

# **B. Sc. (Bachelor of Science) in Microbiology**

**Faculty of Science**



## **PROGRAM OUTCOMES**

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

**PO2: 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 team work, 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 Microbiology.

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

**PSO3:** Constant integration with the latest developments in Microbiology 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

Sl. No	Course Code	Course Title	L T P	Cr
1	MIC 103	INTRODUCTORY BIOLOGY	2 1 0	3
2	CHY 103	CHEMISTRY	3 1 0	4
3	ENG 100	ENGLISH	2 1 0	3
4	MIC 100	INTRODUCTORY MICROBIOLOGY	2 1 0	3
5	PHY103	PHYSICS	3 1 0	4
6	22ADM101	FOUNDATIONS OF INDIAN HERITAGE	2 0 0	2
7	AVP103	MASTERY OVER MIND (MAOM)	1 0 2	2
8	MIC 180	INTRODUCTORY MICROBIOLOGY LAB	0 0 4	2
<b>Total Credits</b>		<b>23</b>		

### Semester 2

Sl. No	Course Code	Course Title	L T P	Cr
1	CSA100	INFORMATION SYSTEMS	2 1 0	3
2	MIC101	MICROBIAL ECOLOGY, DIVERSITY & CLASSIFICATION	2 1 0	3
3	BIO 103	BIOCHEMISTRY	2 1 0	3
4	ENG 101	ENGLISH/ CREATIVE WRITING & SOFT SKILLS	2 1 0	3
5	MAT 100	MATHEMATICS	3 1 0	4
6	22ADM111	GLIMPSES OF GLORIOUS INDIA	2-0-0	2

7	PHY 182	PHYSICAL SCIENCES LAB		2
8	BIO 180	BIOCHEMISTRY LAB	0 0 4	2
<b>Total Credits</b>		<b>22</b>		

### Semester 3

Sl. No	Course Code	Course Title	L T P	Cr
1	BIO 202	MOLECULAR BIOLOGY	2 1 0	3
2	MIC 206	MYCOLOGY	2 1 0	3
3	MAT 201	BIOSTATISTICS	2 1 0	3
4	BIO 206	ANALYTICAL BIOCHEMISTRY	2 1 0	3
5	MIC 205	VIROLOGY	2 1 0	3
6	22ADM201	STRATEGIC LESSONS FROM MAHĀBHĀRATA	1-0-0	1
7	MIC 281	GENERAL MICROBIOLOGY LAB	0 0 4	2
8	BIO 281	CELL AND MOLECULAR BIOLOGY LAB	0 0 4	2
<b>Total Credits</b>		<b>20</b>		

### Semester 4

Sl. No	Course Code	Course Title	L T P	Cr
1	BIO 204	CELL BIOLOGY	2 1 0	3
2	BIF301	INTRODUCTORY BIOINFORMATICS	2 1 0	3
3	BIO 207	IMMUNOLOGY	2 1 0	3
4	BIO 209	ENZYME TECHNOLOGY	2 1 0	3

5	MIC 214	MICROBIAL PHYSIOLOGY & METABOLISM	3 1 0	4
6	MIC 207	FOOD MICROBIOLOGY	2 1 0	3
7	SSD 201	SOFT SKILLS-I		1
8	22ADM211	LEADERSHIP FROM RĀMĀYANA(AVP)	1-0-0	1
9	BIO 282	IMMUNOLOGY LAB	0 0 4	2
10	MIC 283	FOOD MICROBIOLOGY LAB	0 0 4	2
<b>Total Credits</b>		<b>25</b>		

### Semester 5

Sl. No	Course Code	Course Title	L T P	Cr
1	MIC 309	INDUSTRIAL MICROBIOLOGY	2 1 0	3
2	MIC 312	MEDICAL BACTERIOLOGY	2 1 0	3
3	MIC 316	RECOMBINANT DNA TECHNOLOGY	3 0 0	3
4	MIC 317	ENVIRONMENT & AGRICULTURAL MICROBIOLOGY	2 1 0	3
5	BIO 317	RESEARCH METHODOLOGY	2 0 0	2
6	SSD-301	SOFT SKILLS-II		1
7	BIO396	LIVE-IN-LABS/OPEN ELECTIVE		3
8	MIC 384	MEDICAL BACTERIOLOGY LAB	0 0 4	2
9	BIO 386	GENETIC ENGINEERING LAB	0 0 4	2
10.	MIC385	INDUSTRIAL MICROBIOLOGY LAB	0 0 4	2
<b>Total Credits</b>		<b>24</b>		

**Semester 6**

Sl. No	Course Code	Course Title	L T P	Cr
1	MIC 399	BRITE PROJECT		7
2	BIO 319	PHARMACOLOGY	4 0 0	4
3	MIC 311	PARASITOLOGY	2 1 0	3
4	MIC 215	INHERITANCE BIOLOGY	2 1 0	3
<b>Total Credits</b>		<b>17</b>		

<b>Total credits for program completion</b>	<b>131</b>
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**Evaluation policy for various courses**

Evaluation scheme					
Courses	Credits	Internal		External	Attendance
		Continuous Evaluation (CE)	Periodicals	Semester End Examination (SEE)	
Theory Courses	1/2/ 3 /4	25	25	50	5
MaOM	2	80		20	5
22ADM111 (Glimpses of Glorious India)	2	25	25	50	5
22ADM211 (Leadership From Rāmāyana)	1	30	20 (Reflective journal)	50	5
Lab Courses	2/3	40		60	5
BRITE Project	7	20		80	

# **SYLLABUS**

## **SEMESTER 1**

**MIC 103**

**INTRODUCTORY BIOLOGY**

**2 1 0 3**

### **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**

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

#### **Unit 3**

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

## **Unit 4**

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

## **Unit 5**

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

### **REFERENCES:**

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

### **COURSE OUTCOMES:**

#### **After completing the course, students shall be able to**

CO1.Students shall be able to understand the basics of evolution, diversity of life, transmission of genetic information, framing and testing hypothesis.

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

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

**CHY 103**

**CHEMISTRY**

**3 1 0 4**

### **LEARNING OBJECTIVE:**

The main objective of the course is to make the students understand the basic theories, laws and mechanisms of the chemistry and further to make them prolific in extending this basic



knowledge into the understanding and development of the bio-chemistry and related interdisciplinary fields.

