RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

B. Sc. GENERAL (SEMESTER PATTERN)

B. Sc. THIRD YEAR

MICROBIOLOGY – CURRICULUM

UNDER ACADEMIC AUTONOMOUS STATUS 2013 -2018

(MCQ + Theory Pattern)

w. e. f. JUNE, 2016

Rajarshi Shahu Mahavidyalaya, Latur

Dept. of Microbiology

B. Sc. Degree, Course Structure

Under academic autonomy from 2013

Subject: Microbiology

Sr. No.	Semester	Paper No. & Course code	Title of paper	Total periods/week	Total period	Total Marks	Credits
1	I	I,U-MIB-151	Introductory Microbiology	03	45	50	02
		II, U-MIB -152	Methods in Microbiology	03	45	50	02
		Lab Course MB01	Practicals based on theory papers -I&II	06	12 practicals	50	02
2	II	III, U-MIB -251	Basics of Microbiology, Biomolecules & Genomics	03	45	50	02
		IV , U-MIB -252	Microbial Nutrition and Growth	03	45	50	02
		Lab Course MB02	Practicals based on theory papers -III&IV	06	12 practicals	50	02
3	III	V , U-MIB -359	Applied microbiology	03	45	50	02
		VI, U-MIB -360	Fundamentals of Immunology	03	45	50	02
		Lab Course MB03,4	Practicals based on theory papers -V&VI	06	12 practicals	50	02
4	IV	VII, U-MIB -459	Envoronmental Microbiology	03	45	50	02
		U-MIB -460	Medical microbiology	03	45	50	02
		VIII	Practicals based on theory papers – VII &VIII	06	12 practicals	50	02
		Lab Course MB05, MB06		06		50	02

5	V	IX, U-MIB -565 X, U-MIB -566 Lab Course MB07, MB08	Microbial genetics Biocatalyst and Microbial metabolism Practicals based on theory papers IX & X	03 03 06	45 45 12 Practicals	50 50 50 50	02 02 02 02
6	VI	XI XII Lab Course MB09, MB10	Molecular biology Microbial technology Practicals based on theory papers XI & XII	03 03 06	45 45 12 Practicals	50 50 50 50	02 02 02 02

Rajarshi Shahu Mahavidyalaya, Latur

Dept. of Microbiology

B. Sc. THIRD YEAR

MICROBIOLOGY – CURRICULUM

With effect from June-2016

Subject: Microbiology

Sr. No.	Semester	Paper No. Course code	Title of paper	Total periods/week	Total period	Total Marks	Credits
1	V	IX, U-MIB-565 X, U-MIB-566 Lab Course MB-07, MB-08	Microbial genetics Biocatalyst and Microbial metabolism Practicals based on theory papers IX & X	03 03 06	45 45 12 Practicals	50 50 50 50	02 02 02 02
2	VI	XI, U-MIB-665 XII, U-MIB-665 Lab Course MB09, MB10	Molecular biology Microbial technology Practicals based on theory papers XI & XII	03 03 06	45 45 12 Practicals	50 50 50 50	02 02 02 02

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)

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. Microbiology curriculum(Course structure) is given as per, Syllabus for B. Sc III year given as per Annexure-1.

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 are as per Annexur-2.

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.

Annexure-1

RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

B. Sc. Third year (Semester - V)

Semester Pattern

MICROBIOLOGY

Maximum Marks: 50 Periods: 45

PAPER IX – MICROBIAL GENETICS

Course Objectives:

To make the students to understand the mutations and repair mechanisms of damaged DNA.

To make the students aware of recombination and gene exchange processes in bacteria.

Course outcomes :

Completing fifth semester, the Microbiology students will be able to:

i. Describe the basic concepts of bacterial mutations, damage of DNA and its repair mechanisms, the genetic exchange, transposition and recombination processes.
ii. Describe enzymes- the bio catalysts - with reference to its properties, kinetics, inhibition, regulation Understand and elucidate the bacterial metabolic pathways leading to energy yielding processes.

