FIRST SEMESTER

BIO1107: Cell Biology [2 1 2 4]

History and Introduction of Cell: Cell theory, eukaryotic and prokaryotic cells, different models of cell membrane and structure of cell wall, active & passive transport. Cell organelles, chromosome structure and Karyotyping, cell division, cell cycle, cell signaling, and signal transduction pathways. Cellular communication and roles of different adhesion molecules. Cell senescence and programmed cell death.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Use of a compound microscope
2. Measurement of cell size by using micrometry
3. Total cell counting using a haemocytometer
4. Study of mitosis in onion root tip cells
5. Study of meiosis in pollen grains
6. Cell viability test by trypan blue dye exclusion

References:

1. Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell J., Molecular Cell Biology, New York, 2013.
2. Freeman W.H., Rastogi S.C., Cell Biology, New Age International, New Delhi, 2007.
3. Alberts B., Bray D., Lewis J., Raff M., Watson J.D., Molecular Biology of the Cell, Garland Publishing Inc., New York, 2017.
4. Gupta P.K., A Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
5. De Robertis D., Cell and Molecular Biology, Waverly International, New York, 2011.

BIO1120: Diversity of Life [3 1 0 4]

Concept and levels of biodiversity, scientific nomenclature, classical and modern classification systems, phylogenetics and domains of life. Diversity of Viruses, bacteria, archaea, protists and extremophiles. Major plant (cryptogames and phenerogames) and animal (invertebrate and vertebrate) groups, evolutionary trends, ecological and economic importance. Organic evolution, adaptive radiation and functional adaptations, biodiversity hotspots, and endemism.

References:

1. Campbell N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B., Campbell Biology, Pearson Education, 2018.
2. Raven P.H., Evert R.F., Eichhorn S.E., Biology of Plants, W.H. Freeman and Company, 2013.
3. Rastogi V.B., Organic Evolution (14e), Medtech (Scientific International), 2018.
4. Wilson E.O., The Diversity of Life (New ed.), Penguin, 2001.

CHY1101: Atomic Structure, Bonding, and Periodicity [2 1 2 4]

Atomic Structure: Schrodinger's wave equation, significance of Ψ1 and Ψ2, four quantum numbers and their significance, radial and angular probability, shapes of s, p, d and f orbitals, fundamental properties of atoms such as atomic volume, the sizes of atoms, ionization energy, electron affinity and their periodic trends. Electronegativity and Polarity of Bonds: Electronegativity, different scales and methods of determination, dipole moments, percentage of ionic character form dipole moment and electronegativity difference. Periodic Table and Chemical Periodicity: The relationship between chemical periodicity and electronic structure of the atom, the long form of the periodic table, classification of elements in s, p, d and f block of elements, diagonal behaviour between elements. Valence Bond Theory and Molecular Orbital Theory: Valence bond (VB) approach, molecular orbitals (MO) approach of bonding (LCAO Method) bonding in homo-nuclear and hetero-nuclear molecules. Acids-Bases: various definitions of acids and bases, a generalized acid-base concept, measurement of acid-base strength, Lewis interactions, Pearson's HSAB concept. Flame test, potash alum synthesis, boric acid preparation, carbonate and hydroxide estimation, free alkali in soaps, alkali in antacids, borate detection by borax bead test. Preparation and standardization of reference solutions, buffer preparation, redox titration, iodometric titrations.

References:

1. Lee J.D., Concise Inorganic Chemistry (5e), Blackwell Science, Oxford, 2008.
2. Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structure and Reactivity (4e), Pearson India, 2008.
3. Shriver D.F., Atkins P.W., Inorganic Chemistry (5e), Oxford University Press, 2011.
4. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorganic Chemistry (6e), Wiley India, 2007.
5. Nad A.K., Mahapatra B., Ghoshal A., An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

MAS1122: Fundamentals of Computers [1 0 1 2]

Computer fundamentals and hardware organization, data, information, and knowledge, generations and classification of computers, basic organization of computer system, CPU fundamentals, memory organization and storage (memory hierarchy, primary memory, secondary storage), input and output devices. Software, operating systems, and multimedia, software and its types, operating system and its types, windows vs linux, mobile operating systems, multimedia and software applications. Computer networks and internet, computer networks, and applications, types of networks, network topologies, network devices, network cables, internet, introduction and uses; internet connectivity: wired and wireless; ip addressing and domain name system (dns); website, URL, web browser, search engines, introduction to html (purpose and uses). Cyber safety and computer usage guidelines, email concepts and email etiquettes, cyber security basics, secure password formation, internet frauds and online threats, computer security issues, malware, virus, worm, ransomware, social-media and its impact.

References:

1. Sinha P.K., Sinha Priti, Computer Fundamentals, BPB Publications.
2. Rajaraman V., Fundamentals of Computers, PHI Learning.
3. Leon A., Leon M., Fundamentals of Information Technology, Vikas Publishing House.
4. Goel A., Computer Fundamentals, Pearson Education.

LLC1110: Communicative English [2 0 0 2]

Communication: Definition, Process, Types, Flow, Modes, Barriers; Cross cultural communication. · Grammar: Tenses and its usage, Voice, Reported Speech, Subject-Verb Agreement. Reading Comprehension; Précis Writing; Essay Writing; · Principles of professional written communication: Formal Letter Writing; Email Etiquettes; Résumé & Curriculum Vitae; Statement of Purpose; Report Writing; Presentation Skills · Group discussions, Debates, Public speaking, Interview skills, Digital communication practices and platforms: Professional communication in online environments, Digital etiquette and ethical communication.

References:

1. Guffey M.E., Loewy D., Essentials of Business Communication, Cengage Learning.
2. Murphy R., English Grammar in Use, Cambridge University Press.
3. Raman M., Sharma S., Technical Communication: Principles and Practice, Oxford University Press.
4. Rizvi A.M., Effective Technical Communication, McGraw Hill Education.

CHY1003: Environmental Science [2 0 0 2]

Multidisciplinary nature, scope and importance, sustainability and sustainable development. Ecosystems, concept, structure and function, energy flow, food chain, food webs and ecological succession, examples. Natural Resources (Renewable and Non-renewable Resources): Land resources and land use change, Land degradation, soil erosion and desertification, deforestation. Water Use and over-exploitation, floods, droughts, conflicts. Energy resources, renewable and non- renewable energy sources, alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation, levels, biogeographic zones, biodiversity patterns and hot spots, India as a mega-biodiversity nation, endangered and endemic species, threats, conservation, biodiversity services. Environmental pollution, type, causes, effects, and controls of air, water, soil and noise pollution, nuclear hazards and human health risks, fireworks, solid waste management, case studies. Environmental policies and practices, climate change, global warming, ozone layer depletion, acid rain, environment laws, environmental protection acts, international agreements, nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human communities and the environment, human population growth, human

health and welfare, resettlement and rehabilitation, case studies, disaster management, environmental ethics, environmental communication and public awareness, case studies. Field work and visit.

