Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57,
Granted under RUSA, FIST-DST & Star College Scheme of DBT, Government of India, Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: Bachelor of Science (Honours)
Biochemistry
Course: F.YB.Sc.

Semester I & II

Choice Based Credit System (CBCS) with effect from the Academic year 2021-22

A.C. No : 10
Agenda No : 5.1

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

The B.Sc.(Hons) programme in Biochemistry is designed to evolve in students an in-depth knowledge of the core concepts and principles that are central to the understanding of this discipline. Undergraduates pursuing this programme go through laboratory work that specifically develops their quantitative and qualitative skills, provides opportunities for critical thinking and team work, and exposes them to techniques useful for applied areas of scientific study.

Knowledge: Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main sub-disciplines of biochemistry, such as bio-organic chemistry, immunology, pharmaceutical sciences, molecular biology, pathophysiology, metabolism and applied biotechnology.

PSO1: **Width and depth:** Depth in understanding is the outcome of transactional effectiveness and inclusion of specialized course contents. Width is an output as the choice of courses offered are multi-disciplinary.

PSO2: **Laboratory Skills:** A much valued learning outcome of this programme is the laboratory skills that students develop during the course. A mandatory internship provides the students with a hands-on experience of working in a professional atmosphere. Internships basically help in filling the knowledge gaps. It is always fruitful to understand the corporate culture and get training in the same setting to get well equipped when out of the college.

PSO3: **Quantitative, analytical and instrument based:** Quantitative techniques gained through hands on methods opens the horizon for innovation, thus promoting an entrepreneurial mindset, and development of a research aptitude. The programme also provides ample training in handling basic biochemical laboratory instruments and their use in analytical and biochemical estimations.

PSO4: **Communication skills:** Communication is a highly desirable attribute to possess. Programmes on communication skills and technical writing provide opportunities to enhance students' ability to write scientific, methodical, logical and precise reports. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.

PSO5: **Portable Skills & Capacity Enhancement:** Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry further after completion of Biochemistry (Honours) programme. These are critical thinking, ability to think independently as well as be able to work productively in groups, problem solving, mathematical skills, IT and organizational skills. These are valued across work environments.

PSO6: **Hone research aptitude:** Research projects which are an integral component of the programme, will help develop analytical reasoning skills along with ability to draw logical conclusions.

PSO7: **Diverse career prospects:** On completion of this programme, the learner has multiple vistas open for him/her in multidisciplinary areas such as analytical, pharmaceutical, quality testing, quality assurance and standard biochemical laboratories.

Preamble

The syllabus is framed to give students pursuing B. Sc. Biochemistry (Hons) a sound conceptual foundation of the subject, keeping in mind the graduate attributes Mithibai College (Autonomous) aims to establish and promote in its students.

The syllabus is aimed to make the study of Biochemistry popular, interesting, and encouraging amongst the students along with inculcating lateral thinking skills. It provides a wide horizon encompassing different aspects of this multidisciplinary subject thus inculcating a research aptitude. It gradually proceeds from basic concepts moving towards an applied approach to cater to the needs of industries and research. The proposed syllabus has taken an advantage of credit system to gradually make the transition from simple to complex concepts relevant to interdisciplinary nature of biochemistry.

To prepare the students for detailed course in biochemistry, in the initial year emphasis is on setting a foundation in basic biochemistry, cell biology, microbiology and chemistry. The components in the syllabus provide an in-depth knowledge of human physiology, molecular biology, immunology as well as pathophysiology. The multidisciplinary discipline of biochemistry and its allied applications in nutrition and dietetics, biostatistics, environmental sciences, bioinformatics, entrepreneurship development as well as product development are also catered to in the syllabus.
Thus, the syllabus is structured to enlighten students on the very basic principles of life and biochemistry and to emphasize the interdisciplinary arena of the subject.

The courses are as follows:-

Semester I	USMABC101	BIOMOLECULES-I
	USMABC102	CELL BIOLOGY-I
	USMABC103	BIO-ORGANIC CHEMISTRY-I
	USMABC104	CHEMISTRY-I
	USMABC105	MICROBIOLOGY-I
	USMABC106	BASIC MATHEMATICAL CONCEPTS
	USMABC107	ENVIRONMENTAL STUDIES
	USMABCP112	PRACTICAL-I
	USMABCP134	PRACTICAL-II
	USMABCP156	PRACTICAL-III
Semester II	USMABC201	BIOMOLECULES-II
	USMABC202	CELL BIOLOGY-II
	USMABC203	BIO-ORGANIC CHEMISTRY-II
	USMABC204	CHEMISTRY-II
	USMABC205	MICROBIOLOGY-II
	USMABC206	BASIC COMPUTER PROGRAMMING
	USMABC207	COMMUNICATION SKILLS
	USMABCP212	PRACTICAL-IV
	USMABCP234	PRACTICAL-V
	USMABCP256	PRACTICAL-VI

N.B.

(i) The duration of each theory lecture will be 60 minutes. A course consists of 3 modules. For each module the number of lecture hours allotted are 10. The total number of lecture hours for each course will thus be 30.

(ii) There will be one practical for each course. The duration of each practical will be of 2 hours, i.e., 120 minutes

For practical component, the value of one credit is equal to 30 learning hours.

(iii) Thus in a week, a student will study 2 hours of theory and 4 hours of practicals.

