B.Sc. HONOURS

BIOTECHNOLOGY AND INTEGRATED SYSTEMS BIOLOGY

CURRICULUM STRUCTURE

Semester 1

Sl. No	Course Title	Course Code	Credits
1	INTRODUCTORY BIOLOGY	MIC 103	3
2	CHEMISTRY	CHY 103	4
3	ENGLISH	ENG 100	3
4	INTRODUCTORY MICROBIOLOGY	MIC 100	3
5	PHYSICS	PHY103	4
6	FOUNDATIONS OF INDIAN HERITAGE	22ADM101	2
7	MASTERY OVER MIND (MAOM)	AVP103	2
8	INTRODUCTORY MICROBIOLOGY LAB	MIC 180	2
Total Credits		**23**	

Semester 2

Sl. No	Course Title	Course Code	Credits
1	PRINCIPLES OF ECOLOGY AND EVOLUTION	BIO 100	3
2	BIOCHEMISTRY	BIO 103	3
3	ENGLISH/ CREATIVE WRITING & SOFT SKILLS	ENG 101	3
4	INFORMATION SYSTEMS	CSA100	3
5	MATHEMATICS	MAT 100	4
6	GLIMPSES OF GLORIOUS INDIA	22ADM111	2
7	PHYSICAL SCIENCES LAB	PHY 182	2
8	BIOCHEMISTRY LAB	BIO 180	2
Total Credits		**22**	

Semester 3

Sl. No	Course Title	Course Code	Credits
1	MOLECULAR BIOLOGY	BIO 202	3
2	BIOSTATISTICS	MAT 201	3
3	PLANT BIOLOGY	BIO 223	4
4	ANALYTICAL BIOCHEMISTRY	BIO 206	3
5	VIROLOGY	MIC 205	3
6	STRATEGIC LESSONS FROM MAHĀBHĀRATA	22ADM201	1
7	GENERAL MICROBIOLOGY LAB	MIC 281	2
8	CELL AND MOLECULAR BIOLOGY LAB	BIO 281	2
Total Credits		**21**	

Semester 4

Sl. No	Course Title	Course Code	Credits
1	HUMAN PHYSIOLOGY	BIO 201	4
2	GENETICS	BIO 205	3
3	IMMUNOLOGY	BIO 207	3
4	ENZYME TECHNOLOGY	BIO 209	3
5	CELL BIOLOGY	BIO 204	3
6	INTRODUCTORY BIOINFORMATICS		3
7	SOFT SKILLS- 1	SSD201	1
8	LEADERSHIP FROM RĀMĀYANA(AVP)	22ADM211	1
9	IMMUNOLOGY LAB	BIO 282	2
10	ENZYMOLOGY LAB	BIO 283	2
Total Credits		**25**	

Semester 5

Sl. No	Course Title	Course Code	Credits
1	GENETIC ENGINEERING	BIO 314	4
2	OMES AND OMICS	BIO 318	3
3	BIOENERGETICS AND METABOLISM	BIO 311	3
4	INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY	BIO 315	3
5	RESEARCH METHODOLOGY	BIO 317	2
6	INDUSTRIAL BIOTECHNOLOGY LAB	BIO 385	2
7	SOFTSKILLS -II	SSD 301	1
8	LIVE-IN-LABS/OPEN ELECTIVE	BIO396	3
9	GENETIC ENGINEERING LAB	BIO 386	2
Total Credits		**23**	

Semester 6

Sl. No	Course Title	Course Code	Credits
1	INTRODUCTORY BIOPHYSICS		2
2	PHARMACOLOGY	BIO 319	4
3	DEVELOPMENTAL BIOLOGY	BIO 322	3
4	DISCOVERING SYSTEMS BIOLOGY		4
5	PROGRAMMING CONCEPTS		3
6	DATABASE CONCEPTS		2
7	PROGRAMMING CONCEPTS LAB		1
Total Credits		**19**	

Semester 7

Sl. No	Course Title	Course Code	Credits
1	FRONTIERS IN DISCOVERY BIOLOGY		4
2	STRUCTURAL BIOLOGY		4
3	NONCODING RNA BIOLOGY		2
4	MACHINE LEARNING FOR BIOLOGICAL SCIENCES		3
5	ELECTIVE		3
6	MINI PROJECT		3
Total Credits		**19**	

Semester 8

Sl. No.	Course Title	Course Code	Credits
1	PROJECT		10
Total Credits			**10**

Total credits for program completion	**162**

SYLLABUS

SEMESTER 1

MIC 103 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, Types of Learned adaptation- Habituation, Sensitization, Imprinting, Conditioned behaviour-classic conditioning and operant conditioning, Insight learning and Spatial learning; 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.Students shall be able to understand the basics of evolution, diversity of life, transmission of genetic information, framing and testing hypothesis.

CO2. Students shall be able to explain basic concepts of cell theory, the structure of different cell organelles and their function.

CO3. Students shall be able to understand the formation and function of cytoskeletal elements like microfilaments, intermediate filaments and microtubules, cell movement and extracellular matrix.

CHY 103 CHEMISTRY 3 1 0 4

LEARNING OBJECTIVE:

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

SYLLABUS:

Unit 1

Chemical bonding

Introduction to bonding, Classification of elements in the periodic table, Periodic properties, Types of bonds & factors affecting the bond formation, bond parameters, Polarity of bonds, semipolar bonds

Unit 2

Chemical equilibrium and Solutions

Solutions, types of solutions, solvation energy, lattice energy, Equivalent & molecular mass, mole concept, solubility & factors affecting solubility, Expression for concentration of solutions, polarity of solvents, Importance of dielectric constant of solvents, Solvents other than water, classification of solvents, Dilution factor, serial dilution, Solute–solvent interactions in solutions.

Equilibrium constant, Le-Chatelier principle, Acid & bases, strength of acid & bases,pH of aqueous solutions, Acid –base titrations, indicators in titrations, Solubility product & applications, ionic product, Condition for precipitation, Hydrolytic reactions & expression for hydrolytic constant.