References:

1. Rajagopalan R., Environmental Studies: From Crisis to Cure, Oxford University Press, 2016.
2. De B.K., Environmental Studies, New Age International Publishers, 2007.
3. Bharucha E., Textbook of Environmental Studies for Undergraduate Courses, Universities Press, 2013.
4. Carson R., Silent Spring, Houghton Mifflin Harcourt, 2002.
5. Gadgil M., Guha R., This Fissured Land: An Ecological History of India, University of California Press, 1993.
6. Groom M.J., Meffe G.K., Carroll C.R., Principles of Conservation Biology, Oxford University Press, 2005.

PES1030: Health, Fitness, and Active Lifestyle [1 0 2 2]

Participation in Physical Activity: Fit India protocol, physical activity, Health and Fitness, Indicators of Fitness, Field Activity: Aerobic Work Out/ Physical Activity (Walking) , Yoga -Asanas (Lying, Sitting and Standing positions) and Pranayama, Cardiovascular Testing by 12min/9 min Cooper Run/Walk test, Health Related Fitness and their Components: Muscular Strength and Endurance, Body Composition and Flexibility, Flexibility Training: Back Saver Sit and Reach test: Muscular Strength Training: Curl Ups / Standing Broad Jump/ Vertical Jump/ Plyometric, Endurance Training: 1 Mile RockPort Test or 12 /9 minute Cooper run/walk test. Ideal Body Weight, Body Mass Index (BMI), Waist-Hip Ratio, Waist-Height Ratio (Data of at least 10 persons to be collected), Nutrition and Fitness: Healthy Eating Plate, Balanced Diet, Caloric Content of Food, Field Activity: (Select Any): Preparing Daily Diet and Calorie Chart, Aerobic Work Out/ Physical Activity (Walking), Assessment of Physical Activity with the Calorie intake, Asanas for digestive system excretory system, Sports Physiology and Psychology: Depression, Anxiety and Stress Scale (DASS), Rosenberg Self Esteem Scale, Field Activity: (Select Any): Skills learning and Participation in sports, Group Games/ Relays/ Minor Games, Meditative Asanas and Pranayama, Fitness component testing (as per Fit India Protocol and Norms) and Analysis of Results, Data of at least 10 persons to be collected on DASS and self-esteem scale

References:

1. Hoeger W.K., Hoeger S.A., Fitness and Wellness, Cengage Learning, 2014.
2. Fit India Movement Portal, Fit India Movement, Government of India, New Delhi.
3. Corbin C.B., Welk G.J., Corbin W.R., Welk K.A., Concepts of Fitness and Wellness: A Comprehensive Lifestyle Approach, McGraw-Hill Education, 2015.
4. Kenney W.L., Wilmore J.H., Costill D.L., Physiology of Sport and Exercise (2e), Human Kinetics, 2015.
5. International Sports Federations, Official Websites of Various International Sports Federations.
6. Ministry of Youth Affairs and Sports, Government of India, Ministry of Youth Affairs and Sports, New Delhi.

SECOND SEMESTER

BIO1207: Fundamentals of Biotechnology [2 1 2 4]

Introduction and history, basic concepts, definitions, and descriptions of important terminology in biotechnology, major branches of biotechnology. Genes and genome, proteins and proteome. Genetic engineering, plant and animal tissue culture, fermentation technology, recombinant DNA technology, DNA fingerprinting, and forensic analysis. Current status of biotechnology and future prospects, role of biotechnology in environment, medicine, food and agriculture industry.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Introduction to lab and lab environment and Good Laboratory Practices (GLP)
2. Preparation of plasmid from given bacterial sample and gel analysis.
3. Digestion of DNA sample using restriction enzymes
4. Agarose gel electrophoresis
5. Demonstration of PCR amplification of DNA

References:

1. Dubey R.C., A Textbook of Biotechnology (6e), S. Chand Publishing, 2025.
2. Glick B.R., Pasternak J.J., Patten C.L., Molecular Biotechnology: Principles and Applications of

Recombinant DNA (5e), ASM Press, 2020.
3. Primrose S.B., Twyman R.M., Old R.W., Principles of Gene Manipulation and Genomics (8e), Wiley-Blackwell, 2024.
4. Chawla H.S., Introduction to Plant Biotechnology (4e), CBS Publishers & Distributors, 2024.
5. Shukla R.K., Vajpayee K., Dash H., Forensic Biotechnology: The Basics and Beyond, Routledge, 2026.

BIO1290: Fundamentals of Microbiology [2 1 2 4]

Definition and scope of microbiology, key discoveries of microbiology, germ theory of disease, branches of microbiology. Classification and nomenclature of microorganisms, overview of bacteria, viruses, fungi, algae, and protozoa, archaea and extremophiles, prions and viroids. Cell structure of bacteria, viruses, fungal cell structure. Microbial growth, nutrition and metabolism. Microorganisms in human health and disease, food and fermentation, environmental and industry.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Hanging drop for observation of bacterial motility
2. Staining of microorganisms
3. Sterilization methods
4. Culture media: preparation and application for different microbial groups
5. Cultivation techniques for different types of microbes

Reference:

1. Prescott L.M., Harley J.P., Klein D.A., Microbiology (11e), McGraw-Hill Education, 2023.
2. Pelczar M.J., Chan E.C.S., Krieg N.R., Microbiology, Tata McGraw-Hill, 2019.
3. Dubey R.C., Maheshwari D.K., A Textbook of Microbiology, S. Chand Publishing, 2021.
4. Tortora G.J., Funke B.R., Case C.L., Microbiology: An Introduction (14e), Pearson Education, 2022.
5. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M., Stahl D.A., Brock Biology of Microorganisms (16e), Pearson, 2021.

CHY1201: States of Matter and Molecular Properties [2 1 2 4]

Equation of state, Kinetic molecular theory, kinetic gas equation, imperfection in real gases, compressibility, isotherms, equations of state, van der Waal's equation, liquefaction of gases, critical phenomenon, P-V isotherms of carbon dioxide, principle of continuity of state. Transport properties, kinetic energy and temperature, distribution of molecular speeds, derivation of Maxwell-Boltzmann distribution law, thermal conductivity, thermal conductivity in gases. Properties of liquids, the kinetic molecular description, intermolecular forces in, density and its measurements, vapour pressure and its determination, surface tension and its determination, viscosity and measurement of viscosity. Colligative Properties: Solutions of non-volatile solutes, colligative properties. Solid state, space lattice, unit cell. Miller indices, symmetry elements in crystals. X-ray diffraction. Bragg's equation, dimension and contents of unit cell. Electric and magnetic properties, electric properties, polarization of molecules in electric field, Clausious-Mosotti equation, Debye equation, bond moments, dipole moment, group moment, magnetic properties, magnetic susceptibility. Determination of physical parameters, calibration of thermometer, determination of melting points and boiling points of some organic compounds. Distillation, Simple distillation of ethanol-water mixture, distillation of nitrobenzene and aniline. Crystallization of some organic and inorganic compound.

