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S.P.Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for S.Y.B.Sc

Program: BSc (Microbiology)

Program Code: RUSMIC

(Credit Based Semester and Grading System for the academic year 2019-2020)

SEMESTER III

COURSE CODE	UNIT	TITLE	Credits	Lec / Week
RUSMIC 301		MICROBIAL TAXONOMYAND INTRODUCTION TO GENETICS AND MOLECULAR BIOLOGY	2	03
	I	Techniques in Microbial taxonomy		1
	II	Classical Genetics (Mendelian & Non mendelian) & Nucleic acid structure		1
	III	Transfer of Genetic information		1
RUSMIC 302		INTRODUCTION TO EXPERIMENTAL MICROBIAL BIOCHEMISTRY	2	03
	I	Designing and Analysis of experimental data, General laboratory techniques: Electrochemical sensors		1
	II	Fractionation of microbial cells and separation techniques		1
	III	Purification & Estimation of biomolecules		1
RUSMIC 303		ENVIRONMENTAL MICROBIOLOGY	2	03
	I	Air & Fresh Water Microbiology		1
	II	Marine and Sewage Microbiology		1
	III	Soil & Geo Microbiology		1
RUSMIC P301	Practicals based on above three courses		03	09

SEMESTER IV

COURSE CODE	UNIT	TITLE	Credits	Lec / Week
RUSMIC 401		MICROBE INTERACTIONS AND HOST RESPONSES	2	03
	I	Microbial interactions with plants, animals and other microbes		1
	II	Microbial invasion in Human hosts		1
	III	Host Responses to infection		1
RUSMIC 402		INTRODUCTION TO METABOLIC PATHWAYS AND ENZYMOLOGY	2	03
	I	Introduction to Metabolism		1
	II	Enzymology		1
	III	Principles of Bioenergetics		1
RUSMIC 403		APPLIED MICROBIOLOGY	2	03
	I	Industrial Microbiology		1
	II	Food Microbiology		1
	III	Dairy Microbiology		1
RUSMIC P402	Practicals based on above three courses		03	09

Course Code: RUSMIC 301
Course Title: MICROBIAL TAXONOMYAND INTRODUCTION TO GENETICS AND MOLECULAR BIOLOGY
Academic year 2019-20

Learning objectives:

There is immense diversity of microbial flora and microbial systematics has been a major work arena these days. This course will enable the students to understand various techniques including morphological and molecular techniques used for studying microbial taxonomy. The major aim is to acquaint them with the conventional and modern techniques used to characterize the organisms. Understanding biochemical analysis to constructing phylogenetic tree this course spans across all the major techniques used in the field.

Mendelian Genetics is the basic foundation for genetic studies. So, this course will emphasize on both Mendelian & Neo-mendelian genetics. This will help orient the students well for basic structural studies of DNA and RNA.

Here the students will now be introduced to the concept of Central Dogma of life, followed by Transcription & Translation mechanisms seen in Prokaryotes. Also, the difference between Prokaryotic & Eukaryotic protein synthesis mechanisms will be deduced. This course will eventually introduce the concept of Omics which is fundamental in today‟s modern day biological research.

Learning Outcomes:

The students should be able to:

- Understand the techniques used for studying microbial taxonomy
- know how to use Bergey‟s manual for biochemical classification of bacteria.
- Understand the way of constructing phylogenetic tree
- Strengthen the fundamentals of Mendelian and neo-Mendelian genetics
- Understand the structure of DNA & RNA
- Know the central dogma along with the detailed mechanisms of transcription & translation
- Understand & establish a link of Omics to genetic and metabolic studies.

DETAILED SYLLABUS

Course Code	Title	Credits
RUSMIC 301	**MICROBIAL TAXONOMYAND INTRODUCTION TO GENETICS AND MOLECULAR BIOLOGY**	**2 Credits (45 lectures)**
Unit I	**Techniques in Microbial Taxonomy**	**15 Lectures**
	1.1: Introduction to microbial Taxonomy and Taxonomic ranks	**1**
	1.2: Techniques for studying Microbial Taxonomy: a) Microscopic & macroscopic morphology and biochemical characteristics, b) Chemical Analysis c) Serological analysis d) Genetic & molecular analysis: i. Nucleic acid sequencing and finger printing ii. G+C content iii. Nucleic acid hybridization iv. Amino acid sequencing e) Community DNA analysis	**8**
	1.3: Introduction to Microbial Phylogeny: a) Phylogenetic Trees i. Types ii. Construction (an overview) b) Numerical Taxonomy	**5**
	1.4: Bergey's Manual of Systematic Bacteriology a) Understanding classification and identification schemes for bacteria using Bergey‟s manual	**1**
Unit II	**Classical Genetics (Mendelian & Neomendelian) & Nucleic acid structure**	**15 Lectures**
	2.1 :Mendelian genetics: a) Genotype and Phenotype b) Mendel‟s Experiments design c) Monohybrid cross and dihybrid cross, Mendelian Laws of inheritance d) Trihybrid Cross e) Statistical analysis of genetic data using chi square test	**04**
	2.2:Neomendelian genetics: a) Multiple alleles b) Modification of dominance relationships	**05**

