles of viral evolution.
- To provide basic concepts of interaction of virus-host and mechanisms of disease.

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

Learning Outcomes:

By the end of this unit, the student will learn about

- Viruses structure- capsid, nucleic acids
- Classification ICTV and Baltimore classifications.
- 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.

Learning Outcomes:

By the end of this unit, the student will obtain knowledge of

- Antigenic nature of viruses
- Cultivation of viruses
- 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.

Learning Outcomes:

By the end of this unit, the student will be able to gain knowledge of

- Structure of viral genomes
- Replication of viruses
- Replication strategies of viral infections

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

Learning Outcomes:

By the end of this unit, the student will gain knowledge of

- Types of viral infectons- Latent infection, cytopathic effects of viral infections
- Innate and adaptive immune response to viruses.
- Virus spread in the body and 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.

Learning Outcomes:

By the end of this unit, the student will learn about

- The transmission of viruses in animals and plants.
- Viral ecology and epidemiology
- Viral maintenance in communities

Course Outcomes:

By the end of the course, students will

- Gain knowledge on distinctive characteristics of viruses.
- Learn about biological, chemical and physical properties of viruses.

- know about principles of viral taxonomy.
- Learn about structure of viruses and their replicative cycle.
- Develop basic concepts of interaction of virus-host and mechanisms of disease.

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) II SEMESTER

SMB 708: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course provides an overview about the molecular basis of biological activity between biomolecules in the various systems of a cell, including the interactions between DNA, RNA, proteins and their biosynthesis, as well as the regulation of these interactions. The student also learns about the important mechanisms and crucial factors involved in understanding the three complicated processes replication, transcription and translation. Additionally this course provides an overall idea about molecular cloning-from given the DNA template to protein synthesis using rDNA technology techniques.

Course Objectives:

- To provide knowledge about the organization of genetic material in prokaryotes and eukaryotes
- To learn about the mechanisms and crucial factors involved in understanding the three complicated processes replication, transcription and translation.
- To focus on the important phenomenon of regulation of gene expression in prokaryotes and eukaryotes-
- To get an overall idea given the DNA template to protein synthesis using molecular cloning and rDNA technology techniques.
- To learn about the important methods to know the success of the molecular biology and rDNA technology like sequencing etc.

UNIT - I

Organization of genetic material in prokaryotes and eukaryotes. Fine structure of the genes, split genes, overlapping genes. Prokaryotic DNA replication- enzymes involved and mechanism. PCR- Principle, types and applications.

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn about organization of genetic material in prokaryotes and eukaryotes
- Gain knowledge on mechanism of replication of DNA in Prokaryotes, importantly proteins and enzymes involved to each role of subunit in the process.
- Understand the importance of PCR –principles and applications, and exploitation of this technique in present day molecular cloning methods

UNIT - II

Transcription in prokaryotes and eukaryotes, Types of RNA, polymerases and promoter-polymerase interactions. Transcriptional factors. Processing of mRNA, tRNA and rRNA. Translation in prokaryotes: genetic code, mechanism of initiation, elongation and termination. Regulation of translation, co and post translational modifications.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the mechanism of transcription in prokaryotes and eukaryotes; and importantly transcription initiation factors and their roles in the process
- Know about the translation mechanism by studying initiation, elongation, and termination steps in protein synthesis-learn all the parameters involved with respect to translation mechanism.
- Understand regulation of translation, co and post translational modifications.

UNIT – III

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the important regulations of gene expression in prokaryotes and eukaryotes by studying different operons
- Learn about environmental regulation of gene expression.
- Learn important mechanisms of RNA and gene silencing

UNIT – IV

Enzymes in rDNA technology: Restriction enzymes, Reverse Transcriptase, DNA ligases. Cloning vectors and their applications: Plasmids- pBR 322, pUC; Phages – BAC, Lambda, cosmids, SV40. Expression. Vectors. Cloning of genes, selection of clones, expression of cloned genes. Genomic and gene (cDNA) libraries. Probes: types, synthesis and applications.

Learning Outcomes:

By the end of this unit, the student will be able to

- Get overall view about the production of recombinant protein-given the DNA template using the molecular cloning-rDNA technology techniques
- Learn about the importance of restriction enzymes, cloning vectors, transformation, and

selection of positive clones.

- Learn about the genomic and gene (cDNA) libraries, and about probes

UNIT – V

Blotting techniques. DNA sequencing- Maxam Gilbert's method & Sanger's method, DNA foot printing, chromosome walking, 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. Introduction to CRISPR technology

Learning Outcomes:

By the end of this unit, the student will be able to

- Get an overall view about the importance of sequencing and procedures of sequencing methods.
- Learn about important blotting techniques
- Understand about the mechanisms of DNA microarray Protein microarrays
- Learn about transgenic plants and animals and gene therapy and lastly recent technologies like CRISPR.

Course outcomes:

By the end of the course, students will

1. Gain knowledge about the organization of genetic material in prokaryotes and eukaryotes
2. Learn about the mechanisms and crucial factors involved in understanding the three complicated processes replication, transcription and translation.
3. Understand the phenomenon of regulation of gene expression in prokaryotes and eukaryotes-
4. Develop an overall idea about protein synthesis using molecular cloning and rDNA technology techniques.
5. Learn about the success of the molecular biology and rDNA technology like sequencing etc.

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^{th} edition) by E.D.P. De Robertis.
5. DNA Science (2^{nd} edition) by D. Micklos.
6. Molecular Biology of the Gene (7^{th} edition) by J.D. Watson *et. al*.
7. Molecular Biology (2011) by R. F. Weaver.

