VIVEKANANDHA

COLLEGE OF ARTS AND SCIENCES FOR WOMEN

ELAYAMPALAYAM, TIRUCHENGODE (Tk.), NAMAKKAL (Dt.).
(Affiliated to Periyar University, Approved by AICTE,
Re-Accredited with 'A' Grade by NAAC)
Recognized under section 2(f) &12(B) of UGC ACT 1956,
An ISO 9001:2008 (Certificate institution)

AUTONOMOUS

DEPARTMENT OF MICROBIOLOGY

B.Sc MICROBIOLOGY

SYLLABUS & REGULATIONS

FOR CANDIDATES ADMITTED FROM

2018 - 2019 ONWARDS

UNDER AUTONOMOUS & CBCS PATTERN

VIVEKANANDHA EDUCATIONAL INSTITUTIONS

Angammal Educational Trust

SCHEME OF CURRICULUM – B.Sc., IN MICROBIOLOGY

(For the candidates admitted during the academic year 2018 – 2019 and 2020 – 2021 onwards)

Sem	Subject code	Part	Course	Subjects	Hrs/ Week	Credits	Int. Marks	Ext. Marks	Tot. Marks
I	18U1LT01	I	Language – I	Tamil – I	6	3	25	75	100
	18U1LH01			Hindi – I					
	18U1LM01			Malayalam – I					
	18U1LE01	II	English – I		6	3	25	75	100
	18U1MBC01	III	Core – I	Principles of Microbiology	5	5	25	75	100
	18U1MBCP01			Major Practical – I	4	3	40	60	100
	18U1BCA01	III	Allied – I	Biochemistry	4	4	25	75	100
	18U1BCAP01			Allied Practical – I	3	2	40	60	100
	18U1VE01	IV		Value education – (Yoga)	2	2	25	75	100
				Total	**30**	**22**	**205**	**495**	**700**
II	18U2LT02	I	Language – II	Tamil – II	6	3	25	75	100
	18U2LH02			Hindi – II					
	18U2LM02			Malayalam – II					
	18U2LE02B	II	English – II		6	3	25	75	100
	18U2MBC02	III	Core – II	Microbial Physiology and Metabolism	4	4	25	75	100
	18U2MBCP02	III		Major Practical – II	3	2	40	60	100
	18U2MBA01	III	Allied – II	Bioinstrumentation Techniques	4	4	25	75	100
	18U2MBAP01	III		Allied Practical – II	3	2	40	60	100
	18U2ES01	IV		Environmental studies	4	4	25	75	100
				Total	**30**	**22**	**205**	**495**	**700**
III	18U3LT03	I	Language – III	Tamil – III	6	3	25	75	100
	18U3LH03			Hindi – III					
	18U3LM03			Malayalam – III					
	17U3LE03B	II	English – III		6	3	25	75	100
	18U3MBC03	III	Core – III	Molecular Biology and Microbial Genetics	4	4	25	75	100
	18U3MBCP03			Major Practical – III	3	2	40	60	100
	17U3MBA02	III	Allied – III	Bioinformatics	4	4	25	75	100
	17U3MBAP02			Allied Practical – III	3	2	40	60	100
		IV	NMEC – I	Elected by students	2	2	25	75	100
	18U3MAAS01	IV	SBEC – I	Biostatistics	2	2	25	75	100
				Total	**30**	**22**	**230**	**570**	**800**
IV	18U4LT04	I	Language – IV	Tamil – IV	6	3	25	75	100
	18U4LH04			Hindi – IV					
	18U4LM04			Malayalam – IV					
	18U4LE04	II	English – IV		6	3	25	75	100
	18U4MBC04	III	Core – IV	Immunology and Immunotechnology	4	4	25	75	100
	18U4MBCP04			Major Practical – IV	3	2	40	60	100
	18U4BTA01	III	Allied – IV	Biotechnology	4	4	25	75	100
	18U4BTAP01			Allied Practical – IV	3	2	40	60	100
		IV	NMEC – II	Elected by Students	2	2	25	75	100
	18U4MBS02	IV	SBEC – II	Plant Diseases and	2	2	25	75	100

				Management					
				Total	**30**	**22**	**230**	**570**	**800**
V	18U5MBC05	III	Core – V	Medical Bacteriology and Mycology	6	6	25	75	100
	18U5MBC06	III	Core – VI	Industrial and Pharmaceutical Microbiology	5	5	25	75	100
	18U5MBC07	III	Core – VII	Genetic Engineering	5	5	25	75	100
	18U5MBE01/02	III	Elective – I	Elected By Students	4	4	25	75	100
	18U5MBS03	IV	SBEC – III	Computer Applications in Biology	2	2	25	75	100
	18U5MBMP01			Mini Project	2	1	-	-	-
	18U5MBCP05	III		Practical – V	6	3	40	60	100
				Total	**30**	**26**	**165**	**435**	**600**
VI	18U6MBC08	III	Core – VIII	Medical Virology and Parasitology	6	6	25	75	100
	18U6MBC09	III	Core – IX	Soil and Environmental Microbiology	5	5	25	75	100
	18U6MBC10	III	Core – X	Food and Dairy Microbiology	5	5	25	75	100
	18U6MBE03/04	III	Elective – II	Elected by Students	4	4	25	75	100
	18U6MBS04	IV	SBEC – IV	Advances in Microbiology	2	2	25	75	100
	18U6MBCP06	III		Practical – VI	6	3	40	60	100
	18U6MBEX01	-	-	Extension activity	2	1	-		
				Total	**30**	**26**	**165**	**435**	**600**
Overall Total					**180**	**140**	**1200**	**3000**	**4200**

MAJOR ELECTIVE COURSES:

Semester – V

1. Hematology and Blood Banking (18U5MBE01)
2. Entrepreneurship in Microbiology (18U5MBE02)

Semester – VI

1. Microbial Diagnosis in Health Clinics (18U6MBE03)
2. Quality Assessment in Microbiology (18U6MBE04)

NON MAJOR ELECTIVE COURSES:

1. Public Health and Hygiene (18U3MBN01)
2. Diseases - Epidemics and Control (18U4MBN02)

SEMESTER – I	**CORE - I**
18U1MBC01	**Total Number of Hours: 60**
Credits - 5	**5 Hours/ Week**

PRINCIPLES OF MICROBIOLOGY

Course Objectives:

- To study the history and scope of Microbiology
- To gain knowledge about techniques in Microbiology
- To understand the cultivation techniques of microbes
- To study the classification of bacteria
- To gain knowledge on diverse group of bacteria

Course Outcome:

CO1	The students could understand the origin of Microbiology field and its discoveries in reference to the contributions of great scientists
CO2	The use of microscopy and the methods to visualize the microorganisms were could be learnt
CO3	The art of cultivating the microorganisms, storing methods and removal of pathogenic organisms were taught
CO4	The students could learn the diverse groups of microorganisms
CO5	The microorganisms that grow at some extreme conditions were to be introduced

UNIT – I **No. of Hours: 12**

History and Development of Microbiology: Spontaneous generation verses biogenesis Contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming – Germ theory of disease and golden era of microbiology. Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky and Selman A. Waksman. Paul Ehrlich, Elie Metchnikoff and Edward Jenner. Scope of microbiology.

UNIT – II **No. of Hours: 12**

Microscopy: Bright field, Dark Field, Phase contrast, Fluorescence microscope and Electron microscope. **Staining Methods:** Staining and its types – Simple staining, Differential staining – Gram's, Acid fast and Special staining methods – Metachromatic granule, Endospore and Capsule staining. Hanging drop technique.

UNIT – III **No. of Hours: 12**

Cultivation of Microbes: Culture media – solid, liquid, semisolid and its types - Basal- Differential- Selective- Enrichment, Enriched and transport media. Cultivation of anaerobes – Pyrogallol and Gas Pak method. Pure culture isolation techniques – Spread. Pour and Streak plate

methods. Preservation of cultures. **Sterilization:** Physical and Chemical methods of sterilization. Antibiotics classification based on mode of action – Tests for sensitivity to antimicrobial agents.

UNIT – IV **No. of Hours: 12**

Microbial Diversity: Evolution, Phylogeny, Microbial Taxonomy and Classification – Haeckel, Whittaker and Carl Woese system. Numerical Taxonomy and Molecular based classification. Bacterial diversity – General characteristics of bacteria and classification – Bergeys' Manual of Systematic Bacteriology (up to order level) and Actinobacteria.

UNIT – V **No. of Hours: 12**

General characteristics: of Chlamydia, Rickettsia and Mycoplasma. Microbial diversity in different ecosystems - psychrophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles, capnophilic, saccharophilic and other extremophiles (Halophiles, Methanogens). Economic importance of bacteria.

Text Books

1. Pelczar MJ, Chan ECS and Kreig NR (2008). **Microbiology**. 5th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2. Dubey RC and Maheswari DK (2013). **A Textbook of Microbiology.** 3rd Edition. S Chand and Company Limited, New Delhi.
3. Sullia S.B and Santhanam S (2017). **General Microbiology.** 2nd Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Reference Books

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) **Prescott's Microbiology**. 9th Edition. McGraw Hill International.
2. Jacquelyn G. Black (2015). **Microbiology: Principles and Explorations.** 9th Edition. John Wiley and Sons Australia Limited.
3. Kathleen Park Talaro (2014). **Foundations in Microbiology: Basic Principles,** 9th Edition. McGraw-Hill Higher Education.
4. Tortora GJ, Funke BR and Case CL. (2016). **Microbiology: An Introduction**. 11th Edition. Pearson Education Limited.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). **Brock Biology of Microorganisms**. 14th edition. Pearson International Edition
6. Atlas RM. (1997). **Principles of Microbiology**. 2nd edition. WM.T. Brown Publishers. Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (1999). **General Microbiology**. 5th edition. McMillan.