	c) Incomplete dominance d) Codominance (both with their molecular explanations) e) Essential and lethal genes f) Gene expression and effect of environment g) Maternal effect h) Gene interactions and modified Mendelian ratios **2.3: Structure of DNA:** Different 3D forms, and unusual structures DNA methylation **2.4:Structure of chromosomes** **2.5:Structure of RNA**	 **03** **01** **02**
Unit III	**Transfer of Genetic information**	**15 Lectures**
	3.1:Central dogma of Molecular Biology **3.2: Transcription in prokaryotes:** a. RNA biosynthesis b. Prokaryotic transcription i. Prokaryotic promoters ii. Initiation, elongation and termination of transcription **3.3: Translation**: a) Components of protein synthesis apparatus: Genetic code, mRNA, Ribosomes b) Degeneracy of genetic code c) Protein synthesis **3.4:Comparison of eukaryotic & prokaryotic transcription & translation** **3.5 Introduction to the concept of Omics: Genomics & Proteomics**	**1** **6** **6** **1** **1**

References

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1. Prescott‟s Microbiology, Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton, Edition, 7th Edition, 2011, McGraw Hill International
2. Madigan, Martinko, Dunlap and Clark ,Brock Biology of Microorganisms, 12thedition, 2009, Pearson Education
3. Peter J. Russell, “iGenetics - A molecular approach”, 3rd edition , 2010,Benjamin Cummings.

4. Stanier R.Y. And Other, MacMillan General Microbiology, 5th edition,1987, MACMILLAN PRESS LTD
5. D. Nelson & M. Cox, Lehninger‟s Principles Of Biochemistry,4th Edition ,2005, (W.H.Freeman& Co., (LPE)
6. James Watson , Molecular Biology of Gene , 5th edition,2004,Pearson Benjamin Cummings CSHL Press.
7. Benjamin A Pierce ,Genetics: A conceptual approach ,2002 ,W.H. Freeman

Course Code: RUSMIC 302

Course Title: INTRODUCTION TO EXPERIMENTAL MICROBIAL BIOCHEMISTRY

Academic year 2019-20

Learning objectives:

This course will acquaint the students with the apt ways of designing experiments minimizing the chances of experimental errors. It will also help them learn different statistical methods to analyse& validate experimental data. Today, research generates tremendous amount of data so using web directories and databases is a must which will be taught to the students as a part of this course.

The course will enable them know cell fractionation and separation techniques. They will learn both chemical & physical methods of disintegration. After disintegration, the further analysis involves centrifugation, electrophoretic & chromatographic methods. Both conventional and presentday analytical techniques will be a part of this course.

It will also involve study of techniques for separation & purification of proteins and chemical estimation methods for all biomolecules. They will also learn working principles of instruments used in estimation & analysis methods.

Learning outcomes:

The students should be able to:

- Understand the apt experimental design & different experimental errors.
- Know the use of web directories & databases in biochemistry.
- Understand the different cell disintegration methods and know the working principles of different centrifugation, electrophoretic & chromatographic techniques used in analysis.
- Know the separation & purification techniques for proteins & techniques to estimate biomolecules.

