AC/I(21-22).2(II).RUS9

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for U.G.

Program: BSc (Microbiology)

Program Code: RUSMIC

(Choice Based Semester and grading System for academic year 2022–2023)

GRADUATE ATTRIBUTES

GA	GA Description **A student completing Bachelor's Degree in Science program will be able to:**
GA 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
GA 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
GA 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
GA 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
GA 5	Take complex challenges; work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
GA 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
GA 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
GA 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner

PROGRAM OUTCOMES

PO	Description **A student completing Bachelor's Degree in Science program in the subject of Microbiology will be able to:**
PO 1	Recall, explain and summarize basic concepts related to cytology, biochemistry, physiology, genetics and reproduction of prokaryotes and compare it with eukaryotes.
PO 2	Appreciate and exemplify the diversity in the microbial world and evaluate their ecological role as well as state their significance to humankind.
PO 3	Understand the basic concepts associated with growth and control of microorganisms and apply it in pure culture and preservation techniques.
PO 4	Differentiate, classify and characterize microorganisms based on their morphological, cultural, biochemical, and molecular properties.
PO 5	Explore, compare and evaluate the role of microorganisms in different natural environments as well as plants, animals and humans, and evaluate and exemplify their interrelationships.
PO 6	Apply the understanding of microbial processes to diverse science areas such as medical, industrial, agricultural and food and evaluate their potential for human well-being, for tackling environmental issues and exploring sustainable solutions
PO 7	Recall and explain the nature of biomolecules and metabolic processes; the role and kinetics of enzymes as well as the thermodynamic laws that drive these reactions.
PO 8	Recall the basic working principles of various bioanalytical techniques and tools and apply them to detect, estimate and structurally evaluate biomolecules present in the microbial cells.
PO 9	Understand and explain the nature of genetic material and elaborate the molecular mechanisms underlying various genetic processes like replication, transcription, translation, gene transfer and recombination in bacteria; and explain basic concepts in virology.

PO 10	Apply the basics of genetics and molecular biology to understand and evaluate techniques in genetic engineering and also for the use of bioinformatic tools for presentation and processing of data.
PO 11	Recognize and explain the role of microorganisms in different diseases, attribute pathogenesis mechanisms to their properties and extrapolate it to disease diagnosis, treatment and prevention. Outline and recall concepts in epidemiology of diseases. Classify and evaluate different chemotherapeutic agents.
PO 12	Recall, classify and summarize mechanisms of defense in humans, detail out the functioning of our immune system, correlate it to disease and its prevention and outline its association to health. Apply immunological principles for diagnosis of diseases.
PO 13	Understand and outline different biochemical mechanisms and their regulation; retrieve and construct biochemical pathways in microbial metabolism of major macromolecules and, recall and integrate the bioenergetics of metabolic reactions.
PO 14	Evaluate, exemplify and outline the role of microorganisms in different industrial fermentations, summarize technological aspects of bioprocesses, recall knowledge about patents, copyright and regulatory practices and QA.
PO 15	Demonstrate key practical skills/competencies in working with microbes for their study and use in the laboratory as well as outside, including the use of good microbiological practices. Analyze problems involving microbes, articulate them and devise innovative and creative solutions.
PO 16	Hypothesize, design experiments, construct experimental plans, execute them and analyze data with a basic understanding of statistics. Demonstrate an ability to be unbiased and critical in interpretation of scientific data
PO 17	Communicate effectively to express scientific ideas and/or their experimental data in an effective, precise and concise manner.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
FY	I	RUSMIC 101 Core course	Fundamentals of Microbiology	02
		RUSMIC 102 Core course	Techniques in Microbiology	02
		RUSMICP101 Core course	Practical based on above two courses	02
	II	RUSMIC 201 Core course	Microbial world: types and inter-relations	02
		RUSMIC 202 Core course	Microbial biomolecules, Growth & Control	02
		RUSMICP201 Core course	Practical based on above two courses	02
SY	III	RUSMIC 301	Microbial taxonomy and Introduction to Genetics and Molecular Biology	02
		RUSMIC 302	Introduction to Experimental Microbial Biochemistry	02
		RUSMIC 303	Environmental Microbiology	02
		RUSMICP301	Practicals based on above three courses	03
	IV	RUSMIC 401	Microbe interactions and host responses	02
		RUSMIC 402	Introduction to Metabolic Pathways and Enzymology	02
		RUSMIC 403	Applied Microbiology	02