Unit 3

Organic Chemistry

Introduction to functional groups, chemical & physical properties, Reaction intermediates in organic chemistry, electronic effects in organic compounds, Aromaticity with examples, SN1 & SN2 mechanism, Nucleophilic addition & substitution reactions at carbonyl group, E1 & E2 reactions in alcohols, Heterocyclic compounds, Configuration & projection formula, Optical & geometrical isomerism, Tautomerism & its applications

Unit 4

Chemical kinetics and Electrochemistry

Rate of reaction, differential rate law expressions, Order & molecularity, rate constant, integrated equations (Ist,2nd & 3rd order), nth life of a reaction, Arrhenius equations, temperature dependence of rate constant, energy profile diagrams. Reaction intermediates, Different theories on reaction rate, Electrode potential, related problems, Nernst equation & its applications, emf of the cell, related problems, Redox reactions in cells, free energy change & standard emf of the cell, Redox titrations applications with two examples

Unit 5

Coordination Chemistry

Introduction to co-ordination compounds, Crystal field theory, Colour & magnetic properties of complexes, Chelation & applications,biologically relevant co-ordination compounds

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. Understand 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. Able to understand the crystals structure, defects and free electron theory

CO4. Be able to understand the mechanism and application of conductivity polymer is various electronic devices.

ENG 100 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, Francoise. *Developing Reading Skills.*A Practical Guide to Reading Comprehension Exercises.CUP, 2003.
3. Hanock, 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. A*merican 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. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.

CO2. Develop communicative competence in students. Impart knowledge, ideas and concepts in the technicalities of proper pronunciation, structure, appropriate use and style of the English Language as well as the application areas of English communication.

CO3. Expose the students to employment opportunities, challenges and job roles.

CO4. Enable the students to conduct independent surveys, collect and analyze data, prepare and present reports and projects. Guide the students to establish self-employment strategies.

MIC 100 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- CO_2 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. Wheolis 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. Understand the contributions of pioneers in Microbiology.

CO2. Designate the prokaryotic cell structure and functions.

CO3. Establish the concept of microscopy and elaborate basic microscopy techniques.

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

CO5. Designate the basic principles of sterilization methods.

PHY103 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:

Unit1

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 the course, students shall be able to

CO1. Students are able to categorize different types of motions such as 1D, 2D and 3D motions and apply them accordingly.

CO2. They are able to relate work, energy and power and can use it in different scenarios.

CO3. They compare translational motion and rotational motion which makes problem solving very easy.

CO4. Solves problems on waves and oscillations and applies it in different biological instruments.

CO5. They integrate the different phenomena due to light such as reflection, refraction, interference, dispersion and diffraction.

CO6. The students distinguish the properties of matter such as solids, liquids and gases.

CO7. The students are able to compare and relate Dielectrics and magnetism.

22ADM101 Foundations of Indian Heritage 2-0-0-2

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 ofIndia in diverse fields. To equip students with a knowledge of their country and its eternalvalues.

SYLLABUS:

1. **Chapter 1 - Educational Heritage of Ancient India**
2. **Chapter 2 - Life and Happiness**
3. **Chapter 3 - Impact of Colonialism and Decolonization**
4. **Chapter 4- A timeline of Early Indian Subcontinent**
5. **Chapter 5 - Indian approach towards life**
6. **Chapter 6 - Circle of Life**
7. **Chapter 7- Pinnacle of Selflessness and ultimate freedom**
8. **Chapter 8- Ocean of love; Indian Mahatmas.**

9. **Chapter 9 - Become A Strategic Thinker (Games / Indic activity)**
10. **Chapter 10 - Man's association with Nature**
11. **Chapter 11 - Celebrating life 24/7**
12. **Chapter 12 - Metaphors and Tropes**
13. **Chapter 13 - India: In the Views of foreign Scholars and Travellers.**

Self-Study/ Self-reading

14. **Chapter 14 - Personality Development Through Yoga.**
15. **Chapter 15 - Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness**
16. **Chapter 16 - Conversations on Compassion with Amma**

COURSE OUTCOMES:

. CO1: Increase student understanding of true essence of India's cultural and spiritualheritage.

CO2: Emancipating Indian histories and practices from manipulation, misunderstandings,and other ideological baggage thus, shows its contemporary relevance.

CO3: Understand the ethical and political strategic concepts to induce critical

approach tovarious theories about India.

CO4: Familiarize students with the multi dimension of man's interaction with nature, fellow beings and society in general.

CO5: Appreciate the socio-political and strategic innovations based on Indian knowledgesystems. Gives an understanding of bringing Indian teaching into practical 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: Describe Meditation and Understand its Benefits **(CO1)**

A: Importance of meditation. How does meditation help to overcomeobstacles in life .

B: Understand how meditation works. Understand how

meditation helps in improving physical and mental health. Understand how meditation helps in the development of personality.

Unit 2: Causes of Stress and How Meditation Improves Well-being **(CO2)**

A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation.

B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace.

Unit 3: The Science of Meditation **(CO3)**

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method?

B: How meditation helps humanity according to what we know from scientific research

Unit 4: Improving Communication and Relationships **(CO5)**

How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace.

Unit 5: Meditation and Compassion-driven Action **(CO6)**

Understand how meditation can help to motivate compassion- driven action

Practicing MA OM Meditation in Daily Life **(CO4)**

Guided Meditation Sessions following scripts provided (Level One to Level Five) during meditation sessions.

REFERENCES:

1. Chinmayananda, Swami. The Holy Geeta. Central Chinmaya Mission Trust, 1996.
2. Devi, Sri Mata Amritanandamayi. Amritam Gamaya Part 1. Translated by Rajani Menon. M A Center, 2022
3. Easwaran, Eknath. Conquest of Mind. 3rd ed. Tomales: Nilgiri Press, 2010.
4. Goleman, Daniel, and Richard Davidson. The Science of Meditation: How to Change your Brain, Mind and Body. Penguin UK, 2017.
5. Puri, Swami Amritaswarupananda. From Amma's Heart. M.A. Center, 2014.
6. Sivananda, Swami. Concentration and Meditation. Garhwal, India: Divine Life Society, 2009.
7. Thakar, Vimala. Why Meditation. Delhi, India: Motilal Banarsidass, 1996.
8. Vivekananda, Swami. Raja Yoga. India: Sanage Publishing House, 2022.
9. Yatiswarananda, Swami. Meditation and Spiritual Life. Sri Ramakrishna Ashrama, 1979.

COURSE OUTCOMES:

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

MIC 180 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. Students will get practical exposure to common methods of sterilization.

CO2. Skill development for cultivating various microorganisms.

CO3. Identify microorganisms by different staining methods.

SEMESTER 2

BIO 100 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. Students should be able to connect the basic Ecology and Evolution principles.

CO2. Thoroughly know the diversity in the various biomes, be it terrestrial or aquatic.

CO3. Evaluate the significance of population and community.

CO4. Postulate the impact of climate change and pollution and evaluate the possible ways to tackle it.

BIO 103 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. Understand the concepts of basic chemistry including principles of chemical bonding, hybridization, shape of water and ammonia. Acids, bases, buffers, Preparation of buffers, non-covalent interactions, and general types of reactions involved in biochemistry.

