DAV UNIVERSITY, JALANDHAR
DEPARTMENT OF MICROBIOLOGY

Course Scheme & Syllabus
For
M.Sc. (Hons.) Microbiology
(Programme ID 40)
1st to 4th Semester
Examinations 2020–2021 Session Onwards

Course Scheme and Syllabus Applicable to Admissions in 2020-2021

Mission

To ignite and nurture the minds of students with the fundamental as well as applied knowledge of microbiology and help them to bridge the gap between science and society. The program is also designed to expand the body of knowledge in microbiology via research efforts.

Programme Learning Outcomes

After completing M.Sc (Hons.) Microbiology, students will be able to explain the theoretical basis of the tools, technologies and methods common to microbiology and apply the scientific method and hypothesis testing in the design and execution of experiments. They will be able to utilize microbiological concepts to summarize, analyze and synthesize scientific and microbiology related literature and apply the knowledge for the betterment of society.

Scheme of Courses (Program ID 40)
M. Sc. (Hons.) Microbiology

Semester 1

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC531	General Microbiology	Core	4	0	0	4
2.	MIC532	General Microbiology Laboratory	Core	0	0	3	2
3.	MIC533	Microbial Diversity	Core	4	0	0	4
4.	MIC534	Microbial Diversity Laboratory	Core	0	0	3	2
5.	BCH529	Biological Macromolecules	Core	4	0	0	4
6.	BCH530	Biological Macromolecules Laboratory	Core	0	0	3	2
7.	Open Elective I			4	0	0	4
8.	Open Elective I Laboratory			0	0	3	2
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

Suggested list of Open Electives (Choose one and corresponding lab course)							
1.	MIC543	Clinical Microbiology	Open Electives	4	0	0	4
2.	MIC544	Clinical Microbiology Laboratory	Open Electives	0	0	3	2
3.	BCH501	Bioanalytical Techniques	Open Electives	4	0	0	4
4.	BCH503	Bioanalytical Techniques Laboratory	Open Electives	0	0	3	2

Scheme of Courses
M. Sc. (Hons.) Microbiology

Semester 2

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC541	Microbial Genetics	Core	4	0	0	4
2.	MIC542	Microbial Genetics Laboratory	Core	0	0	3	2
3.	BTY521	Recombinant DNA Technology	Core	4	0	0	4
4.	BTY522	Recombinant DNA Technology Laboratory	Core	0	0	3	2
5.	MIC550	Microbial Physiology and Metabolism	Core	4	0	0	4
6.	MIC540	Research Methodology and Aptitude	Core	4	0	0	4
7.	Open Elective II						6
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

Suggested List of open Electives (Choose one theory and its corresponding lab course or choose two theory courses of equivalent credits)							
1.	BOT621	Scientific Writing and Research Methodology	Open Elective	3	1	0	4
2.	BTY641	Intellectual Property Rights, Biosafety and Bioethics	Open Elective	2	0	0	2
3.	MIC547	Advances in Microbiology	Open Elective	4	0	0	4
4.	MIC548	Advances in Microbiology Laboratory	Open Elective	0	0	3	2

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Semester 3

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC641	Industrial Microbiology	Core	4	0	0	4
2.	MIC642	Industrial Microbiology Laboratory	Core	0	0	3	2
3.	MIC637	Food Microbiology	Core	4	0	0	4
4.	MIC638	Food Microbiology Laboratory	Core	0	0	3	2
5.	MIC630	Seminar I	Core	0	0	2	2
6.	MIC701	Project Part I	Core				2
7.	Departmental Elective II			4	0	0	4
8.	Departmental Elective II Laboratory			0	0	3	2
9.	Open Elective I			4	0	0	4
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Departmental Electives (Choose one and corresponding lab course)							
1.	MIC631	Immunology	Departmental Elective	4	0	0	4
2.	MIC632	Immunology Laboratory	Departmental Elective	0	0	3	2
3.	MIC635	Eukaryotic Microbiology	Departmental Elective	4	0	0	4
4.	MIC636	Eukaryotic Microbiology Laboratory	Departmental Elective	0	0	3	2

Suggested List of Open Electives							
1.	BTY511	Molecular Biology	Open Elective	4	0	0	4
2.	BTY631	Environmental Biotechnology	Open Elective	4	0	0	4
3.	BTY633	Plant Biotechnology	Open Elective	4	0	0	4

Scheme of Courses
M. Sc. (Hons.) Microbiology

Semester 4

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC545	Soil and Environmental Microbiology	Core	4	0	0	4
2.	MIC546	Soil and Environmental Microbiology Laboratory	Core	0	0	3	2
3.	MIC640	Seminar II	Core	0	0	2	2
4.	Open Elective II			4	0	0	4
Departmental Elective Course (Choose Project Work or Course of equivalent credits)*							
5.	MIC702	Project Part II / Review/ Course of equivalent credits	Elective*				8
Total							20

***Project Work/ Review/ Course of equivalent credits**

L: Lectures T: Tutorial P: Practical Cr: Credits

Suggested List of Open Electives							
1.	BTY681	Virology	Open Elective	4	0	0	4
2.	BTY637	Enzymology	Open Elective	4	0	0	4

Course Name: GENERAL MICROBIOLOGY
Course Code: MIC531
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: The objective of this course is to familiarize the students to the various aspects of microbiology encompassing the types and structural organization of microbes, bacterial nutritional requirements, reproduction and growth as well as methods for their control to reiterate the importance and core subject areas to be taken up in Microbiology.

Course Content:

Unit1 **No. of hours-8**

History of microbiology. Spontaneous generation *vs*. biogenesis. Major proponents of the respective theories. Discovery of anaerobic life form. Discovery of first antibiotic penicillin. Development of key techniques for isolation and pure culture of microorganisms. History of soil microbiology and enrichment culture techniques. History of medical microbiology and immunology.

Unit 2 **No. of hours-7**

General characteristics of acellular microorganisms and Cellular microorganisms. Molecular Microbiology (Structure of bacterial genome, and central dogma of biology)

Unit 3 **No. of hours -15**

Bacterial Cellular organization: Cell size, shape and arrangement, outer membrane, lipopolysaccharide, cell wall, inner membrane, capsule, flagella, endoflagella, fimbriae and pili, cytoplasm, ribosomes, mesosomes. Endospores. Effect of antibiotics and enzymes on the cell wall. Sphaeroplasts and protoplasts.

Basics of microscopy and observation of microbes. Light microscopy: bright field microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, transmission electron microscopy, scanning electron microscopy.

Unit 4 **No. of hours -15**

Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.

Physical methods involving heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation to control microbes. Chemical methods involving antiseptics, disinfectants, sanitizers, sterilizers and antibiotics to control microbes.

Unit 5 **No. of hours-15**

Asexual methods of reproduction, logarithmic growth of bacterial populations, phases of growth, calculation of generation time and specific growth rate. Diauxic growth. Maintenance of population in exponential phase, synchronous growth, continuous culture, fed batch culture and measurement of growth.

Catabolism vs. anabolism. Energy currency and reducing power of a living cell. Fermentation vs. aerobic and anaerobic respiration.

Bacterial cell division and genes involved in the process.

Learning outcomes: The students will be able to appreciate the vast array of microorganisms and their immense significance in our lives

Suggested Readings:

1. Tortora GJ, Funke BR and Case CL. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 15th edition. Pearson International Edition. 2018. Print
3. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print
4.Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. *General Microbiology*. 5th edition. McMillan. 2005. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015/9
2. http://bio-alive.com/tutorials/microscopy.htm
3. https://www.edx.org/learn/microbiology

Course Name: GENERAL MICROBIOLOGY LABORATORY
Course Code: MIC532
Total Credits: 2
Credits components: Theory-0, Practical-3,Tutorial-0

Experiments:

1. Microbiology Good Laboratory Practices and Biosafety.
2. Study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter, spectrophotometer) used in the microbiology laboratory
3. Preparation of general purpose culture media for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air
8. Use of compound light microscope
9. Motility by hanging drop method
10. Simple staining
11. Negative staining
12. Study of different shapes of microorganisms under microscope.
13. Isolation of pure cultures of bacteria by streaking method
14. Preservation of bacterial cultures by various techniques
15. Gram's staining
16. Acid fast staining
17. Endospore staining
18. Spread plate technique
19. Pour plate technique
20. Estimation of CFU count by spread plate method/pour plate method.

Course Name: MICROBIAL DIVERSITY
Course Code: MIC533
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: The aim of this course is to expose the students to vast microbial diversity with emphasis on the classification of bacteria and archea, as well as general characteristics and applications of algae, fungi and protozoa.

