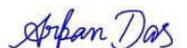
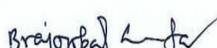
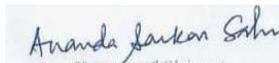


# PANSKURA BANAMALI COLLEGE (AUTONOMOUS)

## NEP Microbiology Syllabus

  
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## Curriculum and Credit Framework for Undergraduate Programmes (w.e.f.2023–2024)

## Structure of the Microbiology UG Programme (B.Sc.) Single Major

Sems.	Major courses		Multi- Disciplinary Courses(M DC)	Minor		Ability Enhancement Comp. Courses(AECC)		Skill Enhance ment Courses (SEC)	Value Added Course s(VAC)	Total Credits
	Core Courses(C C)	Elective (DSE)		Generic Elective(GE)		MIL	Eng. Comm. (EC)			
				GE1	GE1					
<b>I</b>	CC1 (4credits) CC2 (4credits)		MDC1 (3credits)	GE1A (Paper1)( 4credits)	×		AECC(EC1) (2credits)	SEC1 (3credits)	VAC2A (2credits) <b>(Sc.&amp;Com.)</b>	22
							<b>(Science&amp;Commerce)</b>			
<b>II</b>	CC3* (4credits) CC4 (4credits)		MDC2 (3credits)	×	GE2A (Paper1)( 4credits)	AECC(MIL1) (2credits)		SEC2 (3credits)	VAC1A (2credits) <b>(Sc.&amp;Com.)</b>	22
							<b>(Science&amp;Commerce)</b>			
	<b>16</b>	<b>00</b>	<b>06</b>	<b>4 + 4 = 08</b>		<b>2 + 2 = 04</b>		<b>06</b>	<b>04</b>	<b>44</b>
<b>Cert.</b>	<b>Students exiting after completing the courses (44credits) will be awarded UGC certificate in Main / Major subject.</b>									<b>44</b>
<b>III</b>	CC5 (4credits) CC6* (4credits)		MDC3 (3credits)	GE1B (Paper2)* (4credits)	×		AECC(EC2) (2credits)	SEC2*P( 3credits)	VAC2B* (2credits) <b>(Sc.&amp;Com.)</b>	22
							<b>(Science&amp;Commerce)</b>			
<b>IV</b>	CC7 CC8 CC9* (3x4credits)			×	GE2B (Paper2)* (4credits)	AECC(MIL2) (2credits)		Community Outreach(2 credits)	VAC1B* (2credits) <b>(Sc.&amp;Com.)</b>	22
							<b>(Science&amp;Commerce)</b>			
	<b>(16)+ 20= 36</b>		<b>(6)+ 3 = 09</b>	<b>(8)+ 4 + 4= 16</b>		<b>(4)+ 4 = 08</b>		<b>(6)+ 5 = 11</b>	<b>(4)+ 4 = 08</b>	<b>(44)+ 44 = 88</b>
<b>Dip.</b>	<b>Students exiting after completing these courses (88credits) will be awarded UG Diploma in Main / Major subject.</b>									<b>88</b>

\*It indicates a Practical paper; \*P indicates that the paper may be offered by the department concerned as a Practical paper, if applicable.

DSE=Discipline-specific Elective,

VAC1=ENVS; VAC2=Digital & Technological Solution.

Eng.Comm./EC=English Communication. MIL=Modern Indian Language.

**PANSKURABANAMALICOLLEGE (AUTONOMOUS)**  
**Curriculum and Credit Frame work for Undergraduate Programmes (w.e.f.2023–2024)**  
**Structure of the Microbiology UG Programme (B.Sc.) Single Major**

Sems.	Major Courses		Multi- Disciplinary Courses(M DC)	Minor		AbilityEnhanc ementComp.C ourses(AECC)	SkillEnhancementCourses( SEC)	Value Added Courses (VAC)	Total Credits
	Core Courses( CC)	Elective (DSE)		GenericElective(GE)					
				GE1	GE2				
<b>V</b>	CC10 CC11 CC12* (3x4credits)	DSE1 (4credits)	×	GE1C (Paper3) (4credits)	×	×	×	×	20
<b>VI</b>	CC13 CC14 CC15* (3x4credits)	DSE2 (4credits)	×	×	GE2C (Paper 3) (4credits)	×	×	×	20
<b>Degr.</b>	<b>(36)+ 32 =68</b>		<b>(9)+ 0 = 09</b>	<b>(16)+ 8 =24</b>		<b>(8)+ 0 = 08</b>	<b>(11)+ 0 =11</b>	<b>(8)+ 0 = 08</b>	<b>(88)+ 40 = 128</b>
<b>Students pursuing 3year UG programme will be awarded B.Sc. degree in the main /major subject, i.e. core subject upon securing 128credits.</b>									
<b>VII</b>	CC16 CC17 CC18* (3x4credits)	DSE3* (4credits) DSE4 (4credits)	×	GE1D (Paper 4)* (4credi ts)	×	×	×	×	24
<b>VIII</b>	CC19 CC20 CC21* (3x4credits)	DSE5 (4credits) DSE6* (4credits)	×	×	GE2D (Paper 4)* (4credi ts)	×	×	×	24
<b>Hons.</b>	<b>(68)+ 40 =108</b>		<b>(9)+ 0 = 09</b>	<b>(24)+ 8 =32</b>		<b>(8)+ 0 = 08</b>	<b>(11)+ 0 =11</b>	<b>(8)+ 0 = 08</b>	<b>(128)+ 48 = 176</b>
<b>Studentspursuing4yearUGprogrammewillbeawardedB.Sc.degree(Honours)inmain/majorsubject,i.e.coresubjectupon securing176credits.</b>									

\*ItindicatesaPracticalpaper;

**DSE=Discipline-specificElective,**

\*indicates that the paper maybe offered by the department concerned as a Practical paper, if applicable.

**Question patterns of End Semester Examination (ESE)  
For UGC Curriculum and Credit Framework Undergraduate Programmes  
Question pattern for all Courses (Theory only)**

Course		Marks distribution						
Question Types	<b>CC/DSE/IDC/GE/AECC/SEC/VAC (Theoretical)</b>	END Semester Examination Full Marks: <b>40</b> , Time: 2 hours, (Weightage 100%)* <sup>1</sup>				Internal Assessment (Written Mid-Sem+CA)		
						MID-Semester (Written) Examination Full Marks: <b>10</b> , Time: 30 min. (Weightage 50%)* <sup>2</sup>		CA* <sup>3</sup>
	Objective/Very short type	1	Answer 05 question (out of 08) carrying <b>02</b> marks each	<b>02</b> ×5=10	1	Answer 05 question (out of 08) carrying <b>02</b> marks each	<b>02</b> ×5=10	5
	Descriptive/Broad Type* <sup>4</sup>	3	Answer 03 questions (out of 05) carrying <b>10</b> marks each	<b>10</b> ×3=30				
			<b>40</b>			<b>10</b>		

\*<sup>1</sup> 100% weightage means total marks scored out of 40 will be counted/reflected in full finally.  
\*<sup>2</sup> 50% weightage means half the marks scored out of 10 will be counted /reflected finally.  
\*<sup>3</sup> CA stands for Continuous assessment (that may be based on class attendance, roles in departmental activities, *viva* etc.). Full weightage.  
\*<sup>4</sup> Any Descriptive /Broad Type Question, carrying 10 marks, needs not necessarily be a single question.

**Components (All Practical Papers)**

Course		Marks distribution	
<b>Practical</b>	END Semester Examination Full Marks: 50, Time: 2 hours		
	1	Experiments	30
	2	Practical Note Book	15
	3	<i>Vivavoce</i>	5
<b>TOTAL</b>			<b>50</b>

**Components (Project Works other than Research work/Dissertation in the 8<sup>th</sup> Sem.)**

Course		Marks distribution	
<b>Project Work (2Cr.)</b>	END Semester Examination, Full Marks: 50		
	1	Report writing	25
	2	Presentation	15
	3	<i>Vivavoce</i>	10
<b>TOTAL</b>			<b>50</b>

## **Structure of B.Sc.Honours Microbiology**

### **Core Course**

**C-1:**Introduction to Microbiology and Microbial Diversity(Theory)

**C-2:**Bacteriology(Theory)

**C-3:**Introduction to microbial world and bacteriology(Practical)

**C-4:**Virology(Theory)

**C-5:**Biochemistry(Theory)

**C-6:**Biochemistry(Practical)

**C-7:**Microbial physiology and metabolism(Theory)

**C-8:**Cell Biology(Theory)

**C-9:**Cellbiology and microbial metabolism(practical)

**C-10:**Molecularbiology(Theory)

**C-11:**Microbialgenetics(Theory)

**C-12:**Microbial genetics and molecularbiology(Practical)

**C-13:**Immunology(Theory)

**C-14:**Medical Microbiology(Theory)

**C-15:**Medical microbiology and immunology(Practical)

**C-16:**Environmental Microbiology(Theory)

**C-17:**Microbes in sustainable agriculture and development(Theory)

**C-18:**Environmental Microbiology(Practical)

**C-19:**Recombinant DNATechnology(Theory)

**C-20:**Instrumentation and biotechniques(Theory)

**C-21:** Recombinant DNA Technology (Practical)

### **Discipline Specific Elective**

**DSE1:**Industrial Microbiology

**DSE-2:**Foodanddairy Microbiology(Theory)

**DSE-3:**Food and industrial Microbiology(Practical)

**DSE-4:**Bioinformatics(Theory)

**DSE-5:**Biostatistics(Theory)

**DSE-6:**Bioinformatics and Biostatistics (Practical)

## Generic Elective

**GE1:** Introduction and scope of Microbiology (Theory)

**GE2:** Introduction and scope of Microbiology (Practical)

**GE3:** Bacteriology and Virology (Theory)

**GE4:** Bacteriology and Virology (Practical)

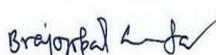
## Skill Enhancement elective Course

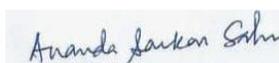
**SEC1:** Biosafety and intellectual property rights (Theory)

**SEC2:** Microbiological analysis of air and water (Theory)

**SEC3:** Microbiological analysis of air and water (Practical)

  
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## **Programme Learning outcomes of BSc. Hons Microbiology course**

A candidate who is conferred an UG (Hons) degree i.e., B.Sc. in microbiology needs to have acquired/developed following competencies during the programme of the study:

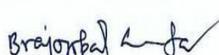
Acquired knowledge and understanding of the microbiology concept applicable to diverse areas such as medical, industrial, environmental, genetics, agriculture, food and others.

