



# **RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. GENERAL (SEMESTER PATTERN)**

**B. Sc. SECOND YEAR**

**MICROBIOLOGY – CURRICULUM (CBCS)**

**UNDER ACADEMIC AUTONOMOUS STATUS 2018-2024**

**JUNE, 2018-19**

## **INTRODUCTION**

Microbiology has been at the forefront of research in industry, environment, agriculture, food, dairy, medicine and biology. It is one of the rapidly growing and applied areas of the science. There many job opportunities available for student in this stream. Industrial production and management are some of the areas in which trained manpower is needed.

Microbiology is one of the optional subjects for B.Sc. degree course of three years. I, II, &III. Students passed 10+2 are eligible for admission. Language of Medium is English.

The pattern of question paper, standard of passing is as per norms given by BOE of Rajarshi Shahu Mahavidhyalaya, Latur (Autonomous)

The admission procedure for course is as per college norms.

Teacher's qualifications are as per UGC norms.

The list of laboratory Equipments and Instruments is given

## **GENERAL OBJECTIVES OF THE COURSE**

- The syllabus of course is designed to provide knowledge which is useful for making carrier in related fields.
- To promote students for self employment.
- To provide basic knowledge and skills to promote students in research and social scientific awareness.

# Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Dept. of Microbiology

**B. Sc. GENERAL (SEMESTER PATTERN)**

**B. Sc. SECOND YEAR  
MICROBIOLOGY – CURRICULUM  
(MCQ Pattern + Theory Pattern)**

Semester	Paper No. & Title, Course code	Lectures / practical	Marks		
			In Sem. Evaluation	End Sem. Evaluation	Total
Semester III	<b>Theory Paper-V:</b> Applied Microbiology (U-MIB-359)	45	20	30	50
	<b>Theory Paper-VI:</b> Fundamentals of immunology (U-MIB 360)	45	20	30	50
	<b>Lab Course-MB-III: Practical's based on theory papers-V</b>	12	----	---	50
	<b>Lab Course-MB-IV: Practical's based on theory papers-VI</b>	12	----	---	50
	Skill Enhancement Course Sec.U-MIB I				
Semester IV	<b>Theory Paper-VII:</b> Environmental Microbiology (U-MIB- 459)	45	20	30	50
	<b>Theory Paper-VIII:</b> Medical microbiology(U-MIB-460)	45	20	30	50
	<b>Lab Course-MB-V: Practical's based on theory papers –VII</b>	12	----	---	50
	<b>Lab Course-MB-VI: Practical's based on theory papers –VIII</b>	12	----	---	50
	Skill Enhancement Course Sec.U-MIB II				

**Note:** B.Sc. I, II, III year practical's includes Studies of growth and life activities of microorganisms.

These Studies needs two consecutive days for completion of practical

**Workload:**

**1. Theory:** Per paper per week three periods

**2. Practical:** Per batch per week one practical (Four periods) for two consecutive days  
(04+04= 08 periods)

**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second year (Semester -III)**

**MICROBIOLOGY**

**Course Code: U-MIB-359**

Maximum Marks: 50

Lectures: 45

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**PAPER V – Applied microbiology**

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**Course Objectives:**

- Students will learn importance of microorganisms in day to day life.
- Students will learn the subject in perspective of public health and hygiene.
- Students will know techniques to control microbial contamination in air, water and food.
- Students will be introduced to microbial nanotechnology-an advanced avenue of applied microbiology.

**Course Outcomes:**

- Completing Paper V, the Microbiology students will be able to:
  - Describe the importance of existence, beneficial and harmful role of microorganisms in air, water, food and waste. Understand and describe various methods of microbiological analysis and controlling microbial growth and activities for making these life governing factors safe