Evaluation Pattern for theory papers

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Internal Continuous Assessment (ICA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (ICA-1)	Test (MCQ/Subjective) / Assignments/ Project/ Presentation	15 marks
Component 2 (ICA-2)	Test (MCQ/Subjective) / Assignments / Project/ Presentation	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
Q1 to Q3	Answer any 3 out of 4 questions	07 marks	21 Marks 21 x 3 = 63 Marks
Q4	Answer any 3 out of 4 questions	04 marks	12 Marks
		Total Marks	**75%**

Evaluation Pattern for practical papers

In the Practical Exams, there will be 20% as continuous assessment and 80% as term end component to be conducted as a semester end exam per course. Two examiners will conduct the practical examination in each course. The average of marks awarded by both the examiners will be considered as final marks.

A learner has to be appear for all the practical examinations failing which he/she will be marked absent.

Signature	Signature	Signature
HOD	Approved by Vice –Principal	Approved by Principal

Program: B.Sc. (Hons.) Biochemistry			Semester : I	
Course: Biomolecules-I			Course Code: USMABC101	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
02	-	2	25%	75%

Learning Objectives:

The cells comprise of biomolecules and amongst them the most abundant and essential constituents of living system are carbohydrates. They are an essential part of diet and provide energy to living organisms besides other important biochemical functions. The learner is made aware of types of carbohydrates, their structures, functions, and their biochemistry.

Another vital biomolecule -lipids, hold a crucial role in growth and development of human beings. Lipids encompass a wide variety of metabolically active substances that can be classified according to their physical properties and chemical composition. Significance and interpretation of various tests performed to determine the quality of the fats/oils is introduced to the learner.

Course Outcomes:

After completion of this course, a learner would be able to:

CO1: Perceive the basic structure of monomeric sugars and their conversion to polymeric carbohydrates.

CO2: Comprehend the chemical nature as well as reactions of carbohydrates in a biological system.

CO3: Justify the physical properties to the structure of carbohydrates.

CO4: Interpret the utility of carbohydrates in biological system.

CO5: Comprehend the structure of fatty acids and lipids.

CO6: Grasp the characteristic properties of lipids and the chemical nature as well as reactions of lipids.

CO7: Appreciate the significant functions lipids in biological systems.

Outline of Syllabus: (per session plan)

Module	Description	No of hours
1	Carbohydrates & Glycobiology-I	10
2	Lipids-I	10
3	Carbohydrates and Lipids-II	10
	Total	**30**
PRACTICALS		**30**

Module	Biomolecules-I	No. of Hours/Credits 30/2
1	**Carbohydrates & Glycobiology-I**	**10**
	Definition and biochemical functions	1
	Classification of carbohydrates	2
	Based on structure -mono, di, oligo, poly saccharides, homo and hetero polysaccharides, aldoses and ketoses	
	Reducing sugars and non-reducing sugars	
	Monosaccharides	4
	Structures of glucose, fructose, galactose, mannose, and ribose	
	Properties:	
	Physical- isomerism D & L, optical, (+) and (-) forms, anomer, epimer, mutarotation	
	Chemical reactions –	
	a) Oxidation to produce aldonic, aldaric and uronic acids (with respect to glucose)	
	b) Reducing action in boiling alkali, enediol formation (with respect to glucose and fructose)	
	c) Osazone formation (with respect to glucose and fructose)	
	d) Orcinol (with respect to ribose)	
	e) Principles of colour reactions of Molisch, Anthrone, Fehling's, Benedict's, Barfoed's, Seliwanoff's	
	Disaccharides	3
	Formation of glycosidic bonds	
	Occurrence, structure and biochemical significance of maltose, lactose and sucrose	
2	**Lipids-I**	**10**
	Biochemical functions of lipids Definition and Bloor's classification	2
	Simple, complex, and derived lipids with examples	
	Fatty acids	3
	Definition and structure Properties	
	Examples of saturated and unsaturated fatty acids, Essential and non-essential fatty acids	
	Geometric isomerism of fatty acids	
	Reactions and characterization of fats	4
	Hydrolysis and ozonolysis	
	Characterization of fats : Saponification value, Iodine number, Acid value (rancidity of fats and its types) Reichert- Meissl number	
	Triacylglycerols	1

	Types, structure, and function	
3	**Carbohydrates and Lipids-II**	**10**
	Polysaccharides Composition: homo & hetero. with two examples of each Storage: starch and glycogen (schematic representation only), iodine test Structural: cellulose, chitin, and pectin (schematic representation only)	2
	Glycosaminoglycans Occurrence, importance and the structure heparin, hyaluronic acid, teichoic acid and chondroitin sulphate. Carbohydrates of industrial importance: Inulin	2
	Phospholipids Definition and general structure of phospholipids, Occurrence, and brief function Types- Glycerophospholipids, phosphatidyl choline (lecithins), phosphatidylethanolamine (cephalins), phosphatidyl serine, phosphatidyl inositol and sphingomyelins	2
	Glycolipids Definition Occurrence Function of cerebrosides and gangliosides (NO structures)	1
	Cholesterol Structure, occurrence, and function	1
	Plant steroids Ergosterol: Definition , Occurrence , Function	1
	Lipids as signals, cofactors and pigments	1

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Nelson, D. L. and Cox, M.M Lehninger Principles of Biochemistry 5th edition Macmillan Education.
2. Rafi M. D., Textbook of Biochemistry for Undergraduates 4th edition Universities Press
3. U. Satyanarayana, Biochemistry, 3rd edition Books & allied (P) Ltd., Kolkata

Suggested Reading

1. Peter Raven, George Johnson and Kenneth Mason and Jonathan, Losos and Tod Dunca: Biochemistry, 12th edition, Mc Graw Hill.
2. Dr. A.C. Deb: Fundamentals of Biochemistry, 8th edition, New central book agency (P) Ltd.
3. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry, 5th edition, Freeman publishers.

4. Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P. Anthony Weil, Harpers illustrated biochemistry, 31st edition, Mc Graw Hill, Lange.
5. Cooper, G.M. and Hausman, R.E: The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Plummer, David T: Introduction to Practical Biochemistry, 3rd edition, Tata Mc. Graw and Hill publishers.
7. Sawhney, S.K. and Singh, Randhir: Introductory Practical Biochemistry, 1st edition, Narosa Publishing House.
8. J L Jain, Sunjay Jai, Nitin Jain: Fundamentals of Biochemistry, 6th edition, S. Chand & Company Ltd.

Any other reference sources as recommended by the course instructor.

Program: B.Sc. (Hons.) Biochemistry			Semester: I	
Course: Cell Biology -I			Course Code: USMABC102	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
02	-	2	25%	75%

Learning Objectives: To appreciate the physiological basis of life, it is imperative to start from the origin of life and the process of evolution. The learner is given detailed idea of the probable theories to explain the origin of life. The evolution of eukaryotes from prokaryotes and the hierarchical complexity is studied, along with the detailed ultrastructure of the cell which includes the cell wall, cell membrane along with comprehensive information of cell organelles. India is rich in ecosystem which provides various habitats for living things. Human beings have been interested in ecology since the beginning of civilization as even emphasized on ancient scriptures about practices and values of environmental conservation. It is now even more critical than ever before for mankind as a whole to have a clear understanding of ecosystem concern.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Conceptualize the process of origin of life and acumen the theories proposed to explain origin of life

CO2: Comprehend the process of evolution

CO3: Correlate paleontology and evolutionary history to evolution

CO4: Gain insight into structure, function and types of ecosystem

CO5: Appreciate the cell, as a functional unit and elucidate the basic cell structure

CO6: Analyze the complexity of eukaryotic cells in comparison to prokaryotes

CO7: Comprehend the ultrastructure and significance of the cell with cell membrane and cell wall

CO8: Elucidate the ultrastructure and functions of various cell organelles

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Origin of life and evolution	10
2	Cell as a unit of life	10
3	Organization of cell and Ecosystem	10
	Total	**30**
PRACTICALS		**30**

Module	Cell Biology-I	No. of Hours/Credits 30/2
1	**Origin of life and Evolution**	**10**
	Life Characteristics of Life Classification of living things ***Origin of life*** Primitive earth- Prebiotic soup Theories on origin- Abiogenesis, Oparin and Haldane theory of chemical evolution Experimental support by - Francesco Redi, Urey and Miller Origin of basic biological molecules - Protenoid microsphere Coacervates droplets, Models of first genetic substances - Cairns-Smith Model, RNA first model, Origin and evolution of - RNP world, DNA world, Retrograde evolution ***Origin of eukaryotes*** Endosymbiotic theory Evolution Comparative overview of Lemarkism and Darwinism Evolutionary time scale; Eras, periods, and epoch; Major events in the evolutionary time scale (Only Flow sheet) Direct evidence of evolution Fossils, Nature of fossils (unaltered and altered), Types of fossils, Conclusions drawn from fossil record, imperfection of fossil record. *Indirect evidence of evolution* Evidence from comparative anatomy, Connecting link, Homology, Analogy, Vestigial organs, Evidence from comparative physiology and biochemistry	1 4 5
2	**Cell as a unit of life**	**10**
	Ultra-structure of cell Structural organization of cell – animal and plant cell. Prokaryotes and eukaryotes -comparative overview Yeast cells as link between prokaryotes and eukaryotes ***Cell wall structure*** Plant cell wall Introduction to microbial cell wall ***Plasma Membrane*** Structure and function Davson-Danielli and Fluid mosaic models	2 2 2

	Transport across cell membranes Diffusion (simple & facilitated) Osmosis (Endo and Exo-osmosis) Channel and carrier proteins, Coupled transport- uniport, antiport and symport Active transport Primary and secondary with one example each Bulk transport- Endocytosis- On the basis of specificity and physical state of matter Exocytosis	4
3	**Organization of cell and Ecosystem**	**10**
	Cell organelles Endoplasmic reticulum (Structure, function and types), Mitochondrion (Structure, function, and genome), Plastids (Structure, types, function, and genome), Ribosome (Structure and function) Golgi apparatus (Structure and function) Peroxisome (Structure and function) Lysosome (Function and types) Vacuoles (Structure and Functions) Microbodies (Structure and Functions) Glyoxysomes (Structure and Functions) Cilia (Structure and Functions) ***Ecosystem*** Structure and Functions of an ecosystem Energy cycle in ecosystem Comparative account of types of ecosystem	6 4

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Verma, P.S. and Agarwal V.K, Cell Biology, Genetics, Molecular biology, Evolution and Ecology, 2nd edition, S. Chand and Co. Ltd
2. Eugene Odum, Gray Barnett , Fundamentals of Ecology, 7th edition, W. H. Freeman & Co
3. Nelson, D. L. and Cox, M.M, Lehninger, Principles of Biochemistry, 5th edition , Palgrave Macmillan
4. J David Rawn, Biochemistry, 2nd edition, Nell Patterson Publishers

