

B.Sc. HONOURS BIOTECHNOLOGY

SEMESTER 1

Sl. No	Course Code	Course Title	L T P	Credits
1	25MIC101	INTRODUCTORY BIOLOGY	2 1 0	3
2	25CHY105	CHEMISTRY	3 1 0	4
3	25ENG100	ENGLISH	2 1 0	3
4	25MIC102	INTRODUCTORY MICROBIOLOGY	2 1 0	3
5	25PHY106	PHYSICS	3 1 0	4
6	22ADM101	FOUNDATIONS OF INDIAN HERITAGE	2 0 1	2
7	22AVP103	MASTERY OVER MIND (MAOM)	1 0 2	2
8	25MIC181	INTRODUCTORY MICROBIOLOGY LAB	0 0 4	2
Total Credits				23

SEMESTER 2

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIO112	PRINCIPLES OF ECOLOGY AND EVOLUTION	2 1 0	3
2	25BIO111	BIOCHEMISTRY	2 1 0	3
3	25ENG110	ENGLISH-CREATIVE WRITING & SOFT SKILLS	2 1 0	3
4	25CSA113	INFORMATION SYSTEMS	2 1 0	3
5	25MAT114	MATHEMATICS	3 1 0	4
6	22ADM111	GLIMPSES OF GLORIOUS INDIA	2 0 1	2
7	25PHY184	PHYSICAL SCIENCES LAB	0 0 4	2
8	25BIO181	BIOCHEMISTRY LAB	0 0 4	2
Total Credits				22

SEMESTER 3

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIO201	MOLECULAR BIOLOGY	2 1 0	3
2	25MAT204	BIostatISTICS	2 1 0	3
3	25BIO203	PLANT BIOLOGY	3 1 0	4
4	25BIO205	ANALYTICAL BIOCHEMISTRY	2 1 0	3
5	25MIC202	VIROLOGY	2 1 0	3
6	25BIF201	INTRODUCTORY BIOINFORMATICS	2 1 0	3

7	22ADM201	AMRITA VALUE PROGRAMME I (STRATEGIC LESSONS FROM MAHĀBHĀRATA)	1 0 0	1
8	25MIC281	GENERAL MICROBIOLOGY LAB	0 0 4	2
9	25BIO282	CELL AND MOLECULAR BIOLOGY LAB	0 0 4	2
Total Credits				24

SEMESTER 4

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIO216	HUMAN PHYSIOLOGY	4 0 0	4
2	25BIO211	GENETICS	2 1 0	3
3	25BIO212	IMMUNOLOGY	2 1 0	3
4	25BIO213	ENZYME TECHNOLOGY	2 1 0	3
5	25BIO214	CELL BIOLOGY	2 1 0	3
6	25BIO215	INTRODUCTORY BIOPHYSICS	2 0 0	2
7	25SSK201	SOFT SKILLS- I	0 1 0	1
8	22ADM211	AMRITA VALUE PROGRAMME II (LEADERSHIP FROM RĀMĀYANA)	1 0 0	1
9	25BIO283	IMMUNOLOGY LAB	0 0 4	2
10	25BIO284	ENZYMOMOLOGY LAB	0 0 4	2
Total Credits				24

SEMESTER 5

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIF302	PYTHON FUNDAMENTALS FOR BIOLOGISTS	2 1 0	3
2	25BIO302	OMES AND OMICS	2 1 0	3
3	25BIO303	BIOENERGETICS AND METABOLISM	2 1 0	3
4	25BIO304	INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY	2 1 0	3
5	25BIO300	RESEARCH METHODOLOGY	2 0 0	2
6	25BIO390*	LIVE-IN-LABS*/OPEN ELECTIVE		3
7	25SSK301	SOFTSKILLS - II	0 1 0	1
8	25BIO381	INDUSTRIAL BIOTECHNOLOGY LAB	0 0 4	2
Total Credits				20

SEMESTER 6

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIO311	PHARMACOLOGY	4 0 0	4
2	25BIO312	DEVELOPMENTAL BIOLOGY	2 1 0	3
3	25BIO313	GENETIC ENGINEERING	3 1 0	4
4	25MIC311	PLANT AND ANIMAL TISSUE CULTURE	2 1 0	3
5	25BIF314	ARTIFICIAL INTELLIGENCE FOR BIOLOGY	2 1 0	3
6	25BIO382	GENETIC ENGINEERING LAB	0 0 4	2
7	25MIC381	PLANT AND ANIMAL TISSUE CULTURE LAB	0 0 4	2
Total Credits				21

SEMESTER 7

Sl. No	Course Code	Course Title	L T P	Credits
1	25BIO401	METABOLIC ENGINEERING	2 1 0	3
2	25BIO404	RESEARCH ETHICS, SCIENCE COMMUNICATION AND IPR MANAGEMENT	2 1 0	3
3	25BIO402	APPLIED BIOANALYTICAL METHODS	2 1 0	3
4		ELECTIVE I	3 0 0	3
5	25BIO403	ADVANCED PHARMACEUTICAL BIOSCIENCES	2 1 0	3
6	25BIO481	ADVANCED MOLECULAR GENETICS AND GENE EXPRESSION LAB	0 0 4	2
Total Credits				17

SEMESTER 8

Sl. No	Course Code	Course Title	L T P	Credit
B.Sc. Hons. By Research				
1	25BIO499	PROJECT		12
B.Sc. Hons. (Regular)				
1	25BIO496	MINI PROJECT		6
2		ELECTIVE II	3 0 0	3
3		ELECTIVE III	3 0 0	3
Total Credits				12

Total credits for program completion	163
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ELECTIVES I -SEMESTER 7				
Sl. No	Course Code	Course Title	L T P	Credit
1	25BIO431	EMBRYOLOGY	3 0 0	3
2	25BIO432	HOST-PATHOGEN INTERACTION AND HUMAN MICROBIOME	3 0 0	3
3	25BIO433	MOLECULAR FLUORESCENCE: APPLICATIONS IN CHEMICAL BIOLOGY	3 0 0	3
ELECTIVES II & III-SEMESTER 8				
Sl. No	Course Code	Course Title	L T P	Credit
1	25BIO441	CANCER BIOLOGY	3 0 0	3
2	25BIO442	PHAGE BIOLOGY	3 0 0	3
3	25BIO443	CELL SIGNALLING	3 0 0	3
4	25BIO444	BIOMIMICRY	3 0 0	3
5	25BIO445	NEUROSCIENCE	3 0 0	3
6	25BIO446	REGENERATIVE BIOLOGY & STEM CELLS	3 0 0	3

SYLLABUS

SEMESTER 1

25MIC101

INTRODUCTORY BIOLOGY

2 1 0 3

LEARNING OBJECTIVES:

The course introduces the principles of molecular biology, cell biology, genetics, evolution, basics of cell structure and function, importance of cytoskeleton remodelling and their role in disease conditions.

SYLLABUS:

Unit 1

Themes in the Study of Life - Adaptations-Physical, Behavioural. Physical- Types of Camouflage- Cryptic Coloration, Disruptive colouration, Mimicry, Counter shading, importance of biochromes in camouflage; Behavioural adaptation: Hibernation, Migration; Biodiversity: Phylogeny and the Tree of Life, Bacteria and Archaea, Protists, Plant Diversity, Fungi, Animal Diversity, Beauty & Utility of Biodiversity in Sustainable Development

Unit 2

Transmission of genetic information- Unity in Diversity at Cellular, Sub-cellular, Molecular Levels: The Composition of Cells, Cell Metabolism, Fundamentals & Central Dogma of Molecular Biology, Expression and Transmission of Genetic Information-Structure of chromosomes, genes, alleles, Types of chromosomes, Scientific Inquiry: Making Observations & Testing Hypotheses.

Unit 3

Structure and function of cell - Fundamentals of Cell Theory, Cell Organelles- Nucleus, Endoplasmic Reticulum, Golgi Apparatus, Mitochondria, Chloroplast, Lysosome & Peroxisome.

Unit 4

Cytoskeleton - Structure and Organization of Microfilaments, Microtubules and Intermediate Filaments, Cell Movement, Motor Proteins.

Unit 5

Extracellular Matrix - Plasma membrane & Transport, Cell Wall, ECM, Cell-Cell Interactions, Cell-Matrix interactions

REFERENCES:

1. *Campbell Biology* – 12th Edition - Lisa A. Urry, Michael L. Cain, Las Cruces, Steven A. Wasserman, Peter V. Minorsky, Rebecca Orr, Pearson (2021).
2. *The Cell: A Molecular Approach* 8e, by Geoffrey M. Cooper. Sinauer Associates, Inc.
3. *Molecular Biology of the Cell*. Alberts B. et al., (2008) 5th edition. Garland Science.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basics of evolution, diversity of life, transmission of genetic information, framing and testing hypothesis.

CO2: Explain the concepts of cell theory, the structure of different cell organelles and their function.

CO3: Understand the formation and function of cytoskeletal elements like microfilaments, intermediate filaments and microtubules, cell movement and extracellular matrix.

LEARNING OBJECTIVES:

The main objective of the course is to make the students understand the basic theories, laws and mechanisms of chemistry and further to make them prolific in extending this basic knowledge into the understanding and development of the biochemistry and related interdisciplinary fields.

SYLLABUS:**Unit 1****Solutions**

Concentration Units, Principles of Solubility, Colligative Properties of Nonelectrolytes, Colligative Properties of Electrolytes

Rate of Reaction

Reaction Rate, Reaction Rate and Concentration, Reactant Concentration and Time, Models for Reaction Rate, Reaction Rate and Temperature, Catalysis, Reaction Mechanisms

Unit 2**Gaseous Chemical Equilibrium**

The $\text{N}_2\text{O}_4\text{--NO}_2$ Equilibrium System, The Equilibrium Constant Expression, Determination of K, Applications of the Equilibrium Constant, Effect of Changes in Conditions on an Equilibrium System

Acids and Bases

Bronsted-Lowry Acid-Base Model, The Ion Product of Water, pH and pOH, Weak Acids and Their Equilibrium Constants, Weak Bases and Their Equilibrium Constants, Acid-Base Properties of Salt Solutions, Extending the Concept of Acids and Bases: The Lewis Model

Equilibria in Acid-Base Solutions

Buffers, Acid-Base Indicators, Acid-Base Titrations

Unit 3**Complex Ion and Precipitation Equilibria**

Complex Ion Equilibria; Formation Constant (K_f), Solubility, Solubility Product Constant (K_{sp}), Precipitate Formation, Dissolving Precipitates

Spontaneity of Reaction

Spontaneous Processes, Entropy S, Free Energy G, Standard Free Energy Change ΔG , Effect of Temperature, Pressure, and Concentration on Reaction Spontaneity, The Free Energy Change and the Equilibrium Constant

Unit 4**Electrochemistry**

Voltaic Cells, Standard Voltages, Relations Between E° , ΔG° , and K, Effect of Concentration on Voltage, Electrolytic Cells, Commercial Cells

Complex Ions

Composition of Complex Ions, Naming Complex Ions and Coordination Compounds, Geometry of Complex Ions, Electronic Structure of Complex Ions

Unit 5**Organic Chemistry**

Saturated Hydrocarbons: Alkanes, Unsaturated Hydrocarbons: Alkenes and Alkynes, Aromatic Hydrocarbons and Their Derivatives, Functional Groups, Isomerism in Organic Compounds, Organic Reactions, Heterocyclic chemistry

REFERENCES:

1. *Chemistry*, Raymond Chang, McGraw-Hill; 10th Edition (2007).
2. *Organic chemistry* Solomons & Fryhle, John Wiley (Wse); 8th Edition (2004).
3. *Physical Chemistry*, Atkins & de Paula, Oxford; 9th Edition (2010)

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recall the fundamental concepts of chemistry to predict the structure, properties and bonding of engineering materials

CO2: Understand the principle of electrochemistry/photochemistry and applications of various energy storage systems

CO3: Explain the crystal structure, defects, and free electron theory.

CO4: Demonstrate the mechanism and application of conductive polymers in various electronic devices.

25ENG100

ENGLISH

2 1 0 3

LEARNING OBJECTIVES:

To provide the students with an ability to build and enrich their communication skills. To make them familiar with different types of communication. To understand the barriers to effective communication. Engage students in meaningful communication through effective tasks. Identify the basic principles of communication. Analyze the various types of communication. Make use of the essential principles of communication. 8. Identify the prominent methods and models of Communication.

SYLLABUS:

Unit 1

Introduction to language aspects-LSRW Skills, English as Second Language, Developing the essential skills of English

Unit 2

A selection in poetry

To daffodils (Robert Herrick), Yussouf (J R Lowell), Ozymandias (P B Shelley), The slave's dream (H W Longfellow), The Ballad of Father Giligan (WB Yeats), Elegy (extract) (Thomas Gray), The Fly (William Blake).

Unit-3

Language practice (Basic grammatical categories for communication)

Parts of speech, Determiners, Modal auxiliaries, Tenses, Phrasal verbs, Connectors expressing purpose, means, cause and effect, comparison and contrast, Concord of number, person, gender, pronoun and antecedent, Voice: Impersonal passive, Modifiers, Nominal compounds, Abbreviations and acronyms, Spelling and Affixation, Punctuation

Unit 4

Language lab, activities related to improving English, Language games

Unit 5

Presentation of skit

REFERENCES:

1. Doff, Adrian and Christopher Jones. *Language in Use. Upper Intermediate*. CUP, 1999.
2. Grellet, Françoise. *Developing Reading Skills. A Practical Guide to Reading Comprehension Exercises*. CUP, 2003.
3. Hancock, Mark. *English Pronunciation in Use*. CUP, 2003.
4. McCarthy, Michael and Felicity O'Dell. *English Vocabulary in Use (Upper Intermediate)* CUP, 2001.
5. Alexander, Harriet Semmes. *American and British poetry: a guide to the criticism, 1925-1978*. Athens, Ohio: Swallow Press, 1984.
6. *Contemporary poets*. Ed. James Vinson. 5th ed. New York: St. Martin's Press, 1991

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand any text in English listening to the inputs given by the teacher in the classroom.

CO2: Interpret the rules of language unconsciously and tune to deduce language structure and usage.

CO3: Demonstrate face-to-face or telephone conversations on familiar topics containing complex grammatical structures with appropriate word choice or grammatical accuracy

CO4: Use the mechanism of language for success in competitive examinations and job-related speaking and writing tasks.

25MIC102

INTRODUCTORY MICROBIOLOGY

2 1 0 3

LEARNING OBJECTIVES:

A basic course introducing the prokaryotic world with specific reference to the metabolic, physiological, and morphological characteristics of microbes.

SYLLABUS:

Unit 1

Basic Concepts of Microbiology – Spontaneous generation, Germ theory of diseases, Cell theory. Contributions of Antonie van Leeuwenhoek, Joseph Lister, Robert Koch, Louis Pasteur, Edward Jenner, John Tyndall, Sergei N. Winogradsky, Selman A Waksman, Alexander Fleming, Paul Ehrlich, Fannie Hesse, Elie Metchnikoff, Kary Mullis. Development of pure culture methods.

Unit 2

Prokaryotic Cell Ultra-Structure - Peptidoglycan structure and Archaeal cell wall composition, and Acid-fast cell wall. Antibiotics introduction and multidrug resistance crisis. Cytoplasmic matrix and components: Inclusion bodies, Flagella, Pili, Endospores

Unit 3

Microbial Control - Sterilization and disinfection- Definitions, Principles. Methods of sterilization- Physical methods (Heat, Filtration), Radiation, and Chemical Methods. Control of sterilization and testing of sterility.

Unit 4

Concepts of Microscopy – Principles, Light microscope, Phase Contrast, Darkfield, Bright field, Fluorescent, Interference microscope (Stereo microscope), Confocal, Inverted microscope, and Electron microscope (TEM and SEM) and Atomic force microscope. Measurement of Microorganisms- Micrometry. Staining- Simple, Gram staining, Negative staining, Capsule staining, Spore staining, Flagellar staining, Nuclear staining and Acid-fast staining.

Unit 5

Physiology of Microbes - Microbiological media, composition and types: selective and differential media Growth curve and growth kinetics. Influence of environmental factors on microbial growth. Nutritional groups of bacteria: overview Estimation of Microbes- Direct Microscopic count, Turbidometric assay, TVC- Indirect Method- CO₂ liberation- Protein estimation- Maintenance and Preservation of cultures. Determination of decimal reduction time: D value and Z value. Introduction to biofilms

REFERENCES:

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. *Microbiology* 2nd edition Wm, C. Brown publishers.
2. Michael J. Pelczar, Jr. E.C.S. Chan, Moel: *Microbiology*, 7th edition Mc Graw Hill Book R. Krieg, 1986 Company.
3. Stainer R.Y. Ingraham J.L. Wheelis H.H and Painter P.R. 1986 *The Microbial world*, 5th edition. Eagle Works Cliffs N.J. Prentice-Hall.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Retrieve the contributions of pioneers in Microbiology.

CO2: Explain the prokaryotic cell structure and functions.

CO3: Illustrate the concept of microscopy and basic microbiology techniques.

CO4: Understand the basics of microbial nutrition and methods of determining growth curves of bacteria.

