SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester I

Category	Subject Name	Subject Code	Subject Credit
Major	Introduction to Microbiology and Microbial Diversity	MBY1011	3
	Introduction to Microbiology and Microbial Diversity Lab		1
Minor	Microbes in Environment	MBY1021	3
	Microbes in Environment Lab		1
Skill Enhancement Courses (SEC)	Instrumentation & Biotechniques	MBY1051	3
Interdisciplinary course (IDC)	Digital Fluency of Education	ED1031	3
Ability Enhancement Courses (AEC)	Communicative English	AEC1041	2
Value Added Course (VAC)	a. Environmental Science	VAC1061	2
	b. Understanding India		2
Total			**20**

Course Name: Introduction to Microbiology and Microbial Diversity
Course Code: MBY1011

Module-I: [15H]
History of Development of Microbiology: Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Module-II: [40H]
Diversity of Microbial World:
A. Systems of classification Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms
B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.
• **Algae:** History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, 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.
• **Fungi:** 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 and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa:** General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia

Module-III: [5H]

An overview of Scope of Microbiology.

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. History and development of microbiology
2. Microbial diversity
3. Sterilization techniques
4. Microbial growth
5. Microscopic techniques

Suggested Reading:

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

Course Name: Microbes in Environment
Course Code: MBY1021

Module-I: [14H]

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

Module-II: [12H]

competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Module-III: [12H]
Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese

Module-IV: [12H]
Waste Management: Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Module-V: [5H]
Microbial Bioremediation: Principles and degradation of common pesticides, hydrocarbons (oil spills).

Module-VI: [5H]
Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

Learning outcomes: *Importance of microorganisms and their role in environment*

Suggested Readings:
1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Course Name: SEC - Instrumentation and Biotechniques
Course Code: MBY1051

Module-I: [10H]
Microscopy: Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Module-II: [14H]
Chromatography: Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Module-III: [14H]
Electrophoresis: Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Module-IV: [10H]
Spectrophotometry: Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Module-V: [12H]
Centrifugation: Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

Learning outcomes: *Different instruments used for carrying out biological experiments and analysis.*

Suggested Readings:
1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.

7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

Course Name: IDC - Digital Fluency of Education
Course Code: ED1031

Course Name: AEC - Communicative English
Course Code: AEC1041

Course Name: VAC - Environmental Science
Course Code: VAC1061

Course Name: VAC - Understanding India
Course Code: VAC1061

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester II

Category	Subject Name	Subject Code	Subject Credit
Major	Biochemistry	MBY2012	3
	Biochemistry Lab		1
Minor	Medical Microbiology	MBY2022	3
	Medical Microbiology Lab		1
Skill Enhancement Courses (SEC)	Microbial Physiology & Metabolism	MBY2052	3
Interdisciplinary course (IDC)	Basics of Life Skill Education	ED2032	3
Ability Enhancement Courses (AEC)	Modern Indian Language	AEC2042	2
Value Added Course (VAC)	a. Environmental Science II	VAC2061	2
	b. Digital Transformation		2
	Internship	MBY2081	2
Total			**22**

Course Name: Biochemistry
Course Code: MBY2012

Module-I: [8H]

Bioenergetics: First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

Module-II: [12H]

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

Module-III: [12H]

Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functionsand properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Module-IV: [12H]

Proteins: Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D-

glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Module-V: [12H]

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

Module-VI: [4H]

Vitamins: Classification and characteristics with suitable examples, sources and importance.

Course Name: Biochemistry Lab.
Course Code: MBY2012

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Standard Free Energy Change of coupled reactions
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models
7. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Theory of bioenergetics
2. Insight of biomolecules
3. Enzymology and enzyme kinetics
4. Role of vitamins

Suggested Reading:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,

6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

Course Name: Medical Microbiology and Immunology
Course Code: MBY2022

Module-I: [8H]
Normal microflora of the human body and host pathogen interaction: Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection,

Module-II: [5H]
Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples and their identification characteristics.

Module-III: [3H]
Bacterial diseases: List of diseases of various organ systems and their causative agents.

Module-IV: [3H]
Viral diseases: List of diseases of various organ systems and their causative agents.

Module-V: [2H] Protozoan diseases: List of diseases of various organ systems and their causative agents.

Module-VI: [2H]
Fungal diseases: Brief description of various types of mycoses.

Module-VII: [7H]
Antimicrobial agents: General characteristics and mode of action: Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine

Module-VIII: [7H]
Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen

Module-IX: [7H]
Antigens and Antibodies: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

Module-X: [6H]
Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

Module-XI: [5H]
Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice).

Module-XII: [5H]

Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.

Course Name: Medical Microbiology and Immunology Lab.
Course Code: MBY2022

1. Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Identification of human blood groups.
6. To perform Total Leukocyte Count of the given blood sample.
7. To perform Differential Leukocyte Count of the given blood sample.
8. To separate serum from the blood sample (demonstration).
9. To perform immunodiffusion by Ouchterlony method.