		RUSMICP401	Practicals based on above three courses	03
TY	V	RUSMIC 501	Microbial Genetics	2.5
		RUSMIC 502	Medical Microbiology	2.5
		RUSMICP501	Practical Based on Above Two Courses	3
		RUSMIC 503	Microbial Biochemistry: Part-I	2.5
		RUSMIC 504	Bioprocess Technology	2.5
		RUSMICP502	Practical Based on Above Two Courses	3
	VI	RUSMIC 601	Genetics, Bioinformatics & Virology	2.5
		RUSMIC 602	Immunology	2.5
		RUSMICP601	Practical Based on Above Two Courses	3
		RUSMIC 603	Microbial Biochemistry Part II	2.5
		RUSMIC 604	Industrial Microbiology	2.5
		RUSMICP602	Practical Based on Above Two Courses	3

Course Code: RUSMIC 101 Core Course

Course Title: Fundamentals of Microbiology

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand and explain the process of formation of earth and evolution of microorganisms on earth.
CO 2	Summarize the key events in the history of Microbiology
CO 3	Recognize the scope and relevance of Microbiology
CO 4	Recall and explain the nature, correlate function of components that make up a prokaryotic cell and identify them microscopically
CO 5	Compare and contrast between structural features of prokaryotic and eukaryotic cell
CO 6	Explain the types and role of normal flora on human body and infer its significance
CO7	Organizing the events of development of infection in human system and summarize the factors affecting host immune system

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUSMIC 101		**FUNDAMENTALS OF MICROBIOLOGY**	**2/45**
I		**Evolution of Microbes, History and Future of Microbiology**	**15**
	1.1	**The Evolution of Microorganisms**	**05**
		a) Formation and Early History of Earth b) Origin of Cellular life. c) RNA world hypothesis and protein synthesis d) Microbial Diversification e) Endosymbiotic origin of prokaryotes f) Microbial Evolution - Process	
	1.2	**History, Branches and Scope of Microbiology**	**08**
		a) Discovery of microorganisms b) Conflict over spontaneous generation c) Golden Age of Microbiology-Koch Postulate, Medical Microbiology, Immunology d) Development of industrial microbiology and microbial ecology e) Scope and relevance of microbiology	
	1.3	**Future of Microbiology and unification with other sciences**	**02**
		a) Molecular and genomic methods to study microorganisms b) Emerging diseases c) Search for extra-terrestrial life d) Bio-based economies	
II		**Prokaryotic and Eukaryotic Cell Structure**	**15**
	2.1	**Prokaryotic Cell Structure and functions**	**10**
		a) Overview of prokaryotic cell structure b) Cell wall c) Cell membrane d) Components external to cell wall-Capsule, Slime layer, Flagella, Pili, Fimbriae	

		e) Cytoplasmic matrix-Inclusion bodies, magnetosomes, ribosomes, gas vesicles f) Nucleoid, Plasmids g) Bacterial endospores and their formation	
	2.2	**Eukaryotic Cell Structure**	**05**
		a) Overview of Eukaryotic cell structure b) Cytoplasmic matrix, microfilaments, intermediate filaments, and microtubules, Cilia and Flagella c) Organelles of the Biosynthetic-secretory and endocytic pathways –Endoplasmic reticulum & Golgi apparatus. Lysosome, Autophagy, Proteasome d) Eukaryotic ribosomes e) Mitochondria f) Chloroplasts g) Nucleus –Nuclear Structure h) Comparison of Prokaryotic and Eukaryotic Cells i) Mitosis & meiosis	
III		**Microbe- Human interactions**	
	3.1	**Normal flora of the human body**	**04**
		a) Skin, Nose & Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear b) Mouth, Stomach, Small intestine, Large intestine c) Genitourinary tract d) Gnotobiotic animals e) Introduction to the concept of microbiome	
	3.2	**Development of infection** a) Portal of entry and infectious dose b) Attaching to host c) Surviving defenses d) Virulence factors e) Process of infection f) Portal of exit g) Patterns of an infection- localized, systemic, focal, mixed, primary, secondary, acute and chronic infections h) Signs and symptoms of disease	**07**

	3.3	Host defense against infection: Overview	04
		a) Factors affecting host defense: Species resistance, racial resistance and Individual resistance b) Introduction to innate and adaptive defences, Barriers at portal of entry: Physical barriers, Chemical defenses, genetic resistance.	

