

 सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in			ACADEMIC YEAR 2026-27
Five-year Integrated MSc in Cell and Molecular Biology				
Year	I	CMM2001C: Diversity of living things (Major)	Credit	4
Semester	I		Hours	75
OBJECTIVE:	• To appreciate the diversity seen in the biological world			
COURSE CONTENT / SYLLABUS				
UNIT-I	Introduction to the concept of taxonomic classification of animals, criteria for Grouping (morphological, biochemical and molecular criteria). Major groups in the animal kingdom: General features of each group (characters of each phylum and examples)			1
UNIT-II	Zoogeographic distribution (realms, the habitats therein, fauna); Animal size and shape; interactions with the environment (homeostasis, osmoregulation, thermoregulation); interactions among species (mutualism, predation, symbiosis, parasitism, etc.)			1
UNIT-III	Plant kingdom - Major groups, Ecosystems and niche, Environmental pressures, adaptation and association; Evolutionary trends and global distribution Anthropological, and natural impact. Microbial ecosystems and effect of environmental factors; Microbiology of specific soil environments; Plant microbe interactions. Specialized groups of microbes.			1
UNIT-IV	Practical Zoology 1. General body organization (models, slides, specimens) 2. Different types of tissues (slides of epithelium, connective tissues, muscles, nerves). 3. Field visit for diversity and classification exercises. 4. Comparative anatomy (models of digestive, nervous, circulatory and skeletal systems).			1
REFERENCES				
1.	Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson Campbell Biology, 9th Edn., Benjamin Cummings; 2010).			
2.	Ravenet al., Biology. Ninth Edition. McGraw-Hill Higher Education, 2010.			
3.	Madigan, M.T., Martinc J.M., Parker, J. Brock Biology of Microorganisms			
4.	A textbook of Algae by Sambamurth			
5.	A textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, by Sambamurth.			

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Integrated MSc in Cell and Molecular Biology						
Year	I	CMM2011C: Evolution and Ecology (Major)			Credit	4
Semester	I				Hours	75
OBJECTIVES :		•To impart basic knowledge of how complex life systems evolved •Introduce the interactions between various components of ecosystem and their interdependence				

COURSE CONTENT / SYLLABUS		
UNIT-I	Evolution: Origin of life, Abiogenesis, Chemical Evolution, Complex biological molecules and formation of protocells. Theories of evolution- Lamarckism, Darwinism, Neodarwinism, Natural selection. Evidences of evolution Direct observations, Homology and development, Vestigial organs, Connecting links, Comparative embryology.	1
UNIT-II	Fossil records: Formation of fossils, conditions of fossilization, Determination of age: Carbon dating technique, Types of fossils. Geological time scale with divisions and detailed analyses of eons and eras. Appearance and extinction of flora and fauna in each time period	1
UNIT-III	Ecosystem: Structure and function; Energy flow and mineral cycling (CNP); Primary production and decomposition; Community Ecology: Community structure and attributes; pattern and community stability, types of interactions. Population Ecology: Characteristic of population; population growth curves; population regulation; life history strategies (r and k selection); Concept of meta-population. Conservation biology: Principles of conservation	1
UNIT-IV	Practical 1. Soil texture and water holding capacity 2. Soil pH and electric conductivity 3. To determine the minimum size of the quadrat by species area curve method 4. To study community by quadrat method to determine % frequency	1
REFERENCES		
1	Futuyama, D. (2005) Evolution, Sinauer Associates.	
2	S.Freeman and J.C.Herron (2004) Evolutionary Analysis, Prentice Hall ISBN-10: 0132275848	
3	T.N.Sherrat and D.M.Wilkinson (2009) Big Questions in Ecology and Evolution.Oxford Univ. Press. ISBN10: 0199548617	
4	Manuel C. Moles (2006) Ecology : Concepts and Applications, 4thEdn., McGraw Hill.	
5	T.M.Smith and R.L.Smith (2012) Elements of Ecology, 8thedition, Benjamin Cummings publications ISBN-10: 0321736079	

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Integrated MSc in Cell and Molecular Biology					
Year	I	CME2001C: Chemistry for biologists I (Minor)		Credit	4
Semester	I			Hours	75
OBJECTIVES :		To introduce basic concepts of physical chemistry for biologists			
COURSE CONTENT / SYLLABUS					
UNIT-I		States of matter Gaseous State: Ideal and Real gases, Postulates of kinetic theory of gases, derivation of Kinetic gas equation, Derivation of gas laws from kinetic gas equation, Deviation from ideal gas Behavior - Derivation of van der Waals gas equation. Liquefaction of gases, Critical phenomena. Liquid State: Intermolecular forces and			1

	structure of liquids (qualitative description) Definition and determination of Vapour Pressure, Surface tension, Viscosity and their variation with temperature.	
UNIT-II	Electrochemistry Metallic and electrolytic conductors: Conduction of electricity by metals and solutions. Classification of substances- electrolytes and nonelectrolytes. Arrhenius theory of electrolytic dissociation. Specific, equivalent and molar conductance - measurement of conductance - variation of conductance with dilution for strong and weak electrolytes, Ionic Equilibria: Arrhenius theory of electrolytic dissociation, ionic product of water, pH scale, measurement of pH, common ion effect, Henderson's equation, buffer solutions, buffer capacity. Hydrolysis of salts. Electrolytic and galvanic cells, reversible and irreversible cells. EMF of a Cell and its measurement. Nernst's equation. Determination of E^0 and equilibrium constant of cell reaction. Standard electrodes (including reference electrodes). Electrochemical series of electrode potentials. Convention for half cell potential. Applications of EMF measurements.	1
UNIT-III	Colloidal State: Classification of colloids, Preparation and purification of sols, Stability of sols, Schulze-Hardy rule, Gold Number. Emulsions, gels and foams. Association colloids, Surfactants, Micelle formation and critical micelle concentration. Mesomorphic state: Difference between liquid crystal, liquid and solid. Classification and structure of nematic, smectic and cholesteric phases.	1
UNIT-IV	Physical Chemistry Practical 1. Viscosity 2. Surface tension 3. Adsorption 4. Chemical Kinetics 5. Conductometry 6. Potentiometry 7. pH-metry 8. Catalysis	1
REFERENCES		
1.	Atkins P. and Paula J. D. (2006), Physical Chemistry, 8th Edition (International Student Edition) Oxford Univ. Press, New Delhi.	
2.	Glasstone, S. (1990), Text Book of Physical Chemistry, 2nd Edition Reprint, Macmillan and Co. Ltd., New York	
3.	Puri, B. R., Sharma, L.R. and Pathania, M. S. (2009), 44th Edition, Principles of Physical Chemistry, Vishal Publ. Co., Jalandhar	
4.	Bahl, B.S., Bahl A. and Tuli, G.D. (2007), Essentials of Physical Chemistry, 25th Edition, S. Chand, New Delhi.	
5.	Engel T. and Reid P. (2007), Physical Chemistry, Pearson Prentice Hall, Noida.	

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Integrated MSc in Cell and Molecular Biology						
Year	I	MDC2311C: Physics and Maths for Biologists (MDC)			Credit	4
Semester	I				Hours	75
OBJECTIVES:		● Mathematics and Its Applications in Biology ● Basic principles of quantum and thermal physics				
COURSE CONTENT / SYLLABUS						
UNIT-I		Functions and their graphs, Limits and Continuity, Derivatives, Derivatives of elementary functions, Implicit differentiation, Higher order derivatives, Applications to maxima and minima, Taylor's and Maclaurin's expansion of functions.				1

UNIT-II	Integration, Integration of elementary functions, Integration by substitution, Integration by parts. First order ODE, Variables separable, Linear and Exact equations, Applications to Growth and decay, Mixture problems, Newton's law of cooling.	1
UNIT-III	Quantum Physics: Wave versus particle, Heisenberg's Uncertainty principle, Matter waves, Photoelectric effect, Quantum principles of atomic structure, orbitals and bounds, Schrodinger's wave equations. MB, BE, FD Statistics and their comparison, X-ray diffraction, laser and its applications in biology. Properties of Matter: Elasticity, Hydrostatic, Surface tension, Broad classification of solids, Structure of crystalline and amorphous solids, Single crystals. Elements of crystal structure, Miller indices	1
UNIT-IV	Thermal Physics: Laws of Thermodynamics and their applications in biological systems, Internal energy, Heat and First law of Thermodynamics, Applications of first law to Ideal Gases, Entropy and the Second law. Fundamental Electromagnetism: Charge and Current, Coulomb's law, Electric field, Electrostatic potential, Gauss's law for Electrostatics, Magnetic effects on steady currents, Electrostatics in Biological systems	1

REFERENCES

1.	G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley Publishers, 1999.
2.	Stanley I. Grossman, Calculus, Harcourt Brace Jovanovich Publishers, 1988
3	Beiser, Concept of Modern Physics. McGraw-Hill Higher education ,sixth edition , 2003
4	Essential of Biophysics by P. Narayan (New edge international Publication)
5	Bio-physics and Introduction by Rodney Cotterill (John Willey)
6	K. W. Zeemansky Heat and Thermodynamics: McGraw-Hill Education, 1997
7	D. J. Griffiths, Introduction to Electrodynamics 3rd Edition, Prentice Hall, 1999.

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Integrated MSc in Cell and Molecular Biology

Year	I	SKILL ENHANCEMENT COURSE (SEC) SEC2301C: Techniques in Physics for Biologists	Credit	2
Semester	I		Hours	60
OBJECTIVES:	• Skills important for physics laboratory			

COURSE CONTENT / SYLLABUS

Practical	1. Newton's Law of Cooling; 2. Melde's Experiment ; 3. Error Analysis ; 4. Y. M. of a wave ; 5. Bending of beam – cantilever 6. M. I. of disc and rigidity of wire 7. Bar pendulum 8. Fly wheel	2
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REFERENCES

1	Practical physics by B L Arora
2	A Text Book of Practical Physics for B.Sc

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Integrated MSc in Cell and Molecular Biology						
Year	I	INDIAN KNOWLEDGE SYSTEM (IKS) IKS2241C: Traditional Ecological Knowledge			Credit	2
Semester	I				Hours	30
OBJECTIVES:		Plants and their ecological niche				
COURSE CONTENT / SYLLABUS						
Properties and relevance of ecological niche for Mesophytes, Submerged hydrophytes. Free floating hydrophytes and anchored hydrophytes; True xerophytes Succulent xerophytes Halophytes, Epiphytes Insectivorous and parasitic plants Parasites, Insectivorous plants						2
REFERENCES						
1	Ravenet al., Biology. Ninth Edition. McGraw-Hill Higher Education, 2010.					
2	Madigan, M.T., Martinc J.M., Parker, J.Brock Biology of Microorganisms					
3	A textbook of Algae by Sambamurth					
4	A textbook of Bryophytes,Pteridophytes, Gymnosperms and Paleobotany, by Sambamurth.					
		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in			ACADEMIC YEAR 2026-27	
Integrated MSc in Cell and Molecular Biology						
Year	I	ABILITY ENHANCEMENT COURSE (AEC) AEC2071C FOUNDATION IN FRENCH			Credit	2
Semester	I				Hours	30
OBJECTIVES:		Introduction to French as a language for basic communication (Level 1)				
COURSE CONTENT / SYLLABUS						
UNIT-I	Comment saluer/la salutation; S’excuser; Les alphabets; Les nombres; Les jours de la semaine; Les mois de l’année; Présenter quelqu’un; Se présenter					1
UNIT-I	La famille; Les articles defines; Les articles indéfinis; Les adjectifs possessifs Les adjectifs et les nationalités; L’interrogation; Les professions; La conjugaisons des verbes au present; Exprimer les goûts					1
REFERENCES						
1	Connexions 1 Niveau 1: Goyal Publisher					

