FYUGP (Microbiology) Review & Proposed as per new structure: 2025

Semester-1			Semester-2		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-1: Introduction to Microbiology and Microbial Diversity**	**4**	**Major**	**Major-2: Cell Biology**	4
Minor	**Minor-1 : Introduction to Microbiology and Microbial Diversity**	4	Minor	**Minor-2: Cell Biology**	4
SEC	SEC-1	3	SEC	SEC-2	3
AEC	AEC-1 (Languages/Alt. English)	4	AEC	AEC-2 (English Communication)	4
MDC	MDC-1	3	MDC	MDC-2	3
VAC	VAC-1	2	VAC	VAC-2	2
		20			**20**

Semester-3			Semester-4		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-3: Microbial Biochemistry**	**4**	**Major**	**Major-5: Virology**	4
	Major-4: Molecular Biology	4		**Major-6: Microbial Physiology and Metabolism**	4
Minor	**Minor-3: Molecular Biology**	4		**Major-7: Bacteriology**	4
SEC	SEC-3 #	3		**Major-8: Microbial Genetics**	4
MDC	MDC-3	3	Minor	**Minor-4: Microbial Genetics**	4
VAC	VAC-3	2			
		20			**20**

Semester-5			Semester-6		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-9: Environmental Microbiology**	**4**	**Major**	**Major-12: Immunology**	**4**
	Major-10: Food and Dairy Microbiology	**4**		**Major-13: Medical Microbiology**	**4**
	Major-11: Industrial Microbiology	**4**		**Major-14: Recombinant DNA Technology**	**4**
Minor	**Minor-5: Industrial Microbiology**	4		**Major-15: Bioinformatics and Biostatistics**	**4**
Internship	Internship	4	Minor	**Minor-6: Immunology**	4
		20			**20**

MICROBIOLOGY

Programme Specific Outcomes (PSOs)

1. Analyze the plant-microbe interaction to elucidate intricate symbiotic relationships and ecological dynamics within diverse ecosystems.
2. Understand the role of unculturable microbial flora in the environment, emphasizing the significance of metagenomic approaches in uncovering microbial diversity and function.
3. Evaluate microbial genetic variation using advanced molecular techniques to elucidate evolutionary processes and phylogenetic relationships.
4. Explore the diversity and economic values of microbes in the NE Region, emphasizing their potential applications in agriculture, healthcare, industry, and environmental management.
5. Assess laboratory procedures in microbiology to ensure adherence to established standards and protocols, promoting accuracy and reliability in experimental outcomes.
6. Investigate the application of microbial resources in addressing agricultural challenges, emphasizing sustainable practices and biotechnological innovations.
7. Utilize bioinformatics tools to analyze nucleic acid and protein sequences, facilitating functional annotation and comparative genomics studies.
8. Examine microbial physiology and biochemistry to comprehend fundamental cellular processes and metabolic pathways, providing insights into microbial adaptation and function in various environments.
9. Interpret epidemiological data to identify patterns of infectious diseases and assess the efficacy of control measures, contributing to public health interventions and disease management strategies.
10. Apply principles of genetic engineering and biosafety regulations to design and conduct experiments with genetically modified microorganisms, ensuring ethical and safe research practices

Four-year Undergraduate Programme
Subject: Microbiology
Semester: First
Course Name: *Introduction to Microbiology and Microbial Diversity*
Existing Base Syllabus: UG CBCS Syllabus
Course Level: 100-199, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**History of the Development of Microbiology:** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton van 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, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner	08	06
Unit 2	**Systems of Classification:** Binomial nomenclature, Whittaker's five kingdoms and Carl Woese's three domain classification systems and their utility. Differences between prokaryotic and eukaryotic microorganisms	05	08
Unit 3	**General characteristics of microorganisms:** Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.	08	08
Unit 4	**Phycology and Mycology:** History of phycology with emphasis on the contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.	15	10

	Historical developments in the field of Mycology including significant contributions by eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism, and parasexual mechanisms. Economic importance of fungi, with examples in agriculture, the environment, industry, medicine, food, biodeterioration, and mycotoxins.		
Unit 5	**Protozoa:** General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania*, and *Giardia*	04	05
Unit 6	**An Overview of the Scope of Microbiology:** Recognize and classify various types of microorganisms based on their structure and function, Discuss the applications of microbiology in various industries, such as pharmaceuticals, food, and biofuels, Identify emerging trends and challenges in the field of microbiology and their implications for the future.	05	08
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Microbiology Good Laboratory Practices and Biosafety. 2. To study the principles 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 heat sensitive material by membrane filtration and assessment for sterility 5. Study of *Rhizopus*, *Penicillium*, and *Aspergillus* using temporary mounts 6. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary mounts 7. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium and Plasmodium*	25	25