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Human microbiome
2. Host-pathogen interaction
3. Infection biology
4. Sample collection
5. Diagnostic techniques
6. Infection biology
7. Antimicrobial treatment
8. Basic immunology
9. Immunological techniques

Suggested Reading:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Course Name: SEC - Microbial Physiology and Metabolism

Course Code: MBY2052

Module-I: [12H]

Microbial Growth and Effect of Environment on Microbial Growth: Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Module-II: [10H]

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

Module-III: [16H]

Chemoheterotrophic Metabolism - Aerobic Respiration: Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Module-IV: [6H]

Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation: Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Module-V: [10H]

Chemolithotrophic and Phototrophic Metabolism: Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Module-VI: [6H]

Nitrogen Metabolism - an overview: Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

Course Name: Internship
Course Code: MBY2081

Students will be advised to do a small project on research/survey/review/case study during the credit hours.

Course Name: IDC - Basics of Life Skill Education
Course Code: ED2032

Course Name: AEC - Modern Indian Language
Course Code: AEC2042

Course Name: VAC - Environmental Science II
Course Code: VAC2061

Course Name: VAC - Digital Transformation
Course Code: VAC2061

UG Microbiology, Semester III – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Bacteriology	MBY3011	3
	Bacteriology Lab	MBY3011	1
	Virology	MBY3012	3
	Virology Lab	MBY3012	1
Minor	Cell Biology	MBY3021	3
	Cell Biology Lab	MBY3021	1
Skill Enhancement Course	SEC: Industrial & Food Microbiology	MBY3051	3
Ability Enhancement Course	AEC: Communicative English	AEC3041	2
Interdisciplinary Course	IDC: Educational Research	ED3031	3
	Internship		2

Course Name: Bacteriology
Course Code: MBY3011

Module-I: [14H]
Cell organization: Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram- positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids, Endospore: Structure, formation, stages of sporulation.

Module-II: [5H]
Bacteriological techniques: Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-cultural bacteria.

Module-III: [6H]
Microscopy: Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Module-IV: [8H]
Growth and nutrition: Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action.

Module-V: [3H]
Reproduction in Bacteria: Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Module-VI: [8H]
Bacterial Systematics: Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria.

Module-VII: [16H]
Important archaeal and eubacterial groups: Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: Gram Negative: Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples Gram Positive: Low G+C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples Cyanobacteria: An Introduction.

Course Name: Bacteriology Lab.
Course Code: MBY3011

1. Preparation of different media: synthetic media BG-11, Complex Media- Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore 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.

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Identification of cells and cellular organelles
2. Staining Techniques
3. Microscopy
4. Nutrient media preparation
5. Culturing and growth of microbes
6. Pure culture isolation
7. Reproduction and growth kinetics
8. Taxonomical analysis
9. Microbialdiversity

Suggested Readings

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

Course Name: Virology
Course Code: MBY3012

Module-I:[12H]
Nature and Properties of Viruses: Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

Module-II: [10H]
Bacteriophages: Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Module-III: [20H]
Viral Transmission, Salient features of viral nucleic acids and Replication: Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions

Module-IV: [6H]
Viruses and Cancer: Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Module-V: [8H]
Prevention & control of viral diseases: Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination

Module-VI: [4H]
Applications of Virology: Use of viral vectors in cloning and expression, Gene therapy and Phage display.

Course Name: Virology Lab
Course Code: MBY3012

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

Learning outcomes: Learning outcomes: After completion of Bacteriology, the student will learn about the

1. General properties of viruses
2. Identification and cultivation of viral particles
3. Taxonomic analysis
4. Viral replication and transfection
5. Viral diversity and infection strategies
6. Virus in oncogenic activation
7. Viral control
8. Medical application of virology

Suggested Reading

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

Course Name: Cell Biology
Course Code: MBY3021

Module-I: [10H]
Structure and organization of Cell: Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell- Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

Module-II: [5H]
Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus

Module-III: [20H]
Protein Sorting and Transport: Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes

Module-IV: [10H]
Cell Signaling: Signaling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Module-V: [15H]
Cell Cycle, Cell Death and Cell Renewal: Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death Stem cells Embryonic stem cell, induced pleuripotent stem cells.

