DEGREE OF BACHELOR OF SCIENCE

Syllabus for

B.SC. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM

(SEMESTER PATTERN)

(For Candidates admitted in the Colleges affiliated to Periyar University from 2021 – 2022 onwards)
REGULATIONS

Program specific outcome (PSO) - microbiology

Bachelor of Science in microbiology students will gain fundamental knowledge about

- The microbiological equipment especially Microscope, Incubator, Laminar Air Flow chamber, Centrifuge etc.,
- The microorganism especially Bacteria, Fungi, Algae, Protozoa, Virus.
- The various fields in microbiology particularly Agricultural, Medical, Environmental, Industrial areas.

Condition for admission (OBE pattern)

A candidate who has passed higher secondary examination in any one of the biological sciences (Botany, Zoology, Biology). (Academic/Vocational stream - Agri, Home Science, Poultry) under higher secondary board of examination, Tamil Nadu or as per norms set by the Government of Tamil Nadu or an examination accepted as Equivalent thereto by the Syndicate subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the BSc., Microbiology degree examination of this University after a course of study of three academic years.

Duration of the course

The course for the degree of Bachelor of Microbiology shall consist of three academic years divided into six semesters.

Course of study

The course of study shall comprise instruction in the following subjects according to the syllabus and books prescribed from time to time.

Examinations

The theory examination shall be three hours duration 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 in the even semesters.
Maximum Duration for the completion

The maximum duration for completion of the UG Program shall not exceed twelve semesters.

Commencement of this Regulation

These regulations shall take effect from the academic year 2021-22, i.e., for students who are to be admitted to the first year of the course during the academic year 2021-22 and thereafter
## COURSE OF STUDY AND SCHEME OF EXAMINATION

### SEMESTER – I

<table>
<thead>
<tr>
<th>Part</th>
<th>Paper Code</th>
<th>Course</th>
<th>Title</th>
<th>Inst. Hrs/week</th>
<th>Credit</th>
<th>Exam Hours</th>
<th>Marks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>21UFTA01</td>
<td>Language-I</td>
<td>Tamil-I /Malayalam /Hindi-I</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>II</td>
<td>21UFEN01</td>
<td>Language-II</td>
<td>English-I</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>III</td>
<td>21UMB01</td>
<td>Core-I (CC)</td>
<td>Basics of Microbiology</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBP01</td>
<td>Core Practical-I (CP)</td>
<td>Basics of Microbiology</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>21UBCA01</td>
<td>Allied-I (AC)</td>
<td>Biochemistry -I</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UBCAP01</td>
<td>Allied Practical-I (AP)</td>
<td>Biochemistry Practical</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IV</td>
<td>21UVE01</td>
<td>Add-on Course</td>
<td>Professional English</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value Education</td>
<td>Manavalakkalai yoga</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
<td><strong>20</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