Reading list:

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. 9th edition. Pearson Education Limited.
4. Pandey BP. (2020). Plant Pathology – Pathogen and plant disease. S. Chand and Company Limited, New Delhi, India.
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International
6. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
7. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
8. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5 th edition. McMillan

Graduate Attributes

Course Objective:

This paper will explain the basics of understanding the history of microbiology, including key contributions and the development of various subfields. It will comprehend different classification systems and differentiate between prokaryotic and eukaryotic microorganisms. Besides, focus will also be on the general characteristics of acellular and cellular microorganisms, including their distribution, morphology, reproduction, and economic importance; gain knowledge of phycology and mycology, including the history, characteristics, life cycles, and applications of algae and fungi; and also provide an understanding of the general characteristics of selected protozoa, such as Amoeba, Paramecium, Plasmodium, Leishmania, and Giardia; recognize and classify microorganisms based on structure and function; and discuss the applications and future challenges of microbiology in various industries.

Learning outcome:

1. Understanding the development of microbiology as a discipline and the contributions made by prominent scientists in this field.

2. Understanding of the characteristics of different groups of microorganisms, methods to organize or classify them, and basic tools to study them in the laboratory.

3. Understanding the useful and harmful activities of microorganisms 4. Practical knowledge of basic experiments to grow and study microorganisms in the laboratory.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 70 (Theory: 45; Practical: 25)

No. of Contact Classes: 70 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

Prof. Kumananda Tayung
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Email id: kumanand@gauhati.ac.in

Dr. Jintu Rabha
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Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Two
Course Name: *Cell Biology*
Existing Base Syllabus: UG CBCS Syllabus
Course Level: 100-199, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Structure and Organization of Cell:** Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extracellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules	12	08
Unit 2	**Nucleus:** Nuclear envelope, nuclear pore complex and nuclear lamina, Chromatin – Molecular organization; Nucleolus	04	06
Unit 3	**Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes	09	08
Unit 4	**Cell Signaling:** Signaling molecules and their receptors, Function of cell surface receptors Pathways of intra- cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway	07	08
Unit 5	Cell Cycle, Cell Death and Cell Renewal: Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Programmed cell death, Stem cells, Embryonic stem cell, induced pluripotent stem cells	08	08
Unit 6	Cancer: Development of cancer, causes and types, pathogenesis, therapy.	05	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Study a representative plant and animal cell by microscopy.		25	30

2. Study of the structure of cell organelles through electron micrographs 3. Cytochemical staining of DNA – Feulgen 4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B 5. Study of polyploidy in Onion root tip by colchicine treatment. 6. Identification and study of cancer cells by photomicrographs. 7. Study of different stages of Mitosis. 8. Study of different stages of Meiosis.		

Reading list:

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA

Graduate Attributes

Course Objective:

This paper aims to provide students with an understanding of the structure and organization of cells, including eukaryotic and prokaryotic cells. Students will learn about the plasma membrane, cell wall, and various cell-cell interactions, as well as the structure and function of organelles like mitochondria, chloroplasts, and peroxisomes. This paper will also explore the nucleus, protein sorting and transport, cell signaling pathways, and the cell cycle. Finally, students will study cell death, cell renewal, and the development and treatment of cancer.

Learning outcome:

1. Understanding the structural and functional aspects of different components of eukaryotic and prokaryotic cells

2. Understanding the folding and transport of proteins among cellular organelles

3. Understanding the role of different signal molecules and their receptors in cellular communication

4. Understanding the cell cycle, its regulation, and how errors in the cell cycle lead to cancer

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 70 (Theory: 45; Practical: 25)

No. of Contact Classes: 70 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

Prof. Kumananda Tayung
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Dr. Jintu Rabha
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Four-year Undergraduate Programme
Subject: Microbiology
Semester: Three
Course Name: *Microbial Biochemistry*
Existing Base Syllabus: UG CBCS Syllabus
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Bioenergetics:** First and second laws of Thermodynamics. Definitions of Gibbs 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, Energy rich compounds: Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP	08	07
Unit 2	**Carbohydrates:** 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 boat 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, peptidoglycan, and chitin	08	07
Unit 3	**Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acid structure and functions. Essential fatty acids. Triacylglycerols structure, functions, and properties. Saponification; Structural lipids. Phosphoglycerides: Building blocks, General structure, functions, and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides, Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers	08	08
Unit 4	**Proteins:** 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	10	09

	Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non-protein amino acids: Gramicidin, beta-alanine, D-alanine and Dglutamic acid 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		
Unit 5	**Enzymes:** 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 turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salt	08	08
Unit 6	Vitamins: Classification and characteristics with suitable examples, sources, and importance	03	06
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts 2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars 3. Qualitative/Quantitative tests for lipids and proteins 4. Study of enzyme kinetics – calculation of Vmax, Km, Kcat values 5. Study effect of temperature, pH and Heavy metals on enzyme activity 6. Estimation of any one vitamin		25	30

Reading list:

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

Graduate Attributes

Course Objective:

This paper will explain the principles of bioenergetics, including thermodynamics, Gibbs free energy, and energy-rich compounds, study carbohydrates, their classification, isomerism, sugar derivatives, and the structure and function of disaccharides and polysaccharides, explore lipids, their classification, structure, and function in storage and structural roles, as well as lipid micelles, monolayers, and bilayers, Learn about proteins, their functions, structures (primary, secondary, tertiary, and quaternary), amino acids, and peptide unit features, enzymes, their structures, classification, mechanisms of action, enzyme kinetics, and the effect of pH and temperature on enzyme activity; and gain knowledge about vitamins, their classification, characteristics, sources, and importance in human health.

Learning outcome:

1. Understanding of various biomolecules that are required for the development and functioning of a bacterial or microbial cell

2. Understanding the role of different types of carbohydrates and their role as structural and functional components such as energy generation and as storage food molecules for the bacterial cells

3. Understanding the multifarious functions of proteins; being able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; Also, knowledge about lipids and nucleic acids

4. Hands-on practical knowledge on buffer making, studying enzyme kinetics, and calculating Vmax, Km, and Kcat values

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
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Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Three
Course Name: *Molecular Biology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick-historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA - mitochondria and chloroplast DNA.	08	07
Unit 2	**Replication of DNA (Prokaryotes and Eukaryotes):** Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair	08	08
Unit 3	**Transcription in Prokaryotes and Eukaryotes:** Transcription: Definition, difference from replication, promoter - concept and strength of promoter; RNA Polymerase and the transcription unit; Transcription in Eukaryotes: RNA polymerases, general Transcription factors	07	07
Unit 4	**Post-Transcriptional Processing:** Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance	08	07
Unit 5	**Translation (Prokaryotes and Eukaryotes):** Translational machinery, Charging of tRNA, 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 eukaryotes	07	08

Unit 6	**Regulation of gene Expression in Prokaryotes and Eukaryotes:** Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in *Bacillus*, Yeast mating type switching, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.	07	08
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Study of different types of DNA and RNA using micrographs and model/schematic representations 2. Study of semi-conservative replication of DNA through micrographs/ schematic representations 3. Isolation of genomic DNA from *E. coli* 4. Estimation of salmon sperm/calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement) 5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement) 6. Resolution and visualization of DNA by Agarose Gel Electrophoresis. 7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).		25	30

Reading list:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th 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.

Graduate Attributes

Course Objective:

This paper aims to provide students with an understanding of the structure and organization of genetic material, including DNA and RNA. They will explore the historical development of DNA and RNA research, DNA topology, and organelle DNA. Students will also study DNA replication

in prokaryotes and eukaryotes, as well as transcription and post-transcriptional processing. Additionally, students will learn about translation and the regulation of gene expression, focusing on mechanisms such as transcriptional regulation and chromatin structure changes, including DNA methylation and histone acetylation.

Learning outcome:

1. Understanding the genome organization of model organisms, namely *E. coli* and *Saccharomyces*, and the molecular mechanisms that underlie mutations
2. Understanding and good knowledge about the three well-known mechanisms by which genetic material is transferred among microorganisms, namely transformation, transduction, and conjugation
3. Understanding the different types of extrachromosomal elements, or plasmids; the nature of the transposable elements in prokaryotic and eukaryotic cells
4. Practical knowledge of the isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
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Four-year Undergraduate Programme
Subject: Microbiology
Semester: Four
Course Name: *Virology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Nature and Properties of Viruses:** 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 and purification of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses	10	07
Unit 2	**Bacteriophages:** Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, regulation of transcription in lambda phage	06	06
Unit 3	**Viral Transmission, Salient features of viral nucleic acids and Replication:** Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), 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) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (ΦX 174, Retroviridae, Vaccinia, Picorna), Assembly, maturation, and release of virions	15	12
Unit 4	**Viruses and Cancer:** Introduction to oncogenic viruses; types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes	06	07
Unit 5	**Prevention and control of viral diseases:** Antiviral compounds and their mode of action; Interferon and their mode of action; general principles of viral vaccination	04	06

