AC/II(22-23).3.RUS9

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: F.Y.B.Sc.

Program Code: (Microbiology)

RUSMIC

(As per the guidelines of National Education Policy 2020-
Academic year 2023-24)

(Choice based Credit System)

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 Statistics 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 (B.Sc.)

CREDIT STRUCTURE BSc

Semester	Subject 1		Subject 2	GE/ OE course (Across disciplines)	Vocational and Skill Enhancement Course (VSC) & SEC	Ability Enhancement Course/ VEC/IKS	OJT/FP/CEPCC, RP	Total Credits
	DSC	DSE						
1	4		4	4 (2*2)	VSC-2 + SEC -2	AEC- 2 (CSK) + VEC- 2 (Env Sc.) + IKS-2		22
2	4		4	4 (2*2)	VSC-2 + SEC-2	AEC-2 (CSK)+ VEC-2 (Understanding India)	CC-2	22
Total	8		8	8	8	10	2	44
Exit option: award of UG certificate in Major with 44 credits and an additional 4 credit Core NSQF course/ Internship or Continue with Major and Minor								
3	Major 8		Minor 4	2	VSC-2	AEC-2 MIL	FP -2, CC-2	22
4	Major 8		Minor 4	2	SEC-2	AEC-2 MIL	CEP-2, CC-2	22
Total	16		8	4	4	4	8	44
Exit option: award of UG Diploma in Major with 88 credits and an additional 4 credit Core NSQF course/ Internship or Continue with Major and Minor								
5	DSC 12	DSE 4	Minor 2		VSC-2		CEP/FP-2	22

6	**DSC 12**	**DSE 4**	**Minor 2**				**OJT-4**	**22**
Total	**24**	**8**	**4**		**2**		**6**	**44**
	Exit option: award of UG Degree in Major with 132 credits or Continue with Major for Honours/ Research							

Course Code-Department Specific Course: RUSMIC.O101

Course Title: Fundamentals of Microbiology

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	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 in different areas of human life
CO 4	Explain the nature, correlate function of components that make up a prokaryotic cell
CO 5	Compare and elucidate the difference between structural features of prokaryotic and eukaryotic cell
CO 6	Explain the principle, construction & functionality differences of various microscopes.
CO 7	Summarize the method & principle of the techniques used for visualization of microorganisms.
CO 8	Perform basic and special staining to visualize microorganisms under a compound microscope

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
RUSMIC.O101		**Fundamentals Of Microbiology**	**3/45**
	Unit I	**Evolution of Microbes, History and Future of Microbiology**	**1/15**
		1.1 The Evolution of Microorganisms 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** 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) Branches, Scope and relevance of microbiology **1.3 Future of Microbiology and unification with other sciences** a) Molecular and genomic methods to study microorganisms b) Emerging diseases c) Search for extra-terrestrial life d) Bio-based economies	
	Unit II	**Prokaryotic and Eukaryotic Cell Structure**	**1/15**
		2.1 Prokaryotic Cell Structure and functions 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**	

		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	
	Unit III	**Visualizing Microbes**	**1/15**
		1.1 Microscopy 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 Staining** a) Morphological characteristics b) Staining procedures i. Dyes and stains: Types, Physicochemical basis, Fixatives, Mordants, Decolorizers ii. Simple and differential staining iii. Special Staining	

Practical: RUSMICP.O101

Course code	Practical	1 Credit
RUSMICP.O101	**Fundamentals of Microbiology**	
	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. 3. Study of prokaryotic subcellular structures by special staining: Cell wall, capsule, endospore, flagella, lipid, metachromatic granules. 4. Study of Motility (Hanging Drop Preparation) 5. Wet mount of Hay infusion 6. Parts of a microscope 7. Micrometry 8. Dark field and Phase Contrast Microscopy: (Demonstration) 9. Monochrome staining 10. Gram staining 11. Negative Staining	

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

Modality of Assessment: Department Specific Course (3 Credit Theory Course for BSc)