CO2. Identify and write the chemical structure of Amino acids, depict their ionization behavior, peptide bond formation; describe the structure of proteins and them functions.

CO3. Identify and know the structure, properties and functions of carbohydrates, lipids, and nucleic acids.

ENG 101 ENGLISH/CREATIVE WRITING & SOFT SKILLS 2 0 1 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. 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. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.

CO2. Develop communicative competence in students.

CO3. Impart knowledge, ideas and concepts in the technicalities of proper pronunciation, structure, appropriate use and style of the English Language as well as the application areas of English communication

CO4. Expose the students to employment opportunities, challenges and job roles. To enable the students to conduct independent surveys, collect and analyze data, prepare and present reports and projects.

CO5. Guide the students to establish self-employment strategies.

CSA 100 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. Students will be understanding different components, signals, microprocessors, input/output devices et.

CO2. The course enables the students to understand the IT applications in biology.

CO3. On completion of the course students will be able to use Microsoft office tools for their computational requirements as a life science professional.

CO4. They will be knowing the fundamentals of programming, making graphs and plots for scientific data etc.

CO5. On completion of the course, students should have acquired essential knowledge to meet their computational requirements as a life sciences aspirant.

MAT 100 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: Apply linear algebra concepts to model, solve and analyze real world situations.

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

CO3: Demonstrate solutions to first order differential equation by various methods and solve basic applications problems related to electrical circuits, orthogonal trajectories and newton's law cooling.

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

22ADM111 Glimpses of Glorious India 2 0 0 2

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:

Chapter 1	-	Face the Brutes
Chapter 2	-	Role of Women in India
Chapter 3	-	Acharya Chanakya
Chapter 4	-	God and Iswara
Chapter 5	-	Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Chapter 6	-	Lessons of Yoga from Bhagavad Gita
Chapter 7	-	Indian soft powers: A solution for many global challenges.
Chapter 8	-	Nature Preservation through faith
Chapter 9	-	Ancient Cultures what happened to them.
Chapter 10	-	Practical Vedanta
Chapter 11	-	To the World from India
Chapter 12	-	Indian Approach to Science

COURSE OUTCOMES:

CO1: This part deals with two topics: The Need to Become Fearless in Life and the Role or Status of Women in India.

CO2: This part deals with three topics: Teachings and Principles of Chanakya, Difference between the terms *God and Iswara* and Contribution of *Bhagavad Gita*

CO3: This area handles two important concepts: Indian Soft powers and A portrayal of how nature was preserved through the medium of Faith.

Inner power is about never giving up on your dreams.

To manifest more of what you desire in life, you must be prepared to embrace your inner power. You must be persistent if you want to succeed. Maintain your modesty and never stop learning. Inner strength is an attitude to life.

Faiths shape and direct how we think, act, and live our lives. However, faith's power is not solely spiritual. To preserve nature, our forefathers established systems and traditions based on faith. Our culture and faith are intricately bound to nature.

CO4: Two important topics are discussed here: A Brief history of Ancient Indian Cultures and a Discussion on Practical Vedanta.

Indian culture is the legacy of the ethno-linguistically diverse country's social norms, moral principles, traditional practices, belief systems, political systems, artefacts, and technologies. Following every invasion or change of political control, new kingdoms carried their respective cultures with them, adding to the Indian culture. Vedanta is the philosophy of the Upanishads. Every soul possesses the potential to be divine. The objective is to manipulate this inner divinity by invoking both internal and external natural forces.

CO5: From this part, a student gets an insight into the contribution that India has made to the world. Moreover, foreign powers have been trying to humiliate and degrade India in front of the world for so long. However, it should be recognized that many inventions that are considered beneficial to the world today have been contributed by the great men of India.

PHY 182 PHYSICAL SCIENCES LAB CREDITS: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.

List of experiments

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:

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

CO2: To gain practical knowledge in differentiating various organic functional groups

CO3: To summarize the viscosity and specific rotation of glucose and there by demonstrate the importance of viscometer and polarimeter.

CO4: To compare the calorimeter and the conductivity meter for the heat changes and conductivity measurements of solutions.

BIO180 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. Students will get practical exposure to common buffer and reagent preparations

CO2. Skill development for students on handling basic laboratory biochemical equipment's (pH meter, colorimeter, centrifuge, micropipettes).

CO3. Developing qualitative and quantitative analytical skills on biomolecules.

SEMESTER 3

BIO 202 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, Hershy 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, 7^{TH} Edition, Pearson, 2007.
2. Gene VIII, Benjamin Lewin, 8^{th} edition, Pearson publishers, 2003.
3. Molecular biology, David Freifielder, 2^{nd} edition, Barlett and Jones, 1986.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. Learn and understand the important discoveries that are made in the field of molecular biology.

CO2. Understand the detailed structure of the double helical nature of DNA as proposed by scientists like Watson and Crick.

CO3. To learn different levels of organizations that regulate the condensation of DNA that leads to the compact metaphase chromosome.

CO4. To learn key molecular events that occur during the transcription and translation processes that leads the protein synthesis from specific genes.

CO5. Understanding the mechanisms that regulate the regulation of gene expression in both prokaryotes and eukaryotes.

CO6. Learn about the molecular events that happen during the replication of DNA prior to cell division.

MAT 201 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: Know the application and limitations of different bioinformatics and statistical methods.

CO3: Perform and interpret bioinformatics and statistical analyses with real molecular biology data.

CO4: 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.

BIO 223 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.The students should be able to 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.Identify plants and the taxa they belong to.

CO3.Appreciate the plethora of plant secondary metabolites and its benefits.

CO4.Apply the knowledge in Agri-biotech areas such as - biofertilizers, biopesticides etc.

BIO 206 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 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 spectrofluorimetric.

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 important biomolecular extraction, quantitation, separation and purification techniques.

CO2. Recall concepts and applications of UV/Visible and fluorescence spectroscopy.

CO3. Differentiate important techniques to analyze biomolecules.

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

MIC 205 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. Understand the reason for studying viruses

CO2. Understand how to cultivate, purify and detect the presence of viruses

CO3. Explain the replicative strategies of different classes of viruses

CO4. Demonstrate the host immune response to viruses

CO5. Discuss the pathogenicity and mode of action of various antiviral drugs used to control viral infections.

MIC 281 GENERAL MICROBIOLOGY LAB 0 0 4 2

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 completing the course, students shall be able to

CO1. Students will get practical exposure on various biochemical tests to identify unknown bacteria

CO2. Skill to isolate and identify fungus by cultivation and staining.

CO3. Understand the use of differential, selective and special media.

BIO 281 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: Practical exposure to microscopy wherein the students will learn to differentiate between plant and animal cells and identify the deposition of lignin in plants using various staining techniques.