25PHY106

PHYSICS

3 1 0 4

LEARNING OBJECTIVES:

The physics course offered to undergraduate students by the School of Biotechnology is a basic course which builds a bridge between physics and Biology. The learning objectives of the course are to develop. Knowledge and ability to use various problem-solving strategies from physics to Biology. Ability to justify and explain specific approaches to solving problems. Ability to synthesize knowledge from different areas of physics and apply it to biological situations. Ability to work in teams for written and oral communication skills.

SYLLABUS:

Unit 1

Mechanics: Motion along a straight line, motion in two- and three-dimension, projectile motion, circular motion, relative motion. Force, Friction, Work, Energy, Power. System of particle, collisions, Rotational motion, combined rotational and translational motions.

Unit 2

Waves and Oscillations: Oscillations: Oscillatory systems, Harmonic motion, Simple harmonic oscillator, applications of simple harmonic motion. Types of oscillations, Resonance. Waves: Types, Wave equation-power, intensity, principle of superposition- interference, standing waves - reflection, resonance. Sound-properties, interference, vibrating system and sources of sound, beats, Doppler effect, Effects at high-speed ultrasonics.

Unit 3

Light: Electromagnetic spectrum, Properties of light, Reflection, Refraction, Optical fiber, Interference-Thin film interference, Diffraction- Single slit, double slit, multipleslit diffraction, grating. X-ray diffraction, Polarization-Types, production and detection of polarized light. Dichroism, polarizing sheets. Laser - principle, types, uses.

Unit 4

Properties of Matter: Properties of solids: elasticity, stress-strain relation, Crystalline solids, crystal structure and Systems, Bragg's law, X-ray diffraction, semiconductors, IC's, Mems, introduction to Nanotechnology. Superconductors-properties, materials, SQUIDS, Cryogenics. **Properties of liquids:** Pressure in liquids, Pressure transmission: Pascal's law and its applications, Buoyancy: Archimedes principle and its applications. Surface tension, capillarity. Fluid flow: streamlines, Bernoulli's Equation- Applications, Viscosity, Viscometers. **Properties of gases:** Ideal gas, Kinetic theory of gases, gas laws, ideal gas equation.

Unit 5

Dielectrics and Magnetism: Properties of dielectrics, non-polar and polar dielectrics, Dielectric strength, Ferroelectrics, Piezoelectric, applications. Magnetic materials: Magnetism, magnetic materials, classification of magnetic materials, types of magnetic materials, soft magnetic materials, hard magnetic materials, applications.

REFERENCES:

1. *Physics* – David Halliday, Robert Resnick, Kenneth S Krane, Vol. 1, 5th (e), Willey Student Edition, 2002.
2. *Physics* – David Halliday, Robert Resnick, Kenneth S Krane, Vol. 2, 5th (e), Willey Student Edition, 2002.
3. *College Physics* – Raymond A Serway, Jerry S. Faughn, Chris Vuille, Charles A Bennett, Vol. 1, Thomson Brooks/Cole, 2006.
4. *College Physics* – Raymond A Serway, Jerry S. Faughn, Chris Vuille, Charles A Bennett, Vol. 2, Thomson Brooks/Cole, 2006.

COURSE OUTCOMES:

After completing this course, students will be able to:

CO1: Describe the fundamentals of mechanics

CO2: Explain the concepts of waves and oscillations

CO3: Illustrate the behavior of light and its applications

CO4: Demonstrate the properties of matter across different states

CO5: Demonstrate dielectrics and magnetic materials and their technological relevance

22ADM101

FOUNDATIONS OF INDIAN HERITAGE

2012

LEARNING OBJECTIVES:

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

SYLLABUS:

Unit 1 -Educational Heritage of Ancient India

Unit 2 -Life and Happiness

Unit 3 -Impact of Colonialism and Decolonization

Unit 4 -A timeline of Early Indian Subcontinent

Unit 5 -Indian approach towards life

Unit 6 -Circle of Life

Unit 7 -Pinnacle of Selflessness and ultimate freedom

Unit 8 -Ocean of love; Indian Mahatmas.

Unit 9 -Become A Strategic Thinker (Games / Indic activity)

Unit 10 -Man's association with Nature

Unit 11 -Celebrating life 24/7

Unit 12 -Metaphors and Tropes

Unit 13 -India: In the Views of foreign Scholars and Travelers.

Self-Study/ Self-reading

Unit 14 -Personality Development Through Yoga.

Unit 15 -Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness

Unit 16 -Conversations on Compassion with Amma

COURSE OUTCOMES:

After completing this course, students will be able to:

CO1: Decolonizing Mind

Description: Understanding the concept of decolonizing and making a student ready to get connected to the Indian Knowledge Systems.

CO2: Sustainability in thoughts

Description: Understanding and applying the ancient wisdom of Yajna concept as one of the sustainable frameworks of thoughts to address modern day challenges.

CO3: Understanding Human Personality

Description: The different layers of human personality as presented by vedantic model will be explored.

CO4: Applying Dharmic Framework

Description: Understanding and applying the concept of Dharma from the scriptures in modern context.

CO5: Expansion of Self

Description: After gaining understanding of the self, furthering the idea into collectives like family, nation and society.

CO6: Integrating Lessons from History

Description: Integrate invaluable lessons from history to achieve excellence in life.

22AVP103

MASTERY OVER MIND (MAOM)

1 0 2 2

LEARNING OBJECTIVES:

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

SYLLABUS:

Unit 1

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the

global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXTBOOKS:

1. Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
2. Swami Amritaswarupananda Puri, "The Color of Rainbow" published by MAM, Amritapuri.

REFERENCES:

1. Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
2. R Nagarathna et al, "New Perspectives in Stress Management" Swami Vivekananda Yoga Prakashana publications, Jan 1986
3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
5. *Secret of Inner Peace*- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion: The only way to Peace: Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

COURSE OUTCOMES:

After completing this course, students will be able to:

- CO1: To be able to describe what meditation is and to understand its health benefits
- CO2: To understand the science of meditation
- CO3: To understand the causes of stress and how meditation improves well-being
- CO4: To learn and practice MAOM meditation in daily life
- CO5: To analyze how meditation improves communication and relationships
- CO6: To apply the power of meditation to compassion-driven action

25MIC181 INTRODUCTORY MICROBIOLOGY LAB 0 0 4 2

LEARNING OBJECTIVES:

The main objective of this course is to provide basic knowledge to undergraduate students on various microbiological practices in the laboratory.

SYLLABUS:

1. Media Preparation and Inoculation: - Slant, Deep and Broth.
2. Pure Culture Techniques: - Streak Plate, Spread Plate and Pour Plate.
3. Cultural Characteristics of Bacteria in Solid, Liquid and Semi Solid Media.

4. Staining Techniques: - Simple, Differential, and Structural Staining.
5. Motility Determination: - Hanging Drop Method

REFERENCES:

1. *Microbiology, A Laboratory Manual*-James Cappuccino, Natalie Sherman, Eighth Edition 2008.
2. *Laboratory Exercises in Microbiology*-Harley Prescott, Ninth edition 2012.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand common methods of sterilization.

CO2: Illustrate microbial culture techniques

CO3: Demonstrate different staining methods.

SEMESTER 2

25BIO112 PRINCIPLES OF ECOLOGY AND EVOLUTION 2 1 0 3

LEARNING OBJECTIVES:

To offer insights on the basic ecological and evolutionary theories and their interrelationships in the environment. Understand Ecology and the concepts of Evolution. Comprehend about human impacts on ecosystems.

SYLLABUS:

Unit 1

Population-The basic unit of evolution, Origin of species, Phylogeny and systematics

Unit 2

Ecology and Biosphere-Introduction, biotic and abiotic factors, biomes.

Unit 3

Population ecology -Dynamics of population, Population growth - Exponential model Logistic growth model.

Unit 4

Community ecology- Interactions- Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views.

Unit 5

Ecosystems- Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc.) Human impacts on ecosystems.

REFERENCES:

1. Reece, Jane B., Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson. *Campbell biology*. Boston: Pearson, 2011.

2. Odum, E. P. (2006). *Ecology*, the link between the natural and the social sciences. Oxford and IBH Publishing. Fifth Edition.
3. *Ecology*, Third Edition, 2013, by Michael L. Cain and William D. Bowman
4. *Molecular Ecology*, 2nd edition 2011, by Joanna R. Freeland and Stephen D. Petersen
5. *Evolution*, 2011, by Carl T. Bergstrom and Lee Alan Dugatkin.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basic principles of Ecology and Evolution.

CO2: Understand the diversity in the various biomes

CO3: Demonstrate the significance of population and community.

CO4: Demonstrate the impact of climate change and pollution and the possible ways to tackle it.

25BIO111

BIOCHEMISTRY

2 1 0 3

LEARNING OBJECTIVES:

This course deals with the concepts of chemical bonding and principal biochemical reaction mechanisms so that the students can apply them in the domains of metabolism, enzyme technology, structural biology, molecular biology and bioinformatics.

SYLLABUS:

Unit 1

Basic Organic Chemistry - Introduction- Important elements in biology, concept of hybridization Shape of water and ammonia molecules Acids and bases, pH, Henderson- Hasselbalch Equation, Buffers, Important functional groups in organic chemistry, non-covalent interactions, General types of reactions in Biochemistry, Electrophiles and nucleophiles in biological system,

Unit 2

Amino Acids and Proteins - Introduction, Classification Optical isomerism, chemical properties, Acid-base properties- polyionic nature, zwitter ions, pKa's, pI, Peptide bond formation and properties, Classification of proteins. Levels of protein structure (brief mention of primary, secondary, tertiary & quaternary structures, Denaturation of Proteins.

Unit 3

Carbohydrates: Introduction - Sources, Classification into mono, di and polysaccharides. Classification of monosaccharides based on no. of carbon atoms.), aldoses and ketoses, Fischer projections, Haworth structures, Anomers, Epimers, Structure and functions of sugars, Disaccharides, Polysaccharides, Glycoconjugates.

Unit 4

Nucleic Acids - Structures of purine and pyrimidine bases Nucleosides, nucleotides, RNA, & DNA Types of RNA Structure of DNA, Watson and Crick model, DNA denaturation, Hyperchromic shift, Aminoacyl tRNA synthetase

Unit 5

Lipids - Introduction, sources, Nomenclature Classification, Properties & Functions, Fatty acids, Triacyl glycerols, Membrane lipids, Glycerophospholipids and sphingophospholipids, Steroids, Structure of steroid nucleus, biological role of Cholesterol, fat soluble vitamins.

REFERENCES:

1. Lehninger, Nelson and Cox, *Principles of Biochemistry*, 7th Edition, Freeman, W. H. & Company, 2017.
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, *Fundamentals of Biochemistry: Life at the Molecular Level*, Wiley, 5th Edition. 2016.
3. Lubert Stryer, *Biochemistry*, 9th Edition, W. H. Freeman, 2019.
4. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder *Organic Chemistry*, 12th edition, Wileyplus 2016.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recall the concepts of basic chemistry.

CO2: Interpret the structure and properties of biomolecules

CO3: Demonstrate the properties and functions of biomolecules.

25ENG110 ENGLISH-CREATIVE WRITING & SOFT SKILLS 2 1 0 3

LEARNING OBJECTIVES:

To provide students with an ability to build and enrich their communication skills. To make them familiar with different types of communication. To understand the barriers to effective communication. Engage students in meaningful communication through effective tasks. Identify the basic principles of communication. Analyse the various types of communication. Make use of the essential principles of communication. Identify the prominent methods and models of Communication.

SYLLABUS:

Unit 1- Listening skills

Unit-2-Speaking skills

Unit-3- Reading Skills

Unit-4 Writing Skills

Unit-5 Activities

Class Activity – Spoken English – Introduction to English sounds/ Rhythm/ Pronunciation, Practice: Short speeches/ Conversation. **Written English** – Letters: formal and informal/ Paragraph: writing, analysis/Essays/ Definitions: short, expanded/ Graphical Representation/ Writing Memos, Circulars, Notices/ Reports: lab, process etc. **Listening** – Listening: for comprehension/ accent/ pronunciation. **Reading** – Intensive and extensive.

REFERENCES:

1. Andrew, Jones. *English for students of Science* – London Orient Longmans 6th ed.2003
2. Stanley, Daavies. *Spoken English for you* – London Emerald,1998
3. Hester, Strang. *English Basics (a companion to grammar and writing)* – CambridgeCUP,6th ed.1997.
4. John, Douglas .*A communicative grammar of English*, III Ed. – London Pearson 2001
5. Strauss, Andrews. *Effective English for Technical Communication* – London Emerald Publishers, 2001
6. Strick Vauen *Spoken English in 4 Easy Steps* – Cambridge ESN pbl,2009

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify the correct stress, right accent and right intonation to ask questions, make requests or to make commands by referring dictionary.

CO2: Illustrate various speaking and writing tasks, such as roleplays, debates, group discussions apart from the use of correct spelling, punctuation and the ability to transfer information in the writing tasks.

CO3: Demonstrate through face-to-face conversations comprehension of simple words and phrases used in common everyday context

CO4: Use grammatically structured questions related to basic needs and respond appropriately

CO5: Use words that signal differences between present and past in simple statements related to common activities.

25CSA113

INFORMATION SYSTEMS

2 1 0 3

LEARNING OBJECTIVES:

To enable the students to understand the fundamentals of IT and to provide the basic understanding of the internet. The students also would learn the essential applications which are useful for a life scientist.

SYLLABUS:

Unit 1

Computer Hardware

What are computers? Its various characteristics, applications, and limitations. Functional block diagram of computer - Components of a computer, digital signals, microprocessors, input/output devices, storage devices etc.

Unit 2

Software Systems

Introduction to software - Types of software - Operating systems - Types and various functions and types of operating system - Basic introduction to Linux, Unix operating system - Languages and their types (High level and low-level language.) – Introduction to programming using C language.

Unit 3

Office Applications

Word processing, spreadsheet and database applications. Basic operations in word processor like styles, table of contents, inserting objects, references, merging the documents etc. Spreadsheet operations like summing, averaging, graphs and visualizations. Making graphs and plots for scientific data.

Unit 4

Fundamentals of Modern Networking

History of Networking, Types of networking, how networks operate, Peer-to-Peer versus Client/Server, network types and topologies, network protocols

Unit 5

Additional Information Systems Concepts

Introduction to supercomputing and high-performance computing – Multimedia application for biological domain – Introduction HTML and web technology.

REFERENCES:

1. Govindarulu, *IBM PC and Clones*, Tata McGraw-Hill Education, 2nd edition 2002.
2. *Computer Fundamentals: Concepts, Systems & Applications*- 8th Edition, Pradeep K. Sinha, Priti Sinha, BPB Publications; 6th edition, 2004.
3. http://www.openoffice.org/documentation/conceptualguide/conceptual_guide_OOo_3_ebook.pdf

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify different components, signals, microprocessors, input/output devices

CO2: Understand software systems and office applications

CO3: Demonstrate networking and computing concepts.

25MAT114

MATHEMATICS

3 1 0 4

LEARNING OBJECTIVES:

The mathematics course deals with linear algebra, differential equations, basic calculus, statistics etc. As an area of study, it has a broad appeal in that it has many applications in different aspects of biology.

SYLLABUS:

Unit 1

Linear Algebra

Matrices-definition, Types of matrices, Addition and subtraction of matrices, Multiplication of matrices, Properties of matrix multiplication, Determinants and properties of determinants, Minors and co-factors, Transpose of a matrix, Symmetric and Skew-symmetric matrix, Orthogonal matrix, Adjoint of a matrix, Singular and Non-Singular matrix, Inverse of a matrix, Rank of a matrix, Cramer's rule, Eigen Values and Eigen Vectors, Cayley Hamilton Theorem.

Unit 2

Algebra

Sequence and Series Sequence-definition, Arithmetic progression, Geometric Progression, Harmonic Progression, Infinite series, Sum to infinity.

Unit 3

Basic calculus

Functions, Limits-definition problems Continuity-definition, properties, Continuity on an interval and continuity of polynomials, continuity of rational functions Differentiation- Slopes and Rate of change

Product rule, Quotient rule Derivative of rational powers of x, Implicit differentiation Indeterminate forms and L Hospital rule Integration – Indefinite integral Integration from the view point of differential equations, Integration by substitution, Area as a limit of a sum, The definite integral

Unit 4

Differential Equation

Differential Equations Definition, Initial and boundary value problems, Classification of First order differential equations, Linear equations, Bernoulli's equation, Exact equations Separable equations, Homogeneous equations,

Unit 5

Statistics

Statistics, Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives Mean, median, mode, Standard deviation.

REFERENCES:

1. P. R. Vittal - *Business Mathematics and Statistics*, Margham Publications 2014, Chennai.
2. S.C Gupta, V. K Kapoor "*Fundamentals of Mathematical statistics*" Sulthan Chand and Sons 12th Edition 2020.
3. S. Lipschitz & M. Lipson "*Discrete Mathematics*" 2001-TMH
4. Thomas Finney "*Calculus* 9th Edition" Pearson publications
5. Seymour Lipschitz, Marc Lipson "*Schaum's Outlines of Probability*" MCGRAWHILL 2000 2nd edition.
6. Bali Iyengar "A textbook of Engineering Mathematics" Dr. B. S Grewal "*Engineering Mathematics*"- 9th Edition – 2010

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe linear algebra concepts to model and solve real world situations.

