B. Sc. (Bachelor of Science) in Biotechnology

Faculty of Science
PROGRAM OUTCOMES

PO1: **Knowledge Based Training**: Provide knowledge of scientific and analytical fundamentals, leading to a holistic understanding of Biological Sciences.

PO 2: **Exposure to Basic and Advanced instrumentation**: Understanding of analytical instrumentation as well as protocols and their applications.

PO3: **Development of Experimental Skills**: Plan and execute a series of laboratory experiments for generation and validation of data.

PO4: **Quantitative Data Analysis**: Analysis, interpretation, integration and comprehension of data for conclusive representation.

PO5: **Environment and sustainability**: Experiencing the impact of scientific processes with the focus on sustainable development goals.

PO6: **Scientific Communication**: Enhancing communication skills through effective understanding of scientific literature.

PO7: **Ethics and Values**: Inculcate ethical principles and values with greater responsibility to the norms of scientific practice.

PO8: **Individual and Teamwork**: Develop qualities of teamwork, interpersonal and leadership skills to think critically and work independently,

PO9: **Science for Society**: Develop the ability to engage in independent and life-long learning to assess health and safety issues for societal benefit.

Programme Specific Outcomes

PSO1: Comprehend the fundamentals of basic sciences enabling the students to imbibe the concepts in Biotechnology.

PSO2: Acquire skillset in Biotechnology and allied domains for successful career progression.

PSO3: Constant integration with the latest developments in Biotechnology to meet the demands of higher education and industry.

PSO4: Inculcate the culture of independent learning, innovative research and productive teamwork.
## CURRICULUM STRUCTURE

### Semester 1

<table>
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<tr>
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Total Credits: 16

Total credits for program completion: 130

### Evaluation policy for various courses

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LEARNING OBJECTIVE:
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

Unit 3

Unit 4

Unit 5
Extracellular Matrix - Plasma membrane & Transport, Cell Wall, ECM, Cell-Cell Interactions, Cell-Matrix interactions

REFERENCES:

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.

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 (1st, 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-ordinations compounds, Crystal field theory, Colour & magnetic properties of complexes, Chelation & applications, biologically relevent co-ordination compounds

REFERENCES:

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

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:

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 2103

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

SYLLABUS:
Unit 1

Unit 2

Unit 3

Unit 4
staining, Negative staining, Capsule staining, Spore staining, Flagellar staining, Nuclear staining and Acid-fast staining.

**Unit 5**


**REFERENCES:**


**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:

Unit 1


Unit 2


Unit 3


Unit 4


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:

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 the 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 of India in diverse fields. To equip
students with a knowledge of their country and its eternal values.

**SYLLABUS:**

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<tr>
<td>1.</td>
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<td>Chapter 3 - Impact of Colonialism and Decolonization</td>
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<td>16.</td>
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**Self-Study/ Self-reading**

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 spiritual heritage.

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 to various 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 overcome obstacles 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.


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:

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.
5. Motility Determination: - Hanging Drop Method

REFERENCES:

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 2103

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.
2. Odum, E. P. (2006). Ecology, the link between the natural and the social
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:**


**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 2103

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

REFERENCES:

**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 2103**

**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:

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 3104

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:

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.
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

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

SYLLABUS:
1. Preparation of standard & dilute solutions.
2. To determine the solubility of an organic acid in water at room temperature.
3. Acid base titration using pH meter.
4. To study the rate of a chemical reaction-2
6. Identification of functional groups.
7. Determination of Viscosity of Organic Solvents by Ostwald Viscometer
8. To study the Effect of urea on the viscosity of BSA using Ostwald Viscometer
9. Measurement of heat changes using a calorimeter
11. Measurement of emf of an electrolyte at a given temperature
12. To find the specific rotation of sugar solution using polarimeter

REFERENCES:
3. Virtual Labs in Chemistry: http://amrita.vlab.co.in
   2. Emf measurement.
   3. Water Analysis –Determination of chemical parameters
   4. Determination of specific conductivity of soil
   5. Crystal field theory of complexes

COURSE OUTCOME:
After completing the course, students shall be able to
CO1. To get the idea about how to handle the chemicals.
CO2. Students will get the exposure to use the equipments like weighing machine, Ostwald Viscometer, polarimeter, pH meter, conductivity meter, calorimeter etc.
CO3. Students will get the chance to compare the theoretical values and practical values.
CO4. They can improve their hands-on skills.
LEARNING OBJECTIVE:
This course deals with basic biochemical calculations and preparations of various reagents, qualitative and quantitative analysis of both carbohydrates and amino acids, chromatography techniques.