CO2: The various stages of mitosis will be analyzed and visualized using the actively dividing cells present at the root tip of Allium cepa.

CO3: Practical exposure to genomic DNA isolation using various plant tissues and standardizing the protocol for each of these tissues.

CO4: Understand the method to assess the quality of DNA using Agarose gel electrophoresis and well as spectroscopic methods.

CO5: Understand the basis of separation of proteins using polyacrylamide gel electrophoresis.

22ADM201 Strategic Lessons from Mahabharata 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 ofIndia in diverse fields. To equip students with a knowledge of their country and its eternalvalues.

SYLLABUS:

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

Self-Study / Self Reading

1. Chapter 12 Mahabharata- An All-Encompassing Text
2. Chapter 13 Mahabharatha- Whats and What Nots
3. Chapter 14 Mahābhārata in Adages

COURSE OUTCOMES:

CO1 : Increase student understanding of 'Mahabharata 'with this lesson plan.

CO2: Appreciate the relevance of Mahabharata for modern times.

CO3: Understand the ethical and political strategic concepts to induce critical approach to Mahabharata.

CO4: Familiarize students with the inspirational female characters and regional tales from Mahabharata to gain a coherent understanding of it on Indian values and culture.

CO5: Appreciate the relevance of Mahabharata for modern times and identify its imperativeness in everyday life.

SEMESTER 4

BIO 201 HUMAN PHYSIOLOGY 3 1 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**.** Understand the organization of the human body

CO2. Describe 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**:** Understand the variation in normal physiology.

BIO 205 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. Students will explain the basic concept of Mendelian principles and apply it in different genetic experiments. This would help the students to solve the majority of genetic problems.

CO2. Students will analyze the deviations from the standard mendelian laws in a few cases and learn the mechanisms.

CO3. Students will identify the underlying genetic mechanisms that regulate sex determination and clinical cases leading into chromosome abnormalities.

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

CO5**.** Students will explain different types of mutations and how DNA repair mechanisms restore the integrity following the DNA damage.

CO6. Describe 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.

BIO 207 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. Students will be able to understand basic immunological mechanisms such as cells and organs of the immune system, innate and adaptive immune response.

CO2. Students will be able to interpret the dysregulation of immune mechanisms during hypersensitivity states, immunodeficiency, or autoimmune conditions.

CO3. Students will be able to apply the understanding of immunology to develop vaccines for protection or therapeutic purpose against diseases.

BIO 209 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 DIPF.

Unit 3

Enzyme Kinetics: Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. 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, enzymes in membranes, concentrations. 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. Understand and define the basic concepts of enzymes, their classification, metalloenzymes, holoenzymes, abzymes, Isozymes, Multienzyme complex.

CO2. Differentiate and discuss the different catalytic mechanisms with examples, transition state theory, Lock and key and induced fit theories. Zymogens, Proenzymes.

CO3. Discuss and explain enzyme kinetics, Michaelis Menton equation, LB plot, Km, Vmax, Kcat and Turnover number. Enzyme inhibitions: reversible and irreversible with example; Kinetics of inhibitions; Allosteric enzymes: regulation of enzymes

CO4. Demonstrate and explain the role of enzymes in industry and medicine with examples.

BIO 204 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 Wint, Notch and Hedgehog, NF-KB signaling, signaling in plants- Auxin, Ethylene and Phytochromes, signaling involved in Circadian rythm 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. Students will identify the different types of sorting signals and their mechanism and their significance in various disease states when impaired.

CO2. Students will 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. Students will understand the regulation of cell cycle and cell death in Cancer.

CO4. Students will describe the role of cytoskeleton in maintaining cell architecture and rigidity

CO5. Understand the basic techniques used to culture animal cells.

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; Hash tables; 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.

Unit 4

Multiple Sequence Alignment- 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 5

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

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

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 the different biological data and relate it to the known databases and formats

CO3: Demonstrate tools for sequence alignment, phylogenetics, characterization, and visualization of biomolecules

CO4: Analyze, compare and apply basic bioinformatic tools for finding motifs, domains gene/protein homologs, designing primers, identifying mutations.

SSD 201 SOFT SKILLS –I CREDITS: 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. Basic understanding of the Soft skills sessions.

CO2. Gain insights on setting objectives.

CO3. Builds confidence to present in front of audience.

CO4. Gains inputs to know to present self.

CO5. Builds confidence to present in front of audience.

222ADM211 Leadership Lessons from Ramayana 1 0 0 1

LLEARNING 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 ofIndia in diverse fields. To equip students with a

knowledge of their country and its eternalvalues.

SYLLABUS:

Chapter 1 - Introduction to the Great Itihasa
Chapter 2 - Bala-Kāṇḍa: (Preparing for the renowned mission.)
And Ayodhya-Kāṇḍa: (Harbinger of an Entire Tradition of Nobleness.)
Chapter 3 - Araṇya-Kāṇḍa: (Tale of the forest life)
And Kishkindha-Kāṇḍa: (The Empire of Holy Monkeys.)
Chapter 4 - Sundara-Kāṇḍa: (Heart of the Ramayana)
And Yuddha-Kāṇḍa: (The most popular part of the Ramayana)
Chapter 5 - Ramayana and Modern-day learning
Chapter 6 - Ecological Awareness in the Ramayana
Chapter 7 - Different Ramayana: (Epic that connects the world)
Chapter 8 - Uttarakhand: (An attempt to explain the untold stories)

CCOURSE OUTCOMES:

CO 1 – This part gives a brief introduction of the Great Ithihasa CO 2 – This topic deals with 6 Kandas of Ramayana.

CO 3 - 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]

CO 4 - This topic explains different Ramayana around the world.

CO 5 – This topic reveals the authenticity of Uttar Kanda and its attempt to explaining the untold stories in the first six Kanda

BIO282 IMMUNOLOGY LAB 0 0 4 2

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. To identify the morphology of cells of the immune system.

CO2. To understand the basic concepts of blood grouping.

CO3. To analyze antigen-antibody interactions and detect the presence of antigens and or antibodies in a biological sample.

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

BIO 283 ENZYMOLOGY LAB 0 0 4 2

LEARNING OBJECTIVES:

Students will begiven 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 Km and Vmax.
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. Describe and reproduce the fundamentals of calculations and problems in preparation of laboratory solutions and buffers.

CO2. Identify and demonstrate the vigorous methods techniques adopted in the isolation of the enzyme.

CO3. Analyze and conclude the characterization of enzymes by evaluating the velocity, specific activity and kinetic parameters in presence of different factors affecting enzyme kinetics.

