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

Accredited by NAAC with A^+ Grade

REGULATIONS AND SYLLABUS

OF

B.Sc. (Hons) Microbiology

(w.e.f. 2020-21 admitted batch)

B.Sc. (Hons.) MICROBIOLOGY
REGULATIONS*

(W.e.f. 2020-21 admitted batch)

1.0 ADMISSIONS

Admissions into B.Sc. (Hons.) Microbiology program of GITAM (Deemed to be University) are governed by GITAM (Deemed to be University) admission regulations.

2.0 ELIGIBILITY CRITERIA

2.1 A pass in Intermediate or +2 with Physics, Chemistry, and Mathematics or Biology with a minimum aggregate of 50% marks or any other equivalent Examination approved by GITAM (Deemed to be University).

2.2 Admissions into B.Sc. (Hons.) Microbiology will be based on the marks obtained in intermediate or equivalent examination and the rule of reservation, wherever applicable.

3.0 CHOICE BASED CREDIT SYSTEM

Choice based credit system (CBCS) is introduced with effect from the admitted batch of 2020-21 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.

4.0 STRUCTURE OF THE PROGRAMME

4.1 The program consists of:

(i) Ability enhancement compulsory core courses (AECC)
(ii) Core Courses (compulsory) (CC)
(iii) Discipline specific electives (DSE)
(iv) Generic electives (GE)
(v) Skill enhancement courses (SEC) are of general nature either related or unrelated to the discipline.
(vi) Practical Proficiency Courses (PPC): Laboratory 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.
- One credit for two hours of Practical per week.
- Eight credits for project

4.4 The curriculum of six semesters B.Sc. (Hons.) MICROBIOLOGY program is designed to have a total of 142 credits for the award of B.Sc. (Hons.) MICROBIOLOGY degree.

5.0 MEDIUM OF INSTRUCTION:

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

6.0 REGISTRATION

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

7.0 ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester 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 have to repeat the semester along with his / her juniors.

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

8.0 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. course 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 performanceinbest 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.) forthe test conducted at the end ofthe Semester conducted bythe 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. RETOTALING & REVALUATION

9.1 Retotaling of the theory answer script of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the result.

10. PROVISION FOR ANSWER BOOK VERIFICATION & CHALLENGE EVALUATION:

10.1 If a student is not satisfied with his/her grade after revaluation, the student can apply for, answer book verification on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a student is not satisfied with revaluation marks/grade awarded, he/she can apply for challenge valuation within one week after announcement of answer book verification result/ two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is succeeded in the appeal with a change for a better grade.

11. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

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

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

11.3 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.

12. PROMOTION TO THE NEXT YEAR OF STUDY

12.1 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.

12.2 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.

13. BETTERMENT OF GRADES

13.1 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.

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

14. REPEAT CONTINUOUS EVALUATION:

14.1 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.

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

14.3 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.

14.4 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.

14.5 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.

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

15. 0 GRADING SYSTEM

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

Table 2: Grades & Grade Points

Sl.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	-

15.2 “

A student who earns a minimum of four grade points (P Grade) in a

Course is declared to have successfully completed the course, subject to securing an average GPA (average of all GPAs in all the semesters) of 5 at the end of the Program to declare pass in the program”.

“Candidates who could not secure an average GPA of 5 at the end of the program shall be permitted to reappear for a course(s) of their choice to secure the same’.

16. GRADE POINT AVERAGE

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

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

Where

C = number of credits for the course,
G = grade points obtained by the student in the course.

16.2 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.

16.3 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

Distinction	≥ 8.0*
First Class	≥ 7.0
Second Class	≥ 6.0

Pass	≥ 5.0

* In addition to the required CGPA of 8.0, the student must have necessarilypassed all the courses of every semester in **first attempt**.

17 ELIGIBILITY FOR AWARD OF THE B.Sc. DEGREE

17. 1 Duration of the program: A student is ordinarily expected to complete B.Sc. program in six semesters of three years. However a student may complete the program in not more than five years including study period.

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

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

17.3.1 Registered and successfully completed all the courses andprojects.

17.3.2 Successfully acquired the minimum required credits as specifiedin the curriculum corresponding to the branch of his/her study within the stipulated time.

17.3.3 Has no dues to the Institute, hostels, Libraries, NCC / NSS etc,and

17.3.4 No disciplinary action is pending against him / her.

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

18 Discretionary Power:

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

BSc Microbiology (H)

Program Educational Objectives

PEO 1. To expose students to the theory and laboratory skills in microbiology

PEO 2. To make students competent in Microbiology and allied areas by providing them hands-on experience.

PEO 3. To instill the ability for research and entrepreneurship in the students

PEO 4. To increase the students ability in integrating various aspects of microbiology

Program Outcomes:

Students will be able to:

1. Will gain basic knowledge about microbiology principles with an understanding of bacteriology, cell biology, molecular biology, virology, mycology, immunology, pathogenesis, laboratory diagnosis, prevention, and control of common diseases in the country.
2. They will also acquire laboratory safety knowledge and routine and specialized microbiological skills applicable to clinical research, including accurately reporting observations and analysis.
3. Relate 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 chromatographic, electrophoretic, and spectrophotometric techniques to purify proteins to homogeneity and quantitate the concentrations successfully.

Course Structure (Microbiology-Major)

Details of courses under B.Sc. (Honours)

COURSE	*CREDITS
I. Core Course Theory (14 Papers)	14×4= 56
Core Course Practical(14 Papers)	14×2=28
II. Elective Course (8 Papers)	
A.1. Discipline Specific Elective **(4 Papers)**	4×4=16
A.2. Discipline Specific Elective Practical**(4 Papers)**	4×2=8
B.1. Generic Elective/ Interdisciplinary **(4 Papers)**	4×4=16
B.2. Generic Elective Practical (**4 Papers)**	4×2=8
C. Skill Enhancement Elective Course **(2 Papers)**	2×2=4
III. Ability Enhancement Courses	
Ability Enhancement Compulsory (3 Papers of 2 credit each) EnglishCommunication Skills Environmental Science	3×2=6
Total credit	**142**

Type of Course	No. of courses		Credits	
	Theory	Lab/Tutorial	Theory	Lab/Tutorial
Ability Enhancement Compulsory Courses	03	--	06	--
Core courses	14	14	56	28
Discipline Specific Electives	04	04	16	08
Generic Electives	04	04	16	08
Skill enhancement Courses	02	--	04	--
TOTAL	27	22	98	44

TOTAL CREDITS: 142 (Theory: 98 and Lab: 44)

SEMESTER-I

Course Code	Category	Title	Periods / week	Credits	Scheme of Evaluation		
					CE	SE	Total Marks
20SFC 101	AECC	English for Communication –I	3	2	40	60	100
20SMB 105	CC	Introductory Microbiology and Bacteriology	4	4	40	60	100
20SMB 107	CC	Chemistry-I	4	4	40	60	100
20SMB 141 / 143	GE	Generic Elective-1	4	4	40	60	100
20SMB 125	PPC	Introductory Microbiology and Bacteriology Practical	3	2	100	--	100
20SMB 127	PPC	Chemistry-I Practical	3	2	100	--	100
20SMB 181 / 183	PPC	Generic Elective-1 Practical	3	2	100	--	100
Total			**24**	**20**			

SEMESTER-II

Course Code	Category	Title	Periods / week	Credits	Scheme of Evaluation		
					CE	SE	Total Marks
20SFC 102	AECC	Environmental Science	3	2	40	60	100
20SMB 106	CC	Chemistry-II	4	4	40	60	100
20SMB 108	CC	Virology	4	4	40	60	100
20SMB 142 / 144	GE	Generic Elective-2	4	4	40	60	100
20SMB 126	PPC	Chemistry-II Practical	3	2	100	--	100
20SMB 128	PPC	Virology Practical	3	2	100	--	100
20SMB 182/184	PPC	Generic Elective-2 Practical	3	2	100	--	100

Total	**24**	**20**			

SEMESTER-13

Course Code	**Category**	**Title**	**Periods / week**	**Credits**	**Scheme of Evaluation**		
					CE	**SE**	**Total Marks**
20SFC 203	AECC	English for Communication-II	3	2	40	60	100
20SMB 205	CC	Microbial Physiology and Biochemistry	4	4	40	60	100
20SMB 207	CC	Cell Biology	4	4	40	60	100
20SMB 209	CC	Molecular Biology	4	4	40	60	100
20SMB 241 / 243	GE	Generic Elective-3	4	4	40	60	100
20SSE 257/259	SEC	Skill Enhancement Course-1	3	2	100	--	100
20SMB 225	PPC	Microbial Physiology and Biochemistry Practical	3	2	100	--	100
20SMB 227	PPC	Cell Biology Practical	3	2	100	--	100
20SMB 229	PPC	Molecular Biology Practical	3	2	100	--	100
20SMB 281 / 283	PPC	Generic Elective-3 Practical	3	2	100	--	100
Total			**34**	**28**			

SEMESTER-14

Course Code	Category	Title	Periods/ week	Credits	Scheme of Evaluation		
					CE	SE	Total Marks
20SMB 206	CC	Microbial Genetics	4	4	40	60	100
20SMB 208	CC	Environmental Microbiology	4	4	40	60	100
20SMB 210	CC	Food and Dairy Microbiology	4	4	40	60	100
20SMB 242 / 244	GE	Generic Elective-4	4	4	40	60	100
20SSE 266 / 268	SEC	Skill Enhancement Course-2	3	2	100	--	100
20SMB 226	PPC	Microbial Genetics Practical	3	2	100	--	100
20SMB 228	PPC	Environmental Microbiology Practical	3	2	100	--	100
20SMB 230	PPC	Food and Dairy Microbiology Practical	3	2	100	--	100
20SMB 282 / 284	PPC	Generic Elective-4 Practical	3	2	100	--	100
Total			**31**	**26**			

SEMESTER 5

Course Code	Category	Title	Periods / week	Credits	Scheme of Evaluation		
					CE	SE	Total Marks
20SMB 305	CC	Industrial Microbiology	4	4	40	60	100
20SMB 307	CC	Recombinant DNA Technology	4	4	40	60	100
20SMB 341 / 343 / 345	DSE	Discipline Specific Elective-1	4	4	40	60	100
20SMB 351 / 353 / 355	DSE	Discipline Specific Elective-2	4	4	40	60	100
20SMB 325	PPC	Industrial Microbiology Practical	3	2	100	--	100
20SMB 327	PPC	Recombinant DNA Technology Practical	3	2	100	--	100
20SMB 371 / 373 / 375	PPC	Discipline Specific Elective-1 Practical	3	2	100	--	100
20SMB 381 / 383 / 385	PPC	Discipline Specific Elective-2 Practical	3	2	100	--	100
Total			**28**	**24**			

SEMESTER 6

Course Code	Category	Title	Periods / week	Credits	Scheme of Evaluation		
					CE	SE	Total Marks
20SMB 306	CC	Medical Microbiology	4	4	40	60	100
20SMB 308	CC	Immunology	4	4	40	60	100
20SMB 342 / 344 / 346	DSE	Discipline Specific Elective-3	4	4	40	60	100
20SMB 352 / 354 / 356	DSE	Discipline Specific Elective-4	4	4	40	60	100
20SMB 322	PPC	Medical Microbiology Practical	3	2	100	--	100
20SMB 324	PPC	ImmunologyPractical	3	2	100	--	100
20SMB 372 / 374 / 381/383	PPC	Discipline Specific elective-3 Instrumentation and Biochemical techniques Food Safety and Hygiene Instrumentation and Biochemical techniques Practical Food Safety and Hygiene Practical	3	2	100	--	100
20SMB 392	PPC	Discipline Specific elective-4 Project work	--	6	100	--	100
Total			**25**	**28**			

GENERIC ELECTIVES (GE)

GE-1 (One paper and corresponding lab to be selected)

20SMB 141	Ecology
20SMB 143	Microbes in Sustainable Agriculture
20SMB 181	Ecology Practical
20SMB183	Microbes in Sustainable Agriculture Practical

GE-2 (One paper and corresponding lab to be selected)

20SMB 142	Biofilms
20SMB 144	Inheritance Biology
20SMB 182	Biofilms Practical
20SMB 184	Inheritance Biology Practical

GE-3 (One paper and corresponding lab to be selected)

20SMB 241	Marine Microbiology
20SMB 243	Bioenergy and Biofuels
20SMB 281	Marine Microbiology Practical
20SMB 283	Bioenergy and Biofuels Practical

GE-4 (One paper and corresponding lab to be selected)

20SMB 242	Bioremediation
20SMB 244	Probiotics and prebiotics
20SMB 282	Bioremediation Practical
20SMB 284	Probiotics and prebioticsPractical

DISCIPLINE SPECIFIC ELECTIVES (DSE)

DSE-1 & 2 (Two papers and corresponding labs to be selected)

20SMB 341	Microbiomics and Bioinformatics
20SMB 343	MicrobialQualityControland Quality Assurance
20SMB 345	Microbial Biotechnology
20SMB 351	Microbiomics and Bioinformatics Practical
20SMB 353	MicrobialQualityControland Quality AssurancePractical
20SMB 355	Microbial Biotechnology Practical

DSE-3 (One papers and corresponding labs to be selected)

20SMB 372	Instrumentation and Biotechniques
20SMB 374	Food Safety and Hygiene
20SMB 381	Instrumentation and Biotechniques Practical
20SMB 383	Food Safety and Hygiene Practical

DSE- 4

20SMB 392	Project work

SKILL ENHANCEMENT ELECTIVES (SEC)

SEC-1 (One paper to be selected)

20SSE 257	Microbial Diagnosis in HealthClinics
20SSE 259	Food Fermentation Techniques

SEC-2 (One paper to be selected)

20SSE 266	Management of Human Microbial Diseases
20SSE 268	Microbiological Analysis of Air and Water

Type of Course	No. of courses		Credits	
	Theory	Lab/Tutorial	Theory	Lab/Tutorial
Ability Enhancement Compulsory Courses	03	--	06	--
Core courses	14	14	56	28
Discipline Specific Electives	04	04	16	08
Generic Electives	04	04	16	08
Skill enhancement Courses	02	--	04	--
TOTAL	27	22	98	44

TOTAL CREDITS: 142 (Theory: 98 and Lab: 44)

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SFC 101: ENGLISH FOR COMMUNICATION– I

Hours per week: 3 End Examination: 60 Marks

Credits: 2

Preamble:

This course has been designed to enrich students' listening, speaking, reading and writing, abilities so they can pursue their personal, academic and career goals through the acquisition and improvement of English language skills. Students engage with the text while reinforcing what is learnt.

Course Objectives:

- To develop right pronunciation
- To enable students to use English in day-to-day communication
- To facilitate the use of language without grammatical errors
- To expose them to prose and poetry and enable them to learn language through simple literature.
- To build advanced vocabulary
- To improve reading skills

UNIT- I

The eyes are not here – Ruskin Bond

Pronunciation: Consonants,**Grammar:** Nouns, **Vocabulary:**Roots forms of words**,**

Spelling: Correcting wrong spelling, **Punctuation:**Capitalisation,

Conversation and Role Play: Introducing oneself in formal or social contexts,

Learning Outcomes:

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

- Develop creative communication skills
- Understand and use consonant sounds in phonemic language
- Use correct spelling and capitalization.

- Introduce oneself in the appropriate diction, style and tone.

UNIT- II

Work Brings Solace – APJ Abdul Kalam

Pronunciation: Monophthongs **Grammar:** Pronouns,

Vocabulary: Prefixes & Suffixes, **Spelling:** using 'un' and 'dis' to complete antonyms**, Punctuation:** Capitalization,

Conversation and Role Play: starting a conversation/controlling a conversation**,**

Learning Outcomes:

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

- Perceive the content in the academic text and recognize the organization and purpose of reading a text.
- Determine the meaning of words using roots, *prefixes, and suffixes*.
- Engage in discussion on everyday topics
- Open and keep *conversations* going.
- Interrupt and end *conversations* appropriately

UNIT –III

Bangle Sellers – Sarojini Naidu

Pronunciation: Diphthongs **Grammar:** Helping verbs & auxiliary verbs, **Vocabulary:** Homophones, Homographs, Homonyms **Punctuation:** comma & full stop,

Conversation: Describing one's college and course of study,**Writing:** Paragraph writing/ Descriptive Writing,

Learning Outcomes:

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

- Comprehend and interpret poetic diction
- Define '*diphthong*'; recognize and identify *diphthongs* in speech and text
- Demonstrate the use of homophones, homographs, and homonyms in writing.
- Recognize and use comma and *full stop* in appropriate places in the text.

- Speak about his/her course of study and describe the college he/she is studying in with the right diction and tone.
- *Construct a paragraph* on familiar and academic topics using a topic sentence

UNIT -IV

The Merchant of Venice (Extract) – William Shakespeare

Pronunciation: varied pronunciation of some letters of the alphabet

Grammar: Main verbs & Tenses, **Vocabulary:** Collocations, **Punctuation:** Question mark and Exclamation mark,

Conversation: Leaving a message and taking an appointment

Learning Outcomes:

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

- appreciate the varied uses of language in Shakespearean Play
- Use present, past and future tenses with appropriate time markers.
- Be aware of the different types of collocations and use them appropriately
- Recognize and use question mark and *exclamation mark* in appropriate places in the text.
- Leave a message and take an appointment in a professional manner

UNIT- V

Vocabulary building: Synonyms, Antonyms, One Word Substitutes,Phrasal Verbs, Idiomatic Expressions, Foreign Phrases

Learning Outcomes:

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

- Demonstrate understanding of synonyms and antonyms in active learning
- Strengthen their vocabulary base in one word substitution
- Use phrasal verbs in their day to day communication
- Familiarize with commonly used idiomatic expressions and use them correctly
- Recognize frequently used foreign words and phrases related to areas of immediate relevance.