References:

a) Willey, Sherwood and Woolverton, Prescott's Microbiology, 9th edition, 2013, International edition, McGraw Hill.
b) Michael T. Madigan & J.M. Martin, Brock's Biology of Microorganisms 13th Ed. International edition 2012, Pearson Prentice Hall.
c) https://www.hort.purdue.edu/newcrop/ncnu02/v5-011.html
d) https://www.weforum.org/agenda/2018/04/can-a-nature-based-economy-help-us-drive-green-growth
a) Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology 5th Edition, 1986, Tata McGraw Hill Publishing Company Tortora, Funke and Case, Microbiology: An Introduction, 10th Edition, 2010, Pearson.
b) Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology International edition 2002, McGraw Hill.
c) Jacquelyn Black, Laura Black, Microbiology, Principles and Explorations, 9th Ed, 2015, Wiley

Course Code: RUSMIC 102 Core Course
Course Title: Techniques in Microbiology

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand and explain the principle, construction & functionality differences of various microscopes.
CO 2	Classify the microorganisms based on their growth requirements & explain the methods of cultivation of different microorganisms.
CO 3	Summarize the method & principle of the techniques used for visualization of microorganisms.
CO 4	Infer the significance of different preservation techniques & emphasize the role of Culture collection centres.
CO 5	Understand the design, working principle and applications of commonly used instruments in a microbiology laboratory
CO6	Comprehend biosafety levels and principle of containment
CO 7	Carry out basic staining and culturing techniques and test microbial activities using aseptic techniques

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUSMIC 102		**Techniques in Microbiology**	**2/45**
I		**Cultivating & Visualizing Bacteria**	**15**
	1.1	**Microscopy**	10
		a) History of microscopy, Optical spectrum, Lenses and mirrors with ray diagrams b) Simple and compound light microscope c) Dark field Microscopy d) Phase contrast Microscopy e) Electron Microscopy f) Confocal Microscopy g) Fluorescence Microscopy	
	1.2	a) Morphological characteristics b) Staining procedures i. Dyes and stains: Types, Physicochemical basis, Fixatives, Mordants, Decolorizers ii. Simple and differential staining iii. Special Staining	**05**
II		**Nutrition and Cultivation of Microorganisms:**	**9**
	2.1	a) Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors. b) Nutritional classification based on source of energy, electron and carbon c) Modes of nutrition: Endocytosis, Phagocytosis, movement of solutes across membranes d) Media Design and composition e) Types of Culture media with examples f) VBNC & oligotrophs g) Anaerobic cultivation	
	2.2	**Pure Culture Techniques**	**4**
		a) Streak plate method b) Pour plate method c) Colony characteristics	

	2.3	**Preservation of microorganisms**	**02**
		a) Methods for maintenance and Preservation of Bacteria b) Culture Collection Centers	
III		**Basic Instrumentation & Biosafety**	**15**
	3.1	**Instrumentation - Construction, Working principle, application:**	**08**
		a) Overview of lab facility design and workflow b) Equipment for sterilization i) Autoclave ii) Hot air oven c) Equipment for cultivation i) Incubator ii) Water bath iii) Shaker iv) Anaerobic jars and work station d) Micropipettes e) Colorimeter f) Electrochemical sensors: pH meter	
	3.2	**Biosafety in Microbiology**	**07**
		a) Precautions to be taken while working in a Microbiology lab b) Biosafety- general principles and terminology with equipment c) Biological containment and laboratory safety levels d) Safe disposal of biohazardous waste e) Biowarfare & Bioterrorism	

References:

a) A.J.Salle, Fundamental Principles of Bacteriology, 1984, McGraw Hill publications

b) Michael J.Pelczar Jr., E.C.S. Chan ,Noel R , Microbiology TMH 5th Edition

c) Stanier, Ingraham et al, General Microbiology, 5th Ed.1987, Macmillan Education.

d) Tortora, Funke and Case, Microbiology: An Introduction, 6th Edition.1998, Pearson.

e) Michael T. Madigan & J.M. Martin, Brock's Biology of Microorganisms 13th Ed. International edition 2012, Pearson Prentice Hall.

f) Willey, Sherwood and Woolverton, Prescott's Microbiology, 7th edition, 2011, International edition, McGraw Hill.