SEMESTER 5

BIO 314 GENETIC ENGINEERING 3 1 0 4

LEARNING OBJECTIVES:

Genetic engineering course allows 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 involving different types of vectors, primer designing strategies, restriction digestion and ligation.

CO2. Describe the application of molecular tools and techniques used in gene cloning and functional genomics: PCR, RT PCR, Electrophoresis, Blotting, DNA sequencing, Microarray, RNA sequencing, SAGE, qRT-PCR.

CO3. Distinguish between different recombinant protein expression systems. Bacteria/ Yeast/ Insect/ Mammalian system and explain the application of transgenic cell or animal models in research and medicine with an emphasis on ethical barriers.

CO4. Describe 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.

CO5. Explain and interpret the advanced molecular techniques including DNA-protein and protein-protein interactions, reporter gene assays and DNA finger printing

CO6. Compile and summarize current genetic engineering research to discuss the impact on research and medicine.

BIO 318 OMES & OMICS 2 1 0 3

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, Functional Genomics.

Unit 2

Transcriptomics: Definition, Analytical techniques, PCR and QRT PCR, Microarrays, snRNA, snoRNA, tRNA, rRNA and miRNA, RNA Sequencing, RNA Splicing, Post-transcriptional regulation of gene expression.

Unit 3

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. Discriminate the differences of different genome.
CO2. Explain the different concepts and mechanisms involved in genomics and transcriptomics.

CO3. Describe methodologies and techniques associated with omics.
CO4. Describe basics of Mass Spectrometry, Proteomics and Metabolomics.
CO5. Recall major separation techniques in Proteomics and Metabolomics.
CO6. Compare and discuss workflows and strategies for protein identification and characterization.

BIO 311 BIOENERGETICS & METABOLISM 2 1 0 3

LEARNING OBJECTIVES:

The course is designed to understand the metabolic pathways, their energetic and regulatory mechanism 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-DG, DG^0 and DG'^0, Relationship between equilibrium constant and DG'^o, 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 its 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, types of metabolic reactions, enzymes involved and energetics of biological reactions.

CO2. Understand the catabolic and anabolic pathways of carbohydrates, lipids and amino acids.

CO3. Apply the concepts of metabolism to analyse the feasibility, energetics, regulation and disorders of metabolism of biomolecules

BIO 315 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, Cylindro-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 of industrially important microorganisms from environment, screening methods based on the type of product, and preservation of microorganisms

CO3. Explain the need for strain improvement and methods involved in order to improve production and growth. Describe the methods for selection of the improved organisms using rational and random screening.

CO4. Describe the major parts of a bioreactor and the functions associated with it. List out the different types of fermenters.

CO5. Describe the importance of sterilization, aeration and agitation in bioreactor operation.

CO6. Explain the steps and stages of Downstream processing

CO7. Describe the ethical waste management system in fermentation industry

BIO 317 RESEARCH METHODOLOGY 2 0 0 2

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. The students shall be able to familiarize with different aspects of research methodology

CO2. To help the students to understand the basic concepts of hypothesis generation and experimental designing.

CO3. To make the students familiarize with analyzing, interpreting and presenting the research data

CO4. To provide the students with basic knowledge on grant writing.

SSD 301 SOFT SKILLS II

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. Basic understanding of the Soft skills sessions.

CO2. Gain insights on setting objectives.

CO3. Gain insights on setting objectives.

CO4. Gain insights on setting objectives.

CO5. Gains inputs to know to present self.

CO6. Builds confidence to present in front of audience.

CO7. Builds confidence to present in front of audience .

CO8. Gains inputs to present in front of audience.

CO9. Gains inputs to present in front of audience .

CO10. Builds confidence to present in front of audience.

CO11. Builds confidence to present in front of audience.

CO12. Gains overall perspective of the course

BIO 385 INDUSTRIAL BIOTECHNOLOGY LAB 0 0 4 2

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. Learn the technique of immobilization of cells like yeast.

CO3. Demonstrate the ability of microorganisms for nitrogen fixation and phosphate solubilization.

BIO 386 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 lab like solution preparation, pH measurements, autoclaving, isolation and analysis of genomic DNA and plasmid DNA, PCR, Restriction enzyme digestion, transformation and protein analysis (Knowledge).

CO2.Explains & interprets the results obtained after performing every lab experiment (Understand).

CO3. Applies the knowledge to solve qualitative and quantitative problems like making a PCR mix or designing a double digestion reaction by restriction enzymes, making stock solutions, buffers and using positive and negative controls for different experiments (Apply).

SEMESTER 6

BIO INTRODUCTORY BIOPHYSICS 1 1 0 2

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. Recall thermodynamics theory and its application to know biological processes.

CO2. Describe concepts of protein folding and function.

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

CO4. Summarize biophysical phenomena and interpret investigative and experimental data.

BIO 319 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.The students shall be able to understand the basics of pharmacology, various stages of drug discovery and intellectual property rights.

CO2. To help the students to understand the basic concepts and principles behind pharmacokinetics, pharmacodynamics, and toxicology

CO3.To make the students familiarize themselves with the principles of antimicrobial and anti-neoplastic chemotherapy

BIO 322 DEVELOPMENTAL BIOLOGY 2 1 0 3

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. Students recognize the various processes that happen during the development of different organisms.

CO2. Students relate the role of genes during development.

CO3. Students predict the problems that can happen by mutation in genes during development.

CO4. Students compare the development of different organisms.

CO5. Students summarise the major genes and signalling processes during the development.

CO6. Students infer basis of different congenital disorders in humans.

BIO xxx DISCOVERING SYSTEMS BIOLOGY 2 2 0 4

LEARNING OBJECTIVES:

The course helps the students to understand the interactions within biological networks and thereby asking some of the fundamental issues concerning protein-protein interactions (PPIs), their need and usage.

SYLLABUS:

Unit 1

Introduction to Systems Biology: Bioinformatics to Systems, Biology of systems, Major and minor components of the systems, Systems Genomics

Unit 2

Experimental methods behind Systems Biology: Top-down and bottom-up systems biology, Analytical and experimental methods in ascertaining protein-protein interactions (PPI)

Unit 3

The essentials of Systems Biology: Metabolic fluxes, Introduction to mathematic models: COPASI models and pathway analysis

Unit 4

Systems Biology Tools: GeneMania, String-db, MINT, Genecards, Phenolyzer, IntAct, BIND, DIP, Biogrid; Visualizers for understanding PPI – Cytoscape, VisANT and Osprey; Regulatory/Systems Genomics; Mini project, quizzes and group discussions

Unit 5

Pathways and Models: Molecules to Pathways, Pathways to Networks, Networks to Models, examples and case studies.