Recommended Readings:

Text Books:

Part – 1 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.ArunaPriya)

Supplementary Reading:

1. Communicative skills for Technical Students, M. Faratullah. Orient Longman

2.Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 105: INTRODUCTORY MICROBIOLOGYAND BACTERIOLOGY (THEORY)

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 learn the subject of microbiology by its history, microscopy, aseptic techniques, sterilization, isolation of bacteria, study of morphological characters, identifying and classification of bacteria.

2. To know the preservation of microbes, staining techniques, understanding nutritional types of bacteria.

3. To learn the details of some clinically important bacteria

4. To understand the importance of study of microbiology of water, milk and microbial interactions in nature.

Unit1

HistoryofDevelopmentofMicrobiology,Spontaneousgeneration*vs*.biogenesis, Germ theory of disease, golden era of microbiology,Contributionsof AntonvonLeeuwenhoek,LouisPasteur,RobertKoch,JosephLister,AlexanderFleming, EdwardJenner

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

- To understand the history and importance of Microbiology
- To learn the contributions of eminent personalities for microbiology

Unit 2

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganismsGeneralcharacteristicsofdifferentgroups:Acellularmicroorganisms(Viruses,Viroids,Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, nutrition, mode of reproduction and economicimportance.

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

- To know how to classify the microbes
- To understand the basic structure and characteristics of microbes

Unit 3

Morphology and ultrastructure of bacterial cell, endospore: Structure, formation, stages ofsporulation. Introduction to Bergey's manual of systematic bacteriology.

Learning Outcomes: By the end of this Unit, the student will be able

- To Understand the structure of bacterial cell
- To learn about the systemic bacteriology

Unit 4

SterilizationPhysicalmethodsofmicrobialcontrol:heat,lowtemperature,highpressure,filtration,desiccation, osmotic pressure,radiation. Chemical methods of microbial *control*: disinfectants, types and mode of action. Isolation, cultivation, enumerationand preservation of microorganisms;Microscopic identification: staining methods- simple, differential, structural and special staining. Bacterial reproduction and growth.Synchronous, batch and continuous cultures.

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

- To learn the methods for microbial control
- To understand the bacterial growth and reproduction

Unit5

BrightFieldMicroscope,DarkFieldMicroscope,PhaseContrastMicroscope, Fluorescence Microscope,ScanningandTransmissionElectronMicroscope

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

- To understand and apply the knowledge of microscopy in the study of micorbes
- To understand different types of microscopes used for microbiology

Course Outcomes:

By the end of the course students will

1. Learn the history of Microbiology, microscopy, aseptic techniques, sterilization,
2. Learn about the isolation of bacteria, study of morphological characters, identifying and classification of bacteria.
3. Learn the preservation of microbes, staining techniques, understanding nutritional types of bacteria.
4. Know the details of some clinically important bacteria
5. Understand the importance of study of microbiology of water, milk and microbial interactions in nature.

RECOMMENDED BOOKS

1. Microbiology 5^{th} edition by Pelczar, Chan and Krieg.
2. General Microbiology, 5^{th} edition by Stanier, Deudroff and Adelberg.
3. Bergey's Manual of Systematic Bacteriology 9^{th} edition, volumes I to VI.
4. Brock Biology of Microorganism 9^{th} edition by Madigan, Martinko and Parker.

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 121: INTRODUCTORY MICROBIOLOGY(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Microbiology Good Laboratory Practices and Biosafety.
2. Tostudytheprincipleandapplicationsofimportantinstruments(biologicalsafetycabinets , autoclave,incubator,BODincubator,hotairoven,lightmicroscope,pHmeterusedinthe microbiology laboratory.
3. Morphological identification of bacteria.
4. Morphological identification of Fungi using permanent slides/wet mounts.
5. Morphological identification of algae using permanent slides/wet mounts.
6. Preparationofdifferentmedia:syntheticmediaBG-11,Complexmedia-nutrient agar, McConkey agar, EMB agar.
7. Simple staining
8. Negative staining
9. Gram's staining
10. Acid fast staining-permanent slide only.
11. Capsule staining
12. Endospore staining.
13. Isolation of pure cultures of bacteria by streaking method.
14. Preservation of bacterial cultures by various techniques.
15. Estimation of CFU count by spread plate method/pour plate method.
16. Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.

2. BlackJG.(2008).Microbiology:PrinciplesandExplorations.7th edition.PrenticeHall
3. MadiganMT,andMartinkoJM.(2014).BrockBiologyofMicro-organisms.14th edition.ParkerJ. Prentice Hall International,Inc.
4. PelczarJrMJ,ChanECS,andKriegNR.(2004).Microbiology.5th editionTataMcGrawHill.
5. SrivastavaSandSrivastavaPS.(2003).UnderstandingBacteria.KluwerAcademic Publishers, Dordrecht

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

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 103: CHEMISTRY-1

Hours per week: 4 End Examination:60Marks
Credits:4 Sessionals:40Marks

Preamble:

This course provides an introduction to the basic concepts related to physical as well as organic chemistry. From physical chemistry respect, students learn regarding the laws of thermodynamics, free energy, entropy, enthalpy and equilibrium constant, pH, Buffer solutions, the theory of indicators along with titration curves. In addition to these students learn concepts related to organic chemistry i.e. chemical, ionic bond and hydrogen bonding, different molecular interactions, sigma, pi and triple bond chemistry. These develop the basic concepts regarding chemical reactions.

Course Objectives:

- To impart basic concepts and understanding on the laws of thermodynamics along with different thermodynamic quantities
- To make the students acquire knowledge on different types of chemical bonds and the nature of forces between the molecules and/or ions
- Acquiring skills to help them understand solution chemistry with concepts on acids, bases, buffers and pH and their applications
- Acquiring knowledge on chemistry of saturated and unsaturated hydrocarbons with emphasis on alkanes, alkenes and alkynes

Unit1

First and second laws of Thermo dynamics.Definitions of Gibb's Free Energy, enthalpy and Entropy, equilibrium constant.Coupled reactions and additive nature of standard free energy change.Properties and importance of water, intra and intermolecular forces.

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

- To learn laws of thermodynamics
- To understand the structure of water and its properties

UNIT-2

Chemical bonding; Ionic bond: General characteristics, types of ions, size effects,radius ratio rule and its limitations. Covalent bond: Lewis structure, Valence Bond theory. Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions. Repulsive forces, Hydrogen bonding. Non-covalent interactions- electrostatic, hydrogen bonding, Vander Waals interactions, hydrophobic and hydrophilic interactions.Disulphide bridges.pH, pK, acid base reactions and buffers.

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

- To learn the types of bonds in chemistry
- To understand the types of chemical interactions

UNIT-3

Ionization of weak acids and bases, pH scale, common ion effect.Buffer solutions-derivation of Henderson equation and its applications; and applications of buffers in analytical chemistry. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

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

- To learn the importance of study of acids and bases
- To understand the importance of buffers in scientific research

Unit -4

Basics of Organic Chemistry; Organic Compounds: Classification, Nomenclature and Hybridization. Electronic Displacements: Inductive, electromeric, resonance, mesomeric, hyperconjugation effect and their applications; Dipole moment, Bond fission (Homolytic and Heterolytic). Organic Reagents – Electrophile and Nucleophile; Nucleophlicity and basicity.Introduction to types of organic reactions and their mechanism – Addition, Elimination and Substitution reactions (Only Basics).

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

- To learn the importance of concepts of hybridization

- To understand the different types of organic reagents and their role in science

UNIT - 5

Carbon-Carbon sigma bonds. Chemistry of Alkanes: Formation of alkanes – Wurtz Reaction, Corey-House synthesis, Kolbe's electrolysis. **Properties of alkanes:** Physical, Chemical properties. Free radical halogenation, oxidation, isomerization and aromatization. **Carbon-Carbon pi bonds:** Formation of alkenes – By elimination reactions (From alcohols, alkyl halide), Mechanism of E1, E2, E1cB reactions. **Properties of alkenes:** Physical, chemical properties. **Formation of alkynes:** From Vicinal dihalide, CaC2, Kolbe's Electrolysis. **Properties of alkynes:** Physical, Chemical properties. Hydrogenation of alkenes and alkynes.

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

- To learn different types of bonds in chemistry and their importance in science
- To know about alkanes, alkenes, and alkynes

Course Outcomes:

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

- Learn basic concepts and understanding on the laws of thermodynamics
- Acquire knowledge on different types of chemical bonds and thenature of forces between the molecules and/or ions
- Improve skills that help them understand solution chemistry
- Develop concepts on acids,bases, buffers and pH and their applications
- Gain knowledge on chemistry of saturated and unsaturated hydrocarbons

RECOMMENDED BOOKS

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).

2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.

3. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB123: CHEMISTRY-1 PRACTICALS

Credits: 2 Sessionals: 100 Marks

1. Checking the calibration of the thermometer

2. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

3. Chromatography;**a.** Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.**b**. Separation of a mixture of two sugars by ascending paper chromatography.

4. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid **ii.** Ammonium chloride-ammonium hydroxide

5.Preparation of solutions of different Molarity/Normality of titrants.

6. Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

7. Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal external (diphenylamine, anthranilic acid) and external indicator.

RECOMMENDED BOOKS

1. Moore, W.J., Physical Chemistry Orient Blackswan, 1999.
2. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
3. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Kalsi, P. S. Textbook of Organic Chemistry 1stEd., New Age International (P) Ltd. Pub.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

Course Outcomes:

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

1. Learn the caliberation of a thermometer and determine the boiling point
2. Perform chromatography
3. Calibrate pH Meter and prepare buffers
4. Perform Titrations

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SFC 102: ENVIRONMENTAL SCIENCE (AECC)

Credits: 2 Sessionals: 40 marks

Preamble:

Environmental science is an interdisciplinary subject that studies the interactions of the physical, chemical, biological, geographical and social components of the environment and also the relationships and effects of these components with the organisms in the environment.

Course Objectives:

- To learn the multidisciplinary nature of environmental studies
- To identify causes, effects and control measures of various environmental problems
- To understand the concept of Environmental Legislation
- To extend the role of information technology in environment and human health.

Unit I

The multidisciplinary nature of environmental studies – Definition - Scope and Importance, Need for Public awareness. Natural Resources: Classification – Renewable and Non Renewable Resources. Renewable Resources: Forest, Water and Energy Resources Non Renewable Resources: Mineral, Food and Land resources (Uses, reasons for over-utilization and effects)

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

- To understand the scope and Importance of environmental studies
- To learn and examine the reasons for over-utilization and effects
- To know the need for public awareness on environmental studies

Unit -II

Eco-system:, Producers, consumers and de-composers, Structure of Terrestrial Ecosystems (Forest Ecosystem, Grassland Ecosystem, and Desert Ecosystem) and Aquatic Ecosystems (Pond Ecosystem and Ocean Ecosystem). Function of an ecosystem -food chains, food web and ecological pyramids - energy flow in the ecosystem.

- To learn about the structure of an Ecosystem
- To understand and describe the Functions of an ecosystem
- To know and gain knowledge on ecological pyramids and energy flow in the ecosystem.

Unit -III

Environmental Pollution: Causes, effects and control measures of Air, Water, soil pollution, Thermal pollution and nuclear hazards and Municipal solid waste management. Environmental problems: Global Environmental Problems, Green house effect, Ozone layer depletion, acid rains and Climate change. National Environmental Problems: Deforestation – Causes and Effects, Environmental Problems associated with dams, mining and environmental effects.

Learning Outcomes:

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

- To understand and outline the different types of pollution
- To know and aware the basic concepts of Global Environmental Problems
- To learn the concepts of Municipal solid waste management

Unit -IV

Social Issues and the Environment: Environmental ethics, Issues and possible solutions. Waste land reclamation, Consumerism and waste products. Environmental Legislation: Environment Protection Act, Air Act, Water Act, Wildlife Protection act and The Biological Diversity Act. Disaster definition, Classification, Disaster Management: Explosion, Earth quake, Hazardous materials spill/release.

Learning Outcomes:

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

- To know the basic concepts of Environment Protection act
- To understand the importance of Disaster Management
- To learn and describe the basic concepts of waste land reclamation

Unit -V

Human Population and the Environment: Population growth, variation among nations, Population explosion-Family welfare program. Environment and human health - human rights - value education, HIV/AIDS, Women and Child welfare, Role of information technology in environment and human health.

Learning Outcomes: By the end of this Unit, the student will be able

- To understand the relation between Environment and human health
- To discuss the role of Population growth on Environment:
- To Extend the concepts of information technology in solving environmental problems

Recommended Readings:

1. Text Book of Environmental studies for Undergraduate courses by ErachBharucha Published by Orient Black Swan. 2nd edition.
2. Environmental Science: A Global Concern by William P. Cunningham and Baraba Woodworth Saigo. Published by McGraw-Hill Science/Engineering/Math; 8th edition,.
3. A text book of Environmental Science by P. C. Joshi and Namita Joshi, Published by A.P.H. Publishing Corporation.
4. A text book of Environmental Science by Arvind Kumar, Published by A.P.H. Publishing Corporation
5. Environmental Science by S C Santra, Published by New Central Book Agency (NCBA); (5th Reprint).
6. Ecology & Environment by P. D. Sharma, Published by Rastogi Publications.

Course Outcomes:

By the end of the practicals, the student will be able to

- Able to develop and implement value education and awareness programs
- Able to suggest solutions for National Environmental Problems
- Identify the differences between renewable and non renewable resources

B.Sc. (H) MICROBIOLOGYII SEMESTER
20SMB102:CHEMISTRY OF BIOMOLECULES (THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course will introduce the students to structures and functions of various biomolecules such as carbohydrates, lipids, proteins and nucleic acids, vitamins and porphyrins. Learning the structure and functions of these biomolecules will help them in forthcoming semester wherein the metabolism of these biomolecules shall be elucidated.

Course Objectives

- To learn the chemical structures and functions of carbohydrates, proteins, lipids and nucleic acids
- To learn the structure and functions of various water soluble and fat soluble vitamins
- To understand the structure and functions of important porphyrins

UNIT-I

Carbohydrates-monosaccharides, Stereo isomerism, epimers, mutarotation and anomers of glucose.Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat formsofglucose,Sugarderivatives.Disaccharides; maltose, lactose, and sucrose. Polysaccharides-storage and structural polysaccharides

Learning Outcomes

After completion of this unit the student will be able

- To learn about classification of carbohydrates and understand their importance is science
- To learn and identify structures of various carbohydrates
- To understand and appreciate the functions of different carbohydrates

UNIT-II

Definition and major classes of storage and structural lipids.Storage lipids.Fatty acids structure and functions.Essential fatty acids. Triacyl glycerols structure, functions and properties, micelles and saponification. Structural lipids- Phosphoglycerides and Sphingolipids

Learning Outcomes

After completion of this unit the student will be able

- To understand and distinguish different types of lipids
- To know and appreciate their role in day to day life

UNIT-III

Classification and biochemical structure of standard protein amino acids. Essential and non-essential amino acids.Zwitterion and isoelectric point.Proteins-primary, secondary, tertiaryandquaternarystructuresofproteins.

Learning Outcomes

After completion of this unit the student will be able to

- To learn the classification of amino acids based on structure and dietary requirement
- To understand the importance of identification of the hierarchy of protein structure

UNIT-IV

Structure and properties of nucleic acids. Different forms of DNA-A, B, Z. Circular DNA and DNA supercoiling. Types of RNA- mRNA, tRNA, rRNA.

Learning Outcomes

After completion of this unit the student will be able to

- To learn about different forms of DNA based on structure
- To know about different types of RNA

UNIT- V

Vitamins-Classification and characteristics with suitable examples, sources, functions and deficiency diseases.Porphyrins-Structure and functions of heme and chlorophyll.

Learning Outcomes

After completion of this unit the student will be able to

- To learn the classification of vitamins and appreciate their functions
- To know the structure of porphyrins with their functions

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB122: CHEMISTRY OF BIOMOLECULES (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Qualitative tests for carbohydrates, total sugars reducing sugars, non-reducingsugars
2. Qualitative tests for amino acids
3. Paper chromatography of amino acids
4. Estimation of proteins by Lowry's method
5. Determination of saponification number
6. Estimation of any onevitamin

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by CengageLearning
2. Campbell,PNandSmithAD(2011)BiochemistryIllustrated,4thed.,PublishedbyChurchill Livingstone
3. TymoczkoJL,BergJMandStryerL(2012)Biochemistry:Ashortcourse,2nded.,W.H.Freeman
4. BergJM,TymoczkoJLandStryerL(2011)Biochemistry,W.H.FreemanandCompany

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB108: VIROLOGY (THEORY)

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 cultivation methods of viruses. Additionally it details of epidemiology and emerging viral infection and preventive measures.