References:

1. Atkins P., de Paula J., Atkins' Physical Chemistry, Oxford University Press, 2004.
2. Puri B.R., Sharma L.R., Pathania M.S., Principles of Physical Chemistry, Vishal Publications, 2010.
3. Rakshit P.C., Physical Chemistry, Sarat Book House, 2014.
4. McQuarrie D.A., Simon J.D., Physical Chemistry: A Molecular Approach, Viva Books, 2011.
5. Barrow G.M., Physical Chemistry (Special Indian Edition), Tata McGraw-Hill Education, 2006.
6. Nad A.K., Mahapatra B., Ghoshal A., An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
7. Vogel A.I., Elementary Practical Organic Chemistry: Small Scale Preparations, Part 1, Pearson India, 2010.

PHY1240: Report Writing [1 1 0 2]

Definition and process elements of effective writing, choice of words and phrases effective writing-

sentence construction and length provide practice in writing, define technical reports, types of reports, preparatory steps (steps involved in report writing; planning and preparation: from data collection to outline making), discuss sources of Data, methods of data collection, provide guidelines for preparing mail questionnaire, report structure, data analysis and illustrations, report writing, memo report and letter report oral presentation of reports.

References:

1. Raman M., Sharma S., Technical Communication: Principles and Practice (2e), Oxford University Press, 2011.
2. Gerson S.J., Gerson S.M., Technical Writing: Process and Product (3e), Pearson Education Asia, 2000.
3. Mohan K., Raman M., Advanced Communicative English, Tata McGraw-Hill, 2010.
4. Sharma R.C., Mohan K., Business Correspondence and Report Writing (5e), Tata McGraw-Hill, 2016.

MAS1221: Logical Reasoning and Competitive Aptitude [1 1 0 2]

Compound statements (and, or, implication, negation, contrapositive, quantifiers), Truth tables, Basic logical equivalences and its consequences, Logical arguments, Theory of Inferences, Recursive relations and its solution (characteristics polynomial), Generating function, Properties of integers, Division algorithm, Divisibility and Euclidean algorithm, Diophantine equations, GCD, LCM, Relatively prime. Applications of Numbers, Prime numbers, Statement of fundamental theorem of arithmetic, Mathematical induction.

References:

1. Goodaire E.G., Parmenter M.M., Discrete Mathematics with Graph Theory (2e), Pearson Education, 2003.
2. Lidl R., Pilz G., Applied Abstract Algebra (2e), Springer, 1998.

MAS1222: Introduction to Python Programming [1 0 1 2]

Introduction to Python, history of Python, features of Python, installing Python and environment setup, Python identifiers, keywords and indentation, comments and document interlude in Python, command line arguments, getting user input. Data types, variables, basic input-output operations, basic operators, data types, variables, Python user defined functions, defining and calling function, loops and statements in Python, Python modules and packages. Boolean values, conditional execution, loops, lists and list processing, logical and bitwise operations, making decisions in Python, Python's loops, logic and bit operations in Python, lists - collections of data, sorting simple lists. Python's built-in data types, string, list, tuple, set, dictionary (characteristics and methods). The object-oriented approach, overview of oop creating classes and objects, inheritance, polymorphism. File processing concept of files, file opening in various modes and closing of a file, reading from a file, writing onto a file, some important file handling functions e.g. Open (), close (), read (), readline () etc. Python libraries: pandas, matplotlib, numpy. Exception handling, what is exception? Handling an exception, try...except...else, try-finally clause.

References:

1. Goodrich M.T., Tamassia R., Goldwasser M.H., Data Structures and Algorithms in Python, Wiley, 2013.
2. Phillips D., Python 3 Object-Oriented Programming: Build Robust and Maintainable Software with Object-Oriented Design Patterns in Python 3.8 (3e), Packt Publishing, 2018.
3. Chun W.J., Core Python Applications Programming (3e), Prentice Hall, 2012.
4. Grus J., Data Science from Scratch: First Principles with Python (1e), O'Reilly Media, 2015.
5. Boschetti A., Massaron L., Python Data Science Essentials: A Practitioner's Guide Covering Essential Data Science Principles, Tools, and Techniques (3e), Packt Publishing, 2019.

MAS1223: Ancient Indian Knowledge System [2 0 0 2]

Indian knowledge system, the vedic corpus, introduction to vedas, a synopsis of the four vedas, sub-classification of vedas, messages in vedas, vedic mathematics, introduction to vedic mathematics, vedic sutras, arithmetic computations, multiplication, practical application in "compound multiplication", practice and proportion in compound multiplication. Division by the nikhilam method, division by paravartya method, argumental division. Factorization (of simple & harder quadratic both).

References:

1. Agrawal V.S., Vedic Mathematics, Motilal Banarsidass Publishers, 2015.
2. Bharucha D., Vedic Mathematics, Edukeen Publisher, 2023.
3. Mahadevan B., Balasubramanian K., Ganesh R., Introduction to Indian Knowledge System: Concepts and Applications (1e), PHI Learning, 2019.

4. Dalal R., The Vedas: An Introduction to Hinduism's Sacred Texts, Penguin India, 2013.
5. Wadekar M.L., Essentials of Vedic Literature, National Book Trust, 2016.

THIRD SEMESTER

BIO2107: Biochemistry [2 1 2 4]

Introduction to biochemistry and biomolecules, classification, chemical structure and properties of biomolecules (Carbohydrates, Lipids, Proteins, Nucleic Acids). Anabolism, catabolism and regulation of biomolecules. Bioenergetics, Biological membranes, Principles of thermodynamics, free energy. Introduction to enzymes, kinetics, inhibition and regulation, isozymes and ribozymes.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Qualitative and quantitative analysis of biomolecules
2. Preparation of Buffer of given pH and molarity and its pH determination.
3. Colorimetric estimation of blood sugar and serum
4. Enzyme digestion and bioactivity analysis

References:

1. Nelson D.L., Cox M.M., Lehninger Principles of Biochemistry (8e), W.H. Freeman and Company, 2021.
2. Voet D., Voet J.G., Pratt C.W., Fundamentals of Biochemistry: Life at the Molecular Level (5e), John Wiley & Sons, 2019.
3. Srivastava H.S., Elements of Biochemistry (Rev. ed.), Rastogi Publications, 2018.
4. Jain J.L., Jain S., Jain N., Fundamentals of Biochemistry (8e), S. Chand Publishing, 2021.
5. Ninfa A.J., Ballou D.P., Benore M., Fundamental Laboratory Approaches for Biochemistry and Biotechnology (2e), John Wiley & Sons, 2010.