Suggested Reading:

1. Sawhney, S.K. and Singh, Randhir, Introductory practical biochemistry, 2nd edition, Narosa Publishing House
2. Dr. A.C. Deb, Fundamentals of Biochemistry, 8th edition, New central book agency (P) Ltd
3. Madhab Chandra Dash and Satya Prakash Dash, Fundamentals of Ecology, 3rd edition, The

McGraw Hill, Companies
4. B. D. Singh, Tripurari Mishra and Diwakar Mishra, Principles of Ecology with Practicals, 3rd edition, Mahaveer Publications
5. U Satyanarayan, Biochemistry, 5th edition, Elsiever

Any other reference sources as recommended by the course instructor.

	Practical USMABCP112 includes Practicals of USMABC101 and USMABC102	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC101	
1.	Identification and color reactions of carbohydrates: a. glucose b) fructose c) maltose d) lactose e) sucrose f) starch g) dextrin	
2.	Isolation of starch	
3.	Qualitative analysis and identification of lipids: a) Palmitic acid b) Oleic acid c) Cholesterol	
4.	Estimation of Saponification value of fat/oil sample	
5.	Estimation of Acid value of fat/oil sample.	
6.	Isolation of oil by the cold-percolation method	
	Practicals USMABC102	
1.	Effect of different solution tonicity on onion peel cells	
2.	Study of electron micrographs of i.Mitochondria ii.Chloroplast iii.Golgi apparatus iv.Endoplasmic reticulum v.Ribosomes vi.Lysosomes	
3.	A 5-page assignment on contribution of scientist to the field of biochemistry	
4.	Study of Osmosis in potato cells	
5.	Effect of organic solvents on Onion cells	
6.	Study hydrolysis of starch by bacteria	
7.	Study ability of bacteria to ferment sugar	
8.	Study gel liquefaction by bacteria	
9.	Study nitrate reduction and denitrification tests by microorganism	

Program: B.Sc. (Hons.) Biochemistry			Semester: I	
Course: Bio-organic chemistry - I			Course Code: USMABC103	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
02	-	2	25%	75%

Learning Objectives:

With 75%% percent of human body and two thirds of the earth's surface covered by water, it is evidently clear that water is one of the prime elements responsible for life on earth. The introduction to the physical and chemical properties of water is important as the students will be able to correlate the presence of life on earth due to the unique properties exhibited by this universal solvent. A physiological system is dependent on pH as it affects metabolic as well as physiological functions of organisms, including humans. Further, most biochemical reactions that are essential for life take place only in a narrow pH range and so the need to understand buffers to ensure that the pH is maintained constant, despite changes in the environment.

The cells comprise of many biomolecules and their reactivity is associated with the functional groups. An insight into organic chemistry is mandatory to conceptualize the biochemical reactions. The syllabus caters to this need of the learner and provides the basic characteristics and features of important functional groups.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Comprehend the unique structure of water and appreciate the exclusive properties of water.

CO2: Correlate the physical properties of water and its biological applications.

CO3: Conceptualize the theory of solutions and its preparation in terms of normal, molar and molal.

CO4: Gain insight into the concept of acids and bases and apprehend their ionization.

CO5: Perceive the basis of organic chemistry and its nomenclature.

CO6: Conceptualize the basis of chemical mechanisms.

CO7: Apprehend the structure and properties of functional groups.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Water and Acids- Bases	10
2	Buffers and Introduction to organic chemistry- I	10
3	Introduction to organic chemistry-II	10
	Total	**30**
PRACTICALS		**30**

Module	Bio-organic Chemistry- I	No. of Hours/Credits 30/ 2
1	**Water and Acids- Bases**	**10**
	Concept of colligative properties Water: Structure and its role as universal solvent Unusual properties of water- cohesion, adhesion, surface tension, specific heat, latent heat, dielectric constant, anomalous behavior of water Applications/ significance of above concepts Concept of potable and deionized water Interactive forces applicable in aqueous systems (Ionic/ covalent/ Van der Waals/ hydrogen bonding/ hydrophobic /disulphide linkages) ***Solutions*** Concepts of percent, ppm, mole, molar, normal, molal ***Ionization of water, weak acids, and weak bases*** pH: pH scale, Introduction to pH meter Derivations: Ionic product of water, Henderson– Hasselbalch equation Weak acids and bases and their dissociation constants K_a & K_b., Titration curves of acids and bases ***Numerical problems based on the above concepts***	5 2 3
2	**Buffers and Introduction to organic chemistry- I**	**10**
	Buffers Definition of buffers and buffering capacity Working of buffers -acetate buffer Introduction to Physiological buffers and their significance Phosphate buffer, Protein buffer, Hemoglobin, Carbonate- bicarbonate buffer ***Classification of organic compounds*** Unique characteristics, Classification as per IUPAC , nomenclature of organic compounds (including bi- functional) and biomolecules ***Reaction mechanisms:*** Concept of inductive effect, electromeric effect, resonance and hyperconjugation. Classification of organic reactions (substitution, addition, elimination and rearrangement), with one examples for each. Concepts of the following – carbanions, carbocations, free radicals, carbenes, nucleophiles and electophiles (Formation and Stability).	4 3 3