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Unit – I Mutations 10L

1.1 Types of Mutations: Somatic, Germ line, Base substitutions, Frame shift, Supresser, Phenotypic effect of mutations

1.2 Spontaneous mutation: Mispairing of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism

1.3 Evidences for spontaneous mutations: Replica plate techniques, Fluctuation test

1.4 Induced mutations: Physical and Chemical Mutagenic agents

1.5 Ames Test to identify chemical mutagens

Unit – II Repair of DNA damage 10L

2.1 Introduction

2.2 Photo-reactivation

2.3 SOS system

2.4 Nucleotide Excision Repair (NER)

2.5 Base Excision Repair (BER)

2.6 Mismatch Excision Repair (MER)

Unit – III Recombination and transposable elements 11L

3.1Types of recombination process:

i) Homologous Recombination in *E .coli* (Holliday Model) Initiation, Synapsis, Branch Migration and resolution.

ii) Site Specific Recombination (Integrative and Excessive Recombination)

iii) Illegitimate Recombination (Non-Homologus Recombination)

3.2Transposition:

i. Transposable Elements in Prokaryotes

ii. Insertion sequences, Transposons

Unit – IV Gene transfer in bacteria 14L

4.1 Transformation

a. Mechanism of transformation (Competence, Binding, Penetration, Synapsis and Integration)

4.2 Conjugation

i. Discovery of conjugation in bacteria

ii. Mechanism of Conjugation

iii. Formation of *Hfr,* F' and Sexduction

4.3 Transduction

i. Discovery of transduction in bacteria

ii. Generalized and Specialized transduction

iii. Abortive transduction

References:

1. Biochemistry by Jeremy M Berg, John L Tymoczko, and Lubert Stryer International 5th Edition, Publisher: W. H. Freeman & Company
2. Essentials of Molecular Biology by David Freifelder (2002), Publisher: Narosa Publishing House.
3. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003), Publisher: Blackwell Publishing
4. Genetics-A molecular approach second edition, Brown T. A., Chapman & Hall, London
5. General Microbiology (5th edn.) Stanier R. Y., Ingraham, J.L., Wheelis, M. L., Painter, P.R. (2008), Publisher: Macmillan Press Ltd, London
6. General Microbiology (Vol. I and II) Powar, C.B. and Daginawala,H.F.(2008), Publisher: Himalaya publishing house
7. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company.
8. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell (2006)
9. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E. Yasbin. Publisher: Wiley-Liss, Inc.
10. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.

RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

B. Sc. Third year (Semester - V)
Semester Pattern
MICROBIOLOGY

Maximum Marks: 50 Periods: 45

PAPER NO. X –BIOCATALYST and MICROBIAL METABOLISM

Course Objectives:

To understand basic principles of enzymology.

To gain knowledge about microbial metabolism.

Course Outcomes:

Completing fifth semester, the Microbiology students will be able to:
Describe enzymes- the bio catalysts - with reference to its properties, kinetics, inhibition, regulation Understand and elucidate the bacterial metabolic pathways leading to energy yielding processes.

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Unit-I Enzymes, enzyme kinetics and immobilization 12 L

1.1 Definition, General properties, physicochemical nature of enzymes, Types of enzymes : extracellular, intracellular, constitutive, inducible

1.2 Enzyme kinetics -i. Michaelis–Menten equation ii. Applications (Lineweaver-Burk Plot)

1.3 Factors influencing enzyme activity

i. Temperature
ii. pH
iii. Substrate concentration
iv. Enzyme concentration
v. Activators
vi. Redox Potential

1.4 Immobilization of enzymes and cells

1.5 Methods of immobilizing enzymes Covalent linkage, Adsorption, microencapsulation, entrapment

1.6 Advantages of immobilized enzymes and cells and limitations.

Unit-II Enzyme inhibition and Regulation 11 L

2.1 Enzyme inhibition

i. Reversible Inhibition
ii. Competitive Inhibition
iii. Non-Competitive Inhibition

iv.Uncompetitive Inhibition
v. Irreversible Inhibition
vi. Substrate and Product Inhibition,
Allosteric Inhibition