SEMESTER II

		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in			ACADEMIC YEAR 2026-27	
Integrated MSc in Cell and Molecular Biology						
Year	I	CMM2002C: Cell Biology (Major)			Credit	4
Semester	II				Hours	75
OBJECTIVES:		• Introduction to components of the cell and their properties				
COURSE CONTENT / SYLLABUS						
UNIT-I	Origin of life: primordial soup bioelements, biomolecules, importance of water, Cell as the unit of life; Development of cell theory, cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellularorganism.					1
UNIT-I	Cell; Cell organelles-ultra structure of animal cells; Diversity of animal cells. Concepts of multicellualrity, cell-cell interactions in animals, tissue level, organ level organization in animals.					1
UNIT-I	Cell; Cell organelles-ultra structure of plant cells; Diversity of plant cells. Concepts of multicellualrity, cell-cell interactions in plants, tissue level, organ level organization in plants.					1
UNIT-IV	Plant cell types; Plant cell organelles; Membrane permeability i.Osmosis ii. Pinocytosis; Effect of physical/chemical mutagens on early seedling growth (Germination) and isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens. Study of meiosis in complex translocation heterozygotes (Rhoeo discolor).					1
REFERENCES						
1	K. Gerald (2007) Cell Biology Concept and Experiment, 5 th Edn., Wiley.					
2	B. Alberts et al. (2010) Essential Cell Biology 3 rd Edn., Garland Science.					
3	K. Roberts J. Lewis, B. Alberts, P. Walter, A. Johnson and M. Raff. (2008) Molecular Biology of the Cell, 5 th Edn., Garland Publishing Inc. New York.					

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Integrated MSc in Cell and Molecular Biology						
Year	I	CMM2012C: Genetics			Credit	4
Semester	II				Hours	75
OBJECTIVES:		• Understanding the basis of inheritance, relationship between genotype and phenotype • Importance of model systems in understanding genetics, genetic variation causes and affects				
COURSE CONTENT / SYLLABUS						

UNIT-I	Introduction and overview of genetics; Information transfer DNA-RNA-Protein/genotype and phenotype; Eukaryotic and Prokaryotic genes, Pseudogenes; Cell division- mitosis and meiosis	1
UNIT-II	Model genetic systems; Mutation, mutagenesis and mutant selection; Mendelian inheritance; Alleles, Complementation	1
UNIT-III	Deviation from Mendelian inheritance, Linkage and Sex-linked inheritance; Recombination, recombination mapping and mechanism of recombination.	1
UNIT-IV	Practical Zoology Department 1. Mathematical problems based on Mendelian genetics (Test of goodness of fit), Interaction of genes and Linkage and gene mapping. 2. Induction of polyploidy using colchicine; preparation of C-metaphase and karyotyping.	1
REFERENCES		
1.	Snustad, D.R. and Simmons, M.J., Principles of Genetics, 5th edition by, John Wiley and Sons, 2010	
2.	William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino, Concepts of Genetics, 9th Edition, Benjamin-Cummings Pub Co. 2008.	

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Integrated MSc in Cell and Molecular Biology					
Year	I	CME2002C: Chemistry for biologists II (Minor)	Credit	4	
Semester	II		Hours	75	
OBJECTIVES		Introducing the basics of Inorganic chemistry for biologists			
COURSE CONTENT / SYLLABUS					
UNIT-I		Electronic configuration and chemical properties: Origin of quantum numbers and their relation to the symbols and energy of atomic orbitals, radial and angular probabilities. Electronic configuration and Periodic properties – atomic size, ionization energy, electron affinity, electronegativity. Trends in the metallic character. Ionization of elements and stabilization of various oxidation states. Characteristic and distinctive properties of elements.			1
UNIT-II		Chemistry of s Block elements: Hydrogen. Hydrides – Classification and Chemistry. Alkali Metals: Li, Na, K, Rb and Cs – occurrence, comparative study of elements, oxides, halides, hydroxides and carbonates. Exceptional property of Lithium. Alkaline Earth Metals: Be, Mg, Ca, Sr and Ba - occurrence, and comparative study of the elements, oxides, hydroxides, halides, sulphates and carbonates. Exceptional property of Beryllium. p-Block elements: Comparative study of the elements of Groups 13-18 with special reference to electronic configuration, structure of elements and trends in atomic and ionic radii, ionization potential, electron affinity, electronegativity, metallic character and oxidation states. Inert pair effect. Trends in the acidic / basic properties of oxides, hydroxides / oxyacids of various p –block elements			1

UNIT-III	Chemical Bonding: Introduction to types of bonds. <i>Ionic compounds</i> - lattice energy and factors affecting it, Madelung constants, Born-Habercycle,. Solvation energy. Effect of lattice energy and solvation on the solubility of ionic compounds. Covalent bonding - Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple covalent molecules like H ₂ O, NH ₃ , BF ₃ , CH ₄ , PCI ₅ , SF ₆ , IF ₇ . Valence Bond Theory (VBT) – assumptions, linear combination of atomic orbitals and properties of hybrid orbitals. Hybridization involving s, p and d orbitals (dsp ² , sp ³ d, dsp ³ , d ² sp ³ , sp ³ d ² , sp ³ d ³) and shapes of simple molecules like SF ₆ , IF ₅ , PCI ₅ , IF ₇ . Concept of resonance.	1
UNIT-IV	Practical 1. Volumetric analysis: Acidimetry – Alkalimetry, Oxidation – Reduction, Iodometry, Complexometry. 2. Qualitative analysis of Inorganic Salts (single salts with one cation and one anion). 3. Separation of simple mixtures of metal ions and acid radicals (Introductory level).	1
REFERENCES		
1	Lee J. D. (1991) Concise Inorganic Chemistry, 4th Edition, Chapman and Hall	
2	Cotton F.A. and Wilkinson G., (2009) Basic Principles of Inorganic Chemistry, 3 rd Edition, Wiley Eastern.	
3	Gilreath E. S., (1985) Fundamental Concepts of Inorganic Chemistry, 2nd Edition, McGraw Hill Int,	
4	Shah R C, (2005) Inorganic Analysis Part I Qualitative, Baroda Book Depot, Vadodara	
5	Shah R C, (2005) Inorganic Analysis Part II Qualitative, Baroda Book Depot, Vadodara	

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Integrated MSc in Cell and Molecular Biology					
Year	I	MDC2302C: Statistics and Mathematics for Biologists	Credit	4	
Semester	II		Hours	60	
OBJECTIVES:	1. Introduction to statistics for biologists 2. Introduction to linear algebra for biologists				
COURSE CONTENT / SYLLABUS					
UNIT-I	Introduction to statistics; What is statistics? Statistics in Bio- Sciences; Collection and presentation of data, Type of data – Primary and Secondary data; Qualitative and quantitative data, Tabular presentation of data, diagrammatic representation of data. Summarization of data : Attributes and Variables. Frequency distribution of an attribute. Discrete and continuous variables. Frequency distribution of a variable, Graphical representation of the frequency distribution of a variable, Frequency curve, Types of distribution.				1
UNIT-II	Descriptive measures of statistics – (i) Measure of central tendency Arithmetic mean, median , mode. Their merits and demerits. Other measures of central tendency; (ii) Measures of Dispersion Range, Mean Deviation , Standard deviation, Quintiles, Percentiles etc. Data on two or more attributes. Independence and association; Bivariate data, scatter diagram, correlation , finding correlation coefficient between two variables for grouped and ungrouped data. Regression : Regression lines and related results Rank correlation. Spearman’s Rank correlation and Kendall’s Rank correlation.				1

UNIT-III	Matrices: Definition and types of matrices, Row and column operations, Determinants and its properties, Invertible matrices, Cramer's Rule, Elementary matrices, Solving linear system by Gauss Elimination method, Application to feeding bacteria.	1
UNIT-IV	Eigen values and Eigen vectors of a matrix, Orthogonality of eigen vectors associated with distinct eigen values, Properties of eigen vectors of a real symmetric matrix, Diagonalization of a symmetric matrix, Applications.	1
REFERENCES		
1.	Danial W. W. (2008) Biostatistics-A foundation of analysis in the health Sciences, 9 th Edn., John Wiley and Sons	
2.	Zar J. H. (1999) Biostatistical Analysis, (4 th Edition) Pearson Education	
3.	Ward Cheney and David Kincaid, Linear Algebra, Theory and Applications, Jones and Bartlett 201	
4.	V. Krishnamurthy, V. P. Mainra and J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.	
5.	Jin Ho Kwak and Gungpyo Hong, Linear Algebra, Springer International Edition 2004	

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Integrated MSc in Cell and Molecular Biology					
Year	I	SEC2252C: Techniques in Chemistry for Biologists	Credit	2	
Semester	II		Hours	60	
OBJECTIVES:		1. Introduce analytical laboratory skills for determination of biomolecules			
COURSE CONTENT / SYLLABUS					
Practical	Use of different types pipettes, calibration of pipettes, use of different balances, use of pH meters, pKa determination, Distillation of water, Beer Lambert Law, Molar extinction coefficient, principle of colorimeter and its functioning,				2
REFERENCES					
1.	Practical Biochemistry by Harold Varley				
2.	Principles and Techniques of Biochemistry and Molecular Biology				

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Integrated MSc in Cell and Molecular Biology					
Year	I	VAC2022C: Biodiversity Inventory (VAC)		Credit	2
Semester	II			Hours	30
OBJECTIVES:	1. Understanding variation and diversity in living system				
COURSE CONTENT / SYLLABUS					
1. Study of variants [mutants] in <i>Drosophila</i> . 2. Study of Mendelian traits in <i>Drosophila</i> . 3. Basic Cell Biology Techniques. 4. Sex chromatin. Buccal smear study and staining methods for Barr bodies. Blood smear study of drum sticks in Neutrophils. 5. Normal karyotyping in Humans. 6. Blood cell counting using Haemocytometer.					1
REFERENCES					
1.	Snustad, D.R. and Simmons, M.J., Principles of Genetics, 5 th edition by, John Wiley and Sons, 2010.				
2.	William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino, Concepts of Genetics, 9th Edition, Benjamin-Cummings Pub Co. 2008				

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Integrated MSc in Cell and Molecular Biology							
Year	I	AEC 2012C Developing Communication skills in English				Credit	2
Semester	II					Hours	30
		COURSE OFFERED BY FACULTY OF ARTS					