3	Introduction to organic chemistry- II	10
	Structure and properties of functional groups ***Arenes:*** Structure of benzene – by Resonance and molecular orbital theories. Aromaticity.	2
	Alcohols: Classification, monohydric alcohols-distinguishing reactions for primary, secondary and tertiary alcohols. Eg) Glycol and Glycerol	2
	Phenols: Acidity of phenols	
	Hydroxy acids and dicarboxylic acids: Structure & properties of hydroxy acids*:* Lactic acid, citric acid and isocitric acid. Dicarboxylic acid: Maleic and fumaric acid. Ketoacids: Pyruvic, αketoglutaric, oxalo acetic acids.	3
	Amines: Classification, properties, functional amino group – Basicity of amines, acylation. Distinguishing reactions of primary, secondary and tertiary amines.	3

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. R. T. Morrison & R. N. Boyd, Organic Chemistry, 5th edition, Prentice Hall
2. Nelson, D. L. and Cox, M.M, Lehninger Principles of Biochemistry, 5th edition, Macmillan Education
3. E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen, Textbook of biochemistry, 4th edition, MacMillan, New York.
4. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S. Chand & Company Ltd.

Suggested Reading

1. Upadhyay and Upadhyay, Biophysical Chemistry- Principles and Techniques, Revised edition 2009, Himalaya Publishing House.
2. L. Finar, Organic Chemistry (Vol. I & II), 6th edition, Pearson Publication
3. Plummer, David T, Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill publishers
4. Freifelder, D, Physical Biochemistry, 8th edition, New Age International Publishers
5. Ahluwalia, V.K. & Aggarwal, R, Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Illustrated edition, University Press
6. Sawhney, S.K.and Singh, Randhir, Introductory Practical Biochemistry, 1st edition, Narosa Publishing House

Any other reference sources as recommended by the course instructor.

Program: B.Sc.(Hons.) Biochemistry			Semester: I	
Course: Chemistry-I			Course Code: USMABC104	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	--	2	25%	75%

Learning Objectives:

The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. Formation of a chemical bond is based upon the concept of hybridization and theory behind the valence bonding. The course provides an insight into structures and shapes of different molecules with understanding of sigma and pi bonds. The course also reviews the general principles of acid base theories, electrochemical cell and electromotive force. It also further discusses the concepts associated with of equilibrium which is a need for chemical reactions. Hence this course will further conceptualize the redox reaction and associated terminologies.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Understand the characteristics and demerits of different atomic models and connected principles.

CO2: Comprehend the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces.

CO3: Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory.

CO4: Appreciate the basis of acid-base theory and concept, applications of hard and soft acids and bases.

CO5: Apply the concept of redox reaction, electrochemical cell and electromotive force.

CO6: Explain the idea of law of mass action and equilibrium constant.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Atomic structure and Acid Base theories	10
2	Chemical Bonding and Electrochemistry-I	10
3	Electrochemistry-II and Chemical Equilibria	10
	Total	**30**
PRACTICALS		**30**

Module	Chemistry-I	No. of Hours/Credits 30/2
1	**Atomic structure and Acid Base theories**	**10**
	Atomic models: characteristics and their Limitations Daltons Bohr Thomson Rutherford ***Principles of atomic structure*** Pauling's Exclusion principle Hund's Rule Aufbau's principle ***Acid-Base theory*** Arrhenius, Lowry- Bronsted, Lewis, Solvent – Solute concept of acids and bases Concept of Hard and Soft acids and bases. (HSAB) Applications of HSAB Applications of acid base chemistry	4 2 4
2	**Chemical Bonding and Electrochemistry-I**	**10**
	Ionic Bond Formation of ionic bond Lattice energy Solvation energy ***Covalent Bond*** Lewis electron dot structures VSEPR Theory Concept of hybridization Formation of sigma and pi bond Shapes of molecules and ions- H_2O, NH_3, PCl_3, PCl_5, SF_6, I_3^-, ICl_4^-, and SO_4^{2-} ***Metallic bond*** Definition and Properties Concept of semiconductors and insulators ***Weak chemical forces*** Van der Waals forces Ion-dipole forces Dipole-dipole interactions Induced dipole interaction. ***Electrochemical cell*** Rules of oxidation/reduction of ions based on half-cell potentials. Chemical cells- Reversible and irreversible cells with Examples Electromotive force of a cell Concept and its measurement Applications of EMF	2 3 1 1 3

3	**Electrochemistry-II and Chemical Equilibria**	**10**
	Nernst equation	1
	Equilibrium	3
	Law of Mass action Equilibrium constant Definition Factors affecting equilibrium constants: Temperature, pressure and concentration. Le-Chatelier Principle	
	Redox Reactions	5
	Concept of oxidation, reduction and redox reactions Oxidation number Balancing redox reactions.	1
	Solubility product Concept and examples Common ion Effect- Concept and examples Numericals on the above concept	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. P.W. Atkins, T.L. Overton, J.P. Rourke, M.T. Weller, and F.A. Armstrong, Shriver and Atkins' Inorganic Chemistry, 5th edition, W. H. Freeman and Company
2. Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 10th edition, Oxford University Press