Course Content:

Unit 1 **No. of hours -15**

Microbial Evolution, Introduction to Microbial Classification, and Taxonomy, Taxonomic Ranks, Techniques for Determining Microbial Taxonomy and Phylogeny, Assessing Microbial Phylogeny, The Major Divisions of Life, Binomial Nomenclature, Whittaker's five kingdom, Cavalier's eight kingdom and Carl Woese's three domain classification systems, their criteria of classification and their utility. Difference between prokaryotic and eukaryotic microorganisms, Introduction to Bergey's Manual of Systematic Bacteriology

Unit 2 **No. of hours -5**

Introduction to the Archaea, Phylum Crenarchaeota, Phylum Euryarchaeota, Archaeal Phylogeny, Methanotrophic Archaea

Unit3 **No. of hours -15**

Aquificae and *Thermotogae* , *Deinococcus-Thermus* , Photosynthetic Bacteria, The Mechanism of Gliding Motility, Phylum *Planctomycetes,* Phylum *Chlamydiae* , Phylum *Spirochaetes* , Phylum *Bacteroidetes*

The *Proteobacteria*- Class *Alphaproteobacteria,* Class *Betaproteobacteria,* Class *Gammaproteobacteria,* Class *Deltaproteobacteria,* Class *Epsilonproteobacteria*

The Low G +C Gram Positives-General Introduction, Class *Mollicutes* (The Mycoplasmas), Peptidoglycan and Endospore Structure, Class *Clostridia,* Class *Bacilli*

Bacteria: The High G+C Gram Positives-General Properties of the Actinomycetes, *Actinomycineae, Micrococcineae, Corynebacterineae, Micromonosporineae, Propionibacterineae*

Unit 4 **No. of hours -10**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of Algae in agriculture, industry, environment and food.

Unit 5 **No. of hours-15**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure, asexual and sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi with Examples in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins

Protozoa-General characteristics with special reference to *Amoeba, Paramecium and Giardia*

Learning outcomes: The students will be able to appreciate the vast array of microorganisms and their immense significance in our lives. They will also learn the basis of classification of microorganisms and learn about the signification of Algae, Fungi in Human lives.

Suggested Readings

1. Atlas RM. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 1997. Print
2. Black JG. *Microbiology: Principles and Explorations*. 7th edition. Prentice Hall. 2008. Print
3. Madigan MT, and Martinko JM. *Brock Biology of Micro-organisms*. 14th edition. Parker J. Prentice Hall International, Inc. 2014. Print
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. *Microbiology*. 5th edition Tata McGraw Hill. 2004. Print
5. Srivastava S and Srivastava PS. *Understanding Bacteria*. Kluwer Academic Publishers, Dordrecht. 2003. Print
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. *General Microbiology*. 5th edition McMillan. 2005. Print
7. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition Pearson Education. 2008. Print
6.Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print
7. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 15th edition. Pearson International Edition. 2018. Print.

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015/48
2. https://nptel.ac.in/courses/102103015/34
3. https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryote-structure/v/bacteria

Course Name: MICROBIAL DIVERSITY LABORATORY
Course Code: MIC534
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Preparation of different media: synthetic media, Complex media-nutrient agar, McConkey agar, EMB agar, PVK agar etc.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Spore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.
12. Isolation and growth of fungi by using potato dextrose agar/ Malt extract agar
13. Biochemical characterization of a bacterial culture.

Course Name: BIOLOGICAL MACROMOLECULES
Course Code: BCH529
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:

The course is intended for master's course students. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

Course Content:

Unit 1 **No. of hours-10**

Introduction

Structure of atoms, molecules and chemical bonds, Cellular and chemical foundations of life. Water as a biological solvent.The concept of pH, pKa, dissociation and ionization of acids and bases, Physiological buffers and their buffering mechanism, Henderson-Hasselbalch equation.

Carbohydrates

Structure of monosaccharides.Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides.Glycoproteins.

Unit 2 **No. of hours-20**

Proteins

Definition, importance and functions, amino acids as building blocks of proteins, essential amino acids, non-protein amino acids, structure of peptide bond, organizational levels of protein structure, relationship between primary and higher order structures, supramolecular assemblies of proteins, solubility, denaturation, functional diversity and species specificity of proteins, protein classification, chemical synthesis of polypeptides, Conformation of proteins: Ramachandran Plot, Secondary, tertiary and quaternary structure; domains; motif and folds. Stabilizing interactions: Vander waals, electrostatic, hydrogen bonding, Hydrophobic interactions. Stability of protein structure.

Unit 3 **No. of hours-20**

Porphyrins:

Nucleus and classification of porphyrins, important metallo porphyrins occurring in nature, chemical nature and physiological significance of bile pigment.

Lipids

Definition, importance and functions, classification of lipids, fatty acids and essential fatty acids, general structure and functions of major lipid subclasses, acylglycerols, phosphoglycerides, sphingolipids, terpenes, steroids, eicosanoids.

Vitamins and Minerals

Definition, chemistry and functions of water and fat soluble vitamins, major trace minerals, their bound forms and functions.

Unit 4 **No. of hours-5**

Nucleic acids

Structure and functions of different nitrogeneous bases, nucleosides, nucleotides and different types of nucleic acids (DNA, RNA). DNA with unusual structures, DNA denaturation and renaturation.

Unit 5 **No. of hours- 5**

Overview of metabolite pathways: glycolysis, citric acid cycle, pentose phosphate pathway, oxidation of fatty acids, oxidative phosphorylation and photophosphorylation.

Learning Outcomes: After completion of course the students will be able to understand the organic chemical principles in life processes. They will understand the structure and function of important biological molecules such as DNA, RNA, Carbohydrates, Proteins, Lipids etc.

Suggested readings:

1. Nelson DL and Cox MM. (2013) Lehninger Principles of Biochemistry, 6th Edition. Macmillan Worth Publishers, New Delhi.
2. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman &Co., New York.
3. Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA (2015) Harper's Illustrated Biochemistry, 30th Edition, McGraw- Hill Medical Canada.
4. Voet D, Voet JG and Pratt CW (2015). Fundamentals of Biochemistry, 4th Edition. John Wiley & Sons. New York.

Course Name: BIOLOGICAL MACROMOLECULES LABORATORY
Course Code: BCH530
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Quantitative estimation of blood glucose by Toluidine/Enzymatic method.
2. Estimation of proteins by Biuret method.
3. Quantitative estimation of cholesterol in the blood
4. Estimation of alkaline and acid phosphatases
5. Estimation of blood glucose.
6. Estimation of cholesterol
7. Sugar Fermentation in Microorganisms.
8. Estimation of Glucose 6-Phosphate.
9. Estimation of Urea.
10. Estimation of Uric acid.
11. Estimation of Creatinine.

Course Name: CLINICAL MICROBIOLOGY
Course Code: MIC 543
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:
The objective of this course is to help the students to comprehend role of microbes in disease development, epidemiology of microbial diseases, various techniques used in diagnosis of microbial diseases and various antimicrobial agents and their modes of action.

Course content:

Unit 1: **No. of Hours-15**
Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Immune system. Types of immunity. Mediators of immunity. Loss of virulence in pathogens after subculturing on artificial media.

Unit 2: **No. of Hours-15**
Collection, transport and culturing of clinical samples, principles of laboratory diagnosis of infectious diseases. Staining and microscopy. Isolation and identification of causal organism. Selective and differential medium. Growth media specific to isolate or differentiate various pathogenic bacteria. Immunologic tests like ELISA, Immunofluorescence, Agglutination based tests, Complement fixation. Nucleic acid analysis based tests like PCR, restriction digestion, northern and southern hybridization, western blotting.

Unit 3: **No. of Hours-15**
Control of microbes. Disinfection, pasteurization and sterilization. Physical and chemical agents to control microbes. Mechanism of action of different agents used to control microbes. Kinetics of microbial killing.
Epidemiology of infectious disease. Epidemic, endemic and pandemic with example. Communicable diseases and modes of transmission. Strategies to control epidemics.

Unit 4: **No. of Hours-8**
History of antibacterial agents. Minimal inhibitory concentration. Bactericidal and bacteriostatic. Laboratory tests for checking antimicrobial activity. Trends in antibiotic and antiviral discovery. Source and spectrum of antibacterial agents.
Antibacterial agents: mode of inhibition by Cell wall biosynthesis inhibitor. Protein synthesis inhibitor. Nucleic acid synthesis inhibitors. Membrane active agents.

Unit 5: **No. of Hours -7**

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine,
Inhibitors of uncoating, penetration and neuraminidase. DNA polymerase, RNA polymerase and reverse transcriptase inhibitor. Viral protease inhibitor. Prophylactic and curative treatment. Susceptibility and resistance to antimicrobials. Intrinsic and acquired resistance. Mechanisms of resistance development.
Strategies to avoid development and spread of resistance.
Vaccines: their types and future trends

Learning outcomes: The students will be able to understand the normal flora of body, working of immune system in response to variety of pathogens and cycle of disease establishment and its control using antimicrobial agents.

Suggested Readings:

1. Ananthanarayan R. and Paniker C.K.J. *Textbook of Microbiology*. 10th edition, University Press Publication. 2017. Print
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. *Jawetz, Melnick and Adelberg's Medical Microbiology*. 26th edition. McGraw Hill Publication. 2013. Print
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. *Mims' Medical Microbiology*. 6th edition. Elsevier. 2018. Print
4. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott, Harley and Klein's Microbiology*. 10th edition. McGraw Hill Higher Education. 2016. Print
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2014. Print.

