CENTRE OF RESEARCH FOR DEVELOPMENT
UNIVERSITY OF KASHMIR
SRINAGAR-190006, J & K, INDIA

M. SC. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE TO BE IMPLEMENTED

FROM ACADEMIC SESSION 2017-2018

Prof. Azra N. Kamili

The revised syllabi and courses of study for Post-graduate programme in Microbiology will be based on 96 credits (average of 24 in each semester). All the 96 credits will spread over 5 different components viz. - (i) teaching, (ii) tut

orial, (iii) seminar, (iv) three laboratory courses (one each in the first, second and third semester), and (v) project work /Internship in fourth semester. Each semester will consist of at least 24 credits including 12 core credits (compulsory), 12 discipline centric elective (maximum of 8 credits to be opted) and 2 generic and 2 open elective credits for the students of other department of the university.

Course Structure: There will be 12 core courses (theory and lab.) in all with each semester covering 3 core courses referred to as **MIC-CR**. Each core course will be worth 4 credits with theory covering 8 credits and practical component 4 credits. There will be Discipline Centric Elective (DCE) courses (mainly for Department's own students) worth 4 credits referred to as **MIC-DCE**. Students can opt for 2 courses to earn 8 credits or at least one course each to earn minimum of 4 credits. Further, in addition to **CR** and **DCE** courses there will be Generic Elective courses referred to as **MIC-GE** which will be open to the students of Biological sciences and Open Elective courses referred to as **MIC-OE** that will be open to students from all other faculties (Science, Social Science, Arts, Commerce etc) so that they may seek knowledge from unrelated subject which will nurture student's proficiency and /skill. The total course of M. Sc. Microbiology will comprises of **96 credits out of which 48 are core while other credit combinations would be as under**.

Credits	Core	DCE	GE	OE	Total
Minimum Credits	**12**	**8**	**2**	**2**	**24**
Average Credits	**12**	**8**	**0-2**	**0-2**	**24**
Maximum Credits	**12**	**8**	**0-8**	**0-8**	**36**

Each **CR** course will be worth of 100 marks and 4 credits comprising of **internal assessment of 50 marks** and **external examination of 50 marks**. Internal assessment of theory papers will be based on quiz tests/assignments/seminars, etc. The practical component will also be of internal assessment comprising 20 marks based on student's performance during practical periods and external examination of 80 marks through conduct of common test at the end of each semester to finalize awards for the same. The students will be required to submit their lab work records at the end of each semester examination for evaluation by the examiner/teacher(s) concerned.

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MIC-**DCE** course is a choice based credit course where a student has to acquire 8 credits in total out of 10 DCE credits courses. One paper among **DCE course** will be worth of **4 credits carrying 100 marks** and comprising of **internal assessment of 50 marks** and **external examination of 50 marks**. Two courses will be worth of 2 credits each carrying 50 marks, with **internal assessment of 25 marks** and **external examination of 25 marks**.

Industrial/ Educational Tours: To make on-field observations and impart on-site training in the subject, the students are required to go for tour organized during **2nd semester** (outside state) carrying **2 credits** will form a component of **DCE**. One credit will be given for participation and one credit for tour report and viva voce verified by examiner with **internal assessment of 10 marks** and **external examination of 40 marks**.

Each **GE and OE course** will be worth of **50 marks (2 credits).** Out of these, **25 marks will be for internal assessment and 25 marks** for **external examination** MIC-**DCE, MIC-GE and MIC-OE** will be floated as semester courses wherein the selection will be based on the choice of the teacher concerned in terms of feasibility/availability as well as the number of vacancies available based on the choice of the concerned teacher. However, on the basis of the recommendations of Departmental Committee minimum number of seats under these courses should not be less than 4 for DCE, GE and OE respectively in any such course.

Project work/ Internship: Project work **(MIC-CR)** worth **4 credits** is compulsory for the students and will be assigned in **4th Semester** based on choice of the student and space availability in relation to his/her choice. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and *viva voce* be conducted prior to declaration of the results. The students for project work will be evenly distributed among faculty members of the Department.

