AMRITA VISHWA VIDYAPEETHAM

Program

B. Sc. (Bachelor of Science) in Biotechnology

Faculty of Science

[Revised 2015-2016]

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Program Outcomes

PO1. Successful demonstration of oral, writing and communication skills

PO2. Encouraging interdisciplinary curriculum by cementing their basic knowledge in fundamental sciences.

PO3. An envisioning of value based education for strengthening their personal development.

PO4. Hands on technical as well as experimental skills to complement their theoretical knowledge in the curriculum.

PO5. Students will hold research skills to make them competent as a candidate for various opportunities in India and across the world.

Programme Specific Outcomes

The Undergraduate programme in Biotechnology [B.Sc. Biotechnology] is oriented to create a conceptual background in Biological Sciences. Students will demonstrate an understanding of basic sciences including physics, chemistry and mathematics. Students will perceive in-depth knowledge of a broad range of fundamental biological aspects, including biochemistry, cell biology, molecular biology, molecular genetics, evolution and ecology etc. laboratory courses included in the curriculum enables the students to perform molecular, cellular, and biochemical techniques used in biotechnology. Exposure to courses like Omes and Omics, Pharmacology, Bioinformatics etc. open the wide spectrum of biotechnology to the students. Undergraduate project work in the final semester prepare students to approach a research problem, how to interpret, analyse and effectively communicate their findings to others. Successful completion of the course prepares students to opt for higher studies in Biological Sciences and Biotechnology.

Curriculum Structure

Semester 1

Sl. No	Course Title	Course Code	Credits
1	INTRODUCTORY BIOLOGY	MIC 103	3
2	CHEMISTRY	CHY 103	4
3	ENGLISH	ENG 100	3
4	INTRODUCTORY MICROBIOLOGY	MIC 100	3
5	INFORMATION SYSTEMS	CSA100	3
6	CULTURAL EDUCATION-1	CUL 101	2
7	INTRODUCTORY MICROBIOLOGY LAB	MIC 180	2
Total Credits		**20**	

Semester 2

Sl. No	Course Title	Course Code	Credits
1	PHYSICS	PHY 103	4
2	PRINCIPLES OF ECOLOGY AND EVOLUTION	BIO 100	3
3	BIOCHEMISTRY	BIO 103	3
4	ENGLISH/ CREATIVE WRITING & SOFT SKILLS	ENG 101	3
5	MATHEAMTICS	MAT 100	4
6	CULTURAL EDUCATION-2	CUL 102	2
7	PHYSICAL SCIENCES LAB	PHY 182	2
8	BIOCHEMISTRY LAB	BIO 180	2
Total Credits		**23**	

Semester 3

Sl. No	Course Title	Course Code	Credits
1	MOLECULAR BIOLOGY	BIO 202	3
2	BIOSTATISTICS	MAT 201	3
3	PLANT BIOLOGY	BIO 223	4

4	ANALYTICAL BIOCHEMISTRY	BIO 206	3
5	VIROLOGY	MIC 205	3
6	AMRITA VALUES PROGRAMME -I	AVP201	1
7	GENERAL MICROBIOLOGY LAB	MIC 281	2
8	CELL AND MOLECULAR BIOLOGY LAB	BIO 281	2
Total Credits		**21**	

Semester 4

Sl. No	Course Title	Course Code	Credits
1	HUMAN PHYSIOLOGY	BIO 201	4
2	GENETICS	BIO 205	3
3	IMMUNOLOGY	BIO 207	3
4	ENZYME TECHNOLOGY	BIO 209	3
5	CELL BIOLOGY	BIO 204	3
6	INTRODUCTORY BIOPHYSICS	BIO 212	2
7	SOFT SKILLS- 1	SSD201	1
8	AMRITA VALUES PROGRAMME -II	AVP211	1
9	IMMUNOLOGY LAB	BIO 282	2
10	ENZYMOLOGY LAB	BIO 283	2
Total Credits		**24**	

Semester 5

Sl. No	Course Title	Course Code	Credits
1	GENETIC ENGINEERING	BIO 314	4
2	OMES AND OMICS	BIO 318	3
3	BIOENERGETICS AND METABOLISM	BIO 311	3
4	INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY	BIO 315	3

5	RESEARCH METHODOLOGY	BIO 317	2
6	INDUSTRIAL BIOTECHNOLOGY LAB	BIO 385	2
7	SOFTSKILLS -II	SSD 301	1
8	LIVE-IN-LABS/OPEN ELECTIVE	BIO396	3
9	GENETIC ENGINEERING LAB	BIO 386	2
Total Credits		**23**	

Semester 6

Sl. No	Course Title	Course Code	Credits
1	BRITE PROJECT	MIC 399	7
2	PHARMACOLOGY	BIO 319	4
3	DEVELOPMENTAL BIOLOGY	BIO 322	3
4	INTRODUCTORY BIOINFORMATICS	BIO 301	2
Total Credits		**16**	

Total credits for program completion	**127**

Course Objectives, Course Outcomes, Syllabus

SEMESTER 1

MIC103 INTRODUCTORY BIOLOGY CREDITS: 3

LEARNING OBJECTIVE:

The course introduces the principles of molecular biology, cell biology, genetics, evolution, basics of protein sorting, Importance of cytoskeleton remodelling and their role in disease conditions

SYLLABUS

PART 1

Introduction

Themes in the Study of Life, Biodiversity: Phylogeny and the Tree of Life, Bacteria and Archaea, Protists, Plant Diversity, Fungi, Animal Diversity, Beauty & Utility of Biodiversity in Sustainable Development, Unity in Diversity at Cellular, Subcellular, Molecular Levels: The Composition of Cells, Cell Metabolism, Fundamentals & Central Dogma of Molecular Biology, Scientific Inquiry: Making Observations & Testing Hypotheses

PART 2

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

PART 3

Cytoskeleton & ECM: Structure and Organization of Actin filaments, Microtubules and Intermediate Filaments, Cell Movement, Motor Proteins, Plasma membrane & Transport, Cell Wall, ECM, Cell-Cell Interactions.

REFERENCES:

Textbook:

1. Campbell Biology – 10th Edition - Jane B. Reece et. al. - Boston: Benjamin Cummings / Pearson
2. The Cell, A Molecular Approach – 6th Edition – Geoffrey M.Cooper/Robert E.Hausman- Sinauer Associates, Inc.
3. Molecular Biology of the Cell. Alberts B. et al.,(2008) 5th edition. Garland Science.

COURSE OUTCOMES:

1. Understand the importance of Interdisciplinary Biology
2. Understand about evolution of life and how genetic information is transmitted in organism. Additionally, the students are encouraged to make a scientific Inquiry by framing and testing hypothesis.
3. Understand about cell theory and different cell organelles and their function.
4. Understand the role of cytoskeleton and its remodelling including the diseases associate with improper remodelling.

CHY103 **CHEMISTRY** **CREDITS: 4**

LEARNING OBJECTIVE:

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

SYLLABUS:

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, semi polar bonds. **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. **Chemical equilibrium**: Equilibrium constant, Le-Hotelier principle, Acid & bases, strength of acid & basses of aqueous solutions, Acid –base titrations, indicators in titrations, Solubility product & applications, ionic product, Condition for precipitation, Hydrolytic reactions & expression for hydrolytic constant. **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. **Chemical kinetics:** Rate of reaction, differential rate law expressions, Order & molecularity, rate constant, integrated equations (Ist,2nd & 3rd order), nth life of a reaction, Arrhenius equations, temperature dependence of rate constant, energy profile diagrams. Reaction intermediates, Different theories on reaction rate. **Coordination Chemistry:** Introduction to co-ordinations compounds, Crystal field terricolous & magnetic properties of complexes, Chelation & applications, biologically relevant co-ordination compounds. **Electrochemistry:** 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.