Course code	Practical	2 Credits
RUSMIC P101	**PRACTICAL-1**	
Unit-I	1. Demonstration of Pasteur's experiment to refute Spontaneous Generation theory. 2. Demonstration of microbes in air, cough, on table surface, finger tips, fomites etc.	
Unit-II	1. Study of prokaryotic subcellular structures by special staining: Cell wall, capsule, endospore, flagella, lipid, metachromatic granules. 2. Study of Motility (Hanging Drop Preparation) 3. Wet mount of Hay infusion	
Unit-III	1. Normal flora of the skin, oral cavity and intestine. 2. Role of fomites 3. Cough plate technique	
RUSMIC P102	**PRACTICAL-2**	
Unit-I	1. Parts of a microscope 2. Micrometry 3. Dark field and Phase Contrast Microscopy: (Demonstration) 4. Monochrome staining 5. Gram staining 6. Negative Staining	
Unit-II	1. Nutritional requirements- Designing media using food material 2. Preparation of standard laboratory Culture Media: a. Liquid medium (Nutrient Broth) b. Solid Media (Nutrient agar, Sabouraud's agar) c. Preparation of slant, butts& plates 3. Inoculation techniques and Study of Growth: a. Inoculation of Liquid Medium b. Inoculation of Solid Media (Slants, Butts and Plates) 4. Pure culture techniques- Streak plate method 5. Study of Colony Characteristics of bacteria.	

	6. Use of Differential & Selective Media: (MacConkey& Salt Mannitol Agar), Enriched (Blood Agar) 7. Cultivation in defined and crude media-Demonstration 8. Effect of environment on growth a. Temperature b. pH c. Osmotic pressure 9. Methods of Preservation of culture- Soil stock, oil overlay and preparation of glycerol stocks	
Unit-III	1. Working principle, architecture and applications of: a) Autoclave b) Hot air oven c) Incubator d) Anaerobic jars and work station e) Water bath f) Shaker g) Colorimeter h) Electrochemical sensors: pH meter 2. Working in a laminar air flow	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project/ Presentation	20
2	One class Test (multiple choice questions / objective)	20
	TOTAL	**40**

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be three questions each of 20 marks one on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1) A)	Any 3 out of 5	15	Unit I
Q.1) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
Q.2) A)	Any 3 out of 5	15	Unit II
Q.2) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
Q.3) A)	Any 3 out of 5	15	Unit III
Q.3) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II
Journal	05	05
Experimental tasks	15	15
Total	**20**	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Paper I	Paper II
Laboratory work	25	25
Spots/Quiz/Viva	05	05
Total	**30**	**30**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination & Marks Distribution Pattern

Semester I

Course	101			102			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**100**

Course Code: RUSMIC 201 Core Course

Course Title: Microbial World: Types and inter-relations

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the structure, cultivation and significance of viruses
CO 2	Explain and compare the features of Rickettsia, Chlamydia and Myxobacteria
CO 3	Summarize the characteristics and infer significance of Actinomycetes and Archaebacteria
CO 4	Categorize microorganisms like Protozoa, Algae and Fungi into different groups based on their characteristics
CO 5	Infer the medical and industrial significance of Protozoa, Algae and Fungi
CO 6	Recall & explain the role of microorganisms in biogeochemical cycles & in maintaining balance of the ecosystem
CO 7	Illustrate the different types of microbial interactions & explain the significance of extremophiles.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUSMIC 201		**MICROBIAL WORLD: TYPES AND INTER-RELATIONS**	**2/45**
I		**Microbial diversity-I**	**15**
	1.1	**Viruses**	**06**
		a) Historical highlights, General properties of viruses, prions, viroids b) Structure of viruses-capsids, envelopes, genomes–TMV, Influenza, and T4 as representatives c) Cultivation of viruses- overview	
	1.2	**Domain Bacteria-** General characteristics and list of genera of every group with emphasis on mentioned genera a) Proteobacteria- Rickettsia, Caulobacter, Spirillum, Pseudomonas, Escherichia, Vibrio, Bdellovibrio, Myxobacteria b) Non-proteobacteria Cyanobacteria, Chlamydia, Firmicutes- Clostridium, Mycoplasma, c) High G+C content bacteria- Mycobacteria, Actinobacteria	**09**
II		**Microbial diversity-II**	**15**
	2.1	**Archaea**	**03**
		a) Introduction- Major Archaeal physiological groups, b) Archaeal cell wall, lipids and membranes c) Ecological importance	