Websites and Audio Video lectures:

1.https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm
2. https://nptel.ac.in/courses/102103015
3. https://microbiologyonline.org/

Course Name: CLINICAL MICROBIOLOGY LABORATORY
Course Code: MIC 544
Total Credits: 2

Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Preparation of general purpose medium.
2. Preparation of selective medium.
3. Preparation of differential medium.
4. Use of important selective and differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
5. Identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus*, *Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
6. Test of motility on agar plate and under microscope
7. Test of hemolysis. α, β hemolysis.
8. Siderophore production detection by chromo azurol sulfate agar
9. Study of bacterial flora of skin and mouth by swab method
10. Perform antibacterial sensitivity by Kirby-Bauer method

Course Name: BIOANALYTICAL TECHNIQUES
Course Code: BCH501
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:

The course introduces students all the major bioanalytical techniques relevant to students of microbiology. It covers the theoretical aspects of various techniques, along with their instrumentation and applications.

Course Content:

Unit 1 **No. of hours -15**

Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, Fluorescence Spectroscopy.

Chromatography – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2 **No. of hours- 20**

Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Mass Spectrometry – Principle of MS, ionization modes, equipment, MS of proteins/peptides, interface of MS with other methods – MS/MS, LC/MS, and GC/MS, peptide mapping, post-translation modification analysis of proteins, protein sequencing by MS.

Unit 3 **No. of hours-5**

Electrophoretic techniques – Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis.

Unit 4 **No. of hours -10**

Immunochemical techniques – Making antibodies, Immunoassay formats, Immunomicroscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Fluorescent activated cell sorting (FACS), Cell and tissue staining techniques, Immunocapture, polymerase chain reaction (PCR) Immunoaffinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies.

Unit 5 **No. of hours -10**

Bioinformatics – Overview, Sequence databases – DNA, protein, genome, EST and SNP databases, BLAST programs, ClustalW, Tertiary protein structure databases, PDB, Rasmol, Pymol and Swiss-PDB viewer, Homology modeling.

Learning Outcome: At the end of this course, the students will be able to apprehend the principle, working and application of various bioanalytical techniques in research and basic experiments.

Suggested readings:

1. Physical Biochemistry – Principles and Applications – 2nd Edition – David Sheehan, Wiley-Blackwell (2009).
2. Analytical Biochemistry – 3rd Edition – David Holme and Hazel Peck, Pearson Education Ltd. (1998).

Course Name: BIOANALYTICAL TECHNIQUES LABORATORY
Course Code: BCH503
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:
1. Titration of a weak acid using a pH meter, preparation of buffers
2. Verification of Beer-Lambert's law and determination of absorption coefficients
3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture
4. Thin layer chromatography of fatty acids
5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column
6. Electrophoresis demonstration.

Course Name: MICROBIAL GENETICS
Course Code: MIC541
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:
This course will provide an insight into various aspects of microbial genetics like microbial genetic organization, DNA replication, mutation and repair, control of genetic expression and methods of genetic variations.

Course Content:

Unit 1: **No of Hours-5**
History of DNA structure, from Miescher to Watson and Crick, Building blocks of nucleic acids. Salient features of DNA double helix. Types of DNA. Types of genetic material. Nucleous, nucleoid

Unit 2 **No of Hours-10**
C-value paradox, Denaturation and renaturation of DNA. Bidirectional and unidirectional replication. Conservative, Dispersive and semiconservative nature of replication. Mechanism of DNA replication. Various models of DNA replication including rolling circle and Θ (theta) mode of replication.

Unit 3 **No of Hours-15**
DNA repair (Direct repair, Mismatch repair, excision repair, recombination, SOS repair.)
, Mutation and its relation to variation and evolution. Types of mutation. Mechanism of mutation (spontaneous mutation, chemical mutagen, UV irradiation)
Isolation and identification of mutants (mutation and selection, replica plating, penicillin enrichment, molecular methods) Phenotype restoration (reversion, suppression) Overproduction of primary metabolite, Overproduction of secondary metabolite

Unit 4 **No of Hours-15**
Gene organization. Understanding of events involved in gene expression (transcription, translation, posttranslational events), Transcriptional control (terminators, attenuators, anti-terminators, induction and repression). Translational control. Codon usage.

Unit 5 **No of Hours-15**
Plasmids, Plasmid replication and stability, Plasmid incompatibility, Gene transfer: Transformation, Conjugation (F plasmid), Transduction (general and specialized) Insertion sequence, Transposons, Mechanism of transposition, strain development, Generation of variation, Genetic methods for investigating bacteria (complementation, cross feeding, reporter genes).

Learning outcomes: The students will comprehend the basic intricacies of various processes associated with microbial genetics and their potential applications

Suggested Readings:

1.Freifelder D, Cronan J, Maloy SR. Microbial Genetics. 2nd edition, Narosa Publishers, 2009. Print
2. Klug WS, Cummings MR, Spencer, C, Palladino, M. *Concepts of Genetics*, Benjamin Cummings. International Edition 2019. Pearson publisher. Print
3. Krebs J, Goldstein E, Kilpatrick S. *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning. 2013. Print
4. Pierce BA. *Genetics: A Conceptual Approach*, 4th Ed., Macmillan Higher Education Learning. 2011. Print
5.Watson JD, Baker TA, Bell SP et al. *Molecular Biology of the Gene*, 6th Ed., Benjamin Cummings. 2008. Print
6. Gardner EJ, Simmons MJ, Snustad DP. *Principles of Genetics*. 8th Ed. Wiley-India. 2008. Print
7. Russell PJ. *i Genetics- A Molecular Approach*. 3rd Ed, Benjamin Cummings. 2009. Print
8. Sambrook J and Russell DW. *Molecular Cloning: A Laboratory Manual*. 4th Edition, Cold Spring Harbour Laboratory press. 2001. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015/33
2. https://swayam.gov.in/courses/4620-microbial-genetics
3. https://freevideolectures.com/course/2919/microbial-genomics-and-genetics
4.http://faculty.collin.edu/mweis/Microbiology/Lecture/Micro%20Lecture%20Notes/micro_lecture_notes_genetics_BITC.htm

Other supportive material:

1https://sites.fas.harvard.edu/~biotext/animations/DNAchem.html
2https://sites.fas.harvard.edu/~biotext/animations/replication1.html
3https://www.dnalc.org/resources/animations/pcr.html
4http://www.sumanasinc.com/webcontent/animations/content/replicaplating.html
5https://www.dnalc.org/resources/animations/transformation1.html

Course Name: MICROBIAL GENETICS LABORATORY
Course Code: MIC542
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Isolation of plasmid DNA from *E. coli*
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis
6. Estimation of salmon DNA using UV spectrophotometer (A260 measurement)
7. Preparation of competent cells by chemical method
8. Preparation of competent cells for electroporation
9. Transformation of *Escherichia coli*
10. Transduction of *Escherichia coli* by P1 phage
11. Conjugation mating in *Escherichia coli*
12. PCR amplification of gene from *Escherichia coli* genomic DNA
13. Restriction digestion of DNA
14. Ligation of DNA fragments
15. Blue-white selection cloning of DNA
16. Isolation of DNA from fungal biomass

Course Name: RECOMBINANT DNA TECHNOLOGY
Course Code: BTY521
Total Credits:4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: The basic objective of the paper is to present the principles of gene manipulation and its associated technologies and how developments in gene manipulation have revolutionized medicine, agriculture and health.

Course Content:

Unit 1 **No. of hours -10**

Introduction and scope of Recombinant DNA Technology. DNA modifying enzymes-Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase,
Nucleases, Methylases, Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases.

Unit 2 **No. of hours- 14**

Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA. Cloning and expression vector: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors.

Unit 3 **No. of hours-10**

Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes.DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid. transformation and transfection, electroporation, screening of gene library and selection of clone.

Unit 4 **No. of hours-15**

Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. Expression of cloned genes :Expression of cloned genes in *E. coli*, *Bacillus subtilis*, *Streptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes. Protein-Protein interactions-Phage display (*in vivo, in vitro* and *in planta*, Yeast two hybrid system, Yeast three hybrid system. Bicomplementation and Florescence Resonance Energy Transfer (FRET).

Unit 5 **No. of hours-11**

Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, Real Time PCR, random mutagenesis, site-directed mutagenesis and protein engineering. Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope. Applications of r-DNA technology in industry, agriculture and forensic science.

Learning outcomes: The students will be able to comprehend the intricate relationship between microbiology and recombinant DNA technology and their impact on each other as well as some of the applications of RDT in various fields.

Suggested Readings:

1. Gene cloning and DNA analysis – An Introduction (2006). 5th edition, T.A. Brown, Blackwell publisher.

2. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998). S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

3. Molecular Cloning : A Laboratory Manual (2000). J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York.

4. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003). 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.

5. Principles of Genetic Engineering (2009). Mousumi Debnath, pointer publisher, Jaipur.

6. Principles of gene manipulation and Genomics (2006). 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.

Websites and Audio Video lectures:

1. https://nptel.ac.in/downloads/102103013/
2. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-15-recombinant-dna-1/
3. https://learning.hccs.edu/faculty/tineke.berends/favorite-links/animation-library/dna-cloning-and-sequencing-animations/dna-technology-animations-mcgraw-hill

Course Name: RECOMBINANT DNA TECHNOLOGY LABORATORY
Course Code: BTY522
Total Credits:2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments

1. Preparation and purification of pUC plasmid.
2. Preparation and purification of genomic DNA
3. Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
4. Gene cloning
5. Bacterial transformation
6. Southern blotting and hybridization with non-radioactive probes.
7. Amplification of DNA with PCR Temperature cycler.