## **SYLLABUS:**

### **Unit 1**

#### **Chemical bonding**

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

### **Unit 2**

#### **Chemical equilibrium and Solutions**

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

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

### **Unit 3**

#### **Organic Chemistry**

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

### **Unit 4**

#### **Chemical kinetics and Electrochemistry**

Rate of reaction, differential rate law expressions, Order & molecularity, rate constant, integrated equations (1st, 2nd & 3rd order), half life of a reaction, Arrhenius equations, temperature dependence of rate constant, energy profile diagrams. Reaction intermediates, Different theories on reaction rate, Electrode potential, related problems, Nernst equation & its

applications, emf of the cell, related problems, Redox reactions in cells, free energy change & standard emf of the cell, Redox titrations applications with two examples

## **Unit 5**

### **Coordination Chemistry**

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

#### **REFERENCES:**

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

#### **COURSE OUTCOMES:**

##### **After completing the course, students shall be able to**

CO1. Understand the fundamental concepts of chemistry to predict the structure, properties and bonding of engineering materials

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

CO3. Able to understand the crystals structure, defects and free electron theory

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

**ENG 100**

**ENGLISH**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

##### **Unit 1**

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

## **Unit 2**

### **A selection in poetry**

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

## **Unit 3**

### **Language practice** (Basic grammatical categories for communication)

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

## **Unit 4**

Language lab, activities related to improving English, Language games

## **Unit 5**

Presentation of skit

### **REFERENCES:**

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

### **COURSE OUTCOMES:**

#### **After completing the course, students shall be able to**

CO1. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.

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

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

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

**MIC 100**

**INTRODUCTORY MICROBIOLOGY**

**2 1 0 3**

**LEARNING OBJECTIVES:**

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

**SYLLABUS:**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Unit 4**

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

staining, Capsule staining, Spore staining, Flagellar staining, Nuclear staining and Acid-fast staining.

## **Unit 5**

**Physiology of Microbes:** Microbiological media, composition and types: selective and differential media Growth curve and growth kinetics. Influence of environmental factors on microbial growth. Nutritional groups of bacteria: overview Estimation of Microbes- Direct Microscopic count, Turbidometric assay, TVC- Indirect Method- CO<sub>2</sub> liberation- Protein estimation- Maintenance and Preservation of cultures. Determination of decimal reduction time: D value and Z value. Introduction to biofilms.

### **REFERENCES:**

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

### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Understand the contributions of pioneers in Microbiology.
- CO2. Designate the prokaryotic cell structure and functions.
- CO3. Establish the concept of microscopy and elaborate basic microscopy techniques.
- CO4. Understand the basics of microbial nutrition and methods of determining growth curves of bacteria.
- CO5. Designate the basic principles of sterilization methods.

**PHY 103**

**PHYSICS**

**3 1 0 4**

### **LEARNING OBJECTIVES:**

Physics course offered to undergraduate students by 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 of physics to

Biology. Ability to justify and explain specific approaches to solving problems. Ability to synthesize knowledge from different areas of physics and apply it to biological situations. Ability to work in teams for written and oral communication skills

## **SYLLABUS:**

### **Unit 1**

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

### **Unit 2**

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

### **Unit 3**

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

### **Unit 4**

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

### **Unit 5**

**Dielectrics and Magnetism:** Properties of dielectrics, non-polar and polar dielectrics, Dielectric strength, Ferroelectrics, Piezoelectric, applications. Magnetic materials:

Magnetism, magnetic materials, classification of magnetic materials, types of magnetic materials, soft magnetic materials, hard magnetic materials, applications.

#### **REFERENCES:**

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

#### **COURSE OUTCOMES:**

**After completing 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 it 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 the problem solving very easy.

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

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

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

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

**MIC 180**

**INTRODUCTORY MICROBIOLOGY LAB**

**0 0 4 2**

#### **LEARNING OBJECTIVES:**

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

**SYLLABUS:**

1. Media Preparation and Inoculation: - Slant, Deep and Broth.
2. Pure Culture Techniques: - Streak Plate, Spread Plate and Pour Plate
3. Cultural Characteristics of Bacteria in Solid, Liquid and Semi Solid Media.
4. Staining Techniques: - Simple, Differential, and Structural Staining
5. Motility Determination: - Hanging Drop Method

**REFERENCES:**

1. Microbiology, A Laboratory Manual-James Cappuccino, Natalie Sherman, 8<sup>th</sup> Edition 2008.
2. Laboratory Exercises in Microbiology-Harley Prescott, 9<sup>th</sup> Edition 2012.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Students will get practical exposure to common methods of sterilization.
- CO2. Skill development for cultivating various microorganisms.
- CO3. Identify microorganisms by different staining methods.

**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:**



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

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

**Self-Study/ Self-  
reading**

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

**COURSE OUTCOMES:**

. CO1: Increase student understanding of true essence of India's cultural and 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 knowledge systems. Gives an understanding of bringing Indian teaching into practical life.

**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.

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

Unit 3: The Science of Meditation (CO3)

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

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

Unit 4: Improving Communication and Relationships (CO5)

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

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

Understand how meditation can help to motivate compassion-driven action

Practicing MA OM Meditation in Daily Life (CO4)

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

**REFERENCES:**

1. Chinmayananda, Swami. The Holy Geeta. Central Chinmaya Mission Trust, 1996.
2. Devi, Sri Mata Amritanandamayi. Amritam Gamaya Part 1. Translated by Rajani Menon. M A Center, 2022
3. Easwaran, Eknath. Conquest of Mind. 3rd ed. Tomales: Nilgiri Press, 2010.

4. Goleman, Daniel, and Richard Davidson. *The Science of Meditation: How to Change your Brain, Mind and Body*. Penguin UK, 2017.
5. Puri, Swami Amritaswarupananda. *From Amma's Heart*. M.A. Center, 2014.
6. Sivananda, Swami. *Concentration and Meditation*. Garhwal, India: Divine Life Society, 2009.
7. Thakar, Vimala. *Why Meditation*. Delhi, India: Motilal Banarsidass, 1996.
8. Vivekananda, Swami. *Raja Yoga*. India: Sanage Publishing House, 2022.
9. Yatiswarananda, Swami. *Meditation and Spiritual Life*. Sri Ramakrishna Ashrama, 1979.

#### **COURSE OUTCOMES:**

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

### **SEMESTER 2**

**CSA 100**

**INFORMATION SYSTEMS**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

## **Unit 1**

### **Computer Hardware**

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

## **Unit 2**

### **Software Systems**

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

## **Unit 3**

### **Office Applications**

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

## **Unit 4**

### **Fundamentals of Modern Networking**

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

## **Unit 5**

### **Additional Information Systems Concepts**

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

#### **REFERENCES:**

1. Govindarulu, IBM PC and Clones, Tata McGraw-Hill Education, 2<sup>nd</sup> edition 2002.
2. Computer Fundamentals: Concepts, Systems & Applications- 8th Edition, Pradeep K. Sinha, Priti Sinha, BPB Publications; 6th edition, 2004
3. [http://www.openoffice.org/documentation/conceptualguide/conceptual\\_guide\\_OOo\\_3\\_ebook.pdf](http://www.openoffice.org/documentation/conceptualguide/conceptual_guide_OOo_3_ebook.pdf)

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Students will be understanding different components, signals, microprocessors, input/output devices etc.

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.