## SEMESTER – II

<table>
<thead>
<tr>
<th>Part</th>
<th>Paper Code</th>
<th>Course</th>
<th>Title</th>
<th>Inst. Hrs/Week</th>
<th>Credit</th>
<th>Exam Hours</th>
<th>Marks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21UFTA02</td>
<td>Language-I</td>
<td>Tamil-II/ Malayalam-II/Hindi-II</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td>I</td>
<td>21UFEN02</td>
<td>Language-II</td>
<td>English-II</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UMB02</td>
<td>Core - II(CC)</td>
<td>Microbial Physiology</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UMBP02</td>
<td>Core Practical-II</td>
<td>Microbial Physiology</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>40 60</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UMBP01</td>
<td>Core Practical-I</td>
<td>Basics of Microbiology</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>40 60</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UBCA02</td>
<td>Allied -II(AC)</td>
<td>Biochemistry -II</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UBCAP01</td>
<td>Allied Practical-I</td>
<td>Biochemistry Practical</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>40 60</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Add-on Course</td>
<td>Professional English</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>21UES01</td>
<td>Environmental Studies</td>
<td>Environmental Studies</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>25 75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
<td>36</td>
<td>30</td>
<td></td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>Paper Code</td>
<td>Course</td>
<td>Title</td>
<td>Inst. Hrs/ Week</td>
<td>Credit</td>
<td>Exam Hours</td>
<td>Marks</td>
<td>Total</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>----------</td>
<td>--------------------------------------------------------</td>
<td>-----------------</td>
<td>--------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>I</td>
<td>21UFTA03</td>
<td>Language-I(LC)</td>
<td>Tamil-III/Malayalam-III/Hindi-III</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>II</td>
<td>21UFEN03</td>
<td>Language-II (ELC)</td>
<td>English-III</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Microbial Genetics and Molecular biology</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Core Practical-III(CP)</td>
<td>Microbial Genetics and Molecular Biology</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Microbial Genetics and Molecular Biology</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allied Practical -III(AC)</td>
<td>Computer Application I</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Computer Application practical</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SBEC - I</td>
<td>Applied bio techniques</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
<td>Choose from Other Department</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>19</strong></td>
<td></td>
<td><strong>600</strong></td>
</tr>
<tr>
<td>Part</td>
<td>Paper Code</td>
<td>Course</td>
<td>Title</td>
<td>Inst. Hrs/Week</td>
<td>Credit</td>
<td>Exam Hours</td>
<td>Marks</td>
<td>Total</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>--------</td>
<td>-------</td>
<td>----------------</td>
<td>--------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>I</td>
<td>21UFTA04</td>
<td>Language-I(LC)</td>
<td>Tamil-IV/ Malayalam-IV/Hindi-IV</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>II</td>
<td>21UFEN04</td>
<td>Language-II (ELC)</td>
<td>English-IV</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>III</td>
<td>21UMB04</td>
<td>Core –IV(CC)</td>
<td>Immunology and Immunotechnology</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBP04</td>
<td>Core Practical-IV(CP)</td>
<td>Immunology and Immunotechnology</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>21UMBP03</td>
<td>Core Practical-III(CP)</td>
<td>Microbial Genetics and Molecular Biology</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allied -IV(AC)</td>
<td>Computer Application - II</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allied Practical-II(AP)</td>
<td>Computer Application practical</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>21UMBS02</td>
<td>SBEC - II</td>
<td>Mushroom Cultivation Techniques</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td>NMEC – II</td>
<td>Choose from Other Department</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Add-on Course</td>
<td>Internship</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td>30</td>
<td>31</td>
<td></td>
<td></td>
<td>900</td>
</tr>
<tr>
<td>Part</td>
<td>Paper Code</td>
<td>Course</td>
<td>Title</td>
<td>Inst. Hrs/ Week</td>
<td>Credit</td>
<td>Exam Hours</td>
<td>Marks</td>
<td>Total</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>----------</td>
<td>--------------------------------</td>
<td>-----------------</td>
<td>--------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Int</td>
<td>Ext</td>
</tr>
<tr>
<td>III</td>
<td>21UMB05</td>
<td>Core- V (CC)</td>
<td>Medical Bacteriology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMB06</td>
<td>Core- VI (CC)</td>
<td>Food Microbiology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMB07</td>
<td>Core- VII (CC)</td>
<td>Medical Virology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBP05</td>
<td>Core Practical – V (CP)</td>
<td>Medical and Food Microbiology</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>21UMBE01</td>
<td>Elective - I</td>
<td>Medical Parasitology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBS03</td>
<td>SBEC - III</td>
<td>Microbial Biotechnology</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical/Moral Education</td>
<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>30</td>
<td>19</td>
<td></td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Part</td>
<td>Paper Code</td>
<td>Course</td>
<td>Title</td>
<td>Inst. Hrs/ Week</td>
<td>Credit</td>
<td>Exam Hours</td>
<td>Marks</td>
<td>Total</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>-----------------</td>
<td>--------------------------------------------</td>
<td>-----------------</td>
<td>--------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>III</td>
<td>21UMB08</td>
<td>Core -VIII (CC)</td>
<td>Soil &amp; Agricultural Microbiology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMB09</td>
<td>Core - IX(CC)</td>
<td>Environmental Microbiology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMB10</td>
<td>Core - X (CC)</td>
<td>Industrial Microbiology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBP06</td>
<td>Core Practical– VI (CP)</td>
<td>Agricultural, Environmental and Industrial Microbiology</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>21UMBP05</td>
<td>Core Practical– V (CP)</td>
<td>Medical and Food Microbiology</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>21UMBE02</td>
<td>Elective - II</td>
<td>Medical Mycology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21UMBS04</td>
<td>SBEC - IV</td>
<td>Entrepreneurial Microbiology</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>V</td>
<td>21UEX01</td>
<td>Extension Activities</td>
<td></td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>30</td>
<td>29</td>
<td></td>
<td></td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td></td>
<td></td>
<td>192</td>
<td>148</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B.Sc., Microbiology
(CBCS Pattern)
THEORY QUESTION PAPER PATTERN

Time: 3 hours
Max. Marks: 75

**Part - A (15 Marks) (Answer all the Question)**

15x 1 = 15 (Choose the best answer) (3 Questions each unit)

**Part - B (5 Marks) (Answer any two questions)**

2 x 5 = 10 (One question in each unit)

**Part – C (50 Marks)(Either or Choice)**

5 x 10 = 50 (Two question from each unit)

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 & 2 - 2 X 10 = 20 (A &B)
Spotters - 5 X 2 =10
Record - 05
Viva voce - 05
Internal Marks - 40
Total - 100
LIST OF COURSES

1. Basics of Microbiology
2. Microbial Physiology
3. Microbial Genetics and Molecular Biology
4. Immunology and Immunotechnology
5. Medical Bacteriology
6. Food Microbiology
7. Medical Virology
8. Soil and Agricultural Microbiology
9. Environmental Microbiology
10. Industrial Microbiology
11. Core Practical-1
12. Core Practical-2
13. Core Practical-3
14. Core Practical-4
15. Core Practical-5
16. Core Practical-6