Unit 6	**Applications of Virology:** Use of viral vectors in cloning and expression, Gene therapy and Phage display	04	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs 2. Study and identification of structure of important plant viruses (caulimo, Gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrograph plates. 3. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique 4. Study of cytopathic effects of viruses using photographs 5. Perform local lesion technique for assaying plant viruses.		25	30

Reading list:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th 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. 2nd edition. ASM press Washington DC
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd 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 text book of plant virology by. Backhuys Publishers
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Graduate Attributes

Course Objective:

This paper will explain how students will learn about the nature, properties, and origins of viruses, their structure, and their classification. They will explore bacteriophages, their diversity, and their multiplication process. Students will also study viral transmission, features of viral nucleic acids, and replication strategies. Furthermore, they will gain knowledge about the relationship between viruses and cancer, prevention and control of viral diseases, and applications of virology in gene therapy, phage display, and cloning and expression using viral vectors.

Learning outcome:

1. Understanding viruses as entities and their chemical nature, different types of viruses infecting animals, plants, and bacteria (bacteriophages)

2. Understanding the biology of bacteriophages

3. Understanding the variety of plant viruses and animal viruses

4. Understanding the role of viruses in the causation of cancer

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Email id: kumanand@gauhati.ac.in

Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Four
Course Name: *Microbial Physiology and Metabolism*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Microbial Growth and Effect of Environment on Microbial Growth:** Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to the environment - Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/ Phototroph, heterotrophy, Chemolithoautotroph,Chemolithoheterotroph, Chemoheterotroph,Chemolithotroph, photolithoautotroph, Photo-organoheterotroph.	10	08
Unit 2	**Nutrient uptake and Transport:** Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake	04	07
Unit 3	**Chemoheterotrophic Metabolism** - Aerobic Respiration: Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways i.e., EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors	06	08
Unit 4	**Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation:** 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 heterofermentative pathways), concept of linear and branched fermentation pathways	08	07

Unit 5	**Chemolithotrophic and Phototrophic Metabolism:** Introduction to aerobic and anaerobic chemolithotrophs with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria	12	08
Unit 6	**Nitrogen Metabolism - an overview:** Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification	05	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods. 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. Effect of salt on growth of *E. coli* 6. Demonstration of alcoholic fermentation 7. Demonstration of the thermal death time and decimal reduction time of *E. coli*.		25	30

Reading list:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Graduate Attributes

Course Objective:

This paper aims to teach students about microbial growth, its measurement, and the effects of various environmental factors on growth. Students will learn about different nutrient uptake and transport mechanisms, chemoheterotrophic metabolism, including aerobic and anaerobic respiration, and fermentation. They will also explore chemolithotrophic and phototrophic

metabolism in microorganisms and gain an overview of nitrogen metabolism, including biological nitrogen fixation, ammonia assimilation, and various reduction processes.

Learning outcome:

1. Understanding the growth characteristics of the microorganisms capable of growing under unusual environmental conditions of temperature, oxygen, and solute and water activity.

2. Understanding the growth characteristics of the microorganisms that require different nutrients for growth and the associated mechanisms of energy generation for their survival, like autotrophs, heterotrophs, chemolithoautotrophs, etc.

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

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Four
Course Name: *Bacteriology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Microbial Cell Organization:** Cell size, shape, and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae, and pili. Cell-wall: composition and detailed structure of Grampositive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), spheroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function, and Chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, and stages of sporulation.	10	10
Unit 2	**Bacteriological Techniques and Microscopy:** Pure culture isolation: Streaking, serial dilution, and plating methods; cultivation, maintenance, and preservation/stocking of pure cultures; cultivation of anaerobic bacteria and accessing non- culturable bacteria. Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal Microscopy, Scanning, and Transmission Electron Microscope	08	07
Unit 3	**Growth and nutrition:** Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched, and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and modes of action	06	08
Unit 4	**Reproduction in Bacteria:** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate	03	07

Unit 5	**Bacterial Systematics:** Aims and principles of classification, systematics and taxonomy; concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria	08	06
Unit 6	**Important archaeal and eubacterial groups:** ***Archaebacteria:*** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus, Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium, Methanocaldococcus*), thermophiles (*Thermococcus, Pyrococcus, Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)] ***Eubacteria:*** Morphology, metabolism, ecological significance and economic importance of the following groups: ***Gram Negative:*** Non proteobacteria: General characteristics with suitable examples. Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples ***Gram Positive:*** Low G+C (Firmicutes): General characteristics with suitable examples of Low G+C (Firmicutes) and High G+C (Actinobacteria) ***Cyanobacteria:*** Introduction and general characteristics.	10	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Preparation of different media: synthetic media BG-11, Complex media- Nutrient agar, McConkey agar, EMB agar. 2. Simple staining, Negative staining, Gram's staining 3. Acid fast staining-permanent slide only. 4. Capsule staining, Endospore staining		25	30

5. Isolation of pure cultures of bacteria by streaking method 6. Preservation of bacterial cultures by various techniques 7. Estimation of CFU count by spread plate method/pour plate method 8. Motility by the hanging drop method.		