DEATILED SYLLABUS

Course Code	Title	Credits
RUSMIC 302	**INTRODUCTION TO EXPERIMENTAL MICROBIAL BIOCHEMISTRY**	**2 Credits (45 lectures)**
Unit I	**Designing and Analysis of experimental data, General laboratory techniques: Electrochemical sensors**	**15 Lectures**
	1.1: Designing experiments: a) Aims of laboratory experiments b) Outline of Scientific method c) Experimental design d) Analytical considerations and experimental error	**2**
	1.2: Analysis of experimental data: a) Assessment of performance of an analytical technique -performance indicators b) Introduction to Biostatistics- Normal and Poisson distribution c) Assessment of precision -Mean, Median, Mode, Standard deviation, coefficient of variation and variance d) Assessment of accuracy& Validation of analytical data - population statistics, confidence limit and confidence interval; Students t factor, Q test, F test, ANOVA e) Data presentation: Dot diagram, Bar diagram, Histogram, Frequency curve, Calibration methods: Linear regression, Internal standards	**7**
	1.3: Using computers in biochemistry Using web directories, biological databases and tools (eg. NCBI, EMBL)	**2**
	1.4: General and routine laboratory procedures: Theoretical and practical aspects of: a) Preparation and use of buffers b) Electrochemical sensors: pH meter c) Oxygen electrode d) Biosensors	**4**
Unit II	**Fractionation of microbial cells and separation techniques**	**15 Lectures**
	2.1: Disintegration of cells: a) Physical methods of cell disruption b) Chemical methods	**2**
	2.2: Separation Techniques	

	a. Centrifugation techniques: i. Basic principles of sedimentation ii. Types of centrifuges and their use: preparative & analytical, ultracentrifuges iii. Density Gradient & isopycnic centrifugation b. Electrophoretic techniques: i. General Principles ii. Factors affecting electrophoresis iii. Support media- Agarose gels and PAGE c. Chromatographic Techniques: i. General principles ii. Types and applications- Partition, adsorption, ion exchange, affinity and size exclusion iii. Modes- Paper, TLC, HPLC, GC, Reverse Phase	**3** **3** **7**
Unit III	**Purification & Estimation of biomolecules**	**15 Lectures**
	3.1: Separation and purification of proteins a) Methods of separation/ concentration of proteins based on: i. Size and mass ii. Polarity iii. Solubility iv. Specific binding sites v. Concentration of proteins - Dialysis, Ultrafiltration b) Choice of methods c) Criteria for purity **3.2: Estimation of Biomolecules** a) Visible and UV spectrophotometry i. Principles ii. Instrumentation iii. Applications b) Preparation of bacteria for analysis c) Methods for chemical analysis (Basic principles of all methods to be covered) i. Methods of elemental analysis: Carbon by Slyke"smethod,Nitrogen by Microkjelhdahl method, Phosphorus by Fiske-Subbarow method ii. Estimation of Carbohydrates by Phenol and AnthroneMethod iii. Estimation of Reducing Sugars iv. Estimation of Proteins v. Estimation of Amino acids vi. Extraction of Lipids and estimation of total lipid vii. Estimation of Nucleic acids	**3** **3** **1** **8**

References:

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1. Norris & Ribbon ,Methods In Microbiology,Vol.5B, Edition,1971, Academic Press
2. J. Jayaraman , Laboratory Manual in Biochemistry, 2003, New Age International Publishers
3. D. Nelson & M. Cox, Lehninger‟s Principles Of Biochemistry,4th Edition, 2005, W.H.Freeman & Co., (LPE)
4. B.K. Mahajan. Jaypee brothers , Methods in biostatistics for medical & research workers. 6thedition, Medical Publishers (P) ltd.
5. Rodney Boyer ,Modern experimental biochemistry by 3rd Edition ,2000, Benjamin Cummings
6. I.H. Segel , Biochemical calculations , 2nd Edition 2004, Wiley India
7. Wilson and Walker ,Principles and Techniques of Biochemistry and Molecular Biology 7th Ed ,2010. Cambridge University Press
8. Stanier R.Y. And Other, General Microbiology , 5th edition, 1989 MacMillan Press.
9. Plummer David , An Introduction To Practical Biochemistry ,1979,TMH
10. Wayne Daniel, Biostatistics : A Foundation for Analysis in Health Sciences, 10th edition, 2013, Wiley.

Course Code: RUSMIC 303
Course Title: ENVIRONMENTAL MICROBIOLOGY
Academic year 2019-20

Learning objectives:

This course introduces the concept of environmental niches as a reservoir of microorganisms. It will enable the students to know the types of microorganisms found, enumeration methods and sanitation techniques for air.

Also it deals with the concept of natural water niches & hydrologic cycle, water purification methods, bacteriological examination and standard water quality. The hydrothermal vents, oceanic zones and characteristics of marine environments is emphasized as the oceanic microbes are being commercially harnessed today on a very large scale.

Modern waste water treatment methods and sludge processing and disposal methods are crucial as we are aiming for an eco-friendly and clean environment. This course will help the students to acquaint with the methods used for sewage treatment and disposal.

Different methods used for studying soil microbes and biogeochemical cycles are part of this course. It will also introduce the concept of bioremediation which is a field endorsing a safer and cleaner environment.