Course Name: Cell Biology Lab.
Course Code: MBY3021

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

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Cellular structure and intracellular organization
2. Transport of macromolecules (protein)
3. How cells communicate
4. Cell cycle and its effect on cancer development

5. Microscopic identification of different stages of cell cycle

Suggested Reading

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

Course Name: SEC: Industrial & Food Microbiology
Course Code: MBY3051

Module-I: [10H]
Introduction to Industrial microbiology: Brief history and developments in industrial microbiology Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous Types of fermenters – laboratory, pilot-scale and production fermenters Components of a typical continuously stirred tank bioreactor

Module-II: [8H]
Isolation of Industrial Strains and Fermentation Medium: Primary and secondary screening Preservation and maintenance of industrial strains Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Module-III: [12H]
Microbial fermentation processes: Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Module-IV: [8H]
Food as a substrate for microbial growth: Intrinsic and extrinsic parameters that affect microbial growth in food Microbial spoilage of food - milk, egg, bread and canned foods

Module-V: [10H]
Principles and methods of food preservation and food sanitation: Physical methods - high temperature, low temperature, irradiation, aseptic packaging Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite Food sanitation and control – HACCP

Module-VI: [12H]
Dairy products, probiotics and Food-borne Diseases: Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese Probiotics definition, examples and benefits Food intoxication by Clostridium botulinum and Staphylococcus aureus Food infection by Salmonella and E. coli.

Course Name: AEC: Communicative English
Course Code: AEC3041

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

Course Name: IDC: Educational Research
Course Code: ED3031

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester IV – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Microbial Genetics	MBY4011	3
	Microbial Genetics Lab		1
	Recombinant DNA Technology	MBY4012	3
	Recombinant DNA Technology Lab		1
	Bioinformatics	MBY4021	3
	Bioinformatics Lab		1
Minor	Bioethics & Bio Safety	MBY4051	4
Total			**16**

Course Name: Microbial Genetics
Course Code: MBY4011

Module-I: [18H]
Genome Organization and Mutations: Genome organization: E. coli, Saccharomyces, Tetrahymena Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.

Module-II: [10H]
Plasmids: Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Module-III: [12H]
Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and cotransduction of markers.

Module-IV: [8H]
Phage Genetics: Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda.

Module-V: [12H]
Transposable elements: Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition.

Course Name: Microbial Genetics Lab.
Course Code: MBY4011

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells

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

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Genetic mutations and mutagens
2. Development of genetic variation in microbes
3. Plasmid biology
4. Phage genetics
5. Transposons: the jumping genes

Suggested Reading:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings

Course Name: Recombinant DNA Technology
Course Code: MBY4012

Module-I: [2H]
Introduction to Genetic Engineering: Milestones in genetic engineering and biotechnology.

Module-II: [20H]
Molecular Cloning- Tools and Strategies: Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: E. coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

Module-III: [16H]
Methods in Molecular Cloning: Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Module-IV: [10H]

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

Module-V: [6H]

Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

Module-VI: [6H]

Applications of Recombinant DNA Technology: Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

Course Name: Recombinant DNA Technology Lab
Course Code: MBY4012

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting.

Learning outcomes: Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Introduction to rDNA technology
2. Tools for rDNA technologies
3. Cloning strategies
4. PCR techniques
5. Gene therapy

Suggested Reading

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

Course Name: Bioinformatics
Course Code: MBY4021

Module-I: [8H]
Introduction to Computer Fundamentals: RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.

Module-II: [14H]
Introduction to Bioinformatics and Biological Databases: Biological databases – nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Module-III: [16H]
Sequence Alignments, Phylogeny and Phylogenetic trees: Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood.

Module-IV: [10H]
Genome organization and analysis: Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes Genome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy Major features of completed genomes: *E. coli*, *S. cerevisiae*, *Arabidopsis*, Human.

Module-V: [12H]
Protein Structure Predictions: Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design.

Course Name: Bioinformatics Lab.
Course Code: MBY4021

1. Introduction to different operating systems - UNIX, LINUX and Windows 2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool.
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi-pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK).
7. Prediction of different features of a functional gene.

Learning outcomes: Application of computational biology

Suggested Reading

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

Course Name: Bioethics & Bio Safety
Course Code: MBY4051

Module-I: [8H]
Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

Module-II: [12H]
Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Module-III: [4H]
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Module-IV: [12H]
Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

Module-V: [12H]
Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

Module-VI: [12H]
Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

Learning outcomes:

1. Safety guidelines to carry out biological experiments

2. Bioethics
3. Intellectual property rights

Suggested Reading:

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

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester V – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Immunology	MBY5011	3
	Immunology Lab		1
	Molecular Biology	MBY5012	3
	Molecular Biology Lab		1
	Bioprocess Technology	MBY5013	3
	Bioprocess Technology Lab		1
	Quality Assurance & Quality Control	MBY5014	4
Minor	Biostatistics	MBY5021	4
Total			**20**

Course Name: Immunology
Course Code: MBY5011

Module-I: [4H]
Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Module-II: [7H]
Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Module-III: [4H]
Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Module-IV: [6H]
Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Module-V: [5H]
Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Module-VI: [4H]
Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Module-VII: [10H]
Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Module-VIII: [10H]
Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Module-IX: [10H]
Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Course Name: Immunology Lab
Course Code: MBY5011

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample. 4. Separate serum from the blood sample (demonstration).
4. Perform immunodiffusion by Ouchterlony method.
5. Perform DOT ELISA.
6. Perform immunoelectrophoresis.