ELECTIVE COURSES

1. Elective -1-Medical Parasitology
2. Elective-2 –Medical Mycology
SKILL BASED ELECTIVE COURSES (SBEC)

1. SBEC-1- Applied Bio techniques
2. SBEC-2- Mushroom Cultivation Techniques
3. SBEC-3- Microbial Biotechnology
4. SBEC-4- Entrepreneurial Microbiology

ALLIED COURSES

1. Biochemistry -I
2. Biochemistry -II
3. Computer Application - I
4. Computer Application -II
5. Allied practical - I - Biochemistry
6. Allied practical - II - Computer Application

NON MAJOR ELECTIVE COURSES (NMEC)

1. NMEC - 1 - Bio-Fertilizer Technology
2. NMEC - 2 – Mushroom Technology
3. NMEC - 3 - Clinical Lab Technology
4. NMEC - 4- Quality Control in Industry

PART-IV

1. Environmental Studies
2. Value Education-Yoga

PART-V

1. Extension Activities(Awareness program conducted based on hygiene practices to the other department students /nearby school students /village people)
Course Objectives
This subject aims to introduce the history and development of Microbiology. The contents of this course will help students to understand the history, biology, growth and control of microorganisms. Thus the beginners are rightly exposed to understand about Microbiology which would lead them towards progressive advancement of the subject.

Unit- I
Definition and scope of Microbiology – History and recent developments Spontaneous generation – Biogenesis Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff and Fleming.

Unit- II

Unit- III
Microbial Evolution and Diversity - Endosymbiotic theory. Binomial nomenclature of Microbes. Classification - Five kingdoms concept - Eight kingdoms concept (Cavalier Smith).

Unit- IV
Anatomy of prokaryotes - cell wall, cytoplasmic membrane, cilia, flagella capsule, cytoplasmic inclusions, sporulation. Stain and Staining techniques – Simple, differential and special staining.

Unit - V
Sterilization - methods of sterilization and Disinfection. Antimicrobial chemotherapy - tests for sensitivity to antimicrobial agents.

Course Outcome
❖ Students will get overall understanding about the fundamentals of microbiology.
❖ To understand the concepts of microscopy.
❖ Gain knowledge about the microbial evolution and diversity.
❖ Acquire information on anatomy of prokaryotes.
REFERENCES


7. https://www.researchgate.net/publication/324037626_Basic_Medical_Microbiology
B.Sc., MICROBIOLOGY
SEMESTER II
CORE - II - MICROBIAL PHYSIOLOGY

Course Objectives
To understand the kinetics of microbial growth and influence of varied physio chemical parameters. The information on energy deriving process of a living cell from organic and inorganic substances explained through metabolic reactions. To endow with the process of synthesizing macromolecules and their role in metabolism.

Unit - I
Nutritional requirements of Microorganisms- Autotrophs, Heterotrophs, Chemotrophs, Copiotrophs and Oligotrophs. Transport Mechanisms - Diffusion- Facilitated Diffusion, Active transport- Group translocation.

Unit- II

Unit- III
Metabolism - EMP, HMP, EDPathway - TCA cycle - Electron transport chain, Phosphorylation, Oxidative Phosphorylation, Substrate level Phosphorylation

Unit- IV
Anaerobic respiration - sulphur, nitrogenous compounds and C02 as a final electron acceptor- Fermentation: Alcoholic fermentation, mixed acid fermentation, lactic acid fermentation

Unit- V
Photosynthesis - Characteristics and types of Photosynthetic Prokaryotes. C02 fixation Oxygenic and Anoxygenic - Bio luminescence.

Course Outcome
❖ The students will get an overall understanding of basic cell structure and classification of microorganisms based on its nutritional requirements.
❖ Gain knowledge on the growth pattern of microorganisms and the influence of nutrients to obtain active growth phase.
Information on energy deriving mechanism from different energy sources.
Acquire information on synthesis of organic molecules via photosynthetic process

REFERENCES

Course objectives

To make the students to understand the genetics and molecular biology of microbes. To gather the sound knowledge about gene expressions of target genes. To bring advancement in human life.

Unit - I

Historical introduction - DNA and RNA as the genetic material - DNA double helix - plasmid structure and its types. Bacterial chromosome organization, structure and function of DNA, RNA and its types.

Unit - II


Unit - III


Unit - IV


Unit - V

Gene transfer mechanisms - Transformation, Conjugation and Transduction (Specialized and Generalized). Transposons.

Course outcome

❖ Understand the knowledge about the genetic material and DNA replication.
❖ Created an understanding about mutation and its types.
❖ Procured the knowledge about Transcription and Translation.
❖ Learned about gene transfer mechanisms in bacteria.
REFERENCES

**Course objectives:**

To introduce the structure and function of macromolecules in living organisms. It reveals the basic concepts of instrumentation used in biotechniques. It imparts the knowledge on identification of physical properties of biochemical composition to provide better chemical information. To improve the efficacy of qualitative and quantitative analysis of different molecules involved in biochemical reactions.

