TECHNO INDIA UNIVERSITY
WESTBENGAL

Syllabus for 3-year B.Sc (Honours)in Microbiology

2018

Choice Based Credit System (CBCS)

Department of Microbiology

Techno India University, West Bengal

EM-4, EM Block, Sector V, Bidhannagar, Kolkata, West Bengal 700091

TECHNO INDIA UNIVERSITY
WESTBENGAL

B.Sc Microbiology (CBCS)

Course Curriculum for All Semester

Semester IV

Sl. No.	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
Theory							
1	TIU-HMB-T202	Microbial Genetics	03	01	00	04	
2	TIU-HMB-T204	ENVIRONMENTAL MICROBIOLOGY	03	01	00	04	
3	TIU-HMB-T206	RECOMBINANT DNA TECHNOLOGY	03	01	00	04	
4	TIU-SEE-T202/ TIU-SEE-T204	Food Fermentation Techniques/ Microbiological Analysis of Air and Water	01	01	00	02	
5	TIU-UCS-T202	Computer	03	01	00	04	
Practical							
1	TIU-HMB-L202	Microbial Genetics	00	00	02	02	
2	TIU-HMB-L204	ENVIRONMENTAL MICROBIOLOGY	00	00	02	02	
3	TIU-HMB-L206	RECOMBINANT DNA TECHNOLOGY	00	00	02	02	
4	TIU-UCS-L202	Computer	00	00	02	02	

CORE COURSES

SEMESTER –4

TIU-HMB-T202: Microbial Genetics (THEORY)

TOTAL HOURS: 60 CREDITS: 4

Course Outcome:

After successful completion, this course enables students:

- To understand the genome organization in prokaryotic and eukaryotic cells.
- To understand the plasmids and its types.
- To understand the different mechanisms of gene transfer.
- To understand about phage genetics.
- To understand the different transposable elements in prokaryotic and eukaryotic system.

Contents:

Unit 1 Genome Organization and MutationsNo. of Hours: 18

Genome organization: E. coli, Saccharomyces, Tetrahymena 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 inter-genic suppression; Ames test; Mutator genes

Unit 2 Plasmids No. of Hours: 10Types of plasmids – F plasmid, R Plasmids, 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

Unit 3 Mechanisms of Genetic Exchange No. of Hours: 12

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

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: 12 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

TIU-HMB-L202: Microbial Genetics (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Preparation of Master and Replica Plates

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

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). 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 FriefelderD(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

TIU-HMB-T204: ENVIRONMENTAL MICROBIOLOGY (THEORY)

TOTAL HOURS: 60 CREDITS: 4

Course Outcome:

After successful completion, this course enables students:

- To understand the different types of microorganisms along with their habitat and to understand about extremophiles.

- To understand the microbe interactions and to learn about different microbe-Plant interaction.
- To understand the different biogeochemical and nutrient cycles.
- To understand the management of different types of solid waste and to understand the sewage and its disposal methods.
- To understand the principles and degradation of common pesticides and to understand the bioremediation.

Contents:

Unit 1 Microorganisms and their HabitatsNo. of Hours: 14 Structure and function of ecosystems.

Terrestrial Environment: Soil profile and soil microflora

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. Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions No. of Hours: 12 Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling No. of Hours: 12

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

Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese

Unit 4 Waste Management No. of Hours: 12Solid 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

Unit 5 Microbial Bioremediation No. of Hours: 5 Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inroganic (metals) matter, biosurfactants

Unit 6 Water PotabilityNo. of Hours: 5 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 faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

TIU-HMB-L204: ENVIRONMENTALMICROBIOLOGY (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.

2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).

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) in soil.

7. Isolation of Rhizobium from root nodules.

SUGGESTED READINGS

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. SubbaRao 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.

TIU-HMB-T206:RECOMBINANT DNA TECHNOLOGY (THEORY)

TOTAL HOURS: 60 CREDITS: 4

Course Outcome:

After successful completion, this course enables students:

- Students will study Restriction enzymes- nomenclature, types, and applications. Students will learn application of DNA Modifying enzymes- alkaline phosphatase, polynucleotide kinase and terminal deoxynucleotidyl transferase.
- Students will study the process of gene cloning and expression. Students will study How to construct Gene libraries and Gene delivery.
- Students will learn types of gene delivery & Transcription. Perform PCR amplification of DNA sample. Describe blue/white screening and antibiotic selection methods of cloning.
- Students will study the process of various hybridization techniques. Describe the principle of gene silencing, gene knockouts and gene therapy. Review various applications of genetic engineering
- Students will able to Isolate DNA from cell and Perform agarose gel electrophoresis. Explain the process of constructing genomic and c-DNA library, Differentiate various DNA sequencing methods
- Students will study probe and hybridization technique and learn the process of various hybridization techniques

Contents:

Unit 1 Introduction to Genetic Engineering No. of Hours: 2 Milestones in genetic engineering and biotechnology

Unit 2 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 deoxynucleotidyltransferase, 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 3 Methods in Molecular CloningNo. 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.

Unit4 DNA Amplification and DNA sequencingNo. of Hours: 10

PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing

Unit 5 Construction and Screening of Genomic and cDNA libraries No. of Hours: 6 Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit 6 Applications of Recombinant DNA Technology No. of Hours: 6Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagensis

TIU-HMB-L206:RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

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

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 Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

6. Brown TA. (2007). Genomes-3. Garland Science Publishers
Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

SEMESTER 4

TIU-SEE-T202: Food Fermentation Techniques (THEORY)
TOTAL HOURS: 30 CREDITS: 2

Course Outcome:
After successful completion, this course enables students:

- To understand the advantages, types, and beneficial health applications of fermented food.
- To provide knowledge about industrially important microorganisms and the production process of various dairy and milk products.
- To provide knowledge about microorganisms used in the production of grain-based fermented foods and their production process.
- To learn about the microorganisms used in the production of Pickles, Sauerkraut, and the production process.
- To understand the types, and microorganisms involved and the processing of fermented meat and fish.

Contents:
Unit 1 Fermented Foods No of Hours: 4 Definition, types, advantages and health benefits
Unit 2 Milk Based Fermented Foods No of Hours: 8 Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process
Unit 3 Grain Based Fermented Foods No of Hours: 6 Soy sauce, Bread, Idli and Dosa: Microorganisms and production process
Unit 4 Vegetable Based Fermented Foods No of Hours: 4Pickels, Saeurkraut: Microorganisms and production process
Unit 5 Fermented Meat and Fish No of Hours: 4 Types, microorganisms involved, fermentation process
Unit 6 Probiotic Foods No of Hours: 4 Definition, types, microorganisms and health benefits

Suggested Readings
1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan 4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

TIU-SEE-T204: Microbiological Analysis of Air and Water (THEORY)
TOTAL HOURS: 30 CREDITS: 2
Course Outcome:
After successful completion, this course enables students:

- To understand the aero microbiology and microbes present in air.
- To understand the different sample collection from air and its analysis.
- To understand the different control measures of airborne microbes.
- To understand the microbiology of water.
- To understand the different control measures of waterborne microbes.

Contents:
Unit 1 Aeromicrobiology 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 MicrobiologyNo 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 MeasuresNo of Hours: 4
Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading
1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4 th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009).Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press