2.2 Regulation of enzyme -Multienzyme System and Regulation
2.3 Isoenzymes
2.4 Coenzymes

Unit-III Microbial Metabolism **12L**

3.1 Definitions i. Metabolism ii. Catabolism iii. Anabolism
3.2 Energy yielding biochemical process
i. Role of ATP in metabolism
ii. Role of reducing power in metabolism
iii. Modes of ATP generation.
3.3 Biochemistry of fueling reaction in heterotrophs
i. EMP (Embden Meyerhof Parnas pathway)
ii. HMP (Hexose Monophosphate Pathway)
iii. ED (Entner Doudoroff Pathway)
iv. PKP (Phosphoketolase Pathway)
v. TCA (Tri Carboxylic Acid cycle)
vi. RETC (Respiratory Electron Transport Chain)
3.4 Hydrocarbon metabolism

Unit-IV Pathways of Microbial Fermentations **10L**

4.1 Alcohol Fermentation
Ethanol fermentation by Yeasts, the Pasteur effect,
Ethanol Fermentation by Bacteria
4.2 Lactate Fermentation i. Homo and Hetero Fermentative Pathways
4.4 Mixed Acid and Butanediol Fermentation
4.5 Butyrate and Butanol- Acetone Fermentation
4.6 Propionate and Succinate fermentations

References:

1. Biochemistry by Jeremy M Berg, John L Tymoczko, and Lubert Stryer International 5th Edition, Publisher: W. H. Freeman & Com

2. Biochemistry by S.C. Rastogi Publisher: Tata McGraw –Hill Publishing Company, New Delhi

3. Outlines of Biochemistry by E.E. CONN and P.K. STMPF Publisher: John Wiley & Sons Inc., New York

4. Bacterial Metabolism by Gerhard Gottschalk , 2nd Springer International Edition, Publisher: Springer Verlag Inc., New York

5. Bacterial Metabolism by H.W. Doelle , 2nd Academic Press International Edition, Publisher: Elsevier ,New Delhi

RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

B. Sc. Third year (Semester – V)

Microbiology

Maximum Marks: 50 Periods: 45

Lab Course-MB 07,U-MIB-567

Course objectives: To study bacterial mutations, recombination , Enzyme kinetics and immobilization .

Course outcomes: A student successfully completing **Lab course MB07 and 08** will exhibit ability to:

Design and perform experiments to study bacterial mutations, genetic exchange, activities, kinetics and immobilization of enzyme which has got academic and industrial importance.

Experiments

(Based on Theory paper: IX)

1. Replica plate Technique.
2. Effect of UV radiations to study the survival pattern of *E. coli* /yeast.
3. Repair mechanisms in *E.coli* / yeast (Dark and Photo reactivation).
4. Isolation of antibiotics resistant Bacterial Mutants by Physical mutagenesis
5. Isolation of antibiotic resistant mutants by chemical mutagenesis.
6. Ampicillin selection method for isolation of auxotrophic mutants.
7. Study of Conjugation in *E. coli*.
8. Isolation of lac mutant of *E col*

B. Sc. Third year (Semester – V)
Microbiology

Maximum Marks: 50 Periods: 45

Lab Course-MB 08, U-MIB-568

Course objectives:

To study Enzymes and enzyme kinetics

To study Enzymes immobilization.

Course outcomes: A student successfully completing **Lab course MB 08** will exhibit ability to:

Design and perform experiments to study different enzyme activities, kinetics and immobilization of enzyme which has got academic and industrial importance

1. Study of enzymes (Lecithinase , Gelatinase , Lipase, Casienase , Catalase , cellulose).
2. Estimation of enzyme activity and determination of Km.
3. Effect of various physicochemical parameters on amylase activity (pH, Temp).
4. Fermentative production of Production of amylase.
5. Immobilization of enzyme by alginate method.
6. Isolation of hydrocarbon degrading microorganisms

RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

B. Sc. Third year (Semester - VI)

MICROBIOLOGY

Maximum Marks: 50 **Lectures: 45**

PAPER NO. XI – MOLECULAR MICROBIOLOGY

Course Objective:

To make the students to understand the molecular biology

To make the students to recognize the modern techniques of genetic engineering.

Course Outcomes:

Microbiology students will be able to describe the gene and its expression; exploit the highly advanced molecular and gene cloning techniques.