SEMESTER III

 सत्यं शिवं सुन्दरम्		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in		ACADEMIC YEAR 2026-27	
Integrated MSc in Cell and Molecular Biology					
Year	II	CMM2003C: Biomolecules (Major)		Credit	4
Semester	III			Hours	75
OBJECTIVES :	• Appreciating the importance of molecules in biological system • To understand the chemistry of the molecule with its biological role				
COURSE CONTENT / SYLLABUS					
UNIT-I	Water, chemical and physical properties, dissociation constant, pKa, pH, buffer, buffering capacity; Carbohydrates- classification. Carbohydrates- classification, structure, function and properties of monosaccharides, Disaccharides, Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran) . Glycosaminoglycans–source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate, proteoglycans. O- Linked and N-linked glycoproteins. Carbohydrates in Bacterial and plant cell wall				1
UNIT-II	Lipids – classification, fats, fatty acids. Lipids – classification of lipids, structure, properties and functions of fatty acids, triglycerides, phospholipids, glycolipids, sphingolipids and steroids. Eicosanoidsclassification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – structure, function and mechanism of transport Amino acid and Protein structure; Amino acids – classification, structure and properties of amino acids. Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary and quaternary structure of proteins. Determination of amino acid sequence. Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Structural characteristics of collagen and hemoglobin.				1
UNIT-III	Nucleoside, nucleotide – physical and chemical properties Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA Mitochondrial and chloroplast DNA. DNA supercoiling. Determination of nucleic acid sequences by Maxam Gilbert and Sanger’s methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA and their structure				1
UNIT-IV	Practical Analysis of inorganic ions and vitamins- phosphorus and iron, Ascorbic acid; Estimation of organic ions- Glucose, amino acids, proteins and Cholesterol.				1
REFERENCES					
6.	D. L. Nelson and M. M. Cox(2007) Lehninger Principles of Biochemistry, Fourth Edition.				
7.	R. H. Garrett and C. M. Grisham (2008) Biochemistry4thEdn.,Brooks/cole Cengage Learning.				
8.	Voet, D., Voet, J. G., and Pratt, C. W. (2011) Fundamentals of Biochemistry, 4th Edn., John Wiley and Sons.				

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	Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in			
Integrated MSc in Cell and Molecular Biology				
Year	II	CMM2013C: Microbiology (Major)	Credit	4
Semester	III		Hours	75
OBJECTIVES :	• To impart basic knowledge of microorganisms • Introduce the different classes and their features • Importance of media to grow microorganisms and their growth characteristics			
COURSE CONTENT / SYLLABUS				
UNIT-I	Introduction to the microbial world: Salient features of Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses; History and scope of microbiology; Microscopic and staining techniques in Microbiology.			1
UNIT-II	Overview of prokaryotic cell structure and function Bacterial nutrition and nutritional classification, cultivation of microbes (media and techniques); Bacterial Classification; Eubacteria, Archaeabacteria			1
UNIT-III	Microbial growth curve, measurement of growth, Continuous cultures Control of microbial growth by physical and chemical agents, survival curves, evaluation of effectiveness of antimicrobial agents, Useful and harmful activities of bacteria			1
UNIT-IV	Practical 1. Pure culture techniques 2. Biochemical tests for identification of bacteria 3. MIC determination			1
REFERENCES				
1	Willey, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott's Microbiology, 8 th edition, McGraw Hill, 2010.			
2	Madigan, M.T., Martinko, J.M., Stahl, D. A. and Clark, D. P. (2010) Brock Biology of Microorganisms, 13 th edition, Benjamin-Cummings Publishing Company.			
3	Mark Wheelis (2007) Principles of Modern Microbiology, Jones and Bartlett Pub.			
4	Jeffrey C. Pommerville (2013) Alcamo's Fundamentals of Microbiology, 10 th Edn., Jones and Bartlett.			

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Integrated MSc in Cell and Molecular Biology						
Year	II	SEC2503C: Techniques in Microbiology			Credit	2
Semester	III				Hours	60
OBJECTIVES:		• Skills important for microbiology laboratory • Media and its importance in culturing microorganism • Sterilization methods				
COURSE CONTENT / SYLLABUS						
Practical		1. General rules and regulations for safety in Microbiology laboratory. 2. Demonstration of laboratory equipments – autoclave, pressure cooker, hot air oven, incubator, Inoculation hood/ chamber, Inoculation loop, Inoculation needle, membrane filter and colony counter.				2

	3. Concept of sterility- autoclaving, moist and dry heat and filtration methods 4. Media preparation- solid, liquid media, basal media, enriched media, and selective media. 5. Preparation of stains, mordant and mounting media – Methylene blue, Crystal violet, Safranin, Nigrosin, Carbol Fuchsin, Malachite green, Gram's iodine, Cotton blue, Glycerine & Lactophenol. 6. Preparation of microorganisms for light microscopic observation – simple (direct and indirect) staining, differential staining (Gram-staining), Structural staining – capsule and endospore of bacteria) 8. Staining and mounting of algae (e.g., spirogyra/ Nostoc) and fungi (e.g., Rhizopus/ Aspergillus) 7. Observation of bacterial motility by Hanging drop method. 8. Microscopic measurements of microorganisms/ spores using stage and ocular micrometer.	
REFERENCES		
1	Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott's Microbiology, 8 th edition, McGraw Hill, 2010.	
2	Madigan, M.T., Martinko, J.M., Stahl, D. A. and Clark, D. P. (2010) Brock Biology of Microorganisms, 13 th edition, Benjamin-Cummings Publishing Company.	
3	Mark Wheelis (2007) Principles of Modern Microbiology, Jones and Bartlett Pub.	
4	Jeffrey C. Pommerville (2013) Alcamo's Fundamentals of Microbiology, 10 th Edn., Jones and Bartlett.	

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Integrated MSc in Cell and Molecular Biology					
Year	II	IKS2273C: Indian Fermented foods (IKS)	Credit	2	
Semester	III		Hours	30	
OBJECTIVES:		• Basics of fermentation techniques used in food industry • Fermentation in traditional Indian cooking • Benefits of fermented foods			
COURSE CONTENT / SYLLABUS					
UNIT-I		Definition of Fermentation: History of food fermentations, types of fermented foods, benefits of fermentation - nutritive value of fermented foods, microorganism - proteolytic, lipolytic and fermentative bacteria. Classification of Fermented foods on basis of substrate used: Eggs of Fermented foods Different types of pickles like olive, cabbage, cucumber, Dairy based fermented products like Cheese, Acidophilus milk, Butter, Yoghurt, Kefir, Kumiss, Cultured butter milk. Indian Fermented foods: idli, dosa, appam, dhokla, pickles, chutneys, kanji, and lassi, baking using yeast, Fermented milk foods: Cheese; Production of fermented beverages – beer and wine.			1
UNIT-II		Mechanism of fermentation and changes occurring during fermentation. Importance of fermented foods in health, disease and nutrition, Value addition through fermentation: removal of anti-nutritional factors, act as probiotic and prebiotic, production of bioactive compounds, Use of fermentation in food preservation, to increase shelf life,			1
REFERENCES					

1	Food Microbiology: Fundamentals & Frontiers Michael P. Doyle, Francisco Diez-Gonzalez, Colin Hill
2	Food Microbiology M R Adams and M O Moss; New age International 2007

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Integrated MSc in Cell and Molecular Biology						
Year	II	CMM2023C: BIOPHYSICS I (Major)			Credit	4
Semester	III				Hours	75
OBJECTIVES:	• Biophysical tools for biology					
COURSE CONTENT / SYLLABUS						
UNIT-I	Structure determination of biological molecules, X-ray structural analysis, Fourier transform and X-ray Crystallography, Protein X- ray Crystallography, X- Ray scattering, Nuclear Magnetic resonance.				1	
UNIT-II	Microscopy: Optical Microscopy, Features of OM, Types of OM: Bright Field, Dark Field, Phase Contrast, Polarized light and fluorescent microscopy. Spectroscopic methods an introduction and applications in Biology. Absorption spectroscopy, spectrophotometry, chromophores, fluorescent spectroscopy, UV, IR, Raman and atomic Spectroscopy				1	
UNIT-III	Confocal Microscopy, Quantitative Fluorescence assays using Confocal Microscope, SEM and TEM Microscopy, Cryo-electron Microscope and Atomic Force Microscopy.				1	
UNIT-IV	Practical Parts of Microscope and their role, Study of simple and compound microscopes, their handling including oil immersion objective Demonstration of use of microscope to study various biological samples, Microscopic measurements of microorganisms/ spores using stage and ocular micrometer.				1	
REFERENCES						
1	P. Naryanan (2000) Essentials of Biophysics, New Age Int. Publ., New Delhi.					
2	Glaser Ronald (2001) Biophysics, Springer.					
3	Methods in Modern Bio-Physics by Bengt Nolting (Springer international edition)					

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Integrated MSc in Cell and Molecular Biology					
Year	II	MDC2633C: MATHEMATICS AND CHEMISTRY		Credit	4
Semester	III			Hours	60
OBJECTIVES:		- Discrete Mathematics for biologists - Basics in Organic Chemistry			
COURSE CONTENT / SYLLABUS					
UNIT-I		Induction and recursion: Mathematical induction, Recursively defined sequences, Solving recurrence relations. Principles of counting: The principle of inclusionexclusion, The addition and multiplication rules, The Pigeonhole principle.			1
UNIT-II		Permutations and combinations, Probability theory, Repeated experiments, Counting and probability, The Euclidean Algorithm, The RSA Public-Key Cryptosystem.			1
UNIT-III		<i>Chemistry of Carbonyl Group</i> <i>Aldehydes and Ketones:</i> Introduction, preparation: oxidation, reduction, Reimer– Tiemann reaction, Friedel–Crafts acylation, use of lithium dialkylcuprates. Reactivity, nucleophilic addition reactions, oxidation, reduction, haloform reaction, aldol condensation, Claisen condensation, Wittig reaction, Beckmann Rearrangement. <i>Carboxylic acids and their derivatives:</i> Introduction, acidity, Preparation: oxidation of primary alcohols, alkylbenzene s, carbonation of Grignard reagents, hydrolysis of nitriles. Reactions of carboxylic acids: Hell-Volhard-Zelinsky reaction, reduction, conversion into acid chlorides, anhydrides, esters and amides, mechanism of esterification and decarboxylation. Anhydrides and imides.			1
UNIT-IV		<i>Amines and Amino acids.</i> <i>Amines:</i> Structure, Introduction, preparation of alkyl and aryl amines, reduction of nitro and nitrile compounds, reductive amination of aldehydes and ketones. Hofmann rearrangement, basicity of amines, effect of substituent on basicity quaternary ammonium salts, Hofmann exhaustive methylation, Hofmann elimination and orientation. diazotization and its mechanism, synthetic applications of aromatic diazonium salts. <i>Amino Acids:</i> Introduction, Classification, Isoelectric point, Preparation: ma lonic acid synthesis, Gabrialphthalimide synthesis, Reactions.Synthesis of Peptides: Classical peptide synthesis, solid phase peptide synthesis.			1
REFERENCES					
1	E. G. Goodaire and M. M. Parmenter, Discrete Mathematics with Graph Theory, Prentice-Hall of India, 2007.				
2	W. D. Wallis, A Beginner’s guide to Discrete Mathematics, Birkhauser, 2003				
3	Morrison R.T. and Boyd R.N; (1994) Organic Chemistry, Prentice Hall of India, New Delhi				
4	Graham Solomons T.W. and Fryhle C., (2002) Organic Chemistry, John Wiley, New York.				