REFERENCES:

Text Books.

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

COURSE OUTCOMES

This course covers the fundamental principles, concepts and laws of chemistry and general mechanisms of the chemical reactions. Topics include chemical bonding, stoichiometry, chemical equilibrium, kinetics, electrochemistry, coordination chemistry, and organic chemistry. After completion of this course students will be thorough in the basic chemistry and will be able exercise applied sciences and interdisciplinary areas of sciences such as biochemistry, with the help of basic principles and mechanisms discussed in this course.

ENG 100 **ENGLISH** **CREDITS: 3**

LEARNING OBJECTIVE:

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:

LANGUAGE LEARNING

English as Second Language, Developing the essential skills of English

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)

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

REFERENCE:

Textbooks

1.Doff, Adrian and Christopher Jones. Language in Use. Upper Intermediate. CUP, 1999
2. Grellet, Francoise. Developing Reading Skills.A Practical Guide to Reading Comprehension Exercises.CUP, 2003.
3.Hanock, Mark. English Pronunciation in Use.CUP, 2003.
4. McCarthy, Michael and Felicity O'Dell. English Vocabulary in Use (Upper Intermediate) CUP, 2001.
5.Alexander, Harriet Semmes. 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

1. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.
2. 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.

3. Expose the students to the employment opportunities, challenges and job roles.
4. To 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 CREDITS 3

LEARNING OBJECTIVE:

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

SYLLABUS:

Basic concepts– 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 Flemming, Paul Erlich, Fannie Hesse, Elie Metchnikoff, Kary Mullis. Development of pure culture methods. Cell ultra-structure: Peptidoglycan structure. Archeal cell wall composition,and Acid fast cell wall. Antibiotics introduction and multidrug resistance crisis. Cytoplasmic matrix and components: Inclusion bodies.

Sterilisation and disinfection- Definitions, Principles. Methods of sterilization- Physical methods (Heat, Filtration), Radiation and Chemical methods. Control of sterilization and Testing of sterility. Microscopy – Principles, Light microscope, Phase Contrast, Dark field, 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.

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

Taxonomy– Principle and its types (Classical approach– Numerical, Chemical, Serological and Genetic). Bacterial taxonomy– Bergey's manual of Systematic Bacteriology (Eubacteria and Archaebacterium).

REFERENCES:

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

COURSE OUTCOMES:

1. To expose students to the pioneers in microbiology and introducing their contributions.
2. To detail the prokaryotic cell and related organelles and their functions.
3. To introduce the concept of microscopy and to elaborate of few basic microscopy techniques.
4. To elaborate on microbial nutrition and methods of determining growth curve.
5. To introduce the basic principles of sterilization methods.

CSA100 INFORMATION SYSTEMS CREDITS: 3

LEARNING OBJECTIVE:

Fundamentals of IT - introduction to the internet and the world wide web (WWW) Information technology - an overview of what it is and what are its applications. Computer system types.

SYLLABUS:

Components, digital signals, microprocessors, input/output devices, storage devices etc. Introduction to software - operating systems, word processing, spreadsheet and database applications. Foundations of modern networks - overview of different architectures and protocols. Multimedia. IT applications in biology and biotechnology, Introduction to supercomputing, Basic operations in Spreadsheets like summing, averaging, graphs and visualizations. Making graphs and plots for scientific data, Fundamentals of programming.

REFERENCES:

Textbooks:

1. Norton, Peter, "Introduction to Computers, Mc-Graw-Hill, 6/e.
2. Raja Raman, Fundamentals of Computers, Prentice Hall of India.

Reference Books:

1. Govindarulu, IBM PC and Clones, Tata McGraw-Hill Education, 2002
2. http://www.openoffice.org/documentation/conceptualguide/conceptual_guide_OOo_3_ebook.pdf

COURSE OUTCOMES

1. Students will be having an understanding of different components, signals, microprocessors, input/output devices et.
2. The course enables the students to understand the IT applications in the area of biology
3. They will be knowing the fundamentals of programming, making graphs and plots for scientific data etc.
4. On completion of the course, students should have acquired essential knowledge to meet their computational requirements as a life sciences aspirant.

CUL101 CULTURAL EDUCATION-1 CREDITS 2

LEARNING OBJECTIVE:

The Necessity of CE- Education for life and Livelihood, Role of spirituality in Indian culture, Science and Spirituality ,Motto of Amrita University, Meaning of college prayer

SYLLABUS:

Culture and Civilization- Defenitions, Differences, Relation of culture and Values, Indian culture-Uniqueness and the pillars of Indian culture , Purusharthas or Goal of life Dharma, Artha,Kama,Moksha.

Symbols of Indian Culture – Forms, Meanings and Significance of symbols – Religious Symbols – Swastika – Omkara – Lingam – Lotus – Tilak – Rudraksha – Shankha, lotus

Man, and Nature- Depletion of natural resources-Root causes, Our ancestors life-Harmony

with nature, Pancha yajnas and Pancha matas, Reestablish the lost harmony, role of religion. Rishis and scientist, India's Ecological heritage- Vedic view of nature, Sacred groves, Causes of destructions and solutions

Introduction to Vedas and Vedanta – *Fourteen Abodes, Four Vedas, Samhitas, Brahmanas, Aranyakas, Upanishads, Six Vedangas, Four Upavedas*
Vedanta and Image worship, Sadhana and self-realization, Imbibe principles of Vedanta

REFERENCES:

Text Books:

1. Cultural Education: Reading Material for students - prepared by Cultural Education Dept., Amrita Vishwa Vidyapeetham.
2. *Eternal truth*- Mata Amritanandamayi Devi

MIC 180 INTRODUCTORY MICROBIOLOGY LAB CREDITS 2

LEARNING OBJECTIVE:

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

SYLLABUS:

Basic lab practices in Microbiology: Sterilization, Disinfection. Culture media , preparation of solid,semi solid and liquid media , incoculation in slant, deep and plate. Identification of normal flora using swab, **Pure culture techniques**: Streak plate, Serial dilution, spread plate and pour plate procedures. Determining the cultural characteristics of microorganisms in plate and growth pattern in slant and broth. **Staining techniques**: Simple, differential and structural stains: Gram staining, Negative staining, Capsule staining, Spore staining. **Motility determination**: Hanging drop method

REFERENCES:

Text Books:

1. Microbiology, A Laboratory Manual-James Cappuccino, Natalie Sherman.
2. Laboratory Exercises in Microbiology-Harley Prescott

Course Outcomes:

1.Understand the physical and chemical method of sterilization.
2.Understand the methods of cultivation of microorganisms
3.Understand different staining methods

SEMESTER 2

PHY103 PHYSICS CREDITS:4

Learning Objectives:

Physics course offered to under graduate 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:

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.

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 ultrasonic's .

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.

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.

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:

Textbooks:

Physics – David Halliday, Robert Resnick, Kenneth S Krane, Vol. 1, 5th (e), Willey Student Edition, 2002.

Physics – David Halliday, Robert Resnick, Kenneth S Krane, Vol. 2, 5th (e), Willey Student Edition, 2002.

REFERENCE BOOKS:

- College Physics – Raymond A Serway, Jerry S. Faughn, Chris Vuille, Charles A Bennett, Vol. 1, Thomson Brooks/Cole, 2006.
- College Physics – Raymond A Serway, Jerry S. Faughn, Chris Vuille, Charles A Bennett, Vol. 2, Thomson Brooks/Cole, 2006.

Course Outcomes:

1. Students are able to categorize different types of motions.
2. They are able to relate work, energy and power.
3. They compare translational motion and rotational motion.
4. Solves problems on waves and oscillations.
5. They integrate the different phenomena's due to light such as reflection, refraction, interference, dispersion and diffraction.
6. The students distinguish the properties of matter such as solids, liquids and gases.