Learn different microbial industrial production techniques. Describe the role of microorganisms in production of various secondary metabolites of human benefit by fermentation processes.

UNIT - I Genes and genetic code 10L

1.1 Genes, genome, plasmone

1.2 Genes within a Genome, Genome size and complexity, Recon, muton, cistron

1.3 Eubacterial genome, archeal genome, fungal and yeast genomes, T4 genes and genome

1.4 Characteristics of Genetic code:

(Triplet code, comma free, non-overlapping, degenerate, start and stop signals and wobble hypothesis

UNIT – II Gene Expression 11L

2.1 Structure of RNA Polymerase (RNAP) and the Process of transcription

2.2 Structure of Ribosomes, t-RNA and the Process of Translation

2.3 The transcriptome and proteome

2.4Transcriptional regulation of gene Expression:

i) The *lac* Operon of *E. coli*

ii) The *trp* Operon of *E. coli*

UNIT – III Advanced molecular biology 10L

3.1 PCR: different types, applications (RFLP, RAPD, DNA fingerprinting

3.2 DNA sequencing: Maxam and Gilbert's method, Sanger's method, 3.3 Blotting techniques: Southern blotting, Northern blotting, Western blotting

UNIT - IV Gene cloning 14L

4.1 Introduction, Definition and Purpose of Cloning

4.2 Outline of gene cloning procedure (shot gun method)

4.3 Insertion of target DNA into vector: Cohesive end ligation, blunt end ligation, homopolymer tailing, use of linkers and adaptors

4.4 Gel Electrophoresis

4.5 Methods of gene transfer: $CaCl_2$Transformation, Electroporation, Liposome fusion, Transfection

4.6 Screening Strategies (In brief)

i. Insertional inactivation

ii. Immunochemical methods

iii. Colony hybridization

iv. cDNA cloning of human insulin gene in *E.coli*

4.8 Synthetic microbiology

i. health care: insulin

ii. Agriculture: Bt cotton

iii. Pollution : SOX and NOX gene clonning

References:

1. Principles of Gene Manipulation and Genomics; Third edition; 2003 S.B. Primrose and R.M. Twyman Blackwell Publishing
2. Analysis of Genes and Genomes Richard J. Reece John Wiley & Sons Inc
3. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell (2006)
4. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W. H. Freeman and Company.
5. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.
6. Essentials of Molecular Biology by David Freifelder (2002), Publisher: Narosa Publishing House.
7. Gene biotechnology, Second revised edition, Jogdand S. N., Himalaya Publishing House
8. Molecular Biology and Genetic Engineering by Narayanan, Moni, Selvaraj, Singh, Arumugam (2004) Publisher: Saras Publication,Nagercoil, Kanyakumari.
9. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E. Yasbin. Publisher: Wiley-Liss, Inc.
10. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003), Publisher: Blackwell Publishing.
11. An Introduction to Genetic Engineering: Third Edition, Desmond S. T. Nicholl Cambridge University Press, Cambridge, New York

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B. Sc. Third year (Semester - VI)

MICROBIOLOGY

Maximum Marks: 50 Lectures: 45

PAPER NO. XII – MICRBIAL TECHNOLOGY

Course Objectives

To understand scope of microbial technology and different techniques related to industrial fermentations, QC and GMP.

Course Outcomes:

Completing sixth semester, the Microbiology students will be able to: Learn different microbial industrial production techniques, describe the role of microorganisms in production of various secondary metabolites of human benefit by fermentation processes.

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UNIT I: Definition and Scope of Microbial Technology 09

1.1. Introduction, Definition, Scope and Development of Industrial Microbiology.

1.2. Role of microbiologist in biopharma technology.

1.3. Bioprocess technology

1.4. Fermentors : design and role of different parts.

1.5. Types of Fermentor: laboratory fermentor, pilot plant fermentor, Horton sphere. Tubular, fed batch, fluidised bed reactor, tower fermentor (In brief).

