Placed at the meeting of
Academic Council
held on 26.03.2018

APPENDIX - BI

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

B.Sc. MICROBIOLOGY - SEMESTER

REVISED SYLLABUS
CBCS

(EFFECT FROM THE ACADEMIC YEAR 2018-2019 ONWARDS)

SCHEME OF EXAMINATIONS AND REGULATIONS

1. Introduction of the programme

This three year Bachelor of Science course in Microbiology deals with the study of microorganisms comprising Bacteria, Fungi, Protozoans, Algae and Virus; and its association with the environment, plants, animals and humans. Candidates undertaking this curriculum will understand the basic and applied concepts of Microbiology. This includes the beneficial and harmful role of microorganism in the production of commercially important products and its role in various diseases respectively. Basic concepts of Immunology of the host and its interaction with infectious microorganisms are also included in the syllabus. The scope of this course is wide which enables the candidate to get placed in diagnostics, pharma, fermentation, dairy, food and medical arena.

2. Eligibility for admission:

A candidate who has passed Higher Secondary examination (10+2) conducted by the Board of Higher Secondary Education, Govt. of Tamil Nadu or any other examinations accepted as Equivalent thereto by the syndicates subject to such conditions

a) Biology/Physics/Chemistry as subjects in the Higher Secondary education.
b) Candidates should have secured at least 60% in the above subjects individually and as total aggregates
c) A relaxation of 10% marks in the aggregate shall be given to SC/ST candidates

2.1 Duration of the programme:

The students will undergo the prescribed course of study for a period of not less than three academic years (six semesters)

The maximum duration for completion of the UG Program shall not exceed twelve semesters, beyond which the candidate has to get readmitted in the course with the new syllabus if any.

2.2 Medium of Instructions of the programme: English

3. Objectives of the Programme

- To inculcate the basic and advanced concepts of Microbiology including taxonomy, physiology, Immunology, biomolecule interactions, genomics, proteomics and rDNA technology.
- To impart the scope for the application of concepts learned in the subject.
- To introduce about the recent advances in the field of Microbiology and its importance in research.

4. Outcome of the programme:

At the end of this three year course, a candidate will have a thorough understanding on the basic concepts of Microbiology and its applications in the various fields of science and technology. Through the knowledge and hands-on experience imparted during the practical subjects, the candidate will get conveniently placed in the diagnostics, production and R&D units of various hospitals and industries respectively. This course will also lay a strong foundation to build the individual research caliber in the aspirants of Bachelor of Science in Microbiology.

5. Core subject papers:

Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – 1						
CS01	General Microbiology	5	5	3	25	75	100
CS02	Microbial Physiology & Taxonomy	5	5	3	25	75	100
CS03	Biochemistry	5	5	3	25	75	100
CS04	Major Practical -1 (Basic Microbiology)	5	3	3	40	60	100

CS05	Microbial Genetics & Molecular Biology	5	5	3	25	75	100
CS06	Immunology	5	5	3	25	75	100
CS07	Industrial Microbiology	5	5	3	25	75	100
CS08	Major Practical – II Microbial genetics, Molecular Biology, Immunology, Industrial Microbiology	5	5	3	40	60	100
CS09	Bioinformatics	5	5	3	25	75	100
CS10	Medical Microbiology	5	5	3	25	75	100
CS 11	Soil & Agricultural Microbiology	4	4	3	25	75	100
CS 12	Major Practical – III	6	3	3	40	60	100
CS13	Biotechnology	4	4	3	25	75	100
CS14	Major Practical – IV	6	3	3	40	60	100

6. Subject elective papers

ES01	Enzymology and Enzyme Technology (Theory & Practical)	6	5	3	25	75	100
ES02	rDNA Technology & Tissue culture Technology (Theory & Practical	6	5	3	25	75	100
ES03	Project Work	6	5	3	20	80	100

7. Non Major Elective papers

NME1	Food & Dairy Microbiology	2	2	3	25	75	100
NME2	Microbial Biotechnology	2	2	3	25	75	100

8. Unitization

Content of Every paper divided into FIVE units.

9. Pattern of Semester Exams:

Examinations will be conducted at the end of each semester. Each semester has two pattern of examinations namely Internal (25) External (75).

10. Scheme of internal evaluation:

The pattern of internal valuation may be:

\Tests	-	*10 Marks (average of the best two tests)*
Assignment	-	*5 Marks*
Seminar / Group Discussion	-	*5 Marks*
Peer-Team-Teaching	-	*5 Marks*
Total	**-**	***25 Marks***

Core Practical Internal examination

The pattern for internal valuation for 40 marks may be

Two internal tests of 25 marks	: Average = 25 marks
Observation Book	: 10 Marks
One assignment	: 05 Marks

11. External exam

As per the information furnished in no.9

Examinations

The duration of theory examination shall be three hours to each paper at the end of each semester. The candidate failing in any subject(s) will be permitted to appear for each failed subject(s) in the subsequent examinations. The practical examinations for UG course should be conducted at the end of the every semester

12. Question Paper Pattern

THEORY QUESTION PAPER PATTERN

Time: 3 hours Max. Marks: 75

Section- A (10 x 1 = 10 Marks) (Answer all the Question; 1 to 10)

1. Choose the correct answer type questions.
2. Two questions from each unit
3. Four choices with one correct answer in each question.
4. Answer all questions.

Section- B (5 x 7 =35 marks)

Answer all questions – Either Or type

Answers not exceeding two pages
(One question from each unit)

Question Nos.

11a	or	11b
12a	or	12b
13a	or	13b
14a	or	14b
15a	or	15b

Section - C (3 x 10 = 30 Marks)

Answer Any Three out of Five

Answer not exceeding four pages
(One question from each UNIT)

Question Nos. 16 - 20

CORE PRACTICAL QUESTION PAPER PATTERN

Time : 6 hours Maximum Marks (University Exam) - 60

Major Practical - 1	: 20 Marks
Minor Practical - 1	: 10 Marks
Spotters - 2	: 2 x 2.5 = 5 Marks
Record	: 5 Marks
Viva voce	: 15 Marks
Internal Marks	: 40 Marks
Total	: 100Marks

13. Scheme for evaluation

Section A – 10 X 1 = 10
Section B – 5 X 7 = 35
Section C – 3 X 10 = 30
Total = 75 (External)

14.Passing minimum

Guidelines for the Pass minimum:

To get a pass, a student should fulfill the following conditions:

a)Theory:
i) Minimum 40% or above as total aggregated marks including both internal and external.
ii) No separate minimum pass marks for the internal, however the candidate must secure a minimum of 27 marks out of 75 in the external examination to be declared as pass.

b) Practical
i) 40% of the aggregated (Internal +External)
ii) No separate minimum pass marks for the internal, however the candidate must secure a minimum of 21 marks out of 60in the external examination to be declared as pass.

c) Project
i) 40% of the aggregated (Internal +External)
ii) No separate minimum pass marks for the internal, however the candidate must secure a minimum of 28 marks out of 80in the external examination to be declared as pass.

Candidates who have secured 60% and above in aggregates of the Part III will be given First class; Candidates who have secured 50% and above but less than 60% will be given Second class; Candidates who have secured 40% and above but below 50% will be given a Third class.

Ranking will be made for the candidates who have necessarily completed the course without any arrears in each semester and scored the maximum total among all candidates appeared for the examination in the Part III will be given the First Rank. Such candidates will be honored with a Gold Medal if there is a sponsorship or an endowment.

14.1. Classification

S. No	Range of CCPA	Class
1	50 & above but below 60	II
2	60 & Above	I

15. Model questions

Section A
Answer all questions (10X1=10)

1. According to Pasteur statements which one of the following is true
a. Living organisms discriminate between stereoisomers
b. Fermentation is a aerobic process
c. Living organisms doesn't discriminate between stereoisomers
d. Both a and b.

2. Who demonstrated that open tubes of broth remained free of bacteria when air was free of dust.
a. AbbcSpallanzani
b. John Tyndall
c. Francisco Redi
d. Pasteur

3. In electron microscope, what material is used as an objective lense?
a. Magnetic coils
b. Superfine glass
c. Aluminium foils
d. Electrons

4.**Meosomes are also known as**
a. Mitochondria
b. Endoplasmic reticulum
c. Plasmids
d. Chondroids

5. **Term vaccine was coined by**
a. Robert Koch
b. Pasteur
c. Needham
d. None of these

6. The mode of reproduction which occurs in mycoplasma is
a. Budding
b. Bursting
c. Binary fission
d. Binary fusion

7. **The bacterial pili mainly contain**
a. Carbohydrates
b. Lipids

c. Proteins
d. Minerals

8. **Sulphur oxidizing bacteria is**
a. Alcaligenes
b. Pseudomonas
c. Thiobacillus
d. None of these

9. beta haemolytic bacteria is
a. Streptococcus pyogenes
b. Str. pneumoniae
c. Str. viridans
d. Str. Faecalis

10. **Batch fermentation is also called**
a. Closed system
b. Open system
c. Fed-Batch system
d. Sub-merger system

Section B:

Answer all questions (5 x 7= 35 marks)

11a. Write the contributions of Pasteur and Beijerink.

Or

11b. Explain briefly the structure and functions of bacterial cellwall.

12a.Briefly explain the concept of containment facility.

Or

12b. Write a commonly used method for isolation of pure culture of bacterium.