7. The students are able to compare and relate the Dielectrics and magnetism.

BIO100 PRINCIPLES OF ECOLOGY AND EVOLUTION CREDITS 3

Learning Objective:

To offer insights on the basic ecological and evolutionary theories and their interrelationships in the environment. Evolution- Definition, scope and history, Darwinian view of life,

SYLLABUS:

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

Ecology and Biosphere-Introduction, biotic and abiotic factors, biomes. Population ecology - Dynamics of population, Population growth-Exponential model Logistic growth model. Community ecology- Interactions- Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views. Ecosystems- Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

REFERENCES:

Text books

1. Reece, Jane B., Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson. Campbell biology. Boston: Pearson, 2011.
2. Odum, E. P. (2006). *Ecology, the link between the natural and the social sciences*. Oxford and IBH Publishing.

Reference Books:

1. Ecology, Third Edition, 2013, by Michael L. Cain and William D. Bowman
2. Molecular Ecology, 2011, by Joanna R. Freeland and Stephen D. Petersen
3. Evolution, 2011, by Carl T. Bergstrom and Lee Alan Dugatkin

Course Outcomes

Students should be able to connect the basic eco-evo principles with the courses like

molecular biology, microbiology, etc. to have a broader picture of the biotic systems.

BIO103 BIOCHEMISTRY CREDITS 3

Learning objective:

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:

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,

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.

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.

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

Lipids Introduction, sources, Nomenclature Classification, Properties & Functions ,Fatty acids, Triacyl glycerols, Membrane lipids, Glycerophospholipids and sphigophospholipids, Steroids, Structure of steroid nucleus, Biological role of Cholesterol, fat soluble vitamins, Biological Membranes

Reference Books

1. Lehninger, Nelson and Cox, Principles of Biochemistry, 5th Edition, W.H.Freeman & Company

2. Voet & Voet, Fundamentals of Biochemistry, 3rd Edition 2004.
3. Lubert Stryer, Biochemistry, 6 th Edition, W.H.Freeman and Company, 2007.
4. Graham Solomons and Craig B. Frhyle , Organic Chemistry, Eighth Edition John Wiley and Sons, 2004.

Course Outcomes:

1.To 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.

2.Identify and write the chemical structure of Amino acids and dpeict their ionisation behaviour, Peptide bond formation; describe the Primary, Secondary, Tertiary and Quaternary structure of proteins and their functions.

3.Analyse the structure and properties of Carbohydrates, Monosaccharide, Disaccharides and polysaccharides, Glycoconjugates.

4.Identify and analyse the classification, Structure and properties of lipids including Storage lipids, Membrane lipids, Steroids etc.

5.Identify and know the chemical structure of nucleotides including their components , describe primary, secondary structure of DNA and RNA.

ENG101 ENGLISH/CREATIVE WRITING & SOFT SKILLS CREDITS 3

Learning Objective

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:

Text-English and Soft Skills-S P Dhanavel

(Comprising different authors representing different stories each dealing with a soft skill)

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 English for students of Science – Orient Longmans
2 Spoken English for you – Emerald
3 English Basics (a companion to grammar and writing) – Cambridge
4 A communicative grammar of English, III Ed. – Pearson
5 Effective English for Technical Communication – Emerald Publishers
6 Spoken English in 4 Easy Steps – ESN pbl

Course Outcomes:

1. Prepare the students to seek and find employment in the corporate, media, English language teaching and content writing sectors.
2. Develop communicative competence in students.
3. 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
4. Expose the students to the employment opportunities, challenges and job roles. To enable the students to conduct independent surveys, collect and analyze data, prepare and present reports and projects.
5. Guide the students to establish self-employment strategies.

MAT100 MATHEMATICS CREDITS 4

Learning Objective:

Mathematics is a course offered to 2ndt semester B.Sc., (BT & MB). The 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:

Linear Algebra:

Matrices-definition, Types of matrices, Addition and subtraction of matrices, Multiplication of matrices, Properties of matrix multiplication, 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,

Sequence and Series Sequence-definition, Arithmetic progression, Geometric Progression, Harmonic Progression, Infinite series, Sum to infinity, Matrices, Determinants and properties of determinants, Minors and co-factors,

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,

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,

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:

Text Books:

1. Anton-Bivens-Davis " 7th Edition Calculus " WSE WILEY
2. S.C Gupta, V. K Kapoor "Fundamentals of Mathematical statistics " Sulthan Chand and Sons.

Reference books

1. S.Lipschutz&M.Lipson "Discrete Mathematics" 2001-TMH
2. Thomas, Finney "Calculus 9th edition" Pearson publications
3. Seymour Lipschutz, Marc Lipson "Schaum's Outlines Of Probability" MCGRAWHILL 2000 2nd
4. Bali Iyengar " A text book of Engineering Mathematics " Dr. B . S Grewal " Engineering Mathematics "

Course Outcomes:

1: To understand the concepts.
2: To solve the problems by using properties.
3: The difference between any two consecutive terms is the same.
4: Find the general solution to a linear first order differential equation.
5: To solve the problems by using different methods.
6: To find the area by using integration.

CUL102 CULTURAL EDUCATION-2 Credits 2

Learning Objective:

Relevance of Srirama and Sri Krishna in the scientific age, Lessons from epic of India . Ramayana and Mahabharata, Vidura neeti- Wise man, Rulers dharma, Story-King Shibi Karma- Role and theory of re incarnation, Bagavad gita –Introduction, Action without desire

SYLLABUS:

Awakening of Universal motherhood, Role & Position of Women in Indian Society – Great women of India, rishikas in the Vedas, women characters in the epics, decline of women's status.

Indian Society: Its Strengths and Weaknesses –family values, social values, community values etc., varnashrama, caste, dowry etc.

Overview of Patanjali's Yoga Sutras with focus on value systems mentioned in Yama and Niyama- Yoga system for Personality refinement, Heroism and patriotism in Modern India.

REFERENCES:

Text Book:

Cultural Education: Reading Material for students - prepared by Cultural Education Dept., Amrita Vishwa Vidyapeetham.

Mother of Sweet Bliss – a biography of Mata Amritanandamayi Devi

PHY182 Physical Sciences Lab credits: 2

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:

Name of the experiments

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; 5th edition (2006)

2. Advanced practical physical chemistry Yadav J.B., Goel Publications (2008

Virtual Labs in Chemistry

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

Reference:

http://amrita.vlab.co.in

Course Outcomes:

1. To get the idea about how to handle the chemicals.
2. Students will get the exposure to use the equipments like weighing machine, Ostwald Viscometer, polarimeter, pH meter, conductivity meter, calorimeter etc.
3. Students will get the chance to compare the theoretical values and practical values.
4. They can improve their hands on skills.

BIO180 **BIOCHEMISTRY LAB** **CREDITS: 2**

Learning Objective:

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

SYLLABUS:

List of Experiments

List of Experiments

1. Preparation of Laboratory Solutions and Buffers
2. Estimation of amino acids by ninhydrin method
3. Separation of aminoacids using TLC
4. Isoelectric precipitation of casein from milk
5. Qualitative analysis of carbohydrates
6. Qualitative analysis of amino acids
7. Estimation of reducing sugar using DNS method.
8. Verification of Beer-lamberts law using potassium dichromate

REFERENCES:

"Experimental Biochemistry", Beedu Sashidhar rao, Vijay Deshpande, I K International Pvt.

Ltd., ISBN 81-88237-41-8.

Laboratory Manual in Biochemistry; J.Jayaraman, New Age International Private Limited.

Course Outcome

Students will get practical exposure to commonly used biochemical techniques and also they become familiar to use instruments like calorimeter, pHmeter etc.