SYLLABUS:
1. Preparation of Laboratory Solutions and Buffers.
2. Verification of Beer-lamberts Law using Potassium Dichromate.
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.

REFERENCES:

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.
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 help 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

REFERENCES:

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 2103**

**LEARNING OBJECTIVES:**
Biostatistics is a course offered to 3rd semester B.Sc., (BT & MB). We have considered distributions relating to a single characteristic. How far the two variables, corresponding to two characteristics, tend to move together in same or opposite directions. The theory of probability is a study of Statistical or Random experiments. Using these figures, it might be possible to estimate the possible level of prices at some future data so that some policy measures can be suggested to tackle the problems. Average is a value which is typical or representative of a set of data.

**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

REFERENCES:

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**  **3104**

**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:**

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

BIO 206 ANALYTICAL BIOCHEMISTRY 2103

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:**


**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 2103

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:**

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:

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.
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:**

**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 1001

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

SYLLABUS:

Chapter 1 Mahābhārata - A Brief Summary
Chapter 2 A Preamble to the Grand Itiḥāsa
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
Chapter 7 Acumen
Chapter 8 Karna: The Maestro that Went Wide of the Mark
Chapter 9 Strategical Silhouette of An Extraordinary Peace Mission
Chapter 10 Yajñāsena, A Woman from Fire.
Chapter 11 Popular Regional Tales
Chapter 12 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.

SEMMETER 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:

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, neuromuscular, 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.
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


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:


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 2103

LEARNING OBJECTIVE:
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


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:


COURSE OUTCOMES:

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 2103

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

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

Unit 4


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:
6. Internet/Journal Resources

COURSE OUTCOMES:
After completing the course, students shall be able to
BIO 204  CELL BIOLOGY  2103

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

Unit 2
Cell Signaling: Basics of animal Communications, Modes & Types of Cellular Signals, Receptors: GPCRs, RTKs, Cytokine Receptors & NRTKs, Enzyme linked receptors, GPCRs in vision, smell and taste, Mechanism of actions of toxins, Nitric oxide signaling,
signaling in developmental pathways like Wnt, Notch and Hedgehog, NF-KB signaling, signaling in plants- Auxin, Ethylene and Phytochromes, signaling involved in Circadian rhythm in Humans, Drosophila and Cyanobacteria.

**Unit 3**

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

**Unit 4**

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

**Unit 5**

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

**REFERENCES:**


**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.

**BIF 301 INTRODUCTORY BIOINFORMATICS 2103**

**LEARNING OBJECTIVE:**
To introduce to the field of bioinformatics via an array of publicly available tools and resources

SYLLABUS:

Unit 1

**Introduction: 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

Unit 4

**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 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:

COURSE OUTCOMES:
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

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 OUTCOME:
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.

22ADM211  Leadership Lessons from Ramayana  1 0 0 1

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

SYLLABUS:
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 - Aranya-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)

COURSE OUTCOMES:
CO 1 – This part gives a brief introduction of the Great Itihasa 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

**BIO 282 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:**
4. Latex Agglutination Reaction.
5. Ouchterlony Double Diffusion.
6. Dot ELISA

**REFERENCES:**

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

SYLLABUS:
1. Preparation of phosphate and acetate buffer. Isolation of Alpha/Beta Amylase from saliva/sweet potato.
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.

REFERENCES:

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
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:

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 fingerprinting.

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

BIO 318 OMES & OMICS 2103

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


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:


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.
CO5. Recall major separation techniques in Proteomics and Metabolomics.
CO6. Compare and discuss workflows and strategies for protein identification and characterization.
LEARNING OBJECTIVES:
The course is designed to understand the metabolic pathways, their energetic and regulatory mechanism inside the cell.

SYLLABUS:

Unit 1

Unit 2

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:

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 2103

LEARNING OBJECTIVE:
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, Cavittator, 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. Advantage and disadvantage of bioremediation.

**REFERENCES:**

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 of 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 2002

LEARNING OBJECTIVE:

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:

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 OBJECTIVE:

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”.