Suggested Reading

1. J.D Lee, Concise Inorganic Chemistry, 5th edition, Wiley India
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K., Inorganic Chemistry- Principles of Structure and Reactivity, 4th edition, Pearson Education
3. Douglas, B.E., McDaniel, D.H., Alexander, J.J., Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley & Sons
4. David Ball, Physical Chemistry, 2nd edition, Cengage India Private Limited
5. Miessler, Gary L., Fischer Paul J., Tarr, Donald A., Inorganic Chemistry, 5th edition, Pearson Education
6. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, 18th edition, R Chand & Co.
7. Garland C. W., Nibler, J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th edition, McGraw-Hill
8. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd edition, W.H. Freeman and Co.
9. Athawale V.D. and Mathur P, Experimental Physical Chemistry, 5th edition, New Age International

Any other reference sources as recommended by the course instructor

	Practical USMABCP134 includes Practicals of USMABC103 and USMABC104	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC103	
1.	Demonstration of working of a pH-meter.	
2.	Preparation of buffers- acetate and phosphate buffers	
3.	Numerical's on buffers	
4.	Qualitative tests for Functional groups through systematic qualitative analysis of the organic compounds: Urea, acetalinamide, aniline, nitrobenzene, chlorobenzene, alpha and beta naphthol, benzoic acid, salicylic acid, oxalic acid, succinic acid, cinnamic acid, resorcinol, ethyl alcohol, acetone, acetaldehyde, ethyl acetate, phosphate group, sulphanilic acid	
5.	Tutorial on identifying structures and nomenclature	
6.	Case study	
7.	Organic synthesis: Aspirin from salicylic acid, benzoic acid from benzaldehyde, p-bromo acetanilide from acetanilide and meta-dinitrobezene from nitrobenzene.	
8.	Application of concepts on course content of Practical I	
	Practicals USMABC104	
1.	Calibration and use of apparatus.	
2.	Preparation of standard solutions of titrants of different Molarity/Normality	
3.	To determine the strength of commercial sample of hydrochloric / acetic acid. (Standard solution of succinic acid to be prepared, NaOH solutions to be supplied.).	
4.	Acid-Base Titrations:	
5.	Titration of strong acid strong base	
6.	Titration of weak acid weak base	
7.	(ii) Estimation of sodium carbonate using standardized HCl.	
8.	Estimation of Fe(II) with K2Cr2O7 using internal indicator (diphenylamine) and discussion of external indicator	
9.	Determination of the number of electrons required in a chemical reaction between potassium oxalate and potassium permanganate titrimetrically.	
10.	To determine the rate constant for the saponification reaction between ethyl acetate and NaOH	
11	Qualitative estimations of inorganic components (Na+, K+, Ferrous, Ferric, Cl^-, NO_3^-, Group A) Pb2+, Cu2+, Fe^{+2}, Fe3+, Ni2+, Zn2+, Ca2+, Mg2+, NH41+ Group B) NH4, I+, K1+, AI3+, Cd2+, Mn2+, Ba2+, Co2+, Mg2+; Group C) K1+, Fe3+, Sr2+, Cu2+, Cr3+, Ni2+, AI3+, Mg2- Anions: CO32-, SO42-, NO31-, Cl1-, Br1-, I1-)	

Program: B.Sc. (Hons.) Biochemistry	**Semester: I**
Course: Microbiology-I	**Course Code:USMABC105**

Teaching Scheme			Evaluation Scheme	
Lecture (Lectures per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE)**	**End Semester Examinations (ESE)**
02	-	2	25%	75%

Learning Objectives: Microorganisms are the simplest of all living creatures and play a key role in understanding origin of life, and thus there is need to study Microbiology. It is one of the important disciplines of the biological sciences which has changed the world by discovery of microorganisms. These are present in every segment of environment and have varied nature, characteristics and applications. There are different branches of microbiology which includes bacteriology, mycology, phycology, parasitology, virology etc. It is one of the most vital discipline having applications in every field such as food science, various industries, medical, agriculture, pharmaceutical, veterinary science and many more. Microbes are not always harmful or pathogenic but can be useful too, and the learner will be acquainted with the same. Students will be able to understand the classification, characteristics, structure of the microbes as well as learn about the various staining techniques which help in identification of microorganisms as well as enhance the visualization of cells and cellular components. Microbes also help in recycling various elements in terrestrial and aquatic ecosystems of biosphere and carry out decomposition of dead animals and plants which contributes to mineral restoration. Hence, introduction to microbiology will help students understand various aspects of the subject and its applicability.

Course Outcomes:

After completion of the course, students would be able to:

CO1: Get introduced to the subject of microbiology and its use in day-to-day life.

CO2: Appreciate the contribution of various scientists to the field of microbiology and its development.

CO3: Get an insight into the diversity of the microbial world.

CO4: Gain knowledge about the microbial taxonomy and classification of microorganisms.

CO5: Study microbial morphology and other cellular details by performing various staining techniques.

CO6: Acquire knowledge of Environmental microbiology.

CO7: Learn about water quality standards and microbiological analysis of water.

CO8: Get acquainted with the microbes of air, water and soil and biogeochemical cycles.