Web References

1. https://www.britannica.com/science/microbiology
2. https://nptel.ac.in/courses/102103015/pdf/mod8.pdf
3. https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.html

SEMESTER – I	**CORE PRACTICAL - I**
18U1MBCP01	**Total Number of Hours: 45**
Credits - 3	**4 Hours/ Week**

PRINCIPLES OF MICROBIOLOGY (PRACTICALS)

Objectives

- To introduce the Good laboratory practices and biosafety
- To learn the SOP of basic instruments in microbiology lab
- To cultivate the microbes in laboratory
- To learn the basic techniques leading to characterization of microbes
- To evaluate the antibiotic sensitivity pattern of microbes

Course Outcome:

CO1	The knowledge on microbiology laboratory, working practices, basic instruments to be imparted
CO2	The handling of microscope for visualizing the morphology, size and movement of microbes could be learnt
CO3	The non pathogenic microbial cultivation may be practiced
CO4	The enumeration techniques from various samples may be experienced
CO5	The efficacy of the antibiotic sensitivity test might be learnt

1. Microbiology Good Laboratory Practices and Biosafety.
2. The principle and applications of instruments (Laminar air flow, biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for aerobic and anaerobic bacteria.
4. Pure culture technique- Serial dilution, pour plate, spread plate and streak plate.
5. Enumeration of bacteria and actinobacteria from environmental water sample (soil/ water).
6. Staining techniques- simple, differential, negative, Metachromatic, endospore, capsular, metachromatic granules and flagellar staining.
7. Determination of bacterial motility by hanging drop technique.
8. Microscopic Examination of fungus by LCB
9. Microscopic examination of Algae
10. Antibiotic sensitivity test by Kirby Bauer method.

Suggested Reading

1. Cappucino J and Sherman N (2010). **Microbiology: A Laboratory Manual**. 9th edition. Pearson Education Limited.

2. P. Gunasekaran (2005). **Laboratory Manual in Microbiology**. 1st Edition. New Age International Publishers.

3. Mette Praetorius Ibbe and Katherine Elasky (2017). **Basic and Practical Microbiology Laboratory Manual**. 1st Edition. Cognella. Incorporated.

4. Norbel A.Tabo (2004). **Laboratory Manual in Microbiology**. 1st Edition. Rex Book Store.

5. N.Kannan (2002). **Laboratory Manual in General Microbiology**. 1st Edition. Panima Publishing Corporation.

6. Sundara Rajan. S (2001). **Practical Manual of Microbiology**. 1st Edition. Anmol Publication Private.

SEMESTER – II **CORE - II**
18U2MBC02 **Total Number of Hours: 60**
Credits – 4 **4 Hours/ Week**

MICROBIAL PHYSIOLOGY AND METABOLISM

Course Objectives:

- To study the Cellular structure of prokaryotes and eukaryotes.
- To gain knowledge about bacterial growth.
- To understand the transport mechanism of the bacteria.
- To study the metabolism and its types.
- To gain knowledge on mechanism of photosynthesis in bacteria.

Course Outcome:

CO1	The difference between the Eukaryotic and Prokaryotic cellular organizations were understood
CO2	The student got a clear idea of the bacterial growth and the factors influencing the growth
CO3	The different methods involved in the transport of materials from outside environment into the bacterial cell were taught
CO4	The metabolism of microbes with reference to different cycles were learnt
CO5	The microbial respiration and its classification based on the respiration were studied

UNIT – I **No. of Hours: 12**

Cellular structures of prokaryotes: Prokaryotic cellular organization and function - cell wall, Cytoplasmic membrane, Flagella, Pili, Slime layer, Capsule, inclusion bodies, Lysozymes – Structure and functions of cyanobacteria.

UNIT – II **No. of Hours: 12**

Growth of bacteria: Nutritional requirements of bacteria Nutritional types of bacteria - Classification of bacteria based on nutrients - Autotroph, Phototroph and Chemotroph - factors influencing microbial growth – growth curve – Generation time - Specific Growth Rate - Mathematical determination of growth. Multiplication, Sporulation and its mechanism. Mechanism of sporulation.

UNIT – III **No. of Hours: 10**

Microbial nutrients Microbial growth culture and transport: Nutrients – Synchronous, Batch, continuous and diauxic growth culture. Structure and organization of membrane – Methods of nutrient transport in bacteria – Diffusion, active transport, passive transport and facilitated diffusion – group translocation.

UNIT – IV **No. of Hours: 14**

Aerobic respiration and Fermentation: glycolysis, pentose phosphate pathways, EMP, TCA and Glyoxalate cycle - ATP synthesis and utilization – photophosphorylation, oxidative phosphorylation, substrate level phosphorylation - Fermentation types – Lactic acid, Butanol and Propionic acid. Respiration types – aerobic and anaerobic respiration.

Bacterial Photosynthesis and Fermentation: Distribution of the phototropic bacteria – the elementary processes of photosynthesis – anoxygenic photosynthesis –oxygenic photosynthesis – photosynthesis in halobacteria. Outline mechanisms and ATP regeneration by fermentation. Alcoholic fermentation by yeasts and bacteria ethanol formation. Lactic acid fermentation

UNIT – V **No. of Hours: 12**

Anaerobic respiration: Characteristics and metabolism of autotrophs - autotrophic CO_2 fixation and mechanism of photosynthesis – Oxygenic (cyanobacteria) and Anoxygenic (purple sulfur, green sulfur and halobacteria) – Physiology of Bio luminescence, Nitrogen fixation.

Aerobic and Anaerobic respiration: Aerobic - Glycolysis, Pentose Phosphate Pathways, EMP, TCA and Glyoxalate cycle - Anaerobic respiration (Nitrate reduction, Sulfidogenesis Methanogenesis and Acetogenesis) - . Physiology of Bio luminescence.

Text Books

1. Pelczar MJ, Chan ECS and Kreig NR (2008).**Microbiology**. 5th Edition, Tata McGraw Hill-Hill Education Pvt. Ltd., New Delhi.
2. Ram Reddy S and Reddy SM (2005). **Microbial Physiology.** 1st Edition. Scientific Publishers, India.
3. Meenakumari S (2006). **Microbial Physiology**. 1st Edition.MJP Publishers, A unit of Tamil Nadu Book House, Chennai.

Reference Books

1. Moat G, John W Foster and Michael P Spector (2002). **Microbial Physiology.** 4th Edition. Wiley-Lis, Inc., New York.
2. Daniel R. Caldwell (2000). **Microbial Physiology and Metabolism.** 2nd Edition. Star Publishing Company.
3. Willey, J.M., Sherwood, L and Wool Verton C.J. (2011). **Prescott's Microbiology.** 8th edition, McGraw Hill, New York.

Web sources

1. https://nptel.ac.in/courses/122103039/pdf/mod4.pdf
2. https://nptel.ac.in/courses/102103015/19
3. https://www.cliffsnotes.com/study-guides/biology/biology/the-biology-of cells/prokaryote-and-eukaryote-cell-structure

SEMESTER – II	**CORE PRACTICAL – II**
18U2MBCP02	**Total Number of Hours: 45**
Credits – 2	**3 Hours/ Week**

MAJOR PRACTICAL – II - MICROBIAL PHYSIOLOGY AND METABOLISM

Course Objectives

- To study the bacterial growth
- To study the effect of temperature, pH, carbon, nitrogen and salt concentration, incubation time, inoculums size on bacterial growth
- To understand the characterization of unknown organisms

Course Outcome:

CO1	Different stages of bacterial growth could be studied
CO2	The impact of different physical parameters on bacterial growth are to be learnt
CO3	The impact of different chemical parameters on bacterial growth are to be learnt
CO4	The characterization of microorganisms based on IMViC tests are to be introduced
CO5	The characterization of microorganisms based on sugar assimilation are to be introduced

1. Bacterial growth curve – Turbidometric assay.
2. Determination of generation time.
3. Effect of temperature and pH on growth of bacteria.
4. Effect of temperature on growth of bacteria.
5. Effect of pH on growth of bacteria.
6. Effect of carbon and nitrogen sources on growth of bacteria.
7. Effect of salt concentration on growth of bacteria.
8. Effect of incubation time and inoculum size on growth of bacteria
9. Determination of microbial biomass: Wet and Dry
10. Biochemical parameters
    a) IMViC
    b) Sugar assimilation (glucose, lactose, maltose, mannitol and sucrose)
    c) Catalase
    d) Oxidase
    e) Urease
    f) TSI

g) Nitrate reduction test

Reference Books

1. Cappucino J and Sherman N. (2010). **Microbiology: A Laboratory Manual**. 9th edition. Pearson Education Limited.
2. P.Gunasekaran. (2005). **Laboratory Manual in Microbiology**. 1st Edition. New Age International Publishers.
3. Mette Praetorius Ibbe and Katherine Elasky. (2017). **Basic and Practical Microbiology Laboratory Manual**. 1st Edition. Cognella. Incorporated.
4. Norbel A.Tabo. (2004). **Laboratory Manual in Microbiology**. 1st Edition. Rex Book Store.
5. N.Kannan. (2002). **Laboratory Manual in General Microbiology**. 1st Edition. Panima Publishing Corporation.
6. Sundara Rajan. S. (2001). **Practical Manual of Microbiology**. 1st Edition. Anmol Publication Private.

SEMESTER – II **ALLIED – II**
18U2MBA01 **Total number of Hours: 60**
Credits: 4 **4 Hours/Week**

BIOINSTRUMENTATION TECHNIQUES

Course Objectives:

- To gain knowledge about laboratory requirement for microbiology laboratory
- To study the recent advancements in chromatography
- To impart knowledge on Electrophoretic techniques and its applications
- To study the different types of centrifuges
- To understand spectroscopic techniques

Course Outcome:

CO1	The course emphasizes on the basics of laboratory, its requirements and rules. It also gives an understanding about the recent advancements in microscopy, principle and the operation of the basic equipments used in the microbiology/clinical laboratory
CO2	Provides basic principles and separation of molecules by various chromatography techniques
CO3	Able to uptake introductory principle and background of electrophoresis and its common application in separation of genetic material and high throughput techniques for the separation of biomolecules
CO4	It is an opportunity to understand the working principles of analytical spectrophotometers and its applications
CO5	Ability to understand the most common and routine laboratory separation of molecules based on physical and chemical properties

UNIT – I **No. of Hours: 12**

Microbiological Instruments: Basic requirements of a SOP Guidelines for Microbiology Laboratory – Basic microbiological Instruments – Laminar Airflow, Biosafety Cabinets – levels – 1 to 3, Inoculation loop, Colony counter, Anaerobic jar, Neubaeur chamber, Transillumintor, Cyclo mixer, Homogenizer, Sonicator and fumigator. Incubators - Shaker incubator, BOD incubator, CO_2 Incubator – water and air jacketed. Microscopy – SEM, TEM and Confocal and Atomic. Weighing Balance – microbalance mono pan, top and physical, Deep freezers – horizontal, verticle – Lyophilizer and rotary evaporator.

UNIT – II **No. of Hours: 12**

Centrifugation and filtration: Centrifuge – Sedimentation principle, Relative centrifugal force, Sedimentation coefficient, factors affecting sedimentation velocity, Centrifuge rotors. Types of centrifuges – Low speed clinical bench top centrifuge, High speed refrigerated microcentrifuge. Ultracentrifugation – Preparative and Analytical – Centrifugation – Types – Differential, Density gradient - Rate zonal, Isopycnic technique and analytical. Membrane, Syringe and Seitz filtration methods.