BIO2108: Molecular Biology [2 1 2 4]

Definition and scope of molecular biology, DNA as genetic material, central dogma and overview of genes and genomes. Structure and organization of nucleic acids in prokaryotes and eukaryotes. DNA Replication, transcription and translation in prokaryotes and eukaryotes. Regulation of gene expression.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Isolation of genomic DNA from prokaryotic and eukaryotic cells
2. Quantification of nucleic acids and proteins
3. Gel electrophoresis, staining and visualization
4. Blotting techniques

References:

1. Singh B.D., Biotechnology (3e), Kalyani Publishers, 2014.
2. Gupta P.K., Textbook of Cell and Molecular Biology (4e), Rastogi Publications, 2018.
3. Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P., Molecular Biology of the Cell (7e), Garland Science, 2022.
4. Karp G., Cell and Molecular Biology: Concepts and Experiments (9e), John Wiley & Sons, 2021.
5. Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., Scott M.P., Molecular Cell Biology (9e), W.H. Freeman and Company, 2021.

BIO2109: Genetics [3 1 0 4]

History and scope of Genetics, terminology used in genetics. Mendelian and non Mendelian genetics, chromosome theory. Linkage, crossing over, homologous and nonhomologous recombination, chromosomal mapping. Pedigree analysis. Sex Determination, sex linked, sex limited and sex influenced characters. Intragenic and intergenic interactions. Chromosomal mutations - deletion, duplication, inversion, translocation, aneuploidy and polyploidy. Nuclear DNA content, CoT curve and its significance. Hardy-Weinberg law, gene frequencies and factors affecting gene frequencies.

References:

1. Singh B.D., Fundamentals of Genetics (8e rev.), Kalyani Publishers, 2014.
2. Pandey B.N., Pandey S., Cytology, Genetics and Molecular Genetics (Rev. ed.), Tata McGraw-Hill

Education, 2018.
3. Strickberger M.W., Genetics (5e), Pearson Education, 2012.
4. Snustad D.P., Simmons M.J., Principles of Genetics (6e), John Wiley & Sons, 2016.
5. Pierce B.A., Genetics: A Conceptual Approach (7e), W.H. Freeman and Company, 2023.

CHY2170: Scientific Writing [2 0 0 2]

Introduction to scientific communication and ethics in writing. Structure of scientific documents, abstracts, research papers, review articles, thesis, and project reports. Literature survey techniques and use of scientific databases. Referencing styles, citations, plagiarism, and use of reference management tools. Basics of data presentation, tables, graphs, figures, and captions. Writing laboratory reports and short scientific articles. Seminar skills, topic selection, preparation of seminar presentations, use of audio-visual aids, poster presentation, and effective oral communication. Group discussion, question handling, and peer evaluation.

References:

1. Alley M., The Craft of Scientific Writing (4e), Springer, 2018.
2. Parks L.C., Scientific Writing: A Reader and Writer's Guide, Wiley, 2010.
3. Gastel B., Day R.A., How to Write and Publish a Scientific Paper (8e), Cambridge University Press, 2016.
4. Pechenik J.A., A Short Guide to Writing About Biology (9e), Pearson, 2016.

CHY2121: General Chemistry [2 1 0 3]

Introduction to stereochemistry; Conformational analysis of open chain systems; Conformational analysis of cyclic systems; Symmetry elements, Point group analysis; Stereochemical conventions; Stereogenicity, Topicity; Stereochemical reactions; Reactions involving stereo centres; Aromaticity, Aromatic stabilization energy, Hückel MO, Polycyclic aromatic hydrocarbon (PAH), Polyacenes, Annulene; Aromatic Electrophilic substitutions; Aromatic Nucleophilic substitutions; Reaction dynamics, Hammond postulate; Linear free energy relationship, Hammett equation; Carbocation: Generation, Structure and Geometry, Stabilization of carbocation, Reactions of Carbocation; Carbanions: pKa and its significance; Hard and Soft Acid and Base principle; Structure, Formation, Stability, Reactivity; Free radical: Formation, Structure, Stability, Reactivity; Carbene, Nitrene: Generation, Structure, Reactivity.

Basics: Distillation, crystallization, decolourization and crystallization using charcoal, sublimation. Qualitative Analysis: Identification, functional group analysis, melting point, preparation of derivatives.

References:

1. Solomons T.W.G., Fryhle C.B., Organic Chemistry (10e), John Wiley & Sons, 2010.
2. Sykes P., A Guidebook to Mechanism in Organic Chemistry (6e), Pearson India, 2003.
3. Nad A.K., Mahapatra B., Ghoshal A., An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

PHY2140: Basic Instrumentation Skills [2 1 0 3]

Basics of measurements, screw gauge, vernier calipers, travelling microscope, optical labelling, mechanical labelling, instruments accuracy, errors in measurements. Multimeter, measurement of DC and AC voltage current, electronic voltmeter, advantage over conventional multimeter, principles of voltage measurement (block diagram only), specifications of an electronic voltmeter/multimeter. Ac millivoltmeter, type of AC millivoltmeter, amplifier-rectifier, and rectifier-amplifier. Cathode ray oscilloscope, block diagram, construction and working principle. Signal generators and analysis instruments, block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. Impedance bridges & Q-meters, block diagram of bridge, working principles of basic, RLC bridge, block diagram and working principles of a Q-meter, digital LCR bridges. Digital instruments, principle and working of digital meters, comparison of analog and digital instruments. Digital multimeter, block diagram and working of a digital multimeter. Hands on training, cro as a versatile measuring device, use of digital multimeter/VTVM for measuring voltages, circuit tracing of laboratory electronic equipment, winding a coil/transformer, troubleshooting a circuit, balancing of bridges. Brief idea about instrumentation of the various spectroscopic techniques, uv-vis spectroscopy, IR, and FTIR spectroscopy.

References:

1. Theraja B.L., Theraja A.K., A Textbook of Electrical Technology, S. Chand Publishing, 2010.
2. Venugopal K.R., Digital Circuits and Systems, Tata McGraw-Hill, 2011.

3. Ghoshal S., Digital Electronics, Cengage Learning India, 2012.
4. Salivahanan S., Kumar N.S., Electronic Devices and Circuits (3e), Tata McGraw-Hill, 2012.
5. Tietze U., Schenk C., Electronic Circuits: Handbook of Design and Applications, Springer, 2008.