Outline of Syllabus: (per session plan)

Module	Description	No of hours
1	Introduction to Microbiology	10
2	Staining techniques, Reproduction and Growth	10
3	Environmental Microbiology	10
	Total	**30**
PRACTICALS		**30**

Module	Microbiology- I	No. of Hours/Credits 30/ 2
1	**Introduction to Microbiology**	**10**
	History and Development of Microbiology History and development of microbiology as a discipline Contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming (DIY- assignment) ***Classification of bacteria based on:*** Morphology- shape Nutrition (Autotrophs, heterotrophs, phototrophs, chemotrophs) Physical conditions (aerobic, anaerobic, facultative) Extreme environment (Thermophiles, Psychrophiles, Halophiles, Magnetotactic, Radiation resistant organisms: examples and significance) ***Microbial cell organization and Subcellular structures*** Generalized bacterial cell Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, Capsule, Mesosomes, Ribosomes, Flagella, pili, endospore, exospores and cysts, nucleoid Locomotion-flagellar, spirochaetal, gliding	1 4 5
2	**Staining techniques, Reproduction and growth**	**10**
	Staining techniques Principles of staining Monochrome, Negative, differential- Gram staining and acid fast Special staining of bacteria- Spore, Capsule, Lipid ***Bacterial growth media*** Types of media (Selective, enrichment, Differential, Assay, maintenance, solid and semisolid) Natural & synthetic ***Microbial growth*** Cell division-binary fission Normal growth curve- growth phases, generation time Quantitative measurement of growth-concept of cell count The plate count, Membrane filter count, turbidity, nitrogen content, dry weight of cells Physical factors influencing growth- temperature. pH, osmotic pressure, salt concentration	2 4 4

3	**Environmental Microbiology**	**10**
	Microflora of Air Important airborne microorganisms Acrosols, nature of aerosols-droplets and droplet nuclei, Airborne diseases and causative agents (Tuberculosis/Influenza/ measles/ mumps)	3
	Water Microflora Fresh water microorganisms (springs, streams, lake, river, marshes) Indicator microorganisms of faecal pollution and their detection in water	3
	BIS Water quality standards- Overview Waterborne diseases and causative agents- Dysentery, Cholera, gastroenteritis, Rota virus	4
	Soil Microflora Soil composition Types of microorganisms in soil and their activities Role of Soil microorganisms in biogeochemical cycles	

To develop scientific temper and interest by exposure through industrial visits and study/ educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Pelczar Michael J.; Chan Jr., E.C.S., Krieg, Noel R, Microbiology, 5th edition, TMH
2. Powar and Daginawala, General Microbiology, Vol I and II, 1st edition, Himalaya Publishing House

Suggested Reading

1. Wiley JM, Sherwood LM and Woolverton CJ, Prescott's Microbiology, 9th edition, McGraw Hill International.
2. Atlas RM, Principles of Microbiology, 2nd edition, WM.T. Brown Publishers
3. Madigan MT, Martinko JM, Dunlap PV and Clark DP, Brock Biology of Microorganisms, 14th edition, Pearson International

Any other reference resources as instructed by the course instructor.

Program: B.Sc.(Honours) Biochemistry			Semester: I	
Course: Basic Mathematical Concepts			Course Code:USMABC106	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2		2	25%	75%

Learning Objectives: The mathematics is introduced to learners with the aim to encourage and enable students to recognize that mathematics permeates the world around us. It is an integral part of life to have knowledge and understanding of mathematics for investigating biological problems. Algebric manipulation, calculus of linear and nonlinear equations and mathematical modelling develop learner's skills to analyze biological processes. As collaboration among biochemists and mathematician can result in richer, more sophisticated understanding of complex biological system, presenting basic mathematics at undergraduate level would shift the paradigm of both established sciences.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Recall sets, relation and understand different functions.

CO2: Acquire the knowledge about trigonometric, inverse trignometric functions and their properties.

CO3: Solve quadratic equations.

CO4: Understand the geometric representation of complex numbers.

CO5: Use the differentiation rules to compute derivatives and express differential equations.

CO6: Apply differential equations to real life problems in biochemistry.

CO7: Study integration and apply to evaluate integrands express in differential equations.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Algebra	10
2	Calculus	10
3	Differential Equations	10
	Total	**30**
PRACTICALS		**30**

Module	Basic Mathematical Concepts	No. of Hours/Credits 30/2
1	**Algebra**	**10**
	Sets	1
	Relations and Functions	2
	Trigonometric and Inverse Trigonometric Functions	2
	Complex Numbers	1
	Quadratic Equations Matrices and	2
	Determinants	2
2	**Calculus**	**10**
	Limits and Derivatives Continuity and	1
	Differentiability Applications of	2
	Derivatives Definite Integrals	1
	Indefinite Integrals Applications of	2
	the Integrals	2
		2
3	**Differential Equations**	**10**
	First Order Differential Equations Homogeneous	2
	Differential Equations	2
	Non Homogeneous Differential Equations Bernoulli	2
	Differential Equations Applications of Differential	2
	Equations	2

RECOMMENDED READING:

Essential Reading:

1. Courant and John, A Introduction to Calculus and Analysis, 2015, Springer
2. Ajit kumar and Kumaresan, A Basic Course in Real Analysis, 2014, CRC Press

Suggested Reading

1. Ghorpade Limaye, A Course in Calculus and Real Analysis, 2000, Springer International Ltd
2. Binmore, Mathematical Analysis, 1982, Cambridge University Press
3. G. B. Thomas, Calculus, 12th edition, 2009, Springer International Ltd

Any other reference sources as recommended by the course instructor.