UNIT – III **No. of Hours: 10**

Spectrophotometry: Principle and applications – Beer's and Lambert's Law. Principle and applications of Colorimeter, UV-Visible single and dual beam spectrophotometer, ELISA plate reader, Atomic Adsorption Spectrophotometer, Raman spectrophotometer. Analysis of biomolecules using UV and visible spectrophotometer Spectroflourimeter and flow cytometer.

UNIT – IV **No. of Hours: 12**

Electrophoresis: Principle and applications of Agarose gel electrophoresis, Southern blotting, Pulse Field Gel Electrophoresis, SDS – polyacrylamide gel electrophoresis, Western blotting, Isoelectric focusing - 2D gel electrophoresis and Zymogram Zymography. preparation.

UNIT – V **No. of Hours: 14**

Chromatography: Introduction, Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography, Column chromatography, Gel filtration chromatography, Gas chromatography coupled with mass spectrometry, Ion-exchange chromatography, affinity chromatography and HPLC.

Text Books

1. Praful K Godkarand and Darshan P Godkar (2006). **Text book of Medical Laboratory Technology.** Bhalani Publishing House, Mumbai.
2. Arora CK and Prakash M (1998). **Laboratory instrumentation.** Anmol Publications Pvt. Ltd., New Delhi.

Reference Books

1. Keith Wilson and John Walker (1994). **Principles and Techniques of Practical Biochemistry.** 5th Edition, Cambridge University Press, New York.
2. Rodney Boyer (2000). **Modern Experimental Biochemistry.** 3rd Edition**,** Addition Wesley Longman, San Francisco.
3. Webster JG (2004). **Bioinstrumentation**. University of Wisconsin, John Wiley & Sons, Inc. UK.

SEMESTER – II	**ALLIED PRACTICAL – II**
18U2MBAP01	**Total number of Hours: 45**
Credits – 2	**4 Hours/Week**

ALLIED PRACTICAL – II - BIOINSTRUMENTATION TECHNIQUES

Course Objectives:

- To know about the basics of solution preparation for various experiments
- To get trained in the estimation of biomolecules
- To understand the working principle and methods of analytical instruments
- To get skilled in basic molecular biology techniques
- To get trained in basics of chromatography

Course Outcome:

CO1	Become well-versed in preparation of reagents and buffers
CO2	It offers to participate with very advanced chromatographic methods for the separation of molecules
CO3	The student can learn most common methods to separate genetic material and proteins
CO4	Allows to capture detailed working principle of spectrophotometry and its application
CO5	A hands on approach to develop skill in estimation of biomolecules using spectrophotometry

1. **Calculation in preparation of reagents:** Normality of solution, Molarity of solution
2. **Chromatographic Techniques**: (A) Paper and (B) Thin layer chromatography (C) Column Chromatography
3. **Electrophoretic Techniques:** Agarose gel electrophoresis, SDS-PAGE
4. **Spectrophotometry**: Principle and operating mechanism of Spectrophotometry, Estimation of biomolecules like Protein and Carbohydrate and Lipid using UV and visible Spectrophotometer.

Reference Books

1. Rodney Boyer (2000). **Modern Experimental Biochemistry.** 3rd Edition**,** Addition Wesley Longman, San Francisco.
2. John G Webster (2004). **Bioinstrumentation**. University of Wisconsin, John Wiley & Sons, Inc. U K.
3. Keith Wilson and John Walker (1994). **Principles and Techniques of Practical Biochemistry**. 5th Edition, Cambridge University Press, New York.

SEMESTER – III	**CORE – III**
18U3MBC03	**Total number of Hours: 60**
Credits – 4	**4 Hours/Week**

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Course Objectives:

- To gain knowledge about DNA and RNA
- To understand DNA replication and transcription in prokaryotes & eukaryotes
- To impart knowledge on translation and gene regulation
- To study the features of plasmid and mechanism of genetic exchange
- To gain knowledge about mutation and repair mechanisms

Course Outcome:

CO1	It enables to understand the historical perspective and background / basic knowledge of genetics
CO2	It gives exposure on central dogma of life
CO3	It helps to uptake knowledge on translation and gene regulation in prokaryotes
CO4	It delivers basic knowledge and techniques used in gene transfer
CO5	It provides basic concepts of mutation and mutagenesis and gene repair mechanisms

UNIT – I **No. of Hours: 12**

Genetic Material (DNA & RNA): Genetics – Historical perspectives, discovery of DNA structure – Watson and Crick model – Types and forms of DNA, Genome organization in Prokaryotes, Viruses and Eukaryotes. DNA as a genetic material. RNA as genetic material. Physical structure and chemical composition of nucleic acid. RNA types – t RNA, mRNA and rRNA.

UNIT – II **No. of Hours: 12**

Replication and transcription: DNA replication in prokaryotes – Meselson and Stahl experiment – Mechanism and enzymology of replication - Rolling circle and theta model of replication. Eukaryotic replication. Transcription in prokaryotes and eukaryotes: promoter, operator, RNA polymerase functions.

UNIT – III **No. of Hours: 12**

Translation: Salient features of genetic code - Wobble hypothesis. Translational machinery, charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination in prokaryotes. Operon concept – *lac* and *trp* operons.

UNIT – IV **No. of Hours: 12**

Plasmid: Types of plasmids – F plasmid, R Plasmids, Col plasmids, pBR322, PUC vectors Ti plasmids, Plasmid - replication, partitioning, Host range, plasmid incompatibility, plasmid amplification, regulation of copy number and curing of plasmids.

UNIT – V **No. of Hours: 12**

Gene transfer, Mutation and DNA repair mechanisms: Transformation – Discovery, mechanism of natural competence. Conjugation – mechanism, Hfr and F' strains, Transduction – Generalized transduction and specialized. transduction. Mutations and types of mutation - Auxotrophic mutant detection: Replica plate technique. Mutagenicity testing – Ames Test. DNA repair mechanisms – excision, mismatch, SOS, photoreactivation and recombination repair.

Text Books

1. David Freifelder (2005). **Molecular Biology**. 2nd Edition. Narosa Publishers, New Delhi.
2. Verma PS and Agarwal VK (2006). **Cell Biology, Genetics, Molecular Biology, Evolution and Ecology**. S. Chand & Company Ltd., New Delhi.

Reference Books

1. Friedberg EC, Walker GC, Siede W (2006). **DNA repair and mutagenesis**. ASM press, Washington DC.
2. Benjamin Lewin (2000). **Genes VII.** 7th Edition. Oxford University press, Inc.
3. Maloy SR, Cronan JE, FreifelderD (1994). **Microbial Genetics.** Jones and Bartlett Publishers.
4. Gardner EJ, Simmons MJ, Snustad DP (2008). **Principles of Genetics**. 8th Ed. Wiley-India.
5. 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

Web sources:

1. http://biology.kenyon.edu/courses/biol63/watson_06.pdf
2. https://nptel.ac.in/courses/102103015/33
3. https://nptel.ac.in/courses/102103017/module26/lec26_slide9.htm

SEMESTER – III	**CORE PRACTICAL – III**
18U3MBCP03	**Total number of Hours: 30**
Credits – 2	**3 Hours/Week**

MOLECULAR BIOLOGY AND MICROBIAL GENETICS (PRACTICALS)

Course Objectives:

i) To be aware of the isolation of chromosomal and plasmid DNA
ii) To obtain knowledge on physical and chemical mutagenesis
iii) To achieve knowledge about coli phage transfer method
iv) To know about the gene transfer methods
v) To get information about the techniques used in genetics

Course Outcome:

CO1	The students would be skilled in chromosomal and plasmid DNA isolation from eukaryotes
CO2	They would be expertise with effects of physical and chemical agents responsible for mutagenesis
CO3	They can able to isolate antibiotic resistant and auxotrophic mutants
CO4	They would be exposed to hands on technique for the isolation of phage from sewage
CO5	They were enabled with fundamental techniques used for prokaryotic gene transfer techniques

1. Isolation of chromosomal DNA from bacteria
2. Isolation of plasmid DNA from *E. coli*
3. Quantification of genetic material
4. Physical and Chemical mutagenesis
5. Isolation of antibiotic resistant mutant by gradient plate technique
6. Isolation of auxotrophic mutant (replica plating Complete plating)
7. Isolation of coli phage Bacteriophage from sewage
8. Bacterial Gene Transfer – Transformation (Demonstration)

Reference Books

1. Sambrook J and Russell DW (2001). **Molecular Cloning – A laboratory manual.** 3rd Edition. Cold Spring Laboratory Press, New York.
2. Dubey RC and Maheshwari DK (2002). **Practical Microbiology**. S Chand and Co. Ltd., New Delhi.
3. Aneja KR (2010). **Experiments in Microbiology, Plant Pathology and Biotechnology.** New Age International (P) Limited Publishers.
4. Harold J Benson (2002). **Microbiological Applications: Laboratory manual in General Microbiology**. 8th Edition. Mcgraw-Hill, Boston.
5. James G Cappuccino and Natalie Sherman (2005). **Microbiology: A Laboratory manual.** 7th Edition, Pearson Education, Inc.

Semester – III	**ALLIED - II**
17U3MBA02	**Total number of Hours: 60**
Credits: 4	**4 Hours/Week**

BIOINFORMATICS

Objectives:

1. To gain knowledge about the fundamentals of computer.
2. To impart knowledge on bioinformatics and biological database.
3. To gain knowledge about sequence alignments and phylogeny tree.
4. To impart knowledge on genome organization.
5. To understand about protein structure prediction

This course aims to introduce the fundamentals of computer that supports to impart knowledge on bioinformatics and biological database of an organisms and to gain the diversity of an organism by analyze the phylogeny tree.

Unit 1 **No. of Hours: 08**

Introduction and Databases - Introduction, database model, types of database - primary, secondary database, raw database and processed database, data mining, data storage and retrieval, querying in database and tools for querying – BLAST, FASTA.