Course Name: MICROBIAL PHYSIOLOGY AND METABOLISM
Course Code: MIC550
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objectives:
This course will allow the students to understand various types of microbial metabolic activity including unique features of bacterial biosynthesis and differentiation.

Unit 1 **No of Hours -10**

Definitions of growth, measurement of microbial growth, generation time, growth rate, synchronous growth, diauxic growth, classification of microbes with respect to carbon, energy and electron source, Effect of carbon source, nitrogen source and inhibitors on bacterial growth.
Principles of thermodynamic reaction, Electron carriers, entropy, enthalpy

Unit 2 **No of Hours -15**

Embden MayerHoff Pathway, Enter Doudroff Pathway, Hexose Monophosphate Pathway, Krebs Cycle, Oxidative phosphorylation, Synthesis of sugars.
Anaerobic respiration, with special reference to dissimilatory nitrate reduction, Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation, Stickland reaction

Unit 3 **No of Hours -15**

Chemolithotrophy -aerobic and anaerobic chemolithotrophy, Hydrogen oxidation, sulphur oxidation, methanogenesis
Photolithotrophy- Oxygenic and anoxygenic photosynthetic bacteria and their mechanism, photosynthetic pigments, Photosynthetic electron transport system, Photophosphorylation, Dark reaction - Calvin cycle, hydroxypropionate pathway

Unit 4 **No of Hours -5**
Amino acid biosynthetic pathway, Assimilation of nitrogen, Dinitrogen, Nitrate nitrogen and ammonia assimilation,

Unit 5 **No of Hours -15**

Synthesis of peptidoglycan, Structure, arrangement and function of bacterial flagella, Synthesis of bacterial flagella, bacterial motility, Bacterial chemotaxis
Bacillus endospore formation, Activation of bacterial endospores, Germination of bacterial endospores, Outgrowth of bacterial endospores

Learning outcomes: The students will comprehend the diverse metabolic activities undertaken by the microbial cells and their significance.

Suggested Readings:

1Moat AG and Foster JW. *Microbial Physiology*. 4th edition. John Wiley & Sons. 2002. Print
2 Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2017. Print
3. Reddy SR and Reddy SM. *Microbial Physiology*. Scientific Publishers India. 2005. Print

Reference Books:

1. Gottschalk G. *Bacterial Metabolism*. 2nd edition. Springer Verlag. 1986. Print
2. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. *General Microbiology*. 5th edition, McMillan Press. 1987. Print
3. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 10th edition. McGraw Hill International. 2016. Print

Websites and Audio Video lectures:

1. https://micro.cornell.edu/research/epulopiscium/bacterial-endospores/
2. https://nptel.ac.in/courses/102103015/module6/lec3/3.html
3. https://www.accessscience.com/content/nitrogen-fixation/454100
4. https://microbiologyonline.org/

Other supportive material:

1. https://evolutionnews.org/2013/05/visualizing_che/
2. https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=1
3. https://www.wiley.com/college/boyer/0470003790/animations/tca/tca.htm
4. http://highered.mheducation.com/sites/0072556781/student_view0/chapter3/animation_quiz_1.html

Course Name: RESEARCH METHODOLOGY & APTITUDE
Course Code: MIC540
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: This course will help the students to develop an understanding about the fundamentals of research & using various tools for literature survey and data analysis, methods of data presentation, statistical analysis of data interpretation to appreciate the process of research and try to devise strategies to solve important biological problems.

Course Content:

Unit 1 **No. of Hours-10**

Symbol and prefixes (Multiples and submultiples). Atomic weight, Molecular weight, Equivalent weight, Avogadro number, Normality, Molarity, Molality. Understanding of pH scale. Preparation of solution of known concentration. Stock and working solution. Dilution of solution. pKa values for amino acid, its importance and calculation with problem solving, Molecular weight calculation of biological macromolecules and methods to confirm their molecular weights.
Preparation of solution of known concentration. Stock and working solution. Dilution of solution. with problem solving in the class

Unit 2 **No. of Hours-10**

Word processing tools: Introduction to word processing applications. Page layout. Common features, Using font, paragraph, italics, superscript, subscript. Numbering. Inserting symbol, image and table.
Spreadsheet tools: Introduction to spreadsheet applications. Common features, Using formulas and functions. Data sorting. Use of mathematical and statistical formula. Generating charts / graph.
Presentation tools: Introduction to presentation applications. Common features and functions. Customizing page layout and design. Inserting image and table. Preparing and customizing line diagrams. Showing presentation.

Unit 3 **No. of Hours -10**

Safe web browsing and use of general web search engines. Use of specialized search engines for life sciences. Databases of scientific literature. Searching relevant research and review articles. Citing scientific information resources. Measure of impact of scientific literature. Introduction to biological data bases and their use. Search, collect, process and present the sequence and structure of biologically important macromolecules. Introduction to bioinformatics tools and their scope of use. Using standalone and server based bioinformatics tools.

Unit 4: **No. of Hours -15**

Meaning, motivation and objectives of research. Types of research. Theoretical vs. experimental and quantitative vs. qualitative approach in research. Significance of research. Structuring a research project: Identification of problem, Learning the background, Developing a working hypothesis, Designing the research strategy, Arranging sample/materials required, Performing the experiment and data collection, Data analysis and hypothesis testing, Interpretation and report writing. Qualities of good research and its reporting/presentation.

Unit 5: **No. of Hours -15**

Correlation and Regression, Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance, Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design with application of each in life sciences.

Learning outcomes: The students will be able to appreciate the vast array of methods and tools available for undertaking research and may become inclined towards higher learning to become research professionals.

Suggested readings:

1. Kothari, C.R.Research Methodology–Methods and Techniques. 2nd revised ed. New Delhi: New Age International (P) Ltd. Publishers, 2007. Print.

2. McKillup, S. Statistics Explained. An Introductory Guide for Life Scientists. Cambridge, UK: Cambridge University Press, 2006. Print.

3. Selvin, S. Biostatistics–How it Works. First Impression. New Delhi: Pearson Education Inc., 2007. Print.

4. Agarwal, B.L. Basic Statistics. New Delhi: New Age International, 2006. Print.

5. McDonald, John H., Handbook of Biological Statistics, 3rd Ed, Sparky House Publications.

6. Nicholas Walliman, Research methods, The basics, 2011, Routeledge, Taylor & Francis group.

Websites and Audio Video lectures:

https://onlinecourses.nptel.ac.in/noc18_bt21/preview

Course Name: Scientific Writing and Research Methodology
Course Code: BOT621

Total credits:4
Credits components: Theory-3, Practical-0, Tutorial-1

Course Learning objectives:
To make the students learn how to design an experiment and what are the various research strategies.

Teaching Methodology:
Class room Lectures, practicals, models, charts, power point presentations.

Learning outcomes
This course will impart the comprehensive knowledge of designing a research experiment, how to write a research paper, the relevant ethics, copy right, impact factor etc.

Unit-1 **No. of Hours 13**

Biostatistics: Definition and relevance in biological research; Measures of Central Tendency: Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis

Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression.

Probability theory: Origin and concept, deterministic and random experiments, concept of events, sample space, mutually exclusive and equally likely events; classical concept of probability, addition theorem and multiplication theorem in probability.

Unit-2 **No. of Hours 12**

Inferential Statistics: Hypothesis testing, Errors in Hypothesis Testing- Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two- tailed tests.

Parametric and Non-Parametric Statistics: Definition, Advantages, Disadvantages, Assumptions; Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-Parametric Tests: Analysis of Variance, Chi square and Kendall Rank Correlation

Experimental Set-up: Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design

Unit-3 **No. of Hours 14**

Data collection, organization and interpretation.

Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings.

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

An introduction to Science citation index; H-index, i10 index, Impact factor calculation, Impact factor of a journal; Eigen factor, Major journal search engines.

Copyright act; Academic frauds; Plagiarism; Software's to check plagiarism.

Reference Books

1. Kothari, C.R. Research Methodology – Methods and Techniques. 2nd revised ed. New Delhi: New Age International (P) Ltd. Publishers, 2007. Print.
2. McKillup, S. Statistics Explained. An Introductory Guide for Life Scientists. Cambridge, UK: Cambridge University Press, 2006. Print.
3. Selvin, S. Biostatistics – How it Works. First Impression. New Delhi: Pearson Education Inc., 2007. Print.
4. Agarwal, B.L. Basic Statistics. New Delhi: New Age International, 2006. Print.

Course Name: Intellectual Property Rights, Biosafety and Bioethics
Course Code: BTY641

Total credits:2
Credits components: Theory-2, Practical-0, Tutorial-2

Course Objective: This course has been designed to cover various aspects of IPR, Biosafety and bioethics. Lot of advances have been made in application of biotechnology for the benefit of human being in field of agriculture, medical application, animal husbandry, industrial production and environmental management. Intellectual property ie legal rights resulting from intellectual activity in the Industrial and scientific fields is very important. In this course, safety concerns and ethical issues on application of biotechnology will be discussed under the current issues associated with the benefits and risk concerns on biotechnology.