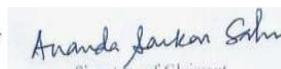
Demonstrate key practical skills/competencies in working with microbes for the study and use in the laboratory as well as outside, including the use of good microbiological practices.

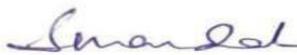
Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate the sewithpeers/team members/other stakeholders, and undertake remedial measures/studies.

Developed abroad perspective of the discipline of Microbiology to enable him to identify challenging social problems and plan his professional career to develop innovative options for such problems.

  
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# CC1: INTRODUCTION TO MICROBIAL WORLD (THEORY)

## Semester-I

**TOTALHOURS -50**

**CREDIT-4**

### Course Learning Outcomes:

**Outcome1.** Give a brief knowledge of history of microbiology and microbiologists those who came consecutively with their discoveries and contributions in this field.

**Outcomes2.** Provides an information about how to classify cellular microorganisms based on their general characteristics.

**Outcomes 3.** Establishes a very good understanding of fungi, algae, protozoa in terms of their general characters, reproduction, lifecycle, habits, thallus organization and importance.

**Outcome4.** Are able to perform basic microbiological laboratory experiments and tools.

### Unit1: History of development of microbiology

**No ofHours-3**

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, Contributions of Antony Von Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.

### Unit 2: System of classification

**No of Hours-4**

Taxonomy and the Linnaean system of classification, Goals of classification, Evolving Trees of Life (Phylogenies), General methods of Classifying Bacteria. Binomial Nomenclature.

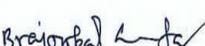
### Unit3: Diversity of Microbial world

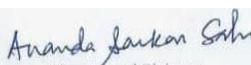
**No of Hours-30**

#### General Characteristics of different groups

Acellular microorganisms (Viruses, Viroid, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

  
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## Viruses, Viroid, Prions

A general introduction with special references to the structure of the following: TMV, Polio virus, T4 and  $\lambda$  phage, lytic and lysogenic cycles, one step multiplication curve.

## Bacteria

A precise account of typical eubacteria and archaeobacteria(extremophiles)

## Algae

General characters of algae including occurrence, thallus organization, algae cellular structure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction. Different types of life cycle in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic lifecycles, Application of algae in agriculture, environment and food.

## Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual and sexual reproduction, heterokaryosis, heterothallism and parasexual mechanisms. Economical importance of fungi with examples in industry, medicine, food, bioderiation, mycotoxins.

## Protozoa

General characteristics with special references to Amoeba, Paramecium and Giardia

## Unit4: Basic Microbiological techniques

**No of Hours-10**

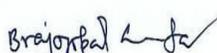
Methods of studying microorganisms, Sterilization techniques - Tyndallization, Pasteurization, Steam under pressure (Autoclave), Incineration, Hot air oven. Inoculation and Incubation, Principle and application of biological safety cabinets (Laminar air flow).

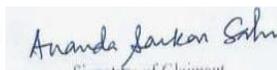
## Unit 5: Importance of Microbiology in Daily Life

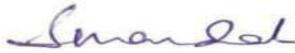
**No. of Hours-3**

Beneficial and harmful microbes and their role in daily life.  
Concept of disease in plant and animal caused by microorganisms.

  
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# Tutorial

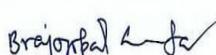
Students will get to learn about-

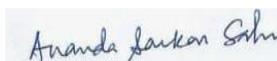
1. Microbiology laboratory practices and biosafety
2. Study of principle and the application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Preparation of different media: Synthetic media BG-11, complex media – nutrient agar
5. Characterization of Bacterial cells and colonies by means of morphological study and staining
  - a) Simple Staining
  - b) Negative Staining
  - c) Gram's staining
  - d) Acid fast – permanent slides
  - e) Endospore staining
  - f) Isolation of pure culture of bacteria by streaking method.
6. Estimation of CFU count by spread plate/pour plate method.

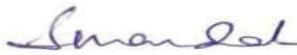
## SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction .9<sup>th</sup> edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9<sup>th</sup> edition. Pearson Education Limited
4. Wiley JM, Sherwood L M and Woolverton CJ. (2013) Prescott's Microbiology. 9<sup>th</sup> edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2<sup>nd</sup> edition. W.M.T. Brown Publishes. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5<sup>th</sup> edition. McGraw Hill Book Company
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5<sup>th</sup> edition. McMillan.

  
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## CC:2BACTERIOLOGY(Theory)

### Semester-I

**Total Hours -50**

**Credit– 4**

**Course learning outcomes:** At the completion of this course, the students are able to–

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or Pilli.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics and classify bacteria into groups.

**Outcome3.** Describe the nutritional requirements of bacteria for growth, developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environment.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms, methods to preserve bacteria in the laboratory, calculate generation time of growing bacteria.

#### **Unit1: Cell organization**

**No ofHours-14**

Cell size, shape and arrangement, glycocalyx, flagella, Endo flagella, fimbriae and Pilli

Cell wall: composition and detailed structure of Gram Positive and Gram-Negative cell walls, archaeobacterial cell wall, Gram and acid-fast staining mechanisms, Lipopolysaccharides (LPS), Spheroplast, protoplast, and L form, Effect of antibiotics and enzymes on cell wall.

Cell Membrane: structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosome, mesosome, inclusion body, nucleoid, chromosome and plasmid, Endospore: structure, formation and stages of sporulation.

#### **Unit2: Bacteriological techniques**

**No. of Hours: 5**

Pure culture isolation: Streaking, serial dilution, plating methods, cultivation, maintenance and preservation /stocking of pure cultures, cultivation of anaerobic bacteria.

#### **Unit3: Microscopy**

**No.ofHours:6**

Bright field and dark field microscope, phase contrast microscope, Fluorescence microscope, Transmission electron microscope, Scanning electron microscope

#### **Unit4: Growth and nutrition**

**No. ofHours:8**

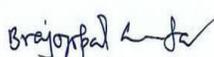
Nutritional requirements of bacteria and nutritional categories.

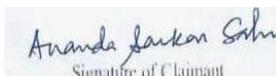
Culture media: components of media, natural, synthetic, chemically defined, complex, selective differential, indicator, enriched and enrichment media

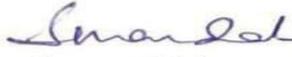
Physical method of microbial control: Heat, low temperature, High pressure, filtration, desiccation, osmotic pressure, radiation

Chemical method of microbial control: Disinfectants, types and mode of action.

  
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**Unit5: Reproduction in Bacteria****No. of Hours:7**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

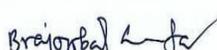
**Unit6: Bacterial Systematics****No. of Hours:10**

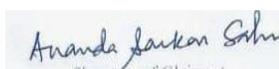
Aims and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chromometers, rRNA oligonucleotide sequencing, signature sequences and protein sequences, Difference between eubacteria and archaeobacteria.

**SUGGESTED READING**

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M. T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14<sup>th</sup> edition Parker J. Prentice Hall International Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava Sand Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers
6. Dordrecht Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9<sup>th</sup> edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9<sup>th</sup> edition. McGraw Hill Higher Education

  
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**GE-1A/2A: INTRODUCTION AND SCOPE OF MICROBIOLOGY(THEORY)**  
**SEMESTER-I/II**

**TOTAL HOURS:50**

**CREDITS:4**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

**Outcome 2.** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

**Outcome3.** Are able to explain the useful and harmful activities of the microorganisms.

**Outcome4.** Are able to perform basic experiment to grow and study microorganisms in the laboratory

**Unit1: History of Development of Microbiology**

**No. of Hours:8**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology,

**Unit2: Diversity of Microorganisms**

**No. of Hours:8**

Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citing examples Protozoa:

**Unit3: Microscopy**

**No. of Hours: 6**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Electron Microscope,

**Unit4: Sterilization**

**No. of Hours:5**

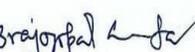
Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration.

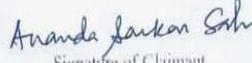
**Unit5: Microbes in Human Health & Environment**

**No. of Hours:10**

Medical microbiology and immunology: Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types Environmental microbiology: Definitions and examples of important microbial interactions—mutualism, commensalism,

  
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parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (e.g., hydrocarbons in oil spills)

**Unit6: Industrial Microbiology**

**No. of Hours:8**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

**Unit7: Food and Dairy Microbiology**

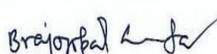
**No. of Hours:5**

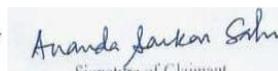
Microorganisms as food (SCP), microorganisms in food fermentations (dairy and nondairy based fermented food products) and probiotics.

**SUGGESTED READING**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition.

  
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**SE-1: BIOSAFETY AND INTELLECTUAL PROPERTY  
RIGHTS(THEORY)  
SEMESTER-I**

**TOTALHOURS:25**

**CREDITS:3**

**Course learning outcomes:** the conclusion of this course, the students have-

**Outcome 1.** Full knowledge of working in a microbiology laboratory taking all safety measures, handling of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit

**Outcome2.** Developed knowledge of basic concepts related to IPR.

**Outcome 3.** Developed knowledge of patent filing, and some well-known/well-publicized case studies related to IPR

**Unit1**

**NoofHours:3**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

**Unit2**

**NoofHours:5**

Biosafety Guidelines: Biosafety guidelines and regulations (National and International);GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC),RCGM,GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs;Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements-Cartagena Protocol.

**Unit3**

**NoofHours:3**

AERB /RSD /RES'S guidelines for using radio isotopes in laboratories and precautions.

**Unit4**

**NoofHours:5**

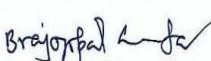
Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR- patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

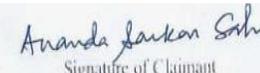
**Unit5**

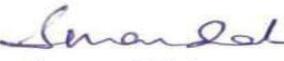
**NoofHours:9**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

  
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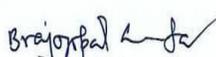
  
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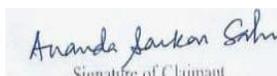
  
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## Suggested Reading

2. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
3. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
4. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
5. Singh KK (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
6. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
7. Senthil Kumar Sadhasvisam and Mohammed Jabbar, M.S. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirappalli, India.

  
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**C3: INTRODUCTION TO MICROBIAL WORLD AND BACTERIOLOGY**  
**(PRACTICALS)**  
**SEMESTER-II**

**TOTAL HOURS: 50**

**CREDIT: 4**

**Course learning outcomes1:** At the completion of this course, the students are able to– **Outcome1:** Have developed a good knowledge of the development of the discipline of Microbiology and the contribution made by prominent scientist in this field.