Learning outcomes: After completion of Bacteriology, the student will learn about the
1. Basics of immunology
2. Immune response and immunodeficiencies
3. Immunological techniques
4. Tumor biology

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

Course Name: Molecular Biology
Course Code: MBY5012

Module I Genetic Material [8H]
DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology: linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure,

Module II Replication of DNA [12H]
Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair.

Module III Transcription in Prokaryotes and Eukaryotes [8H]
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors.

Module IV Transcriptional Processing [8H]
Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance.

Module V Translation [12H]
Translational machinery, charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.

Module VI Regulation of gene Expression [12H]
Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus, Yeast mating type switching, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

Course Name: Molecular Biology Lab
Course Code: MBY5012

1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from E. coli.
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) and UV spectrophotometer (A260 measurement).
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Learning outcomes: After completion of Bacteriology, the student will learn about the
1. Different types of cells and their genetic materials
2. Mechanism of DNA replication
3. DNA repair mechanisms
4. Central dogma mechanism
5. Gene regulation and epigenetic control

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

Course Name: Bioprocess Technology
Course Code: MBY5013

Module-I: [10H]
Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

Module-II: [20H]
Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

Module-III: [15H]
Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

Module-IV: [15H]
Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Course Name: Bioprocess Technology Lab
Course Code: MBY5013

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

Learning outcomes

1. This course offers knowledge on microbial techniques related to growth and production of microbial enzymes and other products.
2. This course makes you expertise in bioreactor designing and upstream and downstream processing of biological products.

Suggested Reading:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Course Name: Quality Assurance & Quality Control
Course Code: MBY5014

Module 1: Introduction to QA and QC (1 Credit)

- Definitions, Scope, and Importance of QA and QC in Biotech and Pharma
- Key Concepts: Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), and ISO Standards
- QA/QC Systems: Objectives, Components, and Workflow
- Risk Assessment and Management in Quality Processes

Module 2: Regulatory Guidelines and Compliance (1 Credit)

- Overview of Regulatory Authorities: USFDA, EMA, CDSCO, WHO
- Regulatory Guidelines: ICH Q8, Q9, Q10, and Q11
- Documentation Practices: Standard Operating Procedures (SOPs), Batch Records, and Validation Protocols
- Audits and Inspections: Types, Preparation, and Handling Non-Compliance

Module3: Quality Control Techniques and Tools (1 Credit)

- Analytical Methods for QC: Chromatography (HPLC, GC), Spectroscopy (UV-Vis, FTIR), and Mass Spectrometry
- Microbial and Sterility Testing in Biotech Products
- Validation Techniques: Process, Analytical, and Cleaning Validation
- Statistical Tools for Quality Control: Six Sigma, Control Charts, and Process Capability Analysis

Module 4: Applications and Case Studies (1 Credit)

- QA/QC in Biopharmaceuticals: Monoclonal Antibodies, Vaccines, and Biosimilars
- QA/QC in Food and Nutraceuticals: Standards and Testing
- Case Studies: Real-World Examples of Quality Failures and Lessons Learned
- Emerging Trends in QA/QC: AI in Quality Monitoring, Real-Time Release Testing (RTRT)

Learning Outcomes: Upon completing this course, students will:

1. Understand the fundamental principles of QA and QC in biotechnology and pharma.
2. Be familiar with global regulatory standards and their application in quality management.
3. Gain hands-on knowledge of QA/QC techniques and tools used in testing and validation.
4. Apply QA/QC principles to biomanufacturing processes and compliance audits.

Course Name: Biostatistics
Course Code: MBY5021

Module-I: [30H]
Biomathematics: Sets. Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits. Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations. Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

Module-II: [30H]
Biostatistics: Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions; Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.

Learning outcomes: Application of mathematics to interpret the biological outcomes and its statistical significance.

Suggested Readings:

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet: Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975) 3. A.
3. Edmondson and D. Druce: Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial: Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester VI – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Plant Pathology	MBY6011	3
	Plant Pathology Lab		1
	Animal Pathology	MBY6012	3
	Animal Pathology Lab		1
	Genetic Engineering & Biotechnology	MBY6013	3
	Genetic Engineering & Biotechnology Lab		1
	Drug Designing	MBY6014	4
Minor	Active Pharmaceutical Ingredient (API) Production	MBY6021	4
Total			**20**

Course Name: Plant Pathology
Course Code: MBY6011

Module-I: [5H]
Introduction and History of plant pathology: Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Module-II: [2H]
Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation.