Learning Outcomes:

The students should be able to:

- Describe the sampling, identification and enumeration of microorganisms present in air & also the sanitation techniques used.
- Understand the freshwater niches and routine water analysis techniques.
- Understand the marine niches and the physiological abilities of organisms found in these niches.
- Know the sewage treatment methods and sludge disposal methods
- Understand the terrestrial environment and the characteristics of organisms found in these niches, the biogeochemical cycles & bioremediation.

DETAILED SYLLABUS

Course Code	Title	Credits
RUSMIC 303	**ENVIRONMENTAL MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit I	**Air & Fresh Water Microbiology**	**15 Lectures**
	1.1: **Air Microbiology:** a) Origin, distribution, number and kinds of microorganisms in air, Factors affecting microbial survival in air b) Enumeration of microorganisms in air: Impingement in liquids, Impaction on solids, Filtration, Sedimentation, Centrifugation, Electrostatic Precipitation. c) Air borne pathogens and diseases, droplets and droplet nuclei d) Air sanitation- methods and application **1.2**: **Fresh water microbiology:** a) General: Hydrologic cycle, groups of natural waters, factors affecting kinds of microorganisms found in aquatic environments and nutrient cycles in aquatic environments b) Fresh Water environments and microorganisms found in Lakes, ponds, rivers, marshes, bogs and springs c) Potable water: Definition, water purification and pathogens transmitted through water. d) Microorganisms as indicators of water quality e) Bacteriological examination of water-sampling,routineanalysis,SPC,membrane filter technique, Standards for water quality	**5** **10**
Unit II	**Marine and Sewage Microbiology**	**15 Lectures**
	2.1: Marine Microbiology: a. Characteristics of marine environments b. Diversity& characteristics of marine microorganisms and their importance c. Ecosystems of Deep sea Hydrothermal vents and Subterranean Water **2.2: Sewage Microbiology:** a. Types of waste water b. Characteristics of waste water c. Modern waste water treatment: Primary, Secondary – (oxidation ponds, activated sludge, trickling filters, anaerobic digestor)and tertiary treatment.	**5** **10**

	d. Removal of pathogens by sewage treatment Processes e. Sludge Processing f. Disposal of Solid Waste, Modern Sanitary Landfills, Composting	
Unit III	**Soil & Geo Microbiology**	**15 Lectures**
	3.1: Terrestrial environment: a. Soil – Definition, composition, function,Textural Triangle b. Types of Soil microorganisms & their activities **3.2 Methods of studying soil microorganisms:** a. Sampling b. Cultural methods c. Physiological methods d. Immunological methods e. NA based methods f. Radioisotope techniques **3.3:Biogeochemical Cycles:** a. Carbon cycle b. Nitrogen cycle c. Sulphur cycle d. Phosphorus cycle **3.4: Soil Bioremediation**	**3** **5** **5** **2**

References

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1. Raina M. Maier, Ian L. Pepper, Charles P. Gerba,Environmental Microbiology, 2nd Edition,2010, Academic Press
2. A.J. Salle , Fundamental Principles of Bacteriology, 7th Editon,1974,Tata McGraw Hill Publishing Company
3. Air Quality Standards - NAAQS Manual, Volume I, 2011
4. Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton Prescott‟s Microbiology, 8th Edition,2011 , McGraw Hill International Edition
5. Frobisher, Hinsdill, Crabtree, Goodheart, Fundamentals of Microbiology, 9th Edition, 1974, Saunders College Publishing
6. Barbara Kolwzan ,Waldemar Adamiak (E Book) Oficyna Wydawnicza Politechniki Wroclawskiej, Wroclaw, 2006
7. N.S Subba Rao, Introduction to Environmental Microbiology –Soil Microbiology -4th Edition ,2000, Oxford and IBH Publishing Co. Pvt Ltd

	PRACTICALS	3 Credits
RUSMICP301	**SECTION-1** **Microbial TaxonomyAnd Introduction To Genetics And Molecular Biology.**	**1 Credit** **(45 lectures)**
	1. Isolation and identification of a natural bacterial isolate 2. Problems on Mendelian genetics 3. Extraction of DNA from onion and *E. coli* 4. Problems on genetic code	
RUSMICP302	**SECTION-2** **INTRODUCTION TO EXPERIMENTAL MICROBIAL BIOCHEMISTRY**	**1 Credit** **(45 lectures)**
	1. Biostatistics problems 2. Study of pH meter and preparation of buffers 3. Density gradient centrifugation 4. Demonstration of agarose gel electrophoresis 5. Demonstration of PAGE 6 Separation of amino acids using paper chromatography 7. Separation of carbohydrates using TLC 8. Demonstration of column chromatography 9. Demonstration of HPLC and GC 10. Determination of λmax 11. Verification of Beer‟s law and determination of extinction coefficient 12. Large scale cultivation of bacteria /yeast/ fungi 13. Determination of Dry and wet Weight 14. Disintegration of cells and separation of biomolecules 15. Estimation of Amino acids by Ninhydrin method	