CO2: Understand rank, eigen values and eigen vectors of a matrix and the importance of Cayley's Hamilton theorem.

CO3: Explain first order differential equations by various methods and its applications.

CO4: Discuss the structure and procedure of solving higher order differential equations with constant and variable coefficients.

22ADM111

GLIMPSES OF GLORIOUS INDIA

2012

LEARNING OBJECTIVES:

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

SYLLABUS:

Unit 1 -Face the Brutes

Unit 2 -Role of Women in India

Unit 3 -Acharya Chanakya
Unit 4 -God and Iswara
Unit 5 -Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Unit 6 -Lessons of Yoga from Bhagavad Gita
Unit 7- Indian soft powers: A solution for many global challenges.
Unit 8 -Nature Preservation through faith
Unit 9 -Ancient Cultures what happened to them.
Unit 10-Practical Vedanta
Unit 11-To the World from India
Unit 12-Indian Approach to Science

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recall key historical events, personalities, and philosophical concepts presented in the chapters of ‘Glimpses of Glorious India’.

CO2: Explain the vision and mission of IKS, the teachings of Acharya Chanakya, Ashtanga Yoga, and the concepts of God and Iswara as foundational elements of Indian culture.

CO3: Apply lessons from the Bhagavad Gita to real-life scenarios, demonstrating the relevance of its teachings.

CO4: Analyze the synthesis of yoga, spirituality, and life principles in Indian culture, as explored in the chapters on Bhagavad Gita and Lessons of Yoga, A glimpse into Yoga and Ashtanga Yoga.

CO5: Evaluate the existing Historiographical framework and expand on new horizons and the evaluation of the Indian Calendar System.

CO6: Develop projects that illustrate Indian contributions to the world, models of health and wellbeing, and the Indian approach to science.

25PHY184

PHYSICAL SCIENCES LAB

0 0 4 2

LEARNING OBJECTIVES:

Students will get the chance to revise the fundamental concepts like viscosity of liquid, conductivity, heat transfer and specific rotation of glucose.

SYLLABUS:

1. Solution preparation
2. Acid-base titration
3. Determination of Hardness in a water sample
4. Determination of alkalinity in a water sample

5. EMF measurement
6. Organic functional group identification
7. Determination of Viscosity of organic solvents
8. To study the effect of urea on the viscosity of diastase using Ostwald viscometer
9. Measurement of heat changes using calorimeter
10. Measurement of conductance of a given solution and the factors affecting it.
11. Determination of Specific rotation of glucose using polarimeter

REFERENCES:

1. *Advanced practical physical chemistry* Yadav J.B., Goel Publications (2008).
2. James Brierley Firth, *Practical physical chemistry*
3. *Quantitative Analysis in Chemistry* Vogel, Pearson; 5th edition (2006).

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify different types of hardness, alkalinity, and its estimation based on complexometric titration.

CO2: Recognize various organic functional groups.

CO3: Summarize the viscosity and specific rotation of glucose employing viscometer and polarimeter.

CO4: Operate calorimeter and conductivity meter

25BIO181

BIOCHEMISTRY LAB

0 0 4 2

LEARNING OBJECTIVES:

This course deals with basic biochemical calculations and preparations of various reagents, qualitative and quantitative analysis of both carbohydrates and amino acids, and chromatography techniques.

SYLLABUS:

1. Preparation of Laboratory Solutions and Buffers.
2. Verification of Beer-lamberts Law using Potassium Dichromate.
3. Estimation of Amino acids by Ninhydrin Method.
4. Separation of Amino acids using TLC.
5. Isoelectric Precipitation of Casein from Milk.
6. Qualitative Analysis of Carbohydrates.
7. Qualitative Analysis of Amino acids.
8. Estimation of Reducing Sugar using DNS Method.

REFERENCES:

1. "*Experimental Biochemistry*", Beedu Sashidhar rao, Vijay Deshpande, I K International Pvt. Ltd., ISBN 81-88237-41-8 1st edition 2005.

2. *Laboratory Manual in Biochemistry*; J.Jayaraman, New Age International Private Limited, Second edition 2011.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Explain buffer and reagent preparations

CO2: Operate basic laboratory biochemical equipment.

CO3: Perform qualitative and quantitative analysis of biomolecules.

SEMESTER 3

25BIO201

MOLECULAR BIOLOGY

2 1 0 3

LEARNING OBJECTIVES:

Introducing and strengthening the basic molecular processes that are common to all living organisms. This course will form the pillar of knowledge which in turn helps the students for better understanding of various other subjects in the field of biotechnology.

SYLLABUS:

Unit 1

Historical Account: Discovery of DNA as genetic material, Griffith's experiment, Hershey and Chase warring blender experiment, Chargaff's rule

Unit 2

Macromolecular Description: Structure of DNA, RNA and Protein Basic mechanism of replication

Unit 3

Flow Of Information-Central Dogma: Basic mechanism of replication, transcription, translation

Unit 4

Regulation In Prokaryotes and Eukaryotes: Gene regulation in prokaryotes and eukaryotes, positive regulation, negative regulation, attenuation, gene regulation in lambda phage life cycle, RNA processing and post transcriptional regulation

Unit 5

Regulatory Mechanisms: Eukaryotic transcription factors, enhancers, silencers, insulators, chromatin structure and gene regulation, Translational regulation in prokaryote and eukaryotes, Post translational modification and protein stability.

REFERENCES:

1. *Molecular Biology of the gene*, James D Watson et al, 7TH Edition, Pearson, 2007.
2. *Gene VIII*, Benjamin Lewin, 8th edition, Pearson publishers, 2003.
3. *Molecular biology*, David Freifelder, 2nd edition, Barlett and Jones, 1986.

COURSE OUTCOMES:

After completing the course, students shall be able to

- CO1: Recall the important discoveries that are made in the field of molecular biology.
CO2: Understand the structure and different levels of organizations of biomolecules.
CO3: Explain the molecular events in replication, transcription and translation.
CO4: Understand the regulatory mechanisms of gene expression.

25MAT204

BIOSTATISTICS

2 1 0 3

LEARNING OBJECTIVES:

Biostatistics is a course offered to 3rd semester B.Sc., (BT &MB). Among topics explored are data representation, central tendency, statistical averages, probability etc. The course will help the students to develop an understanding of the basic methods and underlying concepts of statistics that are used in public health decision making.

SYLLABUS:

Unit 1

Data Representations and Analysis

Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives.

Unit 2

Measures of Central Tendency and Dispersion

Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations, two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks.

Unit 3

Statistical Averages

Mean, median, mode, Standard deviation, curve fitting, principles of least squares,

Unit 4

Probability

Probability theory: Random experiments, sample space, probability theory, conditional probability. Baye's theorem.

Unit 5

Random variable

Random variable, (discrete and continuous), Probability density function (discrete and continuous), Distribution function for discrete random variable. Distribution function for continuous random variable, Joint probability distribution, Conditional and marginal distribution. Mathematical expectations: Introduction, the expected value of random variable, moments, Moment generating functions, Product moments, Conditional expectations. Standard distributions -: Uniform distribution. (Discrete and continuous). Exponential distribution, Gamma distribution, Beta distribution. Binomial distribution, Poisson distribution, Normal distributions. Standard normal distributions.

REFERENCES:

1. *Fundamentals of Biostatistics*. by Irfan A Khan- 2004.
2. *An introduction to Biostatistics*. by P.S.S. Sunder Rao, 5th Edition, 2012.
3. J. Ravichandran, "*Probability and Statistics for Engineers*", Revised Edition 2012, Wiley.

4. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, *Probability and Statistics for Engineers and Scientists*, 8th Edition, Pearson Education Asia, 2007.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe statistical methods and probability distribution relevant for molecular biology data.

CO2: Understand the application and limitations of different bioinformatics and statistical methods.

CO3: Apply descriptive techniques commonly used to summarize public health data.

CO5: Demonstrate basic analytical techniques to generate results.

CO6: Apply statistical knowledge to design and conduct research studies.

25BIO203

PLANT BIOLOGY

3 1 0 4

LEARNING OBJECTIVES:

The course should enable the students to Understand in depth about plant structure and physiology, learn about taxonomy of plants, have an understanding about plant secondary metabolites and its applications and Comprehend about Agricultural Biotechnology.

SYLLABUS:

Unit 1

Plant Structure and Development: Structural organization and function of plant cell, Growth and Division of The Cell, Morphogenesis and organogenesis in plants, programmed cell death, aging and senescence

Unit 2

Plant Physiology: Photosynthesis, Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport, and photo assimilate translocation, Stress physiology

Unit 3

Evolution and Classification of Plants: Principles and methods of taxonomy, Outline classification of plants, Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants.

Unit 4

Secondary Metabolites: Classification, isolation, characterization, Biosynthetic pathway of secondary metabolites, tracer techniques.

Unit 5

Chemical Ecology: Semio-chemicals

Unit 6

Agricultural Biotechnology: Biopesticides, integrated pest control, sericulture, biofertilizers, Bio-communication, bioremediation, bio-catalysis

Unit 7

Feed Stock Chemicals, Designer Chemicals, Phytomedicine

REFERENCES:

1. *Plant Biology*. Allison Smith et al. Garland Science, 2010.
2. *Botany: An Introduction to Plant Biology*, James D. Mauseth. 7th edition, 2019
3. *Organic Chemistry- Natural Product Chemistry at a Glance* by S P Stanforth. 1st edition, 2006
4. *Plant Biochemistry* -Hans-Walter Heldt in cooperation with Fiona Heldt.
5. *Plant Physiology* - Taiz Zeiger 6th edition, 2018.
6. *Biochemistry & Molecular Biology of Plants*. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2nd edition,2015.
7. *Phytochemical Methods A Guide to Modern Techniques of Plant Analysis* by JB Harborne. Springer, 3rd edition,1998.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify the distinguishing anatomical features of various parts of plant.

CO2: Explain the physiological process that are underway in plants under normal conditions as well as stressed conditions.

CO3: Classify plants and the taxa they belong to.

CO4: Discuss plant secondary metabolites and its benefits.

CO5: Apply the knowledge in Agri-biotech areas such as - biofertilizers, biopesticides etc.

25BIO205

ANALYTICAL BIOCHEMISTRY

2 1 0 3

LEARNING OBJECTIVES:

The main objective of this course is to provide basic knowledge to students to understand analytical tools and apply them to decipher the structure and functions of biomolecules.

SYLLABUS:

Unit 1

Protein extraction and quantitation: Enzymatic lysis, Homogenizer, Blender, Sonication, Bead mill shaker, French press, Biuret, Lowry, BCA and Bradford Assays.

Protein precipitation and treatment: Salting-in, Salting-out, Effect of organic solvents and polymers, Dialysis, Ultrafiltration, Centrifugation.

Unit 2

Chromatography: Partition coefficient, Retention, Resolution, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Hydroxyapatite chromatography, Paper chromatography, thin layer chromatography, Reversed-phase chromatography, Normal phase chromatography.

Unit 3

HPLC: Fundamentals of high-performance liquid chromatography, Columns, Detectors.

Unit 4

Electrophoresis: Native PAGE, SDS-PAGE, Isoelectric focusing, 2D-PAGE.

Unit 5

Spectroscopy: Fundamentals of UV/vis Spectroscopy, Applications of UV/vis spectroscopy, Spectrophotometer, Fundamentals of fluorescence spectroscopy, Jablonski diagram, Spectro fluorometer, Applications of spectrofluorimetry.

REFERENCES:

1. *Protein Purification Techniques: A Practical Approach*, Simon Roe, Oxford, 2nd Ed., 2004.
2. *Protein Purification: Principle and Practice*, Robert K. Scopes, Springer, 3rd Ed., 1994.
3. *Physical Biochemistry: Principles and Applications*, David Sheehan, John Wiley & Sons, 2nd Ed., 2000.
4. *Practical Biochemistry: Principles and Techniques*, Keith Wilson and John Walker, Cambridge, 5th Ed., 2004.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe biomolecular extraction and quantitation techniques.

CO2: Summarize concepts and applications of UV/visible and fluorescence spectroscopy.

CO3: Discuss biomolecular separation and purification methods.

CO4: Solve qualitative and quantitative problems related to biomolecular characterization.

25MIC202

VIROLOGY

2 1 0 3

LEARNING OBJECTIVES:

Introducing students to the fascinating world of viruses with special emphasis on their general properties, replication strategies, cultivation methods, diagnostic tools, transformations, immune response and antiviral drugs. Virology course is mainly focused on the study of various types of viral pathogens, advanced study of viruses with regard to the basic, biochemical, molecular, epidemiological, and clinical, aspects of animal viruses primarily and bacteriophage, plant viruses, viroids, and prions. The viral vectors and their applications in biotechnology are also discussed.

SYLLABUS:

Unit 1

Historical and Conceptual Background: History-Properties of viruses -classification of viruses based on the nature of genome-Methods of study, Viral multiplication, Attachment, entry, un-coating, replication, assembly, release, Cell transformations, Cultivation of viruses-Assay techniques

Unit 2

Different Classes of Viruses: Animal Viruses-Virus-Host Interactions-Viral infections, plant viruses, bacteriophages, Viroid.

Unit 3

Host Response and Antiviral Agents: Immune responses to viruses, Interferon and other cytokines, Antiviral therapy.

Unit 4

Bacteriophages: Classification, characterization, morphology, structure, one step growth curve, applications-phage therapy, phage in environment, agriculture & Food applications. Molecular biology tools: Phage display library.

Unit 5

Recent trends in Virology: Viral vaccines: development and mode of action.

REFERENCES:

1. *Prescotts Microbiology*, 11th edition, 2020.
2. Edward K Wanger, *Basic Virology*, Second edition, 2003.
3. S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka, *Principles of Molecular Virology*, Third edition, 2009.
4. Acheson and Nicholas H, *Fundamentals of Molecular Virology*, Second edition, 2011.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basics of virology

CO2: Explain the replicative strategies of different classes of viruses

CO3: Discuss the pathogenicity and mode of action of various antiviral drugs used to control viral infections.

CO4: Demonstrate the host immune response to viruses

25BIF201

INTRODUCTORY BIOINFORMATICS

2 1 0 3

LEARNING OBJECTIVE:

To introduce to the field of bioinformatics via an array of publicly available tools and resources.

SYLLABUS:

Unit 1

Introduction: Bioinformatics- Bioinformatics; Components; Different fields in bioinformatics; Omics; Biological Data Acquisition; Types of DNA sequences; RNA sequencing methods; Protein sequencing and structure determination methods; Gene expression data.

Unit 2

Databases- Format and Annotation: Conventions for databases indexing and specification of search terms; Common sequence file formats; Files for multiple sequence alignment; Files for structural data; Annotated sequence databases - primary sequence databases; Subsidiary data storage unfinished genomic sequence data, organisms specific databases; Protein sequence and structure databases; List of Gateways, RNAi databases, Data – Access, Retrieval and Submission: Data Access - standard search engines; Data retrieval; Software for data building; Submission of new and revised data. NCBI resource; databases

Unit 3

Sequence alignment- Sequence Similarity Searches: Sequence homology as product of molecular evolution; Sequence similarity searches; Significance of sequence alignment; Sequence alignment; Alignment scores and gap penalties; Measurement of sequence similarity; Similarity and homology.

Methods of Sequence Alignment, Graphic similarity comparison; Dot plots; Scoring mutation probability matrices; Sequence similarity searches and alignment tools Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST, Multiple Sequence Alignment, Significance of multiple sequence alignment; Softwares; Clustal package; Considerations while choosing a MSA software for analysis; Sensitivity and specificity of each software. Methods used to come up with the tree structure, Cladogram, Phylogram, Tools like- Phylip, MEGA. DOMAINS AND MOTIFS: Introduction to motifs and domains, Introduction to signature patterns, Identify patterns, Tools like- Prosite, Pfam, InterPro scan

Unit 4

Visualization tools and genome analysis- Pymol, VMD, Rasmol, Swisspdb viewer. Structure of genome; Anatomy of genomes of virus, prokaryotes, eukaryotes; Human genome Genome Analysis, Whole genome analysis – shotgun sequencing, clone contig; Genomic library; Isolation and microdissection of chromosomes; Hybridisation methods - northern blot, southern blot, western blot; Genome identification Feature based approach – ORF's; Primer Designing; Vector designing; APE

Unit 5

Introduction, the what and why of NGS- Concepts of Whole Exome Sequencing/Whole Genome Sequencing; Concepts of whole Transcriptome Shotgun Sequencing (WTSS) and RNA-Seq; Introduction to Bacterial Genome Sequencing and Metagenomics; Introduction to Oxford Nanopore read sequencing; Introduction to Galaxy; Case studies

REFERENCES:

1. Vittal R.Srinivas, " *Bioinformatics: A Modern Approach*", 2005, ISBN: 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
2. Andreas D.Baxevanis, B.F. Francis Ouellette, "*Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins*", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC., U.K.
3. Jean-Michel Claverie, Cedric Notredame, "*Bioinformatics for Dummies*", 2nd Edition, 2006, ISBN: 978-0-470-08985-9
4. Buermans HP, den Dunnen JT. *Next generation sequencing technology: Advances and applications*. *Biochim Biophys Acta*. 2014 Oct;1842(10):1932-1941. doi: 10.1016/j.bbadis.2014.06.015. Epub 2014 Jul 1. PMID: 24995601.
5. Goodwin, S., McPherson, J. & McCombie, W. *Coming of age: ten years of next-generation sequencing technologies*. *Nat Rev Genet* 17, 333–351 (2016). <https://doi.org/10.1038/nrg.2016.49>

COURSE OUTCOME:

After completing the course, students shall be able to

CO1: Define concepts in bioinformatics that could help to solve life science problems

CO2: Classify different biological data and relate it to the known databases and formats

CO3: Understanding the concepts of NGS and other sequencing techniques.