	Practical USMABCP156 includes Practicals of USMABC105 and USMABC106	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC105	
1.	To study the principle and applications of important instruments (biological safety cabinets, Laminar flow cabinet, autoclave, incubator, hot air oven, light microscope,) used in the microbiology laboratory	
2.	Preparation of Culture media for microorganisms: a) Nutrient broth b) Nutrient agar	
3.	Methods of isolation of pure culture:	
4.	Streak plate Method	
5.	Spread plate Method	
6.	Pour plate Method	
7.	Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air	
8.	Total viable count of soil microflora (Identification of morphology of colonies and cell count)	
9.	Monochrome staining of bacterial smear.	
10.	Negative staining	
11.	Staining techniques:	
12.	Gram staining	
13.	Spore staining	
14.	lipid staining	
15.	Capsule staining	
16.	Isolation of bacteria, Actinomycetes and fungi from soil	
17.	Demonstration of anaerobiosis.	
	Practicals USMABC106	
1.	Tutorials on the theory concepts	
2.	Case studies with respect to main content of the paper	

Program: B.Sc. (Hons.) Biochemistry			Semester: I	
Course: Environmental Studies			Course Code: USMABC107	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objectives: The need of the hour is to create environmental awareness and sensitization among commerce students. It requires the need to impart knowledge of various aspects of the natural environment. It requires to highlight functional and spatial links between environment, economy and society. Students need to be sensitized about the impact of environmental damages due to resources' utilization and practices to reduce the harmful impact on the environment. This will facilitate the process of linking Sustainable Development Goals with the environmental objectives of the businesses. Emphasis has to be laid on importance of environment management in all commercial and economic activities along with an understanding the role of various stakeholders in environmental governance.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Develop a better understanding of relationship between environment and commerce.

CO2: Have awareness about the various environmental issues and their implications for environment and society and commerce.

CO3: Adopt environment friendly habits and responsible behavior in use of resources like water, electricity by individuals, industries & commerce.

CO4: Create realization of the extent of the impact of over-exploitation and degradation of resources and practices to ensure conservation of resources.

CO5: Understand the need to adopt sustainable business practices.

CO6: Conceptualize the importance of the environment management practices in all commercial and economic activities.

CO7: Develop better understanding of environmental laws and regulations that govern various commercial and economic activities.

CO8: Gain the right perception of the intensity of the problems of urbanization and role as a responsible occupant of a city.

CO9: Develop the right perceptive for environmentally significant features around them

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Introduction to Environmental Studies and Natural resources	10
2	Environmental Pollution – Environmental Policies and Practices	10
3	Human Communities and Environment	10
	Total	**30**

Module	Environmental Studies	No. of Hours/Credits 30/2
1	**Introduction to Environmental Studies and Ecosystems and natural resources**	**10**
	Multidisciplinary nature of environmental studies Scope and importance; components of environment – atmosphere, hydrosphere, lithosphere and biosphere. Heating of earth and circulation of air; air mass formation and precipitation. ***Ecosystem and biodiversity services*** Ecological, economic, social, ethical, aesthetic and Informational value. Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). ***Energy resources*** Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, ***Case studies/ Visit*** To an area to document environmental assets; river/forest/flora/fauna, etc. Use of energy resources	3 4 2 1
2	**Environmental Pollution – Environmental Policies and Practices**	**15**
	Environmental pollution Types, causes, effects and controls; Air, water, soil, chemical and noise pollution, Pollution case studies. ***Solid waste management*** Control measures of urban and industrial waste. ***Climate change*** Global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Carbon foot- print. ***Environment Laws*** Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention	2 1 2 4

	(CWC). ***Case studies/Visit*** to a local polluted site-Urban/Rural/Industrial/Agricultural	1
3	**Human Communities and Environment**	10
	Human population and growth Impact on environment, human health and welfares. ***Disaster management*** Floods, earthquakes, cyclones and landslides. Nuclear hazards and human health risks Resettlement and rehabilitation of project affected persons; case studies. Nature reserves, tribal population and rights, and human-wildlife conflicts in Indian context ***Environmental movements*** Chipko, Silent valley, Bishnois of Rajasthan. ***Environmental ethics*** Role of Indian and other religions and cultures in environmental conservation	1 5 2 2

To develop scientific temper and interest by exposure through industrial visits and study/ educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. A. K. De, Environmental Chemistry, 6th edition, New Age International
2. U. Satyanarayana, Biotechnology, 2nd edition, Books & Allied Ltd

Suggested Reading

1. Das, B.K., and Banerjee A, Biodiversity Conservation in India: Management Practices, Livelihood Concerns and Future Options, 2014, Concept Publishing Co. Pvt. Ltd. New Delhi
2. Boyle, G. (Ed.), Renewable Energy: Power for a Sustainable Future, 2004, Oxford University Press
3. Goel, S., Management of Resources for Sustainable Development, 2017, Orient Blackswan
4. Mani, N., Environment, climate change and disaster management, 2017, New Century
5. Banerjee, A., Contemporary urbanisation in India: Issues and Challenges, 2013, Concept Publishing Co. Pvt. Ltd. New Delhi
6. Botkin and Keller, Environmental Science, 8th edition, John Wiley & Sons Inc., Wiley India (P) Ltd., New Delhi.
7. Singh, S, Environmental Geography, 1991, Parvalika Publications
8. Rajagopalan, R., Environmental studies: From crisis to cure, 3rd edition, Oxford University Press

9. Ristinen, Robert A, Energy and the environment, 3rd edition, Wiley
10. Sahu, H.K., Sethy J. and Mishra R, Biodiversity Conservation, Research and Management, 2015, Himalaya Publishing House.
11. Santra, S.C., Environmental Science, 3rd edition, New Central