	16. Estimation of Proteins by Biuret method 17. Bradford‟s Method for protein estimation 18. Estimation of Reducing Sugars by DNSA method 19. Estimation of RNA by orcinol method 20. Estimation of DNA by diphenylamine method Note: All the above methods will also be analysed using statistical methods covered in theory	
RUSMICP303	**SECTION-3** **ENVIRONMENTAL MICROBIOLOGY**	**1 Credit** **(45 lectures)**
	1. Enumeration of microorganisms in air and study its load after fumigation 2. Determination of microbial load using air impinger 3. Study of halophilic and haloduric bacteria from marine samples 4. Routine analysis of water 5. Use of membrane filter technique for bacteriological analysis of water 6. Rapid detection of *E.coli* by MUG technique-Demo 7. Visit to Sewage treatment plant 8. BOD of untreated and treated sewage 9. Buried slide technique to study soil flora 10. Mapping of soilflora- building phylogenetic trees 11. Enrichment and isolation of Cellulose degraders, Sulphate reducers and Phosphate solubilizers from soil 12. Winogradsky‟s Column	

Course Code: RUSMIC 401

Course Title: MICROBE INTERACTIONS AND HOST RESPONSES

Academic year 2019-20

Learning objectives:

This course will help the students understand the microbial interactions with plants, animals and other microorganisms. The interactions may be harmful, beneficial or neutral. So there will be commercial, ecological and medical significance to such interactions.

The mechanism of manifestation of an infection, the causative agents, their virulence, mode of transmission, epidemiological surveillance and immunization strategies are a part of this course.

They will also learn the components of immune system, the innate response & the way the complement system functions bringing about a stringent host response against the pathogen.

Learning Outcomes:

The students will be able to:

- Understand the microbial interactions with plants, animals & other microorganisms.
- Know the commercial, ecological & medical significance of such interactions
- Understand the way by which a pathogen lodges itself and manifests an infection.
- Know the components of immune system, the response evoked by the immune system against a specific immunogen.

Course Code	Title	Credits
RUSMIC 401	**MICROBE INTERACTIONS AND HOST RESPONSES**	**2 Credits (45 lectures)**
Unit I	**Microbial interactions with plants, animals and other microbes**	**15 Lectures**
	1.1: Microbial associations with plants a) Phyllosphere b) Rhizosphere&Rhizoplane c) Mycorrhizae d) Nitrogen fixation: Biochemistry of nitrogen fixation, nodulation in *Rhizobia*, Azolla-Anabena symbiosis, Actinorhizae, Stem nodulating *Rhizobia* e) Fungal & Bacterial endophytes f) Plant pathogens -Fungal, bacterial and viral diseases **1.2: Microbial interactions with animals:** a) Zoo xanthallae, Zoo chlorellae- invertebrates b) Bacterial flora in the Rumen c) Worm- bacterial cooperation d) Microbe- Metazoan interactions e) Introduction to Zoonotic diseases **1.3: Microbe -Microbe interactions:** a) Lichen b) Endosymbionts of Protozoa c) Parasitism in microbes	**08** **05** **02**
Unit II	**Microbial invasion in Human hosts**	**15 Lectures**
	2.1: Mechanisms of infection a) Bacterial virulence factors i. Adherence factors ii. Invasion of host cells and tissues iii. Toxins- Exotoxins and Endotoxins iv. Enzymes v. Evading host defense- Antigenic variation, Antiphagocytic factors and Intracellular pathogenicity vi. Iron sequestration vii. The role of Biofilms c) Measuring bacterial virulence: Infective dose & Lethal dose, limulus amoebocyte assay **2.2 Introduction to epidemiological concepts:** a) Reservoirs of infection	**08** **07**