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	10
	TOTAL	**30**

B) External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **One hour thirty Minutes**.
2. Theory question paper pattern:

Paper Pattern:

Question		Options	Marks	Questions Based on
1	A	Any two out of three questions	10	Unit 1
	B	Any 1 set out of 2 (i & ii or i & ii)	03 & 02	
2	A	Any two out of three questions	10	Unit 2
	B	Any 1 set out of 2 (i & ii or i & ii)	03 & 02	
3	A	Any two out of three questions	10	Unit 3
	B	Any 1 set out of 2 (i & ii or i & ii)	03 & 02	
		TOTAL	**45**	

Practicals- 1 Credit: Total Marks 50

Internal Examination: 40%	**Experimental tasks**	20 Marks
Semester End Examination 60%	**Laboratory work**	25 Marks
	Spots/Quiz/Viva	05 Marks

Course Code-Department Specific Course: RUSMIC.E111

Course Title: Microbial diversity & growth

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Explain the structure, cultivation and significance of viruses
CO 2	Explain and compare the features of different groups of bacteria
CO 3	Summarize the characteristics and infer significance of Archaebacteria
CO 4	Categorize microorganisms like Protozoa, Algae and Fungi into different groups based on their characteristics
CO 5	Illustrate the medical and industrial significance of Protozoa, Algae and Fungi
CO 6	Explain the growth pattern with the phases of growth for bacteria.
CO 7	Summarize and perform the indirect, indirect & cultivation-based methods for enumeration of microorganisms.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
RUSMIC.E111		**Microbial diversity & growth**	**3/45**
	Unit I	**Microbial diversity-I**	**1/15**
		1.1 Viruses 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	
	Unit II	**Microbial diversity-II**	**1/15**
		2.1 Archaea a) Introduction- Major Archaeal physiological groups, b) Archaeal cell wall, lipids and membranes c) Ecological importance **2.2 Protozoa** a) General characteristics b) Major categories of Protozoa based on motility, reproduction c) Medically important Protozoa **2.3 Algae** 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 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**	
	Unit III	**Microbial Growth**	**1/15**
		3.1 Growth Curve & Mathematical Expression of Growth Curve a) Definition of Growth, Growth phases b) Determining growth constant & growth rate **3.2 Measurement of Growth** 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 **3.3 Factors affecting growth pattern**	

Practical:

Course code	PRACTICALS	1 Credit
	PRACTICAL	
	1. Demonstration of Bacteriophages in sewage 2. Isolation of Actinomycetes from soil and Slide Culture technique for Actinomycetes 3. Cultivation of algae 4. Isolation of yeast, and other fungi 5. Fungal Wet mounts & Study of Morphological Characteristics Mucor, Rhizopus, Aspergillus, Penicillium 6. Slide culture of fungi 7. Cultivation of fungi- static and shaker conditions 8. Permanent slides of Algae, Protozoa 9. Demonstration of protozoa in hay infusion 10. Study of growth curve of bacteria 11. Enumeration of microorganisms using Haemocytometer & Breed's Count 12. Enumeration of microorganisms Brown's opacity tubes 13. Viable count: Spread plate and pour plate 14. Effect of environment on growth a) Temperature b) pH c) Osmotic pressure	

References:

a) Willey, Sherwood and Woolverton, Prescott's Microbiology, 9th edition, 2013, International edition, McGraw Hill.

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

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2	A	Any two out of three questions	10	Unit 2
	B	Any 1 set out of 2 (i & ii or i & ii)	03 & 02	
3	A	Any two out of three questions	10	Unit 3
	B	Any 1 set out of 2 (i & ii or i & ii)	03 & 02	
		TOTAL	**45**	

Practicals- 1 Credit: Total Marks 50

Internal Examination: 40%	**Experimental tasks**	20 Marks
Semester End Examination 60%	**Laboratory work**	25 Marks
	Spots/Quiz/Viva	05 Marks