REFERENCES: ?

COURSE OUTCOME:

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 fermentors and learn their basic working principles.

SYLLABUS:
1. Isolation and screening of antibiotic producers by crowded plate technique.
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:

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.
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:
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 319 PHARMACOLOGY 4004

LEARNING OBJECTIVE:
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:


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 2103

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

Unit 3
Mechanisms of differentiation: cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development.

Unit 4

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:
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.
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:

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.

EVALUATION SCHEME AND GRADING SYSTEM

CREDIT SYSTEM OF EVALUATION*

Introduction

Amrita School of Biotechnology follows a credit-based system for evaluation under a semester pattern. This allows flexibility on courses, time frame, teaching and learning, evaluation procedures and mobility.

Academic year and Semesters

An academic year (July to June) consists of two semesters and possibly a summer term. Each semester has a minimum of 80-85 teaching days and about 8-10 days for the end semester examinations.

Credit based Academic System

A credit-based system is a systematic way of describing an educational programme by attaching credits to its components. Credit is a way of quantifying the knowledge content. When enough credits are accrued or earned, the programme is completed successfully.

Credit system makes educational programmes easy to understand and compare both nationally and internationally. It facilitates mobility, academic flexibility and universality and helps universities to organize as well as reorganize their study programmes quickly. It can be used across a variety of programmes and modes of delivery.

Programme

An educational programme specializing in a specific area covers many knowledge
segments. An example is the B.Sc. programme in Biotechnology.

**Allotment of Credits**

Credits are allocated to the knowledge segments giving due importance to their weightings. The sum of the credits allotted to the knowledge segments decides the programme credits. The programme is successfully completed from the academic angle, once the specified programme credits have been earned.

Example: (For a B.Sc. Biotechnology Programme)

<table>
<thead>
<tr>
<th>Knowledge Segment</th>
<th>Category</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language, Cultural Education &amp; Soft Skills</td>
<td>S</td>
<td>17</td>
</tr>
<tr>
<td>Mathematics, Physics &amp; Chemistry</td>
<td>M</td>
<td>20</td>
</tr>
<tr>
<td>Core Lifesciences</td>
<td>C</td>
<td>67</td>
</tr>
<tr>
<td>Laboratory Courses</td>
<td>L</td>
<td>16</td>
</tr>
<tr>
<td>Project/Dissertation Thesis</td>
<td>P</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total Credits for programme completion</strong></td>
<td></td>
<td><strong>127</strong></td>
</tr>
</tbody>
</table>
Under each knowledge component, the credits are again distributed among the identified courses. The number of courses and the credits allocated to each, could vary. However, the student need to get only the minimum credits in each of the components as mentioned in the example and a prescribed minimum total number of credits for successfully completing the academic programme. Additional credits taken will be an added advantage from the professional angle, but not from the academic requirements.

**Course Credits**

Each course, except for a few special courses, has a certain number of credits assigned to it depending on the lectures, tutorials, laboratory works and contact hours in a week. Lectures (L) and Tutorials (T) will have one credit per each contact hour in a week. Laboratory and Practical (P) classes carry one credit for two / three contact hours in a week. Projects, fieldwork etc are given a specific number of credits without any direct reference to the hours spent.

Example:

a) A Course on Plant Biology

Number of Lecture hours per week – 3 Credits: 3
Number of Tutorial hours per week – 1 Credits: 1
Total credits for the course 3 + 1 = 4

b) A Laboratory Course on Microbiology:

Number of Laboratory hours per week -3 Credits: 2

These are normally indicated in the curriculum, as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours per week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>BIO223</td>
<td>Plant Biology</td>
<td>L: 3  T: 1  P: 0</td>
<td>4</td>
</tr>
<tr>
<td>L</td>
<td>MIC281</td>
<td>Microbiology Lab</td>
<td>L: 3  T: 0  P: 2</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>BIO399</td>
<td>Project</td>
<td>L: 5  T: 5  P: 20</td>
<td>7</td>
</tr>
</tbody>
</table>

**Curriculum**

Curriculum is the framework of an academic programme. In the credit based system, curriculum will specify the category, course code, course title, course delivery (Lectures / Tutorials / Lab / Project) and the credits. Curriculum is presented semester-wise for convenience and will take into account all the knowledge segments and their assigned credits. The total credits to be earned for programme completion will be specified clearly. Our curriculum has the following credit allocations among the
knowledge segments:

### B.Sc. Biotechnology

<table>
<thead>
<tr>
<th>Knowledge Segments</th>
<th>Category</th>
<th>2016 Admissions onwards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language, Cultural Education &amp; Soft Skills</td>
<td>S</td>
<td>17</td>
</tr>
<tr>
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<td>L</td>
<td>16</td>
</tr>
<tr>
<td>Project/Dissertation Thesis</td>
<td>P</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total credits needed for programme completion</strong></td>
<td></td>
<td><strong>127</strong></td>
</tr>
</tbody>
</table>

### B.Sc. Microbiology

<table>
<thead>
<tr>
<th>Knowledge Segments</th>
<th>Category</th>
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</tr>
</thead>
<tbody>
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<td>17</td>
</tr>
<tr>
<td>Mathematics, Physics &amp; Chemistry</td>
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<td>20</td>
</tr>
<tr>
<td>Core Lifesciences</td>
<td>C</td>
<td>66</td>
</tr>
<tr>
<td>Laboratory Courses</td>
<td>L</td>
<td>18</td>
</tr>
<tr>
<td>Project/Dissertation Thesis</td>
<td>P</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total credits needed for programme completion</strong></td>
<td></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>

For the **M.Sc. programmes**, a total of 76 credits (Biotechnology), 76
Credits (Microbiology), 79 credits (Bioinformatics) have to be earned. 10 credits of project work have to be earned additionally for the successful completion of the programme.

**Credit System Flexibility**

Credit system allows flexibility on the selection of courses and time frame for completion of the programme. It also provides a good blend of teaching and learning, ensuring credible evaluation procedures and student mobility. The credit system is evolved around the teacher and the taught.
The prominent features of the credit system cover continuous evaluation of students’ performance through well-planned assessment procedures and the flexibility to allow a student to progress at a pace suited to his / her individual ability and convenience, subject to certain conditions. While a prescribed minimum number of credits are to be earned for the award of degree, a minimum level of performance is necessary for progressing with the studies.
Class Advisors and Counsellors

Each class will have one/two class counsellor(s) to help and guide the students in the academic process, solve their problems, if there is any, as also to provide counselling and guidance for the needy. They will also monitor the progress of the students in their studies and report the same to their parents periodically.

Checks and Controls in the Credit System

To achieve purposeful flexibility, a good system control is needed. Hence there are specific rules and procedures to be adhered to in the credit system. Certain courses in each knowledge segment are identified as core courses and others as electives. There is mandatory registration and credit earnings requirements for core courses. Electives are free to be chosen from those offered, for registration. While it is mandatory to register for the elective courses, failure to earn credits in them does not necessarily mean repeating the courses. Another elective course may be permitted as a replacement course.

Certain courses are pre-requisites for advanced courses. For example, Molecular Biology could be a pre-requisite for Genetic Engineering. This means that the student cannot take Genetic Engineering unless he/she has completed Molecular Biology. Here the term completion means that the student has registered for the course, done all assignments and tests, attended the class with 75% or more attendance and has written the end semester examination. The student need not have to earn credits (i.e., pass the course) for fulfilling the pre-requisite needs.

How to go about with the credit system?

The first step, in the credit based system, is the registration for the various courses. For first semester, registration is done at the beginning of the semester. In the subsequent semesters (2nd semester onwards), registration will be done at the end of the previous semester. The students have to enroll for the courses, earlier registered, at the start of the semester.

During enrolment, one can drop the earlier registered courses or add new courses, with the approval of the faculty advisor / Counsellor and the concurrence of the Dean of the School.

All students will have to register before a specified date. However for valid reasons, late registration with a fine will be permitted up to a specified date. These dates will be announced well in advance.

Registration

Students will be made aware of all information on the courses being offered in that semester. There will be an on-line registration procedure. The students have to enter the details of the courses they want to register for. In the first few semesters there may not be much of a choice to decide on. As one progresses, the flexibility will become more evident. Students have to consult the faculty members who have been identified as their advisors, for advice and assistance in registration.
Minimum and Maximum credits for which one can register in a semester is specified in the relevant curricula. Any deviations will need the approval from the Dean, School of Biotechnology.

