JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program : B.Sc.

Proposed Course : Microbiology

Semester III

Credit Based Semester and Grading System (CBCS) with effect from the academic year 2020 -21

S.Y.B.Sc. Microbiology Syllabus

Academic year 2020-2021

Semester III			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SMIC301	**Essentials of Molecular Biology**	**3**	**3**
UNIT 1	Principles of Inheritance		
UNIT 2	Molecular techniques based on nucleic acids		
UNIT 3	Replication in prokaryotes & eukaryotes		
SMIC302	**Research methodology, Biostatistics and Analytical techniques**	**3**	**3**
UNIT 1	Estimation of biomolecules and Instrumentation-I		
UNIT 2	Instrumentation-II		
UNIT 3	Research methodology and Biostatistics		
SMIC303	**Environmental and Applied Microbiology**	**3**	**3**
UNIT 1	Aeromicrobiology and Soil microbiology		
UNIT 2	Aquatic and Wastewater Microbiology		
UNIT 3	Applied Microbiology		
SMIC3PR	Practical	**2.5**	**9**

SEMESTER III – THEORY

Course: SMIC301	Course Title: Essentials of Molecular Biology (Credits:03 Lectures/Week:03)	45L
Learning Objectives:	➢ To understand genetics and the principles of inheritance of genetic traits ➢ To learn and apply the principles of molecular techniques based on DNA ➢ To understand the events occurring in both Prokaryotic and Eukaryotic DNA replication, with a focus on the involvement of proteins and enzymes at the cellular level	
Outcomes:	On completion of this course, students will learn about: ➢ Branches of genetics ➢ Principles of inheritance ➢ Process of DNA replication ➢ Techniques used in molecular biology	
Unit I	**Principles of Inheritance**	**15 L**
1.1	**Introduction to genetics:** a. Classical and Modern genetics b. Sub disciplines of genetics	**01**
1.2	**Structural organization of chromosomes** a. Prokaryotic chromosomes b. Eukaryotic chromosomes: i. Packaging DNA molecules into chromosomes ii. Concept of euchromatin & heterochromatin iii. Centromeric and Telomeric DNA iv. Unique sequence and Repetitive sequence DNA	**04**
1.3	**Mendelian Genetics:** a. Monohybrid crosses and Mendel's principle of Segregation b. Dihybrid crosses and Mendel's principle of Independent Assortment c. Trihybrid crosses a. Mendelian genetics in humans and pedigree analysis	**07**
1.4	**Population Genetics:** a. Genetic structure of population b. Hardy Weinberg Law	**03**
Unit II	**Molecular techniques based on nucleic acids**	**15 L**
2.1	a. Extraction, Purification of DNA b. Detection of DNA: Density gradient centrifugation, Gel electrophoresis	**02**

2.2	**Labelling of DNA** a. Radioactive and Nonradioactive labelling b. End labelling and Random primer labelling	**02**
2.3	**Denaturation and Hybridization of Nucleic acids** a. Factors affecting denaturation and hybridization of Nucleic Acids b. Blotting Techniques: Southern Blotting, Nothern Blotting, Dot blotting, Colony blotting	**04**
2.4	**Sequencing of DNA** a. Maxam& Gilbert's Sequencing b. Sanger's Sequencing c. Autosequencing	**03**
2.5	**PCR**: Principle and Application	**02**
2.6	**FISH**: Principle and Application	**02**
Unit III	**Replication in prokaryotes & eukaryotes**	**15 L**
3.1	**Historical perspective-** Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication.	**03**
3.2	**Prokaryotic DNA replication** - Details of molecular mechanisms involved in Initiation, Elongation and Termination	**04**
3.3	**Enzymes and proteins associated with DNA replication-**Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, Ter and Tus proteins	**03**
3.4	**Eukaryotic DNA replication** - Molecular details of DNA synthesis, replicating the ends of the chromosomes, assembling newly replicated DNA into nucleosomes.	**04**
3.5	Rolling circle mode of DNA replication	**01**

Textbooks and Additional References:

1 Lehninger A. L., Nelson D. L. & Cox M. M. Lehninger principles of biochemistry, New York: Worth Publishers, 5th Ed., 2008.