13a.Distinguish between continuous and synchronous cultures.

or

13b. Distinguish between bacteria and mycoplasmas.

14a.Give a brief account of slime molds.

or

14b.Briefly explain the morphological features protozoa.

15a. Write a brief note on bioluminescence

or

15b. Explain Calvin cycle

Section C
Answer any three questions.(3X 10= 30)

16. Give detail note on Bergy'ssytem of bacterial classification

17. Discuss about early era of microbiology and major Scientist contributions
18. Explain about fungal classification
19. Describe the process of sporulation in *Bacillus*
20. Explain the microbes which lives in extreme environments with suitable examples

16. Teaching Methodology

Each subject is designed with lectures/ tutorials/ seminar/ Peer-Team-Teaching / PPT presentation/ assignments etc., to meet the effective teaching and the learning requirements. 10 % of the course content must be taught through peer team teaching methodology.

17. & 18. Text book& Reference books

1) Prescott, Harley and Klein. 2006, Microbiology 6/e. The McGraw-Hill Companies.
2) Pelezar, M.J.. Chan. E.C.S. and Kreig. N.R. 1993. Microbiology, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3) Schlegel. H.G. 1993. General Microbiology. Cambridge University Press, Cambridge.
4) Stainer. R.Y., Ingraham, Wheelis, M.G. and Paintor. P.R.I986, The Microbial World, Prentice Hall, New Jersey.
5) Tauro. P., Kapoor, K.K.and Yadav. K.S.I989, An Introduction to Microbiology, Wiley Publications. New Delhi.
6) Microbiology: A laboratory manual, P. Gunasekaran, New Age international publishers, 1996.
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8) Microbiology: A laboratory manual. J.G. Cappuccino and N. Sherman, Additon-Wesley, 2002.
9) Bergey's manual determinative bacteriology, J.G. Holt and N.R. Krieg. Lippincott Williams & Wilkin publishers, 2000.
10) Moat AG. Foster JW and Spector MP. Microbial Physiology. 4/e Wiley-Liss,2002.
11) Prescott, Harley and Klein, Microbiology. 6/e The McGraw-Hill Companies, 2006.

12) Caldwell DR. Wm. Microbial physiology and metabolism. C Brown publishers, USA 2002.
13) J.C. Cappuccino and N.Sherman, Microbiology: A laboratory manual, Addition – Wesley, 2002.
14) M.T.Maigan, J.M. Martinko and J.Parkar, 2000. Brock Biology of Microorganisms, (9^{th} edition), Prentice- Jall.
15) C.J.Alexopoulos and C.W.Mims 1979, Introductory Mycology (3^{rd} edition) Wiley, New York.
16) L.W.Nester, C.N. Roberts and M.L.Nester 1995, Microbiology – A Human Perspectives, Lowa, USA.
17) R.Y.Stainer, J.I.Ingraham, M.L. Wheelis and P.R.Painter 1999 General Microbiological, McMillian Educational Ltd. London.
18) Principles of Biochemistry. Lehninger, AL. 1993 2^{nd} edition, CSB Publishers.
19) Outlines of Biochemistry, 5/e - Conn. E.E., Stumpf, P.K. Bruening, G and Doi. R.H. John Wiley & Sons (1987)
20) Biochemistry, Voet. D and Voet. JG. 1990. John Wiley & Sons. NY.
21) Text book of Biochemistry. 2/e. Devlin. T.M. 1986. Wiley Medical Publications, NY.
22) Biochemistry, 2/e, Stryer. L. 1998, W.H. Freeman and Company, NY.
23) Biochemistry, 2/e. Zubay. G. 1998. McMillan Publishers NY. Collier McMillan Company Publishers, London.
24) Enzymes. Ribozymes and DNAzyrnes, P. Palanivelu, 2007, Twenty first Century Publications, Palkalai Nagar, Madurai - 625 021.
25) Laboratory manual in biochemistry, 5/e, J. Jayaraman, New Age international publishers, 1996.
26) Principles of practical biochemistry, K. Wilson and J. Walker, Cambridge University press, 2000.
27) An Introduction to practical biochemistry, D.T. Plummer. TATA McGraw Hill, 1997.
28) Microbial Physiology, 4/e, Moat AG, Foster JW and Spector MP. Wiley-Liss. 2002.
29) Gene VII. Benjamin Lewin, 2000: Oxford University Press.
30) Molecular biology of the Gene,4/e. Watson, Hopkins, Roserts. Steits and Weiner, 1987, The Benjamin/Cumming Publishing Company, Inc.
31) Molecular Genetics of Bacteria, 2/e, Larry Snyder and Wendy Champness, 2003, ASM press. Washington DC.
32) Microbial genetics. David Friefelder, 1987, Narosa Publishing Mouse.
33) Essential ofimmunology, Roitt. I.M. 1998, ELBS, Blackwell scientific publication.

34) Immunology, 3/e. Kuby, J. 1997, W.H.Freeman and company. NY.
35) Crueger, W. and A. Crueger (2000), Biotechnology, A Text book of Industrial Microbiology. Panima Publishers, New Delhi.
36) Flinger, M.C., and Drew, S.W., (1999), Encyclopedia of Bioprocess technology - Fermentation, Biocatalysis and Bioseparation (Volumes I - V), John Wiley and Sons, New York.
37) Sambrook, J. Cold Spring Harbor laboratory (2002).
38) Advanced bacterial genetics, David, RW, Botstein, D & Roth, JR. Cold Spring Harbor laboratory (1980).
39) Data basis in life sciences and Biotechnology: A directory - DBT, Govt. of India, March 1995.
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44) Rangasami G and Bagyaraj DJ. 1993. Agricultural Microbiology 2/e Prentice- Hall publications.
45) Ronald Atlas, Bartha Richard, 1987. Microbial ecology 2/e Benjamin/ Cummings publications.
46) Enzymes, Ribozymes and DNAzymes, P. Palanivelu, Twentyfirst Century Publications. Palkalai Nagar, Madurai - 625 021 (2006).
47) Enzymes-Biochemistry, Biotechnology, Clinical chemistry- T. Palmer -East-West press. New Delhi (2.004)

B.Sc., Microbiology

(CBCS Pattern)
THEORY QUESTION PAPER PATTERN

Time: 3 hours Max. Marks: 75

Section- A (10 x 1 = 10 Marks) (Answer all the Question; 1 to 10)

Choose the correct answer type questions.
Two questions from each unit

Four choices with one correct answer in each question.
Answer all questions.

Section- B (5 x 7 =35 marks)

Answer all questions – Either Or type

Answers not exceeding two pages
(One question from each unit)

Question Nos.

11a	or	11b
12a	or	12b
13a	or	13b
14a	or	14b
15a	or	15b

Section - C (3 x 10 = 30 Marks)

Answer Any Three out of Five

Answer not exceeding four pages
(One question from each UNIT)

Question Nos. 16 - 20

The pattern of internal valuation may be:

a) Two internal test of 15 marks each: Average = 15 marks
b) Group Discussion / Seminar / Quiz = 05 Marks
c) Two assignments: 5 marks each = 05 marks

B.Sc., Microbiology

(CBCS Pattern)
CORE PRACTICAL QUESTION PAPER PATTERN

Time : 6 hours Maximum Marks (University Exam) - 60

Major Practical - 1	: 20 Marks
Minor Practical - 1	:10 Marks
Spotters - 2	: 2 x 2.5 = 5 Marks
Record	: 5 Marks
Viva voce	: 15 Marks

Internal Marks : 40 Marks
Total : 100Marks

The pattern for internal valuation for 40 marks may be
Two internal tests of 25 marks : Average = 25 marks
Observation Book : 10 Marks
One assignment : 05 Marks

19. Retotaling and Revaluation Provision

Candidates may apply for retotaling and revaluation within ten days from the date of the result published in the university website along with the required forms and fees.

20. Transitory provision

The candidates of previous scheme may be permitted to write exams in their own schemes up to the examinations of April 2020 as a transitory provision.

21. Subjects and Paper related websites

All the subject details along with syllabus may be downloaded from the university website ***www.mkuniversity.org***

CORE PRACTICAL QUESTION PAPER PATTERN

Time : 6 hours Maximum Marks (University Exam) - 60

Major Practical - 1 : 20 Marks
Minor Practical - 1 : 10 Marks
Spotters - 2 : 2 x 2.5 = 5 Marks
Record : 5 Marks
Viva voce : 15 Marks

Internal Marks : 40 Marks
Total : 100Marks

The pattern for internal valuation for 40 marks may be
Two internal tests of 25 marks : Average = 25 marks
Observation Book : 10 Marks
One assignment : 05 Marks

Overall Course content of B.Sc. Microbiology (CBCS syllabus)

SI.No	Subject	No. of Papers	No. of Hours	No. of Credits
1	Tamil / Hindi	4	24	12
2	English	4	24	12
3	Core subjects	14	70	60
4	Allied subjects	4	24	20
5	Skill Based Subjects	6	12	12
6	Elective Subjects	3	18	15
7	Non Major Electives	2	4	4
8	Extension Activities	1	0	1
9	Environmental Studies	1	2	2
10	Value Education	1	2	2
	Total	**40**	**180**	**140**

Work load per week, Credits per paper and scheme of examinations
(For those admitted in June 2018-19 onwards)

Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – 1						
TA1	Part -1 Tamil	6	3	3	25	75	100
EN1	Part – 2 English	6	3	3	25	75	100
	Paper – 3						
CS01	General Microbiology	5	5	3	25	75	100
CS02	Microbial Physiology &	5	5	3	25	75	100