FOURTH SEMESTER

BIO2207: Immunology [2 1 2 4]

General concepts of immunity, organs of immune system, cells of immune system, components of innate immunity. Adaptive immune response, humoral and cellular immunity. Properties and types of antigen, epitope. Antibody structure, function and properties, polyclonal and monoclonal antibodies, Immunotechniques. Principles of immunization - Active immunity and passive immunity. Vaccines and their types, routes of immunization, adjuvants. Immune disorders and immunodeficiency disorders.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Preparation and staining of peripheral blood smear
2. Estimation of differential white blood cell count
3. Antibody identification and quantification
4. Ouchterlony double immunodiffusion test for antigen-antibody patterns
5. Dot ELISA and sandwich ELISA

References:

1. Owen J.A., Punt J., Stranford S.A., Kuby Immunology (9e), W.H. Freeman and Company, 2023.
2. Kindt T.J., Goldsby R.A., Osborne B.A., Kuby J., Kuby Immunology (8e), W.H. Freeman and Company, 2018.
3. Parham P., The Immune System (5e), Garland Science, 2020.
4. Abbas A.K., Lichtman A.H., Basic Immunology: Functions and Disorders of the Immune System (6e), Elsevier, 2019.
5. Janeway C.A., Walport M., Shlomchik M.J., Immunobiology: The Immune System in Health and Disease (9e), Garland Science, 2022.

BIO2208: Recombinant DNA Technology and Forensics [2 1 2 4]

Milestones in genetic engineering and biotechnology, tools of recombinant DNA technology. Restriction modification systems. Cloning vectors, methods of gene delivery. Genetically engineered organisms case studies. Amplification of nucleic acids. Fundamentals of forensic science and its role in crime investigation and law, toxicology, ethics and professional responsibilities.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Isolation of genomic DNA from prokaryotic and eukaryotic cells
2. Digestion and ligation of DNA using enzymes
3. PCR amplification of DNA
4. Preparation of competent cell
5. Ligation of DNA fragments
6. Transformation and gene cloning

References:

1. Brown T.A., Gene Cloning and DNA Analysis: An Introduction (7e), Wiley-Blackwell, 2016.
2. Primrose S.B., Twyman R.M., Principles of Gene Manipulation and Genomics (7e), Blackwell Publishing, 2006.
3. Glick B.R., Pasternak J.J., Patten C.L., Molecular Biotechnology: Principles and Applications of Recombinant DNA (4e), ASM Press, 2010.
4. Sambrook J., Russell D.W., Molecular Cloning: A Laboratory Manual (3e), Cold Spring Harbor Laboratory Press, 2001.
5. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R., Molecular Biology of the Gene (7e), Pearson Education, 2014.

BIO2220: Bioanalytical Techniques [2 1 2 4]

Microscopy and applications of microscopes, pH scale and measurement of pH, Colorimetery,

Electrophoresis, Spectroscopy and law of absorption (Beer-Lambert's law), Chromatography, Centrifugation, Autoradiography, Mass Spectrometry, NMR.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Preparation of buffers for molecular and biochemical analyses
2. Determination of Lamda-Max and validation of Beer-Lambert's law
3. Separation of amino acids by thin layer chromatography
4. Demonstrations of HPLC, Size-exclusion chromatography
5. Demonstration of Mass Spectrometry (GC MS)

References:

1. Hoffmann A., Walker J.M., Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8e), Cambridge University Press, 2018.
2. Skoog D.A., Holler F.J., Crouch S.R., Principles of Instrumental Analysis (7e), Cengage Learning, 2018.
3. Basha M., Analytical Techniques in Biochemistry, Springer Nature, 2020.
4. Ghatak K.L., Techniques and Methods in Biology, PHI Learning Pvt. Ltd., 2015.
5. Rana S.V.S., Biotechniques: Theory and Practice, Rastogi Publications, 2007.
6. Boyer R.F., Modern Experimental Biochemistry (3e), Pearson Benjamin Cummings, 2005.

BIO2209: Animal Cell Culture [2 1 2 4]

Animal cell cultures and cell lines, cell culture environment, characteristics of cell lines, safety measures, maintenance and preservation of cell cultures, culture media, culture types, of cultured animal cells, cytotoxicity assessment, developing animal models from cell culture and applications of animal cell culture.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Orientation to animal cell culture laboratory: CO_2 incubator, inverted microscope, biosafety cabinet
2. Cleaning, UV sterilization, handling of biohazard waste
3. Preparation of cell culture media
4. Cell lines, culture conditions and maintenance
5. Observation of cell morphology

References:

1. Bhatia S.C., Textbook of Biotechnology, Atlantic Publishers and Distributors, 2006.
2. Chakravarty A.K., Introduction to Biotechnology, Oxford University Press (India), 2013.
3. Pelczar M.J., Chan E.C.S., Krieg N.R., Microbiology (5e), McGraw Hill Education India, 2023.
4. Thieman W.J., Palladino M.A., Introduction to Biotechnology (4e), Pearson (Benjamin Cummings), 2019.

BIO2290: Project Based Learning – I [0 0 4 2]

Students will undertake a short-term, curriculum-aligned project within the department under faculty supervision.

PHY2240: Scientific Translation and Linguistic Competence [2 0 0 2]

Basics of Linguistic Competence: Nature and functions of language, Parts of speech and sentence patterns, Tenses, voice, and reported speech, Common grammatical errors, Academic and scientific vocabulary. Introduction to Translation: Meaning, scope, and importance of translation, Types of translation: literal, free, communicative, technical, Concept of equivalence and fidelity, Problems and limitations of translation, Translation ethics and accuracy, Applied Translation Practice: Translation of general prose (English ↔ Indian language), Translation of academic and basic scientific texts, Terminology, collocations, and expressions, Cohesion, coherence, and tone, Editing and proofreading translated texts. Scientific and Professional Communication: Reading and interpreting scientific passages, Summarizing and paraphrasing, translating instructions, reports, and abstracts, Oral interpretation and short presentations, writing emails, reports, and short technical notes. Pedagogy: Interactive and participatory lectures, Activity-based translation practice, Group discussions and collaborative learning, Experiential learning through real academic/scientific texts, Continuous formative assessment

References:

1. Newmark P., A Textbook of Translation (1e), Prentice-Hall International, 1988.
2. Baker M., In Other Words: A Coursebook on Translation (3e), Routledge, 2018.
3. Thomson A.J., Martinet A.V., A Practical English Grammar (4e), Oxford University Press, 1986.
4. Murphy R., English Grammar in Use (5e), Cambridge University Press, 2019.
5. Day R.A., Gastel B., How to Write and Publish a Scientific Paper (7e), Cambridge University Press, 2012.