A student is permitted to register / enroll for courses only if he / she has:

a) Paid all fees and has no dues to the university
b) Has maintained a progress, as required by the university
c) Has completed any pre-requisite courses prescribed
d) Has no disciplinary action pending against him / her

**Conduct of Courses**

Credit system encourages learning. Apart from regular class lectures, students will be given major assignments which will form a part of the course and will also be considered for evaluation. Seminars, design and other assignments, technical paper writing, quizzes etc. could also be a part of the course being conducted.

The teacher offering the course will evaluate the performance of the students at regular intervals and in the end semester examination. A class committee comprising all teachers handling all the courses for the class, the class advisor and students’ representatives will monitor the conduct of all the courses of a class.

A course committee comprising all teachers / mentors offering a course in all the campuses will decide on the course plan, evaluation procedure and any midway correction to be taken. Decisions taken by this committee will be informed to all students who have registered for the course. The class / course committees without students’ representative will finalise the grades and results for the class / course.

It is mandatory for the students to appear for the end semester examination / supplementary examination for the completion of the course.

If the Project work is not satisfactory, the student will be asked to continue the project till he / she completes it satisfactorily.

**Attendance**

- Additionally, a 5% weightage is given to attendance above the total weightage
- All students are required to attend 100% of the classes.
- Leave of absence could be applied for in the form provided in the School website/Store and will be granted by Counsellor only in genuine cases.
• Two types of leave are permitted, namely, Duty Leave and Other leaves

• All leaves except Duty leave put together, as sanctioned by the Counsellor should not exceed 25% of the total classes, for eligibility to appear for the end semester examination.

• Marks for attendance

  i) 5 marks for 96-100% attendance
  ii) 4 marks for 91-95% attendance
  iii) 3 marks for 86-90% attendance
  iv) 2 marks for 80-85% attendance
  v) 0 mark for 75-79% attendance
  vi) ‘FA’ for < 75% attendance

Students representing the University events either within the campus or outside the campus will be marked as present (OD). However, students should submit an OD form approved by Chairperson/Dean prior to attending the event. OD form submitted after the event will not be entertained and the student will be marked absent.

Grading System

<table>
<thead>
<tr>
<th>2015 Admissions onwards</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade Point</td>
<td>Grade</td>
<td>Rating</td>
</tr>
<tr>
<td>O</td>
<td>10</td>
<td>Outstanding</td>
</tr>
<tr>
<td>A+</td>
<td>9.5</td>
<td>Excellent</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>Very Good</td>
</tr>
<tr>
<td>B+</td>
<td>8</td>
<td>Good</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>Above Average</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>P</td>
<td>5</td>
<td>Pass</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>Failed</td>
</tr>
<tr>
<td>FA</td>
<td>0</td>
<td>Failed due to lack of Attendance</td>
</tr>
<tr>
<td>I</td>
<td>-</td>
<td>Incomplete (Awarded only for Laboratory proj</td>
</tr>
<tr>
<td>W</td>
<td>-</td>
<td>Withheld</td>
</tr>
</tbody>
</table>

If the student secures ‘F’ grade in any of the courses, he/she can reappear for the supplementary exam.

If the student secures ‘FA’ grade in any of the courses, he/she has to re-register (redo) for the course when it is being offered next.
A student who has been awarded ‘I’ grade in the laboratory courses shall take up additional laboratory sessions during the first two months of the next semester and earn a pass grade, which will be reflected in the next semester’s grade sheet.

If a student is absent for the end semester examination, he/she will be allowed to reappear on proper evidence for his/her absence.

**Grade Point Average (SGPA)**

Based on the credits for which the student has registered and the grades awarded, Semester Grade Point Average [SGPA] and Cumulative Grade Point Average [CGPA] are calculated.

\[ \text{SGPA} = \frac{\sum (C_i \times G_i)}{\sum C_i} \]

where \( C_i \) is the number of credits for \( i \)th course in that semester and \( G_i \) is the grade points earned by the student for that course.