Course Objectives:

- To provide knowledge about distinctive characteristics of viruses.
- To provide the knowledge about principles of viral taxonomy.
- To provide the basic knowledge about replication cycles of bacteriophagse.
- To provide basic knowledge regarding viral nucleic acids and viral cultivation methods
- To provide basic concepts of epedimiological concepts and emerging viral infections

Unit 1

Introduction: Structure and general properties of viruses, Viral taxonomy: Classification andnomenclature of viruses. Concept of viroids, virusoids, satellite viruses and Prions.

Learning Outcomes: By the end of this Unit, the student will be able to learn about

- To understand the structure and general properties of viruses
- To learn the classification of ICTV and Baltimore classifications.

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UNIT-II

Bacteriophages-structure, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage. Applications of virology- Use of viral vectors in cloning and expression, Phage therapy

Learning Outcomes: By the end of this Unit, the student will be able to learn about

- To learn about Lytic and lysogenic cycles of bacteriophages
- To understand the applications of virology in various fields

UNIT-III

Salient features of viral Nucleic acids- Unusual bases,overlapping genes, alternate splicing, terminal redundancy, terminal cohesive ends, partial double stranded genomes,long terminal repeats, segmented and non-segmented. Outline on Replication strategies of DNA and RNA virus.

Learning Outcomes: By the end of this Unit, the student will be able to learn about

- To learn about salient features of viral nucleic acids
- To understand and know about replication strategies of DNA viruses
- To know about replication strategies of RNA viruses

UNIT –IV

Isolation and cultivation methods of animal viruses, cell cultures, animal incolucaltion and embryonated eggs, Cellular cytopathic effects (CPE), purification of viruses and inactivation of viruses

Learning Outcomes: By the end of this Unit, the student will be able to learn about

- To learn about isolation methods of viruses
- To study about Cultivation methods of viruses
- To know about Purification and inactivation methods of viruses

Unit V

Epidemiological concepts of viral infections, Epidemics, endemics, pandamics, new emerging viral infections, Viral transmission, prevention and control of emerging viral infections, Influenza, SARS, COVID 19, Viral vaccines, antiviral drugs.

Learning Outcomes:

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

- To learn about epidemiological concepts of viral infections
- To study about emerging viral infections and preventive strategies

Course Outcomes:

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

- Gain knowledge about distinctive characteristics of viruses.
- Learn about principles of viral taxonomy.
- Study the replication cycles of bacteriophage.
- Learn the concepts related to viral nucleic acids and viral cultivationmethods
- Learn epidemiological concepts and emerging viralinfections

Recommended Books

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

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB 128: VIROLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (Caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses)using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU)from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

RECOMMENDED BOOKS

1. Dimmock,NJ,Easton,AL,Leppard,KN(2007).IntroductiontoModernVirology.6th edition, Blackwell Publishing Ltd.
2. CarterJandSaundersV(2007).Virology:PrinciplesandApplications.JohnWileyandSons.
3. FlintSJ,Enquist,LW,Krug,RM,Racaniello,VR,Skalka,AM(2004).PrinciplesofVirology, Molecularbiology,PathogenesisandControl.2nd edition.ASMpress, Washington DC.
4. LevyJA,ConratHF,OwensRA.(2000).Virology.3rd edition.PrenticeHallpublication,New Jersey.
5. WagnerEK,HewlettMJ.(2004).BasicVirology.2nd edition.BlackwellPublishing.

Course Outcomes:

By the completion of the lab course, student will

1. Understand the structure of plant and animal viruses
2. Isolate and propagate animal viruses
3. Assay plant viruses

B.Sc. (H) MICROBIOLOGY III SEMESTER

SFC 203: ENGLISH FOR COMMUNICATION–II

Hours per week: 3 End Examination: 60 Marks

Credits: 2 Sessionals: 40 Marks

Preamble:

This course has been designed to help students acquire English language skills for professional development. The students will be exposed to aspects of English language through some very interesting texts. Each unit of the book carries a very extensive and relevant explanation on pronunciation, grammar, vocabulary, spelling, punctuation, spoken dialogues, writing and reading.

Course Objectives:

- To introduce students to Prosodic features for right speech
- To enable students to use English in day-to-day communication
- To build up their confidence in the usage of English
- To expose them to Group Discussion sessions
- To develop their written communicative competence
- To make them interview ready

UNIT- I

The Open Window : Saki (H.H.Munro)

Pronunciation: Syllabification**, Grammar:** Non-infinite verbs, **Vocabulary:** Simile & Metaphor**, Spelling:** using 'ie' or 'ei', **Punctuation:** semi-colon, **Conversation:** Asking for advice/information,

Learning Outcomes:

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

- Improve their speaking ability in English both in terms of fluency and comprehensibility.
- Heighten their awareness of correct usage of English grammar in writing and speaking.
- Attain and enhance competence in the four modes of literacy: LSRW.
- Utilize phonetic dictionary symbols to continue to improve pronunciation.
- Punctuate quoted statements, sentences and questions correctly.

UNIT- II

The Voice of Humanity – Rabindranath Tagore

Pronunciation: Word Stress, **Grammar:** Adjectives, **Vocabulary:** Oxymoron & Hyperbole**, Spelling:** using 'able' and 'ible', **Punctuation:** Colon & dash, **Group Discussion**

Learning Outcomes:

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

- To use newly acquired vocabulary in classroom activities.
- Develop independent learning strategies and study skills.
- Have the ability to communicate effectively with others.
- Understand the rules of word stress
- Acquire the skills needed for a G.D and participate efficiently

UNIT –III

If – Rudyard Kipling

Pronunciation: Sentence Stress**, Grammar:** Articles, **Vocabulary:** Portmanteau and loan words**, Spelling:** using suffixes,**Punctuation:**Hyphen& dash, **Oral Presentation**

Learning Outcomes:

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

- Demonstrate command of the conventions of Standard English punctuation, and spelling when writing.
- Enable to discuss literary texts from various theoretical and critical perspectives.
- Formulate ideas and connections between literary concepts and themes.
- Establish a deeper appreciation of cultural diversity by introducing them to poetry.
- Acquire effective presentation skills

UNIT -IV

Riders to the Sea – JM Synge

Pronunciation – Intonation**, Grammar:** Adverbs, **Vocabulary:** Palindromes**, Spelling:** completing tables with nouns, verbs, adjectives, adverbs **Punctuation:** Inverted comma, **Conversation/Role play:** Appearing for a job interview/conducting a job interview

Learning Outcomes:

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

- Collaborate with peers for role-playing, story analysis, and presentation planning.
- Use comparative forms of high frequency adjectives and adverbs.
- Apply sentence mechanics and master spelling of high frequency words.
- Demonstrate increased understanding of English syntax and grammatical elements for effective writing.
- Understand and use intonation in spoken language.
- Develop the skills needed for attending an interview

UNIT- V

Academic Writing: Letter Writing, Paragraph Writing, Essay Writing, Resume Preparation, Dialogue Writing, Precis

Learning Outcomes:

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

- Develop outlines, clusters, lists, or other graphic organizers to organize ideas for writing
- Format various types of writing such summaries, personal letters, formal letters and narrative, descriptive, and expository paragraphs on a variety of topics
- Develop own creativity and enhance their writing skills
- Paraphrase text appropriately.
- Write effective introductions and conclusions for paragraphs.
- Prepare a persuasive resume

Course Outcomes:

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

1. Develop outlines, clusters, lists, or other graphic organizers to organize ideas forwriting
2. Apply sentence mechanics and master spelling of high frequency words.
3. Use Prosodic features for right speech
4. Use English in day-to-day communication
5. Participate in Group Discussion sessions
6. Develop their written communicative competence
7. Get ready for the interview

RECOMMENDED BOOKS:

1. Part – 2 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.ArunaPriya)
2. Communicative skills for Technical Students, M. Faratullah. Orient Longman
3. Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

B.Sc. (H) MICROBIOLOGY III SEMESTER

SMB 201: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY (THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course is familiarizes the student with various physiological aspects and metabolic pathways operating in microorganisms. The concept of microbial growth, factors that govern the growth and survival of microbes under various conditions shall be explained. The detailed mechanism of metabolism of carbohydrates, fats, and proteins shall be elucidated comprehensively. The diversity of metabolic pathways with special reference to microbial physiology shall be covered.

Course Objectives

- To understand mechanism of growth and survival strategies operating in microbes
- To learn the nutrient transport mechanisms in bacteria
- To understand types of heterotrophic metabolism viz. aerobic, anaerobic respiration and fermentation
- To appreciate the photosynthetic and nitrogen assimilation mechanism operating in microbes.

Unit1 **No. of Hours: 12**

Microbial Growth and Effect of Environment on Microbial Growth

Nutritional classification of microorganisms . Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate,synchronous growth, diauxic growthcurve, Factors affecting microbial growth-Temperature, pH, solute and water activity, Oxygen, atmospheric pressure.

Learning outcomes

After completion of this unit the students will be able to

- Differentiate microbes based on their mode of nutrition
- Comprehend concept of growth in microbes
- Understand the effect of various factors on microbial growth

Unit 2 No. of Hours: 10

Nutrient uptake and transport- passive and facilitated diffusion, primary and secondary active transport, concept of uniport, symport and antiport, group translocation, iron uptake.

Learning outcomes

After completion of this unit the students will be able to

- Learn mechanism of nutrient transport operating in microbes
- Appreciate the efficiency of nutrient transport system in microbes

Unit3 No. of Hours: 16

Chemoheterotrophic Metabolism-Aerobic Respiration, Concept of aerobic respiration, anaerobic respiration and fermentation Glucose metabolism-*viz.*EMP,ED,Pentose phosphate pathway, TCA cycle, Electron transport chain.Anaerobic respiration with special reference to dissimilatory nitrate reduction. Fermentation–alcohol fermentation and Pasteur effect

Learning outcomes

After completion of this unit the students will be able to

- Learn mechanisms of aerobic and anaerobic respiration operating in microbes
- Understand the fundamental process of glucose metabolism

Unit 4 **No. of Hours: 10**

Chemolithotrophic and Phototrophic Metabolism Introduction to aerobic and anaerobic chemolithotrophy with examples.Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Phostosynthesis-Anoxygenic *vs.*oxygenic photosynthesis with reference to photosynthesisin greenbacteria, purple bacteria and cyanobacterial.

Learning outcomes

After completion of this unit the students will be able to

- Understand fundamental principles of chemolithotrophy
- Comprehend the diversity of phototrophic bacteria

Unit 5 **No. of Hours:6**

Bacterial Chemotaxis , Quorum sensing& biofilms. - Properties of nitrogenase, and ammonia assimilation. Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis.

Learning outcomes

After completion of this unit the students will be able to

- Appreciate the mechanism of bacterial response to chemical stimuli
- Understand the mechanism of biological nitrogen fixation

Course Outcomes:

By the end of the course, students will

1. Understand the mechanism of growth and survival strategies operating in microbes
2. Learn the nutrient transport mechanisms in bacteria
3. Understand different types of heterotrophic metabolism viz. aerobic, anaerobic respirationand fermentation
4. Appreciate the photosynthetic and nitrogen assimilation mechanism operating in microbes.

RECOMMENDED BOOKS

1. Moat A G and Foster J W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
2. Reddy S R and Reddy S M.(2005).Microbial Physiology. Scientific Publishers India
3. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SMB 221: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY(PRACTICAL)

Hours per week: 3

Credits:2 Sessionals:100 marks

1. Study and plot the growth curve of *E.coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E.coli*
4. Effect of pH on growth of *E.coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E.coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E.coli.*

RECOMMENDED BOOKS

1.Madigan MT,and Martinko JM(2014).BrockBiologyofMicroorganisms.14th edition.Pr entice Hall International Inc.

2 ReddySRandReddySM.(2005).MicrobialPhysiology.ScientificPublishersIndia.

3. Gottschalk G. (1986). Bacterial Metabolism.2nd edition. SpringerVerlag

4. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9th editio n. McGraw Hill Higher Education.

Course Outcomes:

After the completion of the lab course, student will

1. Plot the bacterial growth curve
2. Calculate the generation time and specific growth rate of bacteria
3. Study the effect of pH, temperature, carbon, and nitrogen sources on bacterial growth
4. Learn the alcohol fermentation process

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SMB 207: CELL BIOLOGY

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals:40 Marks

Preamble:

The Cell Biology course is designed to help understand how the cells are organized, in prokaryotes and eukaryotes. It helps the students grasp the correlation of the structure of the cell organelles to the function they carry out. They will appreciate how the cells connect, cooperate and control each other with signal transduction. The course provides understanding of how cells divide, while maintaining the genomic integrity, and how variations occur through meiosis.

Course Objectives:

1. To understand the structures and purpose of basic components of prokaryotic and eukaryotic cells
2. To understand how the genetic material is faithfully replicated and transferred to the daughter cells yet allowing for variation in population
3. To learn the methods and importance of protein regulation and transport.

Unit1

Eukaryotic (Plant and animal cells) and prokaryotic Cell Organization. Plasma membrane Structure : sandwich, fluid-mosaic models. Nutrient transport- passive and facilitated diffusion, active transport, group translocation. Cell Wall: Eukaryotic cell wall, Extra cellular matrix. Cell-Cell junctions and plasmodesmata (only structural aspects)

Learning Outcomes: By the end of this Unit, the student will know

- To learn about types of cell organization
- To understand about Plasma membrane structure
- To study about Nutrient transport

Unit-2

Mitochondria, chloroplasts and peroxisomes; Cytoskeleton: Structure and organization of actin filaments, intermediate filaments, microtubules, Nuclear envelope, nuclear pore complex and nuclear lamina, Nucleolus

Learning Outcomes: By the end of this Unit, the student will know about

- To learn about Cell organelles and their function

- To know about Nuclear organization
- To understand about Cytoskeleton structure

Unit- 3

Ribosomes, Endoplasmic Reticulum–Structure, protein targeting and synthesis, smooth ER and lipid synthesis, Golgi Apparatus–Organization,protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

Learning Outcomes: By the end of this Unit, the student will appreciate

- To learn about protein sorting and transport
- To understand the role of ER and Golgi body in protein export
- To study about lysosome function

Unit- 4

Cell Signaling, Signaling molecules, receptors, Structure and Function of cell surface receptors, intracellular receptors. Introduction to Signaling Pathways–Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.Secondary messengers.

Learning Outcomes: By the end of this Unit, the student will understand

- To learn about principle and methods of signaling
- To understand about importance and types of receptors
- To know the role of secondary messengers

Unit-5

Prokaryotic cell cycle, Eukaryotic cell cycle and its regulation, Mitosis and Meiosis, Programmed cell death, Stem cells Embryonic stem cell, induced pluripotent stem cells, tumor cells.

Learning Outcomes: By the end of this Unit, the student will know about

- To learn about regulation and stages of eukaryotic cell divisions
- To understand the principle of apoptosis
- To know about Stem cells and tumor cells

Course Outcomes:

After completion of the course, students will

1. Understand the structures and basic components of prokaryotic and eukaryotic cells
2. Know how the genetic material is faithfully replicated and transferred to the daughter cells.
3. Learn the methods and importance of protein regulation and transport.

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

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SMB 227: CELL BIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals:100 marks

1. Microscopic study of plant cell,
2. Microscopic study of animal cell.
3. Study of the structure of cell organelles through electron micrographs
4. Cytochemical staining of DNA-Feulgen
5. Study of different stages of Mitosis.
6. Study of different stages of Meiosis
7. Study of polyploidy in Onion root tip by colchicine treatment.
8. Identification and study of cancer cells by photomicrographs.

Course Outcomes:

After completion of the lab course, students will

1. Study the plant and animal cell
2. Study the cell organelles
3. Identify different stages of mitosis and meiosis
4. Study polyploidy and identify cancer cells

RECOMMENDED BOOKS

1. Cell biology: Practical manual, 2018 by Renu Gupta et al

2. Cell And Molecular Biology: A Lab Manual, 2013, PHI learning India Limited.

B.Sc. (H) Microbiology III SEMESTER

20SMB 209: MOLECULAR BIOLOGY (THEORY)

Hours per week: 4 End Examination: 60

Marks Credits:4 Sessionals:40 Marks

Preamble

The course of Molecular Biology explains the structure and function of the DNA and RNA. Provides details of the DNA replication and roles of various enzymes. The translation of the language of nucleotides of DNA through mRMA to the aminoacids of proteins. The course details the regulation of the gene expression, at transcriptional translational and post translational stage.

Course objectives

At the end of this course students should be able to demonstrate a clear understanding of the facts and basic concepts of molecular biology including:

1. Concept of replication.
2. Transcription and translation
3. Regulation of gene expression

Unit--1

DNA Structure: Miescher to Watson and Crick- historic perspective. Salient features of double helix, Types of DNA. Types of genetic material.Denaturation and renaturation, cotcurves. DNAtopology-linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNAStructure,Organelle DNA—mitochondria and chloroplast DNA.