FIFTH SEMESTER

BIO3120: Environmental Biotechnology [2 1 2 4]

Introduction, bioremediation of hydrocarbons, pesticides, industrial wastewater, contaminated ground water and soil metals, molecular techniques in bioremediation. Pollution types and its biological control, bioleaching and biomining, microbial degradation of xenobiotic. Bio-assessment of environmental quality. Biofertilizers, biopesticides and biofuel.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Introduction to Environmental Biotechnology Laboratory
2. Bioremediation processes
3. Slurry and groundwater bioremediation
4. Biodegradation of pesticides and heavy metals
5. Industrial wastewater treatment
6. Bioassessment of environmental quality

References:

1. Evans E., Furlong J.C., Environmental Biotechnology: Theory and Application, John Wiley & Sons, 2012.
2. Bhattacharya B.C., Banerjee R., Environmental Biotechnology, Oxford University Press, 2007.
3. Jordening H.J., Winter J., Environmental Biotechnology: Concepts and Application, Wiley-VCH Verlag, 2005.
4. Rittmann B.E., McCarty P.L., Environmental Biotechnology: Principles and Applications, McGraw-Hill, 2012.

BIO3121: Plant Tissue Culture [2 1 2 4]

Introduction and history, totipotency, methods of sterilization, nutrient media components and types. Tissue culture methodologies, hardening and acclimatization. Somatic embryogenesis and androgenic haploids. Clonal fidelity and somaclonal variations. Secondary metabolite production in tissue culture, biotransformation and cell suspension cultures. Germplasm conservation and cryopreservation. Applications of plant tissue culture.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Preparation of plant tissue culture media.
2. Sterilization of culture media, explants and glassware.
3. Initiation of callus culture, elongation and multiplication.
4. Micropropagation, organogenesis and somatic embryogenesis.
5. Initiation of cultures for secondary metabolite production.

References:

1. Razdan M.K., An Introduction to Plant Tissue Culture (2e), Oxford & IBH Publishing Co. Pvt. Ltd., 2005.
2. Chawla H.S., Introduction to Plant Biotechnology (3e), Science Publishers, 2012.
3. Bhojwani S.S., Razdan M.K., Plant Tissue Culture: Theory and Practice (Revised ed.), Elsevier, 2013.
4. Purohit S.D., Introduction to Plant Cell, Tissue and Organ Culture, PHI Learning Pvt. Ltd., 2013.
5. Gamborg O.L., Phillips G.C., Plant Cell, Tissue and Organ Culture: Fundamental Methods, Springer-Verlag, 1998.
6. Narayanaswamy S., Plant Cell and Tissue Culture, Tata McGraw-Hill Publishing Company, 2008.

BIO3107: Medical Biotechnology [2 1 2 4]

Introduction, pharmaceuticals, biopharmaceuticals, and therapeutic proteins, vaccines and monoclonal antibodies,. Common techniques - PCR, fluorescence *in situ* hybridization, DNA sequencing, interference

RNA, genome editing (CRISPR), Emerging trends in medical biotechnology, stem cell therapy, gene therapy, biomarker based drug discovery and toxicology. Role of animal models in medical biotechnology and ethical issues.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. PCR amplification of DNA
2. Detection of SNPs using PCR-RFLP analysis
3. Mismatch match amplification PCR assay
4. Demonstration of rare mutation detection by digital PCR
5. Reporter gene assays
6. Transformation of eukaryotic cells (by electroporation)
7. Demonstration of gene knockdown by siRNA
8. Recombinant protein analysis

References:

1. Murray U.B., Mohr S., Klose J., Lehmann J., Medical Biotechnology (2e), Wiley-Blackwell, 2014.
2. Walsh G., Biopharmaceuticals: Biochemistry and Biotechnology (3e), Wiley-Blackwell, 2018.
3. Glick B.R., Pasternak J.J., Patten C.L., Molecular Biotechnology: Principles and Applications of Recombinant DNA (5e), ASM Press, 2018.
4. Thieman W.J., Palladino M.A., Introduction to Biotechnology (4e), Pearson Education, 2019.
5. Brown T.A., Gene Cloning and DNA Analysis: An Introduction (7e), Wiley-Blackwell, 2016.

BIO3122: Ethical Issue and IPR [3 1 0 4]

Classification and importance of Intellectual property rights, concepts and principles, rights of patents, infringement of patent rights, ethical issues, plagiarism. Rules, regulations and requirements for development of genetically modified organisms. biosafety and biological warfare.

References:

1. Fleming D.O., Hunt D.L., Biological Safety: Principles and Practices, American Society for Microbiology, 2006.
2. Shannon T.A., An Introduction to Bioethics, Paulist Press, 2009.
3. Rockman H.B., Intellectual Property Law for Engineers and Scientists, Wiley-IEEE Press, 2004.
4. Vaughn L., Bioethics: Principles, Issues, and Cases, Oxford University Press, 2009.
5. World Health Organization (WHO), Laboratory Biosafety Manual, World Health Organization, 2005.

BIO3190: GLP and Biosafety [3 1 0 4]

Introduction to GLP and laboratory ethics, overview of GLP guidelines, laboratory safety rules and emergency preparedness, biosafety levels (BSL-1 to BSL-4) and containment strategies, handling and storage of chemicals and reagents, laboratory notebooks and electronic data management, data integrity, traceability, and record retention.

References:

1. Fleming D.O., Hunt D.L., Biological Safety: Principles and Practices, American Society for Microbiology, 2006.
2. Shannon T.A., An Introduction to Bioethics, Paulist Press, 2009.
3. Rockman H.B., Intellectual Property Law for Engineers and Scientists, Wiley-IEEE Press, 2004.
4. Vaughn L., Bioethics: Principles, Issues, and Cases, Oxford University Press, 2009.
5. World Health Organization (WHO), Laboratory Biosafety Manual, World Health Organization, 2005.

SIXTH SEMESTER

BIO3207: Industrial Biotechnology [3 1 0 4]

Principles of fermentation technology, fermentation media and sterilization techniques, factors affecting fermentation process. Types of fermenters and their control. Microbial fermentation and its applications in industry. Microbial process for immunization and production of monoclonal antibodies.

References:

1. Casida J., Industrial Microbiology, New Age International Pvt. Ltd., 2006.
2. Prescott S.C., Dunn C.G., Industrial Microbiology, Agrobios (India) Pvt. Ltd., 2004.

3. Murray M., Comprehensive Biotechnology, Pergamon, 2007.
4. Cruger W., Cruger A., Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2008.