8. Principles of Gene Manipulations and Genomics (2009) by S. B. Primrose and R. Twyman.
9. Molecular Biotechnology: Principles and applications of Recombinant DNA (2010) by B. R. Glick et. al.
10. Gene Cloning: An Introduction (1995) by T.A. Brown.
11. Recombinant DNA (1992) by J. Watson,
12. Genetic Engineering: Principles and Practice (2015) by Sandhya Mitra.
13. Molecular Cloning (1989) J. Sambrook et. al.
14. An introduction to Genetic Engineering (3rd edition) D. Nicholl.

M.Sc. (Microbiology) II SEMESTER

SAE 702: PROFESSIONAL COMMUNICATION SKILLS

Hours per week: 3 Sessionals: 100 Marks

Credits: 2

Preamble

This course is designed to expose students to the basics of academic and professional communication in order to develop professionals who can effectively apply communication skills, theories and best practices to meet their academic, professional and career communication needs.

Course Objectives:

- acquaint themselves with basic English grammar
- acquire presentation skills
- develop formal writing skills
- develop creative writing skills
- keep themselves abreast with employment-readiness skills

UNIT - I

BACK TO BASICS: Tenses, Concord – Subject Verb Agreement, Correction of Sentences-Error Analysis, Vocabulary building.

Learning Outcomes:

At the end of the unit, the student will be able to

- Use structures and tenses accurately (L3)
- apply the right verb to the right subject in a sentence (L3)
- Detect incorrect sentences in English and write their correct form (L1)
- Acquire new vocabulary and use in speaking and writing (L3)

UNIT - II

ORAL PRESENTATION: What is a Presentation? Types of Presentations, Technical Presentation – Paper Presentation, Effective Public Speaking, Video Conferencing.

Learning Outcomes:

At the end of the unit, the student will be able to

- Overcome speaking anxiety prior to presentation (L3)
- Plan and structure effective presentations that deliver persuasive messages (L6)

- Prepare slides that can catch the attention of the audience (L6)
- Engage the audience (L3)
- Demonstrate skills in organizing, phrasing, and expressing the ideas, opinions and knowledge. (L3)
- Facilitate and participate in a video conference effectively (L3)

UNIT III

DOCUMENTATION : Letter –Writing, E-mail Writing & Business Correspondence, Project Proposals, Report Writing, Memos, Agenda, Minutes, Circulars, Notices, Note Making.

Learning Outcomes:

At the end of the unit, the student will be able to

- Write a business letter, which includes appropriate greetings, heading, closing and body and use of professional tone. (L6)
- Draft crisp and compelling emails (L6)
- Draft project proposals, reports and memos (L6)
- Prepare agenda and draft minutes (L6)
- Prepare circulars, notices and make notes.(L6)

UNIT IV

CREATIVE WRITING: Paragraph Writing, Essay writing, Dialogue Writing, Précis Writing, Expansion of Hints, Story Writing.

Learning Outcomes:

At the end of the unit, the student will be able to:

- Write paragraphs on familiar and academic topics using a topic sentence, supporting detail sentences and a conclusion sentence. (L6)
- Learn the structure of a five-paragraph essay and write essays that demonstrate unity, coherence and completeness (L1)
- Structure natural, lucid and spontaneous dialogues (L6)
- Draft clear, compact logical summary of a passage (L6)
- Recognize the elements of a short story and develop their functional writing skills.(L1)

UNIT V

PLACEMENT ORIENTATION: Resume preparation, group discussion – leadership skills, analytical skills, interviews –Types of Interviews, Preparation for the Interview, Interview Process.

Learning Outcomes:

At the end of the unit, the student will be able to

- Write a professional resume that highlights skills, specific to the student's career field (L6)
- Demonstrate the personality traits and skills required to effectively participate in a G.D (L3)
- Understand the purpose of interviews (L2)
- Be aware of the processes involved in different types of interviews (L2)
- Plan how to prepare for an interview (L6)
- Prepare how to answer common interview questions(L6)

Course Outcomes:

After completion of the course, students will

- Acquaint with basic English grammar
- Acquire presentation skills
- Develop formal writing skills
- Develop creative writing skills
- Keep themselves abreast with employment-readiness skills

Recommended Books :

1. Essentials of Business Communication by Rajendra Pal and J S KorlahaHi, Sultan Chand & Sons.

2. Advanced Communication Skills by V. Prasad, Atma Ram Publications.

3. Effective Communication by Ashraf Rizvi, McGraw Hill Education; 1st Edition , 2005.

4. Interviews and Group Discussions How to face them by T.S.Jain, Gupta,1st Edition, Upkar Prakashan,2010.

5. High School English Grammar and Composition by P.C.Wren & Martin, N.D.V.Prasada Rao S.Chand.

M.Sc. (Microbiology) II SEMESTER

SMB 722: MICROBIAL PHYSIOLOGY

Hours per week: 8

Credits: 3 Sessionals: 100 Marks

1. Estimation of proteins by Bradford/ Lowry 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 nitrates
6. Estimation of DO, BOD and COD.
7. Production and Assay of microbial enzymes – Amylase, protease, lipase, esterase, and gelatinase
8. Enzyme Kinetics: (any one of the above enzymes):

a) Effect of substrate and enzyme concentration on enzyme activity; Determination of KM and *Vmax* values.

b) Effect of pH, temperature and inhibitors on enzyme activity.