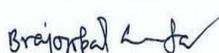
**Outcome2:** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify and basic tools to study them in the laboratory.

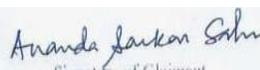
**Outcome3:** Are able to explain the useful and harmful activities of the microorganisms.

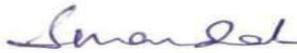
**Outcome4:** Are able to perform basic experiments to grow and study microorganisms in the laboratory.

- a) Microbiology good laboratory practices and biosafety.
- b) To study the principle and application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
- c) Preparation of cultural media for bacterial cultivation.
- d) Sterilization of media using autoclave and assessment for sterility
- e) Sterilization of glassware using hot air oven and assessment for sterility
- f) Sterilization of heat sensitive material using membrane filter and assessment for sterility
- g) Demonstration on the presence of microflora in the environment by exposing nutrient agar plates to air
- h) Study of different shapes of bacteria using electron micrograph
- i) Study of *Rhizopus*, *penicillin*, *Aspergillus* using permanent slides
- j) Study of *Spirogyra*, *Chlamydomonas* and *Volvox* using permanent slides
- k) Study of *Amoeba*, *Entamoeba*, *Paramecium*, *Plasmodium* using permanent slides
- l) Preparation of different media: Synthetic media BG-11, complex media–nutrient agar
- m) Simple Staining
- n) Negative Staining
- o) Gram's staining
- p) Acid fast–permanent slides
- q) Endospore staining
- r) Isolation of pure culture of bacteria by streaking method
- s) Study on preservation of bacteria by various techniques
- t) Estimation of CFU count by spread plate/pour plate method.

  
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**SEMESTER– II**  
**CC-4:VIROLOGY (THEORY)**

**TOTALHOURS:50**

**CREDIT: 4**

**Course learning outcomes:** At the completion of this course, the students are able to–

**Outcome1:** Understand about viruses and the chemical nature of viruses, different types of viruses infecting plant, animal and bacteria.

**Outcome 2:** Understanding about the biology of bacteriophages.

**Outcome 3:** Gain knowledge of a variety of plant and animal viruses.

**Outcome4:** describe the role of viruses in the causation of the cancer.

**Unit1: Nature and Properties of Viruses**

**No.ofHours:12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, Concept of viroid, virusoids, satellite viruses and Prions. Theories of viral origin

Structure of Viruses: Capsid symmetry, enveloped and non- enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

**Unit2: Bacteriophages**

**No of Hours: 10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

**Unit3: Viral Transmission, Salient features of viral nucleic acids**

**No. of Hours:10**

Modes of viral transmission: Persistent, non- persistent, vertical and horizontal Salient features of viral Nucleic acid: Unusual bases (TMV, T4phage), overlapping genes ( $\phi$ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV)

**Unit4: Viruses and cancer**

**No. ofHours:6**

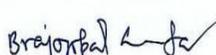
Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses, Concepts of oncogene and protoonco gene.

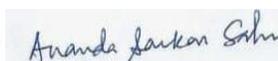
**Unit5: Prevention and control of viral diseases**

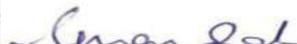
**No. ofHours:8**

Antiviral compounds and their mode of action, Interferon and their mode of action, General principle of viral vaccination.

  
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## Unit6: Application of Virology

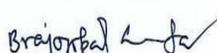
No. of Hours:4

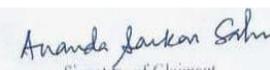
Use of viral vector in cloning and expression, Gene therapy and phage display.

### SUGGESTED READING

1. Dimmock NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6<sup>th</sup> edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2<sup>nd</sup> edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3<sup>rd</sup> edition. Prentice Hall publication, New York.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2<sup>nd</sup> edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses - A textbook of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

  
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**SE-2: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER  
(THEORY) SEMESTER – II**

**TOTAL HOURS: 25**

**CREDITS: 3**

**Course learning outcomes:** By the conclusion of this course, the students-

**Outcome 1.** Have developed a very good understanding and skills of the analysis of air, water and soil.

**Outcome 2.** Have developed a very good understanding of how analysis of water, air and soil contribute to control of environmental pollution.

**Unit 1: Aero microbiology**

**No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

**Unit 2: Air Sample Collection and Analysis**

**No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

**Unit 3: Control Measures**

**No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms–UV light, HEPA filters, desiccation, Incineration

**Unit 4: Water Microbiology**

**No of Hours: 4**

Water borne pathogens; water borne diseases

**Unit 5: Microbiological Analysis of Water**

**No of Hours: 7**

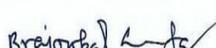
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive / MPN tests, confirmed and completed tests for faecal coliforms, (b) Membrane filter technique and (c) Presence/absence tests.

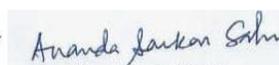
**Unit 6: Control Measures**

**No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light.

  
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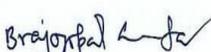
  
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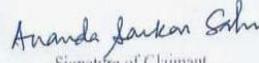
  
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## Suggested Reading

1. daSilvaN, TaniwakiMH,JunqueiraVC, SilveiraN,Nascimento MS,Gomes RAR(2012)MicrobiologicalExaminationMethodsofFoodandWaterALaboratory Manual,CRCPress.
2. AtlasRMandBarthaR.(2000).MicrobialEcology:Fundamentals& Applications. 4thedition. Benjamin/Cummings SciencePublishing, USA
3. MaierRM,Pepper IL and GerbaCP.(2009).EnvironmentalMicrobiology.2nd edition, AcademicPress
4. HurstCJ,CrawfordRL,GarlandJL,LipsonDA(2007)ManualofEnvironmentalMicrobiology, 3rd edition, ASM press

  
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**GE-1A/2A: INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)**  
**SEMESTER – I/II**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

**Outcome 2.** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

**Outcome 3.** Are able to explain the useful and harmful activities of the microorganisms.

**Outcome 4.** Are able to perform basic experiments to grow and study microorganisms in the laboratory

**Unit 1: History of Development of Microbiology**

**No. of Hours: 8**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology,

**Unit 2: Diversity of Microorganisms**

**No. of Hours: 8**

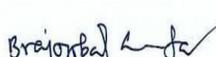
Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citing examples. Protozoa:

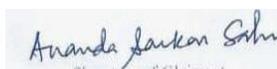
**Unit 3: Microscopy**

**No. of Hours: 6**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Electron Microscope,

  
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**Unit4: Sterilization****No. of Hours: 5**

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration.

**Unit5: Microbes in Human Health & Environment****No. of Hours: 10**

Medical microbiology and immunology: Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (e.g., hydrocarbons in oil spills)

**Unit6: Industrial Microbiology****No. of Hours: 8**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

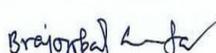
**Unit7: Food and Dairy Microbiology****No. of Hours:**

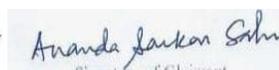
**5** Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermented food products) and probiotics.

**SUGGESTED READING**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
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4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition.

  
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**SEMESTER – III**  
**CC-5: BIOCHEMISTRY (THEORY)**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** At the completion of this course, the students are able to–

**Outcome1:** Developed a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.

**Outcome2:** Developed how the carbohydrates make the structural and functional components such as energy generate ion and as storage food molecules for the bacterial cell.

**Outcome3:** Well conversant about multifarious function of protein, are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics, also knowledge about lipids and nucleic acids.

**Outcome 4:** Students are able to make buffers, study enzyme kinetics and calculate  $V_{max}$ ,  $K_m$  and  $K_{cat}$  values.

**Unit1: Bioenergetics**

**No of Hours :4**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change,

**Unit2: Carbohydrates**

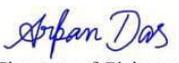
**No of Hours :12**

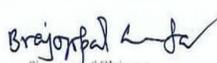
Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and both forms of glucose Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptide glycan and chitin

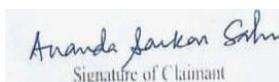
**Unit 3: Lipids**

**No of Hours :10**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acid's structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification, Structural lipids. Phospho glycerides: Building blocks, General structure, functions and properties. Structure of phosphatidyl ethanolamine and phosphatidyl choline, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins.

  
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#### Unit4: Proteins

No of Hours :12

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and Synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta-pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human hemoglobin structure, Quaternary structures of proteins

#### Unit5: Enzymes

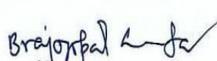
No of Hours :12

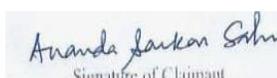
Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turn over number, Multi enzyme complex: pyruvate dehydrogenase ; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfadruugs; non-competitive- heavy metal salts.

### SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W. H. Freeman and Company.
6. Willey MJ, Sherwood, LM & Woolverton CJ (2013) Prescott, Harley and Klein's Microbiology by 9th Ed., McGraw Hill
7. Voet, D. and Voet J. G (2004) Biochemistry 3rd edition, John Wiley and Sons,

  
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## C6: BIOCHEMISTRY (PRACTICALS)

SEMESTER: III

TOTAL HOURS:50

CREDITS:4

**Course learning outcomes:** By the end of this course the students-

**Outcome 1.** Developed a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.

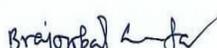
**Outcome2.** Havedevelopedhowthecarbohydratesmakethestructuralandfunctionalcomponentssucha s energy generation and as storage food molecules for the bacterial cells.

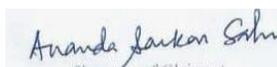
**Outcome 3.** Well conversant about multifarious function of proteins; are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; also, knowledge about lipids and nucleic acids.

**Outcome4.** Student are able to make buffers, study enzyme kinetics and calculate  $V_{max}$ ,  $K_m$ ,  $K_{cat}$  values.

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant.
3. Standard Free Energy Change of coupled reactions.
4. Qualitative/ Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars.
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models (RASMOL)
7. Study of enzyme kinetics—calculation of  $V_{max}$ ,  $K_m$ ,  $K_{cat}$  values
8. Study effect of temperature, pH and heavy metals on enzymatic activity.
9. Estimation of any one vitamin.