**Unit - I**


**Unit - II**

Centrifugation: Principle and applications - types of centrifuges.- low speed, high speed, ultra centrifuge, Differential centrifugation - density gradient centrifugation.

**Unit - III**


**Course outcome**

- To acquire the basic science behind the research techniques.
- Students will become familiar with biotechniques like chromatography, electrophoresis and spectrophotometry for quantitative and qualitative analysis.
- Students will be inculcated with precise and accurate interpretation skills in the research sector.
- To imbibe the knowledge on modernised analytical methods to step in hi-tech industries.
REFERENCES

1. Physical Biochemistry: David Freifelder.
B.Sc., MICROBIOLOGY
SEMESTER V
CORE - IV - IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course objectives
Impart knowledge on immune cells and organs and elementary principles of antigen antibody interactions. Understanding the transplantation immunology, hypersensitivity reactions, autoimmunity, vaccines and its response to immune system.

Unit - I
History of Immunology, Innate immunity and acquired immunity, Haematopoeisis, Cells and organs of immune system. B -cell and T- cell activation. Phagocytosis.

Unit- II

Unit- III
Hypersensitivity reactions - types, Antibody mediated (Type- I, Type II, Type III) and Cell mediated (Type- IV). Auto immune diseases - Types and mechanisms.

Unit-IV

Unit- V

Course outcome
❖ The students will get overall understanding of history and evolution of immunology and immune response developed by human system
❖ To understand the concepts of antigen, antibody interactions and influence on human immune system via hypersensitivity reactions, autoimmune diseases etc.
Detailed understanding of Immunoheamatology, Transplanatation Immunology and Vaccines which will make the minds aware of infection, prevention and control.

Help the students to learn techniques involved in immunological concepts and its role in diagnostic immunology

REFERENCES

Course objectives
To make the students to understand about the mushroom techniques, spawn preparation, diseases control and cultivation ethics.

Unit -I
Edible and non-edible mushroom (Historical account, most commonly cultivated mushrooms in the world, distribution and production in various countries). Cultivation of button mushroom - morphology raising a pure culture & spawn preparation. Preparation of compost & cultivation methods, harvest.

Unit -II
Cultivation of oyster and paddy straw mushroom - preparation of pure culture & spawn cultivation methods, harvest. Pests and diseases of Edible mushrooms (Environmental, fungal, bacterial, viral, insect pests and Nematode diseases and competitor moulds.

Unit -III
Ethics of mushroom cultivation while selecting the area, spawn preparation, spawn run, during cropping harvesting etc.. Mushroom recipes (western and Indian recipes, pickles, powders, jams etc.)

Course outcome
❖ Able to get basic idea about mushroom cultivation.
❖ Learned techniques about spawn multiplication.
❖ Learned about the diseases of edible mushrooms.
❖ Made the students ideally skilled for self-employment.

REFERENCES
6. researchgate.net/publication/316967767_Mushroom_Cultivation_Book_Preprint_version
7. https://books.google.co.in/books/about/Manual_on_Mushroom_Cultivation.html?id=-vxHAAAAYAAJ&redir_esc=y
B.Sc., MICROBIOLOGY
SEMESTER V
CORE - V - MEDICAL BACTERIOLOGY

Course objectives
Designed to develop a basic understanding about infection and the causative bacteria, their differentiation and to gain knowledge on various diseases generated during the pathogenic role of those organisms, this course also deals with the diagnostics and treatment

Unit - I

Unit- II
Morphology, Pathogenicity, Biochemical laboratory diagnosis and prevention of bacterial diseases- Staphylococcus aureus, Streptococcus pyogens, S. pneumoniae, Neisseria sps.

Unit- III
Morphology, pathogenicity, biochemical laboratory diagnosis and prevention of bacterial diseases – Bacillus anthracis, C.diphtheriae, Clostridium tetani, Mycobacterium tuberculosis, M.leprae.

Unit-IV
Morphology, pathogenicity, biochemical laboratory diagnosis and prevention of bacterial diseases - Salmonella typhi, Shigelladysentriae, Vibrio cholerae, E.coli, Proteus vulgaris, Klebsiellapneumoniae,Pseudomonasaeruoginosa, Yersinia pestis.

Unit- V
Morphology, pathogenicity, biochemical laboratory diagnosis and prevention of bacterial diseases - Treponemapallidum, Lept spirainterrogans, Mycoplasma pneumoniae, Haemophilusinfluenzae.

Course outcome
❖ Understood the basic and general concepts of infections and the various parameters of causing infections. Assessment of their severity including the broad categorization of the
methods of diagnosis.
❖ Developed a thorough understanding of common Gram positive bacterial diseases of human being.
❖ Conceptualized the role of the some bacteria as well as the mechanisms underlying the pathogenicity of them.
❖ Developed a thorough understanding of some special pathogenic bacteria affecting the human organ systems

REFERENCES
7. https://www.slideshare.net/El_Omda/anthrax-15737452
B.Sc., MICROBIOLOGY
SEMESTER V
CORE – VI - FOOD MICROBIOLOGY

Course Objectives
To educate students about the food micro flora, role of microbes in food fermentation, food preservation, food spoilage and food safety regulations.

Unit - I
Food and microorganisms - Important microorganisms in food (bacteria, molds and yeasts). Sources of contamination of food. Factors that influence microbial growth in food - Intrinsic factors - extrinsic factors. Microbes as food - single cell protein (SCP) - probiotic and symbiotic – benefits and applications.

Unit - II
Food sanitation and principles of food preservation - Food sanitation, good manufacturing process - hazard analysis, critical control points and personnel hygiene. General principles methods of food preservation – asepsis, removal of microorganisms, anaerobic conditions, high temperature, low temperature, drying, radiation, smoking, chemical preservatives and food additives.

Unit - III
Spoilage of food and fermented food products - Sources, contamination, spoilage, preservation and control - cereals and cereals products, vegetables and fruits, meat and meat products, sugar and sugar products, egg and poultry, fish and sea foods, canned foods. Fermented food – bread, sauerkraut and soy sauce.

Unit - IV
Production and spoilage of various dairy products - Sources, contamination, spoilage, preservation of milk and milk products – yoghurt, cheese and butter - Quality control of milk – MBRT, litmus milk, alkaline phosphatase test and resazurin test.

Unit - V
Course outcome

❖ Know the positive and negative role of microbes in food.
❖ Gain knowledge about fermented food products.
❖ Understand the significance of food borne diseases.
❖ Realize the importance of food sanitation and quality assurance.

REFERENCES

6. https://www.fda.gov/
7. https://en.wikipedia.org/wiki/Food_Safety_and_Standards_Authority_of_India
B.Sc., MICROBIOLOGY
SEMESTER V
CORE - VII - MEDICAL VIROLOGY

Course objectives
It covers the knowledge on history, general characters, and the classification of the viruses and also it is designed to comprehend the mechanisms of different viral infections affecting human, knowledge on the diagnostic methods and their prophylactic measures. This course also describes about the current viral epidemics threatening the whole world.

Unit- I

Unit- II
Pox viruses - Variola, Herpes viruses - Herpes Simplex Virus, Cytomegalo Virus, Epstein Barr Virus.

Unit- III
Adena viruses, Hepatitis viruses, Papova viruses, Papilloma, Polyoma, Parvo virus, Retro virus - HIV.

Unit- IV
Picorna viruses - Polio, Rhino virus, Orthomyxovirus - Influenza, Paramyxo virus - Parainfluenza, Mumps, Measles, Rhabdo virus, Rota virus.

Unit– V

Course outcome
❖ Understood and Recognize characters of different types of viruses causing infections, assessment of their severity, methods of diagnosis and their prophylaxis.
❖ Recognize how the two different classes, DNA and RNA viruses causing viral diseases in human beings.
❖ Conceptualized the role of viruses as well as the mechanisms underlying the pathogenicity of them, their detection and prophylaxis.
Developed a thorough understanding of some special pathogenic viruses causing recent epidemics and threatening the whole world.

REFERENCES


6. https://www.who.int/health-topics/coronavirus

B.Sc., MICROBIOLOGY

SEMESTER V

ELECTIVE - MEDICAL PARASITOLOGY

Course objectives
The candidate will gain knowledge about the morphology of protozoans and helminthes, life cycle patterns, pathogenesis, clinical findings, transmission of parasites, identification and treatment.

Unit - I
Introduction to Parasitology, Classification, Host-Parasite relationship. Lab diagnosis of parasitic infections. Examination of faeces – Direct and concentration methods, examination of blood – Thin and Thick smear method.

Unit - II
Morphology, Transmission, Lifecycle, Pathogenesis, Clinical manifestations, Culture, Lab Diagnosis and treatment of Protozoans – *Entamoeba histolytica*, *Giardia intestinalis*, *Trichomonas vaginalis*, *Balantidium coli*

Unit - III
*Leishmania donovani*, Trypanosomes – *Trypanosoma cruzi*, Sporozoites – Malarial parasites (*Plasmodium falciparum*, *P.vivax*, *P.ovale*)

Unit - IV

Unit – V
Medical Entomology – Vectors - Classification, morphology and metamorphosis of insects–Mosquitoes, Sand fly, Ticks, Fleas, Housefly and Mites. Vector borne diseases and its control measures.

Course outcome
❖ Understanding of taxonomy of parasite and host – parasite interaction.
❖ In depth knowledge on clinical diagnosis, pathogenicity and life cycle of protozoans
❖ Assimilate various lab technologies for diagnosis of medically important protozoans and their treatment.
Articulate the major means of transmission of parasites by insect vectors and their control measures.

REFERENCES


B.Sc., MICROBIOLOGY

SEMESTER V

SBEC - III – MICROBIAL BIOTECHNOLOGY

Course objectives

To understand the Microbial biotechnology. To gather the sound knowledge about desirable characteristics can be improved in the living bodies by controlling expressions of target genes. This technology has multidisciplinary applications and the potential to deal with important aspects of life.

Unit - I

Introduction, Milestones in rDNA technology, strategies involved in gene cloning. Construction of cDNA library and genomic DNA library.

Unit - II


Unit - III


Course outcome

❖ Understand the knowledge about The Basic Principles of Gene Cloning.
❖ Acquire knowledge about Molecular Cloning Tools
❖ Created an understanding about Cloning Vectors Gene transfer Techniques
❖ Procure the knowledge about Methods in Molecular Cloning

REFERENCES


Course objectives

Transforming student society caring nature as an eco-friendly one by introducing the relationship between microbes and nature, its roles and its utilization for the creation of sustainable environment.

Unit - I
Development of Soil Microbiology - Distribution of microorganisms in soil - quantitative and qualitative microflora of different soils - Role of microorganisms in soil fertility –Factors Influencingthe soil microflora

Unit - II

Unit - III
Microbial transformation of phosphorus, sulphur and micronutrients in soil - phosphorus solubilization by phosphobacteria - sulphur cycle,sulphur bacteria and their importance. Interrelationships between plants and microorganisms - Rhizosphere - spermosphere - phyllosphere.

Unit - IV
Mycorrhiza - ecto and endomycorrhiza – distribution and importance – Plant growth regulators and phytotoxin production by microorganisms - use of soil microorganisms for pest and disease control - Pesticide and soil microflora - interactions.

Unit - V
Course outcome

❖ Able to understand the distribution of microbes in soil
❖ Capable to get information about biogeochemical cycle
❖ Able to get the knowledge about microbial interaction
❖ Capable to get idea about plant disease

REFERENCES

B.Sc., MICROBIOLOGY
SEMESTER VI
CORE - IX - ENVIRONMENTAL MICROBIOLOGY

Course objectives
To provide a Fundamental and applied knowledge about the various scopes in Environmental microbiology. To study the distribution and role of microorganisms in Biosphere for improvement of environmental quality, the discovery of microorganisms with metabolic potentials that can be employed Pollution control.

Unit - I
Concept and scope of environmental microbiology: Biodiversity, Distribution of microorganisms in nature, adaptations of microbes, Environmental problems and microbial solutions. Microorganisms inhabiting extreme environments. Environmental education. Environmental organizations and conventions.

Unit - II

Unit - III
Microbial interactions – Plant- microbe interactions and Microbe-microbe interactions-Beneficial- commensalism, synergism, symbiosis. Harmful- competition, amensalism, predation and parasitism. Solid waste management, Vermicomposting, Biogas technology, anaerobic digestion by methanogens.

Unit - IV
Unit - V

Bioremediation concepts - Mineral leaching by bacteria –Biomining of metals – Heavy metal pollutants removed by bioaccumulation. Microbial extraction of oil, Biodegradation of petroleum, Microbial degradation of xenobiotics –Microorganisms in abatement of heavy metal pollution – Heavy metal tolerance in microbes – Microbial plastics

Course outcome

❖ Able to understand about the microbial diversity in environmental
❖ Capable to get information about the ecosystem
❖ Able to get overall understand the pollution
❖ Capable to understand basic knowledge about bioremediation

REFERENCES

Course objectives
To introduce the role of microbes in industries. To impart knowledge on different types of fermentors and fermentation processes. To familiarize with the various industrial production process involving microbes. To provide the information on the role of various factors influencing the fermentation processes.

Unit - I
Industrially important microorganisms - Screening Techniques- Primary and Secondary - Preservation of cultures - Strain improvement- Development of inoculum for various fermentation processes.

Unit - II
Fermentor - Components, Types of fermentors, Control systems in fermentation - pH, Temperature,Oxygen and foam.Computer applications in fermentation technology

Unit - III
Media for industrial fermentation - submerged and solid state fermentation- Downstream processing-Recovery and purification of intra cellular and extracellular products.

Unit - IV
Microbial production Alcoholic beverages - Wine, beer,ethanol.Organic acids - Citric acid and Acetic acid.

UNIT V

Course outcome
❖ Able to select and design a fermentation process for a specific product
❖ Capable of identifying industrially important microbes and its potential applications
❖ Able to device means to improve the production rate of existing fermentation processes
❖ Capable of designing processes for higher production yield at economically cheaper rate
REFERENCES


6. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundle ss)/17%3A_Industrial_Microbiology

Course objectives

To acquire basic knowledge of general properties and taxonomy of medically important fungi, morphological features, diseases caused by fungi, pathogenesis, diagnosis and treatment of fungal infections.

Unit - I


Unit - II

Superficial mycosis - Pityriasis versicolor, Tineanigra, Black and White Piedra. Otomycosis - Cutaneous mycosis - Dermatophytosis.

Unit - III

Subcutaneous mycosis - Sporotrichosis, Mycetoma, Chromoblastomycosis. Systemic mycosis - Histoplasmosis, Coccidioidomycosis, Blastomycosis

Unit - IV

Opportunistic mycosis - Candidiasis, Cryptococcosis, Aspergillosis, Penicilliosis.

Unit - V

Allergic fungal diseases - Bronchial Asthma, Maple Bark Stripper’s disease - Antifungal agents - type and mode of action. Sensitivity tests, Mycotoxins (Mycotoxicosis and Mycetismus).

Course outcome

❖ Basic understanding of fungi, their morphology and culture methods of fungi.
❖ Obtain knowledge on pathogenicity and laboratory diagnosis of medically important fungi.
❖ Grasp knowledge on mycotoxins and their importance.
❖ Gain knowledge on antifungal agents and their testing methods.

REFERENCES

B.Sc., MICROBIOLOGY
SEMESTER VI
SBEC IV - ENTREPRENEURIAL MICROBIOLOGY

Course objective

The aim of the course is to make the student to learn importance of microorganism in various fields. To understand the patenting process and to know the different financial agencies support for entrepreneurship

Unit- I

Entrepreneur development - activities, Institutes involved, Government contributions to entrepreneur, risk assessment, Industrial Microbiology - Definition, scope and historical development.

Unit - II

Microbial cells as fermentation products Baker’s yeast, food and feed yeasts, bacterial insecticides, legume inoculants, SCP production, Enzymes as fermentation products bacterial and fungal amylases, proteolytic enzymes.

Unit - III


Course outcome

❖ To make Knowledge about the role of microbes in Industries
❖ Gained knowledge about fermented products.
❖ To understand the significance of patenting
❖ Able to make the students ideally skilled for self-employment

REFERENCES
3. Arora.EntrepreneurialDevelopmentinIndia.
Course objectives

The aim of the course is to make the student to learn importance of biofertilizers in agriculture and to know about field application and production technologies.

Unit - I

Definition and types, importance of biofertilizers in agriculture, Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings. Biofertilizers – carrier materials - storage, shelf life, foliar applications, quality control and marketing.

Unit - II

Isolation, identification, characterization, mass multiplication, formulation, field application and benefits of *Rhizobium, Azospirillum, Azotobacter* and Cyanobacteria

Unit - III


Course outcome

❖ Able to get basic idea about biofertilizer production
❖ For to learn application techniques about biofertilizer
❖ Capable to make mass multiplication
❖ Able to make the students ideally skilled for self-employment

REFERENCES

3. Ramesh Chandra and Raverkar KP. Bioresources for sustainable plant nutrient
management, scholars world publishers, New Delhi.2014.


Course objective
To make the students to understand about the mushroom cultivation technology, spawn preparation, diseases control and the medicinal values of Mushroom

Unit- I

Unit- II

Unit -III

Course outcome
❖ Able to get basic idea about mushroom cultivation
❖ For to learn techniques about spawn multiplication
❖ Capable to identify the diseases of edible mushrooms
❖ Able to make the students ideally skilled for self employment

REFERENCE
Coimbatore.


7. https://www.saraspublication.com/books/mushroom-cultivation/
Course objectives

The course contents are designed to teach various methods of sterilization, handling various instruments used in the clinical laboratories and its significance in diagnostic field. To train the students on various diagnostic techniques especially to identify the different types bacteria and fungi from the clinical samples.

UNIT - I


UNIT - II


UNIT - III

Introduction to haematology, collection of blood sample and anticoagulants, Specimen collection and processing in hematology, haemocytometer and procedure for RBC, WBC, ESR count, haemoglobin estimation, bleeding time with normal values and interpretation

Course outcome

❖ Learn the handling of instruments and various measurements used in the laboratory.
❖ Gained knowledge about laboratory techniques its significance in diagnostic evaluation.
❖ Identify and differentiate the different types of bacteria and fungi in clinical samples.
❖ Learn the differential diagnosis by the help of different serological techniques.

REFERENCES


6. [http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_technology_students/MedicalLabTechnology.pdf](http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_technology_students/MedicalLabTechnology.pdf)

B.Sc., MICROBIOLOGY
SEMESTER III
NMEC - III - QUALITY CONTROL IN INDUSTRIES

Course Objective
The objective of this course is to impart basic knowledge about quality control in pharmaceutical industry, quality control audits in industries. Train the students on the basics of food safety and food quality. To teach the microbial quality control in hospitals aim to impart knowledge on manufacturing operation in industries.

UNIT - I

UNIT - II
Food safety and Food Quality-Microbiological criteria of food, food products, Monitoring of factory hygiene and sanitation, Food Safety and Standards. Food contaminants and diseases. Microbial quality control in Hospitals-Control of Healthcare associated infections - Monitoring water quality in hospitals, healthcare infrastructures.

UNIT - III
Manufacturing operations and controls-Sanitation of manufacturing premises, cross contamination, processing of bulk products, packaging operations, release of finished product. Expiry date calculation, calculation of yields, production record review, and handling of waste and scrap disposal.

Course Outcome
❖ To acquire the knowledge quality control in pharmaceutical industry
❖ To learn the quality control audits in industries.
❖ To understand the basics of food safety and food quality.
❖ Skilled on manufacturing operation in industries

REFERENCES


5. EPA. "Noise Pollution." 2010-05-18


B.Sc., MICROBIOLOGY
SEMMESTER I
CORE PRACTICAL - I
BASICS OF MICROBIOLOGY

1. Handling of microbiological laboratory instruments and Laboratory safety measures.
2. Handling and Maintenance of compound microscope.
3. Cleaning of glassware and preparation of cleaning solutions
5. Colorimeter- Beer & Lambert’s law
6. pH meter- principle and measurements
7. Preparation of media
   a. Liquid media
   b. Solid media
   c. Enriched Medium
   d. Differential medium
   e. Selective medium
8. Scientific Inquiry - field visit to different ecosystem for sample collection
9. Enumeration of bacteria from environmental samples (Soil, Water and Air)
10. Determination of microorganisms by direct count and viable count

REFERENCES


B.Sc., MICROBIOLOGY
SEMESTER II
CORE PRACTICAL - II
MICROBIALPHYSIOLOGY

1. Pure culture techniques: streak, spread and pour plate methods
2. Motility determination - Hanging drop method, semisolid agar
3. Culture characteristics of Microorganisms- colony morphology, shape, margin.
4. Staining of microorganisms. – Grams staining, AFB staining, Capsular staining and spore staining
5. Biochemical test- IMViC test, Oxidase test, Catalase test, Urease test, Nitrate reduction test
7. Bacterial Growth curve.

REFERENCES
6. https://www.frontiersin.org/books/Microbial_Physiology_and_Metabolism
1. Isolation of Genomic DNA from Bacteria
2. Electrophoresis- Agarose gel electrophoresis,
3. Poly Acrylamide Gel Electrophoresis (PAGE)
4. Estimation of DNA by DPA method.
5. Restriction digestion of DNA
6. Isolation of Auxotrophic mutants from Soil sample by Replica plating.
7. Isolation of spontaneous mutants by Gradient plate technique.
8. Isolation of phage from Sewage (Demonstration)
9. PCR amplification - Demonstration.

REFERENCES
IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Collection and Separation of serum/plasma from blood.
2. Serological tests:
   a. Blood grouping- A,B,O, Rh
4. Erythrocyte sedimentation rate
5. Agglutination reaction :
   a. Widal test, RA test, CRP test
   b. Pregnancy test (Slide and Card test)
6. Ouchterlony double immunodiffusion test.
7. Immunoelectrophoresis
8. Counter current immunoelectrophoresis
9. HIV - Tri Dot test and Hepatitis- Hepacard

REFERENCES

3. Myer's and Koshy's manual of diagnostic procedures in medical microbiology and immunology / serology. Published by department of clinical microbiology, CMC and Hospital, Vellore, Tamil Nadu.
7. https://www.academia.edu/14724561/A_TEXT_BOOK_OF_IMMUNOLOGY_AND_IMMUNOTECHNOLOGY
B.Sc., MICROBIOLOGY
SEMESTER V
CORE PRACTICAL - V
MEDICAL AND FOOD MICROBIOLOGY

1. Collection and processing of medical samples (Urine, pus and faces)
2. Isolation and identification of pathogenic bacteria from clinical specimens
   - a. *Staphylococcus aureus*
   - b. *Escherichia coli*
   - c. *Klebsiella pneumoniae*
   - d. *Salmonella typhi*
   - e. *Proteus vulgaris*
   - f. *Psedomonas aeruginosa*
3. Isolation and identification of clinically important fungi- *Candida albicans*, *Aspergillus*, and *Cryptococcus neoformans*
4. Blood smear examination for malaria parasite (*Plasmodium vivax* and *Plasmodium malariae*)
5. Antibiotic susceptibility test: disc diffusion method and Determination of minimal inhibitory concentration (MIC)
6. Microscopic examination for parasite from Stool samples by Zinc-sulphate floatation method.
7. Staining Techniques (Grams and LPCB)–Food samples- vegetables and packed foods.
8. Isolation and identification of food born pathogen from spoiled and contaminated food/Vegetable samples.
9. Milk quality test (Methylene blue reductase assay, Resazurin test.).

REFERENCES


B.Sc., MICROBIOLOGY

SEMESTER VI

CORE PRACTICAL - VI

AGRICULTURE, ENVIRONMENTAL AND INDUSTRIAL MICROBIOLOGY

1. Examination of plant diseases - Blight of rice, Citrus canker, Red rot of sugarcane, Wilt of cotton and Tikka leaf spot, Rust in groundnut
2. Isolation of Nitrogen fixing bacteria from root nodules of legumes and Rhizosphere soil
3. Isolation of Phosphate solubilizers from Agricultural Soil.
4. Enumeration of Microbes from air by open plate method.
5. Microbial analysis of Drinking water (MPN)
6. Immobilization of microbial cells (Baker’s yeast)
7. Production of ethanol & wine from grapes.
8. Production and characterization of citric acid using A. Niger
9. Production of Extra cellular enzymes – Amylase by fermentation
10. Demonstration of batch fermentation using Erlenmeyer flask

REFERENCES