9. Enzyme and Whole cell immobilization.

RECOMMENDED BOOKS:

1. Experimental Biochemistry (3^{rd} edition) by B. S. Rao and V. Deshpande.
2. Introductory Practical Biochemistry (2^{nd} edition) by S.K. Sawhney and R. Singh.
3. Principles and Techniques of Practical Biochemistry (7^{th} edition) by K. Wilson and J. Walker.
4. Laboratory Manual in Biochemistry (2^{nd} 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.

Course Outcomes:

After the completion of the above experiments the students will be able to

- Learn the techniques of colorimetric estimations
- Determine the quality of water by various measurable indices
- Isolate enzymes using different substrates

- Quantify enzyme activity and study enzyme kinetics
- Standardize conditions for optimum enzyme activity
- Immobilize enzymes in a matrix

M.Sc. (Microbiology) II SEMESTER

SMB 724: MOLECULAR MICROBIOLOGY

Hours per week: 8

Credits: 3 Sessionals: 100 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 Tm 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^{th} edition) by J.G. Cappuccino and Sherman.
4. Methods in Molecular Biotechnology: Experimental Analysis (2010) by V. Gomase *et. al.*

Course Outcomes:

After the completion of the above experiments the students will be able to learn

- Transformation and conjugation reactions
- DNA extraction and determination techniques
- DNA fingerprinting technique
- Complementation test

M.Sc. (Microbiology) III SEMESTER

SMB 801: IMMUNOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

Immunology course provides the knowledge about structure and function of immune system. This course provides the basic mechanism of hypersensitivity, autoimmunity and other immunological disorders.

Course Objectives:

- Ground knowledge about the immune system and its functions
- Key components of the innate and adaptive immune responses
- Fundamental working knowledge of the basic principles of immunology and diagnostic immunology
- Mechanism of hypersensitivity, autoimmunity and immunological disorders
- Basic principles of immunization.

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.

Learning Outcomes:

By the end of this unit, the student will be able to gain knowledge regarding

- Cells involved in immune system
- Primary and secondary lymphoid organs and their functions.
- Immunological memory
- Differences and variations between 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, neutralization, Opsonisation. and important immunological diagnostic tests- ELISA, RIA, immuno blot, Immunodiffusion, immunoflourescence, Immunoelectrophoresis, Complement fixation test (CFT).

Learning Outcomes:

By the end of this unit, the student will be able to gain knowledge about

- Nature of antigens
- Structure, diversity and functions of antibodies
- Antigen antibody reactions and their principles
- Antigen and antibodies role in diagnostic tests

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.

Learning Outcomes:

By the end of this unit, the student will be able to learn about

- Development maturation and activation of T and B lymphocytes
- T and B cell interactions
- Functions and role of cytokines
- CTL activity and ADCC
- Functions and activation pathways of complement system

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.

Learning Outcomes:

By the end of this unit, the student will be able to learn about

- Major Histocompatibility Complex (MHC) and Human leucocyte Antigen (HLA).
- Immune system involvement during transplantation and graft rejections
- Immune responses to infectious diseases
- Immunological tolerance and immunosuppression

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.

Learning Outcomes:

By the end of this unit, the student will be able to learn about

- Mechanism of hypersensitivity and autoimmunity
- Fundamental knowledge about immune deficiency disorders
- MAB technology
- Immunotherapy and principles of immunization

Course Outcomes:

By the end of the course, students will

1. Gain knowledge about the immune system and its functions
2. Learn components of the innate and adaptive immune responses
3. Develop fundamental working knowledge of the basic principles of immunology and diagnostic immunology
4. Learn the mechanism of hypersensitivity, autoimmunity and immunological disorders
5. Know the principles of immunization.

Recommended books:

1. Kuby Immunology (7^{th} 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^{th} edition) by W.E. Paul.
9. Advanced immunology (2000) by R. Fernandez-Botran

M.Sc. (Microbiology) III SEMESTER

SMB 803: ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course will introduce students to fundamental concepts of ecology, terminology, positive and negative interactions among organisms in environment and survival strategies of different organisms. The course will also emphasize the relevance of microbiology in aerial and aquatic ecosystems, pollution and its control in the light of bioremediation.

Course Objectives:

- To introduce the student to concepts of ecology
- To familiarize the students with interactions between different organisms in ecosystems
- To introduce the concept of aeromicrobiology and sampling techniques
- To provide an in depth understanding of aquatic microbiology
- To create awareness regarding hazards of pollution and control measures
- To introduce the concept of waste management and bioremediation

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Have an understanding of terminology associated with ecology
- Understand the concepts of food chains and food webs and energy flow through them

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

Learning Outcomes

After completion of this unit the student will be able to

- Categorize positive and negative interactions in the environment
- Understand the survival strategies of various organisms
- Appreciate the species diversity

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the concepts of aerobiology
- Have a theoretical knowledge of air sampling techniques
- Distinguish fresh water and marine ecosystems
- Understand the importance of potability of water, water borne diseases and their prevention

UNIT - IV

Pollution and waste treatment-, hydrogen sulphide, CO, NH_3, 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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Comprehend the gravity of pollution and associated control measures
- Elucidate the measures for solid and liquid waste management

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Appreciate the importance of bioremediation and its applications
- Understand the pros and cons of GEMS
- Understand the role of microbes in biodegradation of plant and animal products , metal corrosion and their prevention.