In the Table below the terms refer to:

L – Lecture
T – Tutorial
P – Practical Work
CR – Core Course
DCE -Discipline Centric Elective
GE – Generic Elective
OE – Open Elective

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General course outline for Ist year program for two semesters

1st Semester

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	MIC17101CR	Fundamentals of Microbiology	Core	4			4
	MIC17102CR	Bacteriology & Virology	Core	4			4
	MIC17103CR	Laboratory Course	Core			8	4
DCE	MIC17104DCE	Environmental Microbiology	DCE	3	1		4
	MIC17105DCE	Biotechniques	DCE	3	1		4
GE	MIC17106GE	*Invitro* Plant Morphogenesis and Regeneration	GE	1	1		02
	MIC17107GE	Genotoxicity	GE	1	1		02
OE							

2nd Semester

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	MIC17201CR	Cell biology & Enzymology	Core	4			4
	MIC17202CR	Microbial Physiology & Metabolism	Core	4			4
	MIC17203CR	Laboratory Course	Core			8	4
DCE	MIC17204DCE	Microbial Technology	DCE	3	1		4
	MIC17205DCE	Microbial Diversity & Extremophiles-1	DCE	1	1		2
	MIC17206DCE	Microbial Diversity & Extremophiles-2	DCE	1	1		2
	MIC17207DCE	Industrial Tour	DCE			2	2
GE	MIC17206GE	Analytical Instrumentation	GE	1	1		02
	MIC17207GE	Applied Microbiology and Toxicology	GE	1	1		02
OE							

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Course Description 1st Semester

CORE COURSES

MIC-17101CR: FUNDAMENTALS OF MICROBIOLOGY (Credits 04)

Unit I:

1.1. Historical perspective of microbiology
1.2. Relevance and scope of microbiology
1.3. Field of microbiology
1.4. Microbes and human welfare
1.5. Microbes and human disease

Unit II:

2.1. Biosafety and various biosafety levels in a microbiology laboratory
2.2. Bright field microscope: Principles, working and applications
2.3. Electron microscope: Principles, working and applications
2.4. Protozoa: Introduction, structure, cultivation and significance with special reference to *Leishmania*, *Trichomonas*, *Entamoeba* and *Plasmodium*
2.5. Ultra structure of Prokaryotic and Eukaryotic cells

Unit III:

3.1. Sterilization and methods of sterilization
3.2. Staining methods – simple, differential, structural and special stainings
3.3. Culture media: Classification of media (simple, complex and special media with examples)
3.4. Preservation and maintenance of microbial cultures
3.5. Growth: Nutritional requirements, growth kinetics, generation time, growth curve, factors affecting growth

Unit IV:

4.1. Microbial taxonomy (Brief account)
4.2 General account of microbial diversity
4.3. Nomenclature and classification of microorganisms
4.4. Recent trends in exploitation of microbial diversity
4.5. Metagenomic approach

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MIC-17102CR: BACTERIOLOGY AND VIROLOGY **(Credits 04)**

Unit I:

1.1. Historical account of bacterial classification

1.2. Characteristics, classification and economic importance of the following

a) Spirochaetes
b) Gram negative aerobic rods and cocci
c) Gram negative facultative anaerobic rods
d) Endospore-forming Gram positive rods and cocci
e) Actinomycetes
f) Cyanobacteria

1.3. General characters and the importance of

a) Mycoplasma
b) Rickettsiae

1.4. Domain Archea (phylogenetics and morphology)

1.5. Genetics and ecology of archeabacteria

Unit II:

2.1. Morphology and fine structure of bacteria

2.2. Cell wall of bacteria: Gram positive and Gram negative

2.3. Organization of bacterial cell membrane and function

2.4. Intracytoplasmic inclusions

2.5. Cultivation, reproduction and growth of bacteria

Unit III:

3.1. Discovery of viruses (brief account), composition, morphology and architecture of viruses

3.2. Principles of symmetry with reference to T4, TMV, Adeno, Polio, Influenza, Rhabdo, Reo and HIV viruses. Nucleic acid diversity in viruses