Module-III: [5H]
Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Module-IV: [19H]
Host Pathogen Interaction: A. Microbial Pathogenicity Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). B. Genetics of Plant Diseases Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. Defense Mechanisms in Plants Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Module-V: [10H]
Control of Plant Diseases: Principles & practices involved in the management of plant diseases by different methods, viz. regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes- bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Module-VI: [19H]
Specific Plant diseases: Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control A. Important diseases caused by fungi White rust of crucifers - Albugo candida Downy mildew of onion - Peronospora destructor Late blight of potato - Phytophthora infestans Powdery mildew of wheat - Erysiphe graminis Ergot of rye - Claviceps purpurea Black stem rust of wheat - Puccinia graminis tritici Loose smut of wheat - Ustilago nuda Wilt of tomato - Fusarium oxysporum f.sp. lycopersici Red rot of sugarcane - Colletotrichum falcatum Early blight of potato - Alternaria solani B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadan.

Course Name: Plant Pathology Lab
Course Code: MBY6011

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.

Learning outcomes: Plant metabolites and its application in biological advances

Suggested Readings:
1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

Course Name: Animal Pathology
Course Code: MBY6012

Module 1:
Introduction and scope of Animal Pathology, Brief outline of major intrinsic and extrinsic causes of disease. Basic Terminology of disease, etiology, pathogenesis, lesion, morbidity, mortality, diagnosis, prognosis, and epidemiology. Pathology of hyperemia, congestion, hemorrhage, edema, thrombosis, embolism, infarction and shock. General principles of disease causation: Causes of diseases, including genetic, environmental, infectious, and immune-

related factors. Causes and mechanism of reversible and irreversible cell injury, necrosis and its types, apoptosis, differences between post- mortem autolysis and necrosis.

Module 2:
General principles of disease causation: Causes of diseases, including genetic, environmental, infectious, and immune-related factors. Mechanisms of disease: Inflammation, necrosis, apoptosis, and repair. Wound healing by primary and secondary intention. Pathology of autoimmune diseases and amyloidosis. Definitions, general characteristics and classification of neoplasms. Differences between benign and malignant tumours. Etiology and spread of neoplasms, immunity and neoplasia, effects and diagnosis of neoplasia, stages and grades of neoplasms.

Module 3:
Pathological changes including neoplasms in non- infectious disease conditions affecting Digestive System (mouth, pharynx, salivary glands, esophagus, stomach, intestines, liver, gall bladder, pancreas), Respiratory System (nasal cavity, larynx, bronchi, trachea, lungs and pleura), Musculo- skeletal system (muscle, bone, joints, ligaments, tendons), Cardio- vascular System (pericardium, myocardium, epicardium, endocardium, arteries, veins), Haemopoietic System (bone marrow), Lymphoid System 3 (lymph nodes, vessels and spleen), Urinary System (kidneys, ureter, bladder and urethra), Reproductive System (male and female genital organs), Nervous System (brain, spinal cord and peripheral nervous system), Endocrine System (adrenal, thyroid, thymus, pituitary, parathyroid and pancreas), skin and appendages (hoof and horn), Ear and Eye.

Module 4:
Infectious Diseases and Pathology - Bacterial Infections: Pathogenesis of bacterial diseases (e.g., tuberculosis, brucellosis, mastitis). Bacterial toxins and immune response. Viral Infections: Mechanisms of viral pathogenesis (e.g., rabies, foot-and-mouth disease). Fungal and Parasitic Infections: Mycotic infections and parasitic diseases in animals.

Course Name: Animal Pathology Lab
Course Code: MBY6012

i. Microscopic examination of tissues and organs. Histopathological staining techniques (H&E, special stains). Preparation of histological slides.
ii. Study of gross lesions in animal organs. Identification of inflammatory, neoplastic, and degenerative lesions.
iii. Study of histopathological slides showing haemorrhage, congestion, oedema, infarction, hyperplasia, metaplasia, hypertrophy, necrosis, cloudy swelling, amyloid degeneration, fatty changes, calcification, infiltration etc.
iv. Culture and identification of bacterial pathogens. Techniques for viral diagnosis: PCR, ELISA, and viral isolation.

Learning outcomes: Animal metabolites and its application in biological advances

Course Name: Genetic Engineering & Biotechnology
Course Code: MBY6013

Module-I: [16H]
Introduction to genetic engineering: Milestones in genetic engineering and biotechnology Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning: Use of linkers and adaptors Transformation of DNA: Chemical method, Electroporation Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Module-II: [16H]
Vectors: Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Expression vectors: E. coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Module-III: [10H]
DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR Genomic and cDNA libraries: Preparation and uses, Genome sequencing Sanger's method of DNA Sequencing: traditional and automated sequencing

Module-IV: [14H]
Application of Genetic Engineering and Biotechnology: Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium - mediated delivery Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering

Module-V: [4H]
Intellectual Property Rights: Patents, Copyrights, Trademarks

Course Name: Genetic Engineering & Biotechnology Lab
Course Code: MBY6013

1. Isolation of Plasmid DNA from E. coli
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Ligation of DNA fragments
4. Interpretation of sequencing gel electropherograms
5. Designing of primers for DNA amplification 6. Amplification of DNA by PCR
6. Demonstration of Southern blotting

Learning outcomes: After completion of Bacteriology, the student will learn about the
1. Introduction to rDNA technologies
2. Tools for rDNA technologies
3. Cloning strategies
4. PCR techniques
5. Gene therapy

Suggested Reading:

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Course Name: Drug Designing
Course Code: MBY6014

Module I [10H]

Introduction to The Drug Discovery/Development: Drug Discovery, Drug Development, Source of Drugs.