	Taxonomy						
	Allied Subject						
AS01	Chemistry (Theory & Practical)	6	5	3	25	75	100
	Non Major Elective Subject						
NME1	Food & Dairy Microbiology	2	2	3	25	75	100
	Total	30	23				600

Tamil and English syllabi and workload are as per the other degree courses.
The allied 1 (Chemistry and Allied II (Biology) syllabi are as per other degree courses (E.g. B.Sc. Biochemistry)

Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – II						
TA2	Part -1 Tamil	6	3	3	25	75	100
EN2	Part – 2 English	6	3	3	25	75	100
	Paper – 3						
CS03	Biochemistry	5	5	3	25	75	100
CS04	Major Practical -1 (Basic Microbiology)	5	3	3	40	60	100
	Allied Subject						
AS02	Chemistry (Theory & Practical)	6	5	3	25	75	100
	Non Major Elective Subject						
NME2	Microbial Biotechnology	2	2	3	25	75	100
	Total	30	21				600

Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – III						
TA3	Part -1 Tamil	6	3	3	25	75	100
EN3	Part – 2 English	6	3	3	25	75	100
	Paper – 3						
CS05	Microbial Genetics & Molecular Biology	5	5	3	25	75	100
CS06	Immunology	5	5	3	25	75	100
	Allied Subject						
AS03	Chemistry (Theory & Practical)	6	5	3	25	75	100
	Skill Based Subject						
SBS01	Mushroom Technology	2	2	3	25	75	100
	Total	30	23				600
	Semester – IV						
TA4	Part -1 Tamil	6	3	3	25	75	100
EN4	Part – 2 English	6	3	3	25	75	100
	Paper – 3 Core Subject						
CS07	Industrial Microbiology	5	5	3	25	75	100
CS08	Major Practical – II Microbial genetics, Molecular Biology, Immunology, Industrial Microbiology	5	5	3	40	60	100
	Allied Subject						
AS04	Biology (Theory & Practical)	6	5	3	25	75	100
ENS01	Extension Activities	1	1				

	Total	30	22				600
Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – V						
	Paper – 3 (Core papers)						
CS09	Bioinformatics	5	5	3	25	75	100
CS10	Medical Microbiology	5	5	3	25	75	100
CS 11	Soil & Agricultural Microbiology	4	4	3	25	75	100
CS 12	Major Practical - III	6	3	3	40	60	100
	Elective Subject						
ES01	Enzymology and Enzyme Technology (Theory & Practical)	6	5	3	25	75	100
	Skill Based Subject						
SBS02	Computer Application in Biology	2	2	3	25	75	100
	Environmental Studies	2	2	3	25	75	100
SBS03	Medical Lab Technology	2	2	3	25	75	100
	Total	30	28				600
Sub. Code	Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
					Int.	Ext.	Tol.
	Semester – VI						
	Paper – 3 (Core papers)						
CS13	Biotechnology	4	4	3	25	75	100
CS14	Major Practical - IV	6	3	3	40	60	100

	Elective Subject						
ES02	rDNA Technology & Tissue culture Technology (Theory & Practical	6	5	3	25	75	100
ES03	Project Work	6	5	3	20	80	100
	Skill Based Subject						
SBS02	Computer Application in Biology	2	2	3	25	75	100
SBS03	Medical Lab Technology	2	2	3	25	75	100
	Value Education	1	2	2	25	75	100
	Total	30	23				600

CORE SUBJECTS

CS 01: GENERAL MICROBIOLOGY

Objectives

To facilitate the students to

- Enrich their knowledge in basic microbiology and its applications
- Know the basic features and functions of microbial taxonomy and its importance
- Get familiarized with the taxonomic positions and key identification features of microbes
- Understand the biology of most important microbes diseases, industries, environment, agriculture & medicinal importance.

Unit – I

Introduction - Definition, History, and Scope of Microbiology. Difference between the prokaryotic and eukaryotic microorganisms. Classification of microorganisms - general principles and nomenclature – Haeckel's three kingdom concept. Whittaker's five kingdom concept, Molecular Taxonomy.

Unit – II

Microscopy - Principles & Applications: Resolving power, numerical aperture. components, working principles and applications of simple, compound microscope, light & dark field microscope, electron microscope, phase contrast microscopes, Atomic Force Microscopy, Confocal microscopy and fluorescent microscopy.

Unit – III

Prokaryotes - structure and functions of cell and cellular components, slime, capsule, pili, flagella, cell wall, cytoplasmic membrane, mesosomes, ribosome, nucleoid and other cytoplasmic inclusions of - bacteria, archea, actinomycetes.

Unit – IV

Salient features of Algae, structure and reproduction of Chlamydomonas. Chlorella. Euglena. Diatoms, Dinoflagellates. Salient features of fungal morphology, structures and reproduction: *Dictvostelium, Rhizopus, Aspergillus, Penicillium, Agaricus, Saccharomyces, Neurospora & Candida.*

Unit – V [Peer team teaching]

Microbiology and Human Health - Contributions by Leeuwenhoek, Jenner. Spallanzani, Louis Pasteur, John Needham and Robert Koch. Difference between electron microscope and Compound Microscope. Differences between prokaryotic and eukaryotic cells. Salient features of Bacteria: *Bacillus. Clostridium, E. coli. Salmonella.* Blue green algae, *Streptomyceles* and *Mycoplasma.*

Viruses: T4. Lambda, TMV, Adenovirus, Polio, IIIV, Protozoa: Plasmodium.

Reference

1. Prescott, Harley and Klein. 2006, Microbiology 6/e. The McGraw-Hill Companies.
2. Pelezar, M.J.. Chan. E.C.S. and Kreig. N.R. 1993. Microbiology, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Schlegel. H.G. 1993. General Microbiology. Cambridge University Press, Cambridge.
4. Stainer. R.Y., Ingraham, Wheelis, M.G. and Paintor. P.R.I986, The Microbial World, Prentice Hall, New Jersey.
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8. Microbiology: A laboratory manual. J.G. Cappuccino and N. Sherman, Additon-Wesley, 2002.
9. Bergey's manual determinative bacteriology, J.G. Holt and N.R. Krieg. Lippincott Williams & Wilkin publishers, 2000.

CS 02 MICROBIAL PHYSIOLOGY & TAXONOMY

Objectives

To facilitate the students:

- To understand the basics of microbial physiology and metabolism.
- To gain knowledge about the importance of metabolism in microbial life.
- To know the basic & through knowledge about the microbial metabolism in the environment.

Unit - I

Generation of Energy - Concepts for Respiration and Fermentation. Fermentation (*vs*) respiration pathways, anaerobic respiration, acid fermentations. Generation of ATP substrate level phosphorylation, oxidative phosphorylation, proton motif force. Cell membrane of bacteria and fungi. Transport of sugars and metabolites - active, passive and facilitated transport systems, chemiosmosis, ion gradients. Secretion in bacteria - type of secretion systems.

Unit - II

Photosynthesis and inorganic metabolism – Bacterial Photosynthesis - Oxygenic and anoxygenic photosynthesis (BGA and Green bacteria). C2, C3 and C4 pathways of carbon assimilation. Assimilation of inorganic phosphorus, sulfur and nitrogen in bacteria - sulfate reduction pathway, ammonia assimilation pathway, nitrogenase and nitrogen fixation.

Unit – III

Bacterial cell division and differentiation – Bacterial Cell wall synthesis (Gram positive & Gram negative) and pattern of cell division in *E. coli* and Yeast. Life cycle of *Bacillus*, stages of endospore formation, germination and outgrowth. Morphology and life cycles of *Hyphobacterium* and *Caulobacter*. Gliding bacteria and gliding motility, life cycle of fruiting bacteria – Myxobacteria, Sporulation in fungi.

Unit - IV

Principles of chemotaxonomy and numerical taxonomy. Classification of bacteria as per Bergey's Manual of Systematic Bacteriology - Organisms placed in the five kingdoms - Their salient features with examples. Archea, Eubacteria, mycoplasma, Extremophiles.

Unit – V

Classification of Algae by Fritsch, classification of Fungi by Alexopoulos & Mims. Principles of Virus taxonomy, characteristics used in nomenclature & classification of bacterial, plant and animal viruses- their major families with suitable examples.

References

1. Moat AG. Foster JW and Spector MP. Microbial Physiology. 4/e Wiley-Liss, 2002.
2. Prescott, Harley and Klein, Microbiology. 6/e The McGraw-Hill Companies, 2006.
3. Caldwell DR. Wm. Microbial physiology and metabolism. C Brown publishers, USA 2002.

4. J.C. Cappuccino and N.Sherman, Microbiology: A laboratory manual, Addition – Wesley, 2002.
5. L.M. Prescott, J.P. Harley and D.A. Klein, 2005, Microbiology (6^{th} edition) McGraw Hill Publishers.
6. M.T.Maigan, J.M. Martinko and J.Parkar, 2000. Brock Biology of Microorganisms, (9^{th} edition), Prentice- Jall.
7. C.J.Alexopoulos and C.W.Mims 1979, Introductory Mycology (3^{rd} edition) Wiley, New York.
8. L.W.Nester, C.N. Roberts and M.L.Nester 1995, Microbiology–A Human Perspectives, Lowa, USA.
9. R.Y.Stainer, J.I.Ingraham, M.L.Wheelis and P.R.Painter 1999 General Microbiological, McMillian Educational Ltd. London.