Course Outcomes

At the end of the course, students will

- Learn the basic concepts of ecology
- Be familiarized with interactions between different organisms in ecosystems
- Develop the concept of aero microbiology and sampling techniques
- Have an in depth understanding of aquatic microbiology
- create awareness regarding hazards of pollution and control measures
- get introduced to the concept of waste management and bioremediation

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) III SEMESTER

SMB 805: MEDICAL MICROBIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

To teach all the concepts of morphology pathogenesis laboratory diagnosis epidemiology of bacteria, fungi, viruses, protozoans and helminths

Course Objectives:

- To study normal flora of human body, process of infection, virulence factors and pathogenicity
- To gain knowledge on classification of pathogenic bacteria and their detailed study
- To provide access to study of medically important viruses.
- To learn about drug susceptibility testing

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.

Learning Outcomes:

By the end of this unit, the student will be learn about

- Normal flora of human body
- Process of infection
- Virulence factors and pathogenicity

UNIT - II

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

Learning Outcomes:

By the end of this unit, the student will

- Know classification of pathogenic bacteria
- Have completed a detailed study of each microorganisms

UNIT - III

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

Learning Outcomes:

By the end of this unit, the student will be able to complete

- Detailed study of medically important fungi
- Detailed study of medically important protozoans

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).

Learning Outcomes:

By the end of this unit, the student will know

- medically important viruses and their characters
- Importance of oncogenic viruses.

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.

Learning Outcomes:

By the end of this unit, the student will be able to know and understand

- Drug susceptibility testing
- Mechanism of action of antibiotics
- Nosocomial infections

Course outcomes:

At the end of the course, students will

- Study normal flora of human body, process of infection, virulence factors and pathogenicity
- Gain knowledge on classification of pathogenic bacteria and their detailed study
- Study medically important viruses.

- Learn about drug susceptibility testing

RECOMMENDED BOOKS:

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

M.Sc. (Microbiology) III SEMESTER

SMB 841: Microbial Genomics and Proteomics

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course provides about basic concepts of genomics, proteomics and metagenomics. Protein structure determinations and proteomic interactions. Concepts of protein engineering, microarray technology and analytical proteomics tools.

Course Objectives:

- Basic concepts of genomics and metagenomics
- Basic concepts of proteomics and tools to proteomics
- Protein structure determinations and Proteomic interactions
- Concepts of protein engineering
- Microarray technology
- Analytical proteomics tools and Mass spectrometry

UNIT I

Introduction to Genomics Genome definition, Genomics and its diversifications,

Strategies for Whole Genome Sequencing – Hierarchical and Whole Genome Shotgun Sequencing, role of Genetic and Physical maps in Genome assembly, De novo and reference based assembly, Genome finishing – Gaps and their resolution, basic concepts of genome annotation – ORF, ab initio and homology based Gene prediction Second generation sequencing techniques – Pyrosequencing and Virtual terminator Sequencing, single cell genomics

Learning Outcomes:

By the end of this unit, the student will be able to

- Basic concepts of genomics and genome sequencing
- Genome finishing
- Gene prediction, second generation sequencing techniques

UNIT II

Assessing genomic variations Dominant and codominant markers, Homoplasy concept, Identical by state Vs Identical by descent markers, Hybridization based marker system – RFLP, PCR based marker

systems – RAPD, AFLP, CAPS, SCAR, SSRs, Microarray based SNP detection techniques, Expressed sequence tags, Applications of DNA markers. Introduction to metagenomics.

Learning Outcomes:

By the end of this unit, the student will be able to

- Assess genomic variations
- Comprehend basic concepts of metagenomics

UNIT III

Introduction to Proteomics; Current Proteomics; Tools to study proteome; Protein-protein interaction networks; Topology; Network motifs. Pfam (protein families) 5000 strategy and targetDB (targetdb.pdb.org).

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Basic concepts of proteomics
- Tools to study proteomics

UNIT IV

Interaction: Proteomics Interactomes and Proteomic interactions (Y2H approaches, Co-IP); Proteome-wide interaction maps; Protein structure determinations and Structural proteomics tools (experimental and computational); Concepts of protein engineering

Learning Outcomes:

By the end of this unit, the student will be able to appreciate and use

- Proteomic interactions
- Protein structure determinations
- Structural proteomics tools
- Concepts of protein engineering

UNIT V

Proteomic technologies Transcriptomes and analysis; SAGE, Microarray technology; Analytical proteomics tools (1-D & 2-D gel electrophoresis); Mass spectrometry and analysis (ESI, MALDI and Hybrid), LC/MS-MS; Applications of mass spectrometry (PMF and PTMs)

Learning Outcomes:

By the end of this unit, the student will be able to comprehend

- Microarray technology

- Analytical proteomics tools
- Mass spectrometry and analysis
- Applications of mass spectrometry

Course Outcomes:

At the end of the course, students will

- Learn the basic concepts of genomics and metagenomics
- Get exposure to the tools of proteomics
- Learn the importance of Protein structure determinations and Proteomic interactions
- Develop the concepts of protein engineering and Microarray technology
- Know about the Analytical proteomics tools and Mass spectrometry

RECOMMENDED BOOKS:

1. Cantor and Smith, Genomics. John Wiley & Sons, 1999.

2. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.

3. R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.

4. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.

5. L.Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007.

6. Principles of Gene Manipulation and Genomics- Sandy B. Primrose, Richard Twyman, Blackwell Publishing Professional (Mar. 1st, 2006)

M.Sc. (Microbiology) III SEMESTER

SMB 843: BIOENERGY AND BIOFUELS

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course aims to provide an overview of the fundamental concepts of biofuels, bioenergy. Biofuel production by biomass conversion process. Biodiesel production using oil seeds and algae.