SEMESTER – 3

BIO202 MOLECULAR BIOLOGY CREDITS:3

Learning Objective:

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:

Discovery of DNA as genetic material, Griffith's experiment, Hershy and Chase warring blender experiment, Chargaff's rule, Strucuture of DNA, RNA and Protein
Basic mechanism of replication, transcription, translation, Gene regulation in prokaryotes and eukaryotes, positive regulation, negative regulation, attenuation, gene regulation in lambda phage life cycle, RNA processing and post transcriptional regulation

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

REFERENCES:

Text books

1. Molecular biology of gene, J.D.Watson
2. Gene VIII, Benjamin Lewin

3. Molecular biology, David Freifielder

Course Outcomes:

1. Learn and understand the important discoveries that are made in the field of molecular biology.
2. CO2. Understand the detailed structure of the double helical nature of DNA as proposed by scientists like Watson and Crick.
3. To learn different levels of organizations that regulate the condensation of DNA that leads to the compact metaphase chromosome.
4. To learn key molecular events that occur during the transcription and tranlation processes that leads the protein synthesis from specific genes.
5. Understanding the mechanisms that regulate the regulation of gene expression in both prokaryotes and eukaryotes.
6. Learn about the molecular events that happen during the replication of DNA prior to the cell division.

MAT 201 BIOSTATISTICS CREDITS 3

Learning Objective

Biostatistics is a course offered to 3st semester B.Sc., (BT &MB). We have considered distributions relating to a single characteristics. 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:

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

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

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

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:

Text book:

1. Fundamentals of Biostatistics. by Irfan A Khan.
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe

Reference:

1. Principles of Biostatistics. Marcello Pagano.
2. Course Manuals: S-PLUS Command Line Essentials, The Analysis of Microarrays

Course Outcomes:

1. To understand the concepts.
2. To find r, ρ and study the nature of correlation and regression. Identify the different axiomatic approach.
3. To study and solve problems related to connectives under different situations.
4. To study the need of statistical approach, Identify the different axiomatic approach.
5. To get a single value that describes the whole data and to study the variability of observation.
6. To understand the basic concepts of pmf and pdf.

BIO223 PLANT BIOLOGY CREDITS:4

Learning Objective

The course should enable the students to • Understand in depth about plant structure and physiology • Learn about taxonomy of plants • Have an understanding about plant secondary metabolites and its applications • Comprehend about Agricultural Biotechnology

SYLLABUS:

PLANT STRUCTURE AND DEVELOPMENT: Structural organization and function of plant cell, Growth and Division of The Cell, Morphogenesis and organogenesis in plants, Programmed cell death, aging and senescence

PLANT PHYSIOLOGY: Photosynthesis, Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport and photoassimilate translocation, Stress physiology

EVOLUTION AND CLASSIFICATION OF PLANTS: Principles and methods of taxonomy, Outline classification of plants, Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants

SECONDARY METABOLITES: Classification, isolation, characterization, Biosynthetic pathway of secondary metabolites, tracer techniques

CHEMICAL ECOLOGY: SEMIO-CHEMICALS

AGRICULTURAL BIOTECHNOLOGY: Biopesticides, integrated pest control, sericulture, biofertilizers, Bio-communication, bioremediation, bio-catalysis

FEED STOCK CHEMICALS, DESIGNER CHEMICALS, PHYTOMEDICINE

REFERENCES:

Text books

1. Plant Biology. Allison Smith et al. Garland Science, 2010.
2. Botany: An Introduction To Plant Biology, James D. Mauseth
3. Organic Chemistry- Finar Natural Product Chemistry at a Glance by S P Stanforth

Other References:

1. Plant Biochemistry -Hans-Walter Heldt in cooperation with Fiona Heldt
2. Plant Physiology - Taiz Zeiger
3. Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem,

Russell Jones. John Wiley & Sons, 2002.
4. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis by JB Harborne. Springer, 1998.

Course Outcomes:

1. The students should be able to identify the distinguishing anatomical features of various parts of plant
2. Ascertain what taxa commonly seen plants belong to.
3. Appreciate the plethora of plant secondary metabolites and its benefits
4. Apply the knowledge in Agri-biotech areas such as - biofertilizers, biopesticide etc.

BIO206 ANALYTICAL BIOCHEMISTRY CREDITS: 3

Learning Objective

The main objective of this course is to provide basic knowledge to undergraduate students on various analytical tools to understand structure and functions of biomolecules.

SYLLABUS:

Methods of protein extraction, Protein quantitation: Biuret, Lowry, BCA and Bradford methods, Protein precipitation: Salting-in, Salting-out, Effect of organic solvents and polymers, Protein separation: Dialysis, Ultrafiltration, Centrifugation.

Chromatography: Partition coefficient, Retention, Resolution, Gel flitration chromatography, Ion exchange chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Hydroxyapatite chromatography, Paper chromatography, Thin layer chromatography, Reversed-phase chromatography, Normal phase chromatography, Fundamentals of high performance chromatography, HPLC columns, HPLC detectors.
Electrophoresis: Native PAGE, SDS-PAGE, Isoelectric focussing, 2D-PAGE,. Spectroscopy: Fundamentals of UV/Vis Spectroscopy, Applications of UV/Vis spectroscopy, Spectrophotometer, Fundamentals of fluorescence spectroscopy, Jablonski diagram, Spectro fluorometer, Applications of spectrofluorimetry.

REFERENCE:

1. Biochemistry: Voet and Voet

2. Protein Purification Techniques: Simon Roe
3. Protein Purification: Robert K. Scopes
4. Physical Biochemistry: David Sheehan
5. Practical Biochemistry: Keith Wilson and John Walker
6. Mass Spectrometry for Biotechnology: Gary Siuzdak

Course Outcomes:

1. Introduce the primary steps in biomolecules (focus on proteins) purification which includes various methods in isolation and quantitation of proteins.
2. Learn how to separate proteins from a heterogenous mixture.
3. Learn to apply important chromatographic techniques to purify biomolecules
4. Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of proteins

MIC205 VIROLOGY CREDITS: 3

Learning Objective

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:

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

DIFFERENT CLASSES OF VIRUSES: Animal Viruses-Virus-Host interactions-Viral infections, plant viruses, bacteriophages, Viroids.

HOST RESPONSE AND ANTIVIRAL AGENTS: Immune responses to viruses, Interferon and other cytokines, Antiviral therapy.

TEXT BOOKS

1. Basic Virology – Edward K Wanger
2. Matthew's Plant virology
3. Fundamentals of molecular virology – Acheson and Nicholas H

Course Outcomes:

1. Students will be able to access the reason for studying viruses
2. Understand how to cultivate ,purify and detect the presence of viruses
3. Understand the replicative strategies of different classes of viruses
4. Understand the host immune response to viruses
5. Understand the pathogenicity and various antiviral drugs used to control viral infections.

MIC 281 GENERAL MICROBIOLOGY LAB CREDITS: 2

LEARNING OBJECTIVE

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

Culture Techniques-Spread plate, Pour plate and Decimal dilution.

Motility Determination-Soft agar deeps and Hanging drop method, Biochemical tests: IMViC test, Catalase test, Oxidase test, Triple sugar iron test, carbohydrate fermentation test ,urease test, fungal cultivation and staining .Identification of bacteria is using differential /selective media.

REFERENCE:

1. Microbiology Lab Manual by James G. Cappuccino and Natalia Sherman.
2. Benson's Microbiological Applications by Alfred E. Brown
3. www.microbeonline.com

Course Outcomes:

1. To understand and perform pure culture techniques which includes, Pour plate and spread plate .
2. To understand and perform various biochemical tests to identify unknown microorganisms, practical exposure to fungus cultivation and staining.
3. To understand the use of differential, selective and special media.
4. To perform isolation of bacteriophages from waste water.