CO4: Demonstrate tools for sequence alignment, phylogenetics, characterization, and visualization of biomolecules

CO5: Apply basic bioinformatic tools for finding motifs, domains gene/protein homologs, designing primers, identifying mutations.

22ADM201 STRATEGIC LESSONS FROM MAHABHARATA 1001

LEARNING OBJECTIVES:

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

SYLLABUS:

- Unit 1 Mahābhārata - A Brief Summary
- Unit 2 A Preamble to the Grand Itihāsa
- Unit 3 The Unbroken Legacy
- Unit 4 Dharmic insights of a butcher
- Unit 5 The Vows we take: Pratijñā
- Unit 6 Mahābhārata - The Encyclopaedia for Kingship and Polity Acumen
- Unit 7 Karna: The Maestro that Went Wide of the Mark
- Unit 8 Strategical Silhouette of An Extraordinary Peace Mission
- Unit 9 Yajñaseni, A Woman from Fire.
- Unit 10 Popular Regional Tales
- Unit 11 Death & deathlessness

Self-Study / Self Reading

- Unit 12 Mahabharata- An All-Encompassing Text
- Unit 13 Mahabharata- Whats and What Nots
- Unit 14 Mahābhārata in Adages

COURSE OUTCOMES:

After completing the course, students shall be able to

- CO1: Recall key events and characters from the Mahabharata.
- CO2: Explain the strategic decisions made by characters in the Mahabharata and their implications.
- CO3: Apply strategic principles from the Mahabharata to contemporary business scenarios.
- CO4: Analyze the diverse strategic approaches employed by characters in the Mahabharata.
- CO5: Evaluate the enduring relevance of Mahabharata's strategic wisdom in present-day contexts.
- CO6: Develop innovative strategic frameworks by synthesizing insights from the Mahabharata.

25MIC281 GENERAL MICROBIOLOGY LAB 0042

LEARNING OBJECTIVES:

To elaborate their knowledge in basic microbiology techniques and performing experiments to identify unknown bacteria by biochemical tests, fungal cultivation and staining, special media

SYLLABUS:

1. Motility Determination-Soft agar deeps and Hanging drop method.
2. Biochemical tests: IMViC test, Catalase test, Oxidase test, Triple sugar iron test, carbohydrate fermentation test, Urease test.

3. Fungal cultivation and staining.
4. Identification of bacteria is using differential /selective media

REFERENCES:

1. *Microbiology Lab Manual* by James G. Cappuccino and Natalia Sherman, Eighth Edition 2008.
2. *Benson's Microbiological Applications* by Alfred E. Brown, Indian Edition 12 2011.

COURSE OUTCOMES:

After complet CO1: Understand

CO1: Understand biochemical tests to identify unknow bacteria. ia

CO2: Demonstrate isolation and identification of fungi

CO3: Perform microbial cultivation using differential and selective media.

25BIO282 CELL AND MOLECULAR BIOLOGY LAB 0 0 4 2

LEARNING OBJECTIVES:

Hands-on experience of research in Cell Biology. Focuses on using microscopy to investigate various structural features of cells as well as understanding the state of the cells (resting/dividing). Lab also focuses on basic molecular biology techniques including DNA isolation and electrophoresis.

SYLLABUS:

1. Micro pipetting.
2. Lignin staining: comparison between monocots and dicots.
3. Plant and animal cell identification.
4. Mitosis in onion root tip.
5. Genomic DNA isolation by CTAB method from different sources like leaf, flowers and fruits of plants.
6. Spectrophotometry
7. Agarose gel electrophoresis.
8. Polyacrylamide gel electrophoresis

REFERENCES:

1. *Cell and Molecular Biology: Concepts and Experiments* - Gerald Karp, 3rd Edition, 2006.
2. *Cell and Molecular Biology: A lab manual* -K.V. Chaitanya, 2013.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Illustrate microscopic techniques to differentiate between plant and animal cells

CO2: Illustrate various stages of mitosis.

CO3: Perform genomic DNA isolation and characterisation.

CO4: Perform protein separation techniques

SEMESTER 4

25BIO216

HUMAN PHYSIOLOGY

4 0 0 4

LEARNING OBJECTIVES:

This course deals with basic concepts and knowledge of the structure and functioning of different systems in the body and to understand integrated aspect of functioning of the individual and all the systems in totality in body.

SYLLABUS:

Unit 1

Basic Cell Physiology-Cell- Introduction, Cell membrane, Movement of the substances and water through the cell membrane, Bioelectric potentials.

Unit 2

Nervous System and Neuro Muscular System- Sensory nervous system, Motor nervous system, Higher functions of the nervous system, Synapse, Reflexes, Cerebrospinal fluid, Blood brain and blood CSF barrier Muscles- Skeletal Muscles-Properties of skeletal muscles, Muscular contraction and relaxation, Neuromuscular junction, Sarco tubular system, Smooth muscle- mechanism of contraction.

Unit 3

Blood and Lymph, Circulatory System, Endocrinology and Respiratory system -Functions of Blood, Hemopoiesis, Erythropoiesis, Anemias, granulocytes and agranulocytes. Leukemia, Reticule endothelial system, Macrophage system, Hemostasis, Blood clotting defects, Blood groups - Functional anatomy of the heart, Properties of cardiac muscles, Conducting system of the heart ,Pressure changes during cardiac cycles, Capillary circulation, Arterial and venous blood pressure- Endocrine glands, hormones ,their functions, Disorders of endocrine system- Mechanism of breathing, Ventilation, Regulation of respiration, Transport of gases, Hypoxia, Artificial ventilation, Non respiratory functions of the lungs

Unit 4

Gastrointestinal System- General structure of alimentary canal, Gastric secretion, Pancreatic secretion, Gastric motility-digestive peristalsis Gastrointestinal hormones, Disorders of GIT

Unit 5

Renal Physiology- Structure of kidney, Nephrons, Juxta glomerular filtrate, Reabsorption, Secretion- mechanism of secretion, Concentrating and diluting mechanism of urine, Dialysis

REFERENCES:

1. Guyton AC and Hall JE, *Textbook of Medical Physiology* 12th Edition 2011.
2. Lauralee Sherwood, *Human Physiology –From Cell to Systems*, 7th Edition 2010.
3. *Human Physiology*, Fox, Stuart Ira, 8th Edition 2004.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recall the organization of human body

CO2: Understand the functioning of the human body as different systems like, neuro-muscular, digestive, respiratory, urogenital, body fluids etc.

CO3: Explain the interplay between different organ systems and how organs and cells interact to maintain biological equilibria.

CO4: Demonstrate variation in normal physiology.

25BIO211

GENETICS

2 1 0 3

LEARNING OBJECTIVES:

Genetics is the study of heredity and genes. The aim of this course is to strengthen the Mendelian principles along with other molecular genetics topics like recombination, pedigree analysis, transposons. This course will help students to venture into the different areas of biomedical sciences.

SYLLABUS:

Unit 1

Introduction to Genetics: Genes, chromosomes & heredity, DNA as genetic material. Mendelian principles, extension and variation of Mendelism, problem solving for both mendelian and non mendelian crosses.

Unit 2

Chromosomal basis of Heredity: Variation in chromosome number & structure, genetic basis of sex determination in selected organisms. Population and Evolutionary Genetics. Extrachromosomal inheritance

Unit 3

Linkage and Crossing-over: Mechanism of chromosomal linkage and crossing-over. Molecular mechanisms of recombination. Genetic and cytological mapping. Genetic markers and distances. Pedigree analysis.

Unit 4

Mutations and DNA repair: Classification and source of mutations. Polymorphisms. Types of DNA repair mechanisms. Transposable elements and their classification.

Unit 5

Genome editing: homologous recombination, zinc-finger nucleases, TALENS, CRISPR-Cas9, site directed mutagenesis.

REFERENCES:

1. *Genetics* – 6th Edition – Snustad& Simmons – Wiley, 2011.
2. *Concepts of Genetics* – 10th Edition – Klug et al – Pearson, 2011.
3. E.J.Gardner, M.J. Simmons and D.P. Snustad.1991"*Principles of Genetics*". Eighth edition John Wiley.
4. D.L. Hartl and E.W. Jones. "*Genetics, Analysis of Genes and Genomes*". Sixth edition. Jones and Bartlett Publishers. 2004

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basic concept of Mendelian principles and apply it in different genetic experiments.
CO2: Explain the deviations from the standard Mendelian laws in a few cases and learn the mechanisms.

CO3: Interpret the underlying genetic mechanisms that regulate sex determination and clinical cases leading into chromosome abnormalities.

CO4: Explain the principles of linkage, recombination and chromosome mapping to establish the physical and genetic connection between two neighboring genes.

CO5: Explain different types of mutations and how DNA repair mechanisms restore the integrity following the DNA damage.

CO6: Demonstrate the process of gene editing using different methods like homologous recombination, zinc finger nucleases, TALENS, CRISPR-Cas9, site directed mutagenesis, identify the technical and ethical barriers of gene editing.

25BIO212

IMMUNOLOGY

2 1 0 3

LEARNING OBJECTIVES:

In this course, students should understand basic immunological mechanisms such as cells and organs of the immune system, innate and adaptive immune response. They should be able to interpret the dysregulation of immune mechanisms during hypersensitivity states, immunodeficiency, or autoimmune conditions. Students should be able to apply the understanding of immunology to develop vaccines for protection or therapeutic purpose against diseases.

SYLLABUS:

Unit 1

Introduction to the Immune System: Historical perspectives in Immunology. Cells and Organs of the Immune system, Development of immune cells, Host-pathogen interactions, overview of innate and adaptive immune system. Innate immune responses: Different barriers, phagocytosis, pattern recognition receptors, signaling, cytokines and chemokines, Inflammatory response. Functions of complement system, components of complement, complement activation, Regulation of complement system, biological consequences of complement.

Unit 2

Humoral Immune response: Factors that influence immunogenicity, adjuvants, haptens, epitopes, Antigen capture and presentation to lymphocytes, Antigen recognition in the adaptive immune system, B cell activation and effector functions, B cell maturation and proliferation. Basic structure of antibodies, Immunoglobulin fine structure, antibody mediated effector functions, antibody classes and biological activities, monoclonal antibodies, strength of antigen-antibody interactions: affinity, avidity.

Unit 3

Cell mediated Immune Response: T cell receptor: structure, function, General properties of effector T cells, Antibody-Dependent Cell-mediated Cytotoxicity. Major Histocompatibility complex and antigen presentation: MHC restriction, Antigen presentation and T cell activation.

Unit 4

Irregularities in immune response: Hypersensitivity Reactions: Allergies, Type I, II, III, IV, Autoimmunity: organ-specific autoimmune diseases, systemic autoimmune diseases.

Immunodeficiency diseases: primary immunodeficiencies, AIDS and other acquired or secondary immunodeficiencies. Tumor immunology: malignant transformation of cells, oncogenes and cancer induction, tumor antigens, immune response to tumors, tumor evasion of immune system, cancer immunotherapy.

Unit 5

Biology of vaccines and immunization: Active and passive immunization, designing vaccines for active immunization, whole-organism vaccines, purified macromolecules as vaccines, recombinant-vector vaccines, DNA vaccines, multivalent subunit vaccines.

REFERENCES:

1. *Basic Immunology: Functions and disorders of the Immune system*, Abul K abbas, Andrew H Lichtman and Shiv Pillai, 6th edition, 2019.
2. *Immunology*, Kuby, by Kindt, Goldsby, Osborne, Sixth Edition, 2006.
3. *Immunobiology, The Immune system in Health and Disease*, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand basic immunological mechanisms such as cells and organs of the immune system, innate and adaptive immune response.

CO2: Interpret the dysregulation of immune mechanisms during hypersensitivity states, immunodeficiency, or autoimmune conditions.

CO3: Apply the understanding of immunology to develop vaccines for protection or therapeutic purpose against diseases.

25BIO213

ENZYME TECHNOLOGY

2 1 0 3

LEARNING OBJECTIVES:

To provide a detailed knowledge about enzymes, their chemical nature, kinetics, catalysis, classifications, factors affecting the velocity of enzymes, theories of enzyme action, enzyme regulation, inhibitions, clinical enzymes, industrial enzymes, non-protein enzymes, coenzymes and cofactors.

SYLLABUS:

Unit 1

Introduction to Enzymes: General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNazymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of Coenzymes. Isozymes, Abzymes, Synzyme, Specificity of enzymes, Active site, Allosteric site.

Unit 2

Enzyme Catalysis and Inhibition: Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. mechanism of Serine Proteases-Chymotrypsin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).

Reversible Inhibition- Competitive, Non-Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitors like Penicillin, Iodoacetamide and DIFP.

Unit 3

Enzyme Kinetics: Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, K_m , V_{max} , L.B Plot, Turnover number, K_{cat} . Kinetics of Enzyme Inhibition. Kinetic Allosteric enzymes. Numerical problems in enzyme kinetics and enzyme inhibition.

Unit 4

Enzyme Regulation: Feedback Regulation, Allosteric Regulation, Reversible, Covalent Modification and Proteolytic Activation. Enzyme processing. Enzymes in post translational modifications.

Organization of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways and enzymes in membranes. Mechanisms of enzyme degradation, lysosomal and non-lysosomal pathways, examples.

Unit 5

Industrial and Clinical uses of Enzymes (Applied Enzymology): Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes.

Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases. Immobilization of enzymes, ELIZA. Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes

Unit 6

Enzyme Structure activity Relationship (SAR) and Drug Discovery- Properties of Enzymes.: Lead Compound, Structure based drug design, combinatorial chemistry, High-throughput screening, Case study of DHFR etc.

REFERENCES:

1. Nicholas Price & Lewis Stevens, *Fundamentals of Enzymology*, 3rd Edition; 2009.
2. Trevor Palmer and P L Bonner, *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*, 2nd Edition, 2007.
3. Lehninger, Nelson and Cox, *Principles of Biochemistry*, 7th Edition, 2016.
4. Donald Voet, Judith G. Voet, Charlotte W. Pratt, *Fundamentals of Biochemistry: Life at the Molecular Level*, 5th Edition. 2016.
5. Gary walsh, *Proteins*, 2nd Edition, 2015.
6. Internet/Journal Resources

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recall the basic concepts of enzymes and their classifications.

CO2: Explain enzyme kinetics, catalytic mechanisms and theories of enzyme action.

CO3: Understand enzyme inhibition and regulation.

CO4: Demonstrate the role of enzymes in industry and medicine.

25BIO214

CELL BIOLOGY

2 1 0 3

LEARNING OBJECTIVES:

The course provides in depth knowledge of various concepts of cell biology that involves understanding mechanisms underlying protein sorting into the different organelles and diseases associated with impaired sorting processes, different aspects of Cell signaling, Cell Cycle and its regulation, Cancer, Apoptosis and basics of animal cell culture.

SYLLABUS:

Unit 1

Protein Sorting: Sorting Signals, Types of Transport, Protein Sorting to different Organelles- Nucleus, Endoplasmic Reticulum, Golgi apparatus, Mitochondria, Chloroplast, Peroxisomes, Lysosome, Vesicular Transport, Diseases associated with impaired Transport processes.

Unit 2

Cell Signaling: Basics of animal Communications, Modes & Types of Cellular Signals, Receptors: GPCRs, RTKs, Cytokine Receptors & NRTKs, Enzyme linked receptors, GPCRs in vision, smell and taste, Mechanism of actions of toxins, Nitric oxide signaling, signaling in developmental pathways like Wnt, Notch and Hedgehog, NF-KB signaling, signaling in plants- Auxin, Ethylene and Phytochromes, signaling involved in Circadian rhythm in Humans, Drosophila and Cyanobacteria.

Unit 3

Cell Division and Cell cycle: Mitosis and Meiosis. Biochemical analysis of cell cycle control systems in animal embryos and mammalian cell culture. Cell cycle check points. Role of cyclins and Cdks in cell cycle regulation.

Unit 4

Cytoskeleton: Introduction to major cytoskeletal elements in eukaryotes. Self-assembly and dynamic structure of cytoskeleton.

Unit 5

Advanced Cell Biology: Cell Death & Cancer, Cell Culture Techniques & Assays.

REFERENCES:

1. *The Cell, A Molecular Approach* – 6th Edition – Geoffrey M. Cooper, Robert E. Hausman – Sinauer Associates, Inc. 2013.
2. *Molecular Biology of the Cell* – 5th Edition – Alberts et al – Garland Science, 2008.
3. *Molecular Cell Biology* 5th Edition by Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris Kaiser, Monty Krieger, Matthew Scott, Lawrence Zipursky and James Darnell. W.H Freeman and Company. 2003.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify different types of sorting signals and their mechanism and their significance in various disease states when impaired.