CS 03 BIOCHEMISTRY

To facilitate the students:

- To know the basics of bio-molecules, structure, complexity and properties.
- To understand the biochemical process of life.
- To gain the thorough knowledge about the major biomolecules like carbohydrates, Proteins and lipids.
- To enrich the analytical and theoritical knowledge in the biomolecules and life

Unit I

Water and Life - pH and Buffers. Law of Thermodynamics-Oxidation and reduction reactions, redox potential, free energy and reaction. ATP energetics. Entropy, Enthalpy, Theory of thermodynamics.

Unit II

Carbohydrates - Biological significance-Classification, Structure, chemical and physical properties of monosaccharide, disaccharides and polysaccharides. Metabolism of carbohydrates- Embden-Meyerhof-Parnas, Entner-Doudoroff. Pentose Phosphate pathways – TCA cycle.

Unit III

Lipids-fatty acids- simple fats. Physical and Chemical properties- Nomenclature of fatty acids- Phospholipids- Spingolipids- Lipoproteins - Reaction of phospholipids and Eicosanoids, Oxidation of fatty acids (β-Oxidation) - Fatty acid synthesis.

Unit IV

Proteins- Structure- Classification, properties of ammo acids and proteins. Primary, secondary, tertiary and quaternary structures of proteins - Enzymes and their classifications - General properties of enzymes (pH, Temperature, substrate concentrations). Michaelis-Menton equation, enzyme inhibition. Isozymes.

Unit V

Nucleic acids - Components. Double helical structure- Nucleic acid denaturation-Classes of nucleic acids- Metabolism of nucleic acids.

References:

1. Principles of Biochemistry. Lehninger, AL. 1993 2nd edition, CSB Publishers.
2. Outlines of Biochemistry, 5/e - Conn. E.E., Stumpf, P.K. Bruening, G and Doi. R.H. John Wiley & Sons (1987)
3. Biochemistry, Voet. D and Voet. JG. 1990. John Wiley & Sons. NY.
4. Text book of Biochemistry. 2/e. Devlin. T.M. 1986. Wiley Medical Publications, NY.
5. Biochemistry, 2/e, Stryer. L. 1998, W.H. Freeman and Company, NY.
6. Biochemistry, 2/e. Zubay. G. 1998. McMillan Publishers NY. Collier McMillan Company Publishers, London.
7. Enzymes. Ribozymes and DNAzyrnes, P. Palanivelu, 2007, Twenty first Century Publications, Palkalai Nagar, Madurai - 625 021.

CS 04 MAJOR PRACTICALS - I

Objectives

To facilitate the students:

1. To learn the basic principles of laboratory practice, handling the equipments etc.
2. To learn the experimental procedures of handling the pathogenic and non-pathogenic microbes.
3. To perform and understand the morphology and growth behaviors of bacteria, fungi, actinomycetes and algae.
4. To develop a skill to evaluate antimicrobial sensitivity, motility, physiological properties of microbes.
5. To carryout the bioassay and analytical principles to quantify the biomolecules.

BASIC MICROBIOLOGY

1. Parts, working principle and applications of the compound microscope
2. Sterilization methods: moist heat, dry heat, filtration, disinfectants
3. Preparation of bacterial and fungal culture media
4. Isolation of bacteria and fungi from environmental samples
5. Enumeration of bacteria and fungi from environmental samples
6. Observation of bacterial and fungal colony morphology
7. Observation of bacterial and fungal cell morphology under microscope
8. Measurement of bacterial size by micrometry method
9. Pure culture techniques: streak, spread and pour plate methods
10. Observation of bacterial motility by hanging drop method
11. Staining methods: Gram-staining, capsule-staining, endospore-staining

Microbial taxonomy

Observation of permanent specimen slides:

Bacteria: *Bacillus; E. coli; Staphylococcus; Streptococcus* Algae: *Chlamydomonas, Chlorella, Euglena,* Diatoms Fungi: *Aspergillis: Penicillium; Rhizopus;* Yeast: *Agaricus* Visues: T4; Lambda; TMV. Pox: Vaccinia (photomicrographs)

Biochemical tests for bacterial identification

1. Carbohydrate fermentation: Acid-gas production
2. McConkey agar test for Lactose fermentation
3. IMViC tests
4. Catalase test
5. Oxidase test
6. Urease test
7. Starch, protein, and lipid hydrolysis
8. Coagulase test
9. Triple Sugar Iron test

Microbial Physiology

1. Measurement of growth-

a) Determination of direct count and viable count

b) Plotting growth curve on cm and semi-log graph sheets

c) Calculation of growth rate of *E. coli* and generation time

2. Effect of pH and Temperature on bacterial growth

Biochemistry:

1. Acid-Base titration to determine pK_a values
2. pH meter- principle and measurements
3. Colorimetry- Beer & Lambert's law
4. Estimation of Carbohydrates
5. Estimation of Proteins (Lowry's method)
6. Estimation of Nucleic acids
7. Separation of amino acids by Paper chromatography
8. Thin layer chromatography

References

1. Microbiology: A laboratory manual, P. Gunasekaran, New Age international publishers, 1996.
2. Laboratory manual in general microbiology. N. Kantian, Panima publishers, 2002.

1. Microbiology: A laboratory manual, J.G. Cappuccino and N. Sherman, Additon-Wesley, 2002.
2. Analytical Biochemistry & Separation Techniques, III Edition - P. Palanivelu, 21st Century Publication, Palkalai Nagar, Madurai - 625 021 (2004).
3. Laboratory manual in biochemistry, 5/e, J. Jayaraman, New Age international publishers, 1996.
4. Principles of practical biochemistry, K. Wilson and J. Walker, Cambridge University press, 2000.
5. An Introduction to practical biochemistry, D.T. Plummer. TATA McGraw Hill, 1997.
6. Microbial Physiology, 4/e, Moat AG, Foster JW and Spector MP. Wiley-Liss. 2002.

CS 05 MICROBIAL GENETICS & MOLECULAR BIOLOGY

Objectives

To facilitate the students:

- To understand the basic principles of genetic materials & its inheritance.
- To know the importance of molecular biology and genetics in life
- To enrich the knowledge in basic genetic features of bacteria, bacteriophages, fungi, and algae.
- To become familiar with the principles and applications of microbial genetransfer methods.

Unit I

Genetics - Microbial genetics vs. Mendelian genetics-DNA as genetic material-experimental evidence- concept of gene and mutations- fluctuation test and its significance-complementation. Mutagenes-chemical and physical mutagens – UV, NTG and hydroxylamine - mode of action- isolation of auxotroph and drug resistance mutants- DNA damage and repair.

Unit II

Structural aspects of DNA - the double helical model- Various forms of DNA- Genome organization - Prokaryotes and Eukaryotes. DNA replication- Semi conservative - Nature of replication- DNA polymerases in prokaryotes & eukaryotes - the processes of DNA replication - Replication in eukaryotes- Mitochondrial DNA replication.

Unit III

Genetic exchange in bacteria – transformation, transduction (Generalized and Specialized), and conjugation - co-transduction and its use in genetic mapping-chromosome transfer by Hfr strains & arriving at *E. coli* genetic map.

Unit IV

Transcription - RNA polymerases in prokaryotes and eukaryotes - their function- process of transcription in prokaryotes- initiation and elongation and termination- factors involved. Regulation of gene expression in bacterial system- the operon model- detailed study of *lac* and *trp* operons.

Unit V

Genetic code, Codons and Anticodons. Wobble hypothesis. Protein synthesis- the stages of protein synthesis- the process of translation in prokaryotes factors involved in translation- the triplet nature of genetic code- an overview of comparisons with eukaryotic translation.

References

1. Gene VII. Benjamin Lewin, 2000: Oxford University Press.
2. Molecular biology of the Gene,4/e. Watson, Hopkins, Roserts. Steits and Weiner, 1987, The Benjamin/Cumming Publishing Company, Inc.
3. Molecular Genetics of Bacteria, 2/e, Larry Snyder and Wendy Champness, 2003, ASM press. Washington DC.
4. Microbial genetics. David Friefelder, 1987, Narosa Publishing Mouse.

CS 06 IMMUNOLOGY

Objectives

To facilitate the students to

- Understand the basics of Immunology
- Widen their knowledge in classical and molecular Immunology
- Become familiar with immunization practices and their importance
- Enabling their knowledge in the techniques of Immunology

Unit I

Elements of Immunity: Overview of the Immune system- Basic concepts in Immunology (History), principles of innate and acquired immunity - Cells and organs of the immune system - Classes of antigens and their characteristics. Haematopoiesis.

Unit II

Antibody structure: Classification, structure and characterization. Antigen Antibody reaction - properties, agglutination, precipitation, ELISA, RIA and Immunofluorescence. Complement pathways, immune tolerance. Monoclonal antibody and it's applications

Unit III

Humoral and cell mediated immune response: Activation, differentiation of T-cells and B-cell maturation. Major Histocompatibility complex (MHC) - antigen processing and presentation.

Unit IV

Hypersensitivity reaction: Different types, disorders of immune response, auto immunity, T and B cell and NK cell associated diseases; Phagocytosis.

Unit V

Transplantation immunology: Basics of graft rejection. Tissue typing, Clinical importance of transplantation, Tumor antigen, Immune response to tumor. Cancer immunotherapy.