Course Objectives:

- Fundamental concepts of biofuel and bioenergy production
- Properties of biomass
- Biomass conversion strategies
- Biodiesel by algae and oil seeds

UNIT I

Fundamental concepts of biofuels, bioenergy, renewable feedstocks, current energy consumption, road map of bioenergy, availability and attributes for biofuel/bioenergy production; types of biomass-derived fuels and energy. Microbial Fuel Cells.

Learning Outcomes:

By the end of this unit, the student will be able to explain

- Fundamental concepts of biofuels and bioenergy
- Availability and attributes for biofuel and bioenergy production
- Microbial fuel cells

UNIT II

Properties of biomass; Feed stocks availability, characterization and attributes, calorific value, density, moisture content, t*ypes of biomass:* lignocellulosic, starchy, sugar, *oilseeds, and* Municipal residual waste, organic waste, sewage sludge, manure.

Learning Outcomes:

By the end of this unit, the student will know

- Properties of biomass
- Types of biomass with proper examples

UNIT III

Biofuels from biomass conversion process Solid: biochar, Liquid: bioethanol, biodiesel, Gaseous: biogas and syngas, Preprocessing or pretreatment of biomass: drying, size reduction and densification. Detoxification methods.

Learning Outcomes:

By the end of this unit, the student will be able to know

- Biofuel from biomass conversion process
- Preprocessing or pretreatment of biomass
- Detoxification methods

UNIT IV

Process for biomass conversion: Thermochemical (pyrolysis, gasification, reforming, combustion), biochemical or biological process (anaerobic digestion, fermentation). Enzyme hydrolysis and their applications in ethanol production

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Thermochemical, biochemical or biological process for biomass conversion
- Enzyme hydrolysis and their merits for ethanol production

UNIT V

Biodiesel production from oil seeds waste oils and algae. Environmental impacts of biofuel production; Energy balance, economics and life-cycle analysis of biofuel production, value-added processing of biofuel residues and co-products.

Learning Outcomes:

By the end of this unit, the student will be able to know about

- Biodiesel production from oil seeds or waste oils and algae
- Economics and life-cycle analysis of biofuel production
- Value-added processing of biofuel residues and co-products

Course outcomes:

By the end of the course, students will

- Learn the fundamental concepts of biofuel and bioenergy production
- Know the Properties of biomass
- Design biomass conversion strategies

- Know about the production of biodiesel by algae and oil seeds

RECOMMENDED BOOKS:

1. Biofuel and Bioenergy, Edited by John Love and John A Bryant, wiley Black well publishers

2. Handbook of biofuel production, Process and Technologies, Edited by Rafael Luque, Juan Champelo and James Clark, Woodhead publishers

3. Biofuel Technologies, recent developments, edited by Vijai Kumar Gupta, Maria G Tuohy, Springer publishers

4. Bioenergy, biomass to biofuel, edited by Anju Dhahia , Elsevier

5. Advances in Biofuel, Edited by Ravindra Pogaku, Rosalam Hj.Sarbately, Springer

M.Sc. (Microbiology) III SEMESTER

SMB 845: DAIRY TECHNOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals:40 Marks

Preamble:

Dairy Technology deals with processing of milk and milk product. Dairy technology study involves processing, storage, packaging, distribution and transportation of dairy products by entailing the science of bacteriology, nutrition and biochemistry.

Course Objectives:

- To know the need and importance of dairy industry
- To know the compositional and technological aspects of milk
- To study processed milk and milk products

UNIT I

Introduction, milk - composition, food and nutritive value, physico-chemical properties. Buying and collection of milk, transportation of milk, milk reception in dairies, quality and quantity tests at reception. Microbiological quality of milk and its spoilage.

Learning Outcomes:

By the end of this unit, the student will learn of

- Milk, its properties nutritive value, physico-chemical properties
- Buying and collection of milk, perform quality analysis at the reception desk.

UNIT II

Filtration / clarification, storage of milk, standardization, types of milk- low fat milk, full fat milk, SNF. Homogenization, pasteurization – types of pasteurization process. Equipment used in each process - cream separating centrifuges, pasteurizers (heat exchangers), homogenizers, bottle and pouch fillers, milk chillers.

Learning Outcomes:

By the end of this unit, the student will be able to

- Know the processing stages of milk and milk products.
- Utilization of variety of equipments used in various stages of processing

UNIT III

Manufacture of cream, butter, ghee, milk powder, cheese – types and defects in cheese. Chemical and microbiological quality. Dairy equipment- butter churn, ghee boiler, spray and drum dryers.

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn manufacturing of cream, butter, ghee, milk powder, and cheese
- Learn dairy equipment related to the the above products manufacturing

UNIT IV

Manufacture of ice cream – chemistry and technology – microbiology of ice cream – quality aspects. Manufacture of paneer, toned milk, sweetened condensed milk, khoa. Extraction of casein from milk – properties, composition and industrial uses. Production of lactose and whey.

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn ice cream manufacturing, manufacturing to quality aspects
- Preparation of paneer, khoa, whey etc.

UNIT V

Fermented products – yoghurt, curd, acidophilus milk, butter milk. Dairy plant sanitization – cleaning in place – bottle and can washing, cleaning of tankers and silos – detergents and sanitizers.

Learning Outcomes:

By the end of this unit, the student will be able to

- Study of different milk products and its production.
- Understand the importance of dairy sanitization.