## **MIC 101 MICROBIAL ECOLOGY, DIVERSITY & CLASSIFICATION 2 1 0 3**

### **LEARNING OBJECTIVES:**

The course should enable the students to familiarize the students with physiological diversity of microorganisms and Microbial taxonomy decipher the roles and characteristics of various microorganisms; To get requisite knowledge about the habits and habitats of microorganisms; To evaluate explicitly the Nutritional requirement of microorganisms. Get insight into the various applications of microorganisms, such as bioremediation and composting.

### **SYLLABUS:**

#### **Unit 1**

**Classification:** Five kingdom classification of microbes, definition of microbial diversity and mode of evolution; microbial phylogeny; structural diversity of microbes, Physiological diversity of microorganisms

#### **Unit 2**

**Basic Concepts:** Principles of microbial ecology, nutrient acquisition, microbial competition and antagonism, environments and micro environments, Association of microbes with eukaryotes, Rumen micro flora, Aquatic habitats: Marine and fresh water; terrestrial habitats; key nutrient cycles: Carbon, Nitrogen and Sulphur.

#### **Unit 3**

**Diversity:** Prokaryotic diversity; eukaryotic microorganism; Microbial taxonomy, Phylogeny of *Archaea*; extremophiles; commercial uses of extremophiles

#### **Unit 4**

**Application:** Microbial diversity and its application in modern science

## Unit 5

**Bioremediation, Biomining:** Microbial bioremediation, bioleaching, biodegradation, biomining.

### REFERENCES:

1. Microbial Ecology, Lynch. JM, NJ. Poole, 1<sup>st</sup> edition, John Wiley and Sons, 1980
2. Microbial Ecology: Fundamentals and Applications, Ronald M. Atlas, Richard Bartha, 4<sup>th</sup> edition, Pearson, 1998.

### COURSE OUTCOMES:

**After completing the course, students shall be able to**

CO1. Clearly distinguish various microorganisms, know their habitat and also discern the nomenclature.

CO2. Thoroughly know the microbial diversity in the various biomes.

CO3. Identify Aquatic as well as Marine habitats and how humans have impacted the environment.

CO4. Postulate applications of microorganisms, such as in bioremediation, biodegradation etc.

CO5. Employ microorganisms for pollution abatement and various other environmental applications.

**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 in the domains of metabolism, enzyme technology, structural biology, molecular biology and bioinformatics

### SYLLABUS:

#### Unit 1

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

## **Unit 2**

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

## **Unit 3**

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

## **Unit 4**

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

## **Unit 5**

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

### **REFERENCES:**

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

### **COURSE OUTCOMES:**

#### **After completing the course, students shall be able to**

CO1. Understand the concepts of basic chemistry including principles of chemical bonding, hybridization, shape of water and ammonia. Acids, bases, buffers, Preparation of buffers, non-covalent interactions, and general types of reactions involved in biochemistry.



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

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

## **ENG 101 ENGLISH/CREATIVE WRITING & SOFT SKILLS 2 1 0 3**

### **LEARNING OBJECTIVES:**

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

### **SYLLABUS:**

#### **Unit 1**

#### **Listening skills**

#### **Unit 2**

#### **Speaking skills**

#### **Unit 3**

#### **Reading Skills**

#### **Unit 4**

#### **Writing Skills**

#### **Unit 5**

### **Activities:**

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

### **REFERENCES:**

1. Andrew, Jones. *English for students of Science* – London Orient Longmans 6<sup>th</sup> ed.2003

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

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.

CO2. Develop communicative competence in students.

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

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

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

**MAT 100**

**MATHEMATICS**

**3 1 0 4**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

##### **Unit-1**

##### **Linear Algebra:**

Matrices-definition, Types of matrices, Addition and subtraction of matrices, Multiplication of matrices, Properties of matrix multiplication, Determinants and properties of determinants, Minors and co-factors, Transpose of a matrix, Symmetric and Skew-symmetric matrix,

Orthogonal matrix, Adjoint of a matrix, Singular and Non-Singular matrix, Inverse of a matrix, Rank of a matrix, Cramer's rule, Eigen Values and Eigen Vectors, Cayley Hamilton Theorem.

## **Unit-2**

### **Algebra:**

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

## **Unit-3**

### **Basic calculus:**

Functions, Limits-definition problems Continuity-definition, properties, Continuity on an interval and continuity of polynomials, continuity of rational functions Differentiation- Slopes and Rate of change Product rule, Quotient rule Derivative of rational powers of x, Implicit differentiation Indeterminate forms and L Hospital rule Integration – Indefinite integral Integration from the view point of differential equations, Integration by substitution, Area as a limit of a sum, The definite integral

## **Unit-4**

### **Differential Equation:**

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

## **Unit-5**

### **Statistics:**

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

### **REFERENCES:**

1. P. R. Vittal - Business Mathematics and Statistics, Margham Publications 2014, Chennai.
2. S.C Gupta, V. K Kapoor "Fundamentals of Mathematical statistics" Sulthan Chand and Sons 12<sup>th</sup> Edition 2020.
3. S. Lipschitz & M. Lipson "Discrete Mathematics" 2001-TMH.
4. Thomas Finney "Calculus 9th Edition" Pearson publications.
5. Seymour Lipschitz, Marc Lipson "Schaum's Outlines of Probability" MCGRAWHILL 2000 2<sup>nd</sup> edition.

6. Bali Iyengar “A textbook of Engineering Mathematics” Dr. B. S Grewal “Engineering Mathematics”- 9<sup>th</sup> Edition - 2010

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1: Apply linear algebra concepts to model, solve and analyze real world situations.

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

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

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

**22ADM111**

**Glimpses of Glorious India**

**2 0 0 2**

**LEARNING OBJECTIVES:**

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

**SYLLABUS:**

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

Chapter 11 - To the World from India

Chapter 12- Indian Approach to Science

### **COURSE OUTCOMES:**

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

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

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

Inner power is about never giving up on your dreams.

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

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

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

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

CO5: From this part, a student gets an insight into the contribution that India has made to the world. Moreover, foreign powers have been trying to humiliate and degrade India in front of

the world for so long. However, it should be recognized that many inventions that are considered beneficial to the world today have been contributed by the great men of India

## **PHY 182**

## **PHYSICAL SCIENCES LAB**

### **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
5. Water Analysis I- Determination of hardness of water sample using EDTA Solution.
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
10. Measurement of conductance of a given solution & factors affecting it.
11. Measurement of emf of an electrolyte at a given temperature
12. To find the specific rotation of sugar solution using polarimeter

### **REFERENCES:**

1. Quantitative Analysis in Chemistry Vogel, Pearson; 5<sup>th</sup> edition (2006).
2. Advanced practical physical chemistry Yadav J.B., Goel Publications (2008).
3. **Virtual Labs in Chemistry:** <http://amrita.vlab.co.in>
  1. Calorimetry -Water equivalent & heat of neutralization.
  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.