References

1. Essential of immunology, Roitt. I.M. 1998, ELBS, Blackwell scientific publication.
2. Immunology, 3/e. Kuby, J. 1997, W.H.Freeman and company. NY.
3. Immunobiology. The immune system in health and disease-3/e - Travers. J. 1997 - Garland publishers. NY.
4. Immunology; Understanding of immune system. Klaus, E., Elgert, 1996. Wiley Liss. NY.
5. Cellular and Molecular Immunology, 5/e, Abbas, A.K. Lichtman. A.H.2000. Sunders.

CS 07 INDUSTRIAL MICROBIOLOGY

Objectives

To facilitate the students to

- Know the basic features of fermentation biology and fermentors.
- Widen their knowledge in industrial uses of microbes.
- Know the In-depth information about the lab to industrial practices.
- Understand the biosafety features, containment facilities and other quality parameters.

Unit I

Industrial Microbiology: Introduction and Scope. Fermentation types: aerobic, anaerobic and solid state fermentation. Operation of fermentation by batch, fed batch and Continuous fermentations.

Unit II

Fermentor: Basic design, configurations, parts and function. Types of fermentors: Air lift and CSTR tower fermentor and packed bed bioreactor. Control and monitoring of variables, temperature, pH, agitation, pressure, online measurement, on/off control, PD control Computer applications in fermentation technology.

Unit III

Fermentation processes: Sterilization of fermentor and media. Inoculum preparation-Inoculum build-up, production processes. Scale-up process of fermentation. Downstream process of fermented products – cell harvesting, purification methods and drying.

Unit IV

Production processes: Aerobic fermentation of Penicillin, Glutamic acid, Lysine, and Vitamin B_{12}. Anaerobic fermentation of Ethanol, Acetone – Butanol, and solid state of Gibberellic acid. Detection and assay of fermentation products.

Unit V

Biosafety consideration: Types of containment, personal practices, primary and secondary contaminant barriers, Risk assessment and Regulation, Biosafety levels, guidelines and regulations. Quality assurance and quality control of fermented products.

Reference Books

1. Crueger, W. and A. Crueger (2000), Biotechnology, A Text book of Industrial Microbiology. Panima Publishers, New Delhi.
2. Flinger, M.C., and Drew, S.W., (1999), Encyclopedia of Bioprocess technology - Fermentation, Biocatalysis and Bioseparation (Volumes I - V), John Wiley and Sons, New York.
3. Nandari, H., (2005), Industrial Biotechnology, Dominant Publications and Distributors, New Delhi.
4. Reed, G. (1987), Prescott and Dunn's Industrial Microbiology, CBS Publishers and Distributors, New Delhi.
5. Rita Singh and Ghosh, S.K., (2004), Industrial Biotechnology, Global Vision Publishing House, New Delhi.
6. Stanbury, O.F., Whitakar, A., and Hall, S.J., (1997), Principles of Fermentation Technology, Aditya Books (P) Ltd.. New Delhi.

a. Winnacker, EX., 1987, From Genes to Clones: Introduction to Gene Technology, VCH Publications, Germany.

CS 08 MAJOR PRACTICALS - II

Objectives

To facilitate the students to

- Learn the basic genetic experiments to understand the complexity of biological process.
- Perform an experiment to know the inheritance of bacterial genes.
- Demonstrate the techniques for the production, purification and assay of industrially valuable compounds.
- Develop the skill to evaluate the immune response, antigen-antibody reactions etc.

Microbial genetics & Molecular Biology

1. Separation of proteins by acrylamide gel electrophoresis
2. Isolation of spontaneous mutant: antibiotic resistant mutants

3. Isolation of auxotrophic mutant by chemical and UV mutagenesis, i. Replica plating technique.
4. Induction of *lac* operon

Immunology

1. Lymphoid organs in experimental animals - mouse/rat/rabbit
2. Immunization and bleeding techniques
3. Separation of serum/plasma
4. Erythrocyte sedimentation rate
5. Blood cell count: RBC count, WBC count - total and differential
6. Blood typing: ABO, Rh factor
7. Agglutination tests: Widal test
8. Precipitation: Ouchterlony's double immunodiffusion

Industrial Microbiology

1. Isolation of amylase and protease producing bacteria and fungi
2. Crowded plate technique for antibiotics producing microbes
3. Alcohol (ethanol) production
4. Immobilization of yeast.

References

1. Analytical Biochemistry & Separation Techniques, III Edition - P. Palanivelu, 21st Century Publication, Palkalai Nagar, Madurai - 625 021 (2004).
2. Molecular Cloning, A laboratory manual, Maniatis, T., Fritsch, E.F. &
3. Sambrook, J. Cold Spring Harbor laboratory (2002).
4. Advanced bacterial genetics, David, RW, Botstein, D & Roth, JR. Cold Spring Harbor laboratory (1980).
5. Roitt. L.M. 1998. Essential of immunology. ELBS, Blackwell scientific publication.
6. Kuby. J. 1997. Immunology -3rd edition. W.H.Freeman and Company. New York.
7. Travers. J. 1997, Immunobiology- The immune system in health and disease-3rd edition- Garland publishers, NY.
8. Klaus, E., Elgert, 1996. Immunology understanding of immune system. Wiley Liss, New York.
9. Abbas. A.K. Lichtman, A.M. 2000. Cellular and Molecular Immunology, 5" edition. Sunders.

CS 09 BIO INFORMAT ICS

Objectives

To facilitate the students to

- Understand the principles of computer and networking
- Understand the principles of bioinformatics
- Widen their knowledge in genomics & Proteomics
- Become familiar with biological databases and data banks
- Enabling the knowledge in the processing of biological data

Unit I

Components of computers input/output devices. Storage devices. Graphic devices. Program and representation of information. Operations system. MS DOS & WINDOWS - Networks-Intranet and Internet - LAN.

Unit II

Use of commercial software: Lotus, D Base, Wordstar. Windows. Power Point. MS Excel, Print artist, Sigma Plot, Mathcad,

Unit III

Biological resource databases- Examples and application - Sequence analysis-Protein Nucleic acid: Genome analysis; sequence alignment, BLAST, MSA, etc.,.

Unit IV

Collection and downloading information from databases- Literature search -CCOD-Medline - Biological websites.

Unit V

Accessing information through Internet-Bionet news groups- WWW Software. (HTTP. HTML).

References

1. Software Director}' for molecular Biologists Christopher J Rawlings, Stockton Press, Mac Millan Publishers, 1986.
2. Data basis in life sciences and Biotechnology: A directory - DBT, Govt. of India, March 1995.
3. Protein Structure Analysis - Springer Lab Manual. R.M.Kamp, T.Choli-Papadaopoulu B. Witman Liebold.
4. Computer in microbiology- a practical approach. T.N, Bryant, JWT Wimpenny, IRL, Press, 1989.
5. Bio-Statistics Analyses by Zar. Second Edition, Prentice Hall International Englewood Cliffs, New Jersey.

CS10 MEDICAL MICROBIOLOGY

Objectives

To facilitate the students:

- To know the medically important microbes and pathogenesis.
- To understand the disease life.
- To gain the thorough knowledge about the pathogenesis, diagnosis, treatment methods of communicable diseases
- To enrich the research knowledge in medical Microbiology

Unit I

The History of Infectious Diseases: Host - pathogen interactions -epidemiology of infectious diseases. Systemic bacteriology: General characters, molecular pathogenesis and laboratory diagnosis of diseases using Southern and western blotting methods. Applications of PCR in Medical Microbiology - Role of virulent factors in bacterial adhesion and colonization - Host-defense mechanisms.

Unit II

Diagnosis and control of microbial diseases - Collection and identification of pathogens from specimen - Biochemical tests for bacteria - Diagnosis of viral infections using immunological tests and phage typing. Principle and significance of antimicrobial chemotherapy and susceptibility testing. Mechanism of action of β-lactam - drugs affecting protein and nucleic acid synthesis - Mode of action of antiviral and antifungal drugs- Development of drug resistance.

Unit III

Bacterial diseases: Transmission, diagnosis, clinical symptoms and treatment for bacterial diseases: diphtheria, plague, tuberculosis, leprosy, gonorrhea, syphilis, cholera typhoid, shigellosis, peptic ulcer, Staphylococcal and Streptococcal diseases.

Unit IV

Viral diseases: Etiology, prophylaxis, clinical symptoms and treatment for human viral diseases. Smallpox, yellow fever, rabies, viral hepatitis, poliomyelitis. AIDS and secondary infections.

Unit V

Fungal and protozoan diseases: Cutaneous mycoses, systemic mycoses, opportunistic mycoses. Life cycle, diagnosis and treatment of following protozoan diseases - amoebiasis, giardiasis, malaria, kala-azar, trypanosomiasis.

References

1. Jawetz. E. Melnic. JL. & Adelberg. EA. Medical microbiology 22/e McGraw Hill Companies, 2004.

2. Minis, C. Playfair, J Roitt, I, Wakelm, D. & Williams. R. Medical Microbiology, 3/e Mosby publications. 2004.
3. Prescotl, Harley and Klein, Microbiology, 6/e The McGraw-Hill Companies, 2008.
4. Ananthanarayanan R. & Jayaram Panicker, C.K. Textbook of Microbiology. Orient Longman. 2005.