	2.2	**Protozoa**	**03**
		a) General characteristics b) Major categories of Protozoa based on motility, reproduction c) Medically important Protozoa	
	2.3	**Algae**	**04**
		a) Characteristics of algae: morphology, Pigments, reproduction b) Cultivation of algae c) Major groups of Algae –an overview d) Biological, Medical and economic importance e) Medical, ecological &Commercial application	
	2.4	**Fungi and Yeast**	**04**
		a) Characteristics: structure, Reproduction b) Cultivation of fungi and yeasts c) Major fungal divisions- overview d) Life cycle of yeast e) Biological and economical importance	
	2.5	**Slime molds**	**01**
III		**Microbes in Natural Environments**	**15**
	3.1	**Microorganisms in Nature**	**03**
		a) Microenvironments b) Introduction to microbial biofilms c) Mixed populations and microbial consortia d) Introduction to Quorum Sensing	
	3.2	**Role of microbes in Biogeochemical cycles**	**06**
		a) C- cycle, N- cycle, S- cycle, Iron cycle b) Interaction between elemental cycles	
	3.3	**Microbial competition and cooperation**	**04**
		a) Types of Microbial Interactions: Mutualism, Cooperation, Commensalism, Predation, Parasitism, Amensalism, Competition with examples b) Functions of symbiosis c) Establishment of symbiosis	
	3.4	**Introduction to extremophiles with importance**	**02**

References:

a) Willey, Sherwood and Woolverton, Prescott's Microbiology, 9th edition, 2013, International edition, McGraw Hill.
b) Michael T. Madigan & J.M. Martin, Brock's Biology of Microorganisms 13th Ed. International edition 2012, Pearson Prentice Hall.
c) Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology 5th Edition, 1986, Tata McGraw Hill Publishing Company
d) Stanier, Ingraham et al, General Microbiology, 5th Ed. 1987, Macmillan Education Ltd.

Course Code: RUSMIC202 Core Course

Course Title: Microbial Biomolecules, Growth & Control

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the characteristics and structures of biomolecules and classify and detect them in various samples
CO 2	Understand and explain the growth pattern with the phases of growth for bacteria.
CO 3	Summarize the physical, chemical &cultivation-based methods for enumeration of microorganisms.
CO 4	Recall & exemplify the mechanisms of physical & chemical antimicrobial agents.
CO 5	Execute & perform the techniques used for enumeration of microorganisms & evaluate the microbicidal action of physical & chemical agents.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUSMIC 202		**Microbial Biomolecules, Growth & Control**	**2/45**
I		**Chemical basis of life**	**15**
	3.1	**Chemical foundations**	**02**
		a) Biomolecules as compounds of carbon with a variety of functional groups. b) Universal set of small molecules. c) Macromolecules as the major constituents of cells. d) Configuration and Conformation with definitions and suitable examples only. e) Types of Stereoisomers and importance of stereoisomerism in biology. f) Types of bonds and their importance: Hydrogen, van der Waal's, Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic.	
	3.2	**Water- Structure, properties in brief**	**01**
	3.3	**Carbohydrates and glycobiology**	**04**
		a) Definition, Classification, Biological role. b) Monosaccharides, (Chair and boat conformation) oligosaccharides (maltose, cellobiose, sucrose, lactose) and polysaccharide (starch, glycogen, peptidoglycan, cellulose), glycoproteins (glycosaminoglycans and proteoglycans), glycome.	
	3.4	**Lipids**	**02**
		a) Fatty acids as basic component of lipids b) Classification, nomenclature, storage lipids and structural lipids. c) Types of lipids with general structure of each and mention examples.	

	3.5	**Amino acids & proteins**	**03**
		a) General structure and features of amino acids (emphasis on amphoteric nature) b) Classification by R-group, Uncommon amino acids and their functions Peptides and proteins- Definition and general features and examples with biological role. c) Primary, secondary, tertiary, quaternary structures of proteins- Brief outline.	
	3.6	**Nucleic acids**	**03**
		a) Nitrogenous bases- Purines, Pyrimidines b) Pentoses-Ribose, Deoxyribose, c) Nomenclature of Nucleosides and nucleotides, d) N-β-glycosidic bond, e) polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds). f) Basic structure of RNA and DNA	
II		**Microbial Growth**	**15**
	1.1	**Growth Curve & Mathematical Expression of Growth Curve**	**05**
		a) Definition of Growth, Growth phases b) Determining growth constant & growth rate	
	1.2	**Measurement of Growth**	**07**
		a) Direct microscopic count i) Breed's count, ii) Petroff-Hausser counting chamber iii) Haemocytometer b) Viable count using Spread plate and Pour plate technique c) Measurements of cell constituents. d) Turbidity measurements– Brown's opacity tubes and spectrophotometer techniques e) Coulter Counter	
	1.3	**Factors affecting growth pattern**	**03**
III		**Control of Microorganisms**	**15**
	2.1	**Definition of terms**	**01**
	2.2	**Physical agents for control of microorganisms (mode of action, advantages, disadvantages and applications)**	**07**