Learning Outcomes: By the end of this Unit, the student will know about

1. The deciphering DNA as genetic material, and structure elucidation
2. Types and organization of genetic material
3. Extra genomic DNA

Unit-2

Bidirectional and unidirectional replication,semi-conservative,semi-discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase, Various models of DNA replication-rolling circle, Θ(theta) mode. Mismatch and excision repair

Learning Outcomes: By the end of this Unit, the student will know about

1. DNA replication
2. Characters and function of enzymes of replication
3. Plasmid DNA reliplication
4. Repair of DNA

Unit-3

Transcription: Definition, promoter-concept and strength of promoter, transcription in prokaryotes and eukaryotes. RNA Polymerases.general transcription factors. Split genes, introns and exons, splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and itssignificance

Learning Outcomes: By the end of this Unit, the student will know about

1. Transcription factors, promoters and transcription process
2. Split genes, and splicing
3. Types and processing of RNA
4. Interfering RNA

Unit-4

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of translation in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryotes

Learning Outcomes: By the end of this Unit, the student will know about

1.Charging of tRNA
2.Mechanism of translatioin in prokaryotes
3.Mechanism of translatioin in eukaryotes
4. Protein synthesis inhibitors

Unit-5

Chromatin Structure, role in regulation- DNA methylation and Histone Acetylation mechanisms, operon concept, Regulation of initiation with examples from *lac* and *trp* operons, Yeast mating type switching.

Learning Outcomes: By the end of this Unit, the student will know about

1. Transcriptional regulation
2. Operon
3. Yeast mating types

Course Outcomes:

At the end of this course students will

1. Demonstrate a clear understanding of the facts and basic concepts of molecular biology
2. Understand the process of replication
3. Gain knowledge on transcription and translation
4. Know about gene expression and its regulation

RECOMMENDED BOOKS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and LosickR (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, HardinJ and Bertoni GP (2009) The World of the Cell,7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. DeRobertis EDP and DeRobertis EMF(2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Krebs J,Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
5. Gardner EJ, Simmons MJ, Snustad DP(2008).Principles of Genetics. 8th Ed.Wiley-India

B.Sc. (H)MICROBIOLOGY III SEMESTER

20SMB 229: MOLECULAR BIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study of different types of DNA and RNA using micrographs and model/schematic representations
2. Study of semi-conservative replication of DNA through micrographs/schematic representations
3. Isolation of genomic DNA from plant material.

4. Estimation of salmon sperm / calf thymus DNA using colorimeter(diphenylamine reagent) or UV spectrophotometer (A260 measurement)

5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)

6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS- PAGE).

Course Outcomes:

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

1. Isolate the genomic DNA
2. Estimate the concentrations of DNA and RNA
3. Perform Electrophoresis for the separation of DNA, RNA and protein

SUGGESTED READINGS

1.WatsonJD,BakerTA,BellSP,GannA,LevineMandLosickR(2008)MolecularBiologyoft h e Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. BeckerWM,KleinsmithLJ,HardinJandBertoniGP(2009)TheWorldoftheCell,7thedition , Pearson Benjamin Cummings Publishing, SanFrancisco

3. De Robertis EDP and De Robertis EMF (2006)Cell and Molecular Biology, 8th edition.Lippincott Williams and Wilkins, Philadelphia

4. KarpG(2010)CellandMolecularBiology:ConceptsandExperiments,6thedition,JohnWil ey& Sons.Inc.

5.Sambrook J and Russell D W(2001).Molecular Cloning:A LaboratoryManual.4thEdition,Cold Spring Harbour Laboratory press.

B.Sc. (H) MICROBIOLOGY IV SEMESTER

SMB 206: MICROBIAL GENETICS (THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals:40 Marks

Preamble

While Fidelity in genome replication allows for stability of a species, changes in genome are important for variability of individuals and evolution of species. The changes can be brought about through processes inherent to the cell or as an effect of outside factors. This course deals with the molecular mechanisms, such as mutation, recombination and transpositions, which allow for the incorporating variations in the genome.

Course Objectives

1. To teach the students the types of mutations

2. To elucidate the Plasmids structure, function and types

3. To provide a detailed information on Recombination in bacteria

4. To describe the Genetic mapping using recombination

5. To teach the students about mobile genetic elements

UNIT--I

Genome organization: *E. coli, Saccharomyces, Tetrahymena*. Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression:Truerevertants;Intra-andinter-genicsuppression;Amestest;Mutator genes

Learning Outcomes: By the end of this Unit, the student will know about

1.Genome organization of type species

2. Mutations: cause and types

3. Molecular basis of mutations

Unit-2

Plasmids and their types, – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2μplasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Learning Outcomes: By the end of this Unit, the student will know about

1. Plasmids general characters
2. Functional types of plasmids
3. Replication and regulation

Unit-3

Genetic exchange in prokaryotes, Transformation - Discovery, mechanism, Conjugation-Discovery,mechanism, Hfr and F' strains, Transduction-Generalized transduction, specialized transduction,

Learning Outcomes: By the end of this Unit, the student will know about

1. Transformation and mechanism
2. Conjugation
3. Transduction and types

Unit- 4

Phage Genetics: Genetic Mapping- Interrupted mating technique and time of entry mapping, co-transduction of markers, Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda

Learning Outcomes

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

1. Genetic mapping
2. Interrupted mating
3. Lytic lysogenic switch

Unit- 5

Transposable elements: Prokaryotic transposable elements–Insertion Sequences, composite and non-Replicative transposition, Mu transposon. Eukaryotic transposable elements-Yeast (Ty1 transposon), Drosophila (P elements),Maize (Ac/Ds). Uses of transposons and transposition.

Learning Outcomes:

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

1. Define transposons, and types
2. Know the characters of transposons in type studies
3. List the advantages of transposons

Course Outcomes

After completion of the course, students will

1. Learn about the types of mutations

2. Elucidate the Plasmids structure, function, and types

3. Gather detailed information on Recombination in bacteria

4. Understand the process of genetic mapping using recombination

5. Learn the concepts of mobile genetic elements

RECOMMENDED BOOKS:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and LosickR (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith L.J, HardinJ and Bertoni GP (2009) The World of the Cell,7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. DeRobertis EDP and DeRobertis EMF(2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Krebs J,Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
5. Gardner EJ, Simmons MJ, Snustad DP(2008).Principles of Genetics. 8th Ed.Wiley-India

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 222: MICROBIAL GENETICS(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100

1. Preparation of Master and Replica Plates
2. Study the effect of physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV)light
4. Isolation of Plasmid DNA from *E.coli*
5. Demonstration of Bacterial Conjugation
6. Demonstration of bacterial transformation/transduction
7. Demonstration of AMES test

SUGGESTED READINGS

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley& Sons.Inc.
2. Sambrook J and Russell DW.(2001). Molecular Cloning: A LaboratoryManual.4thEdition, Cold Spring Harbour Laboratory press.
3. Cell biology: Practical manual, 2018 by Renu Gupta et al
4. Cell And Molecular Biology: A Lab Manual, 2013, PHI learning India Limited.
5. Laboratory Manual of Microbiology and Biotechnology , 2014, K.R.Aneja. publisher Med. Tech.

Course Outcomes:

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

1. Isolate plasmid DNA
2. Understand bacterial conjugation, transformation, and transduction
3. Perform Ames test for identification of mutations

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 208: ENVIRONMENTAL MICROBIOLOGY(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course will introduce the students to fundamental aspects of environmental microbiology. They will learn the basics of distribution of microbes in terrestrial habitats aquatic habitats and atmosphere. The interesting mechanisms operating in microorganisms surviving under extreme conditions, the interactions between various microbes in environment will be unraveled. The students will also learn nutrient cycles operating in nature, solid waste and its management and importance of water quality testing.

Course objectives

- To study the microflora of terrestrial, aquatic and aerial habitats
- To learn the various interaction operating amongst microbes in environment
- To explore principles of biogeochemical cycling of elements
- To understand the solid waste management
- To learn the standard methods for water quality testing

Unit 1

Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aero microflora and dispersal of microbes. Extreme Habitats: Extremophiles: Microbes thriving at high& low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Learning outcomes

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

- Appreciate the microbial distribution in various habitats
- Understand the mechanism operating in extremophiles

Unit 2

Microbeinteractions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non-symbiotic interactions Microbes in ruminants, nematophagus fungi ,luminescent bacteria

Learning outcomes

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

Appreciate the interactions operating in microbes in environment

Unit 3

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification andnitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphurcycle: Microbes involved in Sulphur cycle Other elemental cycles: Iron and manganese.

Learning outcomes

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

- Understand the role of microbes in recycling of elements in environment

Unit 4 Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition andstrength of sewage (BOD and COD), Primary,secondary oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Microbial Bioremediation

Learning outcomes

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

- Comprehend the categorization of solid waste and its management
- Explore the role of microbes in bioremediation

Unit 5

Treatment and safety of drinking (potable) water, methods to detect potability of water samples:(a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for fecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Learning outcomes

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

- Explain the principle of water quality testing underlying various methods

Course Outcomes

After completion of the course, students will

1. Understand the diversity of microflora of terrestrial, aquatic and aerial habitats
2. Learn the various interaction operating amongst microbes in environment
3. Explore principles of biogeochemical cycling of elements
4. Understand the solid waste management

RECOMMENDED BOOKS

1. MaierRM,PepperILandGerbaCP.(2009).EnvironmentalMicrobiology.2ndeditio

n,Academic Press
2. Okafor,N(2011).EnvironmentalMicrobiologyofAquatic&Wastesystems.1steditio
n,Springer, NewYork
3. SinghA,Kuhad,RC&WardOP(2009).AdvancesinAppliedBioremediation.V
olume17, Springer-Verlag, BerlinHedeilberg

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB228: ENVIRONMENTAL MICROBIOLOGY(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Analysis of soil-pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of bacteria from soil (28ºC & 45ºC).
3. Isolation of fungi from soil (28ºC & 45ºC).
4. Isolation of microbes (bacteria & fungi) from rhizosphere
5. Isolation of microbes (bacteria & fungi) from rhizoplane.
6. Assessment of microbiological quality of water.
7. Determination of BOD of wastewater sample.
8. Study the presence of microbial activity by detecting(qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
9. Isolation of *Rhizobium* from root nodules.

Course Outcomes

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

1. Isolate bacteria from soil
2. Isolate fungi from soil
3. Isolate microbes from rhizosphere
4. Assess the microbio activity of the water

RECOMMENDED BOOKS

1.Atlas RM and Bartha R.(2000).MicrobialEcology:Fundamentals&Applications.4th editio n. Benjamin/Cummings Science Publishing, USA

2. Madigan MT, Martinko JM and Parker J.(2014).BrockBiologyofMicroorganisms.14th editio n. Pearson/ Benjamin Cummings

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B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 210: FOOD AND DAIRY MICROBIOLOGY (THEORY)

Hours per week: 4 | End Examination: 60 Marks

Credits: 4 | Sessionals: 40 Marks

Preamble

This course deals with processing of milk, milk products and the role of microbes in milk processing and product development. Dairy microbiology involves processing, storage, packaging and spoilage of dairy and food products by entailing the science of bacteriology, nutrition and biochemistry

Course Objectives

- To know the need and importance of micro-organisms in dairy and food industry
- To know the compositional and technological aspects of food, its processing, storage
- To study processed principals of food preservation, food spoilage and microbe involved in spoilage.

Unit1

Foods as a substrate for microorganisms- Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods.

Learning Outcomes: By the end of this unit, the student will know about

- Food, its properties nutritive value, factors responsible for the growth and survival of microbes
- Microorganisms involved in the food contamination.

Unit 2

Food spoilage: Factors affecting food spoilage, spoilage of different groups of foods: perishable and non-perishable foods (cereals and cereal products, vegetables and fruits, meat, egg and poultry, fish, milk and milk products), canned foods.

Learning Outcomes: By the end of this unit, the student will

- Learn about food and types of foods
- Learn about food spoilage.

Unit3

Principles of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Learning Outcomes: By the end of this unit, the student will gain knowledge regarding the

- Food preservation and factors responsible for the food preservation
- Types and mechanisms involved in the preservation of food.

Unit 4

Fermented foods-Dairy starter cultures fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Learning Outcomes: By the end of this unit, the student will learn about the

- Dairy Foods, production of dairy foods
- Health benefits of probiotics.

Unit 5 No. of Hours:10

Food borne diseases (causative agents, foods involved, symptoms and preventive measures) Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus,Vibrio para haemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni* Cultural and rapid detection methods of food borne pathogens in foods.

Learning Outcomes: By the end of this unit, the student will learn of

- Food borne diseases, food intoxications symptoms and preventive measures
- mechanisms for the rapid detection of food borne pathogens.

Course Outcomes:

After completion of the course work, students will

1. Know the need for and importance of micro-organisms in dairy and food industry
2. Understand the compositional and technological aspects of food, its processing, storage
3. Learn the principals of food preservation, food spoilage and microbe involvedin spoilage

RECOMMENDED BOOKS

1. Outlines of Dairy Technology (2008) by S. De.
2. Food Engineering and Dairy Technology (1981) by H.G. Kessler.

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 230: FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any five food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/ Dahi.

RECOMMENDED BOOKS

1. JayJM, Loessner MJ and Golden DA.(2005).ModernFoodMicrobiology.7th edition,CBS Publishers and Distributors, Delhi, India.
2. Lund BM, Baird Parker AC, and Gould GW.(2000).The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
3. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:AnIntroduction.9th edition .Pearson Education.

Course Outcomes

After completion of the lab course, students will

1. Calculate the MBRT of the milk samples
2. Study the pasteurization of milk
3. Isolate Microorganisms from spoiled vegetables and bread

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB305: INDUSTRIAL MICROBIOLOGY (THEORY)

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 fermentors and types of fermentors, fermentation economics, and production of valuable products by fermentation technology such as antibiotics, beverages and organic acids and enzymes including downstream processing methods.

Course Objectives:

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

Unit 1

Significance of industrial microbiology in various fields, Industrially important microorganism and their source, Screening and strain development methods, Isolation and preservation methods of industrially important microbial strains, Media formulation for industrial fermentations, crude and synthetic media

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

- Significance of industrial microbiology
- Screening and Strain development methods
- Media formulation

Unit 2

Types of fermentation process, solid state and liquid state fermentations, Growth kinitics, batch, fed batch, continuous fermentations, dual and multiple fermentation process, scale-up and fermentation economics

Learning Outcomes: By the end of this unit, the student will be able to gain knowledge on the

- Types of fundamental fermentation process
- Significance of scale-up process
- Fermentation economics

Unit 3

Design and components of typical bioreactor, Types of bioreactors-Laboratory, pilot-scale and production fermenters,stirred tank and air lift bioreactor, control of fermentation parameters-pH, temperature, dissolved oxygen and foaming and aeration

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

- Design and components of typical bioreactor
- Types of bioreactors
- Control of fermentation parameters

Unit 4

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and applications)-Citric acid, ethanol, penicillin, glutamic acid, VitaminB12 Enzymes (amylase, protease, lipase) Wine, beer

Learning Outcomes: By the end of this unit, the student will be understand the processes related to the

- Microbial productions of oraganic acids and beverages
- Microbial production process of enzymes and vitamins
- Applications and fermentation conditions for fermented products

Unit 5

Down-stream processing- cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray dring, enzyme immobilization method and their advantages and limitations

Learning Outcomes: By the end of this unit, the student will be gain knowledge on

- Various downstream processing methods used for fermented products
- Basic concepts of immobilization technology and their types

Course Outcomes:

By the end of the course, students will

1. Be familiarized with the range of fermentation processes
2. Gain knowledge on fermentor design and types of bioreactors
3. Develop concepts on fermentation medium selection, importance of growthkinetics
4. Understand about the production of ethanol, organic acids,vitamins, enzymes and immobilization technique

Recommended Books

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan IndiaLimited
2. OkaforN.(2007).ModernIndustrialMicrobiologyandBiotechnology.1stedition.Bi osScientific Publishers Limited.USA
3. WaitesM.J.,MorganN.L.,RockeyJ.S.andHigtonG.(2001).IndustrialMicrobiology:An Introduction. 1st edition. Wiley –Blackwell

B.Sc. MICROBIOLOGY V SEMESTER

20SMB 325: INDUSTRIAL MICROBIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study different parts of fermenter
2. Microbialfermentationsfortheproductionandestimation(qualitativeandquantitative)of :

(a) Enzymes: Amylase and Protease
(b) Amino acid: Glutamic acid
(c) Organic acid: Citric acid
(d) Alcohol: Ethanol

3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

RECOMMENDED BOOKS

1. Glaze A.N. and Nikaido H.(1995).Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company

2. Casida LE. (1991). Industrial Microbiology.1st edition.Wiley Eastern Limited.

3. RruegerW and Crueger A.(2000).Biotechnology: A text book of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

4. Stanbury PF, Whitaker A and Hall SJ.(2006). Principles of FermentationTechnology.2nd edition , Elsevier Science Ltd.

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB307: IMMUNOLOGY (THEORY)

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 fundamentals of Antigens, antibodies, antigen and antibody interactions along with complement activation and MHC

Course Objectives:

- To provide ground knowledge about the immune system and its functions
- To provide key components of the innate and adaptive immune responses
- To Provide fundamental working knowledge of the basic principles of immunology and diagnostic immunology
- To provide mechanism of complement system activation pathways and structure and functions of Major Histo Compatable complex ,
- To provide Basic principles of immunization.