Unit 1 **No. of hours 5**

Fundamentals of IPR: Intellectual Property Rights, general introduction patent claims, ownership of tangible and intellectual property. Patents, copyrights, trademarks, trade secrets, geographical indications, industrial designs, protection of IC layout designs, WIPO, TRIPS agreement.

Unit 2 **No. of hours 6**

Basic requirements of patentability, Patentable subject matter novelty and the public domain, non-obviousness. Special issues in biotechnology patents: Disclosure requirements, collaborative research, competitive research, foreign patents, patenting of microorganisms and cells, patenting animals and plants, PPA, PVPA, PVPC, utility patents.

Unit 3 **No. of hours 7**

Patent litigation: Substantive aspects of patent litigation, procedural aspects of patent litigation, recent development in patent system and patentability of biotechnology inventions, IPR issues of the Indian content, current patent laws, International Depository Authority (IDA), International agreements relevant to biological inventions: PCT, UPOV, Budapest Treaty, EPC, Pan- S Union Convention.

Unit 4 **No. of hours 5**

Public acceptance issues for biotechnology: Case studies/ experiences from developing and developed countries, biotechnology and hunger, challenges for the Indian biotechnological research and industries. Bioethics: Social and ethical implications of biotechnology and biological weapons.

Unit 5 **No. of hours 7**

Good safety practices, GLP standards, lab contaminants, GMPs, The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology, Regulatory bodies- EPA, USDA, FDA, APHIS.

Reference Books:

- New developments in biotechnology: Patenting life-special report (1990) Office of Technology Assessment (OTA), US Congress (Washington D.C. Dekker). Library of Congress Catalog Card Number 88-600596
- Evolution of patent laws: "developing countries' perspective" (2006) by D.N. Choudhary, (Capital Law House).

- Evolution of patent laws: developing countries, perspective / D.N. Choudhary; foreword by S.S. Kang.-- Delhi: Capital Law House, 2006. 476p.; 24cm. 346.0486 P6 B174893
- Draft manual of patent practice and procedure (2008) Patent Office, India.

Course Name: ADVANCES IN MICROBIOLOGY
Course Code: MIC547
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objectives: The aim of this course is to provide an exposure to the students about some recent developments in the field of microbiology with special emphasis on genomics, metagenomics, systems biology and synthetic biology.

Course Content:

Unit 1 **No. of Hours: 15**

Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance, Quorum sensing in bacteria and networking in biological systems, Two component signaling.

Unit 2 **No. of Hours: 15**

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach. Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics. Engineering of microbial bio-synthetic pathways and applications.

Unit 3 **No. of Hours: 10**

Evolution of bacterial virulence – Genomic islands, Pathogenicity islands (PAI) and their characteristics.
Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, protein secretion systems in microbes.

Unit 4 **No. of Hours: 5**

Selection of Industrial micro-organisms, Production Process, Production of Pharmaceuticals: Antibiotics, Steroids, Human Proteins, Vaccines, Vitamins at pilot scale. Quality control of industrial products.
Microbiologically enhanced recovery of mineral resources, Bioleaching of metals, Oil recovery.

Unit 5 **No. of Hours: 15**

Environmental engineering (pesticide degradation,hydrocarbon degradation by microbes)
Fungal and viral based biopesticides. Production technology for BT and *Baculovirus* based pesticide. Genetic improvement of *Baculovirus* for pesticide preparation. Advantages and limitations of biopesticides.
Antisence RNA technology in disease control, RNA in controlling plant pathogens.

Learning outcomes: The students will get familiarized with the modern approaches and current scenario in the field of microbiology.

Suggested Readings:

1 Fraser CM, Read TD and Nelson KE. *Microbial Genomes*. Humana Press. 2004. Print
2. Miller RV and Day MJ. *Microbial Evolution- Gene establishment, survival and exchange*. ASM Press. 2004. Print
3 Wilson BA, Salyers AA Whitt DD and Winkler ME. *Bacterial Pathogenesis- A molecular Approach.* 3rd edition, ASM Press. 2011. Print
4 Sangdun C. *Introduction to Systems Biology*. Humana Press. 2007. Print
5. Bull AT. *Microbial Diversity and Bioprospecting*. ASM Press. 2004. Print

6. Klipp E, Liebermeister W. *Systems Biology – A Textbook.*Wiley –VCH Verlag. 2009. Print
7. Caetano-Anolles G. *Evolutionary Genomics and Systems Biology*. John Wiley and Sons. 2010. Print
8. Madigan MT, Martink JM, Dunlap PV and Clark DP. *Brock's Biology of Microorganisms*. 14th edition, Pearson-Bejamin Cummings. 2017. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102104056/3
2. https://www.frontiersin.org/articles/10.3389/fgene.2015.00348/full
3. https://www.coursera.org/learn/metagenomics
4. https://nptel.ac.in/courses/102106035/
5. https://www.thermofisher.com/in/en/home/life-science/cloning/synthetic-biology/synthetic-biology-videos.html

Other supportive material:

1. https://systemsbiology.org/about/what-is-systems-biology/
2.http://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::500::500::/sites/dl/free/0073375225/594358/QuorumSensing.swf::Quorum%20Sensing
3.https://highered.mheducation.com/sites/9834092339/student_view0/chapter24/horizontal_gene_transfer.html
4.https://phylogenomics.me/misc-notes/metagenomics-notes

Course Name: ADVANCES IN MICROBIOLOGY LABORATORY
Course Code: MIC548
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:
1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place
6. Microbial biofilm preparation
7. Isolation of pesticide degrading microbes
8. Isolation of plastic/hydrocarbon degrading microbes
9. Isolation of metal toxicity tolerant microbes
10. Route to GMO from wild type strain

Course Name: INDUSTRIAL MICROBIOLOGY
Course Code: MIC641
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0
Course Objective: The objective of this course is to provide knowledge to the students about the fundamentals of industrial microbiology and fermentation technology like isolation of industrially important microbes, types of fermenters, downstream processing and microbial production of industrial products etc.

Course Content:

Unit 1: **No. of Hours: 15**
Brief history and developments in industrial microbiology, Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations, Design of laboratory bioreactor; Types of Bioreactor: Stirred tank reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors, Scale-up principles, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration
.

Unit 2: **No. of Hours: 15**
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Microbial substrate- Media formulation, Crude and synthetic media; molasses, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates, Optimization of media, Optimization of media using statistical designs.

Unit 3: **No. of Hours: 10**

Downstream processing: Principle, methodology, instrumentation an applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, lyophilization and spray drying, Fermentation economics.

Unit 4: **No. of Hours: 15**
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), Wine, beer, Single cell proteins, steroids biotransformation, Biopesticides, Biofertilizers, Microbial transformation, Production of metabolites of non-microbial origin eg. Insulin, Interlukin, Hormones etc. using rDNA technology.

Unit 5: **No. of Hours: 5**
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase), Biosensors and their fermentation applications.

Learning outcomes:
At the end of this course the students will get acquainted with the industrial aspect of the microbiology, and also learn about growth pattern of microbes in different industrial systems. They will acquire experimental knowhow of microbial production of various industrial products.

Suggested Readings:

- Stanbury P. F., A. Whitaker, S. J. Hall. Principles of Fermentation Technology Publisher: Butterworth-Heinemann.
- Prescott and Dunn's Industrial Microbiology.Publisher: Gerald Reed: Books.
- Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Concepts by Publisher Prentice Hall.
- Vogel H.C., C.L. Todaro, C.C. Todaro: Fermentation and Biochemical Engineering
    - Handbook: Principles, Process Design, and Equipment by Publisher: Noyes Data Corporation/ Noyes Publications.

- W. Crueger and A.Crueger: Biotechnology. A Textbook of Industrial Microbiology,
    - Publisher : Sinauer Associates.

Course Name: INDUSTRIAL MICROBIOLOGY LABORATORY
Course Code: MIC642
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Study different parts of fermenter.
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of enzymes: Amylase, Protease and Cellulase
3. Microbial fermentations for the production and estimation (qualitative and quantitative) of: Amino acid: Glutamic acid
4. Microbial fermentations for the production and estimation (qualitative and quantitative) of Organic acid: Citric acid
5. Microbial fermentations for the production and estimation (qualitative and quantitative) of alcohol: Ethanol, wine
6. Isolation of antibiotic-producing microorganisms from soil.
7. Study enzyme immobilization by sodium alginate method.
8. Demonstration of chromatograpy techniques.
9. Production of wine from grapes/apple etc.
10. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

Course Name: FOOD MICROBIOLOGY
Course Code: MIC637
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective: This course will help the students to appreciate the significance of microbes in the food industry including the negative aspects like food spoilage, food infection, intoxication and the positive aspects like food fermentation. The students will also learn about various approaches of food preservation.

Course Content:

Unit 1: **No. of Hours: 10**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, Cereals, sugar products, meat, eggs, milk and butter, bread, canned Foods. Detection of spoilage and characterization.

Unit 2: **No. of Hours: 15**

Principles, physical methods of food preservation: temperature, irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic

packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit 3: **No. of Hours: 15**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: bread, dosa, sauerkraut, soy sauce and tampeh, Probiotics and Prebiotics: Health benefits, types of microorganisms used as probiotics, probiotic foods available in market. Mushrooms: nutritive values of mushrooms, Edible and poisonous Mushrooms.