Unit 2 **No. of Hours: 14**

Introduction to Bioinformatics and Biological Databases - Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB

Unit 3 **No. of Hours: 16**

Sequence Alignments, Phylogeny and Phylogenetic trees - Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood

Unit 4 **No. of Hours: 10**

Genome organization and analysis - Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy. **Major features of completed genomes:** *E.coli, S.cerevisiae, Arabidopsis*, Human

Unit 5 **No. of Hours: 12**

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

SUGGESTED READING

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

Semester – III	**ALLIED PRACTICAL - II**
17U3MBAP02	**Total number of Hours: 45**
Credits: 2	**5 Hours/Week**

BIOINFORMATICS (PRACTICAL)

1. Introduction to LINUX comments

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 psi-pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)

7. Prediction of different features of a functional gene

SUGGESTED READING

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

SEMESTER – IV	**CORE – IV**
18U4MBC04	**Total number of Hours: 60**
Credits – 4	**4 Hours/Week**

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Objectives:

1. To gain knowledge about the cells and organs of the immune system.
2. To impart knowledge on immunity and vaccines.
3. To gain knowledge about antigens and immunoglobulins.
4. To impart knowledge on antigen-antibody interactions.
5. To understand about autoimmunity and hypersensitivity

Course Outcome:

CO1	Structure and function of immune system and its importance in defense mechanism would be understood
CO2	It offers to understand immunological reactions / response and functions of immune cells
CO3	Ability to learn elaborative on antigen and antibody structure, reaction, activation and production of monoclonal antibodies
CO4	Helps to gain knowledge on antigen-antibody reaction and immunological tools for detection of causative agent
CO5	Concise immunological hypersensitivity and autoimmune disorders could be learned with background information

UNIT – I

Introduction and immune system: Structure, function and properties of Lymphocytes, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell - Primary lymphoid organs: Structure and function of Bursa, Bone Marrow and Thymus - Secondary lymphoid organs: Structure and function of Lymph Node, Spleen, GALT, MALT, CALT.

No. of Hours: 12

UNIT – II **No. of Hours: 12**

Immune response: Immunity - Concept of innate and acquired immunity; Types - Specific and non-specific - 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) - Herd Immunity, Immunisation schedule, Vaccines - Definition and Types.

UNIT – III **No. of Hours: 12**

Antigen, Antibody, MHC and Complement: Antigen - Definition, types and characteristics - Haptens - Adjuvants. Immunoglobulins - Structure, Types, Functions and properties - Theories of antibody synthesis - Hybridoma technology and its applications. Structure and functions of class I&II molecules.of MHC I & II molecules; Complement system;- Classical and Alternative

pathways.- Biological consequences of complement Activation.

UNIT – IV **No. of Hours: 12**

Immunological Techniques: Principles and salient feature of Antigen-Antibody Interactions - Antibody affinity and avidity, Cross reactivity. Agglutination-reactions - Blood grouping and Rh Typing, Haemagglutination, and HAI. Bacterial agglutination, Passive agglutination. Precipitation reactions - in fluid and in gel. Immunoelectrophoresis-. Ouchterlony double diffusion. Immunofluorescence techniques - ELISA: Direct, Indirect and sandwich, Biotin-Avidin system, RIA, Western blotting technique. Flowcytometry and Immunoelectron microscopy.

UNIT – V **No. of Hours: 12**

Immunological Disorders: Hypersensitivity - Immediate and Delayed type Hypersensitivity - Gell and Coomb's classification of Hypersensitivity – Type I, II, III & IV - outline mechanisms with examples. Autoimmunity - Pernicious anaemia and Rheumatoid arthritis. Autoimune diseases.

Text Books

1. Annadurai B (2008).**A Textbook of Immunology and Immunotechnology**.1st Edition. S Chand & Co. Ltd., New Delhi.
2. Chakraborty P (2003).**A Text Book of Microbiology.** 2nd Edition. New Central Book Agency (P) Ltd, Kolkata.
3. Arti Kapil (2013). **Ananthanarayan and Paniker's Text Book of Microbiology**.9th Edition, Orient Blackswan Private Limited.

Reference Books

1. Kindt TJ, Goldsby RA, Osborne BA and Janis Kuby (2007). **Kuby Immunology.** W H Freeman and Company, New York.
2. Tizard IR (1995). **Immunology: An Introduction**. 4th Edition. Saunders College Publishers, USA.
3. Riott IM (1988). **Essentials of Immunology**, ELBS and Black Well Scientific Publishers, London

Web sources

1. https://nptel.ac.in/courses/102103038/1
2. https://nptel.ac.in/courses/102103038/39
3. https://nptel.ac.in/courses/102103038/download/module6.pdf
4. https://medlineplus.gov/ency/article/000821.html

SEMESTER – IV	**CORE PRACTICAL – IV**
18U4MBCP04	**Total number of Hours: 45**
Credits – 2	**3 Hours/Week**

MAJOR PRACTICAL – IV - IMMUNOLOGY & IMMUNOTECHNOLOGY

Course Objectives:

1. To know about the basics in immunology techniques
2. To get trained in the blood grouping
3. To gain knowledge in the agglutination tests
4. To understand the working principle and methods used in immunoelectrophoresis
5. To get skilled in diagnosis of various diseases through ELISA
6. To get trained in basics of complement fixation test

Course Outcome:

CO1	Able to perform ABO blood grouping and separation of serum and plasma
CO2	Can do latex agglutination tests and WIDAL
CO3	Ability to analyze antigen-antibody integration by immunoelectrophoresis
CO4	Trained with ELISA principle and procedure for the diagnosis of diseases
CO5	Can able to understand complement test

1. Identification of human ABO blood groups and Rh Typing.
2. Separation of serum/plasma from the blood sample (demonstration).
3. Latex agglutination test- RA Test, CRP Test, ASO Test.
4. WIDAL slide and tube agglutination technique.
5. Flocculation test – RPR test.
6. Radial and ODD immunodiffusion technique.
7. Rocket immunoelectrophoresis.
8. Counter current immunoelectrophoresis (demonstration).
9. Enzyme Linked Immunosorbent Assay (ELISA) – (demonstration).

References:

1. Sambrook J and Russell DW (2001). **Molecular Cloning - A laboratory manual.** 3rd Edition. Cold Spring Laboratory Press, New York.

2. Surzycki S (2000). **Basic Techniques in Molecular Biology**. Springer-Verlag, New York.
3. Riott IM (1988). **Essentials of Immunology**, ELBS and Black Well Scientific Publishers, London.
4. Kindt TJ, Goldsby RA, Osborne BA and Janis Kuby (2007). **Kuby Immunology.** WH Freeman and Company, New York.
5. Chapel H and Halbey M (1986). **Essentials of Clinical Immunology**. ELBS, London.
6. Weir DM, Steward J (1993). **Immunology.** 7th Edition. ELBS, London.
7. Ausubel FM (1998). **Current Protocols in Molecular Biology.** Vol. 1 & 2. John Wiley & Sons Inc.

SEMESTER – IV	**NMEC - II**
18U4MBN02	**Total number of Hours: 30**
Credits: 2	**2 Hours/Week**

DISEASES - EPIDEMICS AND CONTROL

Course Objectives:

i) To get an awareness about the infectious diseases and its epidemiology
ii) To gain the knowledge on various chronic diseases
iii) To impart the outbreak investigations and the role of laboratory
iv) To endow with an geographic information system in infectious disease
v) To aware the students in prevention of infectious diseases

Course Outcome:

CO1	They could learn about the infectious diseases and its epidemiological reports
CO2	They could learn the various chronic diseases
CO3	Able to learn about outbreak investigations and its diagnostic methods
CO4	Helps to gain the geographic informations in diseases
CO5	It makes expertise in the prevention of infectious diseases

UNIT I **Total No. of hours: 06**

History of infectious disease and epidemiology – Introductory concepts – Laboratory methods in the study of infectious diseases - Models to study infectious diseases - Modeling the spread of a disease- Emergent characteristics of Infectious diseases - Mathematical Epidemiology of Infectious disease.Introduction of microorganisms,types of diseases.Identification of infectious diseases.

UNIT II **Total No. of hours: 06**

Chronic diseases – common bacterial zoonotic diseases - Anthrax, Brucellosis – Vector borne diseases - Malaria and Dengue, Food borne Illness - Salmonellosis, Ameabiasis, Sexually Transmitted Diseases - HIV/ AIDS. Disease Detection & Analysis

UNIT III **Total No. of hours: 06**

Outbreak investigation - Confirm outbreak and diagnosis - advance knowledge about a disease. Role of the Public Health Laboratory - Disease Surveillance - Principles of Screening and Screening Tests. Food poisoning and staining techniques

UNIT IV **Total No. of hours: 06**

Geographic information systems in infectious disease – Pandemic outbreak, Healthcare associated infections/ infection prevention – Development of Drug Resistance & Infection Control in a Hospital Setting.

UNIT V **Total No. of hours: 06**

Principles of elimination and eradication – Vaccination. Behavior change and HIV/STDs - Blood Safety - Immigrant and Refugee Health - International Research in Resource Poor Settings - Critical Reading of Medical Literature. Antibiotics – Penicillin, Kanamycin, Streptomycin, Amoxycillin and Colistin.

Suggested Reading

1. Kenrad Nelson and Carolyn Williams (2014). Infectious Disease Epidemiology. Third Edition.

2. David L. Heymann (2015). Control of Communicable Diseases Manual. 20th Edition, American Public Health Association.

3. Annual Summary of Communicable Diseases Reported to the Minnesota Department of Health, 2015. Minnesota Department of Health.

Web sources

1. www.health.state.mn.us/divs/idepc/newsletters/dcn/sum15/2015dcn.pdf
2. http://www.journals.uchicago.edu/CID/home.html

SEMESTER – V **CORE - V**
18U5MBC05 **Total number of Hours: 60**
Credits: 6 **6 Hours/Week**

MEDICAL BACTERIOLOGY AND MYCOLOGY

Course Objectives:

- To study the pathogenesis, laboratory diagnosis and antimicrobial sensitivity testing
- To gain knowledge about the diseases caused by Gram positive and Gram negative cocci
- To impart knowledge on the diseases caused by Gram positive bacilli and Gram negative bacilli
- To understand the fungal classification, diagnosis, cultivation and antifungal agents
- To study the superficial, cutaneous, sub cutaneous, systemic and opportunistic mycoses

Course Outcome:

CO1	Able to understand beneficial and harmful microbes
CO2	Medically important gram negative pathogens
CO3	Enterobacteria and other STI
CO4	Basics of fungal diseases and diagnostics methods
CO5	Dermatophytes and opportunistic mycosis

UNIT- I Introduction of Medical Bacteriology **No. of Hours:12**

Introduction and History of Medical Bacteriology-,Normal microbial flora of human body – Infection – Types, Source, Modes of Transmission, Mechanism of bacterial pathogenesis – Collection and transport of clinical samples - Laboratory diagnosis of infectious diseases.