Unit1

Concepts and Types of immunity- Innate immunity, Adaptive immunity, immunological response, contribiotions of Scientists in the field of immunology- Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchinikoff

Learning Outcomes: By the end of this unit, the student will be able to Know

- Concepts and types of immune systems
- By the end of this unit, the student will be able to gain knowledge regarding
- Structure and functions of Organs and Cells involved in immune system

Unit 2

Structure, Functions and Properties of organs involved in immune system- Primary lymphoid organs and secondary lymphoid organs, Structure and functions of Immune Cells – T cell, B cell, NK cell, Macrophages, Neutrophils, Esinophil, Basophil, Mast Cell, Dendritic cells

Learning Outcomes: By the end of this unit, the student will be able to Know

- Structure and functions of Cells involved in immune system
- Primary and secondary lymphoid organs and their functions.
- Immunological memory

Unit 3

Characteristics and nature of of antigen- epitopes, haptens, Stucture and characteristics and types of antibodies- Ig G, Ig A, Ig M, Ig E, Ig D. Monocolonal antibodies and polyclona antibodies, Hybridoma technology

Learning Outcomes: By the end of this unit, the student will be able to Know

- Nature of antigens
- Types, structure, and functions of antibodies
- Concept of monoclonal antibodies and hybridoma Technology

Unit 4

Antigen- antibody reactions: principles and applications of precipitation, agglutination, Immunodiffussion, Immunofloruesence, Immunoelectrophoresis, ELISA, RIA, Westernblotting, Complement system-Compliment activation pathways- classical, alternative and lectin pathways, biological consequences of complement action

Learning Outcomes: By the end of this unit, the student will be able to Know

- Antigen antibody reactions and their principles
- Antigen and antibodies role in diagnostic tests
- Concept of complement system
- Activation pathways and biological consequences of complement system

Unit 5

Major histocompatibility comples, Structure and functions of Class I MHC and Class II MHC, Antigen processing and antigen presentation by cytosolic and endocytic pathways, Principles of Immunization

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

- Major Histocompatibility Complex (MHC)
- Structure and functions of Class I and Class II MHC
- Fundamentals of antigen processing and presentation pathways
- Principles of immunization.

Course Outcomes:
At the end of the course, students will

- Develop ground knowledge about the immune system and its functions
- Learn key components of the innate and adaptive immune responses
- Gain fundamental working knowledge of the basic principles of immunologyand diagnostic immunology
- Learn mechanism of complement system activation pathways and structureand functions of Major Histo Compatable complex ,
- Learn Basic principles of immunization.

RECOMMENDED BOOKS

1. AbbasAK,LichtmanAH,PillaiS.(2007).CellularandMolecularImmunology.6th edition Saunders Publication, Philadelphia.DelvesP,MartinS,BurtonD,RoittIM.(2006).Roitt'sEssentialImmunology.11theditio nWiley- Blackwell Scientific Publication,Oxford.
2. GoldsbyRA,KindtTJ,OsborneBA.(2007).Kuby'sImmunology.6theditionW.H.Freemanand Company, NewYork.

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 327: IMMUNOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample(demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOTELISA.
7. Perform immunoelectrophoresis.

RECOMMENDED BOOKS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology .6th edition Saunders Publication. Philadelphia.
2. Delves P, Martin S, Burton D, Roitt I M. (2006). Roitt's Essential Immunology.11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Golds by R A ,Kindt TJ, Osborne BA.(2007).Kuby'sImmunology.6thedition W.H.Free man and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology.7th edition Garland Science Publishers, NewYork.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology.2nd edition Churchil l Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology.6thedition.WileyBlackwellPublication.

B.Sc. (H) MICROBIOLOGY VI SEMESTER

20SMB 306: MEDICAL MICROBIOLOGY (THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

To teach the concepts related to the pathogenesis of microbes belonging to bacteria, viruses, fungi and protozoa. Laboratory diagnosis, epidemiology of the diseases caused due to these pathogens

Course Objectives:

- To study normal flora of human body, host-pathogen interaction and pathogenicity
- To gain knowledge on the pathogenic bacteria and their detailed study
- To provide access to study of medically important viruses.
- To learn about fungal and protozoan diseases.

Unit 1

Normal microflora of the human body and host pathogen interaction. Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract.

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

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

- Normal flora of human body
- Host-pathogen interactions
- pathogenicity and toxigenicity

Unit 2

Bacterial diseases:Symptoms, mode of transmission, prophylaxis and control

Respiratory Diseases: *Streptococcuspneumonia, Mycobacterium tuberculosis, Neisseria meningitis, Corynebacterium diphtheria, Mycobacterium tuberculosis*Gastrointestinal Diseases*: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori,*Others: *Staphylococcus aureus, Clostridium tetani, Treponema pallidum.*

Learning Outcomes: By the end of this unit, the student will

- Know list of pathogenic bacteria, symptoms and mode of their transmission
- Have completed a detailed study of bacteria involved in respiratory diseases.

Unit 3

Viral diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control

Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Learning Outcomes: By the end of this unit, the student will

- Know list of viruses, symptoms and mode of their transmission
- Have completed a detailed study of viral diseases

Unit 4

Fungal and Protozoan diseases. Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention. Cutaneous mycoses: *Tinea pedis* (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis.

Protozoan diseases: Symptoms, mode of transmission, prophylaxis and control of Malaria, Kala-azar

Learning Outcomes: By the end of this unit, the student will

- Know list of fungal and protozoan pathogens, symptoms and mode of their transmission
- Have completed a detailed study of cutaneous mycosis and protozoan diseases

Unit 5

Antimicrobial agents. General characteristics and mode of action. Antibacterial agents: Mechanism of action Penicillin, Streptomycin, Imipenem, Gentamycin, Moxifloxacin, Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin, Antiviral agents:

Mechanism of action of Amantadine, Acyclovir, Azidothymidine, Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

Learning Outcomes: By the end of this unit, the student will

- Know about antimicrobial and antibacterial agents.
- Mechanism of their action

Course Outcomes:
By the end of the course, students will

1. Study normal flora of human body, host-pathogen interaction and pathogenicity
2. Gain knowledge on the pathogenic bacteria and their detailed study
3. Study medically important viruses.
4. Learn about fungal and protozoan diseases.

RECOMMENDED BOOKS

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

B.Sc. (H) MICROBIOLOGY VI SEMESTER

20SMB322:MEDICAL MICROBIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Identify bacteria (any three of *E.coli, Pseudomonas, Staphylococcus, Bacillus*)using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: E MB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method.
4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Determination of minimal inhibitory concentration (MIC) of antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ringworms).
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

RECOMMENDED BOOKS

1. Ananthanarayan R.and Paniker C.K.J. (2009) Text book of Microbiology.8th edition,University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. GoeringR.,DockrellH.,ZuckermanM.andWakelinD.(2007)Mims'MedicalMicrobiology.4th edition.Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014).Brock Biology of Microorganisms. 14th edition. Pearson International Edition

B.Sc. (H) MICROBIOLOGY VI SEMESTER

20SMB308: RECOMBINANT DNA TECHNOLOGY (THEORY)

Hours per week: 4 End Examination: 60

Marks Credits: 4 Sessionals: 40 Marks

Preamble

The discovery of restriction endonucleases, brought on a never ending advent and improvement of the molecular biological techniques and their application in day to day life. This course aims to enhance the understanding of the various tool and methodologies involved in molecular cloning. The course starts with enzymes, cloning vectors, and DNA manipulation, through the amplification of DNA, screening methods, finger printing etc, leading to the microarray techniques

Course objectives

1. To teach the students the types of enzymes important in Recombinant DNA technology, with mechanism and applications.
2. To make them understand the various types of cloning vectors, and their usage
3. Let the students learn of various analysis methods, for screening of clones
4. Make the students appreciate the importance of microarray methods

Unit-1

Restriction modification systems:TypesI, II and III. Modification, nomenclature, applications; Function and application of DNA polymerases.Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases. Use of linkers and adaptors

Learning Outcomes:

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

1. Know the types and function of DNA nucleases
2. Understand mechanism of DNA modifying enzymes
3. Learn the importance and types of DNA polymerases

Unit- 2

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs, , SV40-based expression vectors

Learning Outcomes:

By the end of this Unit, the student will

1. Understand the requirements of a vector
2. Know the characters of important cloning vectors
3. Appreciate the use of expression vectors

Unit- 3

Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral- mediated delivery, Agrobacterium - mediated delivery. DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, SDS-PAGE and Western blotting.

Learning Outcomes:

By the end of this Unit, the student will

1. Understand the various methods for transforming DNA
2. Know the analytical technique for DNA analysis
3. Learn the protein analysis techniques

Unit-4

DNA Amplification and DNAsequencing, PCR: Basics of PCR, RT-PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shot gun sequencing

Learning Outcomes:

By the end of this Unit, the student will

1. Learn the amplification techniques
2. Know about the DNA sequencing
3. Understand the genome sequencing

Unit-5

Genomic and cDNAlibraries:Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping, Applications of Recombinant DNA Technology, microarray technology

Learning Outcomes:

By the end of this Unit, the student will

1. Know about types of DNA libraries
2. Making of and use of library
3. Application of recombinant DNA technology

Course outcomes:

By the end of the course, students will

1. Learn about the types of enzymes important in Recombinant DNA technology, with mechanism and applications.
2. Understand the various types of cloning vectors, and their usage
3. Learn of various analysis methods, for screening of clones
4. Appreciate the importance of microarray methods

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 (10th edition) by J.G. Cappuccinoand Sherman.

4. Methods in Molecular Biotechnology: Experimental Analysis (2010) by V. Gomase et. al.

B.Sc. (H) MICROBIOLOGY VI SEMESTER

20SMB324: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening ofrecombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

RECOMMENDED BOOKS

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley& Sons.Inc.
2. Sambrook J and Russell DW.(2001). Molecular Cloning: A LaboratoryManual.4thEdition, Cold Spring Harbour Laboratory press.
3. Cell biology: Practical manual, 2018 by Renu Gupta et al
4. Cell And Molecular Biology: A Lab Manual, 2013, PHI learning India Limited.
5. Laboratory Mnual of Microbiology and Biotechnology , 2014, K.R.Aneja. publisher Medtech

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 141: ECOLOGY

(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

This paper will introduce to the students the basic understanding of ecosystem and its structural and functional aspects. It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.

UNIT-I

Introduction (5 lectures)

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes.

Learning Outcomes:

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

- Understand the concepts of ecology.
- Understand various factors responsible for stability in an ecosystem.
- Understand the relation between the biotic and abiotic factors.

UNIT-II

Ecology of individuals(10 lectures)

Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

Learning Outcomes:

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

- Understand the Laws proposed to explain the ecological amplitude.

- Understand the specific position and functions of an individual in an ecosystem.
- Understand the factors effecting the adapted characteristics of plants and animals.

UNIT-III:

Ecology of populations (10 lectures)

Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent factors.

Learning Outcomes:

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

- Understand the concept of population in an ecosystem.
- Understand the factors effecting the growth of population.
- Understand r- and K-selection theories relating to the selection of combinations of traits in an organism.

Unit-IV:

Ecology of communities

Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession.

Learning Outcomes:

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

- Understand the associated relationship amongst the organisms.
- Differentiate positive and negative interactions prevailing in an ecosystem.
- Understand the factors, models and types of ecological succession.

Unit V

Ecosystem ecology(10 lectures)

Eco-system:, Producers, consumers and de-composers, Structure of Terrestrial Ecosystems

(Forest Ecosystem, Grassland Ecosystem, and Desert Ecosystem) and Aquatic Ecosystems (Pond Ecosystem and Ocean Ecosystem). Function of an ecosystem -food chains, food web and ecological pyramids - energy flow in the ecosystem.

Learning Outcomes:

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

- Understand various trophic levels in an ecological pyramid
- Differentiate types of ecosystems.
- Understand the functions of respective ecosystems and flow of energy in an ecosystem.

Course Outcomes:

By the end of the course, students will

1. Understand the basics of biodiversity
2. Know about the ecosystems
3. Gain knowledge on Food chain and food web
4. Know about ecological pyramids

RECOMMENDED BOOKS:

1. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21stCentury. World Conservation Press, Cambridge, UK.
2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associates incorporated.
3. Loreau, M. &Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis andPerspectives. Oxford University Press, Oxford, UK.
4. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Sounders.
5. Pandit, M.K., White, S.M.&Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist**203:** 697-703.
6. Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alienplant, animal, and microbe species. CRC Press.
7. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and ResourceConservation. Anamaya Publications.
8. Wilson, E. O. 1985. The Biological Diversity Crisis. BioScience**35**: 700-706.

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 181: ECOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. solation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
2. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
3. Isolation of *Rhizobium* from root nodules.
4. study the physiological ecology of an organism, design an experiment to observe the effect of rising temperatures
5. Calculation of ecological efficiency.
6. Antagonistic study among microorganisms under laboratory conditions.
7. Study of various interactions observed in an ecosystem with examples.

RECOMMENDED BOOKS

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

2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.Pearson/ Benjamin Cummings

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

4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,New York

B.Sc (HONOURS) MICROBIOLOGY
20SMB 143: (THEORY) MICROBES IN SUSTAINABLE AGRICULTURE

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals: 40 Marks

Preamble:
This course is designed to explore the role of microorganisms in the maintenance of soil and agriculture. It discusses the soil structure and its relation to the microbial distribution. Sustainable methods of biocontrol and biofertilizers to overcome chemical burden and and explains the pivotal role of microorganisms in degradation and nutrient release.

Course objectives:
1. For the student to learn about the soil properties, and its microbial population
2. To teach students about problems with agro-chemicals and to impart knowledge of biological alternatives
3. To make them know of symbiotic and non-symbiotic biofertilizers
4. To divulge the biocontrol phenomenon and modes

Unit- 1
Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Rhizosphere microorganisms, PGPR.Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Learning objectives: At the end of the Unit the student should be able to understand

1. The soil profile
2. role of soil as microbial habitat
3. Rhizosphere and PGPR
4. Mineralizaton of various biological wastes

Unit- 2
Biofertilizers-General account, advantages over chemical fertilizers. Symbiotic N2 fixers: Rhizobium- Isolation, characteristics, types, inoculum production and field application ,Frankia. Cyanobacteria- Azolla, characteristics, types, inoculum production

Learning objectives: At the end of the Unit the student should be able to understand

1. Superiority of biological over chemical fertilizers
2. Rhizome legume association, types and applications
3. *Azolla- Anabaena* association in rice cultivation

Unit- 3

Non - Symbiotic N_2 fixers Free living *Azospirillum*, *Azotobacter* – free living cyanobacteria, isolation, characteristics, mass inoculum production and field application. Phosphate solubilizers

Learning objectives: At the end of the Unit the student should be able to understand

1. Nitrogen fixation by Free living microorganisms
2. Mass production and application
3. Phosphate solubilization

Unit- 4

Mycorrhizal biofertilizers Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Learning objectives: At the end of the Unit the student should be able to understand

1. Importance of mycorrhizal biofertilizers
2. Types of mycorrhizae
3. Field application

Unit- 5

Biocontrol definition, advantages over chemical control, Microorganisms used as biocontrol agents - *Bacillus thuringiensis*, production, Field applications; Beauvaria sp, Trichoderma species- characters, uses and mass production, Viruses – cultivation and field applications

Learning objectives: At the end of the Unit the student should be able to understand

1. Biocontrol concept
2. Types of biocontrol agents
3. Cultivation and field application

Course Outcomes:

At the end of the course, students will

1. Learn about the soil properties, and its microbial population
2. Learn about problems with agro-chemicals and to impart knowledge ofbiological alternatives
3. Know about symbiotic and non-symbiotic biofertilizers
4. Divulge the biocontrol phenomenon and modes

RECOMMENDED BOOKS

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,

2. Singh RS. (2017). Introduction to principles of plant pathology.Oxford & IBH, New Delhi.

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

4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
6. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific
Publishers.

7. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert AcademicPublishing GmbH KG

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB 183: MICROBES IN SUSTAINABLE AGRICULTURE (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study soil profile
2. Study microflora of different types of soils
3 Isolation of symbionts fromAzolla
4. *Rhizobium* isolation and culture characterization
5. *Cyanobacteria*- soilisolation and culture characterization
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

1. Laboratory manual of Microbiology, 2009. AK Roy, MM Prasad. New India Publishing Agency.
2. Laboratory manual in Microbiology, 2007, Gunasekaran.New age International Publishers
3. Laboratory Mnual of Microbiology and Biotechnology , 2014, K.R.Aneja. publisher Medtech

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 142: BIOFILMS(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course will examine the microbial quorum Sensing and biofilm, a ubiquitous form of life thriving in a wide range of environments wherever interfaces are found on earth. The broad utilization of biofilm knowledge in engineering includes applications in bioreactors for degradation of pollutant substances, in bioenergy production systems for advantageous surface reactions, in heat exchangers or cooling water towers and on reverse osmosis membranes or ships' hauls for preventing additional heating transfer, mass transfer and frictional resistances. Biofilms also cause contamination problems in food processing industry and on teeth, implants and prosthetic devices, leading to serious or even fatal consequences. This course will provide students better understanding of science and technologies associated with biofilms behind these applications. This course is aimed to meet deeper learning needs of MS and PhD students from Environmental Engineering, Biosystems Engineering, Food Science and Technology, Ocean Engineering, and Biomedical Engineering, etc., that share the same knowledge basis related to biofilms.

Course Objectives: Upon completion of this course, students should be able to:

- Evaluate thebenefits of bacterial communication and the risks of biofilms.
- Utilize mathematical models for describing the quorum sensing biofilm growth kinetics.
- Restate biofilm formation mechanism.
- Design basic biofilm reactors for wastewater treatment or bioenergy production.
- Relate biofilm formation knowledge to appropriate control measures used in medicine and food processing.