SEMESTER IV

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Integrated MSc in Cell and Molecular Biology					
Year	II	CMM2004C: Metabolism I (Major)		Credit	4
Semester	IV			Hours	75
OBJECTIVES:		• Introduction to metabolism • Carbohydrate, lipids, amino acids and nucleic acid metabolism pathways			
COURSE CONTENT / SYLLABUS					
UNIT-I	Carbohydrate Metabolism – Glycolysis, Glycogenolysis, Glycogenesis and Gluconeogenesis; HMP pathways; TCA Cycle.				1
UNIT-II	Lipid metabolism: Triglyceride, cholesterol, phospholipid, lipoproteins and eicosanoids. Structure and function of Vitamins				1
UNIT-III	Amino acid metabolism including urea cycle, Metabolism of purines and pyrimidines				1
UNIT-IV	Practical 1. Case studies on diseases of metabolic disorder 2. Urine analysis for metabolic disorders				1
REFERENCES					
1	<u>D. L. Nelson and M. M. Cox(2007) Lehninger Principles of Biochemistry, Fourth Edition.</u>				
2	<u>R. H. Garrett and C. M. Grisham (2008) Biochemistry 4thEdn., Brooks/coleCengage Learning</u>				
3	<u>Voet, D., Voet, J. G., and Pratt, C. W. (2011) Fundamentals of Biochemistry, 4th Edn., John Wiley and Sons.</u>				

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Integrated MSc in Cell and Molecular Biology						
Year	II	CMM2014C: Molecular Biology (Major-II)			Credit	4
Semester	IV				Hours	75
OBJECTIVES:		• Introduction to nucleic acid and genome • Introduce the central dogma • Introduce Replication, Transcription and translation				

COURSE CONTENT / SYLLABUS		
UNIT-I	Nucleic acids and Genome: The central dogma, evidence that DNA is the genetic material. Structure of DNA and RNA, physical properties of DNA - cot plot, kinetic and chemical complexity, T _m , buoyant density, satellite DNA.	1
UNIT-II	Structure of bacterial genes and operons; Bacterial Replication – Leading strand and lagging strand synthesis; DNA damage and repair. Recombination: homologous, site specific and nonhomologous or illegitimate recombination.	1
UNIT-III	Transcription in bacteria. Post transcriptional modifications in bacteria; Bacterial Translation: Genetic code; structure of tRNA; Structure of ribosomes; Charging of tRNAs and tRNA identity. Inhibitors of protein synthesis in prokaryotes. Post translational modifications in bacteria.	1
UNIT-IV	Practical 1. Isolation of DNA from bacteria, plant cell and animal cell 2. Isolation of total RNA from bacteria, plant and animal cell	1
REFERENCES		
3.	R. Weaver (2007) Molecular Biology, 4 th Edn., McGraw-Hill	
4.	B. Lewin, J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (2009) Lewin's Essential Genes, 2 nd Edn., Jones and Barlett Pub., USA	
5.	J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losik and Inglis, CSHLP (2007) Molecular Biology of the Gene, 6 th Edition, Benjamin Cummings.	

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Integrated MSc in Cell and Molecular Biology					
Year	II	CME2004C: CHEMISTRY (Major III) Chemical Kinetics & Thermodynamics		Credit	4
Semester	IV			Hours	75
OBJECTIVES:		• Chemical reactions and their kinetics • Thermodynamic consideration of chemical reactions			
COURSE CONTENT / SYLLABUS					
UNIT-I		Chemical Kinetics – Chemical Kinetics and its scope, rate of a reaction, factors pseudo cing the rate of a reaction-concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characterisitic of simple chemical reactions- zero order, first order, second order, pseudo order, half life. Determination of the order of reaction- differential method, method of integration, method of half life period and isolation method. Concept of activation energy, Arrhenius equation Experimental methods of Chemical Kinetics- Conductometric, potentiometric, optical methods, polarimetry and spectrophotometry. Catalysis: Homogeneous and heterogeneous catalysis, enzyme catalysis.			1
UNIT-II		Chemical Thermodynamics - Definition of thermodynamic terms: system, surroundings, etc. Types of systems, intensive and extensive properties, state and path functions and their differentials.			1

	Thermodynamic process, concept of heat and work. <i>First law of Thermodynamics:</i> Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's Thomson coefficient and inversion temperature. Calculation of w, q, dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. <i>Second law of thermodynamics:</i> need for the law, different statements of the law. Carnot's cycle and its efficiency, Carnot theorem. Concept of entropy, entropy as a state function, entropy as function of V and T, entropy as a function of P & T, entropy as criteria of spontaneity and equilibrium. <i>Third law of thermodynamics:</i> Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. <i>Gibbs and Helmholtz functions:</i> Gibbs function (G) and Helmholtz (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity. Standard free energy change in Biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, synthesis of ATP from ADP. Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.	
UNIT-III	Integration of Metabolism	1
UNIT-IV	Practical 1. Case studies on diseases of metabolic disorder 2. Laboratory tests used to diagnose inborn errors of metabolism (IEM); multiple IEMs include	1
REFERENCES		
Books 1. Atkins P. and Paula J. D. (2006), Physical Chemistry, 8th Edition (International Student Edition) Oxford Univ. Press, New Delhi. 2. Silbey R. J. and Alberty R. A. (2005), Physical Chemistry, 4th Edition, John Wiley and Sons, India. 3. Glasstone, S. (1990), Text Book of Physical Chemistry, 2nd Edition Reprint, Macmillan and Co. Ltd., New York 4. Rakshit P.C. (1995), Physical Chemistry, 5th Edition Reprint, Sarat Book House, Calcutta 5. Puri, B. R., Sharma, L.R. and Pathania, M. S. (2009), 44th Edition, Principles of Physical Chemistry, Vishal Publ. Co., Jalandhar 6. Engel T. and Reid P. (2007), Physical Chemistry, Pearson Prentice Hall, Noida.		

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Integrated MSc in Cell and Molecular Biology						
Year	II	CMM2024C: (MDC) Biophysics and Statistics			Credit	4
Semester	IV				Hours	75

OBJECTIVES:	• Radioactivity and techniques associated with it • Application of statistics to biological tests
COURSE CONTENT / SYLLABUS	
UNIT-I	Radioactive Tracer Techniques - Radioactive Decay, Half Life, α , β and γ Emitters, Decay of Radioactivity, Types of Radioactivity Used in Biochemistry, Units of Radioactivity Measurements, Gas Ionization and Liquid Scintillation Counters, Gamma Counters, Autoradiography.
UNIT-II	Radiation Safety and Health Physics -Biological Hazards of Radiation and Safety Measures in Handling Radioisotopes, Biological Applications. Penetration power in living systems, Radiation damage, Effect of radiation, Measurement of Ionization Radiation and biological damage, Linear Energy Transfer, Radiation Risk, Radiation Dosimetry, Security of Radioactive material, and Radioactive Management.
UNIT-III	Statistics: Concept of sampling; Types of Sampling - merits and Demerits. Determination of sample size. Introduction to probability; Meaning of Probability. Basic Results and Theorems of Probability (only statements); Concept of random variable Probability distribution of a random variable. Expectation and variance. Study of Binomial , Poisson and Normal distribution. Applications of these distribution in Bio- Sciences. Basic Principles of Statistical Inference, Point Estimation, Interval Estimation, Statistical Hypothesis Framing ; Test of significance, p- value Introduction to t – test , F – test , χ^2 ANOVA , etc. Non – parametric test procedures- sign test , signed rank test (one sample and two sample problem) Mann- Whitney test , run test for randomness.
UNIT-IV	Practical 1. Exercises based on concepts of random variable. 2. Exercises based on expectations and variances. 3. Probability distribution. 4. Point Estimation 5. Interval Estimation 6. One sample Test 7. Two sample test 8. ANOVA 9. Non parametric test 10. Determination of sample size
REFERENCES	
Books Biophysics: S. Sharma (2008) Atomic and Nuclear Physics, Dorling Kindersley (India) Pvt. Ltd. Pearson Education. Statistics: 1. Statistics for the Life Sciences (5th Edition) by Myra L. Samuels, Jeffrey A. Witmer, and Andrew Schaffner. 2. Fundamentals of Biostatistics by Bernard Rosner 3. Biostatistical Analysis (4th Edition) by Jerrold H. Zar 4. The Analysis of Biological Data by Michael C. Whitlock and Dolph Schluter 5. A Foundation for Analysis in the Health Sciences" by Wayne W. Daniel and Chad L. Cross (11th Edition)	

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Integrated MSc in Cell and Molecular Biology					
Year	II	SEC2494C: Techniques in Molecular biology (SEC)	Credit	2	
Semester	IV		Hours	60	
OBJECTIVES:					
2. Introduce laboratory skills for manipulation of Genetic material					
COURSE CONTENT / SYLLABUS					
Practical	Preparation of stock solutions for molecular biology; Colorimetric estimation of DNA Colorimetric estimation of RNA; Determination of Tm value of DNA Determination of purity of DNA; Genetic engineering Extraction of DNA from plant and animal sources Quantification of DNA by Spectrophotometry Linearization of plasmid DNA (pUC 18 with Sma I)				2
REFERENCES					
3.	R. Weaver (2007) Molecular Biology, 4 th Edn., McGraw-Hill				
4.	B. Lewin, J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (2009) Lewin’s Essential Genes, 2 nd Edn., Jones andBarlett Pub., USA				
5.	J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losik and Inglis, CSHLP (2007) Molecular Biology of the Gene, 6 th Edition, Benjamin Cummings.				