	b) Modes of disease transmission c) Epidemiological terminology: epidemic, endemic, pandemic, sporadic, incidence rate, prevalence rate, mortality, morbidity d) Epidemiological methods e) Health care associated infections f) Controlling epidemics: Controlling reservoirs, controlling transmission- Immunization strategies- passive and active, Surveillance	
Unit III	**Host Responses to infection**	**15 Lectures**
	3.1: Basic concepts in Immunology a) Introduction b) Principals of Innate & adaptive immunity-Primary, Secondary & Tertiary Barriers **3.2: Components of the immune system** a) Cells of the immune system b) Organs of the immune system **3.3: Innate mechanisms:** a) Phagocytosis and inflammation-Mechanisms and link to immunity b) Pattern recognition in innate immune system-PAMPs, PRRs, TLRs **3.4: The Complement System** a) Alternative and Lectin Pathways Evolution of Classical Pathway	**03** **05** **04** **03**

References:

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1. Stanier, General microbiology 5th edition ,1987, Macmillan publication.
2. Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton ,Prescott‟s Microbiology, 7th Edition, 2011, McGraw Hill International Edition
3. Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton, Prescott‟s Microbiology, 9th Edition; 2013, McGraw Hill International Edition
4. Madigan, Martinko, Dunlap and Clark , Brock Biology of Microorganisms, 8thedition, 1997 , Pearson Education
5. Madigan, Martinko, Dunlap and Clark ,Brock Biology of Microorganisms, 12thedition, 2009, Pearson Education
6. Katheleen Park Talaro , Foundations of Microbiology , 7th Edition, 2008, Mcgraw Hill International edition
7. Ingraham and Ingraham, Introduction to Microbiology, by 2nd Ed ,2000, Brooks/Cole Publishers
8. Judith A Owen, Jenni Punt, Sharon A Stranford, Patricia P Jones, Janis Kuby, Kuby immunology, 7th edition;, 2013, W.H. Freeman,New York.
9. Sulabha Pathak, Urmi Palan , Immunology : Essential and Fundamental, 3rd edition;
10. Conn P.Stumpf,G.Bruening & R.Doi, Outlines Of Biochemistry,5/E, John Wiley & Sons,New York 1995

Course Code: RUSMIC 402

Course Title: INTRODUCTION TO METABOLIC PATHWAYS AND ENZYMOLOGY

Academic year 2019-20

Learning objectives:

This course introduces to the concept of metabolism, type of metabolic reactions, metabolic networks & metabolomics. Different software‟s are used for understanding metabolic networks which will be a part of this course.

Characteristics of enzymes, their properties, classification and enzyme kinetics are instrumental concepts of enzymology. The cofactors & coenzymes involved will also be a part of this course.

Even biological systems follow thermodynamics. The laws of thermodynamics and bioenergetics are crucial to understand the metabolic process.

Learning Outcomes:

The students will be able to:

- Understand the concept and types of metabolism
- Know the concept of metabolic networks & metabolomics.
- Know classification of enzymes
- Understand enzymes and their kinetics.
- Know the laws of thermodynamics and their applications in microbial metabolism.

DEATILED SYLLABUS

Course Code	Title	Credits
RUSMIC 402	**INTRODUCTION TO METABOLIC PATHWAYS AND ENZYMOLOGY**	**2 Credits (45 lectures)**
Unit I	**Introduction to Metabolism**	**15 Lectures**
	1.1: **Introduction to biochemical reactions** a. Central role of chemical reactions in life b. Characteristics of biochemical reactions	**4**
	1.2: **Introduction to metabolism:** a) Metabolism- Catabolism & Anabolism b) Types of Metabolic pathways c) Metabolic networks, use of different software d) Primary and secondary metabolism e) C- skeleton, Energy and reducing power requirements	**6**
	1.3: Metabolic strategies: Managing metabolic network a. Role of enzymes, enzyme clustering & multienzyme complexes b. Functional coupling c. Compartmentalization in cells	**4**
	1.4: Introduction to omics: Metabolome & Metabolomics	**1**
Unit II	**Enzymology:**	
	2.1: Introduction to enzymes: a. General properties of enzymes b. How do enzymes accelerate reactions? c. Classification of enzymes d. Enzyme kinetics: Rate law for a simple catalysed reaction, Michaelis-Menten equation and its derivation, other plots to determine velocity of reactions	**6**
	2.2: Modifying enzyme catalyses rates: a. Effect of temperature and pH b. Effect of Inhibitors- Reversible and irreversible, competitive, Non-competitive and uncompetitive inhibitors c. Allosteric effects in enzyme catalysed reactions d. Multisubstrate reactions- Ordered, Random and pingpong reactions e. Koshland-Nemethy and Filmer model f. Monod, Wyman and Chageux model	**5**