Reading list:

1. Atlas RM. (1997). Principles of Microbiology 2nd edition. WM.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 Microorganisms. 14th 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 S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. 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. 9th edition Pearson Education
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

Graduate Attributes

Course Objective:

This paper will explain the understanding of the microbial cell organization, including the structure, function, and composition of various cellular components, bacteriological techniques and various microscopy methods for studying microbial cells; microbial growth, nutrition, and physical and chemical methods of microbial control; bacterial reproduction; growth phases; and calculating generation time and specific growth rate. The paper will also grasp bacterial systematics, classification, taxonomy, and evolutionary chronometers, with a focus on the differences between eubacteria and archaebacteria, and examine important archaeal and eubacterial groups, their general characteristics, phylogenetic relationships, ecological significance, and economic importance.

Learning outcome:

1. Understanding the characteristics of bacterial cells, cell organelles, cell wall composition, and various appendages like capsules, flagella, or pili

2. Understanding the differences among many common bacteria by their salient characteristics; classifying bacteria into groups

3. Understanding the nutritional requirements of bacteria for growth; developing knowledge and understanding that, besides common bacteria, there are several other microbes that grow in extreme environments

4. Practical knowledge on basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculating the generation time of growing bacteria

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Four
Course Name: *Microbial Genetics*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Genome Organization:** Genome organization in prokaryotes and eukaryotes; *E. coli*, *Saccharomyces*, *Tetrahymena*.	06	08
Unit 2	**Genetic Mutation:** Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and intergenic suppression; Ames's test; Mutator genes	08	10
Unit 3	**Plasmids:** Types of plasmids – F plasmid, R plasmid, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids	07	08
Unit 4	**Mechanisms of Genetic Exchange:** Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers	09	07
Unit 5	**Phage Genetics:** Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda	07	05
Unit 6	**Transposable elements:** Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition	08	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Preparation of Master and Replica Plates		25	30

2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells 3. Study survival curve of bacteria after exposure to ultraviolet (UV) light 4. Isolation of Plasmid DNA from *E. coli* 5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis. 6. Demonstration of Bacterial Conjugation 7. Demonstration of bacterial transformation and transduction 8. Demonstration of AMES test		

Reading list:

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). i Genetics- 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 Barlett Publishers.

Graduate Attributes

Course Objective:

This paper aims to provide students with an understanding of genome organization in prokaryotes and eukaryotes, genetic mutations and mutagenesis, and the various types and functions of plasmids. Students will also explore the mechanisms of genetic exchange, including transformation, conjugation, and transduction, as well as phage genetics and the genetic basis of the lytic versus lysogenic switch. Lastly, they will study transposable elements in prokaryotes and eukaryotes and learn about their uses and implications in genetic research

Learning outcome:

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

2. Understanding the mechanisms by which genetic material is transferred among microorganisms, namely transformation, transduction, and conjugation

3. Understanding the different types of extrachromosomal elements, or plasmids; the nature of the transposable elements in prokaryotic and eukaryotic cells

4. Practical training in the isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
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Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Fifth
Course Name: *Environmental Microbiology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Microorganisms and their habitats:** Structure and function of ecosystems; Terrestrial Environment: Soil profile and soil microflora; Aquatic Environment: Microflora of freshwater and marine habitats; Atmosphere: Aero-microflora 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. Microbial succession in decomposition of plant organic matter	09	08
Unit 2	**Microbial Interactions:** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non-symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria	06	08
Unit 3	**Biogeochemical Cycling:** 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 solubilisation Sulfur cycle: Microbes involved in sulfur cycle Other elemental cycles: Iron and manganese	10	08
Unit 4	**Waste Management:** 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	08	08

Unit 5	**Microbial Bioremediation:** Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants	06	05
Unit 6	**Water Potability:** 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 tests for fecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	06	08
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action. 2. Isolation of microbes (bacteria & fungi) from soil (28 ºC & 45 ºC). 3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. 4. Assessment of microbiological quality of water. 5. Determination of BOD of waste water sample. 6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease, etc.) in soil. 7. Isolation of Rhizobium from root nodules.		25	30

Reading list:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Graduate Attributes

Course Objective:

This paper aims to familiarize students with the diverse habitats of microorganisms, their interactions with each other, plants, and animals, as well as the role of microbes in biogeochemical cycling. Students will also explore waste management techniques, focusing on solid and liquid waste treatment, and delve into microbial bioremediation principles and applications. Finally, they will learn about water potability, treatment, and safety, as well as methods to detect and ensure the quality of drinking water.