2 Madigan M. T., Martinko J. M. Brock biology of microorganism, Upper Saddle River, NJ: Prentice Hall/Pearson Education, 8th Ed., 1997.

3 Russell P. J., iGenetics – A Molecular approach, Pearson Education, Inc., 2nd Ed., 2006

4 Pierce B.A., Genetics a conceptual approach, W. H. Freeman and company, 3rd Ed., 2008.

5 Snustad S., Principles of genetics, John Wiley & sons, Inc., 3rd Ed., 2003.

6 Lewin B., Genes IX, Jones and Bartlett publishers, 2007.

7 Watson J.D., Molecular biology of the gene, Pearson Education Inc, 5th Ed., 2004.

Course: SMIC302	Course Title: Research methodology, Biostatistics and Analytical techniques (Credits:03 Lectures/Week:03)	45L
Learning Objectives:	➢ Learn and understand the principle and applications of methods used for estimation of biomolecules ➢ To learn analytical techniques ➢ To develop soft skills ➢ To appreciate the role played by biostatistics in analysis of biology data'	
Outcomes	➢ On completion of this course, students will learn about: ➢ Use of different Bioanalytical techniques ➢ Searching for good research papers or doing good literature survey ➢ Reading and presenting a research paper ➢ Biostatistical analysis of data	
Unit I	**Estimation of biomolecules and** Instrumentation-**I**	**15 L**
1.1	Macromolecular composition of a microbial cell Methods of elemental analysis**:** a. Carbon by Van-Slyke's method b. Nitrogen by Microkjeldahl method. **c.** Phosphorus by Fiske-Subbarow method Estimation of Proteins and amino acids**:** a. Proteins by Biuret method (Indirect) **b.** Amino acids by Ninhydrin method Estimation of Carbohydrates**:** a. Total carbohydrates by Anthrone method b. Reducing Sugars (maltose) by DNSA method Extraction of Lipids by Soxhlet method Estimation of Nucleic acids **:** a. General principles and extraction of nucleic acids b. DNA by DPA method c. RNA by Orcinol method (**Only Principles And Applications To Be Discussed**)	**05**
1.2	**Chromatographic techniques** a. General Principles b. Types and applications: Partition, adsorption, ion exchange, affinity and size exclusion c. Modes of chromatography: Paper, TLC, Column, HPLC, GC	**10**

Unit II	Instrumentation-II	15 L
2.1	**Centrifugation** a. Introduction: basic principles of sedimentation	07
	b. Preparative centrifugation & its applications (Differential, Rate zonal, Isopycnic) c. Density Gradient Centrifugation d. Rotor Design, Selection and Care e. Analytical centrifugation and its application	
2.2	**Electrophoresis:** a. General principles b. Factors affecting electrophoresis c. Support media: Agarose Gels & Polyacrylamide gels d. Protein Electrophoresis: Native, SDS-PAGE, Isoelectric Focussing gels, 2-D PAGE e. Nucleic Acid electrophoresis: AGE	08
Unit III	**Research methodology and Biostatistics**	**15 L**
3.1	**Introduction to Research Methodology Define a research Problem**	02
3.2	**Data Collection**	02
3.3	**Testing of Hypothesis**	01
3.4	**Scientific Writing Skills**	01
3.5	**Intellectual Property Rights** a. Intellectual Property Rights (IPR) and Intellectual Property Protection (IPP) b. Rationale of Patents in Research and Scientific innovations c. Requirements for Patentability d. Categories of Biotechnological patents- process and products (Discuss with examples of patents granted) e. Steps involved in patenting f. Bioethical Conflicts	03
3.6	**Basics of Biostatistics** a. Introduction to Biostatistics b. Sample and Population c. Data presentation using computer softwares: Dot plot, Bar diagram, Histogram, Frequency curve. d. Central Tendency: (Mean,Median, Mode) Self study. e. Standard Deviation, Variance f. Statistical test: F- test, t-test, Chi square test	06

Textbooks and Additional References:

1. Norris J.R., Ribbons D.W., Methods In Microbiology Vol 5B, London: Academic Press, 1971.
2. Jayaraman J., Laboratory Manual in Biochemistry. New Delhi: New Age International Publishers, 2003.
3. Wilson K. & Walker J., Principles & techniques of Biochemistry &Molecular biology, Cambridge University press, 6th Ed., 2006.
4. Singh Y.K., Fundamental of Research Methodology and Statistics. New age international publishers, 2006.
5. Kothari C.R. & Garg G., Research methodology methods and techniques, New age international publishers, 3rd Ed., 2005.
6. Williams B.L. & Wilson K., A Biologist's guide to Principles and Techniques of Practical Biochemistry, American Elsevier Pub. Co. 1975.
7. Boyer R.F., Modern Experimental Biochemistry, Pearson publishers, 3rd Ed., 2012.
8. Mahajan B.K., Methods in Biostatistics, Jaypee brothers medical publishers, 6thEd., 2006.
9. Dubey R.C, A Textbook of Biotechnology, S. Chand and Company, New Delhi, 2005.
10. Modi H.A, Fermentation Technology Vol: 2, Pointer Publications, India, 2009.

Course: SMIC303	Course Title: Environmental and Industrial Microbiology (Credits:03 Lectures/Week:03)	45L
Learning Objectives:	➢ To learn role of microorganisms in improving the environment. Study microbial flora of air and air sanitation methods ➢ Explore the types of microorganisms present in fresh water, potable water and waste water. ➢ Learn the methods to evaluate the water quality and processing of sewage ➢ Understanding of microbial processes which may be applicable to biogeochemical cycling	
Outcomes:	On completion of this course, students will learn about: ➢ Microbes and their relation with environment, Microflora of air, water and soil ➢ Check potability of water ➢ Role of microorganisms as biofertilizers and biopesticides ➢ Bioremediation and bioleaching	
Unit I	**Aeromicrobiology and Soil microbiology**	**15 L**
1.1	Aeromicrobiology**:** Important airborne pathogens and toxins, Aerosols, nature of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural aeromicrobiology, intramural aeromicrobiology	**07**
1.2	a. Sampling Devices for the Collection of Air Samples b. Detection of microorganisms on fomites	
1.3	Air Sanitation	
1.4	Soil : Soil as microbial environment Biotic and Abiotic stresses	**01**
1.5	Microorganisms in surface soils – (Self Study) Bacteria, Actinomycetes, Fungi ,Algae, Protozoa	
1.6	Sampling strategies and methods for : Surface and Subsurface soil	**01**
1.7	Sample processing : Culture based analysis (Bacteria, Fungi and Viruses) Community DNA analysis	**02**
1.8	Biogeochemical cycles: Carbon, Nitrogen, Phosphorous, Sulphur , Iron	**04**
Unit II	**Aquatic and Wastewater Microbiology**	**15 L**
1.	Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes , marshes and bogs	**03**
2.	Potable water**:** Definition, water purification and list of Pathogens transmitted through water	**02**

3.	Sanitary analysis of water**:** Indicator organisms and their detection in water **:** Total Coliforms, Fecal Coliforms and *E. coli*, Fecal Streptococci, *Clostridium perfringens*	**02**
4.	The nature of wastewater	**01**
5.	Modern Waste Water treatment**:** Primary, Secondary and Tertiary Treatment	**02**
6.	Removal of Pathogens by Sewage treatment Processes	**01**
7.	Oxidation Ponds and Septic tanks	**01**
8.	Sludge Processing	**01**
9.	Disposal of treated waste water and biosolids	**02**
Unit III	**Applied Microbiology**	**15 L**
3.1	**Biofertilizers** Introduction to Biofertilizers. Advantages and disadvantages Types of biofertilizers Mass production of Biofertilizers (*Rhizobium*) Benefits of inoculation Mass cultivation of Blue green algae and their uses Mass cultivation of *Azolla* and its use	**04**
3.2	**Bioinsecticides** Advantages and disadvantages of bioinsecticides Types of bioinsecticides *Bacillus thuringiensis* preparation **Viricides: Baculovirus preparation** Safety of microbial insecticide	**04**
3.3	**Bioremediation** Microorganisms in bioremediation Bioremediation Technologies In-situ Ex-situ Monitoring the efficacy of Bioremediation	**05**
3.4	**Bioleaching**	**01**
3.5	**Bioplastics**	**01**

Textbooks and Additional References:

1. SubbaRao N.S., Advances in agricultural microbiology, Meditech A division of scientific international, 2nd Ed., 2018.
2. Maier R.M., Pepper I.L. & Gerba C.P., Environmental Microbiology San Diego (California): Academic Press, 2nd Ed., 2010.
3. Salle,A.J., Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Company, 7th Ed., 1984.
4. Willey J. M., Sherwood L., Woolverton C. J. Prescott L. M., & Willey J. M., Prescott's microbiology, New York: McGraw-Hill,10th Ed., 2011.
5. Frobisher, M., Fundamentals of microbiology, Philadelphia: Saunders, 9th Ed., 1974.
6. Thakur I, Environmental Biotechnology Basic concepts and application, IK international Pvt Ltd, 2006.
7. Madigan M., Martinko J. & Parkar J, "Brock Biology of microorganisms", Pearson Education International, 12th Ed., 2009.
8. Peppler, H. J. and Perlman, D.,Microbial Technology,Vol. 1 & 2, Academic Press, 1979.

SEMESTER III – PRACTICAL

Course: SMIC3PR	**Practicals based on SMIC 301 ,SMIC 302 ,SMIC 303 (Credits: 2.5, Practicals /Week: Equivalent to 9 lectures/week)**
Learning Objectives:	➢ Develop analytical skills, problem solving & critical thinking ➢ Gain knowledge of the principles & methods involved in estimation of biomolecules ➢ Understand behaviour & activities of microorganisms in their natural environments ➢ Learn important tools & techniques to study microbial activities and its impact on the environment ➢ Develop soft skills
Outcomes:	On completion of the course, students will be acquire abilities to: ➢ Work with nucleic acids ➢ Carry out Quantitative analysis of sugar, protein and other biomolecules ➢ Design an experiment and present research data ➢ Study microbial activities from environmental samples ➢ Test the quality of air, water and sewage ➢ Use biostatistics in compiling scientific data and presentation.
	PRACTICAL – I *1* Isolation of DNA from *E.coli* 2 Separation of DNA using agarose gel electrophoresis 3 PCR (Demonstration) 4 Problems on Mendelian Genetic, Pedigree analysis and Hardy Weinberg Law **PRACTICAL – II** 1 Estimation of biomolecules: a. Reducing sugar by DNSA method b. Protein by direct and indirect Biuret method c. DNA by DPA method d. RNA by Orcinol method 2 Extraction of lipid by Soxhlet method (Demonstration) 3 Separation and identification of amino acids by ascending paper chromatography. 4 Separation and identification of sugars by TLC. 5 Sizing Yeast cells using Density gradient centrifugation (Demonstration) 6 Use of online tools for referencing 7 Downloading and analysis of research paper 8 Preparation of Scientific poster 9 Writing an abstract from a given paper 10 Writing of Research Proposal (CA) 11 Statistical Analysis of given data

	PRACTICAL – III 1 Enumeration of microorganisms in air and study of its load after fumigation 2 Study of air microflora and determination of sedimentation rate 3 Routine analysis of water: a. Standard Plate Count b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test c. Rapid Detection of *E.coli* by MUG Technique (Demonstration) 4 Waste water analysis: a. Study of microbial flora in raw and treated sewage b. Determination of total solids in wastewater c. Determination of BOD and COD of wastewater 5 Analysis of Soil Flora a. Isolation of bacteria, Actinomycetes and fungi from soil b. Enrichment and isolation of Nitrosifiers, Nitrifiers, Cellulose digesters, Sulphate reducers and Phosphate solubilisers from soil c. Setting of a Winogradskys column 6 Visit to a sewage treatment plant or water purification plant. 7 Biofertilizer preparation

EVALUATION SCHEME:

Examination		Time Duration	Marks
A. EVALUATION SCHEME FOR THEORY COURSES (3 PAPERS)			
I. Continuous Assessment (C.A.)			**40**
C.A.I Test	MCQ, 1M answers etc	40 mins	20
C.A.II Test	Assignment/Project /Posters/ Presentations etc		20
II. Semester End Examination (SEE)		**2 hours**	**60**
Each Theory Paper			**40+60= 100**
B. EVALUATION SCHEME FOR PRACTICAL COURSES (3 COURSES)			
Semester End Practical Examination			**150**
For Each Practical course			**50**
Practical Course (3 courses)		**3 days**	**150**