UNIT- II Gram Positive Pathogens **No. of Hours:12**

General characteristics, pathogenesis, clinical manifestation, laboratory diagnosis and control measures of the following pathogens - *Staphylococcus aureus, Streptococcus pneumoniae, pyogens Corynebacterium diphtheriae, Bacillus anthracis,* Anaerobic wound infection-*Clostridium tetani*Respiratory diseases -*Mycobacterium tuberculosis,* Sexually transmitted diseases:*Neisseria gonorrhoeae*

UNIT- III Gram Negative Pathogens **No. of Hours:12**

General characteristics, pathogenesis, clinical manifestation, laboratory diagnosis and control measures of the following pathogens - *Escherichia coli, Klebsiellapneumoniae,Proteus* species,*Salmonella typhi, Shigella dysenteriae,Pseudomonas aeruginosa, Vibrio cholerae, Treponema pallidum* and *Mycoplasma pneumoniae.*

UNIT- IV Introduction Medical Mycology **No. of Hours:12**

Introduction and History of Medical Mycology-Classification of medically important fungi - Laboratory diagnosis of fungal diseases - Collection and examination of fungal specimens – Culture media - Isolation and identification of pathogen from infected patientfungi - Staining of

fungi –KOH and LCB.PAS, H&E and GMS - Cultivation of fungi - Antifungal drugs mode of action - Antifungal susceptibility test.

UNIT- V Mycoses Classification **No. of Hours:12**

Classification of Mycoses – superficial mycoses – *Dermatophytosis – Tineanigra – Piedra* (White and Black) and subcutaneous mycoses- *Mycetoma - Histoplasmosis* - Systemic mycoses Blastomycoses - Oppertunistic mycoses - *Candidiasis – Aspergillosis* - - *Cryptococcosis. Mycotoxicoses.*

Text Books

1. ArtiKapil (2013). **Ananthanarayan&JayaramPaniker's Text book of Microbiology**. 9th edition, Orient Longman Limited, Chennai.
2. Chakraborty P (2003). **A Text book of Microbiology.** 2nd edition, Published by New Central Book Agency (P) Ltd., Kolkata.
3. JagdishChander (2012). **Text book of Medical Mycology**. 3rd edition. Mehta Publishers, New Delhi.
4. Rajan S. **Medical Microbiology**. MJP Publishers, Chennai. 2007.

Reference Books

1. Jawetz E and JL Melnic (2001). **Medical Microbiology**, 22nd edition, Tata McGraw-Hill, New Delhi.
2. David Greenwood CB and Richard (2002). **Medical Microbiology**. 22nd edition, Tata McGraw- Hill, New Delhi.
3. Monica Cheesbrough (2003). **District Laboratory Practice in Tropical Countries**.Part 1 and 2.Low-Price edition, Cambrige University Press.

Web sources

https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/ln_med_bact_final.pdf
https://mycology.adelaide.edu.au/mycoses/

SEMESTER – V	**CORE - VI**
18U5MBC06	**Total number of Hours: 60**
Credits: 5	**5 Hours/Week**

INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY

Course Objectives:

- To gain knowledge about screening techniques and strain improvement.
- To study about different types of bioreactors.
- To know about industrial production of enzymes and antibiotics.
- To understand the types of pharmaceutical products.
- To study the quality control of pharmaceutical products.

Course Outcome:

The students could able to gain knowledge on

CO1	Basic background information on industrial strain development and sterilization
CO2	Downstream and upstream process of production technology
CO3	Various industrial microbiological product synthesis
CO4	Synthesis of antimicrobial drugs using fermentation technology
CO5	Drug delivery mechanism and clinical trials

UNIT - I **No. of Hours:12**

Introduction to industrial microbiology: Industrially important microorganisms - Isolation, preservation and improvement of strains - handling - development of inoculum for various fermentation processes,upstream processing - media for industrial fermentation - formulation - sterilization. Screening techniques - Primary and Secondary. Upstream processing - Strain improvement - Development of inoculums – Production media – Raw materials, optimization and Industrial sterilization.

UNIT- II **No. of Hours:12**

Industrial Fermenter – Components, of fermentor - Types of bioreactors – Types - of fermentor Instrumentation – Scale up – Monitoring – Sensors - of fermentation -Upstream processing - Strain improvement- Down Stream Processing – Recovery, Purification of intracellular and extracellular products and natural sources.

UNIT- III **No. of Hours:12**

Industrial production of enzymes –α amylase & proteases.Organic acid -citric acid, lactic acid and acetic acid.Alcoholic beverages - Wine and Beer. Aminoacid – glutamic acid. Vitamin - B12. Microbiological production of antibiotics – Penicillin and streptomycin.Introduction; general aspects, production of nucleotides &nucleotides, production of alcohols-acetone-butanol, production of ethanol, Biopolymers, and Biofuels.

UNIT - IV **No. of Hours:12**

Types of pharmaceutical products – production of Vitamin B_{12} - Microbiological production of antibiotics – Penicillin and streptomycin.. Antimicrobial agents - Bioassay of antimicrobial agents – Contamination, spoilage and preservation of pharmaceutical products – Microbiological quality control - Sterility test- Pyrogen test- Toxicity test- Carcinogenicity test.

UNIT - V **No. of Hours: 12**

Drug delivery systems - Drug distribution in body - Bio-availability- Adverse drug reaction and drug interaction. Drug discovery - Phases of drug discovery - Clinical studies: phase I and phase II of clinical trials. Bioprospecting - Extraction, purification and characterization of bioactive molecules from natural resources.

Text Books

1. Patel A.H (2011). **Industrial Microbiology**. 2nd edition. Published by Mac Millan Publishers India Ltd.,Chennai.
2. Cassida L.E(1996).**Industrial Microbiology**.New Age International Publishers, Chennai.
3. Purohit S.S,Saluja A.K and KakraniH.N (2004), Pharmaceutical Microbiology, 1stedition,Agrobios (India), Jodhpur.

Reference books

1. PepplerH.J and Perlman D (1979).Microbial Technology.Vol.1 and II. 2nd edition. Academic Press, New York.
2. StanburyP.F, Whitaker A and Hall S.J (1995).Principles of Fermentation Technology.2nd edition.PergamonPress, New York.

Web Sources

https://pdfs.semanticscholar.org/635d/da50cbf522a7c860ddf899925ffa703123b1.pdf

https://run.edu.ng/directory/oermedia/422231995398.pdf

http://site.iugaza.edu.ps/mwhindi/files/Modern-Industrial-MicrobiologyBiotechnology.pdf

file:///H:/industrial/0c03ce4cbbae680f46362dd24207e254-original.pdf

SEMESTER – V	**CORE - VII**
18U5MBC07	**Total number of Hours: 60**
Credits: 5	**5 Hours/Week**

GENETIC ENGINEERING

Course Objectives:

1. To get hold of knowledge on enzymes and vectors
2. To be familiar with rDNA technology
3. To obtain knowledge about molecular techniques
4. To know the basics on genetic engineering in plants
5. To obtain knowledge in the basics on genetic engineering in plants

Course Outcome:

The students could expertise in

CO1	Restriction modification system and vectors
CO2	Natural gene transfer methods
CO3	Molecular genome amplification techniques
CO4	Use of bacterial Ti, Ri plasmids and plant gene targeting techniques
CO5	Transgenic technology and animals

UNIT - I Restriction Enzyme and Vectors **No. of Hours: 12**

History and introduction to restriction enzymes – types - I, II & III. Restriction and modification System in Bacteria (*E.coli*) - Vectors - Plasmids - Phage, Cosmids, Phagemids and special vectors- broad host range expression in bacteria, shuttle vectors.

UNIT - II Gene Recombination and Gene transfer methods **No. of Hours: 12**

Bacterial conjugation – transformation – transduction. Gene transfer methods – Physical - Microinjection, Electroporation, Gene Gun, Ultrasonication, Microlaser gene transfer. Chemical methods – Liposome mediated, Transfection with DEAE-dextran, Calcium phosphate transfection.

UNIT - III PCR and Its applications Advanced techniques in genetic engineering

No. of Hours: 12

Introduction to PCR technology - gene amplification – PCR primer designing and optimization. Types of PCR - Multiplex and nested PCR, Reverse Transcriptase PCR, Real Time PCR, RACE, RAPD, RFLP, AFLP and their applications.

UNIT - IV Genetic engineering in plants **No. of Hours: 12**

Uses of Introduction to *Agrobacterium tumefaciens* and *rhizogenes* - Ti plasmid, Ri plasmid – structure and functions. Strategies for gene transfer in plant cells - Direct DNA transfer to plants, Use of plant viruses as episomal expression vectors. Gene targeting in plants Introduction to plant tissue culture – Media composition and preparation - callus and cell suspension culturing.

UNIT - V Genetic engineering in animals **No. of Hours: 12**

Introduction to genetically modified organisms (GMO) - Production and applications of transgenic mice – gene knockout technology, role of ES cells in gene targeting in mice, transgenic cow. Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines.

Suggested Reading

1. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
2. Brown T.A (2010). Gene cloning and DNA Analysis. 6th edition. Blackwell publishing, Oxford, U.K.
3. Satyanarayana U 2005 Biotechnology 1st edition. Books & Allied (p) Ltd.-Kolkata.
4. Primrose SB and Twyman RM. (2006). Principles of Gene manipulation and Genomics. 7th edition, Blackwell publishing, Oxford, U.K.
5. Dubey R. C. A Textbook of Biotechnology. Publisher: S. CHAND.
6. Primonrose SB and Twyman RM. (2008). Genomics: Application in human biology Blackwell publishing, Oxford, U.K.

Web Sources

https://nptel.ac.in/downloads/102103013/
https://science.umd.edu/classroom/bsci124/lec41.html
http://genok.no/wp-content/uploads/2013/04/Chapter-4.pdf

SEMESTER – V	**CORE PRACTICAL - V**
18U5MBCP05	**Total number of Hours: 45**
Credits: 3	**6 Hours/Week**

PRACTICAL V

Course Objectives:

- To obtain knowledge about fungal identification methods
- To gain information about immobilization technique
- To know the techniques in amylase production from bacteria
- To update the identification methods used in clinical pathogen detection
- To get knowledge about citric acid producing fungi

Course Outcome:

They students could able to do

CO1	Diagnosis of pathogens from clinical samples
CO2	Demonstration of fungal pathogens
CO3	Screening of bacteria for amylase production
CO4	Screening of bacteria producing citric acid
CO5	Immobilization of products for preservation

1. Isolation, Identification and Biochemical characterizations and identification of clinical pathogens from clinical samples – Urine, Pus, Throat swab and Sputum.