CS 11 SOIL AND AGRICULTURE MICROBIOLOGY

Objectives

To facilitate the students:

- To enrich their knowledge in basic soil microbiology and its applications
- To know the microbial importance in agriculture
- To familiar with beneficial and harmful microbes for soil and agriculture
- To understand the biology of most important nutrient recycling – microbial process.

Unit I

Soil microbes: Bacteria, Fungi and Actinomycetes (abundance & distribution). Microbial interaction: mutualism, amensalism and commensalisms. Beneficial Plant microbial interactions - Symbiotic and free living microbes, N_2 fixation - Genetics of N_2 fixation, phosphate solubilization. Mycorrhizal association: ecto and endomycorrhizae, and actinorrhizae. Rhizosphere effect.

Unit II

Plant microbe interactions (Harmful): Plant pathogens - pathogenesis, mechanism of pathogen establishment and symptoms. Plant diseases caused by Bacteria – *Xanihowonas, Mycoplasma,* Fungi - *Pvricularia, Fusarium* and Viruses –TMV, CMV.

Unit III

Disease control- Fungicides, Pesticides, Biological control mechanisms - Production of bioinsecticides, bacterial and viral. Microbial nematicides and microbial herbicides.

Unit IV

Biofertilizers production and applications: Rhizobium, Azotobacter, Azospirillum, cyanobacteria, Phosphobacter & VAM. Biotechnology in Agriculture: *Bt*. cotton and herbicide tolerant plants. Plant Growth Promoting Rhizobacteria (PGPR) – Bacteria & Actinobacteria.

Unit V

Role of microorganisms in biogeochemical cycles -N, P, S and C cycles. Biodegradation of xenobiotics (chlorinated pesticides) - MEOR - bioleaching of metals. Microbes in waste treatment: solid waste (sanitary land fill and composting) and liquid waste - sewage treatment -BOD - pollution indicating microbes.

References

1. Rangasami G and Bagyaraj DJ. 1993. Agricultural Microbiology 2/e Prentice- Hall publications.
2. Ronald alias, Bartha, Richard, 1987. Microbial ecology 2/e Benjamin/ Cummings publications.
3. Prescott. Harley and Klein, 2006. Microbiology. The McGraw Hill companies.
4. Madigan. VI.T. Martinko, J.M. and Parker. J., 1997. Brock Biology of Microorganisms 8/e. Prentice-Hall Inc.

CS 12 MAJOR PRACTICALS- III

Objectives

To facilitate the students to:

- Learn the basic experimental methods to screen targeted pathogens.
- Perform an experiment to know the antibiotic sensitivity pattern.
- Demonstrate the techniques for enumeration methods and analysis of soil microbial interactions.
- Develop the skill to evaluate the agricultural importance of Microbes.

Medical Microbiology

1. Antibiotic susceptibility test: disc diffusion method
2. Measurement of minimal inhibitory concentration (MIC) and minimal lethal concentration (MLC)
3. Isolation and identification of pathogenic bacteria from clinical specimens: *Staphylococcus*, *Streptococcus*, *Salmonella, Shigella*, *Vibrio.*
4. Preparation of blood smear for malarial parasite
5. Collection and processing of medical samples

Soil and Agricultural Microbiology

6. Isolation and characterization of soil microbes
7. Serial dilution method for enumeration of soil bacteria
8. Identification of microbial pathogen in paddy and vegetable crops (field stud) I.
9. Isolation of symbiotic nitrogen fixing bacteria from root nodules – *Rhizobium*
10. Isolation of free-living nitrogen fixing bacteria from rhizosphere – *Azoiohacter*
11. Isolation of phosphate solubilizing bacteria – *Pseudomonas*
12. Examination of mycorrhizae – VAM
13. Potability testing of water (MPN test)

References

1. Rangasami G and Bagyaraj DJ. 1993. Agricultural Microbiology 2/e Prentice- Hall publications.
2. Ronald Atlas, Bartha Richard, 1987. Microbial ecology 2/e Benjamin/ Cummings publications.

3. Prescott, Harley and Klein, 2006, Microbiology, The McGraw Mill companies
4. Madigan, M.T., Martinko, J.M. and Parker, J. 1997, Brock Biology of Microorganisms 8/e. Prentice-Hall Inc.
5. Jawetz, E, Melnic, J.L & Adelberg, E.A. Medical microbiology 22/e McGraw Hill Companies, 2001.
6. C Minis, J Playfair, I Roitt, D Wakelin, R Williams, Medical Microbiology. 3/e Mosby publications, 2004.
7. Prescott, Harley and Klein, Microbiology, 6/e The McGraw-Hill Companies. 20Q(x
8. Ananthanarayanan, R and CK Jayaram Panicker. Textbook of Microbiology, Orient Longman, 1997.

CS 13 BIOTECHNOLOGY

Objectives

To facilitate the students to

- Understand the principles of biotechnology
- Understand the biology of molecular vectors
- Become familiar with biological applications in agriculture, medicine and Industries
- Enable their knowledge in rDNA technology

Unit I

History and scope of Biotechnology; Biotechnology as an inter-disciplinary course - General Strategies of cloning - Vectors: Plasmids- constructed plasmids, pBR322, pUC18 - Lambda phage derived vectors, cosmids and their applications. Ml3 phage and its uses - BAC and YAC as vectors - Selection of suitable hosts - Cloning in *E. coli* and yeast

Unit II

Gene manipulation techniques: DNA isolation, Plasmid isolation- Restriction enzymes: Types and properties- DNA ligation. - Methods of gene transfer - Gene gun method, electroporation and microinjection methods - Southern and Northern blotting techniques- DNA sequencing.

Unit III

Animal & Plant Biotechnology: Mammalian cell cloning vectors-Transgenic animals: transgenic mice and sheep. - Gemini virus and Cauliflower mosaic virus as cloning vectors. Agrobacterium mediated gene transfer mechanism - Markers and Reporter genes and their applications - Transgenic plants - insecticide resistance, herbicide and drought tolerance.

Unit IV

Microbial production of recombinant proteins: Expression vectors-Constitutive and mducible promoters - Production of recombinant DNA proteins using microbial hosts - Production of Insulin- Growth hormone- Interferons - Tissue Plasminogen Activator, etc.

Unit V

Intellectual property rights - GATT and IPR, different forms of IPR, IPR in India, patent co-operation treaty, forms of patents, process of patenting, Indian and international agencies involved in patenting, patenting biological materials.

References

1. Basic Biotechnology 3/e, Ratledge, C and Kristiansen, B. Cambridge University Press (2008)
2. Brown. T.A., Genetics - A Molecular Approach. Chapman Hall. London. 2004.
3. Darnell, J. Lodish, H.. and Baltimore, D., Molecular Cell Biology, Scientific American Books Inc., Iowa. 2006
4. Glick.B.R. and Pasternak, J.J.,2006, Molecular Biotechnology- Principles and Applications of Recombinant DNA technology, ASM press, Washington.
5. Gower,D.M.,2001, DNA Cloning- A Practical Approach, IRI press, Oxford.
6. Mitra.S.,2001.Genetic Engineering, Macmillan, India Limited, New Delhi.
7. Paolella, P.. 2003. Introduction to Molecular Biology, McGraw Hill Publication, Boston.
8. A.L. Demain, R M. Atlas, W.S Hu, R C. Willson. C. L. Hershberger, G. Cohen, J. E. Davies, D. H. Sherman, J. H. David Wu, 1999 Manual of Industrial Microbiology and Biotechnology, 2nd Edition ASM press,
9. Michael J. Waites, 2001 Industrial Microbiology: An Introduction (Illustrated) Blackwell Science Inc. **CS**

14 MAJOR FRACTICALS – IV

Objectives

To facilitate the students to

- Learn the basic experimental methods to screen the DNA & Plasmids.
- Perform an experiment to know the separation techniques.
- Demonstrate the techniques for construction of recombinant DNA.
- Develop the skill to evaluate the recombinants.

1. Isolation of chromosomal DNA from microbial cells.
2. Separation of DNA by agarose gel electrophoresis
3. Determination of purity and quantification of DNA
4. Isolation and purification of a plasmid DNA
5. Restriction Digestion Analysis
6. Ligation
7. Transformation of *E. coli* using plasmid (pUC 18/19)
8. Blue-white Selection of transformants

References

1. Molecular Cloning, A laboratory manual, Maniatis, T,, Fritsch, E.F. & Sambrook, J. Cold Spring Harbor laboratory (2002).