  
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**GE-1B/2B:INTRODUCTIONAND SCOPEOFMICROBIOLOGY(PRACTICALS)**  
**SEMESTER–III/IV**

**TOTALHOURS:50**

**CREDITS:4**

**Course learning outcomes:** At the conclusion of this course the students–

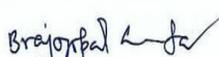
**Outcome 1.** Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

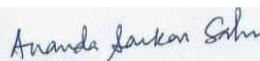
**Outcome 2.** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

**Outcome 3.** Are able to explain the useful and harmful activities of the microorganisms. **Outcome 4.** Are able to perform basic experiments to grow and study microorganism in the laboratory.

1. Microbiology Laboratory Management and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Demonstration of presence of microflora in the environment by exposing nutrient agar plate to air.
7. Study of different shapes of bacteria using permanent slides
8. Study of Rhizopus and Penicillium using permanent mounts
9. Study of Spirogyra and Chlamydomonas using permanent Mounts
10. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium.

  
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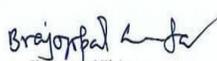
  
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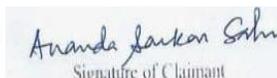
  
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## SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9<sup>th</sup> edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

  
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## SE-2:MICROBIOLOGICALANALYSISOF AIRANDWATER(PRACTICAL) SEMESTER – III

**TOTALHOURS:25**

**CREDITS:3**

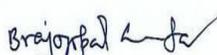
**Courselearningoutcomes:**Bytheconclusionofthiscourse,thestudents-

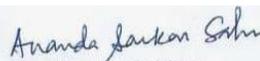
**Outcome 1.** Have developed a very good understanding and skills of theanalysisof air, waterandsoil.

**Outcome2.** Havedevelopedaverygoodunderstandingofhowanalysisofwater,aira ndsoilcontributetocontrolof environmental pollution.

1. Isolationand characterizationofbacteriaandfungifromdifferentsourcesofenvironment.
2. MicrobialanalysisofwatercollectedfromdifferentourcesinPanskuraBana maliCollege(TBC,MPN,PotentiallyHarmfulMicroorganisms).

  
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**C-7: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)  
SEMESTER-IV**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the conclusion of this course, the students are capable of -

**Outcome 1.** Describing the growth characteristics of the microorganisms capable of growing under unusual environmental condition of temperature, oxygen, and solute and water activity.

**Outcome 2.** Describing the growth characteristics of the microorganisms which require different nutrient for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemo litho-autotrophs etc.

**Outcome 3.** Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.

**Unit 1: Microbial Growth and Effect of Environment on Microbial Growth**

**No. of Hours: 12**

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate  
Temperature and temperature ranges of growth pH and pH ranges of growth. Effect of solute and water activity on growth Effect of oxygen concentration on growth Nutritional categories of microorganisms.

**Unit 2: Nutrient uptake and Transport**

**No. of Hours: 10**

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake.

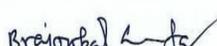
**Unit 3: Chemoheterotrophic Metabolism- Aerobic Respiration**

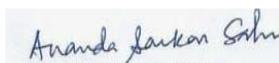
**No. of Hours: 11**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways.

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitor.

  
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**Unit4: Chemo heterotrophic Metabolism-Anaerobic respiration and fermentation****No.ofHours:6**

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/Nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation- Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.

**Unit5: Chemo lithotrophic and Phototrophic Metabolism****No.ofHours:5**

Introduction to aerobic and anaerobic chemo-lithotrophy with an example each. Hydrogen oxidation(definitionandreaction)andmethanogenesis(definitionandreaction) Introduction to phototrophic metabolism-anoxygenicvs. Oxygenic photosynthesis

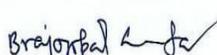
**Unit6: Nitrogen Metabolism****No.ofHours:6**

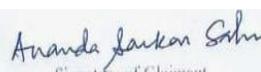
IntroductiontobiologicalnitrogenfixationAmmoniaassimilationAssimilatory nitrate reduction

**SUGGESTED READINGS**

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition.PrenticeHallInternationalInc.
2. MoatAGandFosterJW.(2002).MicrobialPhysiology.4thedition.JohnWiley&Sons
3. ReddySRandReddySM.(2005).MicrobialPhysiology.ScientificPublishers India
4. GottschalkG.(1986).BacterialMetabolism.2ndedition.SpringerVerlag
6. StanierRY,IngrahmJI,WheelisMLandPainterPR.(1987).GeneralMicrobiology.5thedition,McMillanPress.
7. WilleyJM,SherwoodLM, andWoolverton CJ.(2013).Prescott'sMicrobiology.9thedition.McGrawHillHigherEducation

  
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## C-8:CELLBIOLOGY(THEOR Y)SEMESTER–IV

**TOTALHOURS:50**

**CREDITS:4**

**Outcomes:**Studentswillhavebasicknowledgeofcell organization-

**Outcome1.**Abletodistinguish

prokaryoticandeukaryoticcellsintermsoftheirstructuresandinternalorganization.

**Outcome2.**Understoodthestructuresofnucleus.

**Outcome3.**Describedtherolesofribosomes,

endoplasmicreticulum,Golgiapparatus,lysosomesinproteintargeting, folding, processing, sorting andtransporting.

**Outcome4.**Abletounderstandcellsignallingverywell.

### **Unit1:Structureof Cell**

**No.ofHours:12**

Plasmamembrane:Structureandtransportofsmallmolecules

Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-CellInteractions-

adhesionjunctions,tightjunctions,gapjunctions,andplasmodesmata(onlystructuralaspects)

Mitochondria,chloroplastsandperoxisomes

Cytoskeleton:Structureandorganizationofactinfilaments,intermediatefilaments,microtubules

### **Unit2:Nucleus**

**No.ofHours:4**

Nuclearenvelope,nuclearporecomplexandnuclearlaminaChromatin–Molecularorganization

Nucleolus

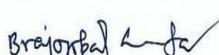
### **Unit3:ProteinSortingandTransport**

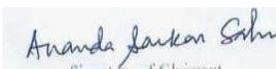
**No.ofHours:12**

Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, proteinfolding,processingandqualitycontrolinER,smoothERandlipidsynthesis,exportofproteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and exportfromGolgiApparatus

Lysosomes

  
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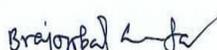
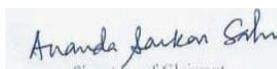
**Unit4:CellSignaling****No.ofHours:10**

SignallingmoleculesandtheirreceptorsFunctionofcellsurfacereceptors

Pathwaysofintra-cellularreceptors–CyclicAMPpathway,cyclicGMPandMAPkinasepathway

**Unit5:CellCycle,CellDeathandCellRenewal****No. of****Hours:12**Eukaryoticcellcycleanditsregulation,MitosisandMeiosisDevelopmentof cancer, causesandtypesProgrammed celldeath**SUGGESTEDREADING**

1. HardinJ,BertoniGand KleinsmithLJ.(2010).Becker’sWorldoftheCell.8thedition.Pearson.
2. KarpG .(2010)Cell and Molecular Biology:Concepts and Experiments.6<sup>th</sup> edition.JohnWiley&Sons.Inc.
3. DeRobertis,EDPandDeRobertisEMF.(2006).CellandMolecularBiology.8th edition.LipincottWilliamsandWilkins,Philadelphia.
4. Cooper,G.M.andHausman,R.E.(2009).TheCell:AMolecularApproach.5<sup>th</sup> Edition.ASM Press&Sunderland, Washington,D.C;SinauerAssociates,MA.

  
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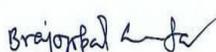
**C9: CELL BIOLOGY AND MICROBIAL METABOLISM (PRACTICAL)**  
**SEMESTER-IV**

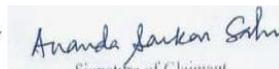
**TOTAL HOURS: 50**

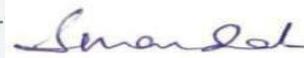
**CREDITS: 4**

1. Study and plot the growth curve of *E. coli* by turbidimetric.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Demonstration of alcoholic fermentation
6. Demonstration of the thermal death time and decimal reduction time of *E. coli*.
7. Study of representative plant and animal cells by microscopy.
8. Study of the structure of cell organelles through electron micrographs
9. Cytochemical staining of DNA – Feulgen
10. Identification and study of cancer cells by photomicrographs
11. Study of different stages of Mitosis
12. Study of different stages of Meiosis
13. Isolation of Sulphur lithotropic bacteria.
14. Preparation of winogradsky column.

  
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**GE-1B/2B:INTRODUCTIONAND SCOPEOFMICROBIOLOGY(PRACTICALS)**  
**SEMESTER–III/IV**

**TOTALHOURS:50**

**CREDITS:4**

**Courselearning outcomes:** Attheconclusionofthiscoursethestudents–

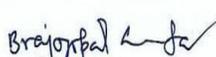
**Outcome1.**Have developedagoodknowledgeofthe developmentofthedisciplineofMicrobiologyand thecontributions madebyprominent scientistsin this field.

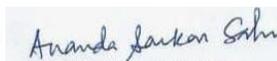
**Outcome2.**Have developedaverygoodunderstandingofthecharacteristicsofdifferenttypesof microorganisms, methods to organize/classify these into and basic tools to study these in thelaboratory.

**Outcome 3.** Are able to explain the useful and harmful activities of the microorganisms.**Outcome4.**Areabletoperformbasicexperimentstogrowandstudymicroorganism sinthelaboratory.

1. MicrobiologyLaboratoryManagementandBiosafety.
2. To study the principle and applications of important instruments (biological safety cabinets,autoclave, incubator, BOD incubator, hot air oven, lightmicroscope, pH meter) used in themicrobiologylaboratory
3. Preparationofculturemediaforbacterialcultivation
4. SterilizationofmediumusingAutoclaveandassessmentforsterility5.Sterilizationofglasswareusi ng Hot AirOvenand assessmentforsterility
5. Demonstrationofpresenceofmicrofloraintheenvironmentbyexposingnutrientagarplatestoair.
6. Studyofdifferentshapesofbacteriausingpermanentslides
7. StudyofRhizopusandPenicilliumusingpermanentmounts
8. StudyofSpirogyraandChlamydomonasusingpermanentMounts11.Studyofthefollowingprotoz oans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium andPlasmodium

  
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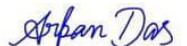
  
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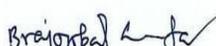
  
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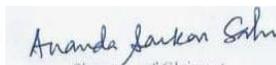
  
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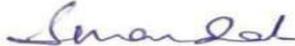
## SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9<sup>th</sup> edition. Pearson Education Limited.
4. 4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

  
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## C-10:MOLECULARBIOLOGY(THEORY)

### SEMESTER–V

**TOTALHOURS:50**

**CREDITS:4**

#### **Outcome-**

**Outcome1.**Studentswillhavebasic

knowledgeofcellorganization,DNAstructureandfunction,RNAstructureandfunction,Central Dogma,Geneexpressionand protein biosynthesis,cell signaling.