BIO281 CELL AND MOLECULAR BIOLOGY LAB CREDITS: 2

Learning Objective

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:

List of Experiments

1. Accurate pipetting
2. Lignin Staining : comparison between monocots and dicots
3. Cheek cell Epithelium
4. Plant cell identification: Identification of stomata and chloroplast
5. Mitosis in onion root tip
6. Polyacrylamide gel Electrophoresis
7. Agarose gel electrophoresis

8. Genomic DNA isolation by CTAB method from different sources like leaf, flowers and fruits of plants
9. Spectrophotometry
10. SDS -PAGE (Polyacrylamide gel electrophoresis)

REFERENCE:

Cell and Molecular Biology: Concepts and Experiments -Gerald Karp

Cell and Molecular Biology: A lab manual -K.V. Chaitanya

Course Outcomes

1. 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.
2. The various stages of mitosis will be analysed and visualised using the actively dividing cells present at the root tip of Allium cepa.
3. Practical exposure to genomic DNA isolation using various plant tissues and standardising the protocol for each of these tissues.
4. Understand the method to assess the quality of DNA using Agarose gel electrophoresis and well as spectroscopic methods.
5. Understand the basis of separation of proteins using polyacrylamide gel electrophoresis.
6. Basic introduction to animal cell culture

AVP201 / AMRITA VALUES PROGRAMME I

AVP211 / AMRITA VALUES PROGRAMME II

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn

people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The

Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability

Organic farming is emerging as an important segment of human sustainability and healthy life. 'Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems

Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion

by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

SEMESTER – 4

BIO201 HUMAN PHYSIOLOGY CREDITS:4

Learning Objective:

To understand the physiological organisation and functioning of human body

SYLLABUS:

Basic cell physiology-Cell- Introduction, Cell membrane, Movement of the substances and water through the cell membrane, Bioelectric potentials
Neuro muscular system-Muscles- Skeletal muscles-Properties of skeletal muscles, Muscular contraction and relaxation, Neuromuscular junction, Sarcotubular system, Smooth muscle-mechanism of contraction.
Nervous system-Sensory nervous system, Motor nervous system ,Higher functions of the nervous system, Synapse, Reflexes, Cerebrospinal fluid, Blood brain and blood CSF barrier
Blood and lymph-Functions of Blood, Hemopoesis ,Erythropoeisis, Anemias, granulocytes and agranulocytes. Leukemia, Reticulo endothelial system, Macrophage system, Hemostasis, Blood clotting defects, Blood groups.

Circulatory system- Functional anatomy of the heart, Properties of cardiac muscles, Conducting system of the heart ,Pressure changes during cardiac cycles, Capillary circulation, Arterial and venous blood pressure

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

Renal physiology- Structure of kidney, Nephrones, Juxtra glomerular filtrate,Reabsorption, Secretion-mechanism of secretion, Concentrating and diluting mechanism of urine, Dialysis

Respiratory system-Mechanism of breathing, Ventilation, Regulation of respiration, Transport of gases, Hypoxia, Artificial ventilation, Non respiratory functions of the lungs

Endocrinology-Endocrine glands, hormones ,their functions, Disorders of endocrine system

Reproductive hormonal functions of males and females

REFERENCES:

Text Book: Guyton AC and Hall JE,Text book of medical physiology

Reference books:

1. Ganong WF Review of Medical Physiology.
2. JOHNSON, Leonard R,Essential Medical Physiology
3. Nordin M and Frankel VH,Basic biomechanics of the musculoskeleton system,Lippincot,Williams and Wilkins.

Course Outcomes:

1. Understand the organisation of human body
2. Understand the functioning of human body as different system like, neuro-muscular, digestive, respiratory, urogenital, body fluids etc.
3. Understand the variation in normal physiology.

BIO205 GENETICS CREDITS: 3

Learning Objective:

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:

Genes, chromosomes & heridity: Introduction, DNA as genetic material – Cellular Reproduction – Mendelism: Basic Principles. Extension and variation of mendelism Chromosomal Basis – Variation in chromosome number & structure – Linkage, Crossing Over and Chromosome Mapping – Genetics of Bacteria and their viruses- Extra Nuclear Inheritance. DNA,gene expression & genomics: Molecular structure of DNA – Mutation, DNA repair & Recombination — Transposable elements – Regulation of gene expression – Cancer & Regulation of Cell Cycle. Genome editing techniques (CRISPR-CAS9)

TEXT BOOKS

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

BIO207 Immunology Credits: 3

Learning Objective:

This course provides understanding about development and function of the immune system during health and diseases states of the body. We emphasize the molecular and cellular aspects of the immune system and response. Course covers innate and adaptive immune response and its components, Antibody and T cell receptor structure, function, molecular development and its genetics, Major histocompatibility complex, antigen presentation, B cell and T Cell activation and signaling, effector mechanisms, biology of vaccines, hypersensitivities, autoimmunity, immunodeficiency diseases, tumor and immunology.

SYLLABUS:

Historical perspectives in Immunology, Host-pathogen interactions; Introduction to the Immune System, Cells and Organs of the Immune system, Innate immune responses, Cells of the innate immune system, Inflammatory response, Antigen capture and presentation to lymphocytes, Antigen recognition in the adaptive immune system, Cell mediated Immune responses, Effector mechanisms of Cell mediated Immune responses

Humoral immune responses, Effector mechanisms of Humoral Immune responses, Immunologic tolerance and autoimmunity, Immune responses against tumors and transplants, Hypersensitivity reactions and diseases, Congenital and acquired Immuno-deficiencies

REFERENCES:

Text Book:

Basic Immunology: Functions and disorders of the Immune system, Abul K abbas, Andrew H Lichtman and Shiv Pillai

Reference materials:

1. Immunology, Kuby, by Kindt, Goldsby, Osborne, Sixth Edition.
2. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008.
3. Research articles and reviews from scientific publications.

Course Outcomes:

1. Understand immune response in our body, both innate and adaptive, to different pathogens, tissue injury and cancer.
2. Understand what happens if our immune system overreact to foreign substances (hypersensitivities and allergies)
3. Understand what happens if our body recognize self as non-self (autoimmunity)
4. Understand the biology of different vaccines against infectious agents and cancer and solutions to produce better vaccines

BIO209 Enzyme Technology CREDITS: 3

Learning Objective:

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

SYLLABUS:

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.

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- Chymotryspin, 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 Inhibitiors like Penicillin, Iodoacetamide and DIPF.

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. Kinetics Allosteric enzymes. Numerical problems in enzyme kinetics and enzyme inhibition.

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

Organisation 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.

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

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

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 :

Textbooks :

1. Fundamentals of Enzymology : Nicholas Price & Lewis Stevens
2. Enzymes : Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry text books by Stryer, Voet and Lehninger (Relevant Chapters)
4. Proteins by Gary Walsh
5. Internet/Journal Resources

Course Outcome:

1. Introduce the term “enzyme” , history and classification
2. Learn about proteinaceous and non proteinaceous enzymes, their purification
3. Familiarise on mechanism of enzyme action-theories of enzyme action.
4. Learn how to define velocity/enzyme activity/rate of a reaction and specific activity
5. Familiarise on factors affecting enzyme activity.
6. Learn about enzyme catalysis, Michelis-Menton's constant.
7. Acquire knowledge about enzyme Inhibitions
8. Learn about enzyme regulations
9. Familiarise on enzyme degradation
10. Detailing on industrial and clinical enzymes.

BIO204 CELL BIOLOGY CREDITS: 3

Learning Objective

Provide in depth knowledge involving the basic concepts of cell biology including cell

signaling, Cell-matrix interactions with specific emphasis on the components that make up the cytoskeleton. The course also includes understanding various mechanisms that govern the growth and regulation of cancer cells including the method to culture such cells.