**BIO 180**

**BIOCHEMISTRY LAB**

**0 0 4 2**

**LEARNING OBJECTIVE:**

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

**SYLLABUS:**

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

**REFERENCES:**

1. "Experimental Biochemistry", Beedu Sashidhar rao, Vijay Deshpande, I K International Pvt. Ltd., ISBN 81-88237-41-8 2005 1<sup>st</sup> edition.
2. Laboratory Manual in Biochemistry; J.Jayaraman, New Age International Private Limited, Second edition 2011.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1.Students will get practical exposure to common buffer and reagent preparations.

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

CO3.Developing qualitative and quantitative analytical skills on biomolecules.

## SEMESTER 3

**BIO 202**

**MOLECULAR BIOLOGY**

**2 1 0 3**

### **LEARNING OBJECTIVES:**

Introducing and strengthening the basic molecular processes that are common to all living organisms. This course will form the pillar of knowledge which in turn 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, Hershey and Chase warring blender experiment, Chargaff's rule

#### **Unit 2**

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

#### **Unit 3**

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

#### **Unit 4**

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

#### **Unit 5**

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

### **REFERENCES:**

1. Molecular Biology of the gene, James D Watson et al, 7<sup>TH</sup> Edition, Pearson, 2007.
2. Gene VIII, Benjamin Lewin, 8<sup>th</sup> edition, Pearson publishers, 2003.



3. Molecular biology, David Freifelder, 2<sup>nd</sup> edition, Barlett and Jones, 1986.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

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

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

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

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

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

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

**MIC 206**

**MYCOLOGY**

**2 1 0 3**

**LEARNING OBJECTIVES:**

This course is to understand the basic knowledge about the fungal kingdom, identification of edible and toad stools. Equip students to know importance of fungi and the systematic classification. Gives a thorough understanding of common diseases caused by different types of fungi, identification, treatment etc

**SYLLABUS:**

**Unit 1**

**General characteristics of fungi:** Introduction, Dimorphism, Growth- Apical Growth Fungi, Importance of fungi in Human life, Ecological interaction- Mycorrhiza, Lichens, interaction with insects, practical uses of fungi.

## Unit 2

**Systemic classification:** Introduction, Reproduction and Life cycle of Micro and Macro fungi- Chytridiomycota, Glomeromycota, Zygomycota, Ascomycota and Basidiomycota.

## Unit 3

**Saccharomyces cerevisiae:** Introduction on yeast, Characteristic features of *S. cerevisiae*, Important as a Model organism in recombinant DNA technology and other fields of application.

## Unit 4

**Mushrooms:** Introduction, medical relevance of mushrooms, Mycotoxins and Mushroom poisoning, Cultivation of different types of edible mushrooms.

## Unit 5

**Medical mycology:** Culture methods fungi, Diagnosis. Mycoses- Superficial, Cutaneous, sub cutaneous, Opportunistic Systemic infection, Dimorphic systemic infection Host responses to fungal infection and Immunity, Antifungal agents

### REFERENCES:

1. Fungal Biology by J W Deacon, 4<sup>th</sup> Edition, 2005.
2. Introductory mycology, Constantine J. Alexopoulos, Charles W. Mims, Meredith M. Blackwell, 4<sup>th</sup> Edition, 2007.
3. Topley & Wilson's Microbiology and Microbial Infections, Medical Mycology, Libero Ajello, Roderick J. Hay, Leslie Collier, Max Sussman, Volume 4, 9<sup>th</sup> Edition, 2001.
4. Medical Mycology and Human Mycoses, Everett Smith, Ph.D. Beneke, Alvin Lee, Ph.D. Rogers, 1<sup>st</sup> Edition, 1996.

### COURSE OUTCOMES:

**After completing the course, students shall be able to**

CO1. Describe the morphology, physiology, classification and function of unicellular and multicellular fungi and gain knowledge to identify and relate the fungi that they see around.

CO2. Summarise the importance of Mycology and its impact on environment and society.

CO3. Understand the importance of fungi in fermentation, pharmaceutical industry, enzyme production, organic acids, bio remedial compounds etc

CO4. Gain ability to distinguish the fungal diseases in different classification and predict the disease from the understanding of symptoms.

**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**

Random variable,(.discrete and continuous), Probability density function(discrete and continuous), Distribution function for discrete random variable. Distribution function for

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

#### **REFERENCES:**

1. Fundamentals of Biostatistics. by Irfan A Khan- 2004.
2. An introduction to Biostatistics. by P.S.S. Sunder Rao, 5<sup>th</sup> Edition , 2012
3. J. Ravichandran, "Probability and Statistics for Engineers", Revised Edition 2012, Wiley India.
4. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

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

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

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

CO4: Apply descriptive techniques commonly used to summarize public health data.

CO5: Demonstrate basic analytical techniques to generate results

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

**BIO 206**

**ANALYTICAL BIOCHEMISTRY**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

##### **Unit 1**

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

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

## **Unit 2**

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

## **Unit 3**

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

## **Unit 4**

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

## **Unit 5**

**Spectroscopy:** Fundamentals of UV/Vis Spectroscopy, Applications of UV/Vis spectroscopy, Spectrophotometer, Fundamentals of fluorescence spectroscopy, Jablonski diagram, Spectrofluorometer, Applications of spectrofluorimetry.

## **REFERENCES:**

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

## **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Describe important biomolecular extraction, quantitation, separation and purification techniques.
- CO2. Recall concepts and applications of UV/Visible and fluorescence spectroscopy.
- CO3. Differentiate important techniques to analyze biomolecules.

CO4. Solve qualitative and quantitative problems related to bio molecular characterization.

**MIC 205**

**VIROLOGY**

**2 1 0 3**

**LEARNING OBJECTIVES:**

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

**SYLLABUS:**

**Unit 1**

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

**Unit 2**

**Different Classes of Viruses:** Animal Viruses-Virus-Host interactions-Viral infections, plant viruses, bacteriophages, Viroids.

**Unit 3**

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

**Unit 4**

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

**Unit 5**

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

**REFERENCES:**

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

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Understand the reason for studying viruses.
- CO2. Understand how to cultivate, purify and detect the presence of viruses.
- CO3. Explain the replicative strategies of different classes of viruses.
- CO4. Demonstrate the host immune response to viruses.
- CO5. Discuss the pathogenicity and mode of action of various antiviral drugs used to control viral infections.

**MIC 281**

**GENERAL MICROBIOLOGY LAB**

**0 0 4 2**

**LEARNING OBJECTIVES:**

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

**SYLLABUS:**

1. Motility Determination-Soft agar deeps and Hanging drop method.
2. Biochemical tests: IMViC test, Catalase test, Oxidase test, Triple sugar iron test, Carbohydrate fermentation test, Urease test.
3. Fungal cultivation and staining.
4. Identification of bacteria is using differential /selective media.