BIO3220: Organic Farming [2 1 2 4]

Principles of organic agriculture, organic vs conventional farming. Soil health and nutrient management, composting and biofertilizers. Crop rotation and intercropping, cover cropping and mulching, organic seed production and selection. Water management in organic farming, Biological pest and weed management. Organic certification process and guidelines, economics of organic farming.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Basic soil analysis and evaluation of organic inputs
2. Determination of soil pH, organic carbon, and major nutrients (N, P, K)
3. Bioassay test using organic manure extracts
4. Preparation of herbarium sheets
5. Documentation and analysis of traditional plant use (basic qualitative/quantitative methods).

Reference:

1. Lampkin N., Organic Farming, Old Pond Publishing, 2002.
2. FAO, Organic Agriculture: What It Is and Why It Matters, Food and Agriculture Organization of the United Nations, 2018.
3. Palekar S., The Philosophy of Spiritual Farming, Zero Budget Natural Farming Research Centre, 2016.
4. Thakur D.S., Sharma K.D., Organic Farming, Kalyani Publishers, 2005.

BIO3208: Bioinformatics [2 1 2 4]

Bioinformatics background, scope and application of bioinformatics, genome organization and genome sequencing projects. Gene, protein, and structural databases. Data acquisition and sequence alignment, phylogenetic trees and dendrograms. Structural bioinformatics and drug discovery.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Information retrieval- referring journals, PubMed & Medline
2. Retrieving nucleotide and protein sequences from database
3. Restriction cut site analysis of given DNA sequence
4. Translation of a nucleotide sequence to a protein sequence
5. Searching for open reading frames in the DNA sequence
6. Prediction of the presence of signal peptides in given protein sequence
7. Designing primers for the given gene sequences for PCR assay
8. Searching for homologs using BLAST program
9. Performing multiple sequence alignment using suitable tool
10. Generating phylogenetic tree using suitable tool
11. Browsing genome database
12. Basic principles of 'R' software for tabulation and graphical representations

References:

1. Attwood T.K., Smith P., Introduction to Bioinformatics, Pearson Education, 2004.
2. Rastogi S.C., Mendairatta N., Rastogi P., Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery), Prentice Hall India Pvt. Ltd., 2008.
3. Subramanian C., A Textbook of Bioinformatics, Dominant Publishers, 2015.
4. Pennington S., Dunn M.J., Proteomics: From Protein Sequences to Function, Viva Books Publishers, 2002.
5. Mount D.H., Bioinformatics, CBS Publishers, 2005.

BIO3209: Nano Biotechnology [2 1 2 4]

Fundamentals of nanobiotechnology, physical, chemical, optical, and biological properties at the nanoscale, interactions between nanomaterials and biological systems. Nanomaterials and their synthesis and functionalization. Characterization of nanomaterials. Bioconjugation techniques,

biocompatibility, cytotoxicity, stability, and biodegradation of nanomaterials. Applications of nanotechnology, nanotoxicology. Future trends in nanobiotechnology.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Synthesis of nanoparticles using chemical or biological methods
2. Characterization of nanoparticles using basic analytical techniques
3. Demonstration of nanoparticle functionalization
4. Preparation and testing of nano-based biosensor models
5. Case studies on nano-drug delivery systems
6. Evaluation of nanomaterial–biological interactions through simulations or demonstrations

References:

1. Niemeyer C.M., Mirkin C.A., Nanobiotechnology: Concepts, Applications and Perspectives (2e), Wiley-VCH, 2020.
2. Goodsell D.S., Bionanotechnology: Lessons from Nature (2e), Wiley, 2021.
3. Yadav B.C., Nanobiotechnology, CRC Press, 2021.
4. Mahapatra A.K., Introduction to Nanoscience and Nanotechnology, McGraw-Hill Education, 2022.
5. Bhushan B., Springer Handbook of Nanotechnology (5e), Springer, 2023.
6. Cao G., Wang Y., Nanostructures and Nanomaterials: Synthesis, Properties and Applications (2e), World Scientific, 2021.
7. Poole C.P., Owens F.J., Introduction to Nanotechnology (2e), Wiley, 2017.

BIO3290: Project Based Learning – II [0 0 8 4]

Students will undertake a short-term, curriculum-aligned project within the department under faculty supervision.

SEVENTH SEMESTER

BIO4120: Omics Technology [3 1 0 4]

Genome projects, genome markers and mapping, genome sequencing, public sequence databases, genome annotation, gene prediction & gene modeling, structural and functional genomics. Gene ontology, GO/KEGG browsers and editors, protein interaction related tools, statistical analysis, term enrichment tools. Organization of proteome, experimental techniques in proteomics.

References:

1. Pevsner J., Bioinformatics and Functional Genomics (4e), Wiley-Blackwell, 2021.
2. Lesk A.M., Introduction to Bioinformatics (5e), Oxford University Press, 2023.
3. Mount D.W., Bioinformatics: Sequence and Genome Analysis (3e), Cold Spring Harbor Laboratory Press, 2023.
4. Singh R., Bioinformatics: Genomics and Proteomics, 2014.

BIO4107: Biostatistics [2 1 2 4]

Introduction, types of data and variables, classification of biological data. Measures of central tendency and dispersion and their applications. Probability, additive rule, multiplicative rule, conditional probability, Bayes theorem. Random variable and probability distribution, Binomial distribution, Poisson distribution, Normal Distribution. Correlation and regression, regression coefficients. Hypothesis and its testing.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Graphical representation of biological data
2. Calculating measures of central tendency: mean, mode, median, range
3. Measures of dispersion: standard deviation, mean deviation, co-efficient of variations, correlation, regression
4. Student's t- test (Unpaired and paired t test)
5. Chi-square test of association
6. ANOVA

References:

1. Sharma A.K., Textbook of Biostatistics I, Discovery Publishing House, 2005.

2. Mahajan B.K., Methods in Biostatistics, Jaypee Brothers Publishers, 2002.
3. Agarwal B.L., Basic Statistics, New Age International, 2006.
4. Pandey M., Biostatistics: Basic and Advanced, MV Learning, 2015.
5. Irfan A.K., Khanum A., Khan S., Fundamentals of Biostatistics (5e).
6. Kanji G.K., 100 Statistical Tests (3e), SAGE Publications, 2006.

BIO4121: Bioenergy And Bioresource Technology [3 1 0 4]

Introduction, definition, classification, and importance of bioresources, renewable vs. non-renewable resources, concept of sustainability and circular bioeconomy. Concept, scope, and significance of bioenergy. Types of biofuels, energy crops and biomass productivity, Liquid biofuels: Bioethanol, biobutanol and biodiesel. Gaseous biofuels: biogas, biohydrogen, lignocellulosic biomass conversion. Microalgal biofuels and fuel cells. Waste valorization and resource recovery, life cycle assessment (LCA) basics.