2. Identification of fungal specimens by direct microscopy – KOH and LCB preparations.

3. Screening of amylase producing bacteria from soil.

4. Screening Production of citric acid producing bacteria and quantification from soil bacteria sample.

5. Immobilization technique.

6. Isolation of plasmid DNA from *E. coli.*

7. Screening of recombinants – Blue / white selection assay.

8. Partial purification of enzymes - (Protease/Amylase)
9. Estimation of enzymes by Lowry *et al* method

Suggested Manuals

1. Arora, B and D.R. Arora, (2013), **Practical Microbiology** CBS Publishers & distributors Pvt. Ltd, New Delhi.
2. Benson, J.H., (2001), "**Microbiological Applications: A Laboratory Manual in General Microbiology**", Eighth Edition, McGraw-Hill, New York.
3. Cappuccino, J.G. and N. Sherman, (2005), "**Microbiology - A Laboratory Manual**", Seventh Edition, Benjamin and Cummings Publications, San Francisco.
4. Gunasekaran, P., (2005), "**Laboratory Manual in Microbiology**", New Age International (P) Ltd, New Delhi.
5. Kannan, N., (2003), "**Laboratory Manual in General Microbiology**", Fourth Edition, Palani Paramount Publications, Palani.

SEMESTER – V	**ELECTIVE - I**
18U5MBE01	**Total number of Hours: 45**
Credits: 4	**4 Hours/Week**

HAEMATOLOGY AND BLOOD BANKING

Course Objectives

- To gain knowledge about the blood cells.
- To study hematological diseases.
- To impart knowledge on hematological tests.
- To gain knowledge about immunohematology.
- To study blood banking and blood transfusion.

Course Outcome:

CO1	Basics of hematology and immune cells
CO2	Immunological and deficiency-oriented disorders
CO3	Analysis of cells by various mathods
CO4	Routine hematological tests
CO5	Blood transfusion and disease transfer

UNIT - I **No. of Hours: 09**

Introduction to Haematology;– Blood – Components and its function. Standard operating procedure. Haematopoietic system of the body – Development of blood corpuscles - Erythropoiesis – Leukopoiesis – Thrombopoiesis. Composition of blood and its function.

UNIT - II **No. of Hours: 09**

Haematological diseases: Anaemia-Types of Anaemia. Iron deficiency anemia. Hemolytic disease of the new born, Infectious mononucleosis, Multiple myeloma, Multiple sclerosis, Hodgkin's lymphoma, Hemoparasitic Parasitic infections of blood, Leukaemia - classification.

UNIT - III **No. of Hours: 09**

Routine haematological tests – Introduction – Collection of blood – Anticoagulants - Complete blood cell count (CBC) – Determination of haemoglobin by Sahli's method – Cynamethaemoglobin method – RBC count – WBC count - Differential count – Determination of ESR.

UNIT - IV **No. of Hours: 09**

Haemostasis and blood Coagulation – Mechanism of coagulation – Determination of bleeding time and clotting time – Platelet disorders. Immunohaematology – Human blood group systems – ABO grouping and other blood group systems – Rh Typing.

UNIT - V **No. of Hours: 09**

Blood banking and blood transfusion – Screening of blood donors – Preservation and storage of donated blood - Cross matching – Blood transfusion – HLA typing - Transfusion transmitted diseases – Transfusion reaction. Cord blood banking.

Text Books

1. Drew Provan (2009). ABC of Clinical Haematology, 3rd edition. BMJ books.
2. Hoffbrand A.V, Pettit J.E and Moss P.A.H (2001). Essential Haematology. 2nd edition. Blackwell Science, New York.
3. Praful B. Godkar, Darshan P. Godkar (2003). Textbook of Medical Laboratory Technology, 3rd Edition.

Reference Books

1. Denise M Harmening (2012). Modern Blood Banking and Transfusion Practices. 6th Edition. F A Davis Company, Philadelphia.
2. Transfusion Medicine Technical Manual (2003). 2nd edition. DGHS, Ministry of Health and Family Welfare, Govt. of India,
3. Peter Delves, Seamus Martin, Dennis Burton (2006). Roitt's Essential Immunology. 11th edition. Wiley-Blackwell, New York.

Web sources

https://nptel.ac.in/courses/102103012/pdf/mod7.pdf

https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/ln_hematology_mlt_final.pdf

http://www.rajswasthya.nic.in/RHSDP%20Training%20Modules/Lab.%20Tech/Blood%20Banking/Introduction.pdf

file:///H:/Hematology/abo%20blood%20grouping.pdf

SEMESTER – V	**ELECTIVE - I**
18U5MBE02	**Total number of Hours: 45**
Credits: 4	**4 Hours/Week**

ENTREPRENEURSHIP IN MICROBIOLOGY

Course Objectives

- To understand the basic concepts of entrepreneurship and become a young women entrepreneur.
- To gain business opportunities on mushroom cultivation.
- To expand systemic knowledge on different composting technology.
- To increase the comprehension on various biotechnological approaches to establish successful enterprises.
- To understand different financial agencies supporting entrepreneurship.

Course Outcome:

CO1	Entrepreneur importance towards women development
CO2	Mushroom cultivation and various products development
CO3	Bio-composting and its application
CO4	Biofertilizer manufacturing techniques
CO5	Funding agencies which supports entrepreneurial development

UNIT - I **No. of Hours: 09**

Evolution of the and concept of Entrepreneur – Characteristics – Functions and types of Entrepreneur – Entrepreneurship – Role of entrepreneurship in economic development – Women entrepreneurs – Problems of women entrepreneurs – Factors affecting entrepreneurial growth.

UNIT - II **No. of Hours: 09**

Composting - types of composting – aerobic and anaerobic, Drilospheres – Biology and ecological classification of earthworm – Physical and chemical effects of earthworm on soil, Vermicomposting - species employed, methods and types of production – preparation of vermiwash – Field application and crop response, Storage and marketing of composts.

UNIT - III **No. of Hours: 09**

Finance to Entrepreneurs – Commercial banks, funding agencies – TNSCST, UGC, DST, ICMR, CSIR, and DBT. Project proposal writing – selection, formulation and financial plan - Project report preparation and submission.

UNIT - IV **No. of Hours: 09**

Mushroom cultivation: Edible mushroom – Morphology, Nutritional and medicinal value – Preparation of spawn, types of spawning – Preparation of substrate - Casing – harvesting – storage and marketing - Mushroom diseases and its management – value added products – Soup, Omlette, Samosa, Noodles, Pickles and Curry.

UNIT - V **No. of Hours: 09**

Biofertilizer – Rhizobium, Azotobacter, Azospirillum, BGA, Azolla, VAM – bioinoculum, mass production, field application and crop response – Biopesticide – bacteria and fungi. Production of SCP – *Spirulina* and Yeast – Herbal sale importance and marketing.

Text Books

1. Khanka S.S (2003). **Entrepreneurial development**. 3rd edition. S.Chand & Company, New Delhi.
2. Kanniyan.S and Ramaswamy K (1980). **A Handbook of Edible Mushrooms**. Today's and Tomorrow's Printers, New Delhi.
3. Kale Radha D (1998). **Earthworm: Cinderella of organic farming**. Prism Books Pvt. Ltd., Bangalore.
4. Subba Rao, N.S. (1993). **Biofertilizers in Agriculture and Forestry**. 3rd edition. Oxford and IBH publication Co. Pvt. Ltd., New Delhi.

Reference Books

1. Shukla M.B (2007). **Entrepreneurship and small business management.** 7th edition. Kitab Mahal publication, Allahabad.
2. Vasant Desai (2001). **Dynamics of Entrepreneurial Development and Management.** 4th edition. Himalaya Publishing House, New Delhi.
3. Chang S.T and Hayes W.A (1978). **Biology and cultivation of mushrooms**. Academic Press, New York.
4. Jogdand SN. Environmental Biotechnology, Himalaya Publishing House. New Delhi. 2010.

Web sources

https://www.biospace.com/article/microbiology-a-field-ripe-for-entrepreneurship/
https://extension.psu.edu/six-steps-to-mushroom-farming
https://www.systemekofungi.com/wp-content/uploads/Mushroom-Cultivation-Manual.pdf
http://www.amm-mcrc.org/publications/Biofertilizers.pdf

SEMESTER – VI **CORE - VIII**
18U6MBC08 **Total number of Hours: 60**
Credits: 6 **6 Hours/Week**

MEDICAL VIROLOGY AND PARASITOLOGY

Course Objectives

To gain basic knowledge on medical virology and parasitology
To get exposure with medically important microbes and their diseases
To get expertise in diagnostic methods
To get an updated knowledge on microbes, disease control, treatment and prevention

Course Outcome:

CO1	Introduction and background on medical virology & parasitology
CO2	Able to gain knowledge on medically important common viruses
CO3	Recently emerged viral infections
CO4	Clinically important Protozoas
CO5	Clinical importance of helminthic infections

UNIT - I **No. of Hours: 12**

Introduction and Historical perspective of medical virology. General characteristics properties of viruses – Viral replication. Multiplication Baltimore classification of viruses. Cultivation of viruses – viral assay - Classification of viruses - Viroids and Prions. – Collection, Transport, Serological and molecular diagnosis of viral infections. Antiviral agents and vaccines. HSV type 1 – type 2 – type 3 – type 4 – type 5, Variola-vaccinia virus.

UNIT - II **No. of Hours**: **14**

Poxviridae: *Othropoxviruses – Variola, Vaccinia* and *Cowpox virus*. ***Herpesviridae***: *Human herpes viruses - type 1 to 8*. ***Papillomaviridae***: - *Human papilloma viruses*. ***Picornaviridae*:** *Enterovirus - Polio virus*. ***Rhabdoviridae***: *– Lyssavirus - Rabies virus*. ***Hepatitis viruses:*** A, B, C, D and E. ***Orthomyxoviridae***: *Influenza A*. ***Paramyxoviridae***: *Morbillivirus – Measles*; *Orthorubulavirus – Mumps* and *Henipavirus - Nipahvirus*. German measles

UNIT - III **No. of Hours**: **12**

Arthropod borne and Rodent borne diseases: ***Togoviridae****: Alphavirus – Chickungunya virus*. ***Flaviviridae****: flavivirus – Yellow fever, KFD virus, Dengue* and *Zika virus*. ***Filoviridae:*** *Ebola* and *Marburg virus*. ***Coronoviridae****: Betacoronavirus – SARS-CoV, MERS-CoV* and *SARS-CoV-2*. ***Retirovidae:*** *Lentivirus - Human Immunodeficiency virus*.