ELECTIVE SUBJECTS

Objectives

- To familiarize with biocatalyst structure and properties
- To know the basic reactions of biocatalyst
- To widen the knowledge with applications of enzymes.
- To Enable their knowledge in enzyme engineering

01 ENZYMOLGY & ENZYME TECHNOLOGY

Unit-1

1. Nomenclature and Classification of enzymes (with examples)
2. General properties of enzymes (Optimum pH, Optimum Temp & Substrate Concentration)
3. Steady state kinetics and derivation of Michaelis-Menten, Linweaver-Burk, equations and their plots.
4. Activation energy
5. Enzyme specificity

Unit- II

1. Extraction of enzymes
2. Assay of enzymes, Calculation of enzyme units
3. Purification of enzymes
4. Enzyme inhibitors

Unit- II

1. Allosteric enzymes
2. Zymogens and their activation (Digestive system, Blood clotting and Blood clot dissolution systems)
3. Multienzyme complexes (Pyruvate dehydrogenase complex & Fatty acid synthetase complex)
4. Coenzymes of Water soluble vitamins

Unit- IV

1. Mechanism of Enzyme catalysis
2. Metal ions in Enzyme catalysis
3. Mechanism of action of enzymes (Chymotrypsin)

Unit- V

1. Application of enzymes (Clinical &" Industrial)
2. Immobilization of enzymes
3. Enzyme engineering for easier purification

Practicals

Production of an enzyme such as amylase, invertase, phosphatase, etc. Ammonium sulphate/ Acetone precipitation; Determination of optimum pH, temperature and K_M

References

1. Enzymes, Ribozymes and DNAzymes, P. Palanivelu, Twentyfirst Century Publications. Palkalai Nagar, Madurai - 625 021 (2006).
2. Enzymes-Biochemistry, Biotechnology, Clinical chemistry- T. Palmer -East-West press. New Delhi (2.004)
3. Fundamentals of Enzymology- T. Palmer 4th edition
4. Handbook on Enzyme Biotechnology- Alan Wiseman, John Wisely & Sons, NY **(1985)**
5. Analytical Biochemistry & Separation Techniques, III Edition - P. Palanivelu, 21st Century Publication, Palkalai Nagar, Madurai - 625 021 (2004).
6. Outlines of Biochemistry. 5/e - Conn, E.E., Stumpf, P.K , Bruening. G and Doi, R.H. John Wiley & Sons (1987)

ES 02 rDNA AND TISSUE CULTURE TECHNOLOGY

Objectives

- To understand the principles of rDNA technology.
- To understand the basic biology of tissue culture methods.
- To become familiar with rDNA applications in agriculture, medicine and Industries
- To enable their knowledge in rDNA technology

Unit I

Basics of rDNA technology- Land Marks in recombinant DNA. technology – Principle and methods of gentic transfer mechanisms Conjugation, Transformation, Transduction and Transfection.

Unit II

Techniques in molecular biology: Principle, methods, types and applications of proteins and DNA Sequencing, Blotting techniques - Southern, northern, western and Dot blot. Gene amplification technique: Polymerase Chain Reaction (PCR).

Unit III

Plant tissue culture: Surface sterilization of field-grown tissues, callus induction, role of hormones in dedifferentiation, regeneration of shoots and roots from callus cultures. Totipotency in plant cells- Micropropagation (large scale production of virus free seedlings for economically important plant species)

Animal tissue culture: Preparation of media, preparation of primary culture, maintenance of secondary culture, evaluation of culture dynamics. Cell synchronization - preservation and revival of cells.

Unit IV

Gene expression strategies, post-transcriptional (RNA splicing) and Post translation (protein folding) modification of expressed gene products.

Unit V

Applications of rDNA technology in Medicine- production of insulin, growth hormone, detection of genetic disorders - Protein engineering and Hybridoma technology (Production and applications of Monoclonal antibody). In Agriculture: Expression of bacterial toxin and herbicide tolerant plants, in Industry: microbial strain improvement and their significance.

Practical: Recombinant DNA & Tissue culture technology

1. Isolation of plasmid DNA
2. Isolation of chromosomal DNA form *E.coli.* plant and animal tissue
3. Restriction digestion
4. Ligation
5. Transformation of *E. coli*
6. PCR
7. Surface sterilization
8. Callus induction
9. Regeneration of shoots and roots from callus cultures

References

1. S. B. Primrose. R. M, Twyman and R. W. Old. 1996. Principles of gene manipulations.6lh edition Blackwell scientific publication. London.
2. A. Slater, N, Scott and M Fowler. 2003. Plant Biotechnology. Oxford.
3. R. K. Gupta. 2001. Biotechnology and Genomics. India

4. Richard H, Baltz. Gorge D He gem an and Paul L Skatrud, 1993. Industrial Microorganisms- Basic and Applied Molecular Genetics. American Society for Microbiology. Washington.
5. J.Mammonds. P McGarvey and V Yusibov, Springer, 2000, Plant Biotechnology, Heidelberg.

ES 03 PROJECT WORK

(For those admitted in June 2018-2019 year and later)

Objectives

- To know the basic understanding with microbes and applications.
- To widen their theory knowledge into application
- To develop a skill in basic microbial research.
- To illuminate their minds to solve the basic and societal problems through their study.

Rules Governing the Evaluation of Project and *Viva Voce*

1. Maximum of Five students shall select a topic for their project work in consultation with his/her guide and Head of the Department.
2. Each student shall submit one copy of his/her project report for valuation.
3. The project report shall contain at least 25 pages excluding bibliography and appendices. This condition may be relaxed in the case of the students who have chosen a research problem for their dissertation on the recommendation of the guide.
4. The project shall be valued for a total of 100 marks by internal guide. For a pass in the project work, the student should secure a minimum of 40 marks.

SKILL BASED SUBJECTS

SBS O1 MUSHROOM TECHNOLOGY

Objectives

To facilitate the students to

- Understand the skills for identification of edible mushrooms
- Widen their knowledge in mushroom classification and applications
- Become skillful self employer in mushroom cultivation technology

Unit I

History of edible mushrooms- Major genera of edible mushrooms - Structure and key for identification - Food values of mushroom - Medicinal values of mushrooms.

Unit II

Methods of cultivation of mushrooms - Substrate for mushroom production – Insect, pest and diseases of mushroom - Mushroom industry - Economics of mushroom production.

Unit III

Exotic mushrooms - Truffles (*Tuber melanosporum)* - Poisonous mushrooms -identification

References

1. Mushroom Technology by Nitabhal. Publications (--)
2. Cultivation of edible mushrooms - ICAR Publications (--).
3. Mushroom Production and Processing Technology/V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Vedams Ebooks Pvt Ltd., New Delhi (2000)

SBS 02 COMPUTER APPLICATIONS IN BIOLOGY

Objectives

To facilitate the students to

- Understand the basic operating skills for computer
- Widen their knowledge in computer softwres and applications
- Become skillful self employer in computer lab technician

Unit I

Computer architecture- Generations of Computers - Computer languages. BASIC. COBOL, FORTRAN, JAVA, etc Structural components of computer and their uses

Unit II

Role of computer in Biological research - Internet and Email- Reference collection - Data submission - Phylogenetic analysis - Structural prediction - Biostatistical analysis-Current trends in IT technology

Unit III

Genomics on the World Wide Web - Nucleic acid sequence analysis- Protein sequence database search and analysis- Multiple sequence alignment- Statistical packages.

References

1. Balagurusamy, N. 2001. Basics of computers, Himalaya Publications. New Delhi, India
2. Lreon. A & Leon. M. 1999. Introduction to computers, Vikas publications. New Delhi, India
3. D. W. Mount Bioinformatics- sequence and genome analysis. CBS publishers & distributors, New Delhi,
4. S. A. Krawetz & D. D.Womble Introduction to Bioinformatics A Theoretical and practical approach. Humana press, Totowa. NJ

SBS 03 MEDICAL LABORATORY TECHNOLOGY

Objectives

To facilitate the students to

- Understand the skills for collection and processing of clinical samples

- Widen their knowledge in identification of pathogenic Microbes & pathology of clinical specimens
- Become skillful self employer in Medical Lab technology

Unit I

Role of Microbiology Labs - Safety regulations. Types of specimens. Collection and handling of specimens. Anticoagulants. Components of blood and their functions-erythrocytes, leukocytes, lymphocytes, monocytes, and thrombocytes. Preparation of blood collecting containers with anticoagulant. Blood collection by venipuncture, Blood collection by capillary puncture,. Preparation of serum and plasma. Routine haematological tests-determination of haemoglobin concentration, RBC and WBC counts. Study of stained blood smear- differential WBC count. Reticulocyte count- ESR- Eosinophils count- Platelet count; Packed Cell Volume. Maintenance of laboratory records.

Unit II

Laboratory identification of infectious agents. Staining techniques-Simple. Gram staining, acid-fast, Capsular (negative staining) and spore staining. Antimicrobial susceptibility tests. Diagnosis of mycotic and parasitic infections.

Unit III

Clinical Pathology- Urine analysis and Stool examination- Clinical Biochemistry-Routine biochemical tests-Blood sugar, urea, creatinine and cholesterol. Routine procedures in blood bank-ABO blood grouping and Rh typing-AHG test-compatibility testing or cross-matching.

References

1. Kanai L. Mukherjee, 1988, Medical Laboratory Technology Volumes-I to III. Tata McGraw-Hill Publishing Company Limited. New Delhi.

SBS 04 BIOCONTROL

Objectives

To facilitate the students to

- Understand the basic skills of Biocontrol of insects & pests
- Lean the techniques for culture and processing of biopesticides
- Become skillful self employer in Biocontrol agent production & marketing.

Unit I

Outline of pest management programme - Insect pest management and Rodent pest management - Need of Biocontrol agents. Economics of Biocontrol

Unit II

Biopesticides - microbes used in biopesticides, *Bacillus thuringemis*, *B. sphaericus*, Metarizyum and *Trichoderma*- Insect control, Nuclear Poiyhedro Virus and CPV- potentials and limitations.

Unit III

Biology and ecology of organisms for Biocontrol- Predators and Parasifoids-*Trichogramma*

References

1. Roy G. Van Driesche and Thomas S Bellows Jr. Biological Control -Giude to its application s, Springer (1996).
2. Helmut Fritz Van Embden and M.W Service, Pest and vector control, Cambridge University Press (2004)

SBS 05 BIOPRQCESS TECHNOLOGY

Unit I

Production and preliminary characterization of an antibiotic or an enzyme - assay - paper chromatography or TLC.