SYLLABUS:

Cell Structure and Function: Nucleus: Internal Structure, Traffic across the nuclear membrane, Nucleolus and rRNA Processing. Protein Sorting & Transport: Endoplasmic Reticulum, Golgi Apparatus, Vesicular Transport, Lysosome. Mitochondria: Structure, Oxidative Phosphorylation, Chloroplasts: Photosynthesis, Peroxisomes

Cell Regulation: Basics of animal communications ,Modes & Types of Cellular Signals, Receptors: GPCRs, RTKs, Cytokine Receptors & NRTKs, Enzyme linked receptors. Intracellular Signal Transduction Pathways, Cell Signalling and Cytoskeleton, Signalling Networks, Signaling in developmental pathways like Wnt, Notch and Hedgehog, Signaling in plants- Auxin, Ethylene and Phytochromes, Prokaryotic Signaling, Signaling involved in Circadian rythm in Humans, Drososphila and Cyanobacteria,

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

REFERENCES:

Text books

The Cell, A Molecular Approach – 6th Edition – Geoffrey M. Cooper, Robert E. Hausman – Sinauer Associates, Inc.

Molecular Biology of the Cell – 5th Edition – Alberts et al – Garland Science

Course Outcomes:

1. Understand how the proteins synthesised in the cytosol are transported to different organelles.
2. Understanding how cells co-operate and communicate with each other and the role of such signaling mechanisms in Cancer, Cell death and other pathological conditions.
3. Understand the regulation of cell cycle and cell death in Cancer. CO4: Understand the basic techniques used to culture animal cells.

BIO212 INTRODUCTORY BIOPHYSICS CREDITS: 2

Learning Objective:

This course is intended to provide basic concepts of biophysics which involves application of Thermodynamics in biological phenomena, understanding molecular level changes of biological processes such as Diffusion, Viscosity and Surface tension.

SYLLABUS:

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

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

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

Dynamics of biomolecules: Diffusion, Laws of diffusion, Diffusion across biological membranes, Oxygen consumption and cellular respiration, Osmosis, Osmotic pressure, Osmoregulation, Osmotic work, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.

REFERENCES:

Text books

1. Biochemistry by Voet and Voet
2. Biological Thermodynamics by Donald T. Haynie
3. Introductory Biophysics by J. R. Claycomb and J.Q.P. Tran
4. Molecular and Cellular Biophysics by Meyer B. Jackson

Course Outcomes

1. Understand the basic concepts of biophysics and application of Thermodynamics in biological phenomena.
2. Acquire basic knowledge on protein folding and function.
3. Familiarize molecular level changes of biological processes such as Diffusion, Viscosity and Surface Tension.

SSD201 SOFT SKILLS -I CREDITS 1

Learning Objectives:

To improve the communication and presentation skills of students

SYLLABUS:

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

Course Outcomes:

1. Basic understanding of the Soft skills sessions
2. Gain insights on setting objectives
3. Builds confidence to present in front of audience
4. Gains inputs to know to present self
5. Builds confidence to present in front of audience
6. Gains overall perspective of the course

BIO 282 Immunology Lab Credits:2

Learning Objective:

To expose the students to common laboratory assays, like blood grouping, agglutination reactions.

SYLLABUS:

ELISA (enzyme-linked immunosorbent assay), which detects the presence of antigen-

antibody interactions in the body fluids.

Principles of Antigen-antibody interactions, applications of antigen-antibody interactions in research.

Blood typing by agglutination, latex agglutination, ouchterlony diffusion on gels for antibody titration, diffusion expts for testing common epitopes on antigens, ELISA

REFERENCE:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition
Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition
Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman
and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Practical Immunology, 4th Edition (2008). Frank C. Hay, Olwyn M. R. Westwood
ISBN: 978-1-4051-4673-9 408 pages,Wiley-Blackwell

Course Outcomes:

1. To understand and identify the morphology of cells of the immune system.
2. To understand the basic concepts of blood grouping.
3. To understand antigen-antibody interactions and detect the presence of antigens and or antibodies in a biological samples.
4. To understand antigen antibody interactions and thus quantitate the presence of antigen and or antibodies in biological samples.

BIO283 **Enzymology Lab** **CREDITS: 2**

Learning Objective:

Students will be exposed to experiments which includes velocity of enzymes, protein quantitation, specific activity and kinetics of enzyme**.**

SYLLABUS:

List of Experiments: Standard Maltose Curve, Isolation of Alpha/Beta Amylase, Determination of enzyme activity, Construction of Protein standard curve by Folin's Lowry method and Determination of specific activity of enzyme, Effect of substrate concentration on Enzyme kinetics and determination of Km and Vmax, Effect of temperature on Enzyme kinetics, Effect of time on Enzyme kinetics, Effect of pH on Enzyme kinetics.

REFERENCES:

1. "Experimental Biochemistry", Beedu Sashidhar rao, Vijay Deshpande, I K International Pvt. Ltd., ISBN 81-88237-41-8.
2. Laboratory Manual in Biochemistry; J.Jayaraman, New Age International Private Limited.
3.

Course Outcomes:

1. Introduce the basic concepts in reagent and buffer preparations through problem solving and hands on preparation of buffers.
2. Hands on experience in isolation of enzymes from natural sources.
3. Performing experiments to calculate the velocity of an enzymatic reaction.
4. Experimenting to quantitate the protein content in enzymes and thus the specific activity.
5. Hands on experience to study the kinetics of an enzymatic reaction

SEMESTER 5

BIO314 GENETIC ENGINEERING CREDITS: 4

Learning Objective:

In this course, students learn the basis of genetic engineering and its applications in health, medicine, agricultural and environmental biotechnology and its impact on society. The course is divided into four main modules in which students will learn about i.) I.Molecular Tools and Techniques used in the generation of recombinant molecules, ii.) Advanced molecular techniques, iii.) how to apply advanced genetic engineering techniques in biotechnology and iv.) recent trends in genetic engineering including genome editing. Students will use creative thinking and newly learned molecular techniques to develop hypothetica new products for biotechnology using genetic engineering.

SYLLABUS:

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,

Vectors for Cloning: Cloning Vectors for E. coli, λ and other high capacity vectors, Cloning Vectors for Eukaryotes, Genomics & cDNA Libraries

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.

Transgenics & Genomics: Gene Transfer Methods, Kock-out, Knock-in & RNA interference, Transgenic Plants & Animals, Microarrays. Genome editing technologies (CRISPR-CAS9). Insilico cloning techniques.

REFERENCES:

TEXT BOOKS

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

Course Outcomes:

1. Students will gain knowledge on the foundation of genetic engineering and how to use advanced molecular biology techniques for application in biotechnology.
2. Students will be able to use primary literature to design novel products using genetic engineering for application in the different sectors of biotechnology and effectively present their ideas.

BIO318 OMES & OMICS credits:3

Learning Objective:

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

SYLLABUS:

Genomics: Basics of genome sequence and annotation, Functional Genomics. **Transcriptomics**: Definition, Analytical techniques, PCR and QRT PCR, Microarrays, snRNA, snoRNA, tRNA, rRNA and miRNA, RNA Sequencing, RNA Splicing, Post-transcriptional regulation of gene expression.

Proteomics: Concept, Tools of Proteomics: Electrophoresis, Liquid Chromatography, Mass Spectrometry: ESI, MALDI, Mass analyzers: Quadrupole, Time-of-flight, Orbitrap, Detectors: EM Horn, MCP, Peptide mass fingerprinting, Tandem mass spectrometry: Data dependent MS/MS, Data independent MS/MS.

Metabolomics: Introduction to metabolomics, Work flow of metabolome analysis.

REFERENCES:

TEXT BOOKS

1.Genomes by Terence A. Brown, Wiley-Liss.

2.Molecular Biology by Robert F. Weaver, McGraw-Hill.