**Cumulative Grade Point Average (CGPA)**

The overall performance of a student at any stage of the M.Tech. program is evaluated by the Cumulative Grade Point Average (CGPA) upto that point of time.

\[ \text{CGPA} = \frac{\sum (C_i \times G_i)}{\sum C_i} \]

where \( C_i \) is the number of credits for \( i \)th course in any semester and \( G_i \) is the grade points earned by the student for that course. The summation is over all the courses registered by the student and evaluated during all
the semesters up to that point of time, including the failed courses. The CGPA is rounded off to two decimals. The ranking of the students in a batch at any intermediate or final stage is based on CGPA.

**Grade Sheet**

Grade sheet issued to the student at the end of the semester will contain the following information.

1. Name, Roll No., Grade Sheet No., Semester, Branch, Month and year of Examination.

2. Course Code, Course Title, Credits and Grade Obtained, Grade Points Earned for the courses registered.

3. Credits registered and earned during the semester.

4. Cumulative Credits earned and Grade Points.

5. SGPA.

6. CGPA.

**Revaluation of Answer Papers**

An aggrieved student can request for revaluation of answer script of the end semester examination, through a well laid out procedure. There will be revaluation fee for each paper. If the revaluation leads to a better grade, the revised grade will be awarded to the student and in such cases the revaluation fee will be refunded in full. Revaluation is allowed only for lecture-based courses.

**Course Completion**

A student is said to have successfully completed a course and earned the corresponding credits, if he / she has;

- Registered for the course.
- Put in 75% or more attendance in the course.
- Written the periodical tests and end semester examination.
- Obtained a pass grade D or above in the course.
- No disciplinary proceedings against him / her.
REMEDIAL MEASURES

Supplementary Examination

• Students with ‘F’ Grade may take the supplementary examination in a course up to a maximum of three additional attempts (excluding main end semester examination) carrying the previous internal assessment marks earned by them.

• Students failing to pass the course after two additional attempt shall henceforth appear for the supplementary examination for the entire 100 marks and the internal assessment marks earned by them in their regular registration shall not be considered.

• Grade Rule for supplementary examination: Supplementary exams will be evaluated against the most recent grade rule (whenever the course was offered recently during a regular semester).

• Fee for the supplementary examination will be Rs.300/- per paper during the regular duration of the program, after which the student shall pay Rs.1000 per attempt.

Re-registration/Redo

A student who has not secured a pass grade in a course in the initial registration can register for the same course when offered next along with the junior batch. Students with FA grade are also permitted to register. Two chances of re-registration is allowed per course apart from the regular registration.

Contact Courses

Students in the final semester with one or two arrears with F grade(s) can register for the contact course, if offered. The contact course will run for 45 / 60 hours of contact classes depending on the credit load of the course. Students with FA grade in a given course cannot register for the course under this option.

Runtime Re-do Course

Students with F / FA grade in course can register for a runtime re-do course, if available, on the condition that the total number of credits registered in the semester shall not exceed 28 credits. Runtime re-do courses are run concurrently with a regular semester and would last a full semester.

Discipline

Every student is required to observe strict discipline and decorous behaviour both inside and outside the campus and should not indulge in any activity which may bring down the prestige of Amrita Vishwa Vidyapeetham.

A disciplinary action committee will deal with any act of indiscipline of misbehaviour, unfair practice in the class / university examination etc., and its decision on the action to be taken shall be final. Serious acts of
indiscipline may even attract penalty leading to expulsion from the University.

**Award of the Degree**

A student will be declared eligible for the award of the Degree, if he / she has:

- Registered and earned the credits for all the core courses and project work.
- Earned the minimum required number of credits for the branch of study as specified in the curriculum.
- Earned the specified number of credits in all categories.

- No disciplinary action pending against him / her.

- There are no outstanding dues against him / her.

**Classification of successful candidates**

A student shall be considered to have successfully completed the programme, if he/she has -

a) registered and successfully completed all the core courses and projects.

b) earned the required minimum number of credits as specified in the curriculum corresponding to the branch of his/her study, within the stipulated time.

c) Earned the specified number of credits in all the categories of courses.

Candidates, who have successfully completed the programme, shall be classified as follows:

a) Candidates securing a CGPA of 8.00 and above – DISTINCTION. b) Candidates securing a CGPA between 6.50 and 7.99 – FIRST CLASS and the same be mentioned in the Degree Certificate’.

c) If the programme is completed after six(B.Sc.)/four(M.Sc.) semesters of study, the candidates securing a CGPA of 6.50 and above shall be classified to have completed the programme, only with FIRST CLASS.