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

Bacterial and nonbacterial food intoxication/infections–with examples of *Clostridium*, *Bacillus, Escherichia, Salmonella, Shigella*, *Staphylococcus, Vibrio, Yersinia*, Nematodes, protozoa, algae, fungi and viruses.

Unit 5: **No. of Hours: 10**

Foodborne outbreaks laboratory testing procedures, Food control agencies and its regulations, HACCP, Indices of food sanitary quality and sanitizers, Plant sanitation –Employee's health standards –waste treatment –disposal –quality control, Cultural and rapid detection methods of food borne pathogens in foods

Learning Outcomes:

The students would be able to explain the interactions between microorganisms and the food environment. They would be able to explain the significance and activities of microorganisms in food.

Suggested Readings:

1. Adams MR and Moss MO. *Food Microbiology*. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. 2015. Print.
2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.

3. Frazier WC and Westhoff DC (2008) *Food Microbiology*. 4th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. Print.
4. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print.
5. Jay JM, Loessner MJ and Golden DA. *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India. 2005. Print
6. Lund BM, Baird Parker AC, and Gould GW. *The Microbiological Safety and Quality of Foods*. Vol. 1-2, ASPEN Publication, Gaithersberg, MD. 2000. Print

Websites, Audio Video lectures and other supportive material:

1. https://swayam.gov.in/courses/5147-food-microbiology-and-food-safety
2. https://microbiologyonline.org/
3. http://www.fda.gov/Food/ScienceResearch/ResearchAreas/SafePracticesforFoodProcesses/defa ult.htm
4. CAC – Principles of microbiological risk analysis www.who.int/fsf/mbriskassess/pdf/draftpr.pdf

Course Name: FOOD MICROBIOLOGY LABORATORY
Course Code: MIC638
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
2. Determination of quality of a milk sample by methylene blue reduction test.
3. Determination of number of bacteria in milk by standard plate count.
4. Isolation of any pathogenic bacteria from food products.
5. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
6. Isolation of spoilage microorganisms from bread.
7. Isolation of bacteria from dairy sample and evalution of probiotic potential.
8. Preparation of Yogurt/Dahi etc.
9. Production of sauerkraut by microorganisms.
10. Demonstration of food preservation techniques.

Course Name: SEMINAR I
Course Code: MIC630
Total Credits:2
Credits components: Theory-0, Practical-0, Tutorial-2

Seminar Objective:
During the course students will come to know about the general understanding of the most common problems, recent advances in microbiology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:
Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Course Name: PROJECT PART – I
Course Code: MIC701
Total Credits:2
Credits components: Theory-0, Practical-0, Tutorial-0

Guidelines for Project Synopsis:

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication.

As a preparatory of project work student/s need to formulate a legible research problem and go through literature search to propose ways to address the problem. A short account of this work need to be presented by the students in written format to the advisors. A verbal presentation aided with media tools should follow the submission of written synopsis.

Course Name: IMMUNOLOGY
Course Code: MIC 631
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:
The students will get an insight into various aspects of immune system like its components, immune cells and their receptors, genetic organization of immune cells, cytokines, antigen-antibody interactions and immune system disorders. This course will also provide information regarding application of immunology in diagnostics and vaccination.

Course Content:

Unit 1: **No. of Hours- 15**
History of immunology. Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory; Innate and Adaptive immune system
Structure, Functions and origin of Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell and Immune Organs like Bone marrow, Thymus, Lymph Node, Spleen.
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes, Adjuvants, Structure, Types and Functions of antibodies.
Techniques in immunology: Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, Flow cytometry, Immunoblotting etc.

Unit 2: **No. of Hours- 15**
Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors.
Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR).

Unit 3: **No. of Hours- 13**
Genetic organization: Organization of the genes for B and T cell receptors.
Genetic organization of MHC-I and MHC-II complex, Peptide loading and expression of MHC-I and MHC-II molecules.
Molecular mechanisms responsible for generating diversity of antibodies and T-cell receptor.
Hybridoma technology and monoclonal antibodies.
Complement system. Classical, lectin and alternative pathway for complement activation.

Unit 4: **No. of Hours- 10**
Major cytokines and their role in immune system: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10, IL-12, IL-17, TGFβ.
Tolerance and autoimmunity and their mechanism; Mechanisms of autoimmunity; autoimmune diseases; Infections leading to autoimmune diseases.

Unit 5: **No. of Hours- 7**
Hypersensitivity and allergy. Comparative study of Type I-V hypersensitivities with examples.
Vaccines and their modes of production, Cancer Immunology: Tumor antigen and immune response to tumor, Anticancer Immunotherapies

Learning outcomes: The students will be able to understand the components, working of immune system in response to variety of pathogens and immunodiagnostics techniques for therapeutic applications of products of immune system.

Suggested Readings:

1. Delves P, Martin S, Burton D, Roitt IM. *Roitt's Essential Immunology*. 13th edition Wiley-Blackwell Scientific Publication, Oxford. 2017. Print
2. Goldsby RA, Kindt TJ, Osborne BA. *Kuby's Immunology*. 8th edition W.H. Freeman and Company, New York. 2019. Print
3. Abbas AK, Lichtman AH, Pillai S. *Cellular and Molecular Immunology*. 9th edition Saunders Publication, Philadelphia. 2017. Print
4. Murphy K, Travers P, Walport M. *Janeway's Immunobiology*. 9th edition Garland Science Publishers, New York. 2017. Print
5. Peakman M, and Vergani D. *Basic and Clinical Immunology*. 2nd edition Churchill Livingstone Publishers, Edinberg. 2009. Print.

Websites and Audio Video lectures:

1. https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm
2. https://nptel.ac.in/courses/102103015
3. https://microbiologyonline.org/

Course Name: IMMUNOLOGY LABORATORY
Course Code: MIC 632
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Identification of human blood groups.
2. To separate serum from the blood sample (demonstration).
3. To perform Total Leukocyte Count of the given blood sample.
4. To perform Differential Leukocyte Count of the given blood sample.
5. To perform immunodiffusion by Ouchterlony method.
6. Agglutination of bacteria
7. Separation of IgG by ammonium sulfate precipitation of blood serum.
8. Reduction of IgG with mercaptoethanol to four chain.
9. SDS-PAGE electrophoresis of immunologic effector proteins.
10. Papain digestion of IgG
11. Pepsin digestion of IgG
12. Immunoelectrophoresis
13. Western Blotting
14. ELISA.

Course Name: EUKARYOTIC MICROBIOLOGY
Course Code: MIC 635
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0
Course Learning Objective:

The course is designed to help the students to comprehend the diversity of eukaryotic microbes like fungi, algae, protists with emphasis on their structural organization, reproduction and life-cycle.

Course Content:

Unit 1 **No. of Hours- 20**

An Overview of Eucaryotic Cell Structure, The Plasma Membrane and Membrane Structure, The Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules Disease Getting Around, Organelles of the Biosynthetic-Secretory and Endocytic Pathways, Eucaryotic Ribosomes, Mitochondria, Chloroplasts, The Origin of the Eucaryotic Cell, The Nucleus and Cell Division, External Cell Coverings, Cilia and Flagella, Comparison of Procaryotic and Eucaryotic Cells

Unit 2 **No of Hours- 10**

Physiology of growing hypha, spores, classification. The structure and composition of fungal cell, The growth and form of fungal cell, The growth of population and colonies. The effect of environment on growth, Vegetative multihyphal system, Prevention of fungal growth. Role of spores in mycology and in the life of a microorganism.

Unit 3 **No of Hours- 5**

General characteristics of the fungal divisions i.e. Myxomycota, Oomycota, Chytridiomycota, Zygomycota, Ascomycota, Plectomycetes, Basidiomycota, Heterobasidiomycota, Urediniomycetes, Ustilaginomycetes etc.

Unit 4 **No. ofHours-20**

Basic characteristics of algae, structure of the algal cell, Nutrition, Classification, Algal fossil records. Toxic algae, Chemical defence mechanism of algae, applications of algae. The prokaryotic algae- cyanobacteria, Morphology, protoplasmic structure, pigments, heterocysts-nitrogen fixation, asexual reproduction, symbiosis, ecology of cyanobacteria, cyanotoxins, cyanophages, General characteristics of the algal divisions i.e. Glaucophyta, Rhodophyta, Euglenophyta, symbiotic dianoflagellates, Cryptophyta, Heterokontophyta, Prymnesiophyta etc.

Unit 5 **No of Hours- 5**

The Protists -Distribution, Nutrition, Morphology, Encystment and Excystment, Reproduction, Protist classification with special reference to *Amoeba, Paramecium and Giardia*

Learning outcomes: The students will be able to understand the variations among prokaryotic and eukaryotic cells and detailed analysis of eukaryotic cells will help them in exploring the different avenues in research.

Suggested Readings:

1. Tortora GJ, Funke BR and Case CL. *Microbiology: An Introduction*. 13th edition. Pearson Education. 2018. Print
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2014. Print
3. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print
4. Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 9th Edition. McGraw Hill International. 2013. Print
5. Atlas RM. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 2014. Print
6. Pelczar MJ, Chan ECS and Krieg NR. *Microbiology*. 5th edition. McGraw Hill Book Company. 2009. Print
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. *General Microbiology*. 5th edition. McMillan. 2005. Print.