References:

1. Demirbas A., Biofuels: Securing the Planet's Future Energy Needs, Springer, 2009.
2. Klass D.L., Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, 1998.
3. Lee J.W. (ed.), Advanced Biofuels and Bioproducts, Springer, 2013.
4. Pandey A., Larroche C., Ricke S.C., Dussap C.G., Gnansounou E. (eds.), Biofuels: Alternative Feedstocks and Conversion Processes, Elsevier, 2011.
5. Brown R.C., Biorenewable Resources: Engineering New Products from Agriculture (2e), Wiley-Blackwell, 2011.

BIO4122: Model Systems in Biological Research [2 1 2 4]

Concept of model system in biomedical research, characteristics of a model system. *Escherichia coli, Drosophila melanogaster, Danio rerio, Mus musculus*. Fundamental discoveries made so far using these organisms, Generation and application of knock out and transgenic mice as disease models. Knockout database.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Preparation of Drosophila culture medium, maintenance of Drosophila.
2. Identification of male and female *Drosophila*
3. Study of different stages of the life cycle of Drosophila, male and female, differentiation.
4. Preparation of competent cell *(E. coli)* and cloning
5. Zebrafish maintenance, identification of developmental stages and applications

References:

1. Conn P.M., Models for the Study of Human Disease (1e), Academic Press, 2013.
2. Freshney R.I., Culture of Animal Cells: A Manual of Basic Techniques and Specialized Application (6e), Wiley-Liss Inc., 2011.
3. Ashburner M., Golic K., Hawley R.C., *Drosophila*: A Laboratory Handbook (2e), Cold Spring Harbor Laboratory, 2005.
4. Westerfield M., The Zebrafish Book: A Guide for the Laboratory Use of Zebrafish (*Danio rerio*) (5e), University of Oregon Press, 2007.

BIO4190: Project Based Learning – III [0 0 8 4]

Students will undertake a short-term, curriculum-aligned project within the department under faculty supervision.

EIGHTH SEMESTER

BIO4270: Major Project [0 0 24 12]

Each student shall undertake a major research project of six months' duration, either within the department/institution (in-house) or at a recognized external organization, research institute, industry, or laboratory. The project shall involve independent experimental, computational, or analytical work related to the core or allied areas of the programme.

BIO4220: Functional Foods and Nutraceuticals [4 0 0 4]

Introduction to functional foods and probiotics and nutraceuticals, classification of probiotics and nutraceuticals, functional foods vs nutraceuticals, Probiotics and Nutraceuticals: sources, vitamins, minerals, fatty acids, antioxidants, polyphenols, role in lifestyle disorder, immunity and aging, probiotics formulation, safety, and regulatory aspects, emerging trends and applications

References:

1. Sanders M.E., Merenstein D.J., Reid G., Gibson G.R., Rastall R.A., Probiotics and Prebiotics in Human Nutrition, CRC Press, 2019.
2. Rishi R.K., Nutraceuticals: Efficacy, Safety and Toxicity, Academic Press, 2016.
3. Ghosh D., Nutraceuticals and Functional Foods in Human Health and Disease Prevention, CRC Press, 2012.
4. Guarner F., Malagelada J.R., Gut Flora in Health and Disease, The Lancet, 2003.

BIO4280: Bioprocess Technology [2 12 4]

Overview and types of bioprocesses, upstream processing, environmental and nutritional factors affecting production, process optimization strategies, bioreactors and process control, scale-up and scale-down considerations. Downstream processing, product formulation and quality control, industrial applications.

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Preparation and sterilization of culture media
2. Determination of microbial growth curve
3. Estimation of biomass and product yield
4. Study of batch fermentation using a laboratory fermenter (demonstration/virtual)
5. Downstream processing: filtration and centrifugation techniques
6. Enzyme assay relevant to industrial bioprocesses

References:

1. Stanbury P.F., Whitaker A., Hall S.J., Principles of Fermentation Technology (3e), Elsevier, 2016.
2. Doran P.M., Bioprocess Engineering Principles (2e), Academic Press, 2013.
3. Crueger W., Crueger A., Biotechnology: A Textbook of Industrial Microbiology (2e), Sinauer Associates, 2000.
4. Moo-Young M. (ed.), Comprehensive Biotechnology (2e), Elsevier, 2011.

BIO4281: Waste Management [3 1 0 4]

Definition, scope, and importance of waste management, Types of waste. Solid and E-waste management, biological and sustainable waste treatment, role of microorganisms in waste degradation, anaerobic digestion and biogas production, phytoremediation and bioaugmentation, waste-to-energy technologies, circular economy and zero-waste concepts, policies and regulations.

References:

1. Tchobanoglous G., Theisen H., Vigil S., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill, 1993.
2. Peavy H.S., Rowland D.R., Tchobanoglous G., Environmental Engineering, McGraw-Hill, 1985.
3. LaGrega M.D., Buckingham P.L., Evans J.C., Hazardous Waste Management (2e), Waveland Press, 2010.
4. Kumar S., Integrated Waste Management, InTech, 2016.

BIO4282: Microbial Diagnostics [2 1 2 4]

Introduction to microbial diagnostics, classification of infectious agents, host–pathogen interactions, conventional diagnostic methods, transport and storage of specimens, microscopy techniques, staining methods, biochemical and immunological techniques for microbial identification, serological tests, antigen-antibody reactions in diagnostics, molecular and advanced diagnostic techniques, sequencing and genotyping, biosensors and point-of-care diagnostics, quality control and biosafety

Practicals:

(Principles and concepts will be reinforced through a combination of wet lab experiments and complementary learning tools such as virtual labs, simulations, videos, and interactive media)

1. Sterilization techniques and laboratory safety practices
2. Preparation of culture media and staining reagents

3. Gram staining and acid-fast staining
4. Isolation and identification of bacteria using biochemical tests
5. Antibiotic susceptibility testing
6. Demonstration of ELISA / rapid diagnostic tests
7. Demonstration of PCR-based diagnostics

References:

1. Forbes B.A., Sahm D.F., Weissfeld A.S., Bailey & Scott's Diagnostic Microbiology (13e), Elsevier, 2014.
2. Tille P., Bailey & Scott's Diagnostic Microbiology (14e), Elsevier, 2017.
3. Murray P.R., Rosenthal K.S., Pfaller M.A., Medical Microbiology (9e), Elsevier, 2021.
4. Winn W., Allen S., Janda W., Koneman E., Procop G., Schreckenberger P., Woods G., Koneman's Color Atlas and Textbook of Diagnostic Microbiology (7e), Lippincott Williams & Wilkins, 2017.