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Integrated MSc in Cell and Molecular Biology						
Year	II	VAC2454C: Disaster Management (VAC)			Credit	2
Semester	IV				Hours	30
OBJECTIVES:		2. To instill importance of comprehending disaster 3. To prepare for mitigation of disaster				

COURSE CONTENT / SYLLABUS		
UNIT-I	Introduction to Disaster Disaster, Hazard, Risk, Vulnerability and related terminology Classification of Disasters: Natural and Man-made Natural Disasters: Endogenic and Exogenic Man-made Disasters: Physical, Chemical and Biological Preparedness and Action at individual level for various disasters.	1
UNIT-II	Disaster Management • Hazard Identification and Evaluation • Risk Assessment • Disaster Management Cycle: Pre- disaster, Emergency (Disaster) and Post Disaster • Disaster Management Act, 2005. • National Framework for Disaster Management	1
REFERENCES		
1.	Sharma, V. K. (2001). Disaster Management.	
2.	Keller, E. A. (2012). Introduction to Environmental Geology	
3.	Merritts, D. (1998). Environmental Geology: an earth system science approach. Macmillan.	
4.	Özerdem, A., & Jacoby, T. (2006). Disaster management and civil society: Earthquake relief in Japan, Turkey and India (Vol. 1)	

SEMESTER V

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Integrated MSc in Cell and Molecular Biology						
Year	III	CMM3015C: Recombinant DNA Technology (Major II)		Credit	4	
Semester	V			Hours	75	
OBJECTIVES :		To learn about DNA and RNA isolation and estimation To learn about properties and application of plasmids and cosmids To learn about principal and applications of certain techniques regarding DNA modifications To learn about related techniques and their applicability RFLP, AFLP, RAPDs and DNA finger printing.				
COURSE CONTENT / SYLLABUS						
UNIT-I		Purification and analysis of Nucleic acids. Enzymes used in recombinant DNA technology – Principles and applications of DNA polymerases; Restriction endonucleases; DNA modifying enzymes.			1	

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Integrated MSc in Cell and Molecular Biology					
Year	III	CMM3005C: Bio analytical techniques (Major1)	Credit	4	
Semester	V		Hours	75	
OBJECTIVES :		Learn about different spectroscopy methods Learn about various properties of light and its applications in microscopy Learn about electrochemical cells and pH electrodes Learn about various labeling techniques for biomolecules Learn about various separation techniques like dialysis and centrifugation Learn about various chromatography techniques Learn about electrophoretic techniques			
COURSE CONTENT / SYLLABUS					
UNIT-I	Principles and Applications of UV-VIS, fluorescence, CD, ORD, NMR, ESR, Dynamic Light Scattering; Microscopy Techniques; Electrochemical cell, pH and electrodes.				1
UNIT-II	Labelling techniques; Separation Techniques; Homogenization. Membrane filtration, and dialysis. Centrifugation. Viscosity.				1
UNIT-III	Chromatography techniques, Ion exchange, gel filtration, Adsorption chromatography, HPLC and GC; Electrophoresis.				1
UNIT-IV	Practical Techniques important for Recombinant DNA Technology				1
REFERENCES					
R. R. Bergethon (2010) The Physical Basis of Biochemistry: The Foundations of Molecular Biophysics, 2 nd Edn., Springer, NY.					
Wilson, K and Walker, J.M (2005) Principles and techniques of biochemistry and molecular biology, 6th ed., Cambridge University Press.					
P. J. Walla (2009) Modern Biophysical Chemistry, Wiley-VCH.					
D. Sheeham (2009) Physical Biochemistry 2 nd Edn., Wiley-Blackwell.					
Susan R. Mikkelsen and Eduardo Cortón (2004) Bioanalytical Chemistry, WileyInterscience,; ISBN 0-471-54447-7.					

UNIT-II	Properties and applications of plasmids, phagemids, phage vectors, cosmids, YAC, BAC, etc; Oligonucleotide synthesis and their uses.	1
UNIT-III	Principles and uses of nucleic acid hybridizations – Nick translation, Primer extension, Radioactive and non-radioactive probes; Principles and methods of nucleic acid sequencing; Principles and applications of Polymerase chain reaction. Applications of RFLP, FLP, RAPDs and DNA finger printing.	1
UNIT-IV	Practical 1. Isolation of plasmid DNA from bacterial cell. 2. Restriction digestion of DNA and gel electrophoresis of DNA and RNA. 3. PCR analysis	1

REFERENCES

Books

1. Primrose, S., Twyman R. and Old B. (2009) Principles of Gene manipulation and Genomics, 8th Edn., Blackwell Science.
2. Glick B. R., Pasternak J. J. and Patten, C. L. (2010) Molecular Biotechnology - Principles and applications of recombinant DNA, 4th Edn., Wiley.
3. D. T. Nicholl (2008) .An Introduction to Genetic Engineering, 3rd Edition Cambridge University Press.
4. J. D. Watson, R. M. Myers, A. A. Caudy, and J. A. (2006) Recombinant DNA : Genes and Genomes, 3rd Edition, W. H. Freeman Publ.
5. M. Wink <http://as.wiley.com/WileyCDA/Section/id-302477.html?query=Michael+Wink> (2011) An Introduction to Molecular Biotechnology: Fundamentals, Methods and Applications, 2nd Edition, Wiley.
1. K. Gerald (2007) Cell and Molecular Biology, Concept and Experiment, 5th Edn., Wiley.
2. B. Alberts et al. (2010) Essential Cell Biology, 3rd Edn., Garland Science.
6. K. Roberts, J. Lewis, B. Alberts, P. Walter, A. Johnson and M. Raff. (2008) Molecular Biology of the Cell, 5th Edn., Garland Publishing Inc. New York.

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Integrated MSc in Cell and Molecular Biology						
Year	III	CMM3025C: Major 3: Cell Biology			Credit	4
Semester	V				Hours	75
OBJECTIVES:		Learn about different types of transport mechanisms in cell Learn about structure and function of sub cellular organelles. Learn about the dynamic structure of cytoskeleton and their role in intracellular movements. Learn about cell adhesion and cell junction molecules. Learn about protein targeting to various sub cellular organelles. Learn about mechanism of vesicular trafficking for secretory proteins.				
COURSE CONTENT / SYLLABUS						
CREDIT 1		Biomembranes: Eukaryotic membrane structure, molecular composition, organization and synthesis, membrane transport and transporters, Fick’s law, Types of membrane transport. simple diffusion, facilitated diffusion, active transport, exocytosis and endocytosis. Structure and function of subcellular organelles.				1

CREDIT II	Cytoskeleton: Microfilaments, intermediate filaments and microtubules – structure and dynamics. Microtubules and mitosis; cell movements. Intracellular transport and the role of kinesin and dynein. Cell – Cell Adhesion -Ca ⁺⁺ dependent cell-cell adhesion; Ca ⁺⁺ independent cell-cell adhesion. Cell junctions and adhesion molecules.	1
CREDIT III	Intracellular Protein Traffic: Protein synthesis on free and bound polysomes, uptake into ER, membrane proteins, Golgi sorting, post- translational modifications. Vesicular trafficking.	1
PRACTICAL	Total count of WBC, RBC, Differential count of WBC, Hemoglobin estimation, electrophoresis; Use of Fluorescent microscopy in cell biology	1

REFERENCES

1. K. Gerald (2007) Cell and Molecular Biology, Concept and Experiment, 5thEdn., Wiley.
2. B. Alberts et al. (2010) Essential Cell Biology, 3rdEdn., Garland Science.
3. K. Roberts, J. Lewis, B. Alberts, P. Walter, A. Johnson and M. Raff. (2008) Molecular Biology of the Cell, 5thEdn., Garland Publishing Inc. New York.

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Integrated MSc in Cell and Molecular Biology					
Year	III	CME3005C: Protein structure & Basic Enzymology (Minor 1)	Credit	4	
Semester	V		Hours	75	
OBJECTIVES:		Understanding the importance of amino acids & their function in proteins. Learn about thermodynamic principles underlying protein structure & enzyme function. Solving /deriving the equations for enzyme kinetics. Understand the efficiency proteins – esp. as biological catalysts. Understand structure-function relationships. Applications of thermodynamic logic in biochemical catalysis & attainment of native structure.			
COURSE CONTENT / SYLLABUS					
UNIT-I		Proteins: classification based on composition, structure and functions. Primary, secondary, super secondary and quaternary structure of proteins. Determination of amino acid sequence. Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Structural characteristics of collagen and hemoglobin. Primary structure and determination; artificial peptide synthesis; restrictions on primary structure (recognition sequences for protein modifications and targeting); secondary and tertiary structure including prediction; quaternary structure.			1
UNIT-II		Scope and history of enzymology, Introduction to the nature of biological reactions, Enzyme classification and nomenclature. Enzyme assays and purification; Enzyme applications			1
UNIT-III		Single substrate kinetics, [S], Michealis Menten equation: derivation and significance, Graphical analysis of Km and Vmax, Variations of velocity with [S], [E], pH and temperature; enzyme inhibition;			1
PRACTICAL		Protein purification techniques; Practicals on protein estimation, protein structure and sequence determination			1
REFERENCES					

1. D. L. Nelson and M. M. Cox (2007) Lehninger Principles of Biochemistry, Fourth Edition
2. R. H. Garrett and C. M. Grisham (2008) Biochemistry http://www.amazon.com/Biochemistry-Reginald-H-Garrett/dp/0030241731/ref=sr_1_2?ie=UTF8&s=books&qid=1265017063&sr=1-24 4th Edn., Brooks/Cole Cengage Learning.
3. Voet, D., Voet, J. G., and Pratt, C. W. (2011) Fundamentals of Biochemistry, 4th Edn., John Wiley and Sons.
4. Trevor Palmer, Philip Bonner ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry, 2/E
5. Lewis Stevens and Nicholas C. Price, Fundamentals of Enzymology, The Cell and Molecular Biology of Cellular Proteins, 3rd Edition

		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in		ACADEMIC YEAR 2025-26	
Integrated MSc in Cell and Molecular Biology					
Year	III	CME3015C: Coordination Chemistry and Structural determination of Organic Molecules (Minor)		Credit	4
Semester	V			Hours	60
OBJECTIVES:		Introduction to Coordination Chemistry, nomenclature and terminologies. Understand the covalent nature of bonding in coordination compounds Introduction to coordination compounds with metal-carbon bonds. Understand the electrostatic nature of metal-ligand bonds in complexes Understand the characteristic properties (spectral & magnetic) of metal complexes Ultraviolet-Visible (UV-Vis) Spectroscopy: Absorption laws, instrumentation, UV-Vis spectrum, types of electronic transitions, chromophore and auxochrome, UV spectra of alkenes, conjugated enes, enones. Infrared (IR) Spectroscopy: Molecular vibrations, instrumentation and measurement of IR spectrum, Fundamental, Combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups. NMR Spectroscopy: Nuclear magnetic resonance, instrumentation, proton NMR, nuclear shielding and deshielding, chemical shift, spin-spin splitting,			
COURSE CONTENT / SYLLABUS					
UNIT-I		Coordination compounds: Introduction to basic terminologies (primary and secondary coordination spheres, ligands and their types, CN, chelation), Effective Atomic Number(EAN) and 18 electron rules. Isomerism in complexes. Valence Bond Theory of Complex formation: Covalency of M-L bond; hybridization involving d-orbitals, high and low spin complexes, preference for geometry by various metal ions, π -bonding in metal complexes. Capabilities and limitations of VBT. Introduction to organometallic compounds, Metal carbon σ -bonds, π -bonding in metalcarbonyls and nitrosyls.			1
UNIT-II		Electrostatic concept of complex formation :Crystal field theory, (CFT), energy of d orbitalsin spherical, octahedral, tetrahedral, tetragonal and square planar fields. Extrinsic andintrinsic distortion in octahedral geometry, Weak field and strong field complexes. Spectrochemical series, colour, magnetism and geometry of complexes on the basis of CFT, Factors affecting the crystal field splitting, Geometry preferred by various transition metalions in strong and weak fields. Limitations of crystal field theory (qualitative approach).Stability of complexes formed by transition metal ions and the factors influencing it. Mechanism of inorganic reactions: Metal and ligand substitution reactions. Complementary and non-complementary redox processes, atom transfer and electron transfermechanisms.			1

UNIT-III	Ultraviolet-Visible (UV-Vis) Spectroscopy: Absorption laws, instrumentation, UV-Vis spectrum, types of electronic transitions, chromophore and auxochrome, UV spectra of alkenes, conjugated enes, enones. Infrared (IR) Spectroscopy: Molecular vibrations, instrumentation and measurement of IR spectrum, Fundamental, Combination and coupled bands, fingerprint region, characteristic absorptions of various functional groups.	1
UNIT-IV	NMR Spectroscopy: Nuclear magnetic resonance, instrumentation, proton NMR, nuclear shielding and deshielding, chemical shift, spin-spin splitting, interpretation of NMR spectra of simple organic molecules. Mass Spectrometry: Principle, Instrumentation, fragmentation of simple organic molecules. Application of UV, IR and NMR for structure determination of simple organic molecules.	1

Books:

1. Day M. C. and Selbin J., (1985) Theoretical Inorganic Chemistry, East-West Press
2. Cartmell E. and Fowles G.W.A., (1977) Valency and Molecular Structure, 4th Edition. ELBS, Butterworths,
3. Kettle S. F. A., Murrell J. N. and Teddler S., (1985) The Chemical Bond, ELBS. Butterworths
4. Lee J. D., (1991) Concise Inorganic Chemistry, 4th Edition, Chapman and Hall,.
5. Emeleus H. J. and Sharpe A.G., (1994) Modern Aspects of Inorganic Chemistry, 4th Edition, UBS.