Course Outcomes:

By the end of the course, students will

- Understand the need for and importance of dairy industry
- Develop knowledge on the compositional and technological aspects of milk
- Learn about processed milk and milk products

RECOMMENDED BOOKS:

1. Outlines of Dairy Technology (2008) by S. De.
2. Modern Technology of Milk Processing and Dairy Products (2004) NIIR Publications.

3. Milk Products (1999) by W.M.C. Harvey and H. Hill.
4. Milk and Dairy Product Technology (2005) by E. Spreer.
5. Food Engineering and Dairy Technology (1981) by H.G. Kessler.

M.Sc. (Microbiology) III SEMESTER

SMB 847: MICROBIAL BIOTECHNOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

Microbial biotechnology course provides applications of microbiology in various fields using biotechnological concepts. Applications in agricultural fields as Biofertilizers and Biopesticides. Microbial biotechnological production of biofuels using microorganisms. Microorganisms used as food and applied as bioremediation purpose.

Course Objectives: To Provide knowledge of

- Concepts of role and applications of Biofertilizers
- Concepts and functions of Biopesticides
- Basic principles and production strategies of biofuels using microorganism
- Role of microorganisms in food industry and used as food
- Bioremediation strategies using microbial biotechnology

UNIT- I

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

Learning Outcomes:

By the end of this unit, the student will be able to know

- Biofertilizers and their applications
- Applications of cyanobacteria, PGPR, PSB in agricultural field
- Applications of marine algae and mycorrhizae

UNIT-II

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

Learning Outcomes:

By the end of this unit, the student will know of

- Biocontrol agents and their merits

- Concept of mycoprasitism and entomopathogenic fungi with proper examples

UNIT-III

Biofuels from microbial biomass - H_2 production, methane, ethanol, biodiesel, butanol, biofuels from wastes, bioelectricity- microbial fuel cell. PHB, biosensors.

Learning Outcomes:

By the end of this unit, the student will be knowledgeable of

- Production of biofuels such as H2, methane, ethanol biodiesel, butanol from waste
- Bioelectricity and biosensors

UNIT-IV

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

Learning Outcomes:

By the end of this unit, the student will be able to know

- SSP and their applications- *Spirulina*, mushroom yeast
- Significance of probiotics and prebiotics

UNIT- V

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

Learning Outcomes:

By the end of this unit, the student will understand

- Bioremediation of pollutants
- Sewage treatment
- Bio-sorption and biodegradation

Course Outcomes:

By the end of the course, students will

- Learn the concepts of role and applications of Biofertilizers
- Know about the functions of Biopesticides
- Learn the principles and production strategies of biofuels
- Study the role of microorganisms in food industry
- Design bioremediation strategies using microbial biotechnology

REFERENCE BOOKS:

1. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd edition) A. 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) III SEMESTER

SMB 821: DIAGNOSTIC MICROBIOLOGY

Hours per week: 8

Credits: 3 Sessionals: 100 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^{th} edition) Cruichshank *et. al.*
3. Microbiology – A Laboratory Manual (10^{th} edition) by J.G. Cappuccino and N. Sherman
4. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation (4^{th} edition) by K. R. Aneja.
5. Laboratory Manual in Microbiology (10^{th} edition) by Alcamo.

Course Outcomes:

After the completion of the above experiments the students will be able to perform

- Laboratory examination of urine, sputum, urine and stool samples

- Preparation differential media for isolation of pathogenic organism
- Isolation of pathogenic fungi, protozoa and bacteria
- Serum diagnostic tests

M.Sc. (Microbiology) III SEMESTER

SMB 823: IMMUNOLOGY

Hours per week: 8

Credits: 3 Sessionals: 100 Marks

1. Separation of Serum - Immunoelectrophoresis.
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.

Course Outcomes:

After the completion of the above experiments the students will be able to perform

- Immunodiffusion and immunoprecipitation techniques
- VDRL, WIDAL, ELISA techniques
- Separation and characterization of serum and lymphocytes from blood

M.Sc. (Microbiology) IV SEMESTER

SMB 802: BIOPROCESS TECHNOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course provides an overview about the study of range of fermentation processes, design of fermenters and types of fermenters, fermentation economics, and production of antibiotics, beverages and organic acids

Course Objectives:

- To familiarize students with the range of fermentation processes
- To provide knowledge on fermentor design, fermentor types etc.
- To give knowledge about fermentation medium selection, importance of growth kinetics etc.
- To make students understand about the production of ethanol, organic acids, vitamins, enzymes etc.

UNIT I

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Range of fermentation processes
- Screening and Strain development methods

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.

Learning Outcomes:

By the end of this unit, the student will be able to know of

- Fermentor design , types of fermenters and control of various parameters
- Computer applications
- 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.

Learning Outcomes:

By the end of this unit, the student will be able to understand importance of

- Fermentation medium
- Growth kinetics
- Types of fermentations

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_{12}) and antibiotics – penicillin, tetracycline.

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Production of beverages and antibiotics
- Production of organic acids and vitamins

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

Learning Outcomes:

By the end of this unit, the student will be able to know of

- Products from GMOs
- Immobilization of enzymes
- Downstream processing

Course Outcomes:

By the end of the course, students will be able to

- Familiarize with the fermentation processes
- Gain knowledge on fermenter design, and fermenter types.

- Learn about fermentation medium selection, importance of growth kinetics etc.
- Understand the production of ethanol, organic acids, vitamins, enzymes etc.