	2.3: Coenzymes& Co-factors: a. Different types and reactions catalysed by coenzymes (in tabular form) b. Water soluble coenzymes (NAD, Nicotinic acid) **c.** Fat soluble vitamins and their examples. **d.** Inorganic cofactors	**4**
Unit III	**Principles of Bioenergetics**	
	3.1:Bioenergetics & thermodynamics: a. Energy transformations b. Thermodynamic quantities, standard -free energy c. Difference between ΔG &ΔG$^{o'}$ **3.2: ATP and it's role:** a. Structure of ATP,phosphoryl group transfer and ATP a. Types of energy -rich compounds b. Multi-roles of ATP inorganic phosphoryl group donor **3.3:Biochemical & chemical reactions, Biological oxidation-reduction reaction**	**6** **5** **4**

References
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1. Principles of Biochemistry by Geoffery Zubay (1988) 4th Edition Wm.C. Brown Publishers
2. Outlines Of Biochemistry,5/E,Conn P.Stumpf,G.Bruening & R.Doi,John Wiley & Sons,New York 1995
3. Fundamentals of Enzymology :Cell and Molecular Biology of Catalytic Proteins 3rd Edition Nicholas Price and Lewis Stevens
4. Lehninger: Principles Of Biochemistry,4th Ed., D. Nelson & M. Cox, W.H.Freeman & Co., (LPE)
5. A biologist's Physical Chemistry by John Gareth Morris.
6. Rodney Boyer

Course Code: RUSMIC 403

Course Title: APPLIED MICROBIOLOGY

Academic year 2019-20

Learning Objectives:

This course will help you understand the characteristics of industrially important strains, types of fermentation & media for fermentation and inoculum characteristics. Fermentation needs several optimum parameters for efficient yield.

The course also deals with food as the substrate for growth of microorganisms, intrinsic & extrinsic factors. Spoilage depends on the nutritional quality of the food. This helps to decide the shelf-life of the food. It deals with the general preservation of food & deals with regulations & HACCP concept applied in food industry.

It also deals with the food borne infections and methods to detect the presence of pathogens in food. It includes the methods to analyse the quality of milk, pasteurization process, and production and spoilage of milk products.

Learning outcomes:

The students will be able to:

- Understand the fermentation process, inoculum development, fermentation media.
- Know food spoilage and preservation techniques
- Understand the regulations & HACCP Concept.
- Know methods to analyse the quality of milk, pasteurization process, production & spoilage of milk products.

DETAILED SYLLABUS

Course Code	Title	Credits
RUSMIC 403	**APPLIED MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit I	**Industrial Microbiology**	**15 Lectures**
	1.1: Strains of industrially important microorganisms a. Desirable characteristics of an industrial strain b. Principles and methods of primary and secondary screening.	**4**
	1.2: Types of fermentations: a. Aerobic b. Anaerobic c. Solid state fermentation	**2**
	1.3: Types of fermentation processes: a. Surface and Submerged b. Batch, continuous, fed-batch fermentation process	**2**
	1.4: Media for industrial fermentations a. Production and Inoculum media b. Media components: - Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers	**5**
	1.5: Inoculum development	**2**
Unit II	**Food Microbiology**	**15 Lectures**
	2.1: Introduction: Significance, food as a substrate and sources of microorganisms in food	**1**
	2.2: Intrinsic and extrinsic factors affecting the microbial growth in food	**2**
	2.3: General Principles of spoilage Spoilage of fresh foods: fruits and vegetables, eggs, meat, poultry and seafood	**4**
	2.4: General principles of food preservation (principle of each method and example of foods only) High temperature, low temperature, drying, radiations and food additives and preservatives (tabular representation),	**4**

	Asepsis, introduction to HACCP, Regulations **2.6: Food borne diseases** **2.7: Methods of detection of microorganisms in food** Overview of cultural, microscopic, physical, chemical and bioassay methods	 **1** **3**
Unit III	**Dairy Microbiology**	**15 Lectures**
	3.1: Milk- Definition,composition,Sources of contamination of milk **3.2: Pasteurization of milk-**LTHT, HTST , UHT **3.3: Milk products: production and spoilage of:** a. Yoghurt b. Butter c. Cheese-Cheddar and Cottage cheese d. Fermented milks **3.4: Quality control of milk** a. Rapid platform tests b. Microbiological analysis of milk.: SPC, Coliform count, LPC, Psychrophiles, Thermophilic count, DRT	**2** **3** **2** **2** **2** **1** **3**