3.3. Sub viral particles: Satellite viruses, viriods, DI particles and prions

3.4. Taxonomy of viruses: classification and nomenclature as per ICTV

3.5. Isolation, purification, cultivation and characterization of plant, animal and bacterial viruses

Unit IV:

4.1. Lifecycles of bacterial viruses: one step growth curve, lytic and lysogenic cycles with reference to T4, Phi X 174 phages. Importance of phages

4.2. Classification and nomenclature of plant viruses, replication of TMV and CaMV

4.3. Classification and replication of animal viruses (Adeno, Influenza, Herpes, Hepatitis and Retro viruses)

4.4. Transmission and management of plant and animal viral diseases (interferons, antiviral drugs and vaccines)

4.5. DNA and RNA oncogenic viruses(Titer value)

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MIC-17103CR: LABORATORY COURSE **(Credits 04)**

Course Contents

1. Preparation of buffers and pH measurements
2. Understandings of biochemical calculations
3. To study sterilization techniques
4. To study types of culture media and their preparations, colony characters of bacteria
5. Isolation of bacteria from water
6. To perform sub culturing, pure culturing, Streak techniques
7. To study the growth curve of bacteria with reference to *E. coli*
8. To Enumerate the CFU of bacteria (any) by serial dilution method
9. Staining techniques – simple, gram, acid-fast. Endospore staining
10. Confirmed test of Coliform bacteria
11. To perform the motility test of bacteria
12. To perform antibiotic sensitivity and resistance assay
13. Screening of amylase, protease producers
14. Screening of lipase producers

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DISCIPLINE CENTRIC ELECTIVE COURSE

MIC-17104DCE: ENVIRONMENTAL MICROBIOLOGY (Credits 04)

Unit I:

1.1. Role of microbiology in conservation and management of natural Resources
1.2. Role of microbes in soil development, soil fertility and terrestrial carbon cycles
1.3. Decomposition and dynamics of organic matter
1.4. Bioremediation of polluted soils/sites employing genetically engineered microorgansims
1.5. Bioleaching and Biomining (*ex situ* and *in situ* leaching).

Unit II:

2.1. Biomonitoring – Bioindicators, Biosensors and Genosensors
2.2. Trophic status of aquatic ecosystem
2.3. Waste water treatment through aerobic micro-organisms – Biological filters, aeration tanks, Biological ponds, Irrigation fields (bio-films)
2.4. Waste water treatment through microbial mediations
2.5. Conversion of waste to wealth.

Unit III:

3.1. Brief account of microbial interactions
3.2. Biogeochemical cycles and the organisms
3.3. Microbiology of degradation of xenobiotics in the environment
3.4. Biomagnification and degradative plasmids, hydrocarbons and substituted hydrocarbons
3.5. Biodeterioration, biotransformation & recovery of metals & metalloids

Unit IV:

4.1. Microbiology of Air: Air spora of indoor and outdoor environment, factors affecting air spora
4.2. Atmospheric layers, microbes as source, sink and transforming agents of atmospheric pollutants. Mapping of the hot spots
4.3. Geomicrobiology: An introduction
4.4. Role of microbes in metallurgy and petroleum product formation
4.5. Space microbiology: Historical development of space microbiology

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MIC- 17105 DCE: BIOTECHNIQUES **(Credits 4)**

Unit I:

1.1 Viscosity: Specific, intrinsic and reduced viscosities, viscometers, determination of molecular size and shape through viscosity

1.2 Centrifugation techniques: Basic principles of centrifugation, standard sedimentation coefficient and measurement of sedimentation co-efficient

1.3 Ultra centrifugation: analytical and preparative centrifugation,(determination of molecular weights)

1.4 Differential, rate zonal and equilibrium density gradient centrifugation

1.5 Crystallography

Unit II:

2.1. Chromatography: General principles. Types- partition, adsorption; paper, thin layer, column chromatography

2.2. Ion exchange chromatography and affinity chromatography

2.3. Gel filtration chromatography

2.4. Gas –liquid chromatography

2.5. GC-MS, HPLC

Unit III:

3.1. Electrophoresis: General principles, types - moving boundary electrophoresis, paper electrophoresis, cellulose acetate, starch gel electrophoresis

3.2. Polyacrylamide electrophoresis and agarose gel electrophoresis, SDS- PAGE

3.3. Two dimensional electrophoresis, immune electrophoresis & MALDI-TOF

3.4. Isoelectric focussing electrophoresis, capillary electrophoresis, pulse-field electrophoresis

3.5. Blotting techniques -Southern, northern and western blotting

Unit IV:

4.1. Radio isotopic techniques: Principle and applications of tracer techniques in microbiology

4.2. Radioactive isotopes, radioactive decay; Detection and measurement of radioactivity

4.3. Spectroscopic techniques- Principle and working of simple theory of absorption of light by molecule

4.4. UV- visible spectrophotometer-principle and working

4.5. Fluorescence spectroscopic, NMR and X ray crystallography

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GENERIC ELECTIVE COURSE

MIC-17106GE: *In-vitro* Plant Morphogenesis and Regeneration (02 credits)

Unit I:

1.1. Morphogenesis and cellular totipotency
1.2. Callus Cultures: Establishment of callus, callus growth and subculture
1.3. Cytodifferentiation: Dedifferentiation and redifferentiation
1.4. Organogenesis: caulogenesis, rhizogenesis
1.5. Factors affecting cellular differentiation and organogenesis

Unit II:

2.1. Somatic embryogenesis: initiation, basic requirements, embryo maturation and plantlet development
2.2. Micropropagation: Definition, stages and techniques of micropropagation
2.3. Problems encountered in micropropagation
2.4. Applications of micropropagation.
2.5. Synthetic seeds

MIC-17107GE : Genotoxicity (02 Credits)

Unit I:

1.1. Necrosis, apoptosis and inflammation
1.2. Somatic and genetic risk of environmental pollutants.
1.3. Cancer latency, threshold and non-threshold model of cancer
1.4. Mechanism of chemical carcinogens (free radicals and alkylating agents)
1.5. Classification of carcinogens (physical, chemical and biological agent)

Unit II:

2.1. Ames test and micronucleus test
2.2. Chromatid and chromosome aberration
2.3. Screening, tier testing and test batteries for mutagenicity testing
2.4. FISH technique
2.5. Use of Comet assay in environmental toxicology

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Course Description 2nd Semester

CORE COURSES

MIC-17201CR: CELL BIOLOGY AND ENZYMOLOGY (Credits 04)

Unit I:

1.1. Ultrastructure and Organization of Unicellular Eukaryotic cells
1.2. Nucleus, mitochondria and chloroplasts and their genetic organization
1.3. Endoplasmic reticulum, Golgi apparatus, Protein trafficking
1.4. Flagella and mechanism of flagellar movements
1.5. Cell Structural organization cytoskeleton (microtubules and microfilaments)

Unit II:

2.1. Membrane structure and dynamics-diversity, structure and physiology of membrane pumps, carriers and channels
2.2. Basic elements of signaling system: extracellular signal molecules, receptors-ion linked, G-protein linked and enzyme linked receptors; calcium and nitric oxide as intracellular messengers
2.3. Cell cycle – over view, phases of the cell cycle, cell growth and extra cellular signals
2.4. Regulations of cell cycle progression (cyclins and cyclin dependent kinases), Cell cycle-check points
2.5. Cell differentiation, apoptosis path-ways and molecular mechanism of apoptosis

Unit III:

3.1. Introduction to enzymology: Properties and classification of enzymes
3.2. IUB nomenclature and classification, concept of ribozymes and abzymes
3.3. Mechanism of enzyme action, specificity of enzyme action, theories of mechanism of enzyme action
3.4. Constitutive, inducible and marker enzymes
3.5. Enzyme activators, co-enzyme, prosthetic group and co-factors in enzymatic catalysis, concept of enzyme and substrate specificity

Unit IV:

4.1. Enzyme kinetics, Michaelis-Menton equation and its derivatives
4.2. Determination of V_{max}, K_m, K_{cat} and their significance, Briggs and Haldane concept, Lineweaver-Burk plots, Eadie-Hofstee and Hanes plots
4.3. Enzyme inhibition - competitive, uncompetitive, non-competitive, and irreversible
4.4. Isozymes and their metabolic significance, allosteric enzymes and co-operativity
4.5. Large scale enzyme extraction, enzyme purification, recovery and yield of enzymes

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MIC-17202CR: MICROBIAL PHYSIOLOGY AND METABOLISM (Credits 04)

Unit I:

1.1. Nutritional diversity in microorganisms

1.2. Essentiality of major and minor elements and mechanism of nutrient transport in microorganisms

1.3. Chemotrophism and its mechanism

1.4. Chemoheterotrophic: Acetogens, methanogens, methanogenenesis and its importance

1.5. Physiology and economic importance of methylotrophs

Unit II:

2.1. Phototrophism: Oxygenic and anoxygenic phototrophs and their diversity

2.2. Photosynthetic pigments and their light absorption, basic photochemistry of PSI, PSII and light driven electron transport

2.3. Modes of CO_2 fixation (Calvin cycle, reverse TCA cycle, HP pathway)

2.4. Carbohydrate metabolism – various pathways underlying the utilization of different sugars (EMP, ED, HMP) in microorganisms

2.5. Gluconeogenesis and its significance

Unit III:

3.1. Aerobic respiration, Glyoxalate cycle and Mechanism of substrate – level phosphorylation and oxidative phosphorylation

3.2. Anaerobic respirations: sulphate, nitrate, carbonate respirations and their ecological significance

3.3. Fermentations: Types of fermentations and their industrial importance

3.4. Concepts of primary and secondary metabolism with specific reference to penicillin and polyketides as secondary metabolites

3.5. Oxidation- reduction reactions, measurement of redox potentials, Electron transport, oxidative phosphorylation, structure of ATP synthase; mechanism of ATP synthesis. Inhibitors and uncouplers

Unit IV:

4.1. Lipid metabolism – Biosynthesis of glycerides, phospholipids and glycolipids

4.2. Oxidation of saturated and unsaturated fatty acids

4.3. Amino acid metabolism

4.4. Biosynthetic pathways of amino acids and their regulation with emphasis on tryptophan and histidine

4.5. Nucleotide metabolism – Biosynthesis of purine and pyrimidine nucleotides and their degradation

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MIC-17203CR: LABORATORY COURSE **(Credits 4)**

Course Contents

1. Cell cycle: Cell division of fungi and bacteria(with help f slides /modals/charts)
2. Differential isolation of chloroplast and mitochondria by differential centrifugation method
3. Estimation of carbohydrates
4. Estimation of lipids
5. Estimation of DNA
6. Estimation of RNA
7. Estimation of protein by Lowry"s, and Bradford method
8. Study of pH stress tolerance by microbes
9. Study of enzyme kinetics, K_m and V_{max} of amylase
10. Effect of optimum pH, temperature on amylase activity.
11. Identification of protozoa cultures
12. Cultivation and Enumeration of Bacteriophages
13. Electron photo micrographic study of viruses
14. To perform biochemical tests (Catalase, Urease test, Peroxidase and IMViC)

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MIC-17204 DCE: MICROBIAL TECHNOLOGY (Credits 04)

Unit I:

1.1. Bioreactor design, types and operation

1.2. Operational modes of bioreactors: Batch, fed-batch and continuous processes, kinetics-heat transfer, applications, advantages and limitations of each type

1.3. Immobilized cell reactors and air-lift reactors – characteristics

1.4. Aeration - Theory of oxygen transfer in bubble aeration, oxygen transfer kinetics, determination of KLa.

1.5. Agitation - Functions of agitation. Flow patterns with different types of impellers

Unit II:

2.1. Monitoring of process variables: Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and Dissolved CO_2

2.2. Biosensors ;principles of operation and its types.

2.3. Growth and product formation during fermentation: Concept of primary and secondary metabolites & their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency etc.)