REFERENCES:

1. Lu, H., Zhou, Q., He, J. *et al.* Recent advances in the development of protein–protein interactions modulators: mechanisms and clinical trials. *Sig Transduct Target Ther* 5, 213 (2020). https://doi.org/10.1038/s41392-020-00315-3 **.**
2. Chuang HY, Hofree M, Ideker T. A decade of systems biology. Annu Rev Cell Dev Biol. 2010; 26:721-44. doi: 10.1146/annurev-cellbio-100109-104122.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. Learn & identify protein interactions

CO2. Find the bona fide candidate interacting pairs for their targets of interest.

CO3. Compare the in-silico approaches with well-known validated approaches.

CO4. Learn the essentials of molecular pathways using top-down approaches.

CO5. The course is e interactive and self-contained with rigorous brainstorming.

CO6. There will be easy hands-on exercises using visualizers and command line.

BIF xxx PROGRAMMING CONCEPTS 2 1 0 3

LEARNING OBJECTIVES:

To introduce concepts of programming with a basic and widely used programming language C and introduction to scripting concepts in Linux operating system. The major objective of this course is to provide students with an understanding of code organization and functional hierarchical decomposition with using complex data types.

SYLLABUS:

Unit 1

Basic Concepts

Introduction – Programming languages – Types of Languages – Problem solving technique - Algorithms - Flow charts - Pseudocode – Compilers - Interpreters - Linux command - Shell script - Evolution of 'C' Language

Unit 2

Structure of C programs

Structure of a 'C' Program - 'C' Program development life cycle - Executing and Debugging a 'C' Program - Keywords and Identifiers - Operators - Constants - Variables - Data Types - Precedence of Operators - Scope and Lifetime of Variables - Control constructs: Decision Making using if statement - Types of if …else block - Switch case Block - Arithmetic Expressions - Evaluation of Expressions - GOTO statement – Loops - For loop - While loop - Do while loop - Jumping in Loop - break and continue statement.

Unit 3

Arrays & Strings

Arrays - One - D Array - Two - D Array - Multidimensional Array - Dynamic Arrays – Matrices Operations – Strings - Implementing String Variables - String handling Functions

Unit 4

Functions & Pointers

Concept of Function - User defined Function - System Defined Function - Types of parameters passing in function - Pointers - Types of Pointers - Pointer Expression - Arrays of Pointers - Pointers and Functions

Unit 5

Structures, Union and File Handlers

Structure and Unions - Concepts of Structure - Implementing Structure Variable - Arrays of Structure - Structure within Structure - Introduction of Unions - Difference between Structure and Unions - File Handling using 'C' - Opening and Closing File - Input / Output operations on File - Random Access to Files - Command Line Arguments

REFERENCES:

1. Yeshwant Kanetkar, Authentic Guide to C Programming Language 17Th Edition, BPB publications, 2020

2. Greg Perry, Dean Miller. “C Programming Absolute Beginner's Guide”, 3rd ed., Que Publishing, 2013.
3. Stephen G. Kochan. “Programming in C”, 4th ed., Addison-Wesley Professional, 2014.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. To understand the use of software and programming for problem solving.

CO2. To understand modular programming approach in diversified problem in biological domains

CO3. To apply the concepts of input, output and control statements, functions, arrays, strings, structures, and file handlers to solve biological problems using C language

CO4. To apply programming logic to solve Bioinformatics problems

BIFxxx DATABASE CONCEPTS 2 1 0 3

LEARNING OBJECTIVES:

The objective of this course is to understand fundamentals of data models and to conceptualize a database system for user requirement. Additionally, this course will also cover fundamental of Database query language, like SQL and relational algebra, concept of normalization in database design, concepts of transaction processing, concurrency control techniques and database recovery procedure.

SYLLABUS:

Unit 1

Basic Concepts of Database Systems

Overview of file systems and Database Systems, Software Architecture of a typical DBMS, Data Models, Relational Data Model, Network Data Model, Hierarchical Data Model, Schemas and Instances, Database Administration and Control.

Unit 2

Relational Model and Query Language:

Overview of Relational Database, Key Integrity constraint, Relational Algebra, Relational Calculus: Domain Relational Calculus, Tuple Relational Calculus, SQL Fundamentals, Basic operators, Missing Information, Null Values, Additional Operations, Advanced SQL features, Embedded SQL, Dynamic SQL, Database Views.

Unit 3

Database Design:

Overview of Normalization, Database Anomalies, Functional Dependencies, Candidate and Super Key, Non-loss Decomposition, Dependency Preservation, Normal forms: First, Second, Third Normal, Boyce Codd Normal Form, Multi-valued Functional Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Denormalization.

Unit 4

Transaction Processing

Overview of Database Transactions, Transaction states, Transaction Recovery, ACID Properties, Transaction Recovery: Two Phase Commit, Commit Points, Serializability, Concurrency control: Need for Concurrency, Locking Protocols: Binary lock, Two Phase Lock, Deadlock, Starvation, Transaction Timestamp**.**

REFERENCES:

1. A Silberschatz, H.F. Korth & S. Sudarshan: Data Base System Concepts, TMH, 1997.
2. A.K. Majumdar and Bhattacharyya: Database Management Systems, THM, 1996.
3. C.J. Date: An Introduction to Database systems 7th Ed. Addison Wesley, Indian Edition, 2000.
4. Elmasri & Navathe : Fundamentals of Database Systems/Oracle 9i Programming 5th Ed. Pearson, 2009

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: To understand fundamental concepts, principles and applications of database system.

CO2: To demonstrate database related programming languages and perform the basics of commercial relational systems.

CO3: To apply the concepts of normalization to database design.

CO4: To Design and Implement a small database project, considering the issues like concurrency control recovery and security.

BIFXXX PROGRAMMING CONCEPTS LAB 0 0 3 1

LEARNING OBJECTIVES:

To introduce concepts of programming with a basic and widely used programming language C and introduction to scripting concepts in Linux operating system. The major objective of this course is to provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.

SYLLABUS:

Unit 1:

To demonstrate the usage of operators and data types in C

A. Write a program to print the size of all the data types with its modifiers supported by C and its range.
B. Write a program to calculate simple interest.

Unit 2:

To demonstrate the usage of if, if-else, nested-if and switch

A. Write a program to find the largest, smallest and second largest of three numbers.
B. Write a program to accept marks of three subjects calculate the total percentage and output the result of the student.
C. Write a program to find the second largest of four numbers.
D. Write a program to calculate Julian date.

Unit 3:

To demonstrate the usage of while, do-while and for loops

A. Write a program to find the sum of numbers from 1 to N.
B. Write a program to reverse a number.
C. Write a program to generate the Fibonacci series.