UNIT - IV **No. of Hours: 12**

Introduction to medical parasitology: Classification - Common diagnostic methods in parasitology - Examination of faeces for ova and cyst – Concentration methods. Blood smear examination of parasites. *Entamoeba histolytica - Giardia lamblia - Trichomonas vaginalis - Leishmania donovani - Trypanosoma brucei - Plasmodium falciparum* and *malariae*.

UNIT - V **No. of Hours: 10**

General Characteristics, life cycle, diagnosis, prophylaxis and control of *Ascaris lumbricoides - Ancylostoma duodenale - Schistosoma haematobium - Taenia solium – Taenia saginata - Diphyllobothrium latum - Enterobius vermicularis- Trichuris trichiura – Wuchereria bancrofti.*

Suggested Reading

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.
10. Parija S.C. (2013) **Text book of Medical Parasitology.** 4th edition. All India Publishers and Distributors, New Delhi.
11. Chatterjee (1986). **Medical Parasitology**. Tata McGraw Hill, New Delhi.
12. Jagdish Chander (2012). **Text book of Medical Mycology**. 3rd edition. Mehta Publishers, New Delhi.

SEMESTER – VI	**CORE - IX**
18U6MBC09	**Total number of Hours: 60**
Credits: 5	**5 Hours/Week**

SOIL AND ENVIRONMENTAL MICROBIOLOGY

Course Objectives

- To study the physico-chemical and microbiological properties of soil.
- To gain knowledge about the biogeochemical cycles and biofertilizer.
- To impart knowledge on microbial interactions in plants and animals and plant pathology.
- To understand the microbiology of air and water.
- To study the microbiology of sewage and sewage treatment methods.

Course Outcome:

CO1	Able to understand soil microbiota
CO2	Concepts of metabolic pathways by soil microbes and their role
CO3	Symbiotic relationship between microbes and plants
CO4	Water quality parameters -Physico chemo parameters
CO5	They could able to perform experiments to test the quality of samples

UNIT - I **No. of Hours: 12**

Introduction to soil microbiology: Structure, Physical and chemical properties of soil - Types and significance of soil microbes – Bacteria, Fungi, Actinomycetes, Protozoa, Nematodes and Viruses. Factors affecting soil microbial population.

UNIT - II **No. of Hours: 12**

Biogeochemical cycles: Carbon, nitrogen, phosphorous and sulphur - Mechanism of nitrogen fixation - Biofertilizer – Rhizobium, Azotobacter and Cyanobacteria – Mass cultivation, field study and its applications. Quality guidelines for biofertilizers.

UNIT - III **No. of Hours: 12**

Microbial interactions and plant pathology: neutralism, commensalism, synergism, mutualism and parasitism. Interaction of microbes with plants – Rhizosphere, Phyllosphere and Mycorrhizae. Microbe-animal interaction - Microbes in ruminants. Plant Pathology – symptoms, disease cycle and its control measures - Bacterial - Citrus canker, Fungal - Wilt of Cotton and Tikka leaf spot of groundnut, Viral – TMV.

UNIT IV **No. of Hours: 12**

Microbiology of air & water – Enumeration of bacteria from air – Air sampling devices (Settling under Gravity, Centrifugal action, Impingment and Electrostatic precipitation) – Air sanitation.

Assessment of drinking water quality (Total count, Membrane filter and MPN) – water standards - indicator organisms – water purification – Waterborne diseases and their control measures.

UNIT V **No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). **Liquid waste management:** Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Biodegradation, Bioremediation, Biodeterioration of wood, paints, leather and textile. Xenobiotics.

Text Books

1. Mishra R.R (2004). **Soil Microbiology**. CBS Publishers & Distributers, New Delhi.
2. Subba Rao (1999)**. Soil Microbiology.** 4th edition. Oxford and IBH publishing Co (P) Ltd, New Delhi.
3. Joseph C Daniel (1999). **Environmental aspects of Microbiology**. 2nd edition. Bright Sun Publications, Chennai.
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.

Reference Books

1. Rangaswami.G and Bagyaraj D.J. (2009). **Agricultural Microbiology**.2nd edition. PHI Learning Pvt. Ltd., New Delhi.
2. Ralph Mitchell and Ji Dong Gu (2010). **Environmental Microbiology**. 2nd edition, Wiley-Blackwell, New Jersy.
3. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

SEMESTER – VI	**CORE - X**
18U6MBC10	**Total number of Hours: 60**
Credits: 5	**5 Hours/Week**

FOOD AND DAIRY MICROBIOLOGY

Course Objectives

- To gain knowledge about the microorganisms involved in food
- To impart the idea in food spoilage
- To gain the knowledge in food preservation.
- To study the food borne infections
- To study the rules and regulations of food sanitation

Course Outcome:

CO1	Food pathogens and their Phsico-chemico parameter analysis
CO2	Spoilage of food by various microbes
CO3	Food Preservation methods
CO4	Able to understand microbial Fermented products
CO5	Food intoxication and determination of food pathogens

UNIT - I **No. of Hours: 12**

Introduction – importance of food microbiology- types of microorganism in food- - Bacteria, Mold and Yeasts Factors influencing the Growth of microorganisms- Intrinsic factors - (pH, moisture, oxidation - reduction potential, and nutrient content), extrinsic factors - (temperature, relative humidity, gases and microbial activities) and inhibitory substances.

UNIT - II **No. of Hours: 12**

Source of contamination food spoilage and preservation - vegetables and fruits, cereals, meat and meat products, Poultry products and eggs, milk and milk products, canned food, fish and sea foods.

UNIT - III **No. of Hours: 12**

Milk – composition and types of milk – microflora of raw milk- microbial analysis of milk- Pasteurization of milk - dye reduction test using methylene blue and resazurin- total bacterial count – somatic cell count – Brucella ring test a.nd test for mastitis. Fermented dairy products - Dairy starter cultures, fermented dairy products - yogurt, acidophilus milk, kumiss, kefir, curd and cheese

UNIT - IV **No. of Hours: 12**

Fermented food products - bread, dosa, sauerkraut, soy sauce, kombucha and tampeh. Probiotics - Health benefits, types of microorganisms used, probiotic foods available in market, GRAS (General Regard as Safe).

UNIT - V **No. of Hours: 12**

Food born infection and intoxications – bacterial and non -bacterial – investigation of food borne diseases - Rapid detection methods for food borne pathogens. Food law and regulations – FSSAI, GMP, HACCP- Codex alimentarius - Food sanitation and control.

Text Books

1. Vijaya Ramesh K (2007). Food Microbiology. First edition, MJP Publishers, Chennai.
2. Adams MR Moss MO (2004). Food Microbiology, 2nd Edition, Panima Publishing House, New Delhi.
3. James M Jay (2003). Modern Food Microbiology. 4th Edition, CBS Publishers & Distributors, New Delhi

Reference Books

1. Frazier WC and Westhoff DC (1988). Food Microbiology, 4th Edition, Mc Graw Hill, New York
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
4. Sivashankar B – Moss (2011). Food Processing and Preservation. Eighth edition, PHI Learning P.Ltd., New Delhi.
5. Roday, S. (1998). Food Hygiene and Sanitation. Tata Mcgraw Hill Publications.

SEMESTER – VI	**ELECTIVE - II**
18U6MBE03	**Total number of Hours: 45**
Credits: 4	**4 Hours/Week**

MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Course Objectives

- To gain knowledge about the microbial diseases.
- To impart knowledge on clinical sample collection.
- To gain knowledge about microbial characters in selective media.
- To study the different detection methods.
- To gain the knowledge on antimicrobial testing & MIC.

Course Outcome:

CO1	Microbial disease diagnosis methods
CO2	To understand the clinical microbiology
CO3	Able to understand the microscopic examination
CO4	Able to understand molecular identification by molecular techniques
CO5	To understand the antibiotics test

UNIT - I **No. of Hours: 5**

Importance of Diagnosis of Diseases: Host-Pathogen Interaction: Distribution and significance of normal human microbial flora. Importance of Diagnosis of Diseases - Bacterial, Viral, Fungal and Protozoan disease of human beings. Bacterial, Viral, Fungal and Protozoan - Diseases of various human body systems - Disease associated clinical samples for diagnosis.

UNIT - II **No. of Hours: 5**

Collection of Clinical Samples: Guidelines for the collection, Transport, Processing and analysis of clinical samples - oral cavity, throat, sputum, skin scrapings, Blood, CSF, urine and faeces. and its precautions - Storage method of clinical samples in laboratory. Disposal methods of clinical samples.

UNIT - III **No. of Hours: 5**

Direct Microscopic Examination and Culture: Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria. Culturing of infectious bacteria by blood culturing method. Preparation and use of various selective media - Distinct colony properties of various bacterial pathogens in selective medium.

UNIT - IV **No. of Hours: 5**

Serological and Molecular and rapid detection Methods: Serological Methods – Agglutination, ELISA and immunofluorescence. Molecular methods – PCR, RT-PCR & Nucleic acid probes. Rapid Detection methods - Typhoid, Dengue, Corona and HIV using diagnostic kits.

UNIT - V **No. of Hours: 5**

Testing for Antibiotic Sensitivity in Bacteria: Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method - Determination of minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of an antibiotic by serial double dilution method, E-Test.

Text Books

1. Ananthanarayan R and Paniker CKJ (2009). Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

Reference Books

1. Topley & Wilsons – Microbiology & Microbial Infections – 9th Edition.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013).
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd.
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.

SEMESTER – VI	**ELECTIVE - II**
18U6MBE04	**Total number of Hours: 45**
Credits: 4	**4 Hours/Week**

QUALITY CONTROL IN FOOD MICROBIOLOGY

Course Objectives:

- GLP practices are intended to promote the quality and validity of test data.
- To get an idea for food business sets around producing and providing safe.
- To be able to differentiate between different enumeration techniques and learn when each should be used.
- To gain knowledge on spoilage microorganisms affects the appearance, smell, texture and taste.
- To Identify sources of potential errors during production and confirm the quality of the final product

Course Outcome:

CO1	Able to understand good laboratory practices
CO2	Able to understand the importance and food safety method
CO3	To gained knowledge about microbes and their food product
CO4	Able to understand food spoilage methods
CO5	Able to understand food preservation technologies

UNIT - I **Total No. of hours: 06**

Good laboratory practices (GLP), Good Microbiological Practices (GMP). Quality policy, quality objectives of food processing company, Standard Operating Procedures, Work instructions, Good Handling Practices (GHP) & GMP checklist.