**REFERENCES:**

1. Microbiology Lab Manual by James G. Cappuccino and Natalia Sherman, 8<sup>th</sup> Edition 2008.
2. Benson's Microbiological Applications by Alfred E. Brown, Indian Edition 12, 2011.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

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

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

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

**BIO 281            CELL AND MOLECULAR BIOLOGY LAB            0 0 4 2**

**LEARNING OBJECTIVES:**

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

**SYLLABUS:**

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

**REFERENCES:**

1. Cell and Molecular Biology: Concepts and Experiments -Gerald Karp, 3<sup>rd</sup> edition. 2006.
2. Cell and Molecular Biology: A lab manual -K.V. Chaitanya, 2013.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Practical exposure to microscopy wherein the students will learn to differentiate between plant and animal cells and identify the deposition of lignin in plants using various staining techniques.

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



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

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

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

## **22ADM201 Strategic Lessons from Mahabharata 1 0 0 1**

### **LEARNING OBJECTIVES:**

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements 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 Itihāsa
Chapter 3	The Unbroken Legacy
Chapter 4	Dharmic insights of a butcher
Chapter 5	The Vows we take: Pratijñā
Chapter 6	Mahābhārata - The Encyclopaedia for Kingship and Polity Acumen
Chapter 7	Karna: The Maestro that Went Wide of the Mark
Chapter 8	Strategical Silhouette of An Extraordinary Peace Mission
Chapter 9	Yajñaseni, A Woman from Fire.
Chapter 10	Popular Regional Tales
Chapter 11	Death & deathlessness

### **Self-Study / Self Reading**

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

### **COURSE OUTCOMES:**

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

CO2: Appreciate the relevance of Mahabharata for modern times.

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

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

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

#### **SEMESTER 4**

**BIO 204**

**CELL BIOLOGY**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

##### **Unit 1**

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

##### **Unit 2**

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

##### **Unit 3**

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

#### **Unit 4**

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

#### **Unit 5**

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

#### **REFERENCES:**

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

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Students will identify the different types of sorting signals and their mechanism and their significance in various disease states when impaired.
- CO2. Students will explain basic concepts of cell signaling including the types of signals and receptors, signaling mechanisms and associate the signaling pathways with various disease conditions.
- CO3. Students will understand the regulation of cell cycle and cell death in Cancer.
- CO4. Students will describe the role of cytoskeleton in maintaining cell architecture and rigidity
- CO5. Understand the basic techniques used to culture animal cells.

**BIF 301**

**INTRODUCTORY BIOINFORMATICS**

**2 1 0 3**

#### **LEARNING OBJECTIVE:**

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

## **SYLLABUS:**

### **Unit 1**

**Introduction: Bioinformatics-** 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 databses; 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:

1. Vittal R.Srinivas, " BIOINFORMATICS: A MODERN APPROACH", Second edition, 2007, ISBN: 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
2. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC., U.K.
3. Jean-Michel Claverie, Cedric Notredame, "Bioinformatics For Dummies", 2nd Edition, 2006, ISBN: 978-0-470-08985-9

## COURSE 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.

**BIO 207**

**IMMUNOLOGY**

**2 1 0 3**

## 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**

**Irregularities in immune response:** Hypersensitivity Reactions: Allergies, Type I, II, III, IV, Autoimmunity: organ-specific autoimmune diseases, systemic autoimmune diseases. Immunodeficiency diseases: primary immunodeficiencies, AIDS and other acquired or secondary immunodeficiencies. Tumor immunology: malignant transformation of cells, oncogenes and cancer induction, tumor antigens, immune response to tumors, tumor evasion of immune system, cancer immunotherapy.

## **Unit 5**

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

## **REFERENCES:**

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

## **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Students will be able to understand basic immunological mechanisms such as cells and organs of the immune system, innate and adaptive immune response.

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

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

**BIO 209**

**ENZYME TECHNOLOGY**

**2 1 0 3**

## **LEARNING OBJECTIVES:**

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

## **SYLLABUS:**

### **Unit 1**

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

### **Unit 2**

**Enzyme Catalysis and Inhibition:** Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis,

Proximity and orientation effects etc. mechanism of Serine proteases-Chymotrypsin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).

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

### **Unit 3**

**Enzyme Kinetics:** Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetic Allosteric enzymes. Numerical problems in enzyme kinetics and enzyme inhibition.

### **Unit 4**

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

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

### **Unit 5**

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

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

### **Unit 6**

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

### **REFERENCES:**

1. Nicholas Price & Lewis Stevens, Fundamentals of Enzymology, 3<sup>rd</sup> Edition; 2009.



2. Trevor Palmer and P L Bonner, Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 2<sup>nd</sup> Edition, 2007.
3. Lehninger, Nelson and Cox, Principles of Biochemistry, 7<sup>th</sup> Edition, 2016.
4. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, 5<sup>th</sup> Edition. 2016.
5. Gary Walsh, Proteins, 2<sup>nd</sup> Edition, 2015.
6. Internet/Journal Resources

#### **COURSE OUTCOMES:**

##### **After completing the course, students shall be able to**

- CO1. Understand and define the basic concepts on enzymes, their classification, metalloenzymes, holoenzymes, apoenzymes, Isozymes, Multienzyme complex.
- CO2. Differentiate and discuss the different catalytic mechanisms with examples, transition state theory, Lock and key and induced fit theories. Zymogens, Proenzymes.
- CO3. Discuss and explain enzyme kinetics, Michaelis Menton equation, LB plot, Km, Vmax, Kcat and Turnover number. Enzyme inhibitions: reversible and irreversible with example; Kinetics of inhibitions; Allosteric enzymes: regulation of enzymes.
- CO4. Demonstrate and explain the role of enzymes in industry and medicine with examples.

## **MIC 214    MICROBIAL PHYSIOLOGY & METABOLISM            3 1 0 4**

#### **LEARNING OBJECTIVES:**

The course provides fundamental understanding about the growth and nutrition requirements of prokaryotes and their adaptation strategies. The course helps the students to understand the different metabolic pathways, energetics, and regulation.

#### **SYLLABUS:**

##### **Unit1**

**Microbial nutrition and growth**-Physical and Nutritional Requirements of Cells - batch, continuous and synchronous cultures, growth kinetics – Control of microbial growth.

## Unit 2

**Transport mechanisms in prokaryotes-** active transport, passive diffusion, facilitated diffusion and group translocation. Mechanism of cell division in bacteria, Min CD system and FtsZ regulation

## Unit 3

**Prokaryotic and eukaryotic microorganisms-** Comparison, Flagella, motility, and process of chemotaxis- uptake and utilization of substrates, Sporulation and germination- Two component signal transduction. **Microbial biofilms** the physiology and collective recalcitrance of microbial biofilm communities: Quorum sensing and quenching mechanisms. **Microbial stress responses:** Heat, temperature, pH.