CO2: Explain basic concepts of cell signaling including the types of signals and receptors, signaling mechanisms and associate the signaling pathways with various disease conditions.

CO3: Understand the regulation of cell cycle and cell death in Cancer.

CO4: Understand the basic techniques used to culture animal cells.

CO5: Demonstrate the role of cytoskeleton in maintaining cell architecture and rigidity

25BIO215

INTRODUCTORY BIOPHYSICS

2002

LEARNING OBJECTIVES:

This course is intended to provide concepts of thermodynamics and its applications in understanding biological phenomena give fundamental ideas about protein folding and function, familiarize molecular level changes involved in biological processes.

SYLLABUS:

Unit 1

Thermodynamics of living systems: Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Activation energy and living cells, Coupled reactions.

Unit 2

Protein folding: Forces for protein stability, Protein denaturation and renaturation, Protein folding pathways, Levinthal's paradox, Molten globule, Folding accessory proteins, Prediction of protein structures.

Unit 3

Protein function: Structure of heme, Structure of Myoglobin and hemoglobin, Oxygen binding mechanism, Oxygen binding co-operativity, Hill equation, Hill coefficient, Allostery in hemoglobin, Bohr effect, Hemoglobin abnormalities.

Unit 4

Dynamics of biomolecules: Diffusion, Laws of diffusion, Diffusion across biological membranes, Oxygen consumption and cellular respiration, Osmosis, Osmotic pressure, Osmoregulation, Osmotic work.

Unit 5

Viscosity and Surface tension: Viscosity and biological importance, Surface tension, Factors influencing surface tension, biological importance.

REFERENCES:

1. *Biochemistry*, Donald Voet and Judith G. Voet, John Wiley & Sons, 4th Ed., 2011.
2. *Biological Thermodynamics*, Donald T. Haynie, Cambridge, 1st Ed., 2001.
3. *Introductory Biophysics: Perspectives on the Living State*, J. R. Claycomb and J.Q.P. Tran, Jones & Bartlett, 1st Ed., 2011.
4. *Molecular and Cellular Biophysics*, Meyer B. Jackson, Cambridge, 1st Ed., 2006.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Explain thermodynamics theory and its application in biological processes.

CO2: Discuss concepts of protein folding and function.

CO3: Summarize molecular-level changes involved in the process of diffusion, viscosity and surface tension.

CO4: Demonstrate biophysical phenomena through investigative and experimental data.

25SSK201**SOFT SKILLS –I****0 1 0 1****LEARNING OBJECTIVES:**

To improve the communication and presentation skills of students.

SYLLABUS:

Introduction / Ice Breaking, Personal Visioning - Classroom Workshop, Importance of assertive communication, Introduction to presentation Skills, Assessment on presentation Skills.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand the Soft skills sessions.

CO2: Discuss insights on setting objectives.

CO3: Demonstrate confidence to present in front of audience.

22ADM211**LEADERSHIP LESSONS FROM RAMAYANA****1 0 0 1****LEARNING OBJECTIVES:**

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

SYLLABUS:

Unit 1 -Introduction to the Great Itihasa

Unit 2 -Bala-Kāṇḍa: (Preparing for the renowned mission.) and Ayodhya-Kāṇḍa: (Harbinger of an Entire Tradition of Nobleness.)

Unit 3 -Araṇya-Kāṇḍa: (Tale of the forest life) and Kishkindha-Kāṇḍa: (The Empire of Holy Monkeys.)

Unit 4 -Sundara-Kāṇḍa: (Heart of the Ramayana) and Yuddha-Kāṇḍa: (The most popular part of the Ramayana)

Unit 5 -Ramayana and Modern-day learning

Unit 6 -Ecological Awareness in the Ramayana

Unit 7 -Different Ramayana: (Epic that connects the world)

Unit 8 -Uttarakhand: (An attempt to explain the untold stories)

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: This part gives a brief introduction of the Great Ithihasa

CO2: This topic deals with 6 Kandas of Ramayana.

CO3: Ramayana and Modern-day learning

[This topic details the relevance of Ramayana and its learning aspects.]

Ecological Awareness in the Ramayana

[This topic demonstrates the Environment and Ecology]

CO4: This topic explains different Ramayana around the world.

CO5: This topic reveals the authenticity of Uttar Kanda and its attempt to explaining the untold stories in the first six Kanda

25BIO283

IMMUNOLOGY LAB

0042

LEARNING OBJECTIVES:

To expose the students to common laboratory assays, like blood grouping, agglutination reactions, and antigen-antibody interactions.

SYLLABUS:

1. Blood smear preparation.
2. Blood Cell Counting using Hemocytometer.
3. Blood Grouping.
4. Latex Agglutination Reaction.
5. Ouchterlony Double Diffusion.
6. Dot ELISA

REFERENCES:

1. Delves P, Martin S, Burton D, Roitt IM. (2006). *Roitt's Essential Immunology*. 11th Edition. Wiley-Blackwell Scientific Publication, Oxford.
2. *Practical Immunology*, 4th Edition (2008). Frank C. Hay, Olwyn M. R. Westwood ISBN: 978-1-4051-4673-9 408 pages, Wiley-Blackwell.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Identify the morphology of cells of the immune system.

CO2: Understand the basic concepts of blood grouping.

CO3: Demonstrate antigen-antibody interactions and detect the presence of antigens and/or antibodies in a biological sample.

CO4: Perform antigen antibody interactions and interpret the data for the presence of antigen and or antibodies in biological samples.

LEARNING OBJECTIVES:

Students will be given hands on exposure to experiments on enzymology which includes preparation of suitable buffer for the isolation of enzymes, velocity of enzymes, protein quantitation, specific activity, kinetics of enzyme and effect of pH and temperature on enzyme kinetics.

SYLLABUS:

1. Preparation of phosphate and acetate buffer. Isolation of Alpha/Beta Amylase from saliva/sweet potato.
2. Standard Maltose Curve, Determination of enzyme activity.
3. Construction of Protein standard curve by Folin's Lowry method and Determination of specific activity of enzyme.
4. Effect of substrate concentration on Enzyme kinetics and determination of K_m and V_{max} .
5. Effect of temperature on Enzyme kinetics.
6. Effect of pH on Enzyme kinetics.

REFERENCES:

1. Beedu Sashidhar rao, Vijay Deshpande, "*Experimental Biochemistry*", A student companion, 2005 Edition, I K International Pvt. Ltd., 9788188237418.
2. J.Jayaraman, *Laboratory Manual in Biochemistry*; 2011 edition, New Age International Private Limited.
3. Lowry, OH, NJ Rosbrough, AL Farr, and RJ Randall. *J. Biol. Chem.* 193: 265. 1951

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Define the fundamentals of calculations and problems in the preparation of laboratory solutions and buffers.

CO2: Illustrate vigorous methods adopted in the isolation of enzymes.

CO3: Demonstrate the characterization of enzymes.

SEMESTER 5

25BIF302 PYTHON FUNDAMENTALS FOR BIOLOGISTS 2 1 0 3

LEARNING OBJECTIVES:

To introduce students to programming using Python, a versatile and beginner-friendly language widely used in science and data analysis, along with foundational scripting concepts in the Linux operating system.

SYLLABUS:

Unit 1: Introduction to Programming and Linux Scripting

- Introduction to programming languages and paradigms
- Problem-solving techniques and algorithm design
- Programming concepts: syntax, semantics, and flow
- Flowcharts and pseudo-code
- Introduction to compilers and interpreters
- Basic Linux commands
- Shell scripting fundamentals

Unit 2: Python Programming Basics

- Python data types and variables
- Operators and expressions
- Control structures: conditionals (if, else, elif)
- Loops (for, while)
- Lists, tuples, and dictionaries
- Handling arrays and basic matrix operations with libraries like NumPy

Unit 3: Advanced Python Concepts

- Functions: defining, calling, scope, recursion
- Introduction to classes and objects (Object-Oriented Programming)
- File input/output operations
- Logical operations and exception handling
- String manipulation and regular expressions
- Using standard and external libraries (e.g., math, os, sys, BioPython)

REFERENCE:

1. *Bioinformatics Programming Using Python* by Mitchell L Model
https://lib.unnes.ac.id/32049/1/Bioinformatics_Programming_Using_Python.pdf

COURSE OUTCOMES:

After completing the course, students shall be able to

- CO1: Describe programming principles and Linux scripting for basic computational tasks.
CO2: Illustrate Python programs using appropriate data types, control structures, and built-in functions.
CO3: Apply Python libraries such as NumPy for array and matrix operations in scientific computing.
CO4: Demonstrate structured code using functions, file operations, and object-oriented programming concepts in Python.

LEARNING OBJECTIVES:

The major aim of this undergraduate course is to provide basic theoretical knowledge in the field of Genomics, Transcriptomics, Proteomics and Metabolomics.

SYLLABUS:**Unit 1**

Genomics: Basics of genome sequence and annotation, Structural and Functional Genomics, Genome Sequencing strategies.

Unit 2

Transcriptomics: Definition, Analytical techniques, PCR and QRT PCR, Microarrays, RNA Sequencing- NGS platforms (Bulk RNA seq, Single cell RNA seq, mRNA seq etc), Protocol for RNA seq-library preparation, bioinformatics analysis.

Unit3

Proteomics: Introduction to proteomics, Importance of mass spectrometry in Proteomics, Basic concepts and Instrumentations, Electrospray (ESI), Matrix Assisted Laser Desorption and Ionization (MALDI), Quadrupole, Ion trap, Time-of Flight, Fourier transform ion cyclotron resonance (FT-ICR), Orbitrap, Electron multiplier horn, Microchannel plate.

Unit 4

Protein separation and detection techniques: Electrophoresis, High-performance liquid chromatography (HPLC), Peptide mass finger printing, Tandem mass spectrometry, Major Protein identification softwares-Mascot and Sequest.

Unit 5

Metabolomics: Introduction to metabolomics, Workflows of metabolome analysis.

REFERENCES:

1. *Genomes*, Terence A. Brown, Garland Publishing, 3rd Ed., 2007.
2. *Molecular Biology*, Robert F. Weaver, McGraw-Hill, 5th Ed., 2012.
3. *Molecular Biology of the Gene*, James D. Watson, Tania A. Baker, Stephen P. Bell, Pearson, 5th Ed., 2006.
4. *Introduction to Proteomics: Tools for the New Biology*, Daniel C. Liebler, Humana Press, 1st Ed., 2001.
5. *Mass Spectrometry for Biotechnology*, Gary Siuzdak, Academic Press, 1st Ed., 1996.
6. *Principles and Techniques of Biochemistry and Molecular Biology*, Keith Wilson and John Walker, Cambridge University Press, 7th Ed., 2010.
7. *Mass spectrometry-based metabolomics: A Practical Guide*, Sastia P. Putri and Eiichiro Fukusaki, CRC Press, 1st Ed., 2015.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Explain concepts of genomics, transcriptomics, proteomics and metabolomics.

CO2: Discuss methodologies and techniques associated with omics.

CO3: Solve omics data.

CO4: Apply workflows and strategies for biomolecular identification and characterization.

25BIO303

BIOENERGETICS & METABOLISM

2 1 0 3

LEARNING OBJECTIVES:

The course is designed to understand the metabolic pathways, their energetic and regulatory mechanisms inside the cell.

SYLLABUS:

Unit 1

Bioenergetics: Thermodynamics – First law of thermodynamics, second law of thermodynamics, Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes- ΔG , ΔG^0 and $\Delta G'^0$, Relationship between equilibrium constant and $\Delta G'^0$, Feasibility of reactions. Simple problems, ATP-Structure, properties and energy currency of the cell, Importance of Coupled reactions, High energy compounds, simple problems. Introduction to Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways.

Unit 2

Carbohydrate Metabolism: Introduction, Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation, Malate-Aspartate Shuttle. TCA cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Chemiosmotic hypothesis Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Oxidative stress., Pentose phosphate pathway (HMP shunt) & its regulation, Photosynthesis – ‘light’ and ‘dark’ reactions: Cyclic photophosphorylation, C4-pathway.

Unit 3

Lipid Metabolism: Beta – oxidations of saturated & unsaturated fatty acids, Carnitine shuttle. Ketone bodies, production during starving and diabetes Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate, energetics, coordinated regulation of fatty acid biosynthesis and oxidation mediated by insulin and glucagon. Biosynthesis of triacylglycerols, Biosynthesis of cholesterol, regulation.

Unit 4

Amino Acid Metabolism: Biodegradation of amino acids – deamination, transamination, decarboxylation, urea cycle including regulation. Biosynthesis of amino acids, Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, biologically active amines, Aminoacid derived neurotransmitters and hormones,

Unit 5

Nucleic Acid Metabolism

Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Lesch-Nyhan syndrome & Gout; Allopurinol and xanthine oxidase inhibition.

REFERENCES:

1. Lehninger, Nelson and Cox, *Principles of Biochemistry*, 7th Edition, Freeman, W. H. & Company, 2017.
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, *Fundamentals of Biochemistry: Life at the Molecular Level*, Wiley, 5th Edition. 2016

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand the basics of metabolism, enzymes involved and energetics of biological reactions.

CO2: Demonstrate the catabolic and anabolic pathways of biomolecules

CO3: Demonstrate the regulatory aspects of metabolic pathways and errors in metabolism.

25BIO304 INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY 2 1 0 3

LEARNING OBJECTIVES:

The objective of this course is to understand the basic skills applied in fermentation technology and use of biological resources as input to biobased processes which are economically and environmentally sustainable.

SYLLABUS:

Unit 1

Introduction to fermentation: Types of fermentation processes, Component parts of fermentation processes, Classification of fermentation process based on physical state of media, oxygen demand and mode of operation, Media formulation. Need of Sterilization, Aeration and Agitation. Stages of downstream processing: Cell disruption (for intracellular products), Removal of insoluble, Product isolation, Product purification, Product polishing, Formulation and Marketing

Unit 2

Isolation, screening, characterization and preservation of industrially important microorganisms: Criteria of industrial microorganisms, industrial strategy for usage of microbes, Isolation of microbes from environment, Primary and secondary screening of isolated organisms, Preservation of isolated microorganisms.

Unit 3

Strain improvement: Need for strain improvement, Optimization of microbial activity (environmental and nutritional), genetic modification of isolated organisms (methods involving and not involving foreign DNA), Selection of mutants or genetically modified or improved organisms (Random and Rational screening (regulatory, auxotrophic, permeability, morphological and revertant mutants)). Examples of production: Penicillin, Streptomycin, Citric acid

Unit 4

Design of fermenter and types of fermenter: Internal view of an industrial fermenter, Provisions and activities carried out in a fermenter, Major parts of a fermenter and their functions- Temperature control of a fermenter, Aeration and agitation-types of sparger, Stirrer Gland and Bearing, Baffles, Achievements and maintenance of aseptic conditions, Sterilization of fermenter and air supply, Feed port and sensor probes, Foam control system, Monitoring and control, Different types of valves, Steam trap. Structural difference of twelve types of fermenters from the common design and their application

in industry- fermentation vessel, Waldhof fermenter, Acetator, Cavitator, Tower Fermenter, Bubble column, Vertical beer tower fermenter, Multistage system, Cyllindro-Conical vessel, Deep Jet Fermenter, Cyclone column fermenter, Packed Tower Fermenter, Rotating Disc Fermenter, Animal cell culture and stirred fermenter, Air lift fermenters for animal cell culture, Microcarriers, Encapsulation and hollow fibre chamber, Packed glass bead reactors and Perfusion cultures for animal cell culture.

Unit 5

Effluent treatment: Fermentation effluents, Industrial contaminants and their impacts, BOD and COD, Effluent treatment processes (primary, secondary and advanced), Biological treatment: aerobic and anaerobic. Factors influencing bioremediation. Advantages and disadvantages of bioremediation.

REFERENCES:

1. *Principles of fermentation technology*, Stanbury and Whitaker, 2nd edition, 2013.
2. *Industrial Microbiology* by L.E Casida, John Wiley and sons INC, 1st edition, 1968.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basics of fermentation technology and their use, and types/classes of fermentation process.

CO2: Explain strategies and criteria involved in isolation, screening and preservation of industrially important microorganisms.

CO3: Discuss the strain improvement strategies and selection of the improved organisms using rational and random screening.

CO4: Illustrate the major parts of a bioreactor and discuss the different types of fermenters.

CO5: Demonstrate the different stages of Downstream processing and waste management in fermentation industry

25BIO300

RESEARCH METHODOLOGY

2002

LEARNING OBJECTIVES:

This course introduces students to research mainly in the field of Life sciences. The objective is to get them ready to do fruitful research during their final semester and prepare for all India level competitions for Fellowship in Indian Academy of Science.

SYLLABUS:

Unit 1

Introduction: Fundamentals of Research Methodology, Applications in life sciences,

Unit 2

Literature Search: Use of databases, framing query with examples, Bibliometric: Citation, Impact factor, Eigen factor.

Unit 3

Hypothesis Testing: Hypothesis as a framework for scientific projects, Alternatives of hypothesis driven research and hypothesis generating research.