UNIT - II **Total No. of hours: 06**

Importance and significance of microorganisms in food safety - Food and Drug Administration (FDA) and its regulation - Factors affecting the growth of micro organisms in food - intrinsic (pH, moisture, oxidation-reduction potential and nutrient content) and extrinsic (Temperature, relative humidity, gases and microbial activities).

UNIT - III **Total No. of hours: 06**

Determination of micro organisms and their products in food: sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods- direct microscopic observation, culture enumeration and isolation methods.

UNIT - IV **Total No. of hours: 06**

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods.

UNIT- V **Total No. of hours: 06**

Rules and regulations for setting up of a processing unit. Criteria for ingredients and finished products. Aspects of microbiological safety in food preservation technologies, Establishment and implementation of HACCP, Continuous Assessment System, Total quality management and quality audits in food industries.

Microbiological quality standards of food, control and inspection, Enforcement and Govt. Regulatory practices and policies. FDA, EPA, HACCP,ISI, Detection of various methods of food toxicity, Hazard analysis criteria control points (HACCP) system for food safety, HACCP principles, Application of HACCP principles.

Suggested Books:

1. Frazier, W.C. (1988) Food Microbiology, Mc Graw Hill Inc. 4th Edition.

2. The training manual for Food Safety Regulators. Vol.II- Food Safety regulations and food safety management. (2011) Food safety and Standards Authority of India. New Delhi.

3. Fundamentals of Dairy Microbiology by Prajapati.

4. Pelczar, M.I., and Reid, R.D. (2009) Microbiology, 5th Ed., McGraw Hill Inc., New York.

5. James, M.J. (2007) Modern Food Microbiology, 2nd Ed., CBS Publisher, New Delhi

6. Adams, M.R., and Moss, M.G., (2005) Food Microbiology, 1st Ed., New Age International (P) Ltd., New Delhi.

SEMESTER – VI	**SBEC - IV**
18U6MBS04	**Total number of Hours: 30**
Credits: 2	**2 Hours/Week**

ADVANCES IN MICROBIOLOGY

Course Objectives

- To understand quorum sensing.
- To gain knowledge about metagenomics.
- To become familiar with microbial fuel cell (MFC).
- To understand biotechnological potential of algae.
- To gain knowledge about modern trends in microbial production.

Course Outcome:

CO1	Able to understand the quorum sensing and their applications
CO2	Able to understand the human metagenomics projects
CO3	To understand the Microbial fuel cell Technology
CO4	Able to understand the animal cell culture methods
CO5	To understand the Modern trends in microbial production

UNIT – I **No. of Hours: 04**

Quorum sensing: Virulence factors associated with Microbial sensing.-quorum sensing - molecular mechanisms-Biofilm formation- Bioluminescence. Quorum quenching – Mechanisms-prokaryotic to prokaryotic quorum quenching - Eukaryotic to prokaryotic quorum quenching - applications of quorum quenching.

UNIT – II **No. of Hours: 04**

Metagenomics: History and development - Steps involved and application of metagenomics - bacterial diversity using metagenomics approach - Prospecting genes of biotechnological importance using metagenomics - Basic knowledge of Pangenomics. and metatranscriptomics, metaproteomics and metabolomics.

UNIT - III **No. of Hours: 04**

Microbial fuel cell (MFC) Technology: Microorganisms involved in MFC - Working principle - Interaction between microbes and electrodes - Design and Architecture of MFC - Types: Single chambered, double chambered. Application of MFC in Bio-hydrogen production. waste water treatment.

UNIT - IV **No. of Hours: 04**

Animal Cell Culture Technology: Introduction – types of cells - cell culture media and supplements, adherent cells – Vero, Hep-2, HepG-2, HeLa, MDCK, BHK – cultivation - sub-culturing.– preservation. – revival.

UNIT – V **No. of Hours: 04**

Modern trends in microbial production: Microbial production of bioplastics – Types (Starch and Cellulose) - Biodegradation- Applications of Bioplastics. Bioinsecticide -thruricide *Bacillus thuringiensis*, Biopolymer – dextran – alginate - Xanthan. Biofertilizer - N_2 fixer - Azotobacter, phosphate solubilizer, Single cell protein (SCP).

Text Books

1. Purohit SS (2005). **Biotechnology: Fundamentals and Applications.** 3rd Edition Agrobios (India).
2. Sathyanarayana U (2005). **Biotechnology.** 1st Edition, Books and Allied (P) Ltd., Kolkata.
3. Dubey RC (2006). **A Text Book of Biotechnology.** 4th Edition. S.Chand & Company (P) Ltd., New Delhi.
4. Jogdand SN (2010). **Environmental Biotechnology**. Himalaya Publishing House, New Delhi.

Reference Books

1. Bernad R Glick (2010). **Molecular Biotechnology - Principles and Applications of Recombinant DNA**. 4th Edition, ASM Press, Washington, D.C.
2. Maheswari DK and Dubey RC (2008). **Potential Microorganisms for Sustainable Agriculture**. I K International Publishing House Pvt. Ltd.
3. Sahoo D and Kaushik BD (2012). **Algal Biotechnology and Environment**.1st Edition, I K International Publishing House Pvt. Ltd.
4. Thatoi HN and Mishra BB (2011). **Microbial Biotechnology: Methods and Applications.** 1st Edition, Alpha Science International Ltd.
5. Fraser CM, Read TD and Nelson KE. (2004). **Microbial Genomes.** Humana Press.
6. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014). **Brook's Biology of Microorganisms**, 14th edition, Pearson-Bejamin Cummings.

SEMESTER – VI	**CORE - VI**
18U6MBCP06	**Total number of Hours: 60**
Credits: 3	**6 Hours/Week**

MAJOR PRACTICAL VI – MEDICAL VIROLOGY AND PARASITOLOGY, SOIL AND ENVIRONMENTAL MICROBIOLOGY, FOOD AND DAIRY MICROBIOLGY

Course Objectives:

- To obtain knowledge about virus identification methods
- To gain information about the identification of human parasites
- To know the techniques in the isolation of bacteria from root nodules
- To update the identification methods used in assess the water quality
- To get knowledge about the microbes from spoiled food materials

Course Outcome:

CO1	To understand the hemagglutination techniques
CO2	Able to understand the cultivation of viruses
CO3	Able to understand the cultivation of soil microbes
CO4	Able to understand the water quality parameter techniques
CO5	To understand the isolation of bacteria from spoiled fruits

1. . Haemagglutination.

3. Egg inoculation methods (Demostration).

4. Wet mount examination of parasites.

5. Concentration methods for egg / ova

    - Flotation technique
    - Sedimentation technique

6. Isolation of bacteria from rhizosphere.

7. Plant diseases – Fungi and Bacteria.

8. MPN and Settle Plate method.

9. 10. Dissolved oxygen.

10. MBRT and Resazurin test.

11. Isolation of bacteria from spoiled fruits and soft drinks.

12.Determination of indices of pollution by measuring BOD/COD of different effluents

13.Isolation of microorganisms from curd.

CERTIFICATE COURSE

(For any UG and PG students)

SPIRULINA CULTIVATION

OBJECTIVES

To enable the students to

i. be familiar with blue green algae
ii. acquire knowledge on taxonomy of blue green algae

iii. know the significance of single cell protein
iv. be familiar with the production of *Spirulina*
v. be acquainted with harvesting of *Spirulina*

UNIT – I **05 Hrs**

Blue green algae (BGA)- Introduction, morphology and distribution of BGA. Economic importance of BGA. Historical background on the use of Spirulina. Economic importance of Spirulina.

UNIT – II **06 Hrs**

Taxonomy of BGA-major taxonomic genera of BGA – characters –diagnostic key or the identification of BGA with special reference to Spirulina. BGA collection centers.

UNIT – III **08 Hrs**

Single Cell Protein (SCP)- Introduction – characteristics of SCP. BGA as a single cell protein: Nutritional value of Spirulina. Therapeutic value of Spirulina. Cosmetic value of Spirulina. Dosage of Spirulina as food and feed. Advantage of algae as SCP.

UNIT – IV **10 Hrs**

Cultivation of Spirulina - media formulation, indoor cultivation-fish tank method. Outdoor cultivation - inoculum preparation - trough, pit and pot culling method. Large scale production - pond method - Monitoring of production by feeding method, temperature, pH, contamination and density. Spirulina cultivation in waste water.

UNIT – V **06 Hrs**

Harvesting and Drying of Spirulina, post-harvest technology. Quality control and standards of Spirulina products. Common Spirulina products and their formulations (any three). Socio economic feasibility forSpirulina cultivation.

REFERENCE BOOKS

1. Barsanti,L. and P. Gualtieri, 2006, "Algal-anatomy, biochemistry, and biotechnology", CRC Press, Florida.
2. Baum, A.W., 2013, "Grow your own Spirulina super food",Algaelaborg, USA.
3. Richmond, A., 2004, "Handbook of Microalgal Culture" Blackwell Science Ltd, USA.
4. Vonshak, A., 2004, "*SprilinaPlantensis* (Arthrospira): Physiology, cell biology and biotechnology", Taylor & Francis, London.

LAB IN SPIRULINA CULTIVATION -PRACTICAL

OBJECTIVES

To enable the students to

i. be familiar with isolation of*Spirulina*
ii. gain knowledge on media preparation for *Spirulina* cultivation
iii. understand indoor cultivation of *Spirulina*
iv. be familiar with nutritional analysis
v. be acquired with commercial formulation preparation

LIST OF PRACTICALS **15 Hrs**

1. Isolation of Spirulina
2. Microscopic examination of *Spirulina*
3. Preparation of Media for *Spirulina* cultivation
4. Inoculum development and mass cultivation of *Spirulina* (indoor cultivation)
5. Mass cultivation of *Spirulina* (outdoor cultivation)

REFERENCE BOOKS

1. Andersen, R.A., 2005, "Algal Culturing Techniques", First Edition,Elsevier Academic Press, San Diego.
2. Barsanti,L. and P. Gualtieri, 2006, "Algal-Anatomy, Biochemistry, and Biotechnology", CRC Press, Florida.
3. Richmond, A., 2004, "Handbook of Microalgal Culture: Biotechnology and Applied Phycology", Blackwell Science, Iowa.
4. Sinha, R.K. and R. Sinha, 2008, "Environmental Biotechnology" Aavishkar Publishers, Jaipur.
5. Vonshak, A., 2004, "*Spirulinaplatensis* (Arthrospira)-Physiology, Cell Biology and Biotechnology", Taylor & Francis Ltd., London.