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

SMB 842: MARINE MICROBIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This course will introduce students to marine environments and their zonation followed by marine metabolic diversity and survival strategies of marine extremophiles. The students will explore positive and negative interaction operating among marine microbes. Further they will learn marine microbial diseases, their prevention and control. At the end they will learn the commercially important marine products and their production protocols.

Course Objectives:

- To familiarize students with structure of marine habitats
- To enable students appreciate marine metabolic diversity
- To introduce the survival strategies of marine extremophiles
- To familiarize students with marine microbial diseases, prevention and control
- To emphasize the economic importance of marine microbial products

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the characteristics of different marine habitats
- Understand the energy and matter circulation in marine ecosystems

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Appreciate the metabolic diversity in marine ecosystems
- Understand nutritional requirements of different marine microbes

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the survival strategies of marine extremophiles
- Categorize positive and negative interactions between marine microbes

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Know the various diseases caused by marine microbes
- Learn the importance of algal toxins

UNIT- V

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Appreciate the economic importance of marine microbial products
- Learn various seafood preservation techniques

Course Outcomes:

By the end of course, students will

- Be familiarized with structure of marine habitats
- Learn about the marine metabolic diversity
- Be introduced to the survival strategies of marine extremophiles
- Know about marine microbial diseases, prevention and control
- Learn about economic importance of marine microbial products

RECOMMENDED BOOKS:

1. Microbiology (2005) L.M. Prescott *et. al.*
2. Marine Microbiology: Ecology and Applications (2^{nd} edition) by C. Munn.
3. Marine Microbiology (2005) by J. H. Paul.
4. Microbiology: Principles and Explorations (7^{th} edition) by J. G. Black.
5. Ocean and Health: Pathogens in the marine environment (2006) by S. Belkin and 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

Preamble:

Plants interact with small organisms in their environment, such as bacteria, fungi, nematodes and viruses. Some of these can cause diseases and pests whereas others can have a plant-beneficial action, such as protecting plants against diseases, enhancing plant growth and productivity, reducing plant stresses caused by attackers, draught and salts, and cleaning soils from pollutants. Our understanding of plant-microbe interactions advances rapidly and the application of beneficial microbes in agriculture and horticulture - presently USD 1.7 billion annually - is increasing fast. In this course, the basics of all interactions mentioned above are taught to the students.

Course Objectives:

- To study about beneficiary action of plant diseases.
- To learn about host-microbe interactions and mechanisms of infection processes
- To learn about plant disease management procedures, and role of biofertilizers

UNIT- I

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn about plant diseases
- Get to know about infective agents-plant pathogenic fungi, bacteria, nematodes and viruses

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn about host-microbe interactions
- Infection processes by fungi, bacteria, nematodes and viruses

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Study about disease cycles of important plant pathogens
- Learn about edible fungi

UNIT-IV

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

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn about mechanisms involved variation in plant pathogens
- Identify methods for 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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Learn about plant disease management procedures
- Get idea about biofertilizers, and their usage

Course Outcomes:

By the end of the course, students will be able to

- Know about beneficiary action of plant diseases.
- Understand host-microbe interactions and mechanisms of infection processes
- Gain knowledge on plant disease management procedures, and role of biofertilizers

REFERENCE BOOKS

1. Roger Hull. (4th Edition) Matthew's Plant Virology

2. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd 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 (4th edition) by Salisbury and Ross.

M.Sc. (Microbiology) IV SEMESTER

SMB 846: RESEARCH METHODOLOGY, STATISTICS AND COMPUTER APPLICATIONS

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This paper consistently integrates methods, statistics, and computer applications to prepare students for both graduate work and critical analysis of research as professionals. In brief they learn about research significance, importance of probability and statistics in research environments, and about several computer tools.

Course Objectives:

- To learn about significance of research and understanding the research problem
- To learn necessary guidelines to be taken while writing research reports and proposals
- To know the importance of testing levels of significance to determine the research result to be significant or not.
- To learn about exploitation of computer tools in performing the statistical calculations and other tools

UNIT-I

Research: significance, conceptualization of problem – hypothesis, Types of research – Research designs, fundamental, applied – action, exploratory, discipline, experimental, survey, case study and ex post facto. Longitudinal, cross sectional and correlational research.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Learn about significance of research and understanding the research problem
- Understand about the types of research

UNIT-II

Theory of probability – population sample. Sampling techniques: Research methods – Interview schedule, important methods and data collection, interpretation of results, observation, social mapping, participatory rapid assessment. Writing up research reports and proposal.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Know the importance of theory of probability.
- Understand necessary guidelines to be taken while writing research reports and proposals
- Analyze the scientific data, importance of statistics and application of various statistical approaches for knowing the significance of data obtained after laboratory experiments.

UNIT– III

Statistics – meaning, role of statistics in research- descriptive research – classification, tabulation of data – graphic and diagrammatic representation of data. Measurement of central tendency , variation, dispersion, normal distribution

– Mean, median, testing levels of significance – "T" test, F test and X^2 test.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Know the formulas for central tendency and do necessary calculations
- Know the importance of testing levels of significance to determine the result to be significant or not.

UNIT– IV

Correlation, coefficient of correlation – rank correlation, analysis of variance, types, regression and forecasting–Fitting regression curves, discrimination analysis.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Know the formulas for Standard deviation, correlation, and regression methods, and usage of these calculations and retrieved values with respect to food technology values.

UNIT - V

Computer applications: MS office-word, excel, power point, internet, photoshop. Statistical software packages used in research. Software controlled food processing operations, application part in food industry. Software applications for quality control.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Learn about exploitation of computer tools in performing the statistical calculations and other tools
- Learn about software controlled food processing operations.