Unit II

Concentration steps: Ammonium sulphate precipitation, acetone precipitation. PEG precipitation - Dialysis- Ultrafillraiion.

Unit III

Purification steps; Principle and applications of by ion exchange and ge! filtration chromatographic techniques. Affinity chromatograph)

References

1. Analytical Biochemistry & Separation Techniques, III Edition P. Palanivelu, 21st Century Publication, Palkalai Nagar, Madurai - 625 021 (2004).
2. Principles of Fermentation Technology, P.F. Stranbury and A. Whitaker (1984) Pergamon Press.
3. Chemical Engineering. J.M. Coulson and J.F. Richardson (1984) Pergamon Press, Bioprocess sequencing Basic concepts, Michael L.Shuler and Fikret Kuzi (!992) Prentice-Hall Inc.
4. Bioprocess sequencing: Kinetics, mass transport reactors and gene expression. Wolf R. Vieth (1994) John Wiley & sons. Inc.

SBS 06 COSMETICS MICROBIOLOGY

Unit I

History of cosmetic microbiology- Need for cosmetic microbiology – Scope of cosmetic microbiology - Role of microbes in cosmetics preparation.

Unit II

Quality control measures in cosmetics preparation - Microbial resistance - Critical control points, etc - Antimicrobial property of natural cosmetic compounds: garlic, neem, turmeric, thulasi.

Unit III

Microorganisms in cosmetics – Preservation of cosmetics – Mechanism of action of cosmetic preservatives – Enzymes in cosmetics.

References

1. Cosmetic Microbiology. A practical Handbook, Edited by Daniel K. Brannan, CRC Press (2004).

NON-MAJOR SUBJECTS

NME 01 FOOD & DAIRY MICROBIOLOGY

Unit I

Importance of Food and Dairy Microbiology- Food as substrate for microbial growth- intrinsic and extrinsic factors affecting growth and survival of microorganism in foods - Microorganisms present in the vegetables, fruits, cereals, milk, egg, etc.

Unit II

Features of food spoilage like fruits, vegetables, milk and milk products - Milk sterilization techniques. Phosphatase test- Spoilage of bread and cereals, egg. meat, fish and poultry.

Unit III

Food preservation by removal of microorganisms, low temperature, high temperature irradiation and chemical methods. Food borne infection, food borne intoxications Detection of food-borne pathogens.

References

1. M.R.Adams and M.O.Moss. 2005. Food Microbiology. New age international Pvt Ltd publications.
2. W. C. Frazier and D. C. Westhoff. 2003. Food Microbiology, 4^{Ih} edition. McGravvHill, NewYork.
3. B. C. Hobbs and D. Roberts. 1993. Food Poisoning and Food Hygiene. Edwards Arnold. London.
4. A. E. Yousef and C.Caristrom. 2003. Food Microbioiogy-A Laboratory manual, Wiley Interscience.
5. J. *M,* Jay. 2000. Modem Food Microbiology. Aspen Publishers.
6. Robinson, R.K.I990. Dairy Microbiology. Elsevier Applied Science. London.

NME 02 MICROBIAL BIOTECHNOLOGY

Unit I

Industrially important microorganisms - Screening strategies for industrially important microorganisms, thermophilic microorganisms, strain improvement by classical and recombinant methods. Principles of microbial fermentation - .liquid and solid-state fermentations, medium development for industrial fermentations.

Unit II

Large-scale fermentation and downstream processing - Scale-up of microbial fermentation, growth kinetics, effect of pH., temperature, nutrient concentrations. Downstream processing, precipitation, centrifugation, filtration, solvent extraction, Chromatographic purification, affinity purification. Fermentation economics - cost analysis.

ANNEXURE – I

Program Structure and Description of courses in B.Sc. Microbiology degree (semester pattern)

Overall Course content of B.Sc Microbiology

SI.No	Subject	No. of Papers	No. of Hours	No. of Credits
1	Tamil / Hindi	4	24	12
2	English	4	24	12
3	Core subjects	14	66	58
4	Allied subjects	12	48	40
5	Skill Based Subjects	3	6	6
6	Elective Subjects	1	4	3
7	Non Major Electives	2	4	4
8	Environmental Studies	1	2	2
9	Value Education	1	2	2
10	Extension Activities	1	0	1
	Total	**43**	**180**	**140**

Work load per week, Credits per paper and scheme of examinations

Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
				Int.	Ext.	Tol.
Semester – 1						
Tamil (Paper I)	6	3	3	25	75	100
English (Paper I)	6	3	3	25	75	100
Core Subject						
General Microbiology	4	4	3	25	75	100
Microbial Physiology & Taxonomy	4	4	3	25	75	100
Allied Subject						
Anc.Chemistry I (Theory)	4	4	3	25	75	100
Anc.Chemistry I (Practical)	2	0				
Major Practical I (Basic Microbiology, Microbial physiology and Biochemistry)	2	0				
Value Education	2	2	3	25	75	100
Total	30	20				600

Tamil and English syllabi and workload are as per the other degree courses.

The Allied 1 (Chemistry) and Allied II (Biology) syllabi are as per other degree courses (E.g. B.Sc. Biochemistry)

Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
				Int.	Ext.	Tol.
Semester – II						
Tamil (Paper II)	6	3	3	25	75	100
English (Paper II)	6	3	3	25	75	100
Core Subject						
Biochemistry	4	4	3	25	75	100
Major Practical -1 (Basic Microbiology, Microbial physiology and Biochemistry)	2	4	3	40	60	100
Allied Subject						
Anc.Chemistry II (Theory)	4	4	3	25	75	100
Anc.Chemistry I (Practical)	2	2	3	40	60	100
Skill Based Subjects						
Mushroom Technology	2	2	3	25	75	100
BioControl	2	2	3	25	75	100
Environmental Studies	2	2	3	25	75	100
Total	30	26				900

Title of the Paper	Weekly Contact Hours	No. of Credits	Exam Hours	Marks		
				Int.	Ext.	Tol.
Semester – III						
Tamil (Paper III)	6	3	3	25	75	100
English (Paper III)	6	3	3	25	75	100
Core Subjects						
Microbial Genetics & Molecular Biology	4	4	3	25	75	100
Major Practical –II (Microbial	2	0				

Genetics & Molecular Biology and Industrial Microbiology						
Allied Subject						
Anc.Chemistry III (Theory)	4	4	3	25	75	100
Anc.Chemistry II (Practical)	2	0				
Anc. Biology I (Theory)	4	4	3	25	75	100
Anc. Biology I (Practical)	2	0				
Total	30	18				500

Title of the Paper	**Weekly Contact Hours**	**No. of Credits**	**Exam Hours**	**Marks**		
				Int.	**Ext.**	**Tol.**
Semester – IV						
Tamil (Paper IV)	6	3	3	25	75	100
English (Paper IV)	6	3	3	25	75	100
Core Subject						
Industrial Microbiology	4	4	3	25	75	100
Major Practical – II(Microbial genetics, Molecular Biology, and Industrial Microbiology)	2	4	3	40	60	100
Allied Subject						
Anc.Chemistry IV (Theory)	4	4	3	25	75	100
Anc.Chemistry II (Practical)	2	2	3	40	60	100
Anc. Biology II (Theory)	4	4	3	25	75	100
Anc. Biology I (Practical)	2	2	3	40	60	100
Extension Activities	0	1				
Total	30	27				800

Title of the Paper	**Weekly Contact Hours**	**No. of Credits**	**Exam Hours**	**Marks**		
				Int.	**Ext.**	**Tol.**

Semester – V						
Core Subjects						
Bioinformatics	5	4	3	25	75	100
Medical Microbiology	5	5	3	25	75	100
Soil & Agricultural Microbiology	4	4	3	25	75	100
Major Practical – III (Bioinformatics, Medical Microbiology and Soil & Agricultural Microbiology	4	0				
Major Practical- IV (Biotechnology and Immunology)	4	0				
Anc. Biology III (Theory)	4	4	3	25	75	100
Anc. Biology II (Practical)	2	0				
Non Major Elective Subject						
Basic Microbiology	2	2	3	25	75	100
Total	30	19				500

Title of the Paper	**Weekly Contact Hours**	**No. of Credits**	**Exam Hours**	**Marks**		
				Int.	**Ext.**	**Tol.**
Semester – VI						
Core Subjects						
Biotechnology	4	4	3	25	75	100
Immunology	4	4	3	25	75	100
Major Practical – III (Bioinformatics, Medical Microbiology and Soil & Agricultural Microbiology	4	4	3	40	60	100
Major Practical- IV (Biotechnology and	4	4	3	40	60	100

Immunology)						
Elective Subject						
rDNA Technology & Tissue culture Technology (Theory)	4	4	3	25	75	100
Anc. Biology IV (Theory)	4	4	3	25	75	100
Anc. Biology II (Practical)	2	2	3	40	60	100
Skill Based Subject						
Medical Laboratory Technology	2	2	3	25	75	100
Non Major Elective Subject						
Food and Dairy Microbiology	2	2	3	25	75	100
Total	30	30				900

Overall coverage:

Total papers 42 x 100 = 4200 marks
Total credits=140 (Inclusive of extension activities: 1 credit)