Unit 4:

To demonstrate the concept of arrays and strings

A. Write a program to check whether a string is a Palindrome.
B. Write a program to insert a number at a given position in an array.
C. Write a program to arrange a list of numbers in ascending order.
D. Write a program to check whether a given matrix is symmetric or not.
E. Write a program to perform matrix multiplication.

Unit 5:

To demonstrate the usage of functions and recursion

A. Write a program to check whether a given number is prime or not.
B. Write a program to find the roots of a quadratic equation
C. Write a recursive program to find the factorial of a number.
D. Write a recursive program to find xy.

Unit 6:

A. To demonstrate the concept of structures
B. Write a program to create a student structure and display the same.

Unit 7:

A. To demonstrate the concept of pointers
B. Write a program using function to swap two numbers using pointers

REFERENCES:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
3. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

COURSE OUTCOMES (COs):

CO1: Develop ability to write, compile and debug programs in C language

CO2: Design programs involving decision structures, loops and functions

CO3: Understand the dynamics of memory by the use of pointers

SEMESTER 7

BIO xxx FRONTIERS IN BIOSCIENCES 1 1 0 2

LEARNING OBJECTIVES:

The course helps the students understand the concepts in emerging areas of biotechnologies. What technologies Sherald biology the next three decades? What makes a perfect technology capacitance? This course would lay focus on know-how of understanding these emerging disciplines with special drive for learning the concepts.

SYLLABUS:

Unit 1

Introduction: Concepts of next generation sequencing: short read and long read sequencing; ddNTPs.

Unit 2

Sequencing Technologies: Sanger sequencing, Second/next generation sequencing (NGS); Illumina technologies.

Unit 3:

Third Generation Sequencing Technology: Third generation sequencing technologies, ONT Minion, Pac bio, 10X, single cell technologies

Unit 4

Spatial Biology: Digital spatial technologies, Vision 2050: Bio-inspired technologies, new vaccines: combating antimicrobial resistance; antibiotic resistance

Unit 5

Genome Editing: ZFNs, TALENs paving way for CRISPR-CAS9, AI driven biology: DNA as a storage device; Structural Biology, the future next: Where are we heading?

REFERENCES:

1. Goldenfeld N, Woese C. Biology's next revolution. Nature. 2007 Jan 25;445(7126):369. doi: 10.1038/445369a. PMID: 17251963.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. Basic concepts of NGS and advanced sequencing Technologies.

CO2. Various challenges and applications of sequencing Technologies.

CO3. Concepts of Genome editing and its applications.

BIO xxx STRUCTURAL BIOLOGY 2 2 0 4

LEARNING OBJECTIVES:

Structural biology approaches have broadened the scope for better understanding of small molecules and macromolecules. The complete genome sequencing of an organism in days which led to generating several numbers of protein sequences and so understanding the three-

dimensional structure of the protein molecules has become a necessity. The course would be helpful to students to attain good knowledge in understanding the structural aspects of biomolecules.

SYLLABUS:

Unit 1

Introduction to Structural Biology: Structure of small molecules, Databases for small molecules, 2D and 3D structures of molecules, conversion, Draw the structures of molecules, Conversion of molecules to various formats, Databases for molecules, Chemical and physical properties of molecules, Lipinski rule, what are ADMET properties.

Unit 2

Introduction to Macromolecules: Protein database, how to understand and read 3D structure files, RCSB, reading PDB files, and related calculations, Basics of macromolecular crystallography, Introduction to importance of Nuclear Magnetic Resonance (NMR) and Cryo-Electron microscopy.

Unit 3

Introduction to Protein Sequences: screen the proteins to specific organism, compare sequences of proteins, identify the 3D structure of protein, introduction to protein-protein interactions and tools, identifying the Active sites in a protein.

Unit 4

Introduction to Ligand: Protein Interactions, concepts of Molecular Docking studies, tools for Molecular Docking, how to prepare Ligand, Protein files, importance of grid and dock files,

Unit 5

Optimization: preparation of Grid parameters and docking parameters, run the commands, validating the Autodock data, 3D visualization tools and labelling the amino acid residues.

REFERENCES:

1. Lubert Stryer, Biochemistry, 4th Edition, WH Freeman & Co.
2. Carl Ivar Branden and John Tooze., "Introduction to Protein Structure" 2nd 2001 Edition, Taylor, and Francis.

COURSE OUTCOMES :

After completing the course, students shall be able to

CO1. Understand the importance of structural biology related to small molecules and their Physico-chemical properties.

CO2. Understand the 3D structure of Proteins and structural aspects of protein using bioinformatic tools.

CO3. Understand the sequence, screening, and actives sites information of the proteins.

CO4. Understand the concepts of ligand-protein interactions and molecular docking studies using Autodock.

BIO xxx NON-CODING RNA (ncRNA) BIOLOGY 1 1 0 2

LEARNING OBJECTIVES:

The subject will allow the participants understand the essentials of non-coding RNA molecules, how they are transcribed; regulate expression of genes and further known to affect the transcription and cell cycle of organism.

SYLLABUS:

Unit 1

Introduction: what and why of ncRNAs, Small and long non-coding RNAs.

Unit 2

Long non-coding RNAs (lncRNAs): ncRNAs as regulatory key players; lncRNAs as candidate biomarkers, case studies

Unit 3

Tools and Databases: To identify ncRNAs, ncRNA databases and webservers; Smith-Watermann algorithm for ascertaining candidate ncRNAs; intergenic non-coding RNAs.

Unit 4

Genome walking: Genome browsers, identifying mutations in ncRNAs.

Unit 5

Case Studies: classical examples, reviewing the literature.

REFERENCES:

1. Ernesto Picardi. RNA Bioinformatics (2021). Springer Verlag. https://link.springer.com/book/10.1007/978-1-0716-1307-8
2. Julio Vera, Xin Lai, Shailendra K. Gupta. (2019) Computational Biology of non-coding RNAs. Springer Methods and Protocols. https://link.springer.com/book/10.1007/978-1-4939-8982-9

3. Non-coding RNA: https://www.cell.com/cell/collections/noncoding-rna.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. Basics on non-coding RNA molecules

CO2. The course is going to be interactive and self-contained with rigorous brainstorming.

CO3. There will be easy hands-on exercises using visualizers and command line.

CO4. long non-coding RNAs (lncRNAs) besides a gist of miRs, PiwiRNAs etc will be focussed.

BIF xxx MACHINE LEARNING FOR BIOLOGICAL SCIENCES

2 1 0 3

LEARNING OBJECTIVES:

The objective of this course is to understand the commonly used machine learning algorithms and provide insight into their theoretical foundations. This course has a special focus on machine learning algorithms for analyzing biological data such as protein/DNA sequences, protein structures, molecular graphs, and so on.