Module II [15H]

Approaches to New Drug Discovery: Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Using Disease Models as Screens for New Drug Leads, Physiological Mechanisms: the Modern "Rational Approach" to Drug Design.
Approaches to Lead Optimization:

1. Bioisosteric replacement
2. Conformation restriction
    a. Increase selectivity, b. Increase affinity
3. Pharmacophore
4. Molecular dissection
5. Metabolic stabilization

Module III [10H]

Enzymes as Targets of Drug Design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors.

Module IV [10H]

Receptors as Targets of Drug Design: Receptor Theory, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Molecular Biology of Receptors, Receptor Models and Nomenclature, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists.

Module V [10H]

Prodrug Design and Applications: Definition, Applications, Prodrug Design Considerations, Prodrug Forms of Various Functional Groups, Ester prodrugs of compounds containing –COOH or –OH, Prodrugs of compounds containing amides Drug release and activation mechanisms:

1. Simple one-step activation

2. Cascade release/activation systems

Learning outcomes
1. This course offers general characteristics of drug designing and drug discovery.
2. This course makes you expertise in Rational Design of Enzyme Inhibitors, Computer-aided drug designing methods.

Course Name: Active Pharmaceutical Ingredient (API) Production
Course Code: MBY6021

Module 1: Introduction to APIs and Manufacturing Processes (1 Credit)
- Definition and Classification of APIs: Small Molecules, Biologics, and Peptides
- Overview of API Manufacturing Workflows: Raw Material Procurement, Synthesis, and Purification
- Key Techniques: Chemical Synthesis, Biocatalysis, and Fermentation
- Role of APIs in Drug Development and Therapeutics

Module 2: Process Development and Optimization (1 Credit)
- Principles of Process Design: Reaction Kinetics, Reactor Design, and Yield Optimization
- Scale-Up Considerations: Lab-Scale to Pilot-Scale and Commercial Production
- API Purification Techniques: Crystallization, Filtration, and Drying
- Process Analytical Technology (PAT) and Continuous Manufacturing

Module 3: Quality Assurance, Regulatory Compliance, and Safety (1 Credit)
- Good Manufacturing Practices (GMP) in API Production
- Regulatory Requirements: USFDA, EMA, WHO, and ICH Guidelines
- Quality Assurance and Quality Control in API Manufacturing
- Safety and Environmental Considerations in API Production

Module 4: Emerging Trends and Case Studies (1 Credit)
- Green Chemistry in API Manufacturing: Sustainable Processes and Waste Reduction
- AI and Machine Learning in API Process Optimization
- Biopharmaceutical APIs: Production of Monoclonal Antibodies, Vaccines, and Biosimilars
- Case Studies: Success Stories and Challenges in API Manufacturing

Learning Outcomes
Upon completing this course, students will:
1. Acquire knowledge of the science and engineering behind API production.
2. Understand process design, optimization, and scale-up in API manufacturing.
3. Demonstrate an understanding of quality assurance, compliance, and safety in API production.
4. Apply emerging technologies to optimize and innovate API production processes.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester VII – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Medical Scribing	MBY7011	4
	Clinical Data Analysis	MBY7012	4
	Computational Aptitude	MBY7013	4
	AI & Machine Learning	MBY7014	4
Minor	Microbial Diagnostics	MBY7021	4
Total			**16**

Course Name: Medical Scribing
Course Code: MBY7011

Module 1: Fundamentals of Medical Scribing (1 Credit)

- Introduction to Medical Scribing: Role and Responsibilities
- Anatomy and Physiology Overview for Medical Scribes
- Medical Terminology and Abbreviations
- Electronic Health Records (EHRs): Systems and Workflow
- Real-Time Medical Documentation: Patient History, Symptoms, and Treatments

Module 2: Principles of Medical Coding (1 Credit)

- Overview of Medical Coding: Purpose and Applications
- ICD-10-CM and ICD-11 Coding: Structure and Guidelines
- CPT and HCPCS: Procedure and Services Coding
- Coding for Different Specialties: Cardiology, Orthopedics, Oncology, etc.
- Error Minimization and Quality Assurance in Coding

Module 3: Technology and Software in Medical Scribing and Coding (1 Credit)

- Introduction to Medical Scribing Tools and Transcription Software
- Coding Software Platforms: 3M CodeFinder, EncoderPro, etc.
- Integration of Artificial Intelligence and Automation in Scribing and Coding
- Data Security and Confidentiality in Medical Records
- Case Studies: Implementing Technology in Real-Life Scenarios