**Outcome2.**Studentswill gettoknowthe connectionbetweenGenome organizationandevolution.

**Outcome3.**Theywill learnhowto assessandreport alaboratory experiments.

**Outcome4.**Overall,thiscourseintegrateslectureandlaboratorysessionsthroughoutthesemester.

#### **Unit1:StructuresofDNAandRNA/GeneticMaterial**

**No.ofHours:10**

Structure:Miescherto WatsonandCrick- historic perspective, DNA structure,Salient features of double helix, Types of DNA, Types of genetic material, denaturation andrenaturation,cotcurves.DNA topology- linkingnumber,topoisomerases;OrganizationofDNAProkaryotes, Viruses,Eukaryotes.RNAStruc ture,OrganelleDNA—mitochondriaandchloroplastDNA.

#### **Unit2:ReplicationofDNA(ProkaryotesandEukaryotes)**

**No.ofHours:10**

idirectional and unidirectional replication, semi-conservative, semi-discontinuousreplicationMechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNApolymerases,DNAligase,primase, telomerase– forreplicationofflinearends

VariousmodelsofDNAreplicationincludingrollingcircle,D-loop(mitochondrial), $\Theta$ (theta)modeof replicationandotheraccessoryprotein,Mismatchandexcisionrepair

#### **Unit3:Transcription inProkaryotesand Eukaryotes**

**No. of Hours:**

**8**Transcription: Definition, difference from replication, promoter- concept and strength ofpromoterRNAPolymeraseandthetranscriptionunit

TranscriptioninEukaryotes:RNAPolymerases,generalTranscriptionfactors

#### **Unit4Post-TranscriptionalProcessing**

**No.ofHours:8**

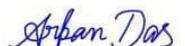
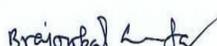
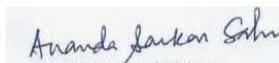
enes, concept of introns and exons, RNA splicing, splice of some machinery conceptofalternative splicing, Poly adenylation and capping, Processing of rRNA, RNA interference:siRNA,miRNAanditssignificance

**Unit5: Translation (Prokaryotes and Eukaryotes)****No. of****Hours: 10** Translational machinery, Charging of t-

RNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

**Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes****No. of****Hours: 4** Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Yeast mating types switching.**SUGGESTED READINGS**

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6<sup>th</sup> edition, Cold Spring Harbour Lab Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7<sup>th</sup> edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6<sup>th</sup> edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4<sup>th</sup> Edition, Cold Spring Harbour Laboratory Press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

  
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## **C 11: MICROBIAL GENETICS AND GENOMICS (THEORY) SEMESTER-V**

**TOTAL HOURS: 50**

**CREDITS: 4**

### **Course learning outcomes:**

**Outcome 1:** Understood genome organization of model organisms and the molecular mechanisms that underlie mutations.

**Outcome 2:** Developed a fairly good knowledge about the three well-known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.

**Outcome 3:** Are able to describe different types of the extrachromosomal elements or the plasmids; the nature of the transposable element in the prokaryotic and eukaryotic.

### **Unit 1: Mutations**

**No. of hours: 14**

Mutation and Mutagenesis: Definition and types of mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); use of mutation; Reversion and suppression; True revertants; Intra and intergenic suppression; Ames test; Mutator genes.

### **Unit 2: Plasmid**

**No. of hours: 14**

Types of plasmid - F plasmid, R plasmid, Colicinogenic plasmid, Ti plasmid, Linear Plasmids, yeast-2  $\mu$  plasmid, Plasmid replication and partitioning, Host range, Plasmid-incompatibility, Plasmid amplification, Regulation of copy number, Curing of plasmids.

### **Unit 3: Mechanisms of genetic exchange**

**No. of hours: 8**

Transformation - Discovery, mechanism of natural competence  
Conjugation - Discovery, Hfr and  $F^+$  strains, Interrupted mating technique and time of entry mapping  
Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates.

### **Unit 4: Phage Genetics**

**No. of hours: 8**

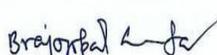
Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda.

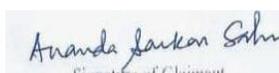
### **Unit 5: Transposable elements**

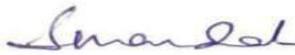
**No. of hours: 10**

Prokaryotic transposable elements - Insertion sequence, Composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon, Eukaryotic transposable element.

  
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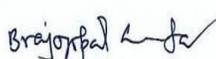
  
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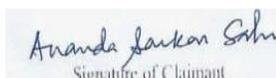
  
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## SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). iGenetics - A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory Press.
8. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Bartlett Publisher

  
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**C-12: Microbial Genetics and Molecular Biology (Practical)**  
**Semester-V**

**Total Hour: 50**

**Credits: 4**

**Course learning outcomes:** By the conclusion of this course, the students have-

**Outcome 1.** Understood genome organization of model organisms namely *E. coli* and *Saccharomyces*, and the molecular mechanisms that underlie mutations.

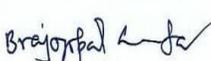
**Outcome 2.** Developed a fairly good knowledge about the three well-known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction, conjugation.

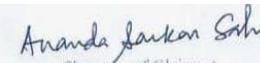
**Outcome 3.** Are able to describe different types of the extrachromosomal elements or the plasmids; the nature of the transposable elements in the prokaryotic and eukaryotic cells.

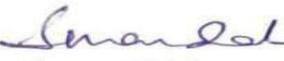
**Outcome 4.** Hands-on skills of isolation of plasmid DNA from bacterial cell and its visualization by performing agarose gel electrophoresis.

1. Proof of Master and replica plate preparation.
2. Study of the effect of chemical ( $\text{HNO}_2$ ) and physical (UV) mutagen on bacterial cells.
3. Study of survival curve of bacteria after exposure to UV light.
4. Isolation of Plasmid DNA from *E. coli*
5. Study of different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Genetic mapping by interrupted mating-Conjugation.
7. Study of different types of DNA and RNA using micrograph model/schematic representations.
8. Demonstration of Bacterial Conjugation.
9. Study of semiconservative replication of DNA using micrograph model/schematic representations.
10. Isolation of genomic DNA from *E. coli*.
11. Estimation of salmon sperm/calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer ( $A_{260}$  measurement).
12. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer ( $A_{260}$  measurement).
13. Resolution and visualization of DNA by agarose gel electrophoresis.
14. Resolution and visualization of protein by Polyacrylamide gel electrophoresis (PAGE).

  
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**DSE1:INDUSTRIAL MICROBIOLOGY(THEORY)**  
**SEMESTER-V**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the conclusion of this course, the students-

**Outcome 1:** Are capable of describing a large number of substrates that are used for the industrial fermentation processes.

**Outcome 2:** Have developed an understanding of different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentation and their processes parameters.

**Outcome 3:** Have acquired a detailed knowledge of number of products which are produced by industrial fermentation process.

**Unit 1: Introduction to industrial microbiology and fermentation process**

**No. of hours:**

**10** Brief history and developments in industrial microbiology, Types of fermentation process: Solid state and liquid state (Stationary and Submerged) fermentation, Batch fermentation, Fed-batch fermentation (e.g. Baker's yeast) and continuous fermentation.

**Unit 2: Types of bioreactors and measurement of fermentation parameters**

**No of Hours:**

**10** Components of a typical bioreactor, Types of bioreactors: laboratory, Pilot Scale and Production fermenter, Constantly Stirred tank bio-reactors and air-lift bioreactor, Measurement and Control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

**Unit 3: Isolation of industrially important microbial strain and fermentation media**

**No. of Hours:**

**10** Source of industrially important microbes and methods for their isolation, Preservation and maintenance of industrial strain, Strain improvements, Crude and synthetic media, molasses, corn-steep liquor, Sulphate waste liquor, Whey, Yeast extraction and protein hydrolysates.

**Unit 4: Downstream Processing**

**No. of hours: 10**

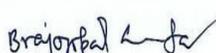
Cell disruption, filtration, Centrifugation, Solvent Extraction, Lyophilization and Spray drying.

**Unit 5: Microbial Production of industrial products (microorganisms involved, media, fermentation conditions, downstream processing and uses)**

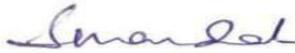
**No. of hours:**

**10** Citric acid, Ethanol, Penicillin, Glutamic acid, Vitamin B12, Wine, Beer.

  
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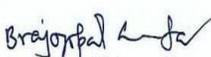
  
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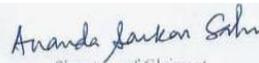
  
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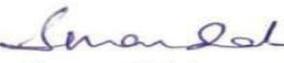
## SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1<sup>st</sup> edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley-Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida L.E. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. tanbury P.F., Whitaker A. and Halls J.S. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd

  
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## GE-1C/2C: BACTERIOLOGY AND

### VIROLOGY (THEORY) SEMESTER – V/VI

**TOTAL HOURS 50**

**CREDITS: 4**

**Course learning outcomes:** At the completion of this course, the students are able to –

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics; classify bacteria into groups.