3. Molecular Biology of the Gene by James D. Watson, Benjamin Cummings.

4. Introduction to Proteomics-Tools for the new biology by Daniel C. Liebler, Humana Press.

5. The evolution from Protein chemistry to proteomics by Roger L. Lundblad, Taylor & Francis.

6. Mass spectrometry based metabolomics, Eds. Sastia Prama Putri, Eiichiro Fukusaki, CRC Press.

7. Web/Journal Resources.

Course Outcomes:

1: Understand the basics of Mass Spectrometry, Proteomics and Metabolomics

2: Should be able to understand major separation techniques in Proteomics

3: Familiarize with few work-flows to identify proteins

BIO311 BIOENERGETICS & METABOLISM CREDITS: 3

Learning Objective:

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

SYLLABUS:

SYLLABUS:

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

Carbohydrate Metabolism: Introduction, Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation, Malate-Aspartate Shuttle. TCA cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Chemiosmotic hypothesis Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation,

Oxidative stress., Pentose phosphate pathway (HMP shunt) & its regulation, Photosynthesis – 'light' and 'dark' reactions: Cyclic photophosphorylation, C4-pathway.

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

Amino Acid/ Nucleic Acid Metabolism: Biodegradation of amino acids – deamination, transamination, decarboxylation, urea cycle including its regulation. Biosynthesis of amino acids, Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, Biologically active amines, Aminoacid derived neurotransmitters and hormones, Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Lesch-Nyhan syndrome & Gout; Allopuriol and xanthine oxidase inhibition.

REFERENCES:

Lehninger, Nelson and Cox, Principles of Biochemistry, 4th Edition, W.H.Freeman & Company, 2004.

1. Voet & Voet, Fundamentals of Biochemistry, Upgrade Edition, Wiley, 2002.
2. Lubert Stryer, Biochemistry, 4th Edition, W.H.Freeman and Company, 1995

Course Outcomes:

1. Understand the thermodynamic principles involved in biochemical reactions. Students should be able to check the thermodynamic feasibility of the reactions, importance of coupling chemical reactions and understand the main high energy compounds involved.
2. Students should be able to understand and depict the metabolic pathways of glucose including glycolysis, gluconeogenesis, citric acid cycle, ETC, ATP synthesis, and photosynthesis and pentose phosphate pathway. Energetics and Regulatory aspects of these pathways will be analysed.
3. Students will be able to demonstrate the relevant catabolic and anabolic pathways of fatty acid, its energetics and regulatory aspects.

4. Students will explain the pathways involved in the synthesis of non- essential amino acids, urea cycle, metabolism of aromatic amino acids and disorders associated with amino acid metabolism. A glimpse on purine biosynthesis will be discussed along with disorders like gout.

BIO315 INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY CREDITS 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:

Industrial Biotechnology, Introduction and history, Isolation and screening, Primary and Secondary screening, Production strains, Production media, Inoculum preparation and inoculum Development, Introduction to Fermenter, Industrial sterilization, Scale up fermentations, Types of fermenters (12 Types), Down stream processing of industrial products. Different types of product purification. Mode of fermenter operation, Industrial production of penicillin, production of streptomycin, Industrial production of organic acids-introduction, production of citric acid, Industrial production of enzymes, introduction; general aspects, production of amylases& proteases, production of nucleotides & nucleotides, production of alcohols-acetone-butanol, production of ethanol, production of amino acids-introduction, production of L- glutamic acid, production of single cell proteins, production of yeast/ mushrooms, production of fermented foods, production of microbial insecticides, production of Biopolymers, Biofuels, biogas, production of Bioplastics, Biosurfactants, and Biofertilizers, General rules in patents and practices. Agitation kinetics and sterilization. Strain improvement methods: Using foreign DNA and mutation.

Environmental Biotechnology - Waste water treatment, Bioremediation, Genetically Engineered Microorganisms in Biotreatment of wastes, Biotechnological methods for pollution detection, Biosensors

REFERENCES:

Text books

1. Industrial Microbiology, A.H.Patel
2. Industrial microbiology, Casida

Reference Books

1. Biotechnology-A textbook of Industrial Microbiology. II edition.Wulf Crueger and Anneliese Crueger.
2. Industrial Microbiology by L.E Casida, John Wiley and sons INC.
3. Industrial microbiology by A.H.Patel, Macillan India Ltd.
4. Principles of fermentation technology by P.Stanbury & Allan Whitekar, Pergamon.
5. Manual of Industrial Microbiology and Biotechnology,II edition. Arnold L.Demain and Juilan E.Davies.

Course Outcomes:

1. An introduction to fermentation process. Learn the history of fermentation process, types of fermentation, and examples of fermentation industry.
2. Design of a fermenter. Understand basic design of a fermenter. Important parts and materials required for aseptic operation and containment practice in a fermenter.
3. Types of Fermenter. Study the difference in design and functioning of different types of fermenters. Understand the advantages and disadvantages of different types of fermenters.
4. Mode of fermenter operation. Covers the basic concepts of microbial growth kinetic and stoichiometry in different bioreactor operational modes.
5. The isolation and improvement of industrially important Microorganisms. Understands the problems in isolation, strain improvement and growth of microorganisms in industrial processes.
6. The recovery and purification of fermentation products. Learn the techniques involved in the extraction and purification of high quality fermentation products.
7. Effluent treatment. Understand the importance of proper waste treatment plant for

fermentation industry. What are the different types of wastes produced and what are the different factors that need to be considered while selecting the treatment method.

BIO317 RESEARCH METHODOLOGY CREDITS 2

Learning Objective:

This course introduces students to research mainly in 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:

Research Methodology in life sciences. Literature Search: Use of databases, framing query with examples. Bibliometrics: Citation, Impact factor, Eigen factor. Hypothesis as a framework for scientific projects. Alternatives of hypothesis driven research: hypothesis generating research. Experimental Design: different experimental designs, controls, Taking measurements. Data Analysis: Between-individual variation, replication and sampling. Common statistical tests with Excel. 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.

Course Outcomes:

This course is supposed to give them the basic knowledge on how to think of a research problem, do experimental designing and research to analyse and presentaion of the results.

SSD 301 **SOFT SKILLS-II** **CREDITS: 1**

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

Course Outcomes:

1. Basic understanding of the Soft skills sessions
2. Gain insights on setting objectives
3. Gain insights on setting objectives

4. Gain insights on setting objectives
5. Gains inputs to know to present self
6. Builds confidence to present in front of audience
7. Builds confidence to present in front of audience
8. Gains inputs to present in front of audience
9. Gains inputs to present in front of audience
10. Builds confidence to present in front of audience
11. Builds confidence to present in front of audience
12. Gains overall perspective of the course

BIO385 Industrial Biotechnology Lab CREDITS: 2

Learning Objectives

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

SYLLABUS:

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

REFERENCE:

1.Microbiology, A Laboratory Manual-James Cappuccino, Natalie Sherman.
2.Manual of Industrial Microbiology and Biotechnology-Arnold L Demain , Julian E Davies

Course Outcomes:

1. Understand various methods of screening industrially important microorganisms from different sources.
2. Understand the working of small scale fermenter and also determine the aeration efficiency of the fermenter Understand the technique of immobilization of cells like yeast and E.coli.

BIO386 GENETIC ENGINEERING LAB CREDITS: 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:

List of Experiments:

Isolation of Plasmid DNA by Alkaline lysis method , Quantitation of DNA, Detection of Plasmid DNA by Agarose gel electrophoresis, Restriction Digestion Analysis, Competent cell preparation, Transformation and Efficiency of competent cells, SDS PAGE, Polymerase Chain Reaction, Isolation of Genomic DNA from Plants, Calibration of pipettes

REFERENCE:

1. Joseph Sambrook, David William Russell "Molecular cloning". 3rd Edition, CSHL Press, 2001.
2. Learn. Genetics. Virtual Lab / learn.genetics.utah.edu/
3. VALUE Virtual Lab / vlab.amrita.edu

Course Outcomes:

1. Hands on training for isolation of plasmids
2. Learn how to identify a plasmid experimentally.
3. Learn how to perform a restriction digestion followed by its mapping
4. Learn how a PCR works
5. Hands on experience on competent cell preparation and transformation.
6. Hands on training for assembling and performing SDS-PAGE

SEMESTER 6

BIO399 BRITE PROJECT CREDITS 7

Learning Objective

The project aims to expose the students to a short term research experience. Through the process they learn to frame hypothesis, define objectives, collect relevant literature, design and perform experiments, data analysis and paper writing.