Learning outcome:

1. Understanding of different types of environments and habitats where microorganisms grow, including the microbiomes of the human gut and animal gut

2. Understanding the important role microorganisms play in maintaining a healthy environment through the degradation of solid and liquid wastes and knowing how these activities of microorganisms are used in sewage treatment plants, the production of activated sludge, and the functioning of septic tanks

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

4. Practical knowledge of conducting experiments to assess the BOD and COD of wastewaters and their interpretation; practically assessing the portability of drinking water using standard microbiological tests

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
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Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Fifth
Course Name: *Food and Dairy Microbiology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Foods as a substrate for microorganisms:** Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora, and source of contamination of foods in general.	07	06
Unit 2	**Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods	07	08
Unit 3	**Principles and methods of food preservation:** Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins	10	08
Unit 4	**Fermented foods:** Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.	08	08
Unit 5	**Food borne diseases (causative agents, foods involved, symptoms and preventive measures):** Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*	07	08
Unit 6	**Food sanitation and control; Detection of foodborne pathogens:** HACCP, Indices of food sanitary quality and sanitizers; Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology	06	07
PRACTICAL [Total Marks: 25]; Credit: 01			
1. MBRT of milk samples and their standard plate count. 2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.		25	30

3. Isolation of any food borne bacteria from food products. 4. Isolation of spoilage microorganisms from spoiled vegetables/fruits. 5. Isolation of spoilage microorganisms from bread. 6. Preparation of Yogurt/Dahi.		

Reading list:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
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. 3rd edition. Tata McGrawHill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Graduate Attributes

Course Objective:

This paper aims to provide students with an understanding of the factors affecting microbial growth and survival in foods, microbial spoilage of various food products, and principles and methods of food preservation. Students will explore fermented foods, their production, and health benefits, as well as learn about foodborne diseases, their causative agents, symptoms, and preventive measures. The course will also cover food sanitation and control measures, including HACCP, detection methods for foodborne pathogens, and an introduction to predictive microbiology.

Learning outcome:

1. Understanding the multifarious roles of microorganisms in soil, in association with plants, and thus in the field of agriculture

2. Understanding the role of microorganisms in the production of food, as causal organisms of food spoilage, and their role or importance in homemade fermented foods

3. Understanding the role of microorganisms in the causation of diseases and how to protect against food-borne pathogens

4. Practical knowledge on testing milk and different foods for the presence of microorganisms.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Fifth
Course Name: *Industrial Microbiology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Introduction to industrial microbiology:** Brief history and developments in industrial microbiology	07	06
Unit 2	**Isolation of industrially important microbial strains and fermentation media:** Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude, and synthetic media; molasses, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates	08	08
Unit 3	**Types of fermentation processes, bio-reactors and measurement of fermentation parameters:** Types of fermentation processes - Solid-state and liquidstate (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration	08	10
Unit 4	**Down-stream processing:** Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying	08	06
Unit 5	**Microbial production of industrial products (microorganisms involved, media, fermentation conditions, downstream processing and uses):** Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase) Wine, beer	08	07
Unit 6	**Enzyme immobilization:** Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)	06	06
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Study different parts of fermenter		25	30

2. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzymes: Amylase and Protease (b) Amino acid: Glutamic acid (c) Organic acid: Citric acid (d) Alcohol: Ethanol 3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.		

Reading list:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st 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 LE. (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. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Graduate Attributes

Course Objective:

This paper aims to provide an understanding of industrial microbiology, including its history and developments. Students will learn about the isolation, preservation, and maintenance of industrially important microbial strains and fermentation media. The course will cover various types of fermentation processes, bio-reactors, and measurement of fermentation parameters. Students will also explore downstream processing techniques and the microbial production of various industrial products, such as citric acid, ethanol, penicillin, and enzymes. Finally, the course will discuss enzyme immobilization methods, advantages, applications, and large-scale applications of immobilized enzymes.