Websites and Audio Video lectures:

1. https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm
2. https://nptel.ac.in/courses/102103015
3. https://microbiologyonline.org/.

Course Name: EUKARYOTIC MICROBIOLOGY LABORATORY
Course Code: MIC 636
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

1. Preparation of potato dextrose and malt extract agar medium.
2. Isolation of fungi from rotten bread and vegetables.
3. Gram stain slides of *Candida albicans* and *Cryptococcus neoformans*.
4. Microscopic examination of *Rhizopus, Aspergillus, Penicillium, Fusarium* from temporary and permanent slides.
5. Microscopic examination of sporulating stage of *Rhizopus, Aspergillus, Penicillium,* and *Fusarium*
6. Study of *Spirogyra, Nostoc, Anabena, Spirulina, Sargassum, Chara, Chlamydomonas,* and *volvox* using temporary Mounts.
7. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium*
8. Preservation methods of fungal culture

Course Name: Molecular Biology
Course Code: BTY511
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

Unit: 1 **No. of Hours- 20**

Introduction to molecular biology: DNA structure and brief history of its discovery, various forms of DNA,DNA packaging, DNA melting, repetitive sequences, cot and rot curves, C value paradox, linking number and super-helical density of DNA. RNA structure and function, DNA-Protein interaction, DNA supercoiling, mechanism of action of topoisomerases, ribozymes and riboswitches.

Unit: 2 **No. of Hours- 20**

Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, telomeres and regulation of telomere length, extra chromosomal replicons.DNA mutability, damage and repair mechanisms, mobile genetic elements, homologous and site specific recombination.

Unit: 3 **No. of Hours- 20**

Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, promoters, enhancers, silencers, insulators and other regulatory elements.Transcriptional activators, repressors& mechanism of transcriptional regulation, operons, post-transcriptional processing of rRNA & tRNA. Capping, RNA splicing and polyadenylation of eukaryotic mRNAs.

Unit: 4 **No. of Hours- 20**

Protein synthesis and processing: Ribosome, mRNA, tRNA structure, aminoacyl tRNA synthetases and tRNA charging,genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, post-translational modifications of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome.

Unit: 5 **No. of Hours- 20**

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Basic techniques in molecular biology.

Reference Books:

1. Molecular cell biology (2008). Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher (W.H.Freeman). ISBN-13: 978-1464183393

2. Genes IX (2008). Benjamin Lewin (Jones and Bartlett Publishers). **ISBN**-13: 978-0763740634

3. Molecular cloning: A laboratory manual, 3rd ed. (2001). J. Sambrook, E.F. Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press,New York). ISBN: 0879695773 (pbk.)

4. Molecular Biology of the Gene. J D Watson (7th edn) 2017. Pearson Publn. ISBN-13: 9780321762436

Course Name: Environmental Biotechnology
Course Code: BTY631
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective: The basic object of the course is to familiarize the students with the gene manipulation processes and microorganisms used for a cleaner environment with respect to various microbial treatments, biofuels, biofertilizers, biopesticides, biomineralization, biodegradation etc.

Unit 1 **No. of Hours- 15**

Renewable and Non-renewable energy resources, Biofuels: Bioethanol, Biodiesel, Biogas and Algal fuels Bioremediation and Biodegradation of major environmental pollutants- heavy metals, pesticides and hydrocarbons. Biomineralization- Use of microbes for mining of metals from ores Biofertilizers- Concept of N_2-fixation, nodule formation, azolla, cyanobacteria, rhizobium and VAM.

Unit 2 **No. of Hours- 15**

Microbiology of waste water treatment, aerobic processes, activated sludge, oxidation ponds, trickling filters, and rotating biological contactors. Treatment strategies for wastewaters of dairy, distillery, tannery, sugar, antibiotic industry. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors.

Unit 3 **No. of Hours- 15**

Bioremediation- Biotechnology for clean environment. Biodegradation of xenobiotics in the environment-Ecological considerations, decay behaviour, derivative plasmids, Degradation of hydrocarbons, substituted hydrocarbons, surfactants and pesticides. Bioremediation of contaminated soil. Biopesticides and Integrated Pest Management.

Unit 4 **No. of Hours- 15**

Solid waste management: Sources, types, composition, characteristics and composition of municipal solid waste, recycling and transformation.Environmental impact assessment, eco-planning and sustainable development: Indian standards IS2490, IS3360, IS3307, IS2296, ISO14000 series, Minas for industries and Ecomarks, public liability insurance act, ElA guidelines and assessment methods, environmental priorities in India and agenda.

Unit 5 **No. of Hours- 15**

Conservation biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling. Bioindicators and biosensors for detection of pollution.

Reference Books:

1. Principles of gene manipulation (2006). Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication). ISBN-13:9781405135443 ISBN: 1405135441.

2. Biodegradation and Bioremediation: Soil Biology (2004).Singh A. and Ward O.P. Springer. ISBN: 978-3-540-21101-3.

3. Environmental Chemistry. A.K. De, Wiley Eastern Ltd., New Delhi. ISBN 9781420059205.

4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold. ISBN-13: 978-0521528870

6. Waste Water Engineering, Metcalf and Eddy Wastewater Engineering: Treatment, Disposal, Reuse (Mcgraw-Hill Series in Water Resources and Environmental Engineering) Hardcover – Import, 1 Dec 1990, by George Tchobanoglous (Author), Frank Burton (Author) ISBN-13: 978-0070416901.

Course Name: Plant Biotechnology
Course Code: BTY633
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective: The objective of this course to familiarize the students with integrated use of different biological sciences. Plant tissue culture has contributed greatly to understanding the factors responsible for growth, differentiation and other vital processes of plant cells, tissues & organs *in vitro*. The technique has contributed immensely towards plant improvement, plant protection and also for large-scale production of industrially important compounds by gene manipulation.

Unit 1 **No. of Hours- 15**

Introduction & basic techniques in tissue culture. Conventional breeding vs tissue culture. Tissue culture media (composition & preparation), sterilization techniques, tissue culture as a technique to produce novel plants & hybrids, Green house and Green home technology. Concept of cellular totipotency. Basic techniques in cell culture and somatic cell genetics. Regulation of cell cycle and cell division. Initiation and maintenance of callus and suspension cultures, single cell clones, nurse culture technique, differentiation, organogenesis & somatic embryogenesis, Production and application of artificial seeds.

Unit 2 **No. of Hours- 15**

Clonal propagation & production of virus-free plants, stages of micropropagation, propagation by direct and indirect organogenesis. Transfer and establishment of whole plants in soil, *in situ* and *ex situ* rooting & difference. Changes during hardening of micropropagated plants. Importance of variability, somaclonal and gametoclonal variations, practical application of somaclonal variations.

Unit 3 **No. of Hours- 15**

Protoplast culture, fusion & culture, somatic hybridization and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids and role of protoplast culture and somatic hybridization in crop improvement. Haploid production and its significance, anther, pollen culture, monoploid production. Hybrid embryo culture/embryo rescue and ovary culture. Endosperm culture, production of triploids. Role of haploids, monoploids and triploids in agriculture.

Unit 4 **No. of Hours- 15**

Germplasm conservation: Cryopreservation in germplasm storage, factors affecting revival of frozen cells, slow growth & DNA banking for germplasm conservation. Plant secondary metabolites a general account, (synthesis & extraction) central mechanism and manipulation of phenylpropanoid pathway, shikimate pathway, Biotransformation and elicitation. Plant tissue culture repository.

Unit 5 **No. of Hours- 15**

Molecular marker-aided breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP (Single Stand Conformational Polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection in plant breeding. Transgenic Plants Technology: Genetic Transformation, Methods for gene transfer in plants, Molecular mechanism of *Agrobacterium* mediated transformation. Selectable markers, Reporter gene and Promoters used in plant transformation vectors. Selection of transgenic (verification of transgene and agronomic traits). Marker free transgenics.

Reference Books:

1. Plant tissue culture – Theory and Practice (2005). Bhojwani, S.S. and Razdan, M.K. Elsevier Publication. Print. ISBN: 9780080539096.

3. Introduction to Plant Biotechnology (2009). Chawla, H.S. 3rd Edition. CRC Press. Print. ISBN 9781578086368

4. Plant Biotechnology (2000). Hammond, J., McGarvey, P. and Yusibov, V. Springer verlag, Germany. Print. ISBN-13:978-3-540-66265-5

5. Recent Advances in Plant Biotechnology (2009). Kirakosyan, A. and Kaufman, P.B. Springer. Print. ISBN 978-1-4419-0193-4

6. Plant Biotechnology: The Genetic Manipulation of Plants (2008). Slater, A., Scott, N.W. and Fowler, M.R. 2nd Edition. Oxford University Press. Print. ISBN-13: 978-0199282616

Course Name: SOIL AND ENVIRONMENTAL MICROBIOLOGY
Course Code: MIC545
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:
This course will help the students to understand the significance of microbes in soil with special emphasis on biogeochemical cycling of nutrients and their environmental applications like bioremediation, waste treatment etc.