Module 4: Ethical, Legal, and Regulatory Aspects (1 Credit)

- Health Insurance Portability and Accountability Act (HIPAA) Compliance
- Documentation Standards and Legal Considerations in Medical Records
- Billing and Reimbursement Processes in Healthcare
- Ethical Issues in Medical Scribing and Coding
- Global Coding Standards: Regional Variations and Challenges

Learning Outcomes

By the end of this course, students will:

1. Develop the ability to document medical encounters accurately and efficiently.
2. Gain competency in using ICD, CPT, and HCPCS coding systems for various medical procedures and diagnoses.
3. Demonstrate proficiency in medical coding software and EHR systems.
4. Understand the ethical and regulatory requirements for handling medical data.
5. Be prepared for careers in medical scribing, coding, and related roles in healthcare and biotech industries.

Suggested Reading:
1. *Essentials of Medical Scribing* by Alex McHugh.
2. *Step-by-Step Medical Coding* by Carol J. Buck.
3. ICD-10-CM/PCS Coding Handbook by Nelly Leon-Chisen.
4. HIPAA Guidelines and Regulatory Resources.
5. Online Tutorials for EHR and Coding Software.

Course Name: Clinical Data Management
Course Code: MBY7012

Module 1: Introduction to Clinical Data Management (1 Credit)
- Definition and Importance of CDM
- Overview of Clinical Trials and CDM in the Drug Development Lifecycle
- Key Stakeholders: Sponsors, CROs, and Regulatory Authorities
- Standard Operating Procedures (SOPs) and Good Clinical Data Management Practices (GCDMP)

Module 2: Regulatory Guidelines and Ethical Considerations (1 Credit)
- International Guidelines: ICH-GCP, US FDA, EMA, and Indian CDSCO
- Data Privacy and Protection: HIPAA, GDPR, and Indian IT Act
- Ethical Issues in Data Collection and Management
- Audits and Inspections in Clinical Data Management

Module 3: CDM Process and Tools (1 Credit)
- Data Collection and Case Report Forms (CRFs): Design and Standards
- Data Entry and Validation: Processes and Best Practices
- Overview of CDM Systems and Software (e.g., Oracle Clinical, Medidata RAVE, EDC tools)
- Data Cleaning, Query Management, and Database Lock

Module 4: Advanced Topics and Applications (1 Credit)
- Integration of CDM with Biostatistics and Data Analysis
- Handling Adverse Event Data and Serious Adverse Events (SAEs)
- Real-World Data (RWD) and Real-World Evidence (RWE)
- Emerging Trends: Artificial Intelligence and Machine Learning in CDM

Learning Outcomes
Upon completion of the course, students will be able to:
1. Design and implement a clinical data management plan for clinical trials.
2. Demonstrate proficiency in using CDM tools and software.
3. Ensure compliance with ethical and regulatory standards for data management.
4. Analyze clinical data and generate comprehensive reports for regulatory submissions.
5. Understand emerging technologies in CDM and their applications in clinical research.

Suggested Reading:
1. Good Clinical Data Management Practices (GCDMP), Society for Clinical Data Management (SCDM).
2. *Principles of Clinical Data Management* by Richard K. Rondel et al.
3. ICH-GCP E6 (R2) Guidelines.
4. *Clinical Data Management* by Eleanor McFadden.

Course Name: Computational Aptitude
Course Code: MBY7013

Module 1: Introduction to Computational Thinking (1 Credit)
- Basics of Computational Thinking: Logical Reasoning and Problem-Solving
- Algorithm Design: Steps in Problem Formulation and Solution Design
- Understanding Flowcharts and Pseudocode for Logical Representation
- Applications of Computational Thinking in Biotechnology

Module 2: Programming Fundamentals (1 Credit)
- Introduction to Programming Languages: Python and R
- Basic Syntax, Variables, Data Types, and Operators
- Control Structures: Loops (for, while) and Conditional Statements (if-else)
- Functions, Modules, and Libraries for Efficient Coding

Module 3: Algorithms and Data Structures (1 Credit)
- Fundamental Algorithms: Sorting, Searching, and Recursion
- Data Structures: Arrays, Lists, Dictionaries, and Stacks
- Algorithm Optimization: Time and Space Complexity
- Case Studies: Biological Sequence Alignment and Phylogenetic Tree Construction

Module 4: Applications in Biotechnology (1 Credit)
- Data Analysis and Visualization using Python and R
- Applications in Genomics and Proteomics: Sequence Analysis and Protein Modeling
- Introduction to Machine Learning: Basics of Supervised and Unsupervised Learning
- Tools for Computational Biology: Biopython, BioPerl, and R Bioconductor

Learning Outcomes
Upon completing this course, students will:
1. Understand computational thinking and its role in solving biological problems.
2. Acquire basic coding skills in Python and R.
3. Develop and optimize algorithms for biological applications.
4. Utilize programming tools to analyze and interpret biological data.