Unit 4

Experimental Design and Data Analysis: Different types of experimental designs, Controls, Taking measurements, Data Analysis: Between-individual variation, replication and sampling, Common statistical tests with Excel.

Unit 5

Art of Scientific Writing and Presentation: Writing research hypothesis (grant). Presenting research: oral and poster.

REFERENCES:

1. Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press.
2. Experimental Design for the Life Sciences. Ruxton & Colegrave. Oxford University Press.
3. Experimental Design for Biologists. David J. Glass. Cold Spring Harbor Laboratory.
4. C.R. Kotari, Research Methodology Methods and Techniques, Second Revised Edition, New Age International (P) Limited, Publishers.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recognise different aspects of research methodology

CO2: Understand the basic concepts of hypothesis generation and experimental designing.

CO3: Perform analysis, interpretation and presentation of research data

CO4: Apply research methodology aspects for formulating grant proposals.

25SSK301

SOFT SKILLS II

0 1 0 1

LEARNING OBJECTIVES:

To improve confidence, presentation skills and communication skills of the students.

SYLLABUS:

Introduction / Ice Breaking, Personal Visioning, Personal Visioning - Classroom Workshop

Personal Visioning – Classroom Workshop, Self-Introduction, Importance of assertive communication, Importance of assertive communication, Introduction to presentation Skills, Discussion on presentation Skills, Assessment on presentation Skills, Assessment on presentation Skills, Concluding Session

Small activity, Familiarization of all members of the class, "Discussing the Questions, Why do we need a vision?, SWOT Analysis, SWOT as a decision making tool", "Further focus on students go deeper and do SWOT Analysis, list of achievements, 1 year action plan in the class", "Further focus on students go deeper and do SWOT Analysis, list of achievements, 1 year action plan in the class", "Sample Self Introductions, Self Intro Videos of examples", Communication merits: Body language and pitch & tone variations, "Articulation Skills: 3Cs of Communication, Verbal / Non-verbal, Written / Voice, Body Language - Video of Obama Speech, provocative questions to students and discussing on various gestures etc...Assertive + Persuasive", "- Public Speaking: Modi, Kalam, Language, Vision, Inspiration, Heart, Don't imitate, be original, making some students to speak randomly, Impromptu speech, Fluency, Structure & content, How to practice public speaking", Assessment on presentation

Skills – Public presentation skills, Assessment on presentation Skills – Public presentation skills, "Concluding session: Pep talk - Practice, Practice, practice, Feedback".

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand the Soft skills sessions.

CO2: Discuss insights on setting objectives.

CO3: Demonstrate confidence to present in front of audience.

25BIO381 INDUSTRIAL BIOTECHNOLOGY LAB 0042

LEARNING OBJECTIVES:

To provide hands on experience on isolating and evaluating the industrial potential of microorganisms from various sources. This course helps students to work with small scale fermenters and learn their basic working principles.

SYLLABUS:

1. Isolation and screening of antibiotic producers by crowded plate technique.
2. Isolation of Actinomycetes from soil, Secondary screening protocols-Giant colony technique, Secondary screening protocols-Kirby-Bauer method.
3. Isolation and screening of microorganism producing proteases.
4. Isolation and screening of microorganisms producing amylases.
5. Isolation of Nitrogen fixers from soil.
6. Isolation of phosphate solubilizers from soil.
7. Immobilization of yeast in alginate beads for ethanol production.
8. Production of citric acid.

REFERENCES:

1. James G. Cappuccino and Natalie Sherman *Microbiology: A Laboratory Manual*, 10th edition, 2014.
2. Arnold L Demain, Julian E Davies, *Manual of Industrial Microbiology and Biotechnology*, 2nd edition, 1996.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand various methods of screening industrially important microorganisms from different sources.

CO2: Perform the technique of immobilization of yeast cells.

CO3: Examine the ability of microorganisms for antibiotic production

SEMESTER 6

25BIO311

PHARMACOLOGY

4 0 0 4

LEARNING OBJECTIVES:

To provide an understanding about the basic concept of drug discovery & designing, mechanism of action of different drugs, pharmacodynamics, pharmacokinetics, pharmacogenomics etc.

SYLLABUS:

Unit 1

Introduction to Pharmacology - Fundamental Principles of Pharmacology, Fundamentals of Cardiovascular, Endocrine, and Immunopharmacology.

Unit 2

Introduction to Drug Discovery - Contemporary Approaches to Drug Discovery, Development and Delivery, Fundamentals of Drug Evaluation and Pharmacogenomics, FDA rules and regulations for the approval of new drugs, Major companies in the pharmaceutical industry, Biopharmaceuticals, Nutraceuticals, Economics of drug development.

Unit 3

Pharmacodynamics and Pharmacokinetics- Receptor theory & kinetics, Dose-response relationships, Mechanism of drug action, Phase I and phase II of drug metabolism, Drug efficacy, Pharmacokinetics concepts, Pharmacogenomics, Principles of Toxicology.

Unit 4

Principles of Chemotherapy- Principles of antimicrobial and antineoplastic chemotherapy, Types of selective targeting by drugs, Antibacterial and antifungal drugs, and mechanisms of action, Antiparasitic drugs and mechanisms of action, Antiviral drugs and mechanisms of action, Antineoplastic drugs and mechanisms of action, Combination chemotherapy (with respect to antimicrobial and antineoplastic drugs).

Unit 5

Intellectual Property Rights with respect to Pharmaceuticals.

REFERENCES:

1. *Pharmaceutical Biotechnology Fundamentals and Applications* by Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer New York.
2. *Principles of Pharmacology* by D. Golan, A. Tashjian, E. Armstrong, J. Galanter, A.W. Armstrong, R. Arnaout and H. Rose, Lippincott Williams and Wilkins.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand the basics of pharmacology, various stages of drug discovery and intellectual property rights.

CO2: Summarise the basic concepts and principles behind pharmacokinetics, pharmacodynamics, and toxicology

CO3: Demonstrate the principles of antimicrobial and anti-neoplastic chemotherapy

LEARNING OBJECTIVES:

To provide an understanding about the basic principles of development of multicellular organisms. To provide an understanding of the role of genes in development. To compare the development of different organisms and to understand the similarities in development. To highlight the application of the field in stem cell therapy, regenerative medicine, drug development etc.

SYLLABUS:**Unit 1**

History & Basic concepts of development: Overview of how the modern era of developmental biology emerged through multidisciplinary approaches, stages of development- zygote, blastula, gastrula, neurula.

Unit 2

Cell fate & commitment: potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map.

Unit 3

Mechanisms of differentiation: cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development.

Unit 4

Specification of adult stem cells. Pattern formation: axis specification, positional identification (regional specification). Morphogenetic movements, Model organisms in Developmental biology: Early Development in invertebrate /vertebrate models Drosophila, C.elegans, Xenopus, Mouse/ human: Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates

Unit 5

Late Development in invertebrate /vertebrate models: Organogenesis- development of central nervous system in vertebrates, vulval formation in C. elegans, Germ cell specification & migration, Importance of developmental genes. Medical implications of developmental biology - genetic errors/ teratogenesis/ stem cell therapy etc.

REFERENCES:

1. *Developmental Biology*, Eighth Edition" by Scott F Gilbert, 2006.
2. *Principles of Development* - Lewis Wolpert, 4th edition, 2011.
3. Website: virtual embryo http://people.ucalgary.ca/~browder/virtualembryo/dev_biol.html

COURSE OUTCOMES:

After completing the course, students shall be able to

- CO1: Recognize the various processes that happen during the development of different organisms.
CO2: Understand the role of genes during development.
CO3: Discuss the problems that can happen by mutation in genes during development.
CO4: Demonstrate the development of different organisms.
CO5: Examine the major genes and signalling processes during the development.

CO6: Examine the basis of different congenital disorders in humans.

25BIO313

GENETIC ENGINEERING

3 1 0 4

LEARNING OBJECTIVES:

Genetic engineering courses allow the students to learn the techniques involved in genetic manipulation or modification. The course mainly focuses on recombinant DNA technology, DNA manipulation, molecular cloning, gene editing, protein engineering, transgenic animals and ethics of genetic engineering. Students will learn to design novel products using genetic engineering for application in the different sectors of biotechnology and effectively present their ideas.

SYLLABUS:

Unit 1

Principles of gene cloning: types of vectors, primer designing strategies, restriction digestion, ligation.

Unit 2

Molecular tools and techniques used in gene cloning and functional genomics: PCR, RT-PCR, electrophoresis, blotting, DNA sequencing, microarray, RNA sequencing, SAGE, qRT-PCR.

Unit 3

Introducing DNA into cells: basic cell culture and transfection methods, generation of transgenic cell lines/animals, expression systems for recombinant proteins: bacteria/ yeast/ insect/mammalian system.

Unit 4

Gene editing: homologous recombination, zinc-finger nucleases, TALENS, CRISPR-Cas9, site directed mutagenesis.

Unit 5

Advanced genetic engineering techniques: reporter gene assays, DNA finger printing, DNA-protein and protein-protein interactions.

REFERENCES:

1. *Gene Cloning and DNA Analysis: An Introduction*, 6th Edition, T. A. Brown, Wiley Blackwell, 2007.
2. *Principles of Gene Manipulation & Genomics – 7th Edition* – Sandy B. Primrose, Richard Twyman– Blackwell, 2001.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the process of molecular cloning.

CO2: Describe the application of molecular tools and techniques used in gene cloning and functional genomics.

CO3: Illustrate different recombinant protein expression and purification systems.

CO4: Demonstrate the process of gene editing using different methods.

CO5: Demonstrate the advanced molecular techniques.

CO6: Analyse current genetic engineering techniques to discuss its impact in biological research and medicine.

25MIC311 PLANT AND ANIMAL TISSUE CULTURE

2 1 0 3

LEARNING OBJECTIVES:

- Understand the fundamental principles of plant and animal tissue culture, including totipotency, differentiation, and media composition.
- Comprehend the physiological and technical requirements for in vitro maintenance and manipulation of plant and animal cells.
- Analyse the theoretical basis and applications of tissue culture techniques such as callus induction, micropropagation, stem cell culture, and recombinant protein production.
- Evaluate the ethical, safety, and industrial implications of tissue culture technologies in agriculture, research, and medicine.

SYLLABUS:

Unit 1: Theoretical Foundations of Plant Tissue Culture

Fundamental principles of plant tissue culture, cellular totipotency, differentiation, and the physiological basis of in vitro growth. Topics include types of explants, composition of culture media (macro- and micronutrients, vitamins, carbon sources, plant growth regulators), and the influence of environmental conditions (light, temperature, and photoperiod). Callus induction, organogenesis, somatic embryogenesis, and micropropagation. Applications discussed include clonal propagation, production of virus-free plants, germplasm conservation, and in vitro mutagenesis for crop improvement and transgenic plants.

Unit 2: Principles of Animal Cell and Tissue Culture

Conceptual and technical underpinnings of animal cell culture. Cell types (primary vs. continuous lines), growth characteristics, and requirements for in vitro maintenance. Media composition, serum function, growth factors, and the concept of cell viability and doubling time. Contamination sources and prevention, authentication of cell lines, and the theoretical basis of cell immortalization. Ethical considerations and biosafety protocols in handling animal-derived cell cultures. Applications such as vaccine development, toxicity testing, and cancer biology research and transgenic animals.

Unit 3: Applications and Advancements in Tissue Culture Technology

Plant and animal systems to highlight advanced applications and recent developments in tissue culture technology. In plant systems: Metabolic engineering for secondary metabolite production, genetic transformation strategies, and protoplast culture and fusion. In animal systems: Stem cell biology, recombinant protein production, hybridoma technology, and the emergence of 3D cultures and organoid models. Insights into the industrial and therapeutic potential of tissue culture, including biopharmaceutical production, regenerative medicine, and conservation biotechnology.

REFERENCES:

1. *Plant Tissue Culture: Theory and Practice*"S.S. Bhojwani and M.K. Razdan, Publisher: Elsevier

2. "*Plant Biotechnology and Genetics: Principles, Techniques and Applications*" C. Neal Stewart Jr., Publisher: Wiley-Blackwell
3. "*Plant Cell and Tissue Culture – A Tool in Biotechnology*" Karl-Hermann Neumann, Ashwani Kumar, János I. Handa, Publisher: Springer
4. "*Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*" R. Ian Freshney, Publisher: Wiley-Blackwell
5. "*Animal Cell Culture: Essential Methods*" John M. Davis, Publisher: Wiley

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the core theoretical foundations and methodologies of plant and animal tissue culture.

CO2: Identify and explain the roles of culture media components and environmental conditions in promoting cell growth and development.

CO3: Classify different types of tissue culture systems and evaluate their applications

CO4: Demonstrate awareness of biosafety, contamination control, and ethical considerations in handling tissue cultures.

CO5: Apply knowledge of plant and animal systems to explore advanced tissue culture strategies.

25BIF314 ARTIFICIAL INTELLIGENCE FOR BIOLOGY 2 1 0 3

LEARNING OBJECTIVES:

An introductory course designed to familiarize students with the role of artificial intelligence in modern biological research. The course focuses on foundational AI concepts and their integration with molecular biology, biomedical literature mining, and real-world applications in drug discovery and protein structure prediction.

SYLLABUS:

Unit 1

Introduction to AI and Its Role in Biology – Definitions and scope of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL). Types of machine learning: supervised, unsupervised, and reinforcement learning. Key concepts: features, labels, models, training, and validation. Overview of biological data types: genomic sequences, expression profiles, imaging, and structural data. Applications of AI in disease prediction, biomarker discovery, and pattern recognition in biological imaging, including disease marker detection, biodiversity conservation, and ecological monitoring such as pollution tracking.

Unit 2

AI Models for Molecular Biology – Role of AI models in protein structure prediction, functional annotation, and interaction prediction. Working with structure prediction data: reading PDB files, interpreting confidence scores, and understanding model limitations. Integration of model predictions into biological hypotheses. Introduction to prominent AI tools and models including AlphaFold, AlphaFold-Multimer, ESMFold, ESM3, RoseTTAFold, diffusion-based models, and FoldSeek.

Unit 3

Natural Language Processing and LLMs in Biology – Overview of NLP in biological contexts. Introduction to biomedical text databases: PubMed, PMC, and ClinicalTrials.gov. Application of NLP

models in named entity recognition (genes, proteins, diseases), relation extraction (e.g., gene-disease, drug-target), automatic summarization, question answering, and literature-based discovery. Ethical considerations: misinformation and hallucination in LLMs, citation practices for AI-generated content, and training data bias.

Unit 4

Using AI Tools in Real-World Biological Research – Working with pre-trained models: interpretation of outputs, evaluation of model reliability and bias. Application of AI in drug discovery: virtual screening, target prediction, and drug repurposing. Ethical, legal, and societal aspects of AI in biology. Guidance on selecting appropriate AI tools based on research needs, accessibility, and ease of use.

REFERENCES:

1. Ramsundar, B., et al. *Deep Learning for the Life Sciences*, 2nd Edition. O'Reilly Media, 2019.
2. *A Biologist's Guide to Artificial Intelligence*, Springer, 2024.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Recognize the scope of artificial intelligence and its applications in biology.

CO2: Understand and utilize AI models relevant to molecular biology, including protein structure prediction and function inference.

CO3: Use natural language processing tools for biomedical literature mining and information extraction.

CO4: Apply pre-trained AI tools for use in drug discovery and biological data analysis.

CO5: Implement ethical and practical considerations while applying AI in biological research.

25BIO382

GENETIC ENGINEERING LAB

0 0 4 2

LEARNING OBJECTIVES:

The course attempts to introduce the basic concepts of recombinant DNA technology namely gene manipulations used for cloning, plasmid and genomic DNA isolation, restriction digestion and analysis by gel electrophoresis and documentation, PCR, transformation techniques, and protein analysis.

SYLLABUS:

1. Plasmid DNA isolation.
2. Agarose gel electrophoresis.
3. Competent cell preparation.
4. Transformation methods.
5. Genomic DNA isolation.
6. Restriction digestion of Plasmid DNA.
7. Polymerase chain reaction (PCR).
8. Poly acrylamide gel electrophoresis and protein analysis.

REFERENCES:

1. Sambrook, J., Russell, D. W., & Russell, D. W. (2001). *Molecular cloning: a laboratory manual* (3-volume set).
2. Amrita University Virtual Lab (<http://vlab.amrita.edu/>)

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe basic principles and methodology of Recombinant DNA technology

CO2: Interprets the results obtained after performing every lab experiment

CO3: Apply the knowledge to solve qualitative and quantitative problems in Recombinant DNA technology

25MIC381 PLANT AND ANIMAL TISSUE CULTURE LAB 0042**LEARNING OBJECTIVES:**

- Understand the fundamental principles and practices of plant and animal tissue culture.
- Gain hands-on experience with aseptic techniques and culture preparation.
- Learn standard procedures for initiating and maintaining plant and animal cell cultures.
- Develop skills in observing, analyzing, and interpreting cultured cell behavior under laboratory conditions.