Books:

1. Spectrometric Identification of Organic compounds by R M Silverstein and F X Webster, Sixth edition (2002), Wiley.
2. Introduction to Spectroscopy by D Pavia, G Lampman, G Kriz, Second edition (1996), Saunders Golden Sunburst Series.
3. Organic Chemistry by R V Hoffman (1997), Oxford University Press.
4. Spectroscopy, by I Fleming.
5. Organic Structure Analysis by P Crews, J Rodriguez, M Jaspars, (1998), Oxford Press.

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Integrated MSc in Cell and Molecular Biology						
Year	III	SEC3755C: Laboratory skills in Enzymology (SEC)			Credit	2
Semester	V				Hours	60
OBJECTIVES:		To be able to extract enzyme from a tissue and assay it To be able to determine the enzyme activity and its optimal condition				
COURSE CONTENT / SYLLABUS						
UNIT-I	1. Estimation of enzyme activity; calculation of Km and Vmax					1
UNIT-II	2. Estimation of enzyme kinetics with temperature, time and pH as variables. Inhibitor kinetics					1
REFERENCES						
1. Trevor Palmer, Philip Bonner ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry, 2/E 2. Lewis Stevens and Nicholas C. Price. Fundamentals of Enzymology. 3 rd Edition						

SEMESTER VI

 सत्यं शिवं सुन्दरम्		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in		ACADEMIC YEAR 2025-26	
Integrated MSc in Cell and Molecular Biology					
Year	III	CMM3006C: Molecular Biology II (Major I)		Credit	4
Semester	VI			Hours	75

OBJECTIVES: Understanding nucleic acids and genome.
Learn about chromosomes, genes and transcription in prokaryotes.
Learn about transcription in eukaryotes and posttranscriptional events.

COURSE CONTENT / SYLLABUS

CREDIT-I	Eukaryotic genome and its organization. Chromosome, structure of chromatin-nucleosomes, solenoids, scaffolds, Chromatin domains and isochores, structure and functional organization of centromeres and telomeres.	1
CREDIT -II	Replication and repair of DNA in eukaryotes; Structure and organization of eukaryotic gene; Structure and mode of action of RNA polymerases I, II and III - capping, poly adenylation. Post transcriptional modifications.	1
CREDIT -III	Translation –regulation and post translational modifications, inhibitors of protein synthesis in prokaryotes and eukaryotes	1
PRACTICAL	Techniques in advanced molecular biology	1

REFERENCES

B. Lewin, J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (2009) Lewin's Essential Genes, 2 ndEdn., Jones & Barlett Pub., USA.
R. Weaver (2007) Molecular Biology, 4 thEdn., McGraw-Hill.
J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losik and Inglis, CSHLP (2007) Molecular Biology of the Gene, 6 th Edition, Benjamin Cummings.
D. Clark (2009) Molecular Biology: Academic Cell, Academic Press.
J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (2009) Lewin's Genes X, 10th Edn., Jones &Barlett Pub., USA.
Twyman, R.M. (1998) Advanced Molecular Biology, Bioscientific Publ.

 सत्यं शिवं सुन्दरम्		The Maharaja Sayajirao University of Baroda Vikram Sarabhai Institute of Cell and Molecular Biology Faculty of Science Sayajigunj, Vadodara 390002 joint.director-cmb@msubaroda.ac.in			ACADEMIC YEAR 2025-26	
Integrated MSc in Cell and Molecular Biology						
Year	III	CMM3016C: Basic Immunology (Major II)			Credit	4
Semester	VI				Hours	75
OBJECTIVES:		Introduction to Immunology To learn about Innate and Adaptive Immunity To learn about Nature of Antigens and Antibodies and their interactions To learn about Histocompatibility				

COURSE CONTENT / SYLLABUS		
CREDIT -I	Nature of Immunity and Immune system Cells and tissues of Immune system; Phagocytes, NK cells, Mechanisms of Migration of immune cells into primary and secondary lymphoid organs. Nature of Immunity	
CREDIT II	Innate Immunity – Role of Microbial Associated Molecular Patterns (Toll-like receptors and Nod Like Receptors); Complement System and its role in innate immunity and adaptive immunity, MALT system;	
CREDIT III	Introductory Adaptive Immunity Nature of Antigens; Structure and function of antibodies. Structure and function of T cell receptors. Monoclonal antibodies; Antigen-antibody interactions; Histocompatibility antigens - HLA and Disease.	1
Practical	Immuno diffusion; Immuno electrophoresis; Testing for Typhoid antigens by Widal test. Enzyme Linked ImmunoSorbent Assay (ELISA); Isolation of peripheral blood mononuclear cells.	1
Books		
A. K. Abbas, A. H. Lichtman and S. Pillai (2007) Cellular and Molecular Immunology, 6 th Edition, Saunders.		
Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2006) Kuby Immunology, 6th edition, W. H. Freeman.		
P. J. Delves, S. J. Martin, D. R. Burton and I. M. Roitt (2006) Roitt's Essential Immunology 11 th Edn., Blackwell Publ..		
D. Male, J. Brostoff, D. B. Roth and I. Roitt (2006) Immunology, 7 th Edn., Mosby-Elsevier.		

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Integrated MSc in Cell and Molecular Biology					
Year	III	CMM3026C: Development Biology (Major III)		Credit	4
Semester	VI			Hours	75
OBJECTIVES: Learn about development in protozoa Learn about gametogenesis, fertilization and embryogenesis in animal model system Learn about early mammalian development from ectoderm, mesoderm and endoderm Learn about geneticimprinting, primordial germ cells and sex determination in animals Learn about plant model system, plant stem cells, vegetative tissues development in plants Learn about flower development, gametogenesis, and embryo development in plants					
COURSE CONTENT / SYLLABUS					
CREDIT I		Development in protozoans; Gametogenesis, Fertilization, Cleavage, Gastrulation, Axis formation, Anterior posterior patterning. Hox gene and dorsoventral patterning left right patterning; Patterning in Central nervous system			
CREDIT II		Early mammalian development-Ectoderm-eye development, epidermis, hair development, neural crest, tooth development and axon guidance, Mesoderm-somites, development of muscle, bone, kidney, heart and vessels, formation of			

	limbs, Endoderm; Imprinting and primordial germ cells, Sex determination	
CREDIT III	Plant model system. Organization and maintenance of shoot and root apical meristems, plant stem cell niches, pluripotent and totipotent stem cells. Primary and lateral root development, root hair specification. Vascular tissues development. Leaf development, leaf identity, leaf polarity, leaf complexity, trichome and stomata development. Shoot development, shoot branching. The transition from vegetative to reproductive development, molecular basis of flower development. Male and female gametogenesis. Molecular basis of self incompatibility. Embryo and seed development, molecular basis of embryogenesis.	
PRACTICAL	PTC: Introduction to plant tissue culture technique: Surface sterilization and media preparation. Role of additives in different explant culture. Shoot tip and nodal sector culture. Effect of plant growth regulators on various explants for callus induction, Cell suspension culture, growth analysis, cell plating efficiency. Organogenesis and Somatic embryogenesis.	1
Books:		
S F Gilbert, 11th edition, Developmental Biology, Sinauer Associates Inc., U.S.		
Klaus Kalthoff, Analysis of biological development, Boston: McGraw-Hill		
Buchanan B, Gruissem W and Jones R. 2008. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.		
Taiz L. and Zeiger E. 2010. Plant Physiology, Fifth Edition, Sinauer Associates, Inc.		
Reviews published in Trends in Plant Science, Plant Cell, The Plant Journal, Plant Physiology, New Phytologist and Journal of Experimental Botany		

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Integrated MSc in Cell and Molecular Biology					
Year	III	CME3006C: Animal & Plant Tissue Culture (Minor I)		Credit	4
Semester	VI			Hours	75
OBJECTIVES:		Helps to understand basics of plant tissue culture.			
		Helps to understand different types of plant cultures and their application.			
		Helps to understand various technique used for producing genetically modified plants and their mass production.			
		Helps to understand different methods to conserve plants for the future.			
		Helps to understand the basics of animal cell and tissue culture			
		Helps to quantitate and identify different types of cell and the application of tissue culture.			
COURSE CONTENT / SYLLABUS					

CREDIT I	Introduction and Historical overview of Plant Tissue Culture: Nutritional media: Obligatory and optional constituents, Plant growth regulators with special reference to Plant Tissue Culture Systems Incubation systems: Light and Dark, static and Agitated, Totipotency, Growth and Cytodifferentiation of cultured plant tissues, Callus and suspension culture systems Organogenesis: Direct and Indirect-Basic aspects, Somatic embryogenesis- Basic aspects; Isolation and culture of protoplasts, Production of secondary metabolites <i>in vitro</i> Culture systems: Differentiated, Undifferentiated. Germplasm conservation: In vitro variations, Somaclonal and gametoclonal variations. Spontaneous and Genetic variations, Genetic and Epigenetic variations Problems in Plant Tissue Culture: Contamination, Phenolics, Recalcitrance, seasonal variations in response. Androgenesis and Haploid Production: Techniques of anther culture, Factors influencing anther culture, Techniques for isolated pollen culture, Applications of Haploids in plant breeding, Haploidy through alternative sources, Problems associated with haploid production.	1
CREDIT II	<i>Animal tissue Culture</i> - Nutrition in tissue culture - Balanced salt solution, synthetic media, sera, dissociation media, antibiotics, growth factors and substrates. Concept of sterilization and aseptic technique, Sources of contamination in tissue culture and their prevention, Cryopreservation of cell. Types of cells in tissue culture- epithelial cells, fibroblast, Mass culture of cells for production; Classification: anchorage dependant and independent, stem cells,	1
CREDIT III	Primary culture, diploid culture and established cell lines and characterization, Cell growth curve, viability, MTT assays; Application of organ culture in virology and toxicology; Cytogenetics studies, chromosome preparation and banding techniques. Principles of cell separation and purification of cells and their products. 3 D organoid Culture; Bioprinting; microfluidics	1
PRACTICALS	Introduction to animal tissue culture technique, media preparation,	1