## Unit 4

**Bioenergetics & Carbohydrate Metabolism:** Gibbs free energy, endergonic & exergonic reactions. Standard state free energy changes- $\Delta G$ ,  $\Delta G^0$  and  $\Delta G'^0$ , Relationship between equilibrium constant and  $\Delta G'^0$ , Feasibility of reactions. Simple problems, High energy compounds, Introduction to Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways

Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis, and its regulation. TCA cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Oxidative stress., Pentose phosphate pathway (HMP shunt) Photosynthesis – ‘light’ and ‘dark’ reactions

## Unit 5

**Lipids, Amino Acids & Nucleic Acid Metabolism:** Beta – oxidations of saturated fatty acids. Ketone bodies, production during starvation and diabetes Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate, energetics, Regulation of fatty acid biosynthesis. Biosynthesis of cholesterol, regulation.

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 Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Lesch-Nyhan syndrome & Gout.

## REFERENCES:

1. Willey, Joanne M., Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M. Willey. Prescott's microbiology. 11<sup>th</sup> edition New York: McGraw-Hill, 2020.
2. Lehninger, Nelson and Cox, Principles of Biochemistry, 7<sup>th</sup> Edition, Freeman, W. H. & Company, 2017.
3. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, Wiley, 5<sup>th</sup> Edition. 2016

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Understand basics of microbial growth requirements.

CO2. Understand physiology of nutrient acquisition, energy generation and cell division regulation in prokaryotes.

CO3. Designate prokaryotic signal transduction network involving physiological processes including chemotaxis and biofilm formation.

CO4. Understand the basics, enzymes involved and energetics of metabolism, the catabolic as well as anabolic pathways of carbohydrates, lipids and amino acids.

CO5. Apply the concepts of metabolism to analyse the feasibility, energetics, regulation, and disorders of metabolism of biomolecules.

**MIC 207**

**FOOD MICROBIOLOGY**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

Students are equipped with knowledge in techniques and experiments related to food preservation, food safety, and sustainability

#### **SYLLABUS:**

##### **Unit 1**

**History and development of Food Microbiology:** Common Foodborne Bacteria, Molds and yeasts. The role and significance of microorganisms in foods.

##### **Unit 2**

**Methods For Detection of Microorganisms in Food:** Physical, Chemical Immunological and biochemical assays.

### **Unit 3**

**Food Preservation & Principles of Quality Control:** Chemicals, Antibiotics, Preservatives of microbial origin: organic acids. Bacteriocins. Applications of Probiotics and prebiotics, Concept of protective cultures. Hurdle concept.

### **Unit 4**

**Food Safety and Quality- HACCP:** applications and microbiological criteria. Applications of HACCP in the industry

### **Unit 5**

**Food Spoilage and Foodborne Diseases:** Common foodborne pathogens, Enteric pathogens, and diseases: Applications of food microbiology: Microorganisms in Food Fermentation.

### **REFERENCES:**

1. Adams, M. R., and M. O. Moss. Food Microbiology. 15<sup>th</sup> edition, Cambridge: Royal Society of Chemistry, 1995.
2. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). 7<sup>th</sup> edition, Modern food microbiology. (Springer eBooks.) New York: Springer.
3. Ray, B., & Bhunia, A. K. (2008). Fundamental food microbiology. 15<sup>th</sup> edition. Boca Raton: CRC Press.

### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Define the microbial composition in food.

CO2. Designate the methods to identify and enumerate microorganisms in food.

CO3. Understand the basics of synthetic and microbial preservation and concepts of protective cultures.

CO4. Understand foodborne infections and prevention methods.

## **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.

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

## **2ADM211                      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**

**0042**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

1. Blood smear preparation
2. Blood Cell Counting using Hemocytometer
3. Blood Grouping.

4. Latex Agglutination Reaction
5. Ouchterlony Double Diffusion
6. Dot ELISA

**REFERENCES:**

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

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. To identify the morphology of cells of the immune system.
- CO2. To understand the basic concepts of blood grouping.
- CO3. To analyze antigen-antibody interactions and detect the presence of antigens and or antibodies in a biological sample.
- CO4. To analyze antigen antibody interactions and interpret the data for the presence of antigen and or antibodies in biological samples.

**MIC 283**

**FOOD MICROBIOLOGY LAB**

**0 0 4 2**

**LEARNING OBJECTIVES:**

The course intends to provide basic exposure to food enumeration, quality control, and detection of spoilage pathogens in food.

**SYLLABUS:**

1. Water quality analysis- MPN test.
2. Dye reduction tests for milk quality determination-methylene blue reductase test.
3. Breed count method for bacterial enumeration in milk.
4. Determination of viable counts in food: Standard plate count method.
5. Food production: yogurt and mushrooms.
6. Production and estimation of lactic acid by *Lactobacillus* spp.
7. Detection of microbial spoilage of canned foods.

**REFERENCES:**

1. Harley, John P. 2011. 15th edition. Laboratory exercises in microbiology. New York: McGraw-Hill.

2. Ray, B., & Bhunia, A. K. (2008). Fundamental food microbiology. 15<sup>th</sup> edition. Boca Raton: CRC Press.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Understand quality control of food products and water.
- CO2. Demonstrate basic skills in food enumeration methods.
- CO3. Designate methods to detect food spoilage pathogens.

**SEMESTER 5**

**MIC 309**

**INDUSTRIAL MICROBIOLOGY**

**2 1 0 3**

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

#### **Unit 5**

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

#### **REFERENCES:**

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

#### **COURSE OUTCOMES:**

##### **After completing the course, students shall be able to**

- CO1. Describe the basics of fermentation technology and their use, and types/classes of fermentation process.
- CO2. Explain strategies and criteria involved in isolation of industrially important microorganisms from environment, screening methods based on the type of product, and preservation of microorganisms.

CO3. Explain the need 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.

**MIC 312**

**MEDICAL BACTERIOLOGY**

**2 1 0 3**

**LEARNING OBJECTIVES:**

Introduces Medical bacteriology and the taxonomic approach to major human pathogens. This course provides the conceptual basis for understanding pathogenic bacterias, particularly addressing the fundamental mechanisms of their pathogenicity.

**SYLLABUS:**

**Unit 1**

**Infection:** Sources of infection, method of transmission of infection, Factors predisposing to microbial pathogenicity, Types of infectious diseases. Normal Microbial flora of human body.

**Unit 2**

**Gram Positive Pathogens:** *Staphylococcus*, *Streptococcus*, *Corynebacterium*, *Bacillus*, and *Clostridium*.

**Unit 3**

**Gram Negative pathogens:** *Neisseria*, *E. coli*, *Klebsiella*, *Proteus*, *Salmonella*, *Shigella*, *Vibrio*, *Haemophilus*, *Pseudomonas*, *Brucella* and *Yersinia*.