SYLLABUS:

1. Preparation and sterilization of MS medium
2. Surface sterilization and inoculation of explants (e.g., leaf, shoot tip)
3. Callus induction from explants
4. Micropropagation via shoot tip culture
5. Root induction in regenerated shoots
6. Preparation and sterilization of animal cell culture media
7. Thawing and revival of a mammalian cell line (e.g., HeLa or CHO)
8. Subculturing (passaging) of adherent cells
9. Trypan blue staining for viability and cell counting using a hemocytometer
10. Observation of cells under inverted microscope and cell counting

REFERENCES:

1. *Plant Tissue Culture: Theory and Practice*", Authors: S. S. Bhojwani and M. K. Razdan
Publisher: Elsevier
2. *Introduction to Plant and Animal Tissue Culture*", Author: A. K. Bhattacharya
Publisher: Kalyani Publishers

COURSE OUTCOME:

After completing the course, students shall be able to

CO1: Illustrate preparation and sterilization of culture media for plant and animal cell growth.

CO2: Perform surface sterilization and in vitro culture of plant explants for callus induction and regeneration.

CO3: Execute mammalian cell culture techniques such as revival, passaging, and viability assessment.

CO4: Perform quantification of cell growth and viability using hemocytometer and microscopy.
CO5: Demonstrate safe handling and maintenance of in vitro cultures, adhering to biosafety protocols.

SEMESTER 7

25BIO401

METABOLIC ENGINEERING

2 1 0 3

LEARNING OBJECTIVES:

- Understand the foundational principles of cellular metabolism and the rationale behind engineering metabolic pathways.
- Learn and apply molecular and synthetic biology tools used for modifying metabolic networks in various host systems from microbial systems to cell line systems
- Analyze metabolic pathways using computational models and metabolic flux analysis techniques.
- Explore industrial applications of metabolic engineering

SYLLABUS:

Unit 1: Foundations of Metabolic Engineering

Basic concepts and scope of metabolic engineering, beginning with an overview of cellular metabolism and metabolic pathway organization. Key biochemical pathways and manipulation of these pathways for biosynthetic applications. Energy and redox balancing, precursor metabolite generation, and regulation of metabolic fluxes. Regulatory mechanisms such as feedback inhibition, catabolite repression, and allosteric control for pathway engineering. Computational tools used for metabolic pathway analysis, including stoichiometric models and basic metabolic flux analysis (MFA).

Unit 2: Tools and Strategies in Metabolic Engineering

Methodologies used to modify and optimize metabolic networks. Gene editing techniques, including gene knockouts, knock-ins, and overexpression systems, as well as synthetic biology tools for pathway reconstruction and refactoring. The use of different host organisms such as *Escherichia coli*, *Saccharomyces cerevisiae*, *Pichia pastoris*, *CHO cell lines* and newer chassis like cyanobacteria and *Corynebacterium glutamicum*, *Aspergillus* sps, for pathway efficiency and scalability. Design of new expression systems, promoter engineering, transcription factor engineering, secretion system and signal peptide engineering, Alleviation of ER stress in recombinant protein production systems, Humanisation of Yeast expression systems for therapeutic protein production. Dynamic regulation techniques such as metabolic switches, biosensors, and CRISPR-based transcriptional control for fine-tuning pathway activity.

Unit 3: Applications and Emerging Trends

Real-world applications of metabolic engineering in various industries, including pharmaceuticals, food, agriculture, and sustainable energy. Case studies for pathway engineering for the microbial production of biofuels, biodegradable plastics, plant secondary metabolites, therapeutic proteins, growth factors, monoclonal antibodies with special reference to novel and modified expression

systems. New genome editing tools and techniques for metabolic engineering. Systems biology approaches for omics data integration and pathway modeling. Advanced topics such as adaptive laboratory evolution (ALE), genome-scale metabolic models (GEMs), and the application of AI and machine learning in strain design. Regulatory, ethical, and safety considerations in commercial metabolic engineering.

REFERENCES:

1. "Metabolic Engineering: Principles and Methodologies", *Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen*, Publisher: Academic Press
2. *Systems Biology and Biotechnology of Escherichia coli*"*Sang Yup Lee, Jens Nielsen, Gregory Stephanopoulos*, Publisher: Springer

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Explain key metabolic pathways and identify potential engineering targets for enhanced metabolite production.

CO2: Discuss genetic and synthetic biology tools such as gene knockouts, CRISPR-based regulation, and promoter engineering for pathway optimization.

CO3: Demonstrate various microbial and mammalian host systems used in metabolic engineering and justify their use based on the application.

CO4: Perform basic metabolic flux analysis and use computational tools to predict outcomes of genetic modifications.

CO5: Analyse case studies and recent advancements in metabolic engineering for the sustainable production of bio-based products and therapeutics.

25BIO404 RESEARCH ETHICS, SCIENCE COMMUNICATION AND IPR MANAGEMENT

2 1 03

LEARNING OBJECTIVES:

The primary objective of this course is to develop scientific communication skills, including oral presentation, academic writing, grant proposal preparation, and digital science communication. The course also aims to instill awareness of intellectual property rights (IPR) and equip students with the knowledge of documentation and administrative procedures related to IPR. Additionally, the course emphasizes the importance of ethics in research, particularly in relation to human rights and responsible scientific conduct.

SYLLABUS:

Unit 1: Scientific Communication:

Introduction and significance of scientific communication, scientific paper writing, publishing process and peer review system, hypothesis framing, grant writing, oral and poster presentations, science communication via digital and social media platforms.

Unit 2: Intellectual Property Rights (IPR)

Importance and types of IPR, definition and process of patent granting, copyrights, trademarks, and design registration. Overview of pharmaceutical patenting in India, implications of the TRIPS agreement, patentable aspects of pharmaceutical products and innovations.

Unit 3: Geographical Indications and IPR Traditional Knowledge

Definition and significance of geographical indications (GI), examples of GI-protected products in India, issues of biopiracy, protection of traditional knowledge systems, AYUSH and traditional medicine, commercialization of AYUSH products and the role of IPR.

Unit 4: IPR Case Studies

Real-world examples highlighting the need for effective IP management strategies, landmark patent infringement cases in pharmaceuticals, biotechnology, diagnostics, and agriculture.

Unit 5: Research Ethics

Ethical principles in scientific research, importance of protecting human rights in research, guidelines for responsible conduct of research, issues of plagiarism, data falsification, authorship disputes.

REFERENCES:

1. Cook, Trevor (2002), *A Users guide to Patents*, Butterworths, London
2. Bently L, and Sherman B, (2001), *Intellectual property law*, Oxford University Press
3. Wegner, Harold (1994), *Patent Law in biotechnology, chemicals & pharmaceuticals*, Stockton, chipperham
4. Bruce Lehman, President, International Intellectual property Institute, *The Pharmaceutical Industry and the Patent system*.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understand scientific communication skills

CO2: Describe the importance of different types of IP protections.

CO3: Explain Ethics moral principles that constitute the basis for ethics in research.

25BIO402

APPLIED BIOANALYTICAL METHODS

2103

LEARNING OBJECTIVES:

- **Understand** the theoretical principles underlying advanced biophysical, spectroscopic, chromatographic, and genomic techniques used in modern biological research.
- **Learn** to select and apply appropriate analytical tools for studying biomolecular structure, interactions, dynamics, and cellular localization.
- **Develop** competence in interpreting experimental data from tools such as fluorescence spectroscopy, NMR, mass spectrometry, flow cytometry, and NGS.
- **Explore** integrated applications of these techniques in proteomics, genomics, molecular diagnostics, and live-cell analysis.

SYLLABUS:

Unit 1: Spectroscopic and Biophysical Analysis of Biomolecules

Fluorescence Spectroscopy and FRET (Förster Resonance Energy Transfer) for biomolecular interactions, Circular Dichroism (CD) Spectroscopy for secondary structure analysis, NMR Spectroscopy for structure and dynamics of biomolecules, Mass Spectrometry in protein and nucleic acid analysis, Isothermal Titration Calorimetry (ITC) and Differential Scanning Calorimetry (DSC) for interaction studies

Unit 2: Advanced Chromatographic and Proteomics Tools

Affinity Chromatography and Fast Protein Liquid Chromatography (FPLC) for tagged protein purification High Performance Liquid Chromatography (HPLC) for biomolecule separation, 2D-Gel Electrophoresis and Mass Spectrometry-based Proteomics, Thermophoresis and Surface Plasmon Resonance (SPR) for kinetic and affinity profiling

Unit 3: Advanced Imaging and Cell Analysis Techniques

Confocal Laser Scanning Microscopy for 3D cellular imaging, Flow Cytometry and Fluorescence-Activated Cell Sorting (FACS), Fluorescence In Situ Hybridization (FISH) for nucleic acid localization, Super-Resolution Microscopy (STORM, PALM), Live Cell Imaging and Label-Free Imaging Techniques

Unit 4: Nucleic Acid Analysis and Genomic Tools

Digital PCR (dPCR) and Droplet Digital PCR (ddPCR) for ultra-sensitive nucleic acid quantification, FRET-based Nucleic Acid Hybridization Assays, Next-Generation Sequencing (NGS) and RNA-Seq, CRISPR-based diagnostics (e.g., SHERLOCK, DETECTR), ChIP-Seq, ATAC-Seq, and Bisulfite Sequencing for epigenomic profiling, Microarrays and Yeast Two-Hybrid for interaction mapping.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology. Editors: Keith Wilson and John Walker Publisher: Cambridge University Press
2. Introduction to Proteomics: Tools for the New Biology. Author: Daniel C. Liebler Publisher: Humana Press

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Apply biophysical and spectroscopic methods to investigate biomolecular structure, folding, and interactions.

CO2: Demonstrate proficiency in protein purification, proteomics, and affinity/kinetic analysis using advanced chromatographic and biophysical tools.

CO3: Use imaging and flow-based techniques for detailed cellular and molecular analysis, including real-time and high-resolution applications.

CO4: Analyze complex genomic and transcriptomic data using digital PCR, NGS, and CRISPR-based diagnostic tools to draw meaningful biological conclusions

25BIO03 ADVANCED PHARMACEUTICAL BIOSCIENCES 2 1 0 3

LEARNING OBJECTIVE:

The course aims to familiarize students with the fundamental concepts of drugs, including their properties, and biologics. It seeks to introduce various methods for target identification and validation, such as phenotypic screening and chemoproteomics. Students will learn about the processes involved in assay development, lead discovery, and optimization, including techniques like computer-aided drug discovery and SAR studies, chemotherapeutic agents and their properties. Additionally, the course covers the processes involved in drug metabolism, mechanisms of action, toxicity evaluation, and the role of prodrugs in enhancing drug efficacy and safety

SYLLABUS:

Unit 1

Introduction, Definition of drug, Composition of drug, Properties of drug, Druggable genome, Biologics, Properties of Biologics, Similarities and differences with respect to Chemical Entities, Target identification and validation: Different types of targets, Methods of target identification, Phenotypic screening, Chemoproteomics, Gene association studies, Transgenics, Compound Libraries, Combi-chem, Computer Aided Drug Discovery (CADD), Fragment Based Drug Discovery (FBDD).

Unit 2

Assay development: Introduction and Importance, Primary screening, Outcomes: Hit identification and re-confirmation Secondary screening, IC₅₀ determination, Lead discovery and optimization, Pharmacophore, SAR studies, Rational drug design, Toxicity studies - Different types: acute, sub-acute chronic, Safety evaluation, Clinical studies, Features, Different types: Phase 1, 2, 3 and 4, Biologics steps in drug development, Biological drug development process, Cloning in biologics development, Hybridoma technology, Bioreactors, Batch, Fed-batch and Continuous cultures, Techniques for purification, Formulation development, Types of antibodies.

Unit 3

Cancer and Chemotherapy, Alkylating agents, Antimetabolites, Folic acid antagonists, Purine antagonists, Pyrimidine antagonists, Antibiotics, Estrogen therapy, Androgen therapy, Aromatase inhibitors, Drugs derived from natural products, Tyrosine kinase inhibitors.

Unit 4

Metabolism, Mechanism of action, Detoxification reactions, Phase I - functionalization reactions, Phase II - conjugation reactions, Structure toxicity relationships, Reactive metabolites, Factors influencing drug metabolism, Metabolic enzyme induction, Biological factors, Prodrugs, Prodrugs to improve membrane permeability, Drugs recognized by transport proteins, Prodrugs to prolong drug activity, Prodrugs masking drug toxicity and side effects, Prodrugs to improve water solubility, Prodrugs to increase chemical stability, Prodrugs activated by external influence.

REFERENCES:

1. *Pharmaceutical Biotechnology*; Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm
2. Springer Nature, Switzerland, Sixth Edition, 2024.
3. *Principles of Pharmacology*; D. Golan, A. Tashjian, E. Armstrong, J. Galanter, A.W. Armstrong, R. Arnaut, H. Rose; Lippincott Williams and Wilkins/Wolters Kluwer, Baltimore, Seventh Edition, 2011.

5. Karyotyping (Optional)
6. Heterologous expression of recombinant proteins and purification in *E. coli*
 - a. PCR amplification of target gene and cloning in inducible vectors
 - b. Chemical mediated transformation/electroporation
 - c. Purification of recombinant protein by affinity chromatography
7. Analysis of fluorescent labelled bacteria
8. Transformation of *Sacharomyces cerevisiae* by electroporation and selection of recombinants

REFERENCE:

1. **Green, M. R., & Sambrook, J. (2012).** *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Illustrate handling and maintenance of *Drosophila* cultures and differentiate between sexes based on morphological traits.

CO2: Perform salivary gland dissection and prepare polytene chromosome slides for cytogenetic analysis.

CO3: Solve classical genetics problems including sex linkage and genetic mapping using *Drosophila*.

CO4: Demonstrate cloning a target gene into an inducible vector, transform *E. coli*, and express and purify the recombinant protein using affinity chromatography.

CO5: Analyze fluorescent-labelled bacterial cells and transform *Saccharomyces cerevisiae*, selecting recombinants through appropriate screening techniques.

SEMESTER 7

ELECTIVE 1 (3 0 0 3)

25BIO431

EMBRYOLOGY

3 0 0 3

LEARNING OBJECTIVES:

This course will cover the basics of human embryo development and explain the role of hormones and other factors involved in the successful implantation of embryo. The course will describe the diagnostic and treatment options available for infertility and the process involved.

SYLLABUS:

Unit 1: Basic Human Embryology, Gametogenesis, Meiosis, Implantation and placentation, Preimplantation embryo development, Development of various organs

Unit 2: Anatomy of Male and Female reproductive system, Physiology of Ovulation, Folliculogenesis, Physiology of Menses, Hormonal control of human, Natural Cycle, Various stimulation protocols, Ovarian Hyper stimulation syndrome (OHSS), Complication of stimulation

Unit 3: Reproductive Endocrinology, Reproductive pathology, Reproductive Pharmacology, Assisted Reproductive Technology- IUI, ICSI, IVF, Recent advances in ART, IVF Procedure: Fertilization, Embryo Production & Cryopreservation Techniques

Unit 4: Ethical & legal aspects of ART, Oocyte Donation Programme, Surrogacy

REFERENCES:

1. Textbook of Clinical Embryology by Vishram Singh, 3rd edition
2. A Textbook of Clinical Embryology, Cambridge University Press, March 2021
3. Human Embryology and Developmental Biology by Bruce M. Carlson, 6th edition
Developmental Biology, by Scott F. Gilbert, 11th edition

COURSE OUTCOME:

After completing the course, students shall be able to

CO1: Explain the basic developmental biology involved in embryo development.

CO2: Explain the physiology of human reproduction and the organs involved including the mechanistic and molecular aspects.

CO3: Demonstrate the endocrine mechanisms involved in reproductive biology and different types of assisted reproductive techniques.

CO4: Demonstrate the ethical and legal aspects of assisted reproductive technology

25BIO432 HOST-PATHOGEN INTERACTION AND HUMAN MICROBIOME 3 0 0 3

LEARNING OBJECTIVES:

- Understand the molecular and cellular strategies used by pathogens to evade and modulate host immune responses.
- Explain the role of host signaling pathways and programmed cell death mechanisms in infection and immunity.
- Describe the structure, diversity, and function of the human microbiome in health and disease.
- Analyze the impact of microbial dysbiosis on chronic and infectious diseases.
- Explore modern diagnostic and therapeutic strategies targeting host-pathogen and host-microbiome interactions.

SYLLABUS:

Unit 1: Host-Pathogen Interactions: Immune Evasion, Intracellular Survival, and Signaling

Pathogenic microbes and their interactions with the host immune system. Molecular and cellular strategies pathogens use to evade host defenses, including antigenic variation, inhibition of phagocytosis, complement evasion, and manipulation of cytokine responses, epigenetic modifications. How *Mycobacterium tuberculosis*, *Salmonella*, *Klebsiella pneumoniae*, *Aspergillus* sps, *Candida* and viruses like HIV manipulate host signaling pathways (e.g., NF- κ B, MAPK, JAK-STAT) to favor their survival and replication. Topics also include pathogen-induced modulation of programmed cell death pathways (e.g., apoptosis, pyroptosis), and the host's use of pattern recognition receptors (e.g., TLRs, NLRs) to detect and respond to infection. Host-directed therapies and other emerging therapies for control of pathogens.

Unit 2: Human Microbiome and Symbiotic Interactions

Composition, diversity, and functional roles of the human microbiome across various body sites such as the gut, skin, oral cavity, and urogenital tract. Dynamic relationships between the host and commensal microbes, including mechanisms of colonization resistance, nutrient exchange, and modulation of the immune system. Influence of microbiota on host metabolism, development, and disease susceptibility, including the effects of antibiotics, diet, and probiotics on microbial communities.