SYLLABUS:

Unit 1

Introduction to Machine Learning

Overview of intelligent systems and machine learning - Knowledge Discovery process - Data understanding and Data exploration – Data Preprocessing

Unit 2

Supervised Learning

Supervised Learning: Classification introduction, performance evaluation, a first simple classifier: Decision tree – Rule-based algorithms – Linear regression – Logistic regression - Advanced Classification methods: Random Forest, Support Vector Machine, Neural Networks

Unit 3

Unsupervised Learning

Unsupervised learning: Clustering: K-Means clustering, DBSCAN - Hierarchical clustering - Pattern mining: a-priori pattern mining

Unit 4

Application of Deep Learning in Bioinformatics

Supervised Learning: Deep Learning with Recurrent Neural Networks: architecture - Protein structure/function prediction using machine learning - application of graph neural network for the prediction of protein interaction network - Deep learning applications to genomics :DNA motif discovery - Deep learning applications to genomics: single cell RNAseq analysis and interpretation

Unit 5

Deep Learning Case Study Bioinformatics

Define Project Objective - Acquire & Explore Data - Model Building - Model validation - Interpret & Communicate - Data Visualization

REFERENCES:

1. A Silberschatz, H.F. Korth & S. Sudarshan: Data Base System Concepts, TMH, 1997.
2. A.K. Majumdar and Bhattacharyya: Database Management Systems, THM, 1996.
3. C.J. Date: An Introduction to Database systems 7th Ed. Addison Wesley, Indian Edition, 2000.
4. Elmasri & Navathe : Fundamentals of Database Systems/Oracle 9i Programming 5th Ed. Pearson, 2009

COURSE OUTCOMES:

After completing the course, students shall be able to

CO 1. Different types of machine learning and its utility in bioinformatics

CO 2. Application of Hidden Markov Model and Artificial neural networks to different types of bioinformatics data

CO 3. Determination of Bayesian Network (BN) from expression data.

ELECTIVES

BIFxxx COMPARATIVE GENOMICS 2 1 0 3

LEARNING OBJECTIVE:

To understand the importance and ways of comparing different parts of the genomes of eukaryotes and prokaryotes in connection to the evolution of gene regulations, protein functions, metabolic networks, etc.

SYLLABUS:

Unit 1

Introduction to Genomes- How, what, and why are genomes sequenced. Benefits of Comparative genomics

Unit 2

Introduction to the CoGe system for Comparative Genomics, Polyploidies within plant genomes. Algorithms and tools for Whole Genome Comparisons,

Unit 3

Conserved Non-coding sequences; Post-polyploidy Fractionation mechanisms;

Unit 4

Repetitive elements within genomes. Transposons and Epigenetic mechanisms in plant genomes;

REFERENCE:

1. Jonathan Wendel, Johann Greilhuber , Jaroslav Dolezel, Ilia J. Leitch, "Plant Genome Diversity", 2012th Ed. Vol1..

COURSE OUTCOME:

CO1: To understand and perform genome-level comparative studies of molecular sequences isolated from multiple individuals within and across species.

CO2: To connect different algorithms and tools for genome comparison

CO3: To relate the plant genomes mechanisms to animal genome

BIF xxx PYTHON FOR BIOINFORMATICS CREDITS:3

LEARNING OBJECTIVES:

To practice and learn basic and intermediate programming concepts in Python.

SYLLABUS:

Unit 1

Introduction: Introduction of Python programming, Introduction to Python IDEs and other programming environments, Fundamentals of data handling, File handling, Flow control, Flow control (loops), Fine turning of flow control.

Unit 2

Functional and Object-Oriented Python - Functional programming, Lambda and map functions, Classes and object in Python.

Unit 3

Numerical Python- Introduction NumPy, Data manipulation using ND-arrays, Broadcasting, ND-array slicing, NumPy inbuilt functions, Vector computation using NumPy

Unit 4

Structured Data Processing and Visualization- Data processing using Pandas, Structured data visualization, plotting data using Matplotlib, creating subplots using Matplotlib

Unit 5

Bio Python and VCS - Introduction to Entrez, Searching and retrieving PubMed articles through Bio Python, Retrieving Genomic sequences through Bio Python, Introduction to Git:- Init, Pull, Push, Commit, Merge, Branches

REFERENCES:

1. [O`Reilly] - Programming Python, 4th ed
2. Biopython Tutorial and Cookbook
3. [O`Reilly] – Python Cookbook - David Beazley

4. Python Data Analytics: With Pandas, NumPy, and Matplotlib - Fabio Nelli
5. Git for Teams: A User-Centered Approach to Creating Efficient Workflows in Git - Emma Jane Hogbin Westby

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Students will be able to implement programs in python language

CO2: Use multi-dimensional data structure to store, analyze and visualize data.

CO3: Use Bio Python to retrieve and analysis biological data such as Genomic sequences and Biomedical literatures

CO4: Implement programs in Python with best practices and version control.

BIO xxx FAIR GUIDELINES/ETHICS IN RESEARCH 2 1 0 3

LEARNING OBJECTIVES:

The course helps the students known the nuances of Reusability and Reproducibility as an essential practice for a researcher to forge ahead. This course would lay focus on know-how of these FAIR guidelines and Ethical practices

SYLLABUS:

Unit 1

Introduction: Concepts of Findable, Accessible, Interoperable, Reusable (FAIR) principles for fair research practices; Reproducibility and standard operating procedures

Unit 2

Principles for Data Modules: Globally unique and persistent identifiers, Rich metadata, Data identifiers, objects, descriptors, searchable resources.

Unit 3

Data Management Skills: Significance of machines in data-rich research environments, FAIRDOM, Implementation data

Unit4

Ethics in Research: Hippocratic Oath for scientists, Etiquette and Ethics in Research.

Unit 5

Scientific Writing: Tips and traps in writing a good review/scientific article, one to one mentoring on a review to be accomplished

REFERENCES:

1. Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al*. The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18
2. **https://www.go-fair.org/fair-principles/**

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1. Learn basics of FAIR research practices.

CO2. Understand standard operating procedures

CO3. Learn basics of Ethics in Research.

CO4. Getting to know how to write a research/review article.

MINI PROJECT

EXPLORING YOUR SCIENCE HONOURS WITH A PROJECT 2 3 5 10

1. The B.Sc. Honours fourth year project entails comprehensive industry orientation for 8 months.
2. The student is encouraged to get trained in best labs in India.
3. The placement cell will take care of logistics if any.