**Unit 4**

**Acid Fast Bacteria:** *M.tuberculosis* and *M.lepreae*.

**Unit 5**

**Spirochetes:** *Leptospira*, *Treponema*, Other medically important bacteria: *Mycoplasma*, *Chlamydia*, *Helicobacter*, *Campylobacter* and anaerobic pathogens.

**REFERENCES:**

1. Text book of Microbiology, Ananthanarayan & Jayaram Panicker 7<sup>th</sup> Edition 2006.
2. Medical Microbiology - Patrick r. Murray, Ken S. Rosenthal, Michael A. Pfaller 8<sup>th</sup> Edition 2013.

3. MIMS' Pathogenesis of infectious disease, Anthony A. Nash Robert G. Dalziel J. Ross Fitzgerald 6<sup>th</sup> edition 2015.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. Understand and demonstrate principles of medical bacteriology and clinical correlation.

CO2. This course describe a detailed knowledge about etiological agents responsible for global infectious bacterial diseases.

CO3. The student will be able to explain general mechanisms by which an infectious agent causes disease.

**MIC 316**

**RECOMBINANT DNA TECHNOLOGY**

**3 0 0 3**

**LEARNING OBJECTIVES:**

The course attempts to introduce the basic concepts of recombinant DNA technology namely Boyer and Cohen's workflow of gene manipulation, restriction and ligation, plasmid and phage-based vectors, transformation techniques, site-directed mutagenesis and applications.

**SYLLABUS:**

**Unit 1**

**Introduction to rDNA technology**

The Basic Principles of Gene Cloning and DNA Analysis Introduction, History, the advent and importance of gene cloning and the polymerase chain reaction, Vectors for Gene Cloning, Purification of DNA from Living Cells, Manipulation of Purified DNA, Introduction of DNA into Living Cells

**Unit 2**

**Vectors for Cloning**

Cloning Vectors for E. coli,  $\lambda$  and other high-capacity vectors, Cloning Vectors for Eukaryotes, Genomics & cDNA Libraries

**Unit 3**

**Applications and Techniques of Gene Cloning**

Polymerase Chain Reaction & qPCR, Electrophoresis & Blotting Techniques, Site- Directed Mutagenesis, DNA Sequencing, Reporter Gene Assays, DNA-Protein Interaction Assays, Protein-Protein Interaction Assays, DNA Fingerprinting.

**REFERENCES:**

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

**COURSE OUTCOMES:****After completing the course, students shall be able to**

CO1. Describe basic concept of cloning, various steps involved, tools used like restriction enzymes, PCR, primer designing, vectors (Knowledge).

CO2. Interpret & discuss the principles of different molecular tools like qPCR, DNA sequencing, Blotting electrophoresis, reporter assay, DNA fingerprinting, DNA-protein and protein-protein interactions (Understand).

CO3. Illustrate the knowledge to apply for recombinant protein production, transgenic plant production for use in agriculture, medicine and research (Apply).

**MIC 317****ENVIRONMENTAL & AGRICULTURAL****MICROBIOLOGY****2 1 0 3****LEARNING OBJECTIVES:**

The course would enable the students to understand in depth about how important the Environment and Ecosystems are, learn about Primary, Secondary and Tertiary wastewater treatments, recent biotechnological advances made in Environmental pollution surveillance, have an understanding about Solid Waste Management, comprehend about Agricultural Microbiology and its significance.

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

Environment and Ecosystems, Biotic and abiotic environment. Food chains, food Eutrophication Effluent treatment: Primary, Secondary waste treatments Anaerobic wastewater treatment – process overview, Methanogenesis, Different types of reactors, Genetically Engineered Microorganisms in Biotreatment of wastes. Domestic solid waste management

**Unit 2**

Heavy metal removal-Biosorption, Bioleaching, Phytoremediation, Other techniques, Bio technological methods for pollution detection- General bioassay, Cell biology and molecular biology in Environmental monitoring, Biosensors, Bioterrorism and drinking water safety

### **Unit 3**

Agricultural Microbiology - Soil general properties, Microorganisms in soil –Decomposition of organic matter in soil-Biogeochemical cycles, Nitrogen fixation, Bacterial diseases of important crops, Biofertilizers and microbial insecticides

### **REFERENCES:**

1. Environmental Biotechnology by Alan Scragg 2<sup>nd</sup> edition 2005.
2. Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann and Perry L. McCarty 2<sup>nd</sup> edition 2020.
3. Agricultural Microbiology: Subba Rao 3<sup>rd</sup> edition 2020.

### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Thoroughly know the microbial diversity in the various biomes.
- CO2. Identify terrestrial as well as marine habitats and know how humans have impacted the environment.
- CO3. Decipher the use of biosensors for various environmental applications.
- CO4. Postulate application of microorganisms for pollution abatement and various other industrial applications.

**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 also prepare for all India level competitions for Fellowship in Indian Academy of Science.

### **SYLLABUS:**

#### **Unit 1**

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

#### **Unit 2**

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

### **Unit 3**

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

### **Unit 4**

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

### **Unit 5**

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

### **REFERENCES:**

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

### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1: The students shall be able to familiarize themselves 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 themselves with analyzing, interpreting and presenting the research data.

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

## **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

**MIC 384**

**MEDICAL BACTERIOLOGY LAB**

**0 0 4 2**

**LEARNING OBJECTIVES:**

Learn about handling of pathogens, common diagnostics methods like staining, culture techniques, antibiotic sensitivity, and identification of pathogens.

**SYLLABUS:**

1. Isolation and identification of normal skin flora.
2. Preparation of blood agar and demonstration of hemolysis.
3. Staining: Acid fast staining, Negative staining.
4. Isolation and identification of unknown bacteria from pure culture.
5. Isolation and identification of unknown bacteria from mixed culture.
6. Antibiotic sensitivity test.
7. Demonstration of WIDAL Test

**REFERENCES:**



1. Microbiology-A laboratory Manual-James G.Cappucino,Natalie Sherman. 10<sup>th</sup> Edition 2014.
2. Color Atlas of Medical bacteriology-Luis M de la Maza,Marie T Pezzlo 3<sup>rd</sup> Edition 2020.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

CO1. This course describes how to make decisions about the pathogenicity of organisms associated with human infections.

CO2. Explain how to apply appropriate microbiology laboratory techniques, methodologies, instruments and equipment in accordance with current laboratory safety protocol.

CO3. Provide the opportunity to practise in microbiology laboratory techniques and to draw and report appropriate conclusions from the analysis of experimental data.

**BIO 386**

**GENETIC ENGINEERING LAB**

**0 0 4 2**

**LEARNING OBJECTIVE:**

The students will learn the theoretical and practical aspects of key molecular biology experiments like Plasmid DNA isolation, Restriction digestion, PCR, Competent cell preparation, Transformation, SDS-PAGE etc. Hands on experience will be given to all the students.