Books:

1. Narayanaswamy, S. (2005) - Plant Cell and Tissue Culture, Tata McGraw-Hill.
2. Reinert, J. and Bajaj, YPS. (1977) - Applied and Fundamental Aspects of Plant, Cell Tissue and Organ Culture, Springer-Verlag.
3. Amirato, PV, Evans DA, Sharp WF and Bajaj YPS (1990) - Handbook of Plant Cell Culture, Vol.1 to 5 McGraw Hill Publishing Co.
4. Bhojwani SS and Razdan MK (1983) - Plant Tissue Culture: Theory and Practice, Elsevier Science Publications.
5. Razdan MK (2005) - Plant Tissue Culture.
6. Vasil IK (1988) - Cell Culture and Somatic Cell Genetics of Plants, Vol. 1 to 6.
7. Biotechnology: Theory and techniques of Plant Biotechnology, Animal cell culture and Immunobiotechnology vols 1 and 2 by Jack K Chirikjian
8. Plant Biotechnology and its applications in Plant tissue culture by Ashwani Kumar and Shikha Roy
9. Chavla S.H. (2009) Plant Biotechnology.
10. Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney.
11. General Techniques of Cell Culture Handbooks in Practical Animal Cell Biology by Maureen A

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Integrated MSc in Cell and Molecular Biology					
Year	III	AEC3506C: Artificial Intelligence concepts for biology (AEC)		Credit	2
Semester	VI			Hours	30
OBJECTIVES:		1. To introduce concepts of AI important for Biology			
COURSE CONTENT / SYLLABUS					
CREDIT I		Introduction; philosophy of AI, agents; informed search, uninformed search; local search heuristic search; evolutionary algorithms; adversarial search; min-max algorithm. Constraint satisfaction, Logic, and satisfiability; decision theory; Bayesian networks representation, inference, and learning. Linear algebra basics: vectors and matrices, matrix addition and multiplication Supervised learning: linear regression, logistic regression, cost function, activation function, gradient descent, overfitting and underfitting, regularization Unsupervised learning: K means clustering, dimensionality reduction by principle component analysis, recommender systems			1
CREDIT II		Learning agents, Cost optimization, Learning template, Discussions on a few algorithms (Regression, Neural Networks). Basic neural network architecture: nodes, layers and back propagation Convolutional neural networks: feature detection with filters, striding, padding, max pooling Transformer network: role of attention, tokenizing, word embedding, position embedding Examples of applications in biology: use of transformer networks in Alpha Fold, image processing with convolutional neural networks, microbiome analysis, benign/malignant classification of tumors			1

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Integrated MSc in Cell and Molecular Biology					
Year	III	SEC3536C: Internship		Credit	4
Semester	VI			Hours	120
OBJECTIVES:					
		1. To give an understanding of how to plan and conduct research 2. To instil the ability to ask questions and plan experiments 3. To give on the job training (OJT)			

COURSE CONTENT / SYLLABUS		
CREDIT I	Go to any industry for 15 days for 8 hrs each	4

SEMESTER VII (TO BE MODIFIED AS PER NEP REGULATION)

PAPER I: Enzyme Mechanism and Regulation (3 Credits)

Credit 1: Two substrate kinetics, Presteady state kinetics, Enzyme mechanism (acid, base, electrostatic, metal ion, free radical, transition state binding and covalent; proximity and orientation effects, contributions of strain; cofactors function; transition state theory of enz. catalysis

Credit 2: Experimental approaches to determine mechanism, along with Case studies eg.: chymotrypsin, lysozyme. Enzyme and metabolic engineering

Credit 3: Allostery concept, various equations & models of allostery; cooperativity in hemoglobin; Flux analysis, Regulatory networks and Metabolic control theory, enzyme function in vivo & in vivo kinetics.

Books:

1. Lewis Stevens and Nicholas C. Price, Fundamentals of Enzymology, The Cell and Molecular Biology of Cellular Proteins, 3rd Edition
2. Alan Fersht, Structure and Mechanism in Protein Science, A guide to enzyme catalysis and Protein folding
3. Athel Cornish-Bowden, Fundamentals of Enzyme Kinetics
4. Irwin H. Segel, Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems (Wiley Classics Library)
5. Paul F. Cook, W. W. Cleland, Enzyme Kinetics and Mechanism, Garland Science; 1 edition (22 March 2007)

PAPER II: Human Physiology and Genetics (4 Credits)

Credit 1: General principles of endocrinology, Endocrine glands- Hormones secreted, regulation and function.

Credit 2: Structure and function of digestive system, digestion and absorption, Structure and function of excretory system and role of kidney in urine formation; Blood Chemistry and blood clotting,

Credit 3: Organization of the nervous system; Cells of the nervous system, their structure and function; special biochemical features (structural and metabolic). Ion Channels and electrical properties of membranes; molecular mechanism of generation of membrane potential. Types of Neurotransmitters and receptors

Credit 4: Principles of population genetics, Hardy-Weinberg law and its application for autosomal genes. Epigenetics, mitochondrial inheritance. Inherited human diseases, single gene diseases, complex traits, Statistical methods for genetic analysis of complex traits.

Books:

1. Guyton, Text book of Medical Physiology, 1998
2. Kelly, Hormones, 1994
3. Ganong, Review of medical physiology, 1997
4. Tortora, G. J. Principles of anatomy and physiology, 2000
5. Devlin, T. M. Text of biochemistry with clinical correlations, 1997
6. Harper, Biochemistry, 1997
7. Voet and Voet Biochemistry, 2016

PAPER III: Microbial Physiology (3 Credits)

Credit 1: Microbial cell surface structure and function and biosynthesis: peptidoglycan, teichoic acids, outer membrane components; Bacterial Motility and chemotaxis; Effect of environmental factors (pH, Temperature, salt, oxygen concentration etc) on bacterial growth. Extremophiles and bacterial stress responses.

Credit 2: Bacterial fermentation pathways. Autotrophic metabolism: Autotrophic CO₂ Fixation, Nitrifying and denitrifying bacteria, Sulfur Bacteria, Methylotrophs, Methanogens.

Credit 3: Symbiotic nitrogen fixation. Bacterial differentiation: endospore formation, Caulobacter and Myxobacterial life cycles.

Books

1. White, D., Physiology and Biochemistry of prokaryotes, 3rd Edn. Oxford Univ. Press, 2007.
2. Moat, A. G. and Foster, J. W., Microbial Physiology, 3rd Edition, Wiley-Liss Publ, 1995.
3. E. L. Sharoud, Bacterial Physiology – A Molecular Approach, Springer, 2008.
4. Byung Hong Kim, Geoffrey Michael Gadd, Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008.
5. Doelle HW, Bacterial Metabolism, Elsevier India Pvt. Ltd., New Delhi, 2005.
6. Gerhard Gottschalk, Bacterial Metabolism, 2nd edn., Springer-Verlag, New York, 2006.

PAPER IV: Plant Physiology (3 Credits)

Credit 1: Water relations of plants. Physico-chemical properties of water - water potential. Mechanism of absorption of water - active and passive transport - Apoplast and symplast concept; Water transport system, evolution of plant water transport system. Stomatal mechanism and transpiration. Antitranspirants. Ascent of sap. Mineral nutrition - criteria for essentiality. Macro and micro nutrients, their role and deficiency symptoms. Absorption of solutes - passive, active diffusion and facilitated diffusion antiport - translocation of solutes - pathways and mechanism.

Credit 2: Photosynthesis and Nitrogen metabolism. Photosynthetic pigments, absorption and transformation of radiant energy, Light harvesting complexes, Kok curve, Kautsky curve, ETS, photo inhibition O₂ and H₂ evolution, Regulation of Calvin cycle, RUBISCO activity, Photorespiration, CAM, C₄ Pathway. Nitrogen metabolism - Source of soil nitrogen. Nitrate reduction - Biochemistry and characteristics of NR and NiR - assimilation of ammonia. GDH and GS – GOGAT pathways - Transamination, Reductive amination. Aspartate synthesis, aromatic amino acid synthesis. Interaction between photosynthesis and nitrogen metabolism.

Credit 3: Photomorphogenesis and Phytohormones. Photomorphogenesis; Photoreceptors: Phytochrome, cryptochromes and phototropins, light control of plant development. Light

signal transduction in plants. Plant hormones: Auxin, Cytokinins, Gibberellins, Ethylene, Absciscic Acid, Brassinosteroids, Salicylates, Jasmonates and Strigolactones. Regulation of flowering, vernalization, fruit ripening, Circadian rhythms. Stress physiology and stress resistance, Senescence and programmed cell death.

Books and other resources:

1. P. M. Dey (Editor), J. B. Harborne Plant Biochemistry
2. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
3. Galstone A.W. (1989) Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
4. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
5. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology, 2nd Edition, Academic Press, San Diego, USA.
6. Buchanan B, Gruissen W and Jones R. 2008. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
7. Taiz L. and Zeiger E. 2010. Plant Physiology, Fifth Edition, Sinauer Associates, Inc.
8. Reviews published in Trends in Plant Science, Plant Cell, The Plant Journal, Plant Physiology, New Phytologist and Journal of Experimental Botany.

PAPER V: Metabolism II (3 Credits)

Credit 1: Bioenergetics: Thermodynamic Considerations, Electron Transport System and energy generation.

Credit 2: Theories of Energy Coupling; Generation of ROS and effects on biomolecules, Mechanism of oxidative damage (Fenton reaction) and anti-oxidant defenses.

Credit 3: Nucleotide metabolism. Integration of intermediary metabolism, Biochemical correlates of altered metabolism, organ specific metabolism; Inborn errors of metabolism.

Books

1. D. L. Nelson and M. M. Cox (2007) Lehninger Principles of Biochemistry, Fourth Edition.
2. R. H. Garrett and C. M. Grisham (2008) Biochemistry 4th Edn., Brooks/Cole Cengage Learning.
3. Voet, D., Voet, J. G., and Pratt, C. W. (2011) Fundamentals of Biochemistry, 4th Edn., John Wiley and Sons.

LABORATORY COURSE Practicals:

Microbial Physiology (2 cr)

Basic Introduction to practicals, framing the protocols and Laboratory preparations, Growth curve of *Staphylococcus aureus*, Growth curve of *Staphylococcus aureus* in different concentration of Lactose medium, Growth curve of *Staphylococcus aureus* in different concentration of Sucrose medium, Growth curve of *Staphylococcus aureus* in different concentration of Fructose medium

Analysis of data and interpretation

Blood Chemistry

Cholesterol: HDL, LDL, TG, SGPT, SGOT, Creatinine, glucose

SEMESTER VIII

PAPER I: Advance Cell Biology (3 Credits)

Credit 1	Mitosis, Meiosis, Cyclin dependent regulation of cell cycle and Apoptosis, Necrosis and Autophagy. Cancer biology – Tumor Anatomy Mechanism of carcinogenesis, tumor suppressor genes and oncogene. Role of different cellular processes in cancer
Credit 2	Cell signalling-Types of receptors, Types of ligands, Target cell adaptation. Signal Transduction pathways, Mechanism of genomic and non-genomic actions. Cell-Cell communication - delta notch, Wnt, hedgehog pathway.
Credit 3	Cell Biology techniques, Cell and tissue culture techniques, cell lines and cell cloning.—Freeze fracture; flow Cytometry; receptor purification and characterization; cell fractionation, autoradiography and immuno-cytochemical techniques, Microscopic techniques.