Course Outcomes

1. Help frame hypothesis.
2. Literature survey.
3. Hands-on experience with regard to different instrumentations and techniques.
4. Data interpretation and statistical analysis.
5. Paper writing.

BIO319 PHARMACOLOGY CREDITS 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:

Fundamental Principles of Pharmacology, Fundamentals of Cardiovascular, Endocrine, and, Immunopharmacology, Principles of Chemotherapy, Principles of Toxicology, 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, Neutraceuticals, Economics of drug development.

Receptor theory & kinetics, dose-response relationships, and mechanism of drug action; Phase I and phase II of drug metabolism, drug efficacy; Pharmacokinetics concepts, Pharmacogenomics and Intellectual Property Rights with respect to Pharmaceuticals.

REFERENCES:

1. Pharmaceutical Biotechnology by Daan J. A. Crommelin, et al
2. "Principles of Pharmacology by D. Golan, A. Tashjian, E. Armstrong, J.Galanter, A.W.Armstrong, R. Arnaout and H.Rose. 2005, Lippincott Williams and Wilkins.
3. Goodman and Gilman's The Pharmacological Basis of Therapeutics Book by J.Hardman, Lee Limbird and A.G. Gilman.

Course Outcomes:

Students learn about drug discovery, mechanism of action of different drugs and get an idea about pharmaceutical research

BIO322 Developmental Biology CREDITS 3

Learning Objectives:

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

SYLLABUS:

History & Basic concepts of development: Overview of how the modern era of developmental biology emerged through multidisciplinary approaches stages of development-zygote, blastula, gastrula, neurula**. Cell fate & commitment** – potency- concept of embryonic

stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map**. Mechanisms of differentiation**- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development**. Specification of adult stem cells. Pattern formation**-- axis specification, positional identification (regional specification)**.** Morphogenetic movements, Model organisms in Developmental biology: Early Development in invertebrate /vertebrate models **Drosophila, C.elegans, Xenopus, Mouse/ human :** Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates

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

REFERENCES

1. Developmental Biology, Eighth Edition" by Scott F Gilbert.
2. Essential Developmental Biology by Jonathan Slack
3. Developmental Biology, Werner A Muller
4. Principles of Development - Lewis Wolpert
5. Website: virtual embryo http://people.ucalgary.ca/~browder/virtualembryo/dev_biol.html

Course Outcomes:

Students learn about the role of genes in the development of different organisms

BIF301 INTRODUCTORY BIOINFORMATICS CREDITS 2

COURSE OBJECTIVE

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

SYLLABUS:

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.

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

Sequence alignment: Sequence Similarity Searches: Sequence homology as product of molecular evolution; Sequence similarity searches; Significance of sequence alignment; Sequence alignment; Alignment scores and gap penalties; Measurement of sequence similarity; Similarity and homology. Methods of Sequence Alignment, Graphic similarity comparison; Dot plots; Hash tables; Scoring mutation probability matrices; Sequence similarity searches and alignment tools Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST, Multiple Sequence Alignment, Significance of multiple sequence alignment; Softwares ;Clustal package; Considerations while choosing a MSA software for analysis; Sensitivity and specificity of each software.

Visualisation 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:

TEXT BOOKS

1. Vittal R.Srinivas, " BIOINFORMATICS : A MODERN APPROACH" , 2005, ISBN : 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.

2. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC. , U.K.

3. Jean-Michel Claverie, Cedric Notredame, “Bioinformatics For Dummies”, 2nd Edition,2006, ISBN: 978-0-470-08985-9

Course Outcomes:

Students should be able to apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding gene/protein homologs, designing primers, identifying mutations, etc.

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	17
Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	67
Laboratory Courses	L	16
Project/Dissertation Thesis	P	7
Total Credits for programme completion		127

Under each knowledge component, the credits are again distributed among the identified courses. The number of courses and the credits allocated to each, could vary. However, the student need to get only the minimum credits in each of the components as mentioned in the example and a prescribed minimum total number of credits for successfully completing the academic programme. Additional credits taken will be an added advantage from the professional angle, but not from the academic requirements.

Course Credits

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

Example:

a) A Course on Plant Biology

Number of Lecture hours per week – 3 Credits: 3

Number of Tutorial hours per week – 1 Credits: 1

Total credits for the course 3 + 1 = 4

b) A Laboratory Course on Microbiology:

Number of Laboratory hours per week -3 Credits: 2

These are normally indicated in the curriculum, as follows:

Category	Course Code	Course Title	Hours per week			Credits
			L	T	P	
C	BIO223	Plant Biology	3	1	0	4
L	MIC281	Microbiology Lab	0	3	0	2
P	BIO399	Project	5	5	20	7

Curriculum

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

B.Sc. Biotechnology

Knowledge Segments	Category Admissions	2016 Admissions onwards
Language, Cultural Education & Soft Skills	S	17
Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	67
Laboratory Courses	L	16

Project/Dissertation Thesis	P	7
Total credits needed for programme completion		127

B.Sc. Microbiology

Knowledge Segments	Category Admissions	2016 Admissions onwards
Language, Cultural Education & Soft Skills	S	17
Mathematics, Physics & Chemistry	M	20
Core Lifesciences	C	66
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.

Evaluation Scheme and Grading System

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^{nd} 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

- Additionaly, 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 Point	**Grade**	**Rating**
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.

$$SGPA = \Sigma (Ci \times GPi)/\Sigma Ci$$

where Ci is the number of credits for *it*h course in that semester and GPi 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.

$$CGPA = \Sigma (Ci \times GPi)/\Sigma Ci$$

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

Grade Sheet

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

1. Name, Roll No., Grade Sheet No., Semester, Branch, Month and year of Examination.
2. Course Code, Course Title, Credits and Grade Obtained, Grade Points Earned for the courses registered.
3. Credits registered and earned during the semester.
4. Cumulative Credits earned and Grade Points.
5. SGPA.
6. CGPA.

Revaluation of Answer Papers

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

Course Completion

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

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

REMEDIAL MEASURES

Supplementary Examination

- Students with 'F' Grade may take the supplementary examination in a course up to a maximum of three additional attempts (excluding main end semester examination) carrying

the previous internal assessment marks earned by them.

- Students failing to pass the course after two additional attempt shall henceforth appear for the supplementary examination for the entire 100 marks and the internal assessment marks earned by them in their regular registration shall not be considered.
- Grade Rule for supplementary examination: Supplementary exams will be evaluated against the most recent grade rule(whenever the course was offered recently during a regular semester)
- Fee for the supplementary examination will be Rs.300/ - per paper during the regular duration of the program, after which the student shall pay Rs.1000 per attempt.

Re-registration/Redo

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

Contact Courses

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

Runtime Re-do Course

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

Discipline

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

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

Award of the Degree

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

- Registered and earned the credits for all the core courses and project work.
- Earned the minimum required number of credits for the branch of study as specified in the curriculum.
- Earned the specified number of credits in all categories.
- No disciplinary action pending against him / her.
- There are no outstanding dues against him / her.

Classification of successful candidates

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

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

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

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

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

a)Candidates securing a CGPA of 8.00 and above – DISTINCTION. b)Candidates securing a CGPA between 6.50 and 7.99 – FIRST CLASS and the

same be mentioned in the Degree Certificate'.

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