2.4. Fermentation broth rheology and power requirements for agitation

2.5. Effect of microbial growth on fermentation

Unit III:

3.1. Fermentation and downstream processing for the following:

a) Antibiotics (rifamycin)
b) Microbial enzyme (amylase, lipase, chitinase, glucoxidase)

3.2. Use of fungi in industry including food industry

3.3. Use of fungi as biosensors and fuel cells

3.4. Use of fungi in agriculture and environmental application

3.5. Biofertilizers, bioremediation and biological control

Unit IV:

4.1. Principles of validation process / method validation: The concept of iso-certification

4.2. Preparation of sops, exercises on preparation of sops

4.3. Validation protocols for methods in quality control

4.4. Bio- patent - concept

4.5. Operation and validation for analytical methods

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MIC-17205 DCE: MICROBIAL DIVERSITY: EXTREMOPHILES -1 (Credits 2)

Unit I:

1.1. Thermophiles: Classification and ecological aspects
1.2. Physical chemistry of thermozymes
1.3. Commercial aspects of thermophiles and thermoenzymes
1.4. Genetics of thermophiles
1.5. Methanogens: Classification, habitats and applications

Unit II:

2.1. Psychrophiles: Distribution and habitat
2.2. Microbial diversity at cold ecosystem: Snow and glaciers ice, sub-glacial environments and permafrost
2.3. Anaerobic bacteria, microalgae and cyanobacteria in cold ecosystem and piezopsychrophiles
2.4. Molecular adaptations to cold habitats: Membrane components, cold sensing, cold adapted enzymes, cryoprotectants and ice binding proteins
2.5. Role of exopolymers in microbial adaptations to sea ice

MIC-17206 DCE: MICROBIAL DIVERSITY: EXTREMOPHILES -2 (Credits 2)

Unit I:

1.1. Classification and distribution: Acidophiles and alkaliphiles
1.2. Isolation and taxonomy: Acidophiles and alkaliphiles
1.3. Cell structures: Flagella, cell wall and cell membrane
1.4. Physiology: Growth conditions, physical adaptations and alkaliphily
1.5. Applications of alkaliphilic and acidophilic enzymes

Unit II:

2.1. Halophiles: Classification, halophilicity and osmotic protection
2.2. Hypersaline environments: Eukaryotic and prokaryotic halophiles
2.3. Halobacteria cell wall, membranes, compatible solutes, osmo-adaptations or halotolerance
2.4. Barophiles: Classification, high pressure habitat, life under pressure, barophily, death under pressure
2.5. Applications of barophilic and halophilic enzymes

MIC-17207DCE INDUSTRIAL TOUR **(2 credits)**

During 2nd semester, students are required to go for institutional visit to various academic and research institutions outside Jammu & Kashmir carrying 02 credits and will form a component of DCE. One credit will be given for participation and one credit for Tour report and viva voce.

GENERIC ELECTIVE COURSE

MIC-17206GE: ANALYTICAL INSTRUMENTATION **(02 credits)**

Unit I:

1.1. Principle and applications of microscopy
1.2. Fluorescent, confocal and electron microscopy
1.3. Principle of centrifugation and its applications
1.4. Ultracentrifugation and its applications
1.5. Chromotography-gel chromatography, GLC, HPLC

Unit II:

2.1. Visible and UV spectroscopy
2.2. Spectro-flourimetry
2.3. Electrophoresis-PAGE, SDS-PAGE
2.4. PCR & agarose gel electrophoresis
2.5. BLOT techniques

MIC-17207GE: APPLIED MICROBIOLOGY AND TOXICOLOGY **(02 credits)**

Unit I:

1.1. Introduction to Microbiology
1.2. Microorganisms good or evils
1.3. Role of microorganisms in wastewater treatment and solid waste management
1.4. Microorganisms and human health
1.5. Role of microorganisms in metallurgy

Unit II:

2.1. Principles of Toxicology
2.2. Ecological concept of xenobiotic and recalcitrant toxicants
2.3. Factors affecting the toxic response, chemical interactions of toxicants
2.4. Concept of LD_{50}, LC_{50}
2.5. Toxicants as health hazards

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