Books

1. K. Gerald (2007) Cell and Molecular Biology, Concept and Experiment, 5thEdn., Wiley.
2. B. Alberts et al. (2010) Essential Cell Biology, 3rdEdn., Garland Science.
3. K. Roberts, J. Lewis, B. Alberts, P. Walter, A. Johnson and M. Raff. (2008) Molecular Biology of the Cell, 5thEdn., Garland Publishing Inc. New York.
4. Kreitzer, G., F. Jaulin and C. Espenel (2009) Cell Biology Assays: Essential Methods, Academic Press.

PAPER II: Advanced Molecular Biology (3 Credits)

Credit 1	Regulation of gene expression in prokaryotes and eukaryotes.
Credit 2	Cloning and manipulation of prokaryotic and eukaryotic genes - Construction of genomic and cDNA libraries; Molecular genetics and reverse genetic strategies. Analysis of cloned genes. Identification of promoters and enhancers, determination of transcriptional start site, Intron-exon organization.
Credit 3	Gene confirmation by gene disruption, Gene knock outs. Protein engineering: site directed mutagenesis, PCR-mediated mutations. Heterologous gene expression systems in <i>E.coli</i> , yeast, insect cell and mammalian cells.

Books

1. R. Weaver (2007) Molecular Biology, 4thEdn., McGraw-Hill.
2. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losik and Inglis, CSHLP (2007) Molecular Biology of the Gene, 6th Edition, Benjamin Cummings.
3. D. Clark (2009) Molecular Biology: Academic Cell, Academic Press.
4. J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (2009) Lewin's Genes X, 10th Edn., Jones andBarlett Pub., USA.

PAPER III: Advanced Immunology (3 Credits)

Credit 1	B Lymphocyte Development and Differentiation: Generation of Diversity; B cell differentiation in Bone marrow, B cell signal transduction, Antigen dependent B cell differentiation - primary and secondary follicles.
Credit 2	T lymphocyte development and Differentiation: Thymus – Negative and positive selection. T lymphocyte Activation and differentiation - subtypes of Th cells, CD8 T cell activation, $\gamma\delta$ T lymphocytes, T and B cell memory. Antigen processing and presentation, Cytokines and Chemokines.
Credit 3	Immunological Disorders : Immunological Tolerance, Peripheral tolerance, Immunosuppression, Transplantation Clinical Immunology: Hypersensitivity - Types I, II, III and IV; Autoimmunity; Cancer immunology.

Books

1. K. M. Murphy, P. Travers, M. Walport (2011) Janeway's Immunobiology, 8th Edition, Garland Science.
2. A. K. Abbas, A. H. Lichtman and S. Pillai (2007) Cellular and Molecular Immunology, 6th Edition, Saunders.
3. Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2006) Kuby Immunology, 6th edition, W. H. Freeman.
4. P. J. Delves, S. J. Martin, D. R. Burton and I. M. Roitt (2006) Roitt's Essential Immunology 11th Edn., Blackwell Publ..
5. D. Male, J. Brostoff, D. B. Roth and I. Roitt (2006) Immunology, 7th Edn., Mosby-Elsevier.
6. B. M. Hannigan, C. B. T. Moore and D. G. Quinn (2010) Immunology 2nd Edn., Viva Books.
7. W. E. Paul (2008) Fundamental Immunology, 6th Edition, Lippincott Williams and Wilkins.
8. K. D. Elgert (2009) Immunology, 2nd Edn., Wiley Blackwell.
9. T. W. Mak and M. E. Saunders (2006) The Immune Response – Basic and Clinical Principles, Academic Press.

PAPER IV: Microbial Genetics (3 Credits)

Credit 1	Historical overview: Classical genetics; Bacterial chromosome; Genetic exchanges in bacteria conjugation, transformation.
Credit 2	Transduction, transfection. Chromosome mapping. Bacterial gene function and regulation operons.
Credit 3	Bacteriophages structure genomes life cycles, use of bacteriophages in genetic studies (Lambda, T4, MS2, M13, P1).

Books

1. Dale, J.W. and Park, S.F. Molecular Genetics of Bacteria, 5th edition, Wiley-Blackwell, 2010.
2. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.

PAPER V: Stem Cell, Regenerative medicine and IPR (3 Credits)

Credit 1	Types of stem Cells- Totipotency, pluripotency, multipotency and unipotency. Embryonic stem cells, induced pluripotent stem cells, adult stem cells, hematopoietic stem cells, mesenchymal stem cells. Differentiation: Cellular basis of differentiation, trans-differentiation, and dedifferentiation. Stem cells maintenance of stemness and control of differentiation, characterization, expansion, regeneration, repair and ageing.
Credit 2	Expression and growth kinetics of different types of stem cells, ES cell technologies, somatic cell cloning and hybridization. Transfection & transformation of cells. Concept of Cell replacement therapy and regenerative medicine.
Credit 3	Introduction to IPR, Types of IP: Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge, Patent writing and patent laws national and international. Patent filing and infringement: Types of patent applications, Patent application-forms and guidelines, Publication of patents-gazette of India, status in European and US. Biosafety, social and ethical issue in stem cell research and regenerative medicine.

LABORATORY COURSE: Practicals (Credits 8)

1. Advance Cell Biology and Molecular Biology – Cytotoxicity, MTT, Cell Cycle RT-PCR, RFLP (3Cr) MS
2. Microbial Genetics – Conjugation, Transduction, Transformation, (3Cr)
3. Advance Immunology – Isolation of primary and secondary lymphoid organs, Detection of cytokines in the organs. (2Cr)

Seminar PRESENTATION OF A SCIENTIFIC ARTICLE (Credit 1)

SEMESTER IX:

ONE SEMESTER OF DISSERTATION AT ANY NATIONAL OR INTERNATIONAL LABORATORY.

SUBMISSION OF THESIS AND DEFENSE IN THE FORM OF PRESENTATION

TOTAL CREDITS: 25

SEMESTER X:

PAPER I: CMB11001 Genomics and Proteomics 3 CREDITS

CREDIT 1: Genomes: History of genomics, DNA based phylogenetic trees, genomes and human evolution, evolution of nuclear, mitochondrial and chloroplast genomes, the concept of minimal genome and possibility of synthesizing it, genetic maps, physical maps, EST and transcript maps, exomes, comparative genomics and colinearity, synteny in maps. Whole Genome sequencing and analysis: Genome sequencing methods review, analysis of the genomes of viruses, bacteria, archaea, eukaryotic – fungi, parasites, plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human).

CREDIT 2: Genome Annotation and Analysis, Insertional mutagenesis, Targeting Induced Local Lesions in Genomes (TILLING) and functional genomics, RNA expression analysis, EST, contigs and unigene sets, use of DNA chips and microarrays, Genomics and Ethical issues

CREDIT 3: Proteomics: Introduction and overview of tools used in proteomics studies, protein - protein interaction, DNA- Protein interaction, application of quantitative proteomics for the analysis of protein - protein interactions and interactomes, two-hybrid systems, mass spectrometry for the analysis of protein complexes, their significance and limitations.

PAPER II: CMB11002 Structural Biology

CREDIT 1: Protein structure and folding, knowledge of protein folding from in vitro studies: Protein structure, folding in vitro, Protein stability – thermodynamics and kinetics; Effect of various factors on folding; Solvent engineering for protein folding; Folding intermediates- kinetic, equilibrium and molten globule intermediates; Techniques for studying the structure and folding of proteins. Single molecule studies.

CREDIT 2: Protein folding in vivo and chaperones: Protein folding in vivo, chaperones, peptidylprolylisomerase (PPI), Protein disulfide isomerase (PDI) and bacterial disulfide bond forming proteins (Dsb's); Membrane proteins and quality control; Cotranslational and post-translational modifications; Protein engineering - Recombinant proteins and domains; Prediction of secondary and tertiary structure of proteins; Protein evolution – divergent and convergent, gene regulation with protein structural changes; Comparison of the structure and stability of proteins of mesophilic and extremophilic origin.

CREDIT 3: Protein degradation and protein aggregation diseases: Protein loss, misfolding, aggregation, context dependence of protein secondary structure, Protein misfolding diseases, therapeutic approaches; Protein degradation, exo- and endo-proteases, mechanisms to escape digestion by exopeptidases, Proteasomes, Ubiquitin dependent and independent mechanisms of protein degradation, Clps.

PAPER III: CMB11003 Neurobiology

CREDIT 1: CNS, PNS, ANS; Myelination, Blood Brain Barrier, Spatial segregation of cellular functions and axonal transport; Types of synapses and their advantages/functions.

CREDIT 2: Neurotransmitter synthesis, storage, release (general treatment); Metabotropic and Ionotropic receptors (ACh, Glutamate). Neurochemistry of sensory system

CREDIT 3: Various reflexes, adaptation, conditioning, facilitation, augmentation; Post-tetanic potentiation, sensitization; potentiation, desensitization, synaptic plasticity, learning and memory; Neurobiology of circadian rhythms – cellular rhythms, organismal rhythms- central and peripheral.

PAPER IV: CMB11006 Molecular Basis of Diseases (Elective II) 3 CREDITS

CREDIT1: Biochemical and molecular basis of pathogenesis, clinical course, diagnosis and treatment of GIT disorders, Liver diseases like jaundice, hepatitis, fibrosis, necrosis and cirrhosis. Acute and chronic renal failure Glomerular and tubular renal diseases.

CREDIT 2: Biochemical and molecular basis of haemoglobinopathies and other blood disorders. Myocardial infarction, Heart Failure, Hypertension

CREDIT 3: Biochemical and molecular basis of metabolic disorders and life style disorders - Diabetes, Atherosclerosis, PCOD, Obesity, Parkinson Disease, and Alzheimer's Disease, OCD, Depression.

PAPER V: CMB11010 SU Basic Pharmacology and Drug Discovery : 3 CREDITS

CREDIT 1: Principles of pharmacokinetics: Types of Drugs, Modes of drug administration, Bioavailability-relative and absolute, Drug absorption, distribution and metabolism, clearance, excretion. Phase I & Phase II Biotransformation, drug-drug interaction, drug herb interaction

CREDIT 2: Principles of pharmacodynamics: Pharmacodynamics- Mechanism of action of drug at different target level. Receptor-ligand interactions. Theories of Receptor- ligand interactions. Classical theory of receptor occupancy, two state theory, coupling of cell, modes of drug action-antipyretics, antacids.

CREDIT 3: Drug development: Basic aspects of drug development, Screening of Drugs, Lead identification & optimization. Preclinical development

Practicals: CMB11013 8 credits

Bioinformatics – 3 Credits Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Research Methodology and scientific writing – **2 credits**

Review Writing – **1 credit**

Project Proposal writing – **2 credits**