**Outcome 3.** Describe the nutritional requirements of bacteria for growth; develop knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

**Outcome 5.** Understand what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages)

**Outcome 6.** Understanding about the biology of bacteriophages.

**Outcome 7.** Gained knowledge of a variety of plant viruses and animal viruses.

**Outcome 8.** The ability to describe role of viruses in the causation of the cancer'

#### **Unit 1: Cell organization**

**No. of Hours: 10**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

#### **Unit 2: Bacterial growth and control**

**No. of Hours: 8**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria Growth: Binary fission, phases of growth

#### **Unit 3: Bacterial Systematics and Taxonomy**

**No. of Hours: 8**

Taxonomy, nomenclature, systematics, types of classifications Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles

**Unit4:IntroductiontoViruses****No.ofHours:8**

Propertiesofviruses;generalnatureandimportantfeaturesSubviralparticles;viroid's,prionsandtheir importanceIsolationandcultivationofviruses

**Unit5:Structure,andmultiplicationofviruses****No.ofHours:8**

Morphologicalcharacters:CapsidsymmetryanddifferentshapesofviruseswithexamplesViralmulti plication in the Cell: Lytic and lysogenic cycle Description of important viruses: salientfeatures of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV&CauliflowerMosaicVirus), Human(HIV)

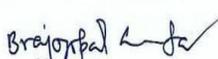
**Unit6:RoleofVirusesinDiseaseanditsprevention****No.ofHours:8**

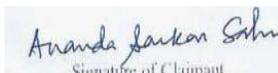
Virusesaspathogens:RoleofvirusesincausingdiseasesPreventionandcontrolofviruses:interferons andantiviralcompounds

**SuggestedReadings:**

1. AtlasRM.(1997). PrinciplesofMicrobiology.2nd edition.WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms.14thedition. Pearson Education,Inc.
3. StanierRY, IngrahamJL,WheelisMLandPainterPR.(2005).GeneralMicrobiology.5thedition. McMillan
4. CarterJandSaunders V(2007).Virology;principlesandApplications.JohnWileyandSons
5. FlintSJ,Enquist, LW,Krug,RM, Racaniello,VRSkalka, AM(2004)Principles ofVirology,MolecularBiology, Pathogenesis and Control.2nd edition.ASM Press
6. ShorsTeri(2013)UnderstandingViruses2ndeditionJonesandBartlettLearningBurlingtonUSA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGrawHill.
8. TortoraGJ, FunkeBR,and CaseCL.(2008).Microbiology: AnIntroduction.9theditionPearsonEducation.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
10. Dimmock,NJ,Easton,AL,Leppard,KN(2007). IntroductiontoModernVirology.6thedition,Blackwell Publishing Ltd.
11. CannAJ(2012)PrinciplesofMolecularVirology, AcademicPressOxfordUK

  
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## C-13:IMMUNOLOGY(THEOR Y)SEMESTER–VI

**TOTALHOURS:50**

**CREDITS:4**

**Courselearningoutcomes:**Bytheconclusionofthiscourse,thestudentsclearly-

**Outcome 1.** Understood the basic and general concepts of causation of disease by the pathogenicmicroorganisms and the various parameters of assessment of their severity including the broadcategorizationofthe methods of diagnosis.

**Outcome 2.** Developed a thorough understanding of common bacterial, viral, fungal, parasiticdiseasesofhumanbeing including someveryimportantdiseases of theanimalsalso.

**Outcome 3.** Conceptualized the protective role of the immune system of the host and developedan understanding of the basic components as well as the mechanisms underlyingthe immunesystemandits response to pathogenicmicroorganisms.

**Outcome 4.** Are able to conduct experiments for growing common bacteria indifferentmicrobiologicalmedia,antibioticsensitivitydeterminationandantigenantibodyreaction(precipitationtest in theagarose)

### **Unit1:Introduction**

**No.ofHours:4**

ConceptofInnateandAdaptiveimmunity;Contributionsoffollowingscientiststothe developmentof field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, ElieMetchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and SusumuTonegawa

### **Unit2:ImmuneCellsandOrgans**

**No.ofHours:7**

Structure,FunctionsandPropertiesof:ImmuneCells– Stemcell,Tcell,Bcell,NKcell,Macrophage, Neutrophil, Eosinophil, Basophil, Mastcell, Dendriticcell and Immune Organs– BoneMarrow,Thymus,LymphNode,Spleen,GALT,MALT,CALT

### **Unit3:Antigens**

**No.ofHours:4**

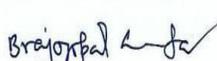
Characteristicsofanantigen(Foreignness,MolecularsizeandHeterogeneity);Haptens;Epitopes(T&B cellepitopes);T-dependent andT-independentantigens;Adjuvants

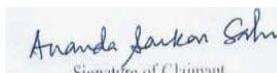
### **Unit4:Antibodies**

**No.ofHours:4**

Structure,Types,FunctionsandPropertiesofantibodies;Antigenicdeterminantsonantibodies(Isotypic, allotypic, idiotypic); Monoclonal andChimericantibodies

  
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**Unit5:MajorHistocompatibilityComplex**

**No.ofHours:5**Orga

nizationofMHClocus(Mice&Human);StructureandFunctionsof MHCI&II molecules;Antigenprocessingandpresentation(CytosolicandEndocyticpathways)

**Unit6:ComplementSystem**

**No.**

**ofHours:4**ComponentsoftheComplementsystem;Activationpathways(Classical,Alternativeand Lectinpathways);BiologicalconsequencesofcomplementActivation.

**Unit7:GenerationofImmuneResponse**

**No.ofHours:10**P

primary and Secondary Immune Response; Generation of Humoral Immune Response(Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHCrestriction,Tcell activation,Co-stimulatorysignals);KillingMechanismsbyCTL.

**Unit8:ImmunologicalDisordersand TumorImmunity**

**No.ofHours:6**

Types ofAutoimmunityandHypersensitivitywith examples;Immunodeficiencies- Animalmodels (Nude and SCID mice), SCID, DiGeorgesyndrome,ChediakHigashisyndrome,Leukocytheadhesiondeficiency,CG D;

**Unit9:ImmunologicalTechniques**

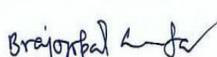
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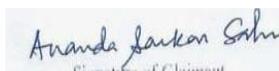
**Hours:6**PrinciplesofPrecipitation,Agglutination,Immunodiffusion,Immuno electrophoresis,E LISA,ELISPOT,Westernblotting,Immunofluorescence,

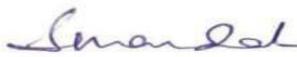
**SUGGESTED READINGS**

1. AbbasAK,LichtmanAH,PillaiS.(2007).CellularandMolecularImmunology.6theditionSaundersPublication,Philadelphia.
2. DelvesP,MartinS,BurtonD,RoittIM.(2006).Roitt’sEssentialImmunology.11theditionWiley-BlackwellScientificPublication,Oxford.
3. GoldsbyRA,KindtTJ,OsborneBA.(2007).Kuby’sImmunology.6theditionW.H.FreemanandCompany,NewYork.
4. MurphyK,TraversP,WalportM.(2008).Janeway’sImmunobiology.7theditionGarlandSciencePublishers,NewYork.
5. PeakmanM,andVerganiD.(2009).BasicandClinicalImmunology.2ndeditionChurchillLivingstonePublishers,Edinberg.
6. RichardCandGeiffreyS.(2009).Immunology.6thedition.WileyBlackwellPublication

  
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## C-14: MEDICAL MICROBIOLOGY (THEORY) SEMESTER – VI

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the conclusion of this course, the students clearly-

**Outcome 1.** Understood the basic and general concepts of causation of disease by the pathogenic microorganisms and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis.

**Outcome 2.** Developed a thorough understanding of common bacterial, viral, fungal, parasitic diseases of human being including some very important diseases of the animals also.

**Outcome 3.** Conceptualized the protective role of the immune system of the host and developed an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms.

**Outcome 4.** Are able to conduct experiments for growing common bacteria in different microbiological media, antibiotic sensitivity determination and antigen-antibody reaction (precipitation test in the agarose)

### **Unit 1: Normal microflora of the human body and host-pathogen interaction**

**No. of Hours: 8**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract

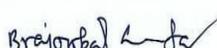
Host-pathogen interaction: Definitions, Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiological effects of LPS.

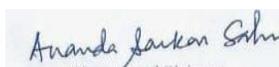
### **Unit 2 Bacterial diseases**

**No. of Hours: 12**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control respiratory diseases: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*

  
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### **Unit3Viraldiseases**

**No.ofHours:12**

Listofdiseasesofvariousorgansystemsandtheircausativeagents.ThefollowingdiseasesindetailwithSymptoms, modeof transmission, prophylaxisandcontrol

Polio,Herpes,Hepatitis,Rabies,Dengue,AIDS,Influenzawithbriefdescriptionofswineflu,Ebola,C  
hikungunya,JapaneseEncephalitis

### **Unit4Protozoandiseases**

**No.ofHours:5**

Listofdiseasesofvariousorgansystemsandtheircausativeagents.ThefollowingdiseasesindetailwithSymptoms,modeoftransmission,prophylaxisandcontrolMalaria,Kala-azar

### **Unit5Fungaldiseases**

**No.ofHours:5**

Briefdescriptionofeachofthefollowingtypesofmycosesandonerepresentativediseasetobestudiedwithrespectto transmission,symptomsandprevention

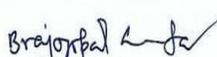
Cutaneousmycoses:Tineaepidis(Athlete'sfoot)Systemicmycoses:HistoplasmosisOpportunisticmycoses:  
Candidiasis

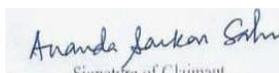
### **Unit6Antimicrobialagents:Generalcharacteristicsand modeofaction**

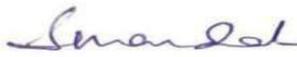
**No. of**

**Hours:8**Antibacterialagents:Fivemodesofactionwithoneexampleeach:Inhibitorofnucleicacidsynthesis;Inhibitorofcellwallsynthesis;Inhibitorofcellmembranefunction;Inhibitorofproteinsynthesis;InhibitorofmetabolismAntifungalagents:MechanismofactionofAmphotericinB,GriseofulvinAntiviralagents:MechanismofactionofAmantadine,Acyclovir,AzidothymidineAntibioticresistance,M  
DR,XDR,MRSA,NDM-1

  
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## C-15: MEDICAL MICROBIOLOGY AND IMMUNOLOGY( PRACTICAL )SEMES TER–VI

**TOTAL HOURS:50**

**CREDITS:4**

**Course learning outcomes:** By the conclusion of this course, the students clearly-

**Outcome 1.** Understood the basic and general concepts of causation of disease by the pathogenic microorganisms and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis.

**Outcome 2.** Developed a thorough understanding of common bacterial, viral, fungal, parasitic diseases of human being including some very important diseases of the animals also.

**Outcome 3.** Conceptualized the protective role of the immune system of the host and developed an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms.

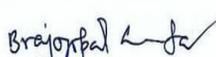
**Outcome 4.** Are able to conduct experiments for growing common bacteria in different microbiological media, antibiotic sensitivity determination and antigen antibody reaction (precipitation test in the agarose)

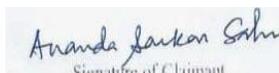
1. Identify pathogenic bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chickenpox, HPV, warts, AIDS (candidiasis), dermatomycoses (ringworms)
6. Study of various stages of Malarial parasite in RBCs using permanent mounts.
7. Identification of human blood groups.
8. Perform Total Leukocyte Count of the given blood sample.
9. Perform Differential Leukocyte Count of the given blood sample.
10. Separate serum from the blood sample (demonstration).
11. Perform immunodiffusion by Ouchterlony method.