**SYLLABUS:**

1. Isolation of Plasmid DNA by Alkaline lysis method.
2. Quantification of DNA.
3. Detection of Plasmid DNA by Agarose gel electrophoresis.
4. Restriction Digestion Analysis.
5. Competent cell preparation.
6. Transformation and Efficiency of competent cells.
7. SDS PAGE
8. Polymerase Chain Reaction.
9. Isolation of Genomic DNA.
10. Calibration of pipettes.

**REFERENCES:**

1. Joseph Sambrook, David William Russell “Molecular cloning”. 3rd Edition, CSHL Press, 2001.

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1: Students will discover how to isolate plasmid DNA
- CO2: Students will identify a plasmid experimentally.
- CO3: Students will illustrate restriction digestion followed by its mapping
- CO4: Students will design PCR conditions and perform PCR.
- CO5: Students will show competent cell preparation and transformation.
- CO6: Students will assemble and perform SDS PAGE.

**MIC 385****INDUSTRIAL MICROBIOLOGY 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.
2. Isolation of Actinomycetes from soil, Secondary screening protocols-Giant colony 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:**

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

**COURSE OUTCOMES:**

**After completing the course, students shall be able to**

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

CO2. Learn the technique of immobilization of cells like yeast.

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

## SEMESTER 6

**BIO 319**

**PHARMACOLOGY**

**4 0 0 4**

### **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:**

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

#### **COURSE OUTCOMES:**

##### **After completing the course, students shall be able to**

CO1. The students shall be able to understand the basics of pharmacology, various stages of drug discovery and intellectual property rights.

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

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

**MIC 311**

**PARASITOLOGY**

**2103**

#### **LEARNING OBJECTIVES:**

To understand the common parasitic relationship in nature, focusing more on human parasite that cause diseases.

#### **SYLLABUS:**

##### **Unit 1**

**Introduction:** Parasitic association, host parasitic interaction, Effect of parasitism in the host, Sources of parasitic infections. Classification of parasites.

##### **Unit 2**

**Introduction to Protozoa:** Amoeba *Entamoeba histolytica*, Free living amoeba, Flagellates-*Giardia* and non intestinal *Trichomonas*, Hemoflagellates, Sporozoa and Microspora.

##### **Unit 3**

**Introduction to Metazoa:** General characteristics Cestodes-Intestinal Tapeworms *Taenia solium*, *Taenia saginata* and extra intestinal tape worm

#### **Unit 4**

**Introduction to Trematodes:** General characteristics *Schistosoma haematobium* *S.mansoni* *S.japonicum*

#### **Unit 5**

**Introduction to Nematodes:** General Characteristics, Intestinal nematodes *Trichinella*, *Trichuris*, *Strongyloides* , Blood and tissue *Wuchereria bancrofti* *Brugia malayi*, *Onchocerca volvulus* *Mansonella spp*

#### **REFERENCES:**

1. Burton J Bogtish. Clint E. Carter, Thomas N. Oeltmann Human parasitology 4<sup>th</sup> edition,2012.
2. General parasitology-Thomas C Cheng, 2<sup>nd</sup> edition ,2012.
3. Markell and Voge's David T. John MSPH, William A. Petri Jr, Medical Parasitology,9<sup>th</sup> edition ,2006.
4. Foundation of parasitology-Roberts, Janovy.,9<sup>th</sup> edition 2006

#### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. Understand the most important groups of eukaryotic parasites in vertebrates.
- CO2. Classify the parasites based on the cellular organization and locomotory organs.
- CO3. Describe their life cycle, infection pathways and types of damage they inflict on the host.
- CO4. Explain the clinical features associated with each parasite.

**MIC 215**

**INHERITANCE BIOLOGY**

**2 1 0 3**

#### **LEARNING OBJECTIVES:**

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

#### **SYLLABUS:**

##### **Unit 1**

**Genes, chromosomes & heredity:** Introduction, DNA as genetic material – Cellular Reproduction – Mendelism: Basic Principles

### **Unit 2**

**Extension and variation of mendelism:** Chromosomal Basis – Variation in chromosome number & structure

### **Unit 3**

**Linkage and crossing over:** Linkage, Crossing Over and Chromosome Mapping – Genetics of Bacteria and their viruses- Extra Nuclear Inheritance.

### **Unit 4**

**DNA, gene expression & genomics:** Molecular structure of DNA – Mutation, DNA repair & Recombination —Transposable elements

### **Unit 5**

**Gene regulation and expression:** Regulation of gene expression – Cancer & Regulation of Cell Cycle

### **REFERENCES:**

1. Genetics – 6th Edition – Snustad & Simmons – Wiley, 2011
2. Concepts of Genetics – 10th Edition – Klug et al – Pearson, 2020

### **COURSE OUTCOMES:**

**After completing the course, students shall be able to**

- CO1. To understand the basic concept of Mendelian principles and learn its application in different genetic experiments. This would help the students to solve the majority of the genetic problems.
- CO2. To extrapolate the deviations from the standard mendelian laws in few cases and learning the mechanisms.
- CO3. To learn the underlying genetic mechanisms that regulate sex determination and clinical cases leading into chromosome abnormalities.
- CO4. To understand the principles of linkage, recombination and chromosome mapping to establish the physical and genetic connection between two neighboring genes.
- CO5. Learning how DNA repair mechanisms restore the integrity following the DNA damage.
- CO6. Applying statistical methods to obtain probability and genetic ratios in the Mendelian crosses.

## **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)

Knowledge Segment	Category	Credits
Language, Cultural Education & Soft Skills	S	7
Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	57
Laboratory Courses	L	6
Project/Dissertation Thesis	P	7
Total Credits for programme completion		127





Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	57
Laboratory Courses	L	16
Project/Dissertation Thesis	P	7
Total credits needed for programme completion		127

### **B.Sc. Microbiology**

Knowledge Segments	Category	2016 Admissions onwards
Language, Cultural Education & Soft Skills	S	17
Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	56
Laboratory Courses	L	18
Project/Dissertation Thesis	P	7
Total credits needed for programme completion		128

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 (2<sup>nd</sup> 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

2015 Admissions onwards		
Grade	Gra	Rat

Point	de	ing
O	10	Outstanding
A+	9.5	Excellent
A	9	Very Good
B+	8	Good
B	7	Above Average
C	6	Average
P	5	Pass
F	0	Failed
FA	0	Failed due to lack of Attendance
I	-	Incomplete (Awarded only for Laboratory project courses)
W	-	Withheld

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.

$$SGPA = \frac{\sum (C_i \times GP_i)}{\sum C_i}$$

where  $C_i$  is the number of credits for  $i$ th course in that semester and  $GP_i$  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.

$$CGPA = \frac{\sum (C_i \times GP_i)}{\sum C_i}$$

where  $C_i$  is the number of credits for  $i$ th course in any semester and  $GP_i$  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 or 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.