Unit I

Bacterial communication - Quorum sensing (QS); signalling molecules - HSLs, AI-2, Pheromones, AIP.Role of QS in promoting microbial virulence and resistance to drugs.

Learning outcome: On successful completion of this module, students should be able to describe quorum sensing and role of QS in virulence.

Unit II

QS in Gram positive bacteria - Staphylococcus, Streptococcus, Bacillus; QS in Gram negative bacteria - Chromobacterium, Agrobacterium, Pseudomonas, Serratia, Vibrio; Virulence traits regulated by QS in bacteria.

Learning outcome: On successful completion of this module,
students should be able to describe in the quorum sensing in Gram positive and Gram negative bacteria.

Unit III

Biofilm: Definition, Composition, Structural organization and mechanism of biofilm formation. Importance of biofilm on environmental, industrial and medical perspectives.Resistance development in biofilm inhabitants.Characteristics of biofilm in clinical devices.The role of biofilm in the dissemination of bacterial virulence.Impact of biofilm in aquaculture.Industrial importance of biofilm prevention.Consequences of biofilm in environment – biofouling and biocorrosion.

Learning outcome: On successful completion of this module,

- Students should be able to describe, evaluate benefits and risks of biofilms.
- Utilize mathematically models to describe the quorum sensing biofilm growth kinetics. Restate biofilm formation mechanism.

Unit IV

Biosensor strains used for QS based study - *Chromobacterium violaceum*, *Agrobacterium tumefaciens*, *Pseudomonas aeruginosa* and its mutants. Role of QS on biofilm. Assays to measure the QS regulated virulence traits - Violacein production, LasA protease, LasB elastase, Pyocyanin, Pyoverdine, Prodigiosin, Serratia total protease, Lipase, Bioluminescence, Swarming and Swimming motility.

Learning outcome: On successful completion of this module,

- To study the various biosensor strains in QS
- To understand the importance of assays to measure the QS regulated virulence traits.

Unit V

In vitro biofilm formation; Quantification of in vitro and in vivo formed biofilms; Microscopical analysis of biofilm architecture - EPS, proteins, e-DNA; Fluorophores used for staining biofilms; Live-dead staining; Confocal microscopy for biofilm studies - Z-stack analysis, Optical sectioning.

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

- To understand the quantification of biofilms *in vitro* and *in vivo*
- To learn the composition of biofilms
- To study the thickness of biofilms by confocal microscopy

Course Outcomes:

With the completion of this course, students will

- Evaluate the benefits of bacterial communication and the risks of biofilms.
- Utilize mathematical models for describing the quorum sensing biofilm growth kinetics.
- Restate biofilm formation mechanism.
- Design basic biofilm reactors for wastewater treatment or bioenergy production.
- Relate biofilm formation knowledge to appropriate control measures used in medicine and food processing.

RECOMMENDED BOOKS

1. Kievit, TR & Iglewski BH. Bacterial Quorum Sensing in Pathogenic Relationships. Infect. Immun. 68(9): 4839 (2000).
2. Stoodley, LH et al. Bacterial Biofilms: From the Natural Environment to Infectious Diseases. Microbiology.2 (2004).
3. Choi et al., Implication of Quorum Sensing in Salmonella enteric Serovar Typhimurium Virulence: the luxS Gene Is Necessary for Expression of Genes in Pathogenicity Island. 75, p. 4885–4890 (2007).
4. Rasmussen TB, Givskov M, Quorum-sensing inhibitors as anti-pathogenic drugs, International Journal of Medical Microbiology, 296, Pages 149-161, 2006.
5. Di Cagno R, De Angelis M, Calasso M, Gobbetti M. Proteomics of the bacterial crosstalk by quorum sensing. J Proteomics. 74(1):19-34. 2011.

B.Sc. (H) MICROBIOLOGY I SEMESTER

20SMB 182: BIOFILMS(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
2. Demonstrate the QuorumSensingExperiment
3. Detection of Biofilm by Congo red method
4. Detection of biofilm by crystal violet tube test method
5. Spectroscopic evaluation of biofilm in a microtitre plate
6. Detection of biofilm on different surface- food, industrial equipment, medical device etc.
7. Antimicrobial Susceptibility of Monoculture Biofilms of a Clinical Isolate.

RECOMMENDED BOOKS

1. Kievit, TR & Iglewski BH. Bacterial Quorum Sensing in Pathogenic Relationships. Infect. Immun. 68(9): 4839 (2000).
2. Stoodley, LH et al. Bacterial Biofilms: From the Natural Environment to Infectious Diseases. Microbiology.2 (2004).
3. Choi et al., Implication of Quorum Sensing in Salmonella enteric Serovar Typhimurium Virulence: the luxS Gene Is Necessary for Expression of Genes in Pathogenicity Island. 75, p. 4885–4890 (2007).
4. Rasmussen TB, Givskov M, Quorum-sensing inhibitors as anti-pathogenic drugs, International Journal of Medical Microbiology, 296, Pages 149-161, 2006.
5. Di Cagno R, De Angelis M, Calasso M, Gobbetti M. Proteomics of the bacterial crosstalk by quorum sensing. J Proteomics. 74(1):19-34. 2011.

B.Sc. (H) MICROBIOLOGY

20SMB144: INHERITANCE BIOLOGY (THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble:

The way in which traits are passed from one generation to the next-and sometimes skip generations-was first explained by Gregor Mendel. He proposed ***the principles of inheritance that described*** *the transmission of genetic traits. Students in this course learn the above as well as the allelic forms, chromosome organization, chromosomal defects and model organisms.*

Course objectives

1. To understand the Mendelian principles and also its deviations
2. To understand types of alleles, and their dominance and recessive traits.
3. To know about linkage and crossing over
4. To find out the types of variation in chromosome numbers, and types of sex determination
5. To appreciate role of different model organisms in genetics

Unit 1

Genetics- History, development. Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

Learning objectives: At the end of the Unit the student should be able to understand

1. The development and principles of Mendelian inheritance
2. The deviations from Mendelian principles
3. Alleles and their dominance or recessiveness

Unit 2

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand , stage, Molecular mechanism of crossing over, mapping, Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces,* Maternal effects – Shell coiling in *Limnaeaperegra,* Infectious heredity - Kappa particles in *Paramecium*

Learning objectives: At the end of the Unit the student should be able to understand

1. Mechanism of crossing over
2. Cytological evidence of time of crossing over
3. Extranuclear inheritance or maternal inheritance

Unit 3

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Normal andabnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polyteneand lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversionand translocation

Learning objectives: At the end of the Unit the student should be able to understand

1. Structure and organization of chromosomes
2. Types of bandings
3. Special chromosomes
4. Chromosomal mutations or variations

Unit 4

Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.Sex determination in insects and animals- XY/XO systems. Pedigree analysis, linkage testing. Polygenic inheritance

Learning objectives: At the end of the Unit the student should be able to understand

1. Numerical aberrations in Chromosomes
2. Associated syndromes
3. Sex determination systems
4. Pedigree charts

Unit 5

Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans Drosophila melanogaster, Arabidopsis thaliana*

Learning objectives: At the end of the Unit the student should be able to understand

1. Traits required of an organism to study genetics
2. Important model organisms

Course Outcomes:

With the completion of the course, students will

1. Understand the Mendelian principles and also its deviations
2. Understand types of alleles, and their dominance and recessive traits.
3. Know about linkage and crossing over
4. Learn about the types of variation in chromosome numbers, and types of sexdetermination
5. Appreciate role of different model organisms in genetics

RECOMMENDED BOOKS

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics.6th Ed. John Wiley and Sons Inc.

3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics.10th Ed.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th
Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett
Publishers
7. Russell PJ. (2009). Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB 184: INHERITANCE BIOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas /Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

RECOMMENDED BOOKS

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9thEd. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and BartlettPublishers
7. Russell PJ. (2009). Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SMB 241: MARINE MICROBIOLOGY(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course will make the students familiar with the profile of marine environment, its composition and diversity of microbial communities inhabiting marine ecosystems. The students will also learn the strategies adopted by microbes surviving in extreme marine environments and economic importance of marine microbial products.

Course Objectives

- To learn the stratification of marine ecosystems and understand marine microbial diversity
- To appreciate the marine metabolic diversity underlying survival of marine extremophiles
- To study the importance of marine pathogens and their control
- To appreciate the economic importance of marine microbial products

UNIT- I

Marine environment–properties of seawater , chemical and physical factors of marine environment. Marine habitat- zonation of marine ecosystems. Significance of Marine micro flora

Learning Outcomes

After completion of this unit the student will be able to

- Understand structure of marine ecosystems
- Appreciate the significance of marine microflora

UNIT- II

Metabolic diversity of microbial communities. Methods of studying marine microorganisms- sample collection- isolation and identification: Cultural, Morphological, physiological, biochemical and Molecular characteristics- Preservation methods of marine microbes.

Learning Outcomes

After completion of this unit the student will be able to

- Elucidate the principles of metabolic diversity of marine ecosystems
- Characterize marine microorganisms based on cultural characteristics

UNIT- III

Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles, halophiles and their importance.

Learning Outcomes

After completion of this unit the student will be able to

- Understand the strategies of marine extremophiles

UNIT- IV

Pathogenic microorganisms, distribution, indicator organisms, prevention and control of water pollution.Microbiology of processed finfish and shellfish products.

Learning Outcomes

After completion of this unit the student will be able to

- Identify the diseases caused by marine microorganisms
- Understand the prevention and control of water pollution

UNIT- V

Marine microbial products – Carrageenan, agar-agar, sea weed fertilizers – Astaxanthin, β carotene , antibiotics, polysaccharides, biosurfactants and pigments. Preservation methods of sea foods.

Learning Outcomes

After completion of this unit the student will be able to

- Appreciate the economic importance of marine microbial products
- Explain seafood preservation methods

Course Outcomes

With the end of the course, students will

1. Learn the stratification of marine ecosystems and understand marine microbialdiversity
2. Appreciate the marine metabolic diversity underlying survival of marine extremophiles

3. Study the importance of marine pathogens and their control
4. Appreciate the economic importance of marine microbial products

RECOMMENDED BOOKS:

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

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SMB 281: MARINE MICROBIOLOGY(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

2. Isolation and identification of microbes from mangroves, coastal waters and sediments with special emphasis on sample collection methodology, collection trips in boats/ trawlers
3. Assessment of salt requirement of marine isolates from different ecosystems
4. Analysis of physico-chemical parameters
5. Study of biofilm microorganisms
6. Isolation of enzymes (amylase and cellulase) of the marine bacterial isolates

REFERENCE BOOKS:

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

B.Sc. (H) MICROBIOLOGY II SEMESTER

20SMB 243: BIOENERGY AND BIOFUELS (THEORY)

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:

- To provide a thorough understanding of various renewable feed stocks and their availability and attributes for biofuels
- To provide a thorough understanding of the broad concept alternative biofuel production from biomass and other low-cost agri-residues and biowastes.
- To provide students with tools and knowledge about advantages and limitations of biofuels facility operations.
- To teach our students to analyze and design processes for biofuel production.

UNIT-I

Fundamental concepts of biofuels, bioenergy, renewable feedstocks, current energy consumption, Microbial Fuel Cells. Applications and limitations of biofuels, bioenergy and biogas

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

- To understand fundamental concepts of biofuels and bioenergy
- To know the availability and attributes for biofuel and bioenergy production
- To study about microbial fuel cells in the generation of bioelectricity.

UNIT-II

Raw material stocks availability, Properties of biomass- calorific value, density, moisture content, types 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 be able to

- To know the availability and properties of biomass
- To understand various types of biomass with proper examples and their utilization.

UNIT III

Conversion of biomass-Preprocessing or pretreatment of biomass: drying and size reduction, Biochemical conversion to ethanol: biomass pretreatment, Different enzymes, enzyme hydrolysis, and their applications in ethanol production and enzymatic hydrolysis, Detoxification methods

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

- To know the synthesis of biofuel from biomass conversion process
- To understand the details of preprocessing or pretreatment of biomass
- To learn the significance of Enzymatic hydrolysis and detoxification methods

UNIT-IV

Biomass conversion to heat and power, Thermal gasification of biomass, chemical hydrolysis of biomass-pyrolysis, biological process by anaerobic digestion and fermentation, Biodiesel production from oil seeds waste oils and algae.

Learning Outcomes: By the end of this Unit, the student will be able

- To understand the biomass conversion to heat and power
- To learn the thermochemical, process for biomass conversion
- To know the biological conversion process of biomass conversion

UNIT-V

Market demand, economics, Energy balance and life-cycle analysis of biodiesel, Environmental impacts of biofuel and biodiesel production, Value added processing of biofuel residues and co-products

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

- To study the market demand of alternative fuels
- To understand the economics and life-cycle analysis of biofuel production

- To learn the production of value-added processing of biofuel residues and co-products

Course Outcomes:

With the end of the course, students will

- Have a thorough understanding of various renewable feed stocks and theiravailability and attributes for biofuels
- Develop a broad concept alternative biofuelproduction from biomass and other low-cost agri-residues and biowastes.
- Gain knowledge on tools and knowledge about advantages and limitations of biofuels facility operations.
- Learn to analyze and design processes for biofuel production.

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

B.SC. (H) MICROBIOLOGY IISEMESTER

20SMB 283: BIOENERGY AND BIOFUELS(PRACTICAL)

Hours per week: 3 Sessionals: 100 Marks

Credits: 2

1. Isolation of ethanol producing yeasts from soil
2. Isolation of butanol producing bacteria from soil
3. Isolation of amylase producing microorganism from soil
4. Isolation of cellululose degrading microorganism
5. Production of ethanol
6. Estiation of ethanol production
7. Ethanol production using agrowaste materials
8. Bioethanol Production by co-culture studies
9. Visit Biogas plant and anaerobic digestion unit

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

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 242: BIOREMEDIATION(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

Bioremediation utilizes microorganisms to improve environmental quality. These improvements include treatment of contaminated waters and wastewaters, cleanup of industrial waste streams, and remediation of soils contaminated with hazardous and toxic chemicals.

Course Objectives

- To develop fundamental understanding of Applications of Biotechnology in Environment science and Environmental related problems
- To understand the Concept of environment and importance of its preservation.
- To Understand the Concept of pollution and methods to control it.
- To Understand the Concept of Bioremediation and its applications.
- To Understand many types of energy sources.

Unit I

Environment and its importance.Ground water contamination. Bacterial metabolism in waste water treatment systems, industrial waste water sources and treatment strategies, overview of waste water treatment process

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

- Understand the importance of environment and its cleanup
- Understand the sources of waste water and its treatment strategies

Unit II

Biotechnology and waste: Composting of Organic Waste, Anaerobic Fermentation of Wet and Semidry Garbage Waste Fractions, Process Engineering of biological waste gas Purification, Commercial Applications of biological waste gas Purification, Perspectives of waste water, waste, off-gas and soil treatment.

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

- Types of industrial waste

- Purification process for industrial waste

Unit III

Cleaner Technologies: fermentation technology, paper industry and plastic industry, ISO14000 and Environment Management System , Reducing environment impact of industrial effluents.

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

- Cleaning technologies of industrial waste
- Environmental management system

Unit IV

Bioremediation using naturally occurringmicroorganism,Removal of spilled oil and grease deposits (Use of oleophilic fertilizers, Use of a mixture of bacterial strains, Use of genetically engineered microbes) Biosensor to detect environmental pollutants (In situ bioremediation of both soil and ground water.

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

- Bioremediation using microbes in the nature
- Bioremediation using genetically modified microbes

Unit V

Bioremediation of contaminated soil, contaminated surface waters (pits, ponds and lagoons) Treatment of toxic wastes before they reach environment, Bioremediation using Genetically Engineered Microbes (GEM) Phytoremediation, Naturally occurring plants for Phytoremediation.

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

- Bioremediation of soils
- Phytoremediation.

Course Outcomes:

With the end of the course, students will

1. Develop fundamental understanding of Applications of Biotechnology in Environment science and Environmental related problems

2. Understand the Concept of environment and importance of its preservation.
3. Understand the Concept of pollution and methods to control it.
4. Understand the Concept of Bioremediation and its applications.
5. Understand many types of energy sources.