Learning outcome:

1. Understanding the various substrates used in industrial fermentation processes and how to describe them

2. Understanding of different types of reactors or fermenters that are used for laboratory, pilot, and industrial scale fermentations and their process parameters

3. Practical knowledge of the number of products that are produced by industrial fermentation processes

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

Prof. Kumananda Tayung
Head, Department of Botany, Gauhati University
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Dr. Jintu Rabha
Department of Botany, Gauhati University
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Four-year Undergraduate Programme
Subject: Microbiology
Semester: Six
Course Name: *Immunology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Introduction:** Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa	05	05
Unit 2	**Immune Cells and Organs:** Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT	07	08
Unit 3	**Antigens and Antibodies:** Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)	11	08
Unit 4	**Generation of Immune Response:** Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance; Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation	12	10
Unit 5	**Immunological Disorders and Tumor Immunity:** Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-	05	08

	Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.		
Unit 6	Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.	05	06
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Identification of human blood groups. 2. Perform Total Leukocyte Count of the given blood sample. 3. Perform Differential Leukocyte Count of the given blood sample. 4. Separate serum from the blood sample (demonstration). 5. Perform immunodiffusion by Ouchterlony method. 6. Perform DOT ELISA. 7. Perform immuno-electrophoresis.		25	30

Reading list:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Graduate Attributes

Course Objective:

This paper aims to provide a comprehensive understanding of immunology, including the concepts of innate and adaptive immunity, contributions of key scientists in the field, and immune cells and organs. Students will explore the characteristics of antigens and antibodies, the organization of MHC locus, and the generation of immune responses. The course will also cover immunological disorders, tumor immunity, and various immunological techniques such as precipitation, agglutination, immunodiffusion, and flow cytometry.

Learning outcome:

1. Understanding the protective role of the immune system of the host

2. Understanding the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Six
Course Name: *Medical Microbiology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**History and evolution:** History of infectious disease, Koch's postulates, molecular postulates, types of pathogens – subcellular and infectious entities, prokaryotic and eukaryotic normal microflora in healthy human body, host parasite interactions and relationships, non-specific host defenses, virulence factors, normal flora and gnotobiology, epidemiology, infectious diseases, disease cycle, diagnostic principles, control, prevention, antimicrobial therapy.	08	08
Unit 2	**Medical virology:** Viral diseases: symptoms and pathogenesis, viral replication – lytic and lysogenic, latent infection, diagnosis, prevention and treatment of diseases caused by polio virus, hepatitis, influenza, HIV and oncogenic viruses, viral vaccines, interferons and antiviral drugs.	06	07
Unit 3	**Medical Bacteriology:** Bacterial diseases, virulence, adhesion, invasion and spread, action of toxins produced by pathogens, mechanism of pathogenesis, prophylaxis, therapy, prevention and laboratory diagnosis caused by *Staphylococcus*, *Streptococcus*, *Pneumococcus*, Enterobacteriaceae and *Mycobacterium*, diagnosis and prevention of bacterial diseases.	08	08
Unit 4	**Parasitology:** Biology of obligate parasite – Rickettsia, Chlamydia, Trypanosomes, Spirochetes etc., common mycotic infections in humans, superficial, subcutaneous, cutaneous and systemic mycosis, general description of mycotic pathogens, diagnosis and prevention.	08	06
Unit 5	**Cancer biology:** Cancer biology: causes of cancer, carcinogens and hereditary factors, pathophysiology of cancer, epigenetics, oncogenes, tumour suppressor genes, cell signaling and cancer, cancer cell biology, clonal evolution, biological properties of cancer cell, therapeutics, anti-angiogenesis, immunotherapy, gene therapy.	10	10

Unit 6	**Community and infection:** Nosocomial infection, Multi Drug Resistance (MDR, XDR), community infection and spreading: SARS-COV2, Influenza, HIV, Pandemic diseases.	05	06
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Identify bacteria 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 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		25	30

Reading list:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Graduate Attributes

Course Objective:

This paper will offer a comprehensive understanding of the history and evolution of infectious diseases, including Koch's postulates, host-parasite interactions, and the role of normal microflora. Students will delve into medical virology, bacteriology, and parasitology, exploring various viral, bacterial, and parasitic diseases, their pathogenesis, diagnosis, and prevention. The course will also cover cancer biology, addressing causes, pathophysiology, and therapeutic approaches. Finally, students will study community and infection, focusing on nosocomial infections, multi-drug resistance, and the spread of pandemic diseases.