12. Study on DOTELISA.

13. Study on immune electrophoresis.

  
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**DSE 2: FOOD AND DAIRY MICROBIOLOGY  
(THEORY) SEMESTER-VI**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:**

**Outcome 1:** Developed a clear understanding of the multifarious roles of microorganisms in food.

**Outcome 2:** Are able to describe the role of microorganisms in the production of food, its spoilage including their role in homemade fermented foods.

**Outcome 3:** Are able to identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens.

**Outcome 4:** Developed experimental skills for testing the milk and different foods for the presence of microorganism.

**Unit 1: Food as a substrate for microorganisms**

**No. of Hours: 10**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

**Unit 2: Microbial spoilage of various foods**

**No. of hours: 10**

Principle, Spoilage of vegetables, fruits, meat eggs, milk and butter, bread and canned foods.

**Unit 3: Principles and methods of food preservation**

**No. of hours: 12**

Physical methods of food preservation: Low temperature, high temperature, Canning, drying, irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packing. Chemical methods of food preservation: Salt, Sugar, Organic acids, SO<sub>2</sub>, nitrite and nitrate, ethylene oxides, antibiotics and bacteriocins.

**Unit 4: Fermented foods**

**No. of hours: 10**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, Kummis, Kefir, Dahi and Cheese, other fermented foods: Dosa, Sauerkaut, Soysauce and temph, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

**Unit 5: Food sanitation and Control**

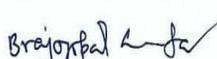
**No. of hours: 5**

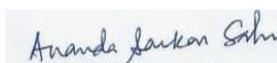
HACCP, Indices of food sanitary quality and sanitizers.

**Unit 6: Culture and rapid detection method of food borne pathogens in foods and introduction to predictive microbiology**

**No. of hours: 2**

  
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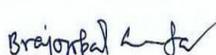
  
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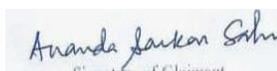
  
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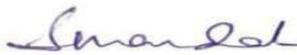
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3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3<sup>rd</sup> edition. Tata McGraw a. -Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
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**GE-1C/2C: BACTERIOLOGY AND VIROLOGY (THEORY) SEMESTER-V/VI**  
**TOTAL HOURS: 50** **CREDITS: 4**

**Course learning outcomes:** At the completion of this course, the students are able to—

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics; classify bacteria into groups.

**Outcome 3.** Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

**Outcome 5.** Understand what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages) **Outcome 6.** Understanding about the biology of bacteriophages.

**Outcome 7.** Gained knowledge of a variety of plant viruses and animal viruses.

**Outcome 8.** The ability to describe role of viruses in the causation of the cancer'

**Unit 1: Cell organization**

**No. of Hours: 10**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

**Unit 2: Bacterial growth and control**

**No. of Hours: 8**

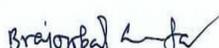
Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria Growth: Binary fission, phases of growth

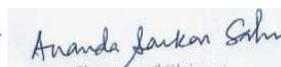
**Unit 3: Bacterial Systematics and Taxonomy**

**No. of Hours: 8**

Taxonomy, nomenclature, systematics, types of classifications Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles

  
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**Unit4:IntroductiontoViruses****No.ofHours:8**

Properties of viruses; general nature and important features Subviral particles; viroid's, prions and their importance Isolation and cultivation of viruses

**Unit5:Structure,andmultiplication ofviruses****No.ofHours:8**

Morphological characters: Capsid symmetry and different shapes of viruses with examples Viral multiplication in the Cell: Lytic and lysogenic cycle Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV)

**Unit6:RoleofVirusesinDiseaseanditsprevention****No.ofHours:8**

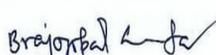
Viruses as pathogens: Role of viruses in causing diseases Prevention and control of viruses: interferons and antiviral compounds

**Suggested Readings:**

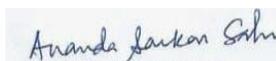
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## C-16: ENVIRONMENTAL MICROBIOLOGY (THEORY) SEMESTER – VII

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the completion of this course, the students -

**Outcome 1.** Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.

**Outcome 2.** Are able to identify the important role microorganisms play in maintaining a healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks

**Outcome 3.** Have understood the significance of BOD/COD and various tests involving use of enumerating fecal *E. coli* for assessing quality of water.

**Outcome 4.** Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests.

### **Unit 1- Microorganisms and their Habitats**

**No. of Hours: 10**

Structure and function of ecosystems  
Aquatic Environment: Microflora of fresh water and marine habitats  
Atmosphere: Aeromicroflora and dispersal of microbes  
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.  
Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

### **Unit 2- Microbial Interactions**

**No. of Hours: 12**

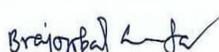
Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation  
Microbe-Plant interaction: Symbiotic and nonsymbiotic interactions  
Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria

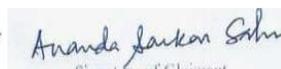
### **Unit 3- BioGeochemical Cycling**

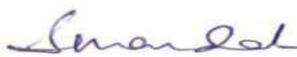
**No. of Hours: 10**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin  
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction  
Phosphorus cycle: Phosphate immobilization and solubilization  
Sulphur cycle: Microbes involved in Sulphur cycle

  
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#### **Unit4-WasteManagement**

**No.ofHours:12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

#### **Unit5-MicrobialBioremediation**

**No.ofHours:2**

Degradation of common pesticides, organic (hydrocarbons, oil spills) biosurfactants

#### **Unit6-WaterPotability**

**No.ofHours:4**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples:

(a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed test for faecal coliforms

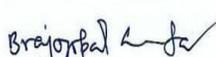
(b) Membrane filter technique

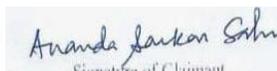
and (c) Presence/absence tests

### **SUGGESTED READINGS**

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2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition. Pearson/Benjamin Cummings
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Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England
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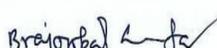
  
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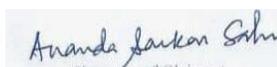
  
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**C-17: MICROBES IN SUSTAINABLE AGRICULTURE  
AND DEVELOPMENT (THEORY)**

**SEMESTER – VII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Outcome 1.** Developed a clear understanding of the multifarious roles of microorganisms in soil, in association with plants and thus in the field of agriculture

**Outcome 2.** Are able to describe the Microbial Control of soilborne plant pathogens. **Outcome 3.** Are able to identify the role of microorganisms in Biofertilization, Phytostimulation, Bioinsecticides.

**Outcome 4.** Developed Secondary Agriculture Biotechnology.

**Unit 1- Soil Microbiology**

**No. of Hours: 8**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

**Unit 2- Soil organic matter**

**No. of Hours: 4**

Mineralization of cellulose, hemicelluloses, lignin and humus

**Unit 4- Microbial Control of soilborne plant pathogen**

**No of Hours:**

**8** Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

**Unit 5- Biofertilization, Phytostimulation, Bioinsecticide**

**No of Hours:**

**14** Plant growth limiting compounds, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non-Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphatesolubilizers, algae) PGPRs

**Unit 6- Secondary Agriculture Biotechnology**

**No of Hours: 10**

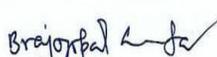
Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

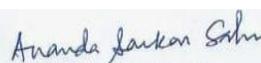
**Unit 7- GM crops**

**No of Hours: 6**

Advantages, social and environmental aspects, Bt-crops, golden rice, transgenic animals.

  
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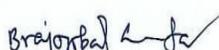
  
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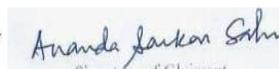
  
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## C18: ENVIRONMENTAL MICROBIOLOGY

### (PRACTICAL) SEMESTER–VII

TOTAL HOURS: 50

CREDITS: 4

**Course learning outcomes:** By the completion of this course, the students-

**Outcome 1.** Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.

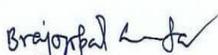
**Outcome 2.** Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks

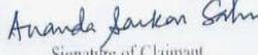
**Outcome 3.** Have understood the significance of BOD/COD and various tests involving use of enumerating fecal *E. coli* for assessing quality of water.

**Outcome 4.** Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests.

1. Analysis of Soil-pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of wastewater sample.
6. Study the presence of Microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.
8. Study soil profile
9. Azotobacter as soil inoculants characteristics and field applications.

  
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## DSE 3: FOOD AND INDUSTRIAL MICROBIOLOGY (THEORY) SEMESTER-VII

**TOTAL HOURS: 50**

**CREDITS: 4**

### Course learning outcomes:

**Outcome 1:** Are capable of describing a large number of substrates that are used for the industrial fermentation processes.

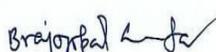
**Outcome 2:** Are able to describe the role of microorganisms in the production of food, its spoilage including their role in homemade fermented foods.

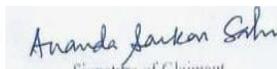
**Outcome 3:** Are able to identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens.

**Outcome 4:** Developed experimental skills for testing the milk and different foods for the presence of microorganisms.

1. MBRT of supplied milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any pathogenic bacteria (Staphylococcus or Salmonella) from food products.
4. Isolation of Spoilage microorganisms from Spoiled vegetables/fruits.
5. Isolation of Spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.
7. Study different parts of fermenter.
8. Microbial fermentation for the production and destination (qualitative and quantitative) of:
  - a) Enzymes: Amylase and Protease.
  - b) Amino acid: Glutamic acid
  - c) Organic acid: Citric acid
  - d) Alcohol: Ethanol.
9. A visit to any industrial institute/industry to see an industrial fermenter, and other downstream processing operation.

  
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**DSE-4: BIOINFORMATICS**  
**(THEORY) SEMESTER-VII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:**

**Outcome 1:** Developed skills to use computers for analysis of biological data.

**Outcome 2:** Skill to use important biological database, use tools to retrieve data, and compare the data of the biological macromolecules.

**Outcome 3:** Developed basic skills for the data retrieval, representation, analysis and interpretation.

**Unit 1: Introduction to Computer Fundamentals**

**No. of hours: 8**

Bioinformatics basics, RDBMS- Definition of relational database.

Mode of data transfer (FTP, SFTP, SCP), advantages of encrypted data transfer.

**Unit 2: Introduction to bioinformatics and Biological database**

**No. of hours: 14**

Biological database- nucleic acid, genome, protein sequence and structure, gene expression database, Database of metabolic pathways, Mode of data storage, File format-

FASTA, Genebank and Uniport, Data submission and retrieval from NCBI, EMBL, DDBJ, Uniport, PDB.