Course Content:

Unit 1: **No of hours-10**
Soil biota, Soil microbial ecology, Soil microbial biomass, Microbiology and biochemistry of root-soil interface; phyllosphere, Biofertilizers, soil enzyme activities and their importance. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels, Metagenomics analysis of solid and aquatic sediments.

Unit 2: **No of hours-15**
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 3: **No of hours- 12**
Biochemical composition and biodegradation of soil organic matter and crop residues. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development. Genetic engineering of microbes for enhanced pesticide degradation Mechanisms of pesticide degradation by microbes. organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants, Phytoremediation.

Unit 4: **No of hours- 8**
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 5: **No of hours-15**
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, Gaseous treatment. 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

Learning outcomes:

The students will be able to recognise the ecological problems and their critical evaluation, impact of human on pollution, climate changes as well as environmental protection.

Suggested Readings:

1. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print

2. Maier RM, Pepper IL and Gerba CP. *Environmental Microbiology*. 2nd edition, Academic Press. 2009. Print

3. Okafor, N. *Environmental Microbiology of Aquatic & Waste systems*. 1st edition, Springer, New York. 2011. Print
4. Singh A, Kuhad, RC & Ward OP. *Advances in Applied Bioremediation*. Volume 17, Springer-Verlag, Berlin Hedeilberg. 2009. Print
5. Barton LL & Northup DE. *Microbial Ecology*. 1st edition, Wiley Blackwell, USA. 2011. Print
6. Coyne MS. *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning. 2001. Print
7. Subba Rao NS. *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi. 1999. Print
8. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print
9. R.M. Atlas and R. Bartha. 3rd edition. *Microbial Ecology*. Benjamin Cumming Publishing Co, USA. 1993.

Websites, Audio video lectures and other supportive material:

1. https://nptel.ac.in/courses/105107173/
2. https://www.sciencedaily.com/news/plants_animals/microbiology/
3. https://www.microbes.info/news/index.php

Course Name: SOIL AND ENVIRONMENTAL MICROBIOLOGY LABORATORY
Course Code: MIC546
Total Credits: 2
Credits components: Theory-0, Practical-3, Tutorial-0

Experiments:

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.
8. Isolation of plant growth promoting rhizobacteria i.e. P-solubilizing bacteria.

Course Name: SEMINAR II
Course Code: MIC640
Total Credits:2
Credits components: Theory-0, Practical-0, Tutorial-2

Seminar Objective:
During the course students will come to know about the general understanding of the most common problems, recent advances in microbiology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:
Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Course Name: PROJECT PART – II
Course Code: MIC702
Total Credits:8
Credits components: Theory-0, Practical-0, Tutorial-0

Guidelines for Project:

Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be criticized by the faculty guide and corrected by the student at each stage.

The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project
- A statement about the extent to which the project has achieved its stated goals.
- Assessment about the outcomes of the experimentation processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.

Report Layout

The report should contain the following components:

Title or Cover Page

The title page should contain the following information: Project Title; Student' name; Course; Year; Supervisor' name

Acknowledgements (optional)

Acknowledgement to any advisory or financial assistance received in the course of work may be given

Abstract

A good abstract should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project

Table of Contents

Title and subtitles are to correspond exactly with those in the text

Introduction

Here brief introduction to the problem that is the central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

Materials and Methods

This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modification if any.

Results and Discussion

Present results, discuss and compare these with those from other workers etc. In writing these section, emphasis should be given on what has been performed and was achieved in the course of the work, rather than discuss in detail what is readily available in the text books. Avoid abrupt changes in the contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter should be included in a smooth flow.

Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary never write in “point” form.

Conclusion

A conclusion should be the final section in which the outcome of the work is mentioned briefly.

Future Prospects

Appendices

The appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

References

This should include papers and books referred to in the body of the report.

Course Name: VIROLOGY
Course Code: BTY681
Total Credits:4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: This course deal with the classical as well as modern concept of virology plant as well as animal virology, as biological concept arising from the virology. Role of plant and animal viruses in agriculture and human health.

Course Content:

Unit 1 **No. of hours-15**

History and development of virology, taxonomy of viruses (earlier classification systems) and viroids, significance of virology and latest ICTV classification of viruses. Origin and evolution of viruses. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals and plants.

Unit 2 **No. of hours-10**

Propagation, purification, characterization, identification and genomics of viruses. Methods of virus diagnosis, detection, assays and comparison of their sensitivities. Structure of viruses and methods employed in structural and functional genomics of the viruses.

Unit 3 **No. of hours -15**

Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control: General discussion on symptoms caused by viruses and viroids in diseased economically important trees and agricultural crops, and their control. Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses. Virus-like agents: Prions, satellite DNAs and RNAs, satellite viruses; defective interfering particles and virophages.

Unit 4 **No. of hours-10**

Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection.

Unit 5 **No. of hours -10**

Anti-viral strategies: prevention and control of viral diseases. Introduction to recent trends in management and control of viral diseases. Introduction to applications of plant and animals viruses.

Learning outcomes: The students will be able to appreciate the vast variety of viruses as well as other acellular entities and immense impact on various types of living organisms.

Suggested Readings:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses (2003). Flint, S.J., Enquist, L.W., Racaniello, V.R. and Skalka, A.M. 2nd Edition, ASM Press, Washington, DC. Print.
2. Introduction to Modern Virology (2007). Dimmock, N., Easton, A. and Leppard, K. 6th Edition. Wiley-Blackwell. Print.
3. Basic Virology (2007). Wanger, E.K., Hewiett, M., Bloom, D. and Camerini, D. 3rd edition, Wiley-Blackwell. Print.
4. Principles of Molecular Virology (2011). Cann, A.J. 5th Edition. Elsevier Academic Press. Print.
5. Plant Virology (2013). Hull, R. 5th Edition. Academic Press. Print.
6. Principles of Molecular Virology (2001). Alan J. Cann, 3rd edition, Elsevier Academic Press.
7. Plant Virology (2002). Roger Hull, 4th edition, Academic press.

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103039/
2. https://freevideolectures.com/course/3022/virology
3. http://www.bio-alive.com/animations/virology.htm

Course Name: Enzymology
Course Code: BTY637
Total Credits:4
Credits components: Theory-4, Practical-0, Tutorial-0

Course objective: This course provides a comprehensive understanding ofthe enzymmes and techniques to be used in enzyme technology. The course also introduces students to basic and advanced enzymology.

Unit 1 **No. of hours-15**

Introduction to Enzymes : Classification of enzymes – Mechanisms of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory and transition state theory – Role of entropy in catalysis.

Unit 2 **No. of hours-15**

Kinetics of Enzyme Action, Kinetics of single substrate reactions; estimation of Michelis-Menten parameters – Multisubstrate reactions – Mechanisms and kinetics – Turnover number LB Plot.

Unit 3 **No. of hours-15**

Enzyme Inhibition, Types of inhibition and models for substrate and product – Allosteric regulation of enzyme – Monod Changeux Wyman model – pH and temperature effect on enzymes & deactivation kinetics.

Unit 4 **No. of hours-15**

Enzyme Immobilization and Biosensors, Physical and chemical techniques for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding and suitable examples – Advantages and disadvantages – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

Unit 5 **No. of hours-15**

Purification and Characterization of Enzymes From Natural Sources, Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays

Reference Books:

1. Enzymes (Trevor Palmer)
2. Biochemistry (2004). Voet D & Voet JG, , 3rd Edition, John Wiley & Sons Inc., Singapore
3. Lehninger Principles of Biochemistry (2008).Nelson DL & Cox M.M., , 5th Edition, WH Freeman & Company, New York.

Assessment

For Theory Courses:
Mid Semester Examination (MSE)- 25 Marks,
Written Quiz (Objective Type MCQs)- 10 Marks
Assignment/ Project Work/Seminar (evidence based) -10 Marks
End Semester Examination (ESE)- 50 Marks
Attendance- 5 Marks

For Practical Courses:
End Semester Practical Exam- 80 Marks
Continuous Assessment – 20 Marks

Question paper formats for mid semester exam (MSE) and end semester exam (ESE)

DAV University, Jalandhar.

Term-

MSE

Name: ……. **Regd. No.: ……**

Course Code: MIC000 **Roll No.: …….**

Time: 1 Hour30 Minutes

Maximum Marks: 25

Course Name: ……

Section – A **(Maximum Marks: 1 x 5 = 5)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

Section – B **(Maximum Marks: 4 x 3 = 12)**

Attempt any **3 Questions out of 5 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Section – C **(Maximum Marks: 8 x 1 = 8)**

Attempt **1 Question out of 2 Questions** and each question should be answered in maximum 4 pages.

Q.7

Q.8

DAV University, Jalandhar.

ESE

Name: …….

Regd. No.: …….

Course Code: MIC000

Time: 3 Hours

Maximum Marks: 50

Course Name: …….

Section – A **(Maximum Marks: 1 x 10 = 10)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

vi.

vii.

viii.

ix.

x.

Section – B **(Maximum Marks: 4 x 6 = 24)**

Short Answer Type: Attempt any **6 Questions out of 8 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Q.7

Q.8

Q.9

Section – C **(Maximum Marks: 8 x 2 = 16)**

Long Answer Type: Attempt **2 Questions out of 4 Questions** and each question should be answered in maximum 4 pages.

Q.10

Q.11

Q.12

Q.13