1.6. Types of fermentation: Batch, continuous,SSF,surface, submerged fermentations

1.7 Automation in bioprocess technology.

UNIT II: Methods in Industrial Microbiology 12

2.1 Introduction, Screening Techniques (Primary and secondary), Strain improvement (Basic idea in brief),

2.2. Stock culture and its maintenance (serial subculture, overlaying with mineral oil, lyophilization, liquid nitrogen, soil stock).

2.3. Inoculum development , Fermentation media, (substances used as raw materials for formulation of fermentation media) and its sterilization (batch and continuous).

2.4. Bioassays • Bioassay of - Amino acids, vitamins.

2.5. Bioassay - Antibiotics.

2.6. Quality Control • Quality control tests- purity testing, Microbial Limit Test (MLT). Pyrogen testing (LAL test), Minimum Inhibitory Concentration(MIC)

2.7.FDA and Good Manufacturing Practices

UNIT III: Down stream processing 12

3.1 Introduction, Recovery and purification of fermentation products

3.2 Solids (Insolubles) removal (Filtration, centrifugation, coagulation and flocculation, foam fractionation) ,Cell disruption.

3.3 Recovery of product (liquid extraction, ion exchange adsorption, precipitation), Purification (Chromatography, carbon decolorization , crystallization),

3.4 Product Isolation (Crystalline processing, drying, packing etc).

UNIT IV: Typical Bioprocess production 12

4.1 Beverages (Beer, Wine),

4.2 Organic acid (Citric acid, lactic acid),

4.3 Antibiotics (Penicillin,Cephalosporein)

4.4 Therapeutic proteins-anticancer products.

4.5 Bioinsecticide (Thuricide), Amino acids (Lysine),

4.6 Enzyme (Amylase). Neutraceuticals.

(Production strain, Fermentation media, Fermentation conditions, metabolic pathway involved in synthesis of the product, Product recovery operations, Uses).

REFERENCES:

1. Industrial Microbiology by A.H. Patel.

2. Industrial Microbiology by Prescott & Dunn.

3. Industrial Microbiology by Casida

4. Biotechnology: A text book of Industrial Microbiology by Cruger and Cruger

5. Modern Industrial Microbiology and Biotechnology by Nduka Okafor

6. Industrial Microbiology: An Introduction by Wastes, Morgan, Rockey and Higten

7. Practical Microbiology by Maheshwari and Dubey

Microbiology

Maximum Marks: 50 Periods: 45

Lab Course-MB- 09, U-MIB-667

Course Objective: To study gene expression , advanced molecular biology techniques.

Course outcome: A student successfully completing **Lab course MB09** will exhibit ability to:

Design experiments to exhibit gene expression in bacteria; perform highly advanced molecular technique using gel electrophoresis and PCR

Experiments

1. Studies on gene expression in *E. coli* with reference to Lac operon.
2. Isolation of chromosomal DNA (bacteria/ fungi),qualitative and quantitative analysis.
3. Isolation of plasmid DNA
4. Agarose gel electrophoresis of DNA
5. Restriction digestion and agarose gel electrophoresis of DNA.
6. Isolation of bacterial DNA from Soil/ Water/ Food/ blood**,** PCR amplification and confirmation by gel electrophoresis
7. Amplification of DNA by PCR.
8. Multiplex PCR demonstration
9. RFLP analysis using gel electrophoresis
10. RAPD analysis

B. Sc. Third year (Semester – VI)

Microbiology

Maximum Marks: 50 Periods: 45

Lab Course:MB -10, U-MIB-668

Course Objective: To study primary screening methods , Bioassays and typical fermentation processes

Course outcomes: Students will be able to design protocols for isolation of industrially important microorganisms and fermentative production, extraction, purification estimation of microbial products

1. Primary screening of antibiotic producers, enzyme producers.
2. Primary screening of organic acid producers and diacetyl producer.
3. Bioassay of penicillin and vitamin B_{12}.
4. Fermentative production of wine.
5. Production of citric acid (Surface / submerged) & its estimation by Titrable acidity
6. Fermentative production of wine & and its estimation by titrable acidity.
7. Fermentative production of enzyme amylase.
8. Recovery of product : amylase , citric acid.

Annexure-2

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.	Refrigetor 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)		
51.	Laminar air flow microfilt(microfilt make) (1)		