RECOMMENDED BOOKS

1. Environmental Biotechnology: Principles and Applications, Rittmann, B. E., and McCarty,P. L., McGraw Hill, 2001

2. Applied Environmental Microbiology and Case Studies, prepared by M. Pirbazari, 2002.

3. Prescott, L. M., Harley, 3. P., and Klein, D. A., Microbiology, Second Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1993

B.Sc. (H) MICROBIOLOGY IV SEMESTER

20SMB 282: BIOREMEDIATION(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

List of Experiments:

1. Study of Sampling Technique and Sample Preservation.
2. Collection of Grab And Composite Sample
3. A) To Estimate Total Hardness of Water
   B) To Estimate Calcium Hardness of Water
4. To Estimate The Total Solids (Ts), Total Dissolved Solids (TDS)And Suspended Solids (SS) In The Given Water Sample.
5. To Estimate Dissolved Oxygen Content of Waste water.(DO)
6. To Estimate Chemical Oxygen Demand of The Given Sample(COD)
7. To Estimate Biological Oxygen Demand(BOD)
8. To Measure The Concentration of Chloride In The Given Sample
9. To Estimate The Amount of Ammonical Nitrogen In The Given Sample
10. To Estimate The Amount of Nitrate Nitrogen
11. To Estimate The Amount of Nitrite Nitrogen
12. To Estimate The Amount of Phosphorus Phosphate In The Given Sample
13. To Measure The Sulfite ($SO3^{-2}$) Content In The Given Sample By IodometricTitration.
14. To Find Out Acidity of The Given Sample.
15. To Find Out The Most Probable Number of Coliforms In The Given Water Sample
16. Practical on soil Bioremediations
17. Visit to waste water treatment plant

RECOMMENDED BOOKS

1. Environmental Biotechnology: Principles and Applications, Rittmann, B. E., and McCarty, P. L., McGraw Hill, 2001

2. Applied Environmental Microbiology and Case Studies, prepared by M. Pirbazari, 2002.

3. Prescott, L. M., Harley, 3. P., and Klein, D. A., Microbiology, Second Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1993

B.Sc. (H) MICROBIOLOGY IV SEMESTER
20SMB 244: PROBIOTICS AND PREBIOTICS(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

Human intestinal tract is colonised by species of bacteria. They represent both the beneficial and the harmful bacteria. Beneficial bacteria are referred as probiotics, and food that supports the growth of probiotics is referred as prebiotics. Probiotics and prebiotics, alone and together, have been proven to promote gastrointestinal health and proper immune function. This course comprehensively explores health benefits and food applications of probiotics and prebiotics.

Course Objectives:

- To understand the history and evolution of probiotics and prebiotics
- To recognize the difference between probiotics, prebiotics and synbiotics
- Identify the sources of probiotics and prebiotics
- To understand the safety and health benefits of probiotics and prebiotics

Unit I

Human intestinal microbiota (bacterial flora)- function in health and disease. Probiotics: Definition, History, Probiotic organisms: bacteria and fungi, sources of probiotics: Plant based probiotic foods, Animal based probiotic foods, Ideal properties of probiotic microorganisms, mechanism of action, factors influencing the efficacy of probiotics

Learning Outcomes:

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

- Understand the role of gut microbiome
- Understand the history of probiotics
- List the approved probiotic microorganisms
- Discuss FAO/WHO Guidelines on Probiotics

Unit II

Classification of probiotics: monoprobiotics, polyprobiotics, combined probiotics; classification of probiotic products: biotherapeutics and probiotic cultures. Dosage of probiotics, industrial design of probiotic foods, effect of probiotics on health, disadvantages of probiotics.

Learning Outcomes:

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

- Classify probiotics
- Discuss the adverse effects of probiotics
- Set the dosage of probiotics

Unit III

Prebiotics: Definition, chemistry, dietary sources, metabolism and bioavailability, Health benefits, mechanism of action, applications of prebiotics, Prebiotic supplements, disadvantages of prebiotics.

Learning Outcomes:

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

- Compare and contrast the mechanisms used by probiotic and prebiotics to benefit host health
- Discuss the adverse effects of prebiotics
- Generate information on the prebiotic supplements available in the market

Unit IV

Synbiotics: Production, Application, and Health Promotion. Safety considerations of probiotics and prebiotics, health claims, Role of probiotics in developing functional foods, labelling considerations of probiotic and prebiotic foods, GMO probiotics

Learning Outcomes:

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

- Compare and contrast the applications of prebiotics, probiotics and synbiotics
- Discuss how prebiotics and probiotics are complementary to each other
- Gain knowledge on the safety considerations of probiotics and prebiotics,

Probiotic delivery systems, Role in treating Dysbiosis, Role of probiotics in treating cancer, lactose intolerance, diarrhea, Antibiotic Associated Diarrhea, Inflammatory Bowel Disease, allergy,Urogenital Tract Disorders, Probiotics in developing functional foods.

Learning Outcomes:

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

- List the uses of probiotics for the prevention or treatment of human diseases
- Discuss current research efforts and applications of probiotics for human health
- Understand how probiotics and prebiotics are incorporated into food products
- Gain knowledge on the use of probiotics as alternative medicines

Course Outcomes:

By the end of the course, students will

- Understand the history and evolution of probiotics and prebiotics
- Identify the difference between probiotics, prebiotics and synbiotics
- Know about the sources of probiotics and prebiotics
- Understand the safety and health benefits of probiotics and prebiotics

RECOMMENDED BOOKS

1. Ronald Watson Victor Preedy. Probiotics, Prebiotics, and Synbiotics.Bioactive Foods in Health Promotion1st Edition.Academic Press, 2015.

2. Dimitris Charalampopoulos, Robert A. Rastall. Prebiotics and Probiotics Science and Technology. Springer-Verlag New York 2009.

3. Venketeshwer Rao, Leticia Rao, Probiotics and Prebiotics in Human Nutrition and Health, Intech publishing, 2016

. B.Sc. (H) MICROBIOLOGY IV SEMESTER
20SMB 284: PROBIOTICS AND PREBIOTICS(PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Isolation of probiotic organisms from various sources
2. Survey of available prebiotic supplements in the market
3. Survey of available probiotic supplements in the market.
4. Study of the survival conditions of probiotics at various temperatures and pH
5. Formulation of media with prebiotic rich components.
6. Study of the effect of prebiotics on the growth of probiotics
7. Formulation of different types of products using probiotics and prebiotics

Recommended Readings:

1. Ronald Ross Watson, Probiotics, Prebiotics, and Synbiotics: Bioactive Foods in Health Promotion, Academic press, 2015
2. Susan Sungsoo Cho , E. Terry Finocchiaro Handbook of probiotics and prebiotics ingredients, CRC Press, 2019
3. Yuan Kun Lee, Seppo Salminen, Handbook of Probiotics and Prebiotics, Wiley Publication, 2009
4. Dimitris Charalampopoulos, Robert A. Rastall, Prebiotics and Probiotics Science and Technology, Springer Publication, 2009

Course Outcomes:

By the end of the practicals, the student will be able to

- Generate information on the available probiotic and prebiotic supplements
- Identify the sources for isolation of probiotics
- Formulate an ideal media to grow probiotics
- Understand the importance growth conditions on the survival of probiotics

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 341: (THEORY)MICROBIOMICS AND BIOINFORMATICS

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This paper gives student an idea about 'Microbiomics', a fast-growing field in which all the microorganisms of a given community (a 'microbiota') are investigated together. Bioinformatics involves the integration of computers, software tools, and databases in an effort to address complex biological systems.

Course Objectives:

- To know the importance of sequencing technologies like WGS and NGS to generate complete genome sequencing data and exploitation of data related to research environments.
- To learn the importance of microbiomics in microbial diversity mapping.
- To study and understand the importance of modes of data transfer, biological databases, data storage systems, phylogenic trees and approaches of phylogenetic tree construction in genome studies, and protein structure prediction tools.

UNIT-I

Explanation of Terms and importance: The Genome, Pangenome, Metagenome, Proteome, Metabolome, and Microbiome. Sequencing technologies (Whole Genome Sequencing – WGS; Next Generation Sequencing – NGS).

Learning Outcomes:

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

- To study and understand the genome and related terminologies and its importance in omics studies.
- To know the importance of sequencing technologies like WGS and NGS to generate complete genome sequencing data.

UNIT-II

Microbiomics-Microbial diversity mapping and deciphering microbial community behavior through Microbiomics – the Gut Microbial Community and its relationship with health and disease; and microbial biofilms as examples system Exploiting the microbiome for health; Microbiomics in food preservation, detection and surveillance of diseases. The US Food and Drug Adminstration's (US FDA) "Genome Trakr"Network.

Learning Outcomes:

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

- To study and understand the importance of microbiomics in microbial diversity mapping.
- To study and understand the importance of microbiomics in health and in food preservation.

UNIT-III

Introduction to Computer Fundamentals-RDBMS - Definition of relational database, Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.Introduction to Bioinformatics and Biological Databases-Biological databases - nucleic acid, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB. High throughput screening;Bioinformatics for NGS; Big Data and their use in identifying patterns of behavior; Toolsand technologies (sequence data analysis and interpretation, databases available and theiruses).

Learning Outcomes:

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

- To study and understand the importance of modes of data transfer, biological databases, and data storage systems.
- To know the importance of NGS, and big data and their analysis and interpretation.

UNIT-IV

Sequence Alignments, Phylogeny and Phylogenetic trees-Local and Global Sequence

alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices

Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbor joining, Maximum Parsomony, Maximum likelihood

Genome organization and analysis- Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, MALDI-TOF spectroscopy Major features of completed genomes: *E.coli*, *S.cerevisiae*, *Arabidopsis*, Human

Learning Outcomes:

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

- To know about phylogenic trees and approaches of phylogenetic tree construction and in genome studies.
- To understand the genome organization with the exploitation of different versatile techniques like 2-D gel, and MALDI-TOF

Unit V

Protein Structure Predictions-Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains

Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot, Protein structure and rational drug design

Learning Outcomes:

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

- To study and understand the protein structures, classes and folds and domains
- To perform the protein structure predictions, and study energy minimizations by Ramachandran plot.

Course Outcomes:

By the end of the course, students will

- Know the importance of sequencing technologies
- Learn the importance of microbiomics in microbial diversity mapping.
- Understand the importance of modes of data transfer, biological databases, data storage systems, phylogenic trees and approaches of phylogenetic tree

RECOMMENDED READING

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

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 351: MICROBIOMICS AND BIOINFORMATICS (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW&phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene

SUGGESTED READING

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

20SMB 343: MICROBIAL QUALITY CONTROL AND QUALITY ASSURANCE(THEORY)

Hours per week: 4 End Examination: 60 Marks

Credits: 4 Sessionals: 40 Marks

Preamble

This course will examine the well-defined product specification with accompanying quality control procedures help to maximize product performance, ensure product safety, standardize manufacturing costs and reduce the risks of supply failure which is very much essential for customer safety and confidence.

Course Objectives

Upon completion of this course, students should be able to:

- Get an idea about the importance of QC and QA.
- To gain both theoretical and practical knowledge with good manufacturing practices and process.
- To acquainted with different pharmaceutical and food industries and their quality sector.
- Successful training will help the students to obtain job in respective sector.

Unit-I

Introduction: Concept, evolution and scopes of quality control and quality assurance, Good laboratory practice: Introduction, scope and overview of ICH guidelines QSEM, with special emphasis on Q-series guidelines, quality assurance unit, protocol for conduct of non clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines.

Learning outcomes: On successful completion of this module, students should be able to describe the guidelines for quality control and quality assurance

Unit-II

cGMP guidelines according to schedule M, USFDA (inclusive of CDER and CBER) and WHO covering: Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, construction and plant lay out, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination and good warehousing practice.

Learning outcomes: On successful completion of this module, students should be able to

- Describe the SOP, GLP, GMP and guidelines for hygiene and maintenance.

Unit-III

Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), developing specification (ICH Q6 and Q3), purchase specifications and maintenance of stores for raw materials. In process quality control and finished products quality control for following dosage forms in pharma industry according to Indian and US Pharmacoepia: Tablets, capsules, ointments, suppositories, creams, parenterals, ophthalmic and surgical products.

Learning outcomes: On successful completion of this module, students should be able to

- Describe quality check on the raw materials used in development of products

Unit-IV

Documentation in pharmaceutical industry: Three tier documentation, policy, procedures and work instructions, and records (Formats), basic principles- How to maintain, retention and retrieval etc. Standard operating procedures (How to write), master batch record, batch manufacturing record, quality audit plan and reports. Specification and test procedures, protocols and reports.Distribution records and electronic data handling.

Learning outcomes: On successful completion of this module, students should be able to

- Describe general Methods of Analysis
- Quality Specification for Pharmaceutical Substances, Excipient and Dosage Forms

Unit-V

Manufacturing operations and controls: Sanitation of manufacturing premises, mix- ups and cross contamination, processing of intermediates and bulk products, packaging operations, release of finished product, process deviations, charge-in of components, time limitations on production, drug product inspection, expiry date calculation, calculation of yields, production record review, change control, aseptic process control, packaging, reprocessing, salvaging, handling of waste and scrap disposal.

Learning outcomes: On successful completion of this module, students should be able to

- Describe good manufacturing practices for food products and pharmaceuticals

Course Outcomes:

Upon completion of this course, students will

- Know about the importance of QC and QA.
- Gain both theoretical and practical knowledge with good manufacturing practices and process.
- Acquainted with different pharmaceutical and food industries and their qualitysector.
- Be trained will help the students to obtain job in respective sector.

RECOMMENDED BOOKS

1. Quality Assurance Guide by Organization of Pharmaceutical Procedures of India, Vol. I and II, Mumbai.
2. Weinberg S., Good Laboratory Practice Regulations, Vol. 69, Marcel Dekker Series.
3. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related materials, Vol. I and II, WHO Publications.
4. Sharma P.P., How to Practice GMP's, Vandana Publications, Agra.
5. The International Pharmacopoeia, Vol. I-V, General Methods of Analysis and Quality Specification for Pharmaceutical Substances, Excipient and Dosage Forms, WHO, Geneva.
6. Hirsch A.F., Good laboratory Practice Regulations, Vol. 38, Marcel Dekker Series, New York.
7. ICH guidelines.
8. ISO 9000 and Total Quality Management.
9. Deshpande S.W. and Gandhi N., The Drugs and Cosmetics Act 1940, Susmit Publishers, Mumbai. 10. Shah D.H., QA Manual, Business Horizons, New Delhi.
10. Willig S. H., Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Vol. 52, Marcel Dekker Series, New York.

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 353: MICROBIAL QUALITY CONTROL AND QUALITY ASSURANCE(PRACTICAL)

Hours per week: 3

Credits: 4 Sessionals: 100 Marks

1. Case studies on total quality management (TQM)
2. Case studies on out of specifications (OOS).
3. Case studies on out of trend (OOT).
4. Development of stability study protocol.
5. Testing of related and foreign substances in drugs and raw materials.

6Organic contaminants residue analysis by chromatography.

7. Assay of official compounds by UV-Visible spectrophotometry.
8. Identification of antibiotic residue by TLC.
9. Qualification of following Pharma equipment: Autoclave; Hot air oven; Tabletcompression machine

RECOMMENDED BOOKS:

1. Quality Assurance Guide by Organization of Pharmaceutical Procedures of India, Vol. I and II, Mumbai.
2. Weinberg S., Good Laboratory Practice Regulations, Vol. 69, Marcel Dekker Series.
3. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related materials, Vol. I and II, WHO Publications.
4. Sharma P.P., How to Practice GMP's, Vandana Publications, Agra.
5. The International Pharmacopoeia, Vol. I-V, General Methods of Analysis and Quality Specification for Pharmaceutical Substances, Excipient and Dosage Forms, WHO, Geneva.
6. Hirsch A.F., Good laboratory Practice Regulations, Vol. 38, Marcel Dekker Series, New York.

.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 345: MICROBIAL BIOTECHNOLOGY (THEORY)

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 microbial metabolites
- Concepts and production of metabolites
- 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

Introduction and historyof industrial microbiology. Isolation and selection of Industrially important microbes.Over production of microbial metabolites.Preservation and maintenance of microbial cultures.

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

- Importance of Industrial Microbiology
- Applications of microbial metabolites in the industry
- Concepts related to the microbial metabolic pathways

UNIT-II

Microbial substrates, Media composition and growth conditions.Components of microbial fermentation.Types of fermentation processes. Design of bioreactor. Types of Bioreactor.

Learning Outcomes: By the end of this unit, the student will know of

- Microbial fermentation process
  Concept of bioreactor with proper examples

UNIT-III

Production of baker's Yeast, Mushroom and their applications. Production of fermented foods, Alcoholic beverages. Production of ethanol, citric acid, amino acids, vitamins, Application of microbial enzymes for food, detergent and pharma industry.

Learning Outcomes: By the end of this unit, the student will be knowledgeable of

- Production of fermented foods and beverages.
- Production of industrially important citric acid, vitamins, etc. using microbes.

UNIT-IV

Production of penicillinandpigments.production of insulin, interluekin, growth hormones, using recombinant DNA technology.

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

- The production of pencilin
- Recombinant DNA technology for the production of hormones

UNIT- V

Biopesticides and biofertilizers, Bioweapons and Bioshields, Single Cell Protein (SCP) production from spirulina, Microbial toxins and mycoparasitism. Microbial leaching of ores.

Learning Outcomes: By the end of this unit, the student will understand

- Biopesticides and biofertilizers
- SCP and microbial toxins
- Bio-sorption and biodegradation

Course Objectives:
By the completion of the course students will

1. Learn the concepts of role and applications of microbial metabolites
2. Develop the concepts and production of metabolites
3. Learn basic principles and production strategies of biofuels using microorganism
4. Understand the role of microorganisms in food industry and used as food

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. 71
7. Handbook of Microbial Biofertilizers (2006) by M. Rai.

B.Sc. (H) MICROBIOLOGY V SEMESTER

20SMB 345:MICROBIAL BIOTECHNOLOGY (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study yeast cell immobilization in calcium alginate gels.
2. Study enzyme immobilization by calcium alginate method.
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium).
4. Isolation of xylanase or lipase producing bacteria.
5. Study of algal Single Cell Proteins.
6. Hydrolysis of Starch/Polysaccharide/Lignocellulosic residue.
7. Biotransformation of steroid and its detection by a suitable method (TLC).
8. Demonstration of production of a recombinant product.