References:

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1. Fundamental Food Microbiology by Bibek Ray, Arun Bhunia (2007), 4th edition CRC Press
2. Food Microbiology by Frazier 5th ed (1971), McGraw-Hill Education.
3. Modern Food Microbiology by James Jay 6th ed(2000), Springer US.
4. Applied Dairy Microbiology by Marth & Steele(2001), CRC Press
5. BIS standards, FSSAI
6. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd,Publishers, New Delhi
7. Stanbury P. F., Whitaker A. & Hall--S. J., 1997, "Principles of Fermentation,Technology", 2nd Edition,Aditya Books Pvt. Ltd, New Delhi.
8. Prescott and Dunn's „"Industrial Microbiology"".1982 4th Edition, McMillan Publishers
9. H. A. Modi, 2009. „"Fermentation Technology"" Vol 2, Pointer Publications, India.
10. Milk and milk products. C. H. Eckles 1943 edition
11. Sukumar De, Outlines of dairy technology , 1st edition,1983, O.U.P

	PRACTICALS	3 Credits
RUSMICP401	**SECTION-1** **MICROBE INTERACTIONS AND HOST RESPONSES**	**1 Credit** **(45 lectures)**
	1. Isolation of *Rhizobium* 2. Demonstration of fungi and algae in lichens 3. Isolation of Xanthomonas from spoilt citrus fruit 4. Study of virulence factors – Enzymes – Streptokinase, Coagulase, Hemolysin, Lecithinase 5. Demonstration of biofilm formation by pathogens in urinary catheters 6. Assignment on classical stages, signs and symptoms of any one microbial disease 7. Staining of blood film to demonstrate different types of leucocytes 8. Phagocytosis (Demonstration) 9. Case studies on Epidemiology	
RUSMICP402	**SECTION-2** **INTRODUCTION TO METABOLIC PATHWAYS AND ENZYMOLOGY**	**1 Credit** **(45 lectures)**
	1. Using KEGG, Ecocyc, metacyc, biocyc and Brenda for understanding metabolic networking 2. Qualitative detection of a. Amylase b. Lipase c. Protease d. DNase e. Catalase f. Oxidase g. Carbohydrate fermentation	

	h. Dehydrogenase 3. Production and purification of an enzyme 4. Assay of an enzyme and determination of enzyme units 5. Determination of km and Vmax of an enzyme 6. Effect of environment on enzyme activity: a. Effect of temperature b. Effect of pH c. Effect of enzyme concentration 7. Effect of inhibitors	
RUSMICP403	**SECTION-3** **APPLIED MICROBIOLOGY**	**1 Credit** **(45 lectures)**
	1. Isolation of antibiotic producers from soil- Wilkin"s overlay method. 2. Determination of microbial counts in food using dip slide technique (demonstration) 3. Isolation of food spoilage agent 4. Determination of TDT and TDP 5. Determination of Salt and sugar tolerance 6. Determination of MIC of a preservative 7. Visit to Food/Dairy industry 8. Rapid platform tests of raw and pasteurized milk. 9. Microbiological analysis of raw and pasteurized Milk 10. Microbiological analysis of Butter, Cheese	

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment - 40% 40 marks.

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project	10
2	One class Test (multiple choice questions / objective)	20
3	Active participation in routine class instructional deliveries(case studies/ seminars/presentation)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

B) External examination - 60 %

Semester End Theory Assessment - 60% 60 marks

i. Duration - These examinations shall be of **two hours** duration.

ii. Theory question paper pattern :-

1. There shall be **three** questions each of **20**marks. On each unit there will be one question.
2. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Questions	Options	Marks	Questions on
Q.1)A)	Any 3 out of 5	15	Unit I
Q.1)B)	Any 5 out of 7	5	
Q.2)A)	Any 3 out of 5	15	Unit II
Q.2)B)	Any 5 out of 7	5	
Q.3)A)	Any 3 out of 5	15	Unit III
Q.3)B)	Any 5 out of 7	5	

Practical Examination Pattern:

(A) Internal Examination: -

	Paper I	Paper II	Paper III
Journal	05	05	05
Test	10	10	10
Participation	05	05	05
Total	20	20	20

(B) External (Semester end practical examination) :- 30 Marks Per Section

Sr.No.	Particulars	Marks Total
1.	Laboratory work	25 + 25+ 25 = 75
2.	Viva	05 + 05 +05 = 15

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 and Marks DistributionPattern

Semester III

Course	301			302			303			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150

Semester IV

Course	401			402			403			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150