		a) High temperature-moist heat and dry heat b) Low temperatures c) Radiation d) Osmotic pressure e) Desiccation f) Physical removal of microorganisms using bacteriological filters	
	2.3	**Chemical agents for control of microorganisms (mode of action, advantages, disadvantages and applications of all major groups of antimicrobial agents)**	**05**
	2.4	**Evaluation of Chemical disinfectants**	**02**
	2.5	**Chemotherapeutic & antimicrobial agents- types & examples (tabular form)**	**01**

References:

a) Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
b) A.J.Salle, Fundamental Principles of Bacteriology,1984, McGraw Hill Book Company
c) Prescott, Hurley Klein-Microbiology, 5th ed, International edition 2002, McGraw Hill.
d) Prescott's Microbiology, 7th Edition, Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton, 2011, McGraw Hill International
e) Michael T.Madigan & J.M. Martin, Brock, Biology of Microorganisms 11th Ed. International edition, 2006, Pearson Prentice Hall.
f) Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 7th edition, 2010, Cambridge University Press.
g) Conn P. Stumpf, G. Bruening and R. Doi, Outlines of Biochemistry 5/E, 1995, John Wiley & Sons. New York
h) D. Nelson and M. Cox, Lehninger's Principles of Biochemistry, 4th Edition, 2005, W.H. Freeman and Company
i) Laurence A. Moran, H. Robert Horton, K. Gray Scrimgeour, Marc D. Perry, Principles of Biochemistry, 5th Edition, 2012, Pearson

Course code	PRACTICALS	2 Credits
RUSMICP 201	**PRACTICAL-1**	
Unit-I	1. Demonstration of Bacteriophages in sewage 2. Isolation of Actinomycetes from soil and Slide Culture technique for Actinomycetes 3. Biogas production using methanogens 4. Cultivation of algae	
Unit-II	1. Isolation of yeast, and other fungi 2. Fungal Wet mounts & Study of Morphological Characteristics Mucor, Rhizopus, Aspergillus, Penicillium 3. Slide culture of fungi 4. Cultivation of fungi- static and shaker conditions 5. Permanent slides of Algae, Protozoa 6. Demonstration of protozoa in hay infusion	
Unit-III	1. Dip slide technique to demonstrate microbial biofilms 2. Crowded plate technique for demonstration of antibiosis 3. Demonstration of bacteroid forms of *Rhizobia*	
RUSMICP 202	**PRACTICAL-2**	
Unit-I	1. Qualitative detection of: a. Carbohydrates- Benedicts, Molisch's test. b. Proteins, amino acids- Biuret, Ninhydrin. c. Nucleic acid detection by DPA and Orcinol	
Unit-II	1. Study of growth curve of bacteria 2. Enumeration of microorganisms using Haemocytometer & Breed's Count 3. Enumeration of microorganisms Brown's opacity tubes 4. Viable count: Spread plate and pour plate	
Unit-III	1. Demonstration of efficiency of autoclave 2. Effect of UV Light on bacteria 3. Effect of surface tension on bacterial growth 4. Study of Oligodynamic action 5. Effect of dyes, phenolic compounds and chemotherapeutic agents on bacteria- disc diffusion method 6. Demonstration of MIC of an antibacterial agent	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project/ Presentation	20
2	One class Test (multiple choice questions / objective)	20
	TOTAL	**40**

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be three questions each of 20 marks one on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1) A)	Any 3 out of 5	15	Unit I
Q.1) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
Q.2) A)	Any 3 out of 5	15	Unit II
Q.2) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
Q.3) A)	Any 3 out of 5	15	Unit III
Q.3) B)	Any 1 set out of 2 (i & ii or i & ii)	03 &02	
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II
Journal	05	05
Experimental tasks	15	15
Total	**20**	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Paper I	Paper II
Laboratory work	25	25
Spots/Quiz/Viva	05	05
Total	**30**	**30**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination & Marks Distribution Pattern

Semester II

Course	201			202			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**