**Unit 3: Sequence Alignment, Phylogeny and Phylogenetic tree**

**No. of hours: 16**

Local and global sequence alignment, Pairwise and multiple sequence alignment. Scoring an alignment, Scoring matrices, PAM & BLOSUM series of matrices.

Types of phylogenetic trees, Different approaches of phylogenetic tree construction- UPGMA, Neighbour joining, Maximum Parsimony.

**Unit 4: Genome organization and analysis**

**No. of hours: 14** Diversity of genome-

Viral, Prokaryotic & Eukaryotic genomes. Genome, Transcriptome, Proteome, MALDI-TOF Spectroscopy. Major features of complete genome- *E. coli*, *S. cerevisiae*, Human.

**Unit 5: Protein Structure Predictions**

**No. of hours: 12**

Hierarchy of protein structure-

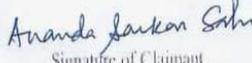
Primary, Secondary and tertiary structure, Modeling Structure Classes, Motifs, Fold and Domain.

**SUGGESTED READING**

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A. (2008) Introduction to Bioinformatics. Oxford Publication, 3<sup>rd</sup> International Student Edition
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2<sup>nd</sup> ed. Prentice Hall India Publication
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

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## **GE-1D/2D: BACTERIOLOGY AND VIROLOGY (PRACTICAL) SEMESTER –VII/VIII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** At the completion of this course, the students are able to –

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics; classify bacteria into groups.

**Outcome 3.** Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

**Outcome 5.** Understand what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages)

**Outcome 6.** Understanding about the biology of bacteriophages.

**Outcome 7.** Gained knowledge of a variety of plant viruses and animal viruses.

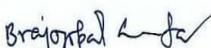
**Outcome 8.** The ability to describe role of viruses in the causation of the cancer'

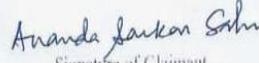
1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.
6. Study of the methods of isolation and propagation of plant viruses
7. Study of cytopathic effects of viruses using photographs

## SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
4. Carter J and Saunders V (2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control. 2nd edition. ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK B.Sc(HONO)

  
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**C-19: RECOMBINANT DNA TECHNOLOGY (THEORY)**  
**SEMESTER–VIII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the conclusion of this course, the students have–

**Outcome 1.** Developed an understanding how microbiology is relevant to technological developments for agriculture and environment.

**Outcome 2.** Developed an understanding how microbiology is relevant to technological developments for industries related to food and fermentations.

**Outcome 3.** Developed an understanding how developments in recombinant DNA technology is juxtaposed with microbially-based technological developments for agriculture, industry and environment.

**Unit 1 Molecular cloning- Tools and Strategies**

**No. of Hours: 20**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: E. coli lac and T7 promoter-based vectors, yeast YIp, Yep and YCp vectors, Baculovirus-based vectors, mammalian SV40-based expression vectors.

**Unit 2 Methods in molecular cloning**

**No. of Hours: 16**

Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium*-mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern- and Northern-blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

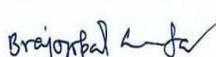
**Unit 3 DNA Amplification and DNA sequencing**

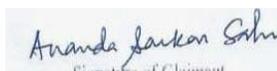
**No. of Hours: 10**

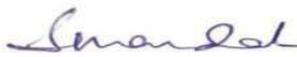
PCR: Basic of PCR, RT-PCR, Real-Time PCR

Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing.

  
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**Unit4 Construction and Screening of Genomic and cDNA Libraries****No. of Hours: 2**

Genomic and cDNA Libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR.

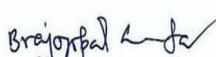
**Unit5 Applications of DNA Technology****No. of Hours: 2**

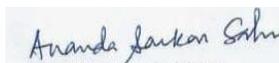
Products of recombinant DNA technology: Products of human therapeutic interest- insulin, hGH, antisense molecules. Bt transgenic-cotton, brinjal, Gene therapy.

**SUGGESTED READING-**

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning- A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woilvertton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

  
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## **C20:INSTRUMENTATIONANDBIOTECHNIQUES(THEORY) SEMESTER– VIII**

**TOTALHOURS:50**

**CREDITS:4**

**Course learning outcomes:**By the conclusion of this course, the students have-

**Outcome1.** Developed understanding of principals, and applications of different microscopic and spectrophotometric methods.

**Outcome2.** Developed understanding of principals, and applications of different separation techniques especially chromatographic, electrophoretic and centrifugation techniques.

**Outcome3.** Skills in handling and use of light microscope, spectrophotometer and centrifugation equipment to study/analyze various microbiological samples.

### **Unit1-Chromatography**

**No.ofHours:10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

### **Unit2-Electrophoresis**

**No.ofHours:10**

Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing.

### **Unit3 Spectrophotometry**

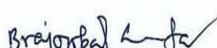
**No.ofHours:10**

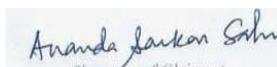
Principle and use of study of absorption spectra of biomolecules.

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Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

  
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## Unit4-Centrifugation

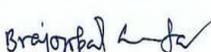
No.ofHours:10

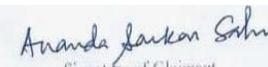
Preparative and analytical centrifugation, fixed angle and swinging bucketrotors.RCFandsedimentationcoefficient,differentialcentrifugation,densitygradient centrifugation andultracentrifugation.

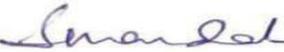
### SUGGESTED READINGS:

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry andMolecularBiology.7thEd, CambridgeUniversityPress.
2. NelsonDL and CoxMM. (2008).Lehninger Principles ofBiochemistry,5thEd., W.H.FreemanandCompany.
3. WilleyMJ, SherwoodLM& WoolvertonCJ.(2013).Prescott,HarleyandKlein'sMicrobiology.9thEd.,McGrawHill.
4. Karp G. (2010) CellandMolecularBiology: ConceptsandExperiments.6thedition.JohnWiley&Sons.Inc.
5. DeRobertisEDPandDeRobertisEMF. (2006). CellandMolecularBiology.8thedition.LipincottWilliamsandWilkins,Philadelphia.
6. CooperG.M.andHausmanR.E.(2009).TheCell:AMolecularApproach. 5thEdition.ASMPress&Sunderland,WashingtonD.C., SinauerAssociates,MA.
7. NigamAandAyyagariA. 2007.LabManualinBiochemistry, ImmunologyandBiotechnology.TataMcGrawHill.

  
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**C21: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)**  
**SEMESTER – VIII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** By the conclusion of this course, the students have-

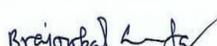
**Outcome 1.** Developed an understanding how microbiology is relevant to technological developments for agriculture and environment.

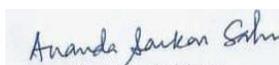
**Outcome 2.** Developed an understanding how microbiology is relevant to technological developments for industries related to food and fermentations.

**Outcome 3.** Developed an understanding how developments in recombinant DNA technology is just a posed with microbially-based technological developments for agriculture, industry and environment.

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel-electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern-blotting
10. Study of fluorescent micrograph to visualize bacterial cells.
11. Ray diagrams of phase contrast microscopy and Electron microscopy.
12. Separation of mixtures by paper/thin layer chromatography.
13. Demonstration of column packing in any form of column chromatography.
14. Separation of protein mixtures by any form of chromatography.
15. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
16. Determination of  $\lambda_{max}$  for an unknown sample and calculation of extinction coefficient.
17. Separation of components of a given mixture using a laboratory scale centrifuge.
18. Understanding density gradient centrifugation with the help of picture.

  
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**DSE 5: BIOSTATISTICS**  
**(THEORY) SEMESTER- VIII**

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcome:**

**Outcome 1:** Understand the basic physical parameters of cell or biological sample and basic method used to study these.

**Outcome 2:** Have developed basic knowledge of mathematical as applied to biological phenomenon.

**Outcome 3:** Have developed basic concepts of statistics and their importance.

**Unit 1: Basic of Statistics**

**No. of hours: 10**

Basic introduction to multivariate statistics. Basic knowledge about data, sample & population. Types of data, collection of data.

**Unit 2: Statistical methods**

**No. of hours: 15**

Statistical methods: Scope of Statistics: utility and misuse. Principal of statistical analysis of biological data.

Measure of central tendency: Mean, Median and Mode. Measure of dispersion, Skewness, Kurtosis, Elementary Probability and basic laws; Discrete and continuous Random variable.

**Unit 3: Sampling parameters**

**No. of hours: 15**

Sampling parameters, Difference between Sample and Population, Sampling errors, Difference between parametric and non-parametric statistics.

Sampling Distribution, Standard deviation & Standard error, Testing hypothesis, Level of significance and Degree of freedom.

**Unit 4: Sample based test**

**No. of hours: 10**

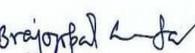
Mathematical Expectation: Curve Fitting, Correlation and Regression

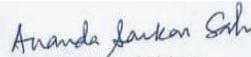
Large Sample test based on normal distribution, small sample test based on t-test, Z-test and F-test, Distribution-free test: Chi-square test. ANOVA.

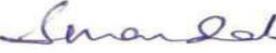
**SUGGESTED READINGS**

1. A. Edmondson and D. Druce: Advanced Biology Statistics, Oxford University Press; 1996.
2. W. Danial: Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

  
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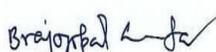
**DSE6:PROJECTWORK(PRATICALS)**  
**SEMESTER-VIII**

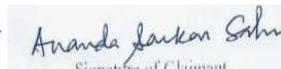
**TOTALHOURS: 50**

**CREDITS: 4**

Projectworkorfieldwork

  
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# G1D/2D: BACTERIOLOGY AND VIROLOGY (PRACTICAL) SEMESTER – VII/VIII

**TOTAL HOURS: 50**

**CREDITS: 4**

**Course learning outcomes:** At the completion of this course, the students are able to –

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics; classify bacteria into groups.

**Outcome 3.** Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

**Outcome 5.** Understand what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages)

**Outcome 6.** Understanding about the biology of bacteriophages.

**Outcome 7.** Gained knowledge of a variety of plant viruses and animal viruses.

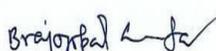
**Outcome 8.** The ability to describe role of viruses in the causation of the cancer'

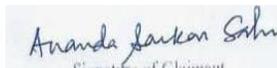
1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.
6. Study of the methods of isolation and propagation of plant viruses
7. Study of cytopathic effects of viruses using photographs

## SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
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