RECOMMENDED BOOKS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

B.Sc. (H) MICROBIOLOGY VI SEMESTER
20SMB 372: INSTRUMENTATION AND BIOTECHNIQUES

Hours per week: 4 End Examination: 60Marks

Credits:4 Sessionals:40Marks

Preamble

This paper gives student an idea about principles of microscopy, centrifuges, 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.

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 in analyzing the proteins.
- To study the principles, procedures and applications of various spectrophotometric methods especially in quantitation of desired compound in the given solutions.

UNIT-I

Microscopy- Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Learning Outcomes:

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

- To study and understand the function of each part of the microscope in knowing the

structure of microorganisms.

- To know the importance of electron microscopy in getting the high resolution images to know the detailed structure of microbes.

UNIT-II

Chromatography-Principles and applications of paper chromatography, thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Learning Outcomes:

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

- To understand the principles, procedures and applications of various chromatographic techniques.
- To imbibe with 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.
- Proficient with the prerequisites for making recombinant protein for ease in purification of proteins with tags such as his-tag etc.
- Identify carbohydrates and amino acids by techniques like paper and thin layer chromatography

UNIT-III

Electrophoresis-Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Learning Outcomes:

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

- To understand the principles, components, and applications of various electrophoretic techniques.
- To know the difference between SDS-PAGE and native PAGE techniques with respect to proteins
- To understand the importance of agarose gel electrophoresis with respect to molecular biology techniques like PCR and molecular cloning

- To visualize the purity of proteins those are purified to homogeneity using various chromatography columns.

UNIT-IV

Spectrophotometry-Principle and use of study of absorption spectra of biomolecules.Analysis of biomolecules using UV and visible range.Colorimetry and turbidometry.

Learning Outcomes:

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

- To know the principles, components, and applications of various spectrometry techniques.
- To apply the utilization of UV-visible spectrophotometer to know the concentrations of the different solutions.
- To understand the importance of colorimetry and turbidometry in knowing the concentration of solutions

UNIT-V

Centrifugation-Preparative and analytical centrifugation, fixed angle and swinging bucket rotors.RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

Learning Outcomes:

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

- To know the importance of method of separating molecules having different densities and molecular weights at high speed centrifuge.
- To study the importance of pelleting the cells for the isolation of recombinant proteins and exploiting the supernatant for the study of biochemical reactions.

Course Outcomes

By the completion of the course, students will

- Understand the detailed principles, procedures and applications of various chromatographic techniques
- Learn the principles, procedures and applications of various electrophoretic techniques.
- Understand the principles, procedures and applications of various spectrophotometric methods especially in quantitation of desired compound in the given solutions.

RECOMMENDED BOOKS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

B.Sc. (H) Microbiology V SEMESTER

20SMB 381: INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

Hours per week: 3

Credits: 2 Sessionals: 100 Marks

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λmax for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

RECOMMENDED BOOKS:

11. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
12. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
13. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
14. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
15. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

B.Sc. (H) MICROBIOLOGY IV SEMESTER

SMB 344: FOOD SAFETY AND HYGEINE (THEORY)

Hours per week: 4

Credits: 4

Preamble:

Food hygiene are the conditions and measures necessary to ensure the safety of food from production to consumption. Food can become contaminated at any point during slaughtering or harvesting, processing, storage, distribution, transportation and preparation. The term 'food hygiene' refers particularly to the practices that prevent microbial contamination of food at all points along the chain from farm to table. Food hygiene and safety issues are not separate from human health concerns or from community health issues. Good food hygiene practices can protect the community from foodborne illness.

Course Objectives:

- To describe the public health importance and aims of food hygiene.
- To define the essential functions of food
- To outline the principle aspects of a food control system and explain why food control is important.

Unit I

Introduction to Food Safety – Definition, Types of hazards, biological, chemical, physical hazards, Factors affecting Food Safety, Importance of Safe Foods, Food Hazards of Physical and Chemical Origin – Introduction, Physical Hazards with common examples, Chemical Hazards (naturally occurring ,environmental and intentionally, added), Packaging material as a threat, Impact on health, Control measures

Learning Outcomes:

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

- Prevent food spoilage, i.e. changes that make food unfit for consumption due to microbial or chemical contamination.
- Inform and educate people about simple and practical methods of keeping food safe to protect themselves against foodborne diseases.

- Protect food from adulteration (intentional contamination).
- Differentiate unsafe food, misbranded food, adulterated food, wholesome food and uncontaminated food

Unit II

Food Hazards of Biological Origin – Introduction, Indicator Organisms, Food borne pathogens: bacteria, viruses and eukaryotes, Seafood and Shell fish poisoning, Mycotoxins. Management of hazards – Need, Control of parameters, Temperature control, Food storage

Learning Outcomes:

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

- Identify whether food is safe for consumption using indicator organisms
- Differentiate between fungal, algal and microbial toxins
- Manage hazards which occur during processing and storage

Unit III

Hygiene and Sanitation in Food Service Establishments – Introduction, Sources of contamination, Control methods using physical and chemical agents, Waste Disposal, Pest and Rodent Control, Personnel Hygiene

Learning Outcomes:

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

- Identify various sources of contamination
- Prevent contamination of food using physical and chemical agents
- Learn how to dispose the waste safely and make money out of waste

Unit IV

Food Safety Management Tools - Basic concept, Prerequisites- GHPs ,GMPs, HACCP, ISO series, TQM - concept and need for quality, components of TQM, Kaizen, Risk Analysis, Accreditation and Auditing

Learning Outcomes:

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

- Illustrate important safety tools like HACCP that will help food industries to handle, store, and sell safe food to customers while ensuring compliance with the necessary standards
- Understand practices and procedures to actively control risks and hazards throughout the food process and ensure regulatory compliance.

Unit V

Microbiological criteria - Microbiological standards and limits (for processed food, water), Sampling, Basic steps in detection of food borne pathogens, Water Analysis Food laws and Standards - Indian Food Regulatory Regime, Global Scenario, Recent concerns - New and Emerging Pathogens, Genetically modified foods\Transgenics, Organic foods, Newer approaches to food safety.

Learning Outcomes:

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

- Understand the advantages of genetically modified foods, that GMO plants can be resistant to specific pesticides and herbicides while becoming adaptive to changing environmental conditions.
- Illustrate that crop yields become more consistent and productive, allowing more people to be fed.

Course Outcomes:

By the end of the course, students will

1. Know about the public health importance and aims of food hygiene.
2. Define the essential functions of food
3. Outline the principal aspects of a food control system and explain why food control is important.

Recommended Readings:

1. Lawley, R., Curtis L. and Davis,J. The Food Safety Hazard Guidebook , RSC publishing, 2004
2. De Vries. Food Safety and Toxicity, CRC, New York, 1997
3. Marriott, Norman G. Principles of Food Sanitation, AVI, New York, 1985
4. Forsythe, S J. Microbiology of Safe Food, Blackwell Science, Oxford, 2000Forsythe,S.J.The Microbiology of Safe Food , second edition, Willey- Blackwell,U.K.,2010
5. Mortimore S.and Wallace C.HACCP,A practical approach, Chapman and Hill,London,1995
6. Blackburn CDW and Mc ClureP.J.Food borne pathogens. Hazards, risk analysis & control.CRC Press, Washington,U.S.A, 2005.

B.Sc. (H) MICROBIOLOGYVI SEMESTER

SMB 383: FOOD SAFETY AND HYGEINE (PRACTICAL)

Hours per week: 3 Sessionals: 100 Marks

Credits: 2

1. Preparation of different types of media (complex, differential and selective)
2. Enumeration of aerial microflora using PDA
3. Identification of Molds by lactophenol blue staining
4. Negative Staining
5. Microbiological Examination of food
6. Bacteriological Analysis of Water by MPN method
7. Assessment of surface sanitation by swab and rinse method
8. Assessment of personal hygiene

Recommended Readings:

1. Lawley, R., Curtis L. and Davis,J. The Food Safety Hazard Guidebook , RSC publishing, 2004
2. De Vries. Food Safety and Toxicity, CRC, New York, 1997
3. Marriott, Norman G. Principles of Food Sanitation, AVI, New York, 1985
4. Forsythe, S J. Microbiology of Safe Food, Blackwell Science, Oxford, 2000Forsythe,S.J.The Microbiology of Safe Food , second edition, Willey- Blackwell,U.K.,2010
5. Mortimore S.and Wallace C.HACCP,A practical approach, Chapman and Hill,London,1995
6. Blackburn CDW and Mc ClureP.J.Food borne pathogens. Hazards, risk analysis & control.CRC Press, Washington,U.S.A, 2005.

B.Sc. (H) MICROBIOLOGY III SEMESTER

SSE257: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

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 Microbial Diagnosis in Health clinics. The course provides the basic concepts related to types of infections, sample collection and diagnostic methods.

Course Objectives:

- To provide a thorough understanding of various Diagnostic methods for clinical samples
- To provide a thorough knowledge about sample collection.
- To provide students with through knowledge regarding Microscoopic methods for direct examination of samples
- To provide serological and molecular methods for diagnosis of clinical samples

Unit 1

Importance of Diagnosis of Diseases Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Learning Outcomes:

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

- Importance of diagnosis and types of infections
- Disease associated clinical samples for diagnosis

Unit 2

Collection of Clinical Samples How to collect clinical samples (Oral cavity, throat, skin, Blood, CSF, Urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Learning Outcomes:

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

- Collection of clinical samples
- Methods of clinical sample transport & storage conditions

Unit 3

Direct Microscopic Examination and Culture Examination of sample by staining - Gram stain, Acid fast staining for tuberculosis, Geimsa – stained thin blood film for malaria. Preparation and use of culture media- Blood agar, Chocolate agar, and MacConkey agar. Distinct colony properties of various bacterial pathogens

Learning Outcomes:

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

- Direct Microscopic methods for identification of disease causing agents
- Preparation of culture media and study of colony characteristics

Unit 4

Serological and Molecular Methods Serological Methods - Agglutination, ELISA. Nucleic acid based methods – PCR, Kits for Rapid Detection of Pathogens Typhoid and Dengue

Learning Outcomes:

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

- Serological and Molecular Methods for disease diagnosis
- Rapid detection of infectious diseases

Unit 5

Testing for Antibiotic Sensitivity in Bacteria Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

Learning Outcomes

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

- Determination of antibiotic resistance/ sensitivity of bacteria
- Determination of MIC

Course Outcomes:

By the end of the course, students will

1. Develop a thorough understanding of various Diagnostic methods for clinicalsamples

2. Gain a thorough knowledge about sample collection.
3. Develop through knowledge regarding Microscoopic methods fordirect examination of samples

RECOMMENDED BOOKS

1. Ananthanarayan R and Paniker CKJ (2009). Textbook of Microbiology, 8th edition, Universities Press PrivateLtd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw HillPublication.
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva inMedical Microbiology 2nd edition, Elsevier India PvtLtd.

B.Sc. (H) MICROBIOLOGY III SEMESTER

SSE 259: FOOD FERMENTATION TECHNIQUES

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 Food fermentation technology. Significance and process of fermented foods

Course Objectives:

- To provide a thorough understanding of various fermented foods, microorganism involved in fermentation
- To provide a thorough understanding about effect of fermentation on nutritional and sensory attributes of foods.
- To provide students with through knowledge regarding traditional fermented foods, alcoholic beverages and fermented dairy products

Unit 1

Fermented foods- History of fermented foods, microorganisms in fermented foods, LAB, Yeast, Fermentations process, factors effecting fermentation conditions

Learning Outcomes:

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

- Fermented foods
- Microorganism involved in fermented foods
- Fundamentals of fermentation process

Unit 2

Effect of fermentation process on nutrient constituents in food. Advantages and Limitations of fermented foods, GRASS.

Learning Outcomes:

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

- Effect of fermentation process
- Advantages and limitations of fermented foods

Unit 3

Traditional fermented foods- South & Noth Indian traditional fermented-idly, dosa, dokla, , cereal and legume based fermented foods-Bread, Soya sauce, khaomak

Learning Outcomes:

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

- Fermented traditional foods
- Cereal and legume based fermented foods

Unit 4

Dairy based fermented food processing- Youghurt, curd, cheese, sour cream, kefir, fermented vegetable based products-sauerkraut. gundruk, sinki, khalpi, inziangsang,soidon.

Learning Outcomes:

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

- Dairy based fermented food
- Fermented vegetable products

Unit 5

Traditional alcoholic beverages-toddy, feni, kokmak, sake, mahua, Alcoholic beverages- beer, wine and fermented meat- salami, ham, sausage and fermented fish- sausages

Learning Outcomes:

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

- Traditional alcoholic beverages
- Fermented meat and fish product

Course Outcomes:

By the end of the course, students will

- Develop a thorough understanding of various fermented foods, microorganism involved in fermentation
- Understand the effect of fermentation on nutritional andsensory attributes of foods.
- Gain knowledge regarding traditional fermented foods,alcoholic beverages and

fermented dairy products

RECOMMENDED BOOKS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New AgeInternational (P) Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology.1st edition.CBS Publishers andDistributors, Delhi, India.

3. Frazier WC and Westhoff DC. (1992). Food Microbiology.3rd edition.TataMcGraw-Hill Publishing Company Ltd, New Delhi, India.

4. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7 thedition, CBS Publishers and Distributors, Delhi, India.

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SSE 266: MANAGEMENT OF HUMAN MICROBIAL DISEASES

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals:40 Marks

Preamble

Management of Human microbial diseases course provides the basic knowledge about infectious agents, transmission infections in human beings and control measures to prevent their spreadout.

Course Objectives:

- To study about human microbial diseases
- To learn about the diagnosis of microbial diseases in humans
- To understand the treatment of the microbial infections in humans
- To study about the prevention of the diseases

Unit 1 No of Hours: 8

Introduction to human microbial diseases, definition and concept of health, disease, Infection and pathogen.Types of human microbial diseases and their transmission, causative agents and symptoms of human microbial diseases. Recent outbreaks of human microbial diseases (SARS/ Swine flu/Ebola) – causes, spread and control.

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

- Human microbial diseases and their types
- Symptoms and causative agents

Unit 2 No of Hours: 8

Diagnosis of human microbial diseases.Various serological and molecular methods for diagnosis of microbial diseases. Detection by diagnostic kits based on ELISA, Immunofluorescence, Agglutination tests, PCR, DNA probes (illustrate each with one example).

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

- Diagnosis of human microbial diseases
- Detection kits for their diagnosis

Unit 3 No of Hours: 8

Treatment using antibiotics: Mechanism of action of antibiotics belonging to different classes: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

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

- Treatment of human microbial diseases
- Antibiotics

Unit 4 No of Hours: 8

Prevention of Microbial Diseases.General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

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

- Prevention of human microbial diseases
- Importance of vaccines

Unit V **No of Hours: 8**

A detailed study of the occurrence, pathogens and therapeutics for respiratory microbial diseases, gastrointestinal microbial diseases, nervous system diseases, skin diseases, eye diseases, urinary tract diseases, sexually transmitted diseases, mosquito borne disease, Microbial mediated cancers and Nosocomial infections.

Learning Outcomes:

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

- therapeutics for human diseases
- their occurrence and pathogenesis

Course Outcomes:

At the end of the course, students will

- Understand about the human microbial diseases
- Learn how to diagnose microbial diseases in humans
- Understand the treatment of the microbial infections in humans
- Learn about the prevention of the diseases

RECOMMENDED BOOKS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition.McGraw Hill Publication.

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition.Elsevier.

4. Willey JM, Sherwood LM, and Woolverton CJ.(2013) Prescott, Harley and Klein's Microbiology.9th edition.McGraw Hill Higher Education.

5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition.Pearson International Edition.

B.Sc. (H) MICROBIOLOGY III SEMESTER

20SSE 268: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

Hours per week: 4 End Examination: 60 Marks

Credits:4 Sessionals:40 Marks

Preamble

This course will increase the understanding of air borne and water borne microbes, their impact on human health, methods of diagnosis and treatment.

Course Objectives: Objectives of the course include

- To study about Understanding of aeromicrobiology
- To learn about Bioaerosol sampling and analysis for aeromicrobes
- To know about Water borne pathogenic bacteria
- To understand about Microbial analysis of water samples for microbe detection, and about Control measures

Unit INo of Hours: 8

Aeromicrobiology.Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens.

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

- Aeromicrobiology, airborne microbes
- Significance of operation theatres and allergans

Unit IINo of Hours: 7

Air sample collection and analysis.Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

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

- Collection of air samples and analysis
- culture media for air borne microbes

Unit III **No of hours: 6**

Introduction to Water Microbiology.Water borne pathogens (bacteria, viruses and fungi) and their role in human health.Description of water borne diseases.

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

- water microbiology, water borne microbes
- Significance of water borne diseases

Unit IV No of Hours: 10

Microbiological analysis of water.Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test(MPN test), confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

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

- analysis of water sample for microbial analysis
- methods for the detection of water potability

Unit VNo of Hours: 9

Control measures. Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. Precipitation, chemical disinfection, filtration, high temperature, UV light.

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

- Control measure against airborne microbes
- Control measure against water borne microbes

Course Outcomes:

By the end of the course, students will

- Understand about aeromicrobiology
- Learn about Bioaerosol sampling and analysis for aeromicrobes
- Know about Water borne pathogenic bacteria
- Understand the Microbial analysis of water samples for microbe detection, andabout

Control measures

RECOMMENDED BOOKS

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

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

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

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