Unit 3: Microbial Dysbiosis and Disease: From Inflammation to Therapeutics

Microbiome dysbiosis, and its association with various diseases such as inflammatory bowel disease (IBD), obesity, diabetes, neurodegenerative disorders, and cancer. Methods for analyzing microbial communities (e.g., 16S rRNA sequencing, metagenomics) and development of microbiome-based diagnostics and therapeutics, including fecal microbiota transplantation (FMT), precision probiotics, and phage therapy. Case studies on how microbial manipulation can restore health or serve as adjuvants in immunotherapy.

REFERENCES:

1. The Human Microbiome, Diet, and Health"; *Institute of Medicine (US) Food Forum*
Publisher: National Academies Press
2. The Human Microbiome Handbook; *Jason Tetro*
Publisher: Springer
3. Mims' Pathogenesis of Infectious Disease" (6th or later dition); *Anthony Nash, Richard M. Dalziel, Cedric Mims*
Publisher: Elsevier
4. "Cellular Microbiology"; Editors: Pascale Cossart, J. Patrice Gorvel, Dominique Ladant
Publisher: ASM Press

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe mechanisms of immune evasion, intracellular survival, and signaling modulation used by key pathogens.

CO2: Explain how the human microbiome contributes to immune homeostasis, nutrient metabolism, and resistance to pathogens.

CO3: Demonstrate the pathological consequences of microbial dysbiosis and its role in diseases.

CO4: Apply knowledge of host-pathogen and microbiome interactions to propose strategies for therapeutic intervention

CO5: Analyse data from microbiome studies and assess their application in research or clinical settings.

25BIO433 MOLECULAR FLUORESCENCE: APPLICATIONS IN CHEMICAL BIOLOGY 3 0 0 3

LEARNING OBJECTIVES:

The syllabus outlines several key learning objectives such as understanding the fundamental principles of fluorescence spectroscopy such as emission and excitation spectra, polarization anisotropy, and

quenching mechanisms. Students will learn to apply these concepts to investigate protein interactions, membrane properties, and develop fluorescence-based probes and biosensors. The course also aims to equip students with skills to analyse lifetime measurements, interpret scattering effects, and utilize various fluorescent probes, including quantum dots and fluorescent proteins, in chemical biology research

SYLLABUS:

Unit 1

Emission Spectra, Raman Peaks, Excitation Spectra, Delayed Fluorescence, Scanning Methods, Applications of Polarization/Anisotropy, Protein Oligomerization, Protein/Ligand Interactions, Proteolytic Processing, Fluorescence Polarization Immunoassay, Membrane Fluidity, Effect of Scattering, Rayleigh Scatter and Rayleigh Ghosts, Depolarization via FRET

Unit 2

Excited State Lifetimes, Time Domain, Frequency Domain, Magic Angles, Anisotropic Decay, Dynamic Polarization, Determination of Quantum Yields, Quenching, Collisional or Dynamic Quenching, Static Quenching, Popular Quenchers, Quenching and Membrane Systems

Unit 3

Fluorophores, Intrinsic Probes, Extrinsic Probes, Photostability, Labelling Proteins In Vitro, Non-covalent Probes, Covalent Probes, Photoaffinity Labelling, Membrane Probes, Nucleic Acid Probes, Biosensors, Ion Probes, pH Probes, Molecular Beacons, Voltage-Sensitive Dyes, Quantum Dots, Fluorescent Proteins

REFERENCES:

1. *Principles of Fluorescence Spectroscopy*; Joseph Lakowicz
Springer, New York, 3rd Edition, 2006.
2. *Introduction to Fluorescence*; David Jameson
Taylor & Francis, Florida, 1st Edition, 2014.
3. *Essentials of Chemical Biology*; Andrew Miller
John Wiley & Sons, Chichester, 1st Edition, 2008.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Explain the principles and techniques of fluorescence spectroscopy, including emission/excitation spectra, polarization, and lifetime measurements.

CO2: Demonstrate various fluorescent probes and sensors for biological applications.

CO3: Analyse molecular interactions, protein oligomerization, and membrane dynamics through fluorescence polarization, quenching, and scattering methods.

SEMESTER 8

ELECTIVE 1I & III (3 0 0 3)

LEARNING OBJECTIVES:

This course covers in details the molecular mechanism of cancer development with emphasis on tumor viruses, oncogenes, tumor suppressor genes, cell cycle and its control and other hallmarks of cancer. It also covers the molecular approaches to cancer diagnostics and treatment. More recent advances in cancer stem cells and cancer epigenetics are also discussed

SYLLABUS:

Unit 1: The Development and Causes of Cancer

Overview of cancer; multistep nature of cancer development; genetic, chemical, and environmental causes; hallmarks of cancer; types and classification of tumors.

Unit 2: Tumor Viruses, Oncogenes, and Tumor Suppressor Genes

Viral oncogenesis; mechanisms of transformation by DNA and RNA tumor viruses; proto-oncogenes and oncogene activation; tumor suppressor genes (p53, Rb, APC, BRCA1/2).

Unit 3: Cell Cycle Control, Apoptosis, and Telomere Biology

Regulation of cell cycle and checkpoints; dysregulation in cancer; apoptosis pathways and their inhibition; telomeres, telomerase, and cellular immortalization.

Unit 4: Cancer Stem Cells, Angiogenesis, and Metastasis

Concept of cancer stem cells; mechanisms of angiogenesis; tumor microenvironment; metastasis cascade; EMT and invasion.

Unit 5: Cancer Epigenetics, Diagnostics, and Therapeutics

Epigenetic regulation in cancer; molecular diagnostics (biomarkers, PCR, sequencing, imaging); cancer genomics and personalized therapy; immunotherapy; prevention and risk assessment.

REFERENCES:

1. *The Biology of Cancer*, 2nd Edition, Robert A. Weinberg
2. *Molecular Biology of the Cell*. Alberts B. et al., (2022) 7th edition. Garland Science.
3. *The Cell: A Molecular Approach*, 8th Edition, Geoffrey M. Cooper (2018).
4. Journal papers: reviews and research articles

COURSE OUTCOMES:

After the successful completion of the course, the students shall be able to

CO1: Describe the different hallmarks of cancer.

CO2: Explain the role of oncogenes and tumor suppressors during the development of cancer

CO3: Understand the dysregulation of apoptosis and cell cycle in cancer

CO4: Demonstrate the factors regulating angiogenesis and metastasis

CO5: Compare molecular approaches to cancer diagnostics and treatment.

CO6: Analyse data published in scientific journal articles and present cancer biology articles from reputed journals

LEARNING OBJECTIVES:

To enable the students to gain Advanced knowledge in bacteriophages and their application

SYLLABUS:

Unit 1: Introduction to Phage Biology and Classification:

History of phage discovery, structure and morphology, classification systems (ICTV, Baltimore), lytic and lysogenic cycles, methods of isolation and quantification.

Unit 2: Ecology and Evolution of Phages

Phage diversity and distribution, phage-host coevolution, horizontal gene transfer, transduction, lysogenic conversion, role of phages in microbial ecology and bacterial virulence.

Unit 3: Molecular Biology and Physiology of Phages

Structure-function relationship of phage proteins, genome replication, regulation of gene expression, host takeover mechanisms, bacterial defense systems (restriction-modification, CRISPR-Cas).

Unit 4: Phage Applications in Health, Agriculture, and Environment

Phage therapy (human and veterinary), biocontrol in agriculture and aquaculture, food safety, wastewater sanitation, and phage role in antimicrobial resistance (AMR).

Unit 5: Genome Engineering and Molecular Biotechnology Applications

Phage genome sequencing and annotation, CRISPR–phage interactions, phage display library, engineered phages, and synthetic biology applications.

REFERENCES:

1. Flint, S. J., Enquist, L. W., Racaniello, V. R., Skalka, A. M., Flint, S. J., Enquist, L. W., ... & Skalka, A. M. (2008). *Principles of Virology*, (Volume I and Volume II).
2. Kutter, E., & Sulakvelidze, A. (Eds.). (2004). *Bacteriophages: biology and applications*. CRC Press.
3. Calendar, R., & Abedon, S. T. (2005). *The bacteriophages*. Oxford University Press.
4. Clokie, M. R. & Kropinski, A.M. (2009). *Bacteriophages: methods and protocols*, volume 1: isolation, characterization, and interactions (Vol. 1 and 2). Humana Press Inc.
5. Lobočka, M., & Szybalski, W. T. (Eds.). (2012). *Bacteriophages (Vol. 82 & 83)*. Academic Press

COURSE OUTCOMES:

After the successful completion of the course, the students shall be able to

CO1: Understand the fundamental principles and techniques of phage biology.

CO2: Apply phage biology science and technology in various biotechnological applications.

CO3: Analyse experiments using phage biology.

CO4: Evaluate research design and analysis in phage biology literature

25BIO443

CELL SIGNALLING

3 0 0 3

LEARNING OBJECTIVES:

The course includes extensive study on different cell signaling pathways and the recent advancements in contributing to various disease conditions. The course involves discussion of recent scientific papers related to each of these signaling pathways.

SYLLABUS:

Unit 1

Basics of animal communications including the different kinds of signals.

Unit 2

Principles of Cell Signaling Systems: Classification of signaling mechanism, Techniques used to understand cell signaling in the laboratory, Growth Factor/ Receptor Tyrosine Kinases (RTKs), Receptor serine threonine kinase, Cytokine Receptors, Other enzyme-linked receptors.

Unit 3

G Protein Signaling: Significance of toxins like cholera and pertussis in understanding GPCR-mediated cell signaling, Nobel lectures in G protein and RTK signaling, Signaling involved in taste, vision and smell, Cross-talk between GPCR and RTK signaling pathways.

Unit 4

Signal Transduction Through Ion Channels, Signals with Long-Term Consequences (Cell cycle and its control, Apoptosis and Cytoskeletal remodeling).

Unit 5

Signaling in developmental pathways like Wnt, Notch and Hedgehog, Signaling in plants- Auxin, Ethylene and Phytochromes, Prokaryotic Signaling, Signaling involved in Circadian rhythm in Humans, Drosophila and Cyanobacteria.

Unit 6

Recent Advances in Signaling Research and Diseases.

REFERENCES:

1. The Biochemistry of Cell Signalling, Ernst J.M. Helmreich (2005) Indian edition, Oxford University Press.
2. Molecular Biology of the Cell. Alberts B. et al., (2008) 5th edition. Garland Science.
3. The Cell: A Molecular Approach, 4th Edition, Geoffrey M. Cooper and Robert E. Hausman
4. Journal papers: reviews and research articles

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Understanding G protein signaling in depth which involves discussions on the noble lectures in the field.

CO2: Extensive study on Receptor tyrosine kinases and their signaling with respect to disease conditions like Cancer.

CO3: Study of other signaling pathways involved during various developmental stages with detailed discussions of scientific articles pertaining to each of the signaling pathways.

CO4: Involves understanding various signalling mechanisms in plants.

CO5: Trained to design experiments and interpret data based on the discussions on each signaling pathway which would help them develop scientific critical thinking skills.

25BIO444

BIOMIMICRY

3 0 0 3

LEARNING OBJECTIVES:

The course aims to present a biological perspective in solving problems concerning man and his environment.

SYLLABUS:

Unit 1

The background- Innovation inspired by nature. The pioneers- Janine M. Benyus, Dayna Baumeister etc. how and why nature can be Model, Measure and Mentor to solve problems.

Unit 2

Biomimetic solutions to food scarcity and energy crises; manufacturing in a benign and sustainable manner.

Unit 3

Nature as a repertoire of drugs and pharmacological strategies

Unit 4

Nature as paradigm to process and store information; ecological concepts in city planning and business.

Unit 5

Individual Mini projects (conceptual) to identify a problem and derive solutions from nature

REFERENCES:

Textbooks

1. Biomimicry- Innovation Inspired by nature, Janine M. Benyus.
2. Biomimicry resource handbook from Biomimicry 3.8

Web resource

<http://biomimicry.net>
<http://biomimicry.org>
<http://www.asknature.org>

COURSE OUTCOMES:

After the successful completion of the course, the students shall be able to

CO1: Remember the historical background, the principles, seeds, terminologies of biomimetics

CO2: Understand how nature can serve as a model, measure and mentor to solve problems

CO3: Demonstrate examples of innovation inspired by nature

25BIO445

NEUROSCIENCE

3 0 0 3

LEARNING OBJECTIVES:

This course deals with the study of structure and function of nervous system and how information is transmitted from one part to the other with emphasis on physiology, development, anatomy etc.

SYLLABUS:

Unit 1

Introduction to Neuroscience, History of Neuroscience, Neuroanatomical planes, parts of Central Nervous system, Neurons and glia,

Unit 2

Neurophysiology basics, resting potential, action potential, Synaptic transmission, types of synapses, behavior of neuron, initiation and propagation of action potential, Ion Channels and properties, Learning and plasticity at the synapse,

Unit 3

Neurophysiology and Neuron Simulation Virtual Labs, Hodgkin-Huxley neuron, patch clamp physiology, electrophysiological techniques, basic protocols in neuroscience,

Unit 4

Vision, Olfaction, Hearing, Motor system, Cerebellum, Brain disorders, Neural basis of Consciousness.

REFERENCES:

1. Kandel, E.R., Schwartz, J.H., Jessell, T.M., & Siegelbaum, S.A. (2013) Principles of Neural Science. 5th Edition. McGraw-Hill Professional. ISBN: 978-0071390118.
2. Neuroscience, 3rd ed, edited by Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel La Mantia, James O. McNamara, and S. Mark Williams. 2004. ISBN - 0-87893-725-0
3. Neuroscience Online, the Open-Access Neuroscience Electronic Textbook!
<http://neuroscience.uth.tmc.edu/>, UT Austin
4. The Synaptic Organization of the Brain, 4th Edition, Gordon Shepherd (Editor), Oxford University Press.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the structural and functional organization of the nervous system, including key components such as neurons, glia, and major brain regions.

CO2: Explain the biophysical principles underlying neural signaling, including resting membrane potential, action potential, and synaptic transmission.

CO3: Apply knowledge of ion channels, neural plasticity, and synaptic physiology to understand mechanisms of learning and memory.

CO4: Analyse sensory and motor pathways in the context of systems neuroscience, including vision, hearing, olfaction, motor control, and cerebellar functions.

CO5: Examine neurological disorders and relate brain function to behavior and states of consciousness using current scientific understanding.

25BIO446 REGENERATIVE BIOLOGY & STEM CELLS 3 0 0 3

LEARNING OBJECTIVE:

This is an interdisciplinary course at the interface of the cutting-edge fields: stem cell research and regenerative medicine and bioengineering. The course covers how adult stem cells are specified into different cellular fate during health and disease, different model organisms used to study adult stem cell biology, role of extracellular niche and other molecular signaling pathways regulating stem cell fate decision. Course covers induced pluripotent stem cells, stem cell treatment using engineered stem cells and disease modelling using iPSCs. Course includes a discussion component where we discuss recent research advances in the field and ethics and policies in stem cell research.

SYLLABUS:

Unit 1

Introduction to regenerative medicine: Adult stem cells, Stem cell niche, Trans differentiation and dedifferentiation, Tissue regeneration during injury, Fibrosis and Regeneration, Influence of Immune system and ECM on regeneration. Regeneration models in invertebrates/vertebrates and the cellular basis. Factors responsible for differences in regenerative capacity in animal kingdom.

Unit 2

Embryonic stem cells and Induced pluripotent stem cells: Derivation of embryonic stem Cells, Derivation of iPSCs, Properties of ES and iPSCs. Disease modelling using induced pluripotent stem cells

Unit 3

Tissue engineering (Stem cell-based therapies): Introduction to Tissue engineering triad (biomaterials, biomolecules and cells). Bone/CNS/Cardiac/Pancreatic/Liver tissue engineering strategies and stem cell therapies.

Unit 4

Molecular signalling regulating stem cell proliferation and differentiation. Notch Signalling, Wnt signalling, Hedgehog signalling, FGF, LIF- smad, Protein Kinase A

Unit 5

Ethics and Policies in stem cell research: Risks, side effects, safety, therapeutic value associated with stem cell therapies.

REFERENCES:

1. Mostly based on Research and Review articles from journals in stem cells and regenerative biology and medicine
2. *Essentials of Stem Cell Biology* by Robert Lanza and Anthony Atala
3. *The Cell Biology of Stem Cells* by Eran Meshorer and Kathrin Plath
4. *Advances in Stem Cell Therapy* by Nagwa El-Badri

COURSE OUTCOMES:

After the successful completion of the course, the students shall be able to

CO1: Explain various types of stem cells in the human body, the microenvironment and their potential in regenerative medicine.

CO2: Demonstrate the cellular and molecular mechanisms of regeneration through a comparative study involving naturally regenerating species.

CO3: Compare embryonic stem cells and induced pluripotent stem cells, stem cell treatment using engineered stem cells and disease modelling using iPSCs.

CO4: Assess new perspectives in tissue regeneration for stem cell therapy and regulations in stem cell therapy.