Course Name: AI & Machine Learning
Course Code: MBY7014

Module 1: Fundamentals of AI/ML in Biology (1 Credit)
- Introduction to AI and ML: Definitions, Types (Supervised, Unsupervised, Reinforcement Learning)
- Key Concepts: Neural Networks, Deep Learning, and Natural Language Processing (NLP)
- Biological Data Types: Genomic, Transcriptomic, Proteomic, and Clinical Data
- Overview of AI/ML Tools: Python Libraries (Scikit-learn, TensorFlow, PyTorch), R Programming

Module 2: AI/ML in Drug Discovery and Development (1 Credit)
- Applications in Drug Target Identification and Validation
- AI in Virtual Screening, Molecular Docking, and ADMET Prediction
- Accelerating Drug Discovery Pipelines with Generative AI Models
- Case Studies: AI-Driven Drug Development (e.g., AlphaFold, BenevolentAI)

Module 3: AI/ML in Biopharma Process Optimization (1 Credit)

- Process Monitoring and Optimization in Bioreactors
- Predictive Models for Yield Optimization and Quality Control
- AI in Supply Chain and Manufacturing Processes
- Integration of AI in Biopharma 4.0 Frameworks

Module 4: Emerging Trends and Ethical Considerations (1 Credit)

- AI in Personalized Medicine and Precision Therapeutics
- Role of AI/ML in Synthetic Biology and Genetic Engineering
- Challenges in Data Privacy, Bias, and Interpretability in AI/ML Models
- Regulatory and Ethical Guidelines for AI Applications in Biopharma

Learning Outcomes

Upon completion of this course, students will:

1. Understand the principles of AI/ML and their applications in biology and biopharma.
2. Develop skills to analyze biological data using AI/ML techniques.
3. Apply AI/ML models to real-world problems in drug discovery and biopharma process optimization.
4. Critically evaluate ethical and regulatory considerations in AI/ML applications.

Course Name: Microbial Diagnostics
Course Code: MBY7021

Module-I: [10H]

Importance of Diagnosis of Diseases: Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Module-II: [10H]

Collection of Clinical Samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Module-III: [10H]

Direct Microscopic Examination and Culture: Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Module-IV: [10H]

Serological and Molecular Methods: Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Module-V: [10H]

Kits for Rapid Detection of Pathogens: Typhoid, Dengue and HIV, Swine flu

Module-VI: [10H]

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

Learning outcomes: After completion of Bacteriology, the student will learn about the

1. Microbial pathology
2. Sample collection
3. Specimen identification
4. Serology
5. Immunological techniques
6. Handling of rapid test kits
7. Bacteriology

Suggested Reading:

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121

UG Microbiology, Semester VIII – NEP Syllabus

Category	Subject Name	Subject Code	Subject Credit
Major	Evolutionary Biology	MBY8011	3
	Evolutionary Biology Lab		1
Minor	Biofertilizers & Biopesticides	MBY8021	4
	Research Proposal	MBY8051	12
Total			**20**

Course Name: Evolutionary Biology
Course Code: MBY8011

Module-I: [2H]
Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

Module-II: [2H]
Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Module-III: [10H]
Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c

Module-IV: [1H]
Sources of variations: Heritable variations and their role in evolution

Module-V: [12H]
Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density- dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

Module-VI: [10H]
Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches

Module-VII: [5H]
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

Module-VIII: [10H]
Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin

Module-IX: [5H]
Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

Course Name: Evolutionary Biology Lab
Course Code: MBY8011

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

Learning outcomes
1. This course offers knowledge on various techniques related to population genetics.
2. This course makes you expertise in analogy and homology study of different species.

Suggested Reading:
1. Mark Ridley. Evolution. 3rd Edition. Blackwell Pubishing. (2004).
2. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Merrut.
3. Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.
4. P. S. Verma and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
5. Strickberger. Evolution. Prentic Hall. (2002).
6. Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970).

Course Name: Biofertilizers & Biopesticides
Course Code: MBY8021

Module-I: [20H]
Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non- leguminous crop symbiosis. Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Module-II: [8H]
Non - Symbiotic Nitrogen Fixers: Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application.

Module-III: [8H]
Phosphate Solubilizers: Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Module-IV: [10H]
Mycorrhizal Biofertilizers: Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Module-V: [14H]
Bioinsecticides: General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications.

Learning outcomes: After completion of Bacteriology, the student will learn about the
1. Microbiome and its role in biofertilizer production and crop improvement
2. Microbial symbionts and its effect in chemical assimilation
3. Insecticidal properties of microbes and biomolecules and their applications

Suggested Readings:
1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

Course Name: Research Proposal
Course Code: MBY8051

Students will be advised to do a small project on research/survey/review/case study during the credit hours.