Course Outcomes:

By the end of the course, students will

- Learn about significance of research and understanding the research problem
- Know about the guidelines for writing research reports and proposals
- Understand the importance of testing levels of significance to determine the research result to be significant or not.
- Learn about exploitation of computer tools in performing the statistical calculations and other tools

Recommended Books:

1. Foundations of Behavouring Research (1983) by F.N.Kerlinger
2. Research Methodology: Methods and Techniques (2004) by C.R.Kothari
3. Methodology and Techniques of Social Research (2000) by P.L. Bandarkar and T.S.Wilkinson.
4. Research Methodology for Biological Sciences (2006) by N.Gurumani
5. Biostatistics (2^{nd} edition) by P.K. Arora and P.K.Malhal.
6. Fundamentals of Biostatistics (1994) by Khan and Khanum
7. An introduction to biostatistics (2^{nd} edition) by N.Gurumani.
8. Basic Concepts in Statistics (2009) by K.S. Kushwaha and R.Kumar

M.Sc. (Microbiology) IV SEMESTER

SMB 848: BIOETHICS AND IPR

Hours per week:4 End Examination: 60 Marks

Credits:4 Sessionals: 40Marks

Preamble:

Bioethics is the study of the ethical issues emerging from advances in biology and medicine. Bioethics are concerned with the ethical questions that arise in the relationships among life sciences, biotechnology, medicine and medical ethics, politics, law, and philosophy. Intellectual property refers to creations of the mind: inventions; literary and artistic works; and symbols, names and images used. Intellectual property is divided into two categories: Industrial Property includes patents for inventions, trademarks, industrial designs and geographical indications.

. **Course Objectives:**

- To create a stable research environment to encourage investigation, analysis and studying the bioethical principles, values, concepts, social and juridical implications.
- To gain knowledge on the human rights contained in the Universal Declaration on Bioethics
- To create awareness on protection of the rights of IP owners to enable them to reap the rewards of their creativity

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the concepts of genetic engineering, patenting , cloning etc
- Gain awareness on social responsibilities and public acceptance
- Apprehend latest research in biotechnology and stem cell research

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the concept of Bioterrorism and its global impacts
- Grasp the biosafety regulations to be followed in India
- Apprehend the guidelines to be followed for conducting research in biology

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Assess the hazards and biosafety in labs
- Illustrate the type and level of biosafety to be followed by different labs
- Understand the consequences of releasing the GM organisms into surroundings

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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Differentiate IPR and IPP
- Understand the importance of patenting in research and scientific innovations
- Apprehend the procedures for 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.

Learning Outcomes:

By the end of this unit, the student will be able to

- Differentiate between the types of patent available
- Understand the pros and cons of patents in biotechnology
- Illustrate the rights and duties of patent owners and farmers rights

Course Outcomes:

By the end of the course, students will

1. Create a stable research environment to encourage investigation, analysis and studying the bioethical principles, values, concepts, social and juridical implications.
2. Gain knowledge on the human rights contained in the Universal Declaration on Bioethics
3. Create awareness on protection of the rights of IP owners to enable them to reap the rewards of their creativity

Recommended Books:

1. Principles of cloning (2002) J. Cibelliet.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

SMB 822: FERMENTATION TECHNOLOGY

Hours per week: 8

Credits: 3 Sessionals: 100 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 A*spergillus 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^{rd} 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 Peppler *et. al.*

Course Outcomes:

After the completion of the above experiments the students will be able to

- Screening techniques for amylase enzyme, organic acid and antibiotic producing microorganism
- Production of citric acid, glutamic acid wine and ethanol
- Isolation of *Rhizobium, Azotobacter*
- Microbial assay of MIC of antibiotics against pathogens

OPEN ELECTIVE

SOE 881: MANAGEMENT OF INFECTIOUS DISEASES

(III SEMESTER)

Hours per week: 3 End Examination: 60 Marks

Credits: 3 Sessionals: 40 Marks

Preamble:

Management of infectious diseases course provides the basic knowledge about infectious agents, transmission infections and control measures

Course Objectives:

- Water borne diseases and control measures
- Food and milk born infections and control measures
- Air born microbial infections prevention and control measures
- Basic knowledge about antibiotics
- Basic knowledge about vaccines and preventive measures

UNIT- I

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

Learning Outcomes:

By the end of this unit, the student will be able to know the importance of

- Potability of water
- Indicator organism
- Water born diseases and control measures

UNIT- II

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

Learning Outcomes:

By the end of this unit, the student will be able to understand about

- Food borne infections
- Food poisoning and intoxicaton
- Food preservation methods

UNIT- III

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

Learning Outcomes:

By the end of this unit, the student will know of

- Air borne microbial infections
- Prevention and control measures of air born infections

UNIT- IV

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

Learning Outcomes:

By the end of this unit, the student will be comprehend

- Antibiotics, sensitivity and resistance to them
- 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.

Learning Outcomes:

By the end of this unit, the student will be able to understand

- Vaccines and vaccination schedule
- Types of vaccines and Vaccinoprophylaxis of cervical cancer

Course Outcomes:

By the end of the course, students will be able to

- Learn about water borne diseases and control measures
- Develop knowledge on food and milk born infections and control measures
- Know about air born microbial infections prevention and control measures
- Gain Basic knowledge about antibiotics
- Be imparted with basic knowledge about vaccines and preventive measures

RECOMMENDED BOOKS:

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