**UNIT I: Air Microbiology**

10L

- 1.1 Definition, composition and quality of air.
- 1.2 Sources of microorganisms in air: Intramural Aerobiology, Extramural Aerobiology, Importance of state of suspension- Bioaerosols: droplet, droplet nuclei and droplet infection
- 1.3 Significance of microorganisms present in air: With respect to human, animal, plant health (list of air borne diseases), environment and industry
- 1.4 Microbiological Analysis of Air: Impaction, liquid impingement, filtration, Anderson air sampler
- 1.5 Control of microorganisms in air: Dust control, UV radiation, laminar airflow system, masks, Bactericidal vapours.
- 1.6 Bioterrorism: List of microbial warfare agents, Brief idea of their detection and

control measures

**UNIT II: Aquatic Microbiology**

12L

- 2.1 Natural waters: Atmospheric, surface, stored and ground water.  
Definitions: Fresh water (ponds, lakes, streams) and Marine water (estuaries, the sea).
- 2.2 Aquatic environment: Temperature, hydrostatic pressure, light, salinity, turbidity, Planktons and other microorganisms
- 2.3 Domestic water: water borne diseases, nuisance microorganisms
- 2.4 Bacteriological evidence of pollution: Fecal pollution, significance of index organisms
- 2.5 Microbiological examination of water: Membrane filter technique, Tests for presence of coliforms (quantitative and qualitative), IMVC test, Elevated temperature test.
- 2.6 Safety of drinking water: Boiling, chlorination, radiation and ozonization

### **UNIT III: Food and milk microbiology**

13L

- 4.1 Sources of microorganisms in foods and milk
- 4.2 Milk as a nutrient medium for microbial growth
- 4.3 Microbiological examination of food: DMC, SPC, Differential enumeration, MBRT, Resazurin test, Milk ring test for brucellosis
- 4.4 Food Spoilage: Classification of foods depending upon ease of spoilage, Different types of spoilages with suitable examples, biochemical types of microorganisms in milk (including starter cultures)
- 4.5 Principles and applications of food Preservation techniques: Aepsis, use of high temperatures (milk pasteurization and phosphatase test, canning ), freezing, dehydration, radiation (UV and Gamma rays), osmotic pressure; use of chemicals- Vinegar.
- 4.6 Microbial food poisoning: Staphylococcal poisoning, Aflatoxin and Salmonellosis (organism, foods involved and type of toxin)

### Unit IV: Microbial Nanotechnology

- 4.1 Definition and concept of microbial nanotechnology
- 4.2 Biosynthesis of nanoparticles using microorganisms
- 4.3 Characterization of nanoparticles
- 4.4 Applications of nanoparticles

**References:**

- 1) Fundamental principles of bacteriology. A.J. Salle. TATA MCGRAW- HILL
- 2) Fundamentals of Microbiology. Martin Frobisher.
- 3) Food microbiology. Fourth edition. Willium Frazier, Dennis Westhoff. TATA McGraw- Hill
- 4) General microbiology Vol. II by Power C.H and H.F. Daginawala. Himalaya Publishing House
- 5) Microbiology. Pelczar, Chan and Crieg. TATA McGraw- Hill
- 6) Text book of applied microbiology. Dr. B.M Sandikar, Himalaya Publishing House
- 7) Microbial biotechnology: fundamentals of applied microbiology. Alexander Glazer, Hiroshi Nikaido. Cambridge university press
- 8) Environmental microbiology. Ralph Mitchell, Ji-Dong Gu. Wiley-Blackwell
- 9) Modern Food Microbiology 4th edition. Jay,J.M. Van Nostra and Rainhokdd Co.
- 10) Review Article: Biosynthesis of Nanoparticles by Microorganisms and Their Applications; Xiangqian Li,1, 2 Huizhong Xu,3 Zhe-Sheng Chen,2 and Guofang Chen4; Journal of Nanomaterials: Hindawi Publishing Corporation; Volume 2011, Article ID 270974,16 pages



**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second year (Semester -III)**

**MICROBIOLOGY**

**Course Code:U-MIB-360**

Maximum Marks: 50

Lectures: 45

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**PAPER VI – FUNDAMENTALS OF IMMUNOLOGY**

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**OVERALL COURSE OBJECTIVES**

- To understand basic principles of immunology.
- To gain knowledge about microbial interactions with relationship.
- To understand antigen, antibody and complement system.
- Get an overview of Immunity and immune responses.  
To understand basic principles and concepts of immunization.
- Knowledge of antigen antibody reaction and their applications.

**Course Outcomes:** Completing third semester, the Microbiology students will be able to understand the body defense mechanisms and describe the immunological concepts with reference to infection, immunity, immunological reactions and importance of immunization

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**UNIT I: Humans microbe interactions**

10 L

- 1.1 Definition –contamination, infection and disease, pathogen, pathogenacity and virulence.
- 1.2 Overview of human microbial interactions.
- 1.3 Virulence factors of pathogen.
- 1.4 Normal micro flora of the human body.

**UNIT II: Antigen and Antibody and Complement**

12 L

**Antigen**

- 2.1 Definition, Immunogenicity versus antigenicity
- 2.2 General properties of antigen.
- 2.3 Antigen specificity.
- 2.4 Bacterial antigens with special reference to antigens of *Sal.typhi*.

**Antibody**

- 2.4 Definition, basic structure of immunoglobulin.
- 2.5 Immunoglobulin classes, properties of immunoglobulin classes

**Complement system-General properties.**

**UNIT III: Immunity and Immune Response**

11 L

3.1 Definition, cells and organs of the immune system.

3.2 Classification of immunity with suitable examples.

3.3 Immune response: Humoral and cellular

3.4 Theories of antibody production

3.5 Vaccines and antisera.

Live attenuated vaccines, killed vaccine, subunit vaccine, toxoid

DNA vaccine, Immune sera

**UNIT IV: Serological reaction**

12L

4.1 General features of antigen antibody reactions

4.2 Mechanism and applications of the following reaction

a. Precipitation

b. Immunodiffusion

c. Immuno electrophoresis

d. Agglutination.

e. Complement fixation.

f. Neutralization: toxin and virus neutralization

g. Enzyme linked immunosorbent assay.

**References:**

- 1) Kuby's Immunology. 6th edition. Goldsby RA, Kindt TJ, Osborne BA. W.H. Freeman and Company, New York.
- 2) Textbook of Microbiology. 7th edition (edited by Paniker CKJ). Ananthanarayan R and Paniker CKJ. University Press Publication.
- 3) Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. Brooks GF, Carroll KC, Butel JS and Morse SA. McGraw Hill Publication.
- 4) Roitt's Essential Immunology. 11th edition Delves P, Martin S, Burton D, Roitt IM. Wiley-Blackwell Scientific Publication, Oxford.
- 5) Basic Immunology. Joshi and Osarano. Agrobotanical publishers Ltd. Bikaner.
- 6) Elementary microbiology Vol.I and II. Dr. A.H Modi. Akta Prakashan. Nadiad.
- 7) Medical Microbiology. N.C.Dey and T.K. Dey.
- 8) Allied agency, Culcutta.
- 9) Microbiology. Davis, Dulbecco, Eisen Harper and Row Maryland.
- 10) Molecular biology. David freidfelder, marosa Publishing house, New Delhi.
- 11) Text book of immunology. B.S.Nagoba and D.V.Vedpathak. BI publications, New Delhi

**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second Year (Semester -IV)**

**MICROBIOLOGY**

**Course Code:U-MIB-459**

Maximum Marks: 50

Lectures: 45

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**PAPER VII – Environmental microbiology**

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**Course Objectives:**

- Students will understand the problem of environmental pollution and its eco-friendly remediation
- Students will gain knowledge of the interrelationship and influence of microorganisms on each other and on environment.
- Students will understand the role of microorganisms in plant growth promotion and its application in agriculture
- Students will understand the multiple role of microbial diversity in managing the natural turnover of metals in soil
- Students will be aware of eco-friendly and sustainable microbial techniques to resolve agro-environmental problems

**Course Outcomes:**

- i. Completing fourth semester, the Microbiology students will be able to:  
Explain why microorganisms are *ubiquitous in nature*; the influence of interactions among different microorganisms and with environment; and on development of an ecosystem.
- ii. Demonstrate that microorganisms have an *indispensable role* in turnover of elements in the environment. Understand and advocate the role of microorganisms in plant growth promotion and plant disease management

**UNIT I: Microbial Ecology and interactions**

11L

- 1.1 Microbial ecology: Ecosystem, Synecology, Autecology, population, community (Autochthonous, Allochthonous), Dispersal (Center, Active, Passive), Community succession (Pioneer, Successive, Climax), Adaptation (Phenotypic, Genotypic)
- 1.2 Symbiosis: Definition and functions  
Types of symbiosis: neutralism, Commensalism, Mutualism (Lichens, Mycorrhiza) Competition, Antibiosis, Synergism, and Parasitism. (Definition and example of each)

**UNIT II: Plant growth promoting rhizobacteria**

11L

2.1 Rhizosphere

2.2 Direct plant growth promotion:

i) Releasing plant growth promoting substances: Indoleacetic acid, gibberellic acid, cytokines, ethylene and ACC deaminase

ii) Decreasing heavy metal toxicity.

2.2 Indirect plant growth promotion –Biocontrol:

i) Competition for an ecological niche,

ii) Suppression of growth of soil-born phytopathogens by producing allelochemicals

iii) Induction of systemic resistance (ISR)

**UNIT III: The cycles of matter**

13 L

3.1 Soil as growth medium for microorganisms: Physical and chemical considerations, Organic fraction of soil

3.2 Carbon cycle: Cycle, Mineralization- cellulose, Starch (Microbiology and enzymology), Carbon assimilation

3.3 Nitrogen cycle: Cycle, Nitrogen fixation(Symbiotic, Non symbiotic, Nitrogenase), Mineralization of proteins, Ammonification, Nitrification, Denitrification

3.4 Sulfur cycle

3.5 Phosphorus cycle.

**UNIT IV: Bioremediation**

10L

4.1 Soil contamination- Xenobiotics

4.2 Bioremediation: Definition and principles

4.3 Microbial Populations for Bioremediation Processes

4.4 Types of Bioremediation: *In situ* bioremediation, *Ex situ* bioremediation

4.5 Advantages and disadvantages of Bioremediation



**References:**

- 1) Introduction to soil Microbiology, Alexander Martin, John Wiley and Sons. N.Y.
- 2) Soil Micro organisms and plant growth, Subba Rao N.S, Oxford and IBH publishing Co. Pvt. Ltd.
- 3) Microbiology. Pelczar, Chan and Crieg. TATA MCGRAW- HILL
- 4) Text book of applied microbiology. Dr. B.M Sandikar, Himalaya Publishing House
- 5) Microbial biotechnology: fundamentals of applied microbiology. Alexander Glazer, Hiroshi Nikaido. Cambridge university press
- 6) Review on Bioremediation of Polluted Environment: A Management Tool: Kumar.A, Bisht.B.S, Joshi.V.D, Dhewa.T. International journal of environmental sciences. Volume 1, No 6, 2011
- 7) Environmental microbiology. Ralph Mitchell, Ji-Dong Gu. Wiley-Blackwell

**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second year (Semester- IV)  
Microbiology**

**Course Code: U-MIB-460**

Maximum Marks: 50

Lectures: 45

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**PAPER VIII- Medical Microbiology**

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**Course objectives:**

- To gain knowledge about disease process and kinds of diseases
- To study reservoirs of infection and modes of transmission of infections.
- To study diseases caused by bacterial, viral pathogens and parasites

**Course outcomes:**

After studying Medical Microbiology, students will be able to:  
Explain a role of microorganisms in causation of diseases;  
antimicrobial, immunological and diagnostic methodologies used in  
disease treatment and prevention.

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**Unit I: Infection and disease process**

**8L**

1. Types of infections
2. Sources of Infection-Human beings, animals, insects, soil, water and food
3. Methods of transmission of infection-contact, ingestion, inoculation and congenital
4. Epidemiology-epidemic, endemic, pandemic, sporadic.
5. Disease process

**UNIT II: Study of bacterial infections**

**15L**

With respect to etiology, pathogenesis, symptomatology, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy

1. Typhoid
2. *Cholera*.
3. *Bacillary dysentery*

**UNIT III: Study of the diseases caused by following pathogens**

**12L**

1. Pulmonary tuberculosis
2. Pneumonia
3. Malaria
4. Candidiasis



#### **UNIT IV: Study of following diseases**

10 L

With respect to - etiology, pathogenicity, pathogenesis, symptoms, laboratory diagnosis epidemiology, prophylaxis and chemotherapy

1. Chickungunya
2. Dengue
3. Hepatitis A and Hepatitis B viruses
4. Swine influenza.

#### **References:**

1. Basic Immunology by Joshi and Osarano. Agrobotanical publishers Ltd. Bikaner.
- 2) Elementary Microbiology Vol.I and II Dr. A.H Modi. Akta Prakashan. Nadiad.
- 3) Medical Microbiology. N.C.Dey and T.K. Dey. Allied agency, Culcutta.
- 4) Microbiology by Davis, Dulbecco, Eisen Harper and Row Maryland.
- 5) Molecular biology by David Frifelder, Narosa Publishing house, New Delhi.
- 6) Immunology by B.S.Nagoba and D.V.Vedpathak. BI publications, New Delhi.
- 7) Text book of Microbiology by R. Anantharayanan, C.K. Jayaram Panikar, Orient Longman, Mumbai
- 8) Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY 2. Roitt, P.I: Mims, C.J. Medical Microbiology
9. Roitt, P.I: Mims, C.J. Medical Microbiology
10. Kuby Immunology

**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second year (Semester – III)**

Semester Pattern effective from June -2014

**Microbiology**

Maximum Marks: 50

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**Lab Course-MB-03, Course code U-MIB-361**

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**Course objectives:**

To study methods used for bacteriological analysis of water, air, soil, food and milk.

Study of pathogens and serological tests.

**Course outcomes:** A student successfully completing Lab course MB03 and 04 will exhibit ability to:

Perform qualitative and quantitative microbiological analysis for quality of Air, Water, Milk and food; Perform hematological procedures for detection of blood groups; diagnosis of bacterial diseases; Observe and differentiate human blood cells.

**Experiments**

- 1) Microbial sampling of air for fungi by solid impingement techniques
- 2) Bacteriological examination of water for potability - Quantitative analysis: MPN
- 3) Bacteriological examination of water for potability –Qualitative: Presumptive, confirmed, completed test
- 4) Test for fecal coliforms: IMViC tests
- 5) Test for fecal coliforms: Elevated temperature tests
- 6) Bacteriological analysis of milk: Reductase test
- 7) Bacteriological analysis of milk: Milk ring test for brucellosis.

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**Lab Course-MB-04 , Course code U-MIB-362**

Maximum Marks: 50

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- 1) Isolation of normal bacterial flora of human body.
- 2) Study of virulence factors of pathogen
- 3) Determination of isoantigens on human RBC: Blood grouping
- 4) Widal test.
- 5) RPR test.
- 6) Immunodiffusion test.
- 7) Differential blood staining for WBC
- 8) Differential count of leucocytes.

**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**B. Sc. Second year (Semester – IV)**

Semester Pattern effective from June -2014

**Microbiology**

Maximum Marks: 50

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**Lab Course-MB-05, Course code U-MIB-461**

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**Course Objective:** To study activities of microorganisms in soil, milk

**Course outcomes :** A student successfully completing Lab course MB05 and 06 will exhibit

ability to:

Exercise and describe Ecological developments; isolate and exploit the plant growth promoting bacteria for agricultural and industrial purpose; identify parasitism and bacterial pathogens diseases using staining procedures, cultural methods and biochemical tests; perform antibiotic sensitivity test

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- 1) Study of microbial succession in raw milk.
- 2) Study of rhizosphere effect- R: S ratio.
- 3) Isolation of rhizospheric bacteria showing biocontrol potential.
- 4) Isolation of starch degrading bacteria.
- 5) Demonstration of i) Ammonification ii) Nitrification and iii) Denitrification .
- 6) Demonstration of i) Nitrate reduction and ii) Sulfate reduction .
- 7) Isolation and study of *Rhizobium* species from root nodules of leguminous plants.
- 8) Isolation and study of *Azotobacter sp.* from soil .

**Experiments:**

- 1) Acid fast staining.
- 2) Staining of blood for malarial parasite.
- 3) Study of biochemical reactions for identification of pathogen.
- 4) Study of morphological and cultural characteristics of *Salmonella* species.
- 5) Study of biochemical characteristics of *Salmonella* species
- 6) Study of morphological and cultural characteristics of pyogenic *Staphylococcus aureus*.
- 7) Study of biochemical characteristics of pyogenic *Staphylococcus aureus*.
- 8) Antibiotic sensitivity tests for pathogens by disc









**RAJARSHI SHAHU MAHAVIDYALAYA, LATUR**

**Choice Based Credit System**

**B. Sc. Second year (Semester -IV)**

**Course: MICROBIOLOGY**

**Skill Enhancement Course SEC.U-MIB II**

**Maximum marks 50 Credits: 2**

**Production of Bio fertilizers**

**Course Objectives:**

- To create awareness about organic farming
- To inculcate skills for mass production of bio fertilizers
- To promote self-employment
- To ecofriendly and sustainable agro practices

**Unit I Organic farming and importance of bio fertilizers**

**Unit II Free living nitrogen fixing bacteria**

Study of Azotobacter and Azospirillum

**Technique/skill-**Isolation, characterization, Mass production and Quality control

**Unit III Study of legume inoculants-Study of Rhizobium**

**Technique/skill-**Isolation, characterization, Mass production and Quality control

**Unit IV Study of Phosphate solubilizing bacteria**

**Technique/skill-** Isolation of PSB and characterization

Maintenance of microbes

**References:**

- Kannaiyan, S. (2003). Biotechnology of Bio fertilizers, CHIPS, Texas.
- Mahendra K. Rai (2005). Hand book of Microbial bio fertilizers, The Haworth Press, Inc. New York.
- Reddy, S.M. (2002). Bio inoculants for sustainable agriculture and forestry, Scientific Publishers.

## List of the Equipments / Instruments

Sr.no.	Equipments / Instruments	Sr.no.	Equipments / Instruments
1.	Shaker 24x24 (1)	23.	Hot air oven (1)
2.	VDRL shaker (1)	24.	Electrophoresis kit (1)
3.	Autoclave (3)	25.	Magnetic stirrer (1)
4.	Incubator (2)	26.	Vortex mixture (1)
5.	Water bath (1)	27.	UV chamber (1)
6.	Photocolorimeter (2)	28.	Paper chromatography Assembly (1)
7.	Spectrophotometer (1)	29.	Refrigerator kelvinator (1)
8.	Warming table (1)	30.	pH meter (1)
9.	Heating mantle (1)	31.	Bottle washing machine (1)
10.	TLC kit (1)	32.	Soxhalet accelerator (1)
11.	Rough balance (1)	33.	Vacuum pump (1)

12.	Fine balance (1)	35.	Pipette washing machine (1)
13.	One pan balance (1)	36.	ESR assembly (1)
14.	Distillation plant(steel) (1)	37.	Seitz filter assembly (1)
15.	Microscope with oil emulsion objective(14)	38.	Micropipette (5)
16.	Slide projector Automatic (1)	39.	Lab research microscope (microne) (3)
17.	Haemocytometer (9)	40.	Metzes optik monocular microscope model METZ_777 (2)
18.	Haemoglobinometer (9)	41.	Digital photoelectric meter (systronics) make type 112 (1)
19.	Electronics balance (1)	42.	Drier heavy duty Philips (1)
20.	Micrometer slide (2)	43.	Vacuum cleaner.Eureks forbes make trendly model (1)
21.	Hot plate (1)	44.	Electronics balance contech model CA-124 ,0.1 mg to 120 gm (1)
22.	Homogenater (1)	45.	Distillation unit (Bhanu make) (1)
Sr.no.	Equipments / Instruments	Sr.no.	Equipments / Instruments
46.	Godrej Refrigetor 1.Model no.280 litre (30 DY)(1) 2.Model no.230 litre (24AC)(1)	52.	Anaerobic jar (kumar make) (1)
47.	Colony counter digital (1)	53.	Lab Fermenter 5 lit capacity make (DYNA biotech) (1)
48.	Orbital shaking incubator (CIS-24)with voltage stabilizer	54.	Air compressor with motor (Apollo) (1)
49.	Cooling centrifuge (C-24 BL) with voltage stabilizer	52.	Anaerobic jar (kumar make) (1)
50.	Deluxe laboratory centrifuge (R-8C) (1)	53	P.C. based Binocular microscope with image processing system
51.	Laminar air flow microfilt(microfilt make) (1)	54	Ultrasonicator probe (Lancer Make )