Learning outcome:

1. Understanding the basic concepts of causation of disease by pathogenic microorganisms and the various parameters of assessment of their severity, including the broad categorization of the methods of diagnosis

2. Understanding of common bacterial, viral, fungal, and parasitic diseases of humans, including some very important diseases of animals

3. Understanding the protective role of the immune system of the host and developing an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms

4. Practical knowledge for growing common bacteria in different microbiological media, antibiotic sensitivity determination, and antigen antibody reaction (precipitation test in agarose)

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

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Dr. Jintu Rabha
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Four-year Undergraduate Programme
Subject: Microbiology
Semester: Six
Course Name: *Recombinant DNA Technology*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Basics of genetic engineering:** Introduction to Genetic Engineering, milestones in genetic engineering and biotechnology, 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	08	08
Unit 2	**Molecular cloning:** 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	08	08
Unit 3	**Transfer of foreign DNA:** Transformation of DNA: Chemical methods, 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.	08	08
Unit 4	**DNA Amplification and DNA sequencing:** PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing, Primer walking and shotgun sequencing	07	07
Unit 5	**Construction and Screening of Genomic and cDNA libraries:** Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping	07	07
Unit 6	**Applications of genetic engineering:** Applications of genetic engineering; products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic -	07	07

	cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis, Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping		
PRACTICAL [Total Marks: 25]; Credit: 01			
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		25	30

Reading list:

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 Woolverton 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.

Graduate Attributes

Course Objective:

This paper will focus on the basics of genetic engineering, how to transfer foreign DNA into a host, various modern approaches, determining the sequence by sequencing methods, how to construct and screen genomic and cDNA libraries, and modern applications of genetic engineering.

Learning outcome:

1. Understanding the tools and techniques for genetic engineering

2. Understanding how these tools and techniques are employed in the laboratory for the manipulation of DNA so as to make it relevant for biotechnological uses

3. Practical knowledge of the isolation of DNA, amplification of any gene by PCR, and its analysis by gel electrophoresis

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

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Dr. Jintu Rabha
Department of Botany, Gauhati University
Email id: jinturabha@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Microbiology
Semester: Six
Course Name: *Bioinformatics and Biostatistics*
Existing Base Syllabus: UG CBCS
Syllabus Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total Marks: 45] Credit: 03; Total No. of Classes: 45			
Unit no.	**Unit Content**	**No. of Classes**	**Marks**
Unit 1	**Introduction to Computer Fundamentals:** Operating systems: DOS, UNIX, LINUX, WINDOWS. Basics of programming languages – Theory on C++, Python, Java.	05	06
Unit 2	**Bioinformatics and Biological Databases:** RDBMS - Definition of relational database, Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, GenBank, Data submission & retrieval from NCBI, EMBL, DDBJ, UniProt, PDB.	07	06
Unit 3	**Approach to modern OMICS study:** Basics of Genomics, Proteomics, Transcriptomics, Metabolomics, KEGG, Gene ontology, functional network study.	06	06
Unit 4	**Sequence alignment and phylogeny:** Sequence Alignments: Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices; Phylogeny and Phylogenetic trees: Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbor joining (NJ), Maximum Parsimony (MP), Maximum likelihood (ML).	06	07
Unit 5	Protein Structure Predictions: Hierarchy of protein structure - primary, secondary, and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design	06	08
Unit 6	**Biostatistics:** Measures of central tendency, Measures of dispersion; skewness, kurtosis; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean	15	12

	and Variance of Discrete and Continuous Distributions namely Binomial, Poisson and Normal distribution. Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test – Chi-square test; Basic introduction to Multivariate statistics, etc.		
PRACTICAL [Total Marks: 25]; Credit: 01			
1. Introduction to different operating systems - UNIX, LINUX, and Windows 2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB 3. Sequence retrieval using BLAST 4. Sequence alignment & phylogenetic analysis using clustalW & phylip 5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/ Genetool 6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swiss Model. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK) 7. Prediction of different features of a functional gene 8. Mean, Median, Mode from grouped and ungrouped Data set 9. Standard Deviation and Coefficient of Variation 10. Skewness and Kurtosis, Curve fitting 11. Correlation and Regression 12. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test	25	30

Reading list:

1. Saxena S (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk MA (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition.

4. Rastogi SC, Mendiratta N, Rastogi P (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.

Graduate Attributes

Course Objective:

This paper will focus on various operating systems, the basics of programming languages, various biological databases, various modern approaches to OMICS study, nucleic acid and protein sequence alignment and phylogeny, predictions of protein structure, and biostatistics.

Learning outcome:

1. Understanding the basics of various operating systems and programming languages

2. Understanding how to align multiple sequences and determining the systematic position of a taxon

3. Understanding of basic knowledge of mathematics as applied to biological phenomena.

4. Understanding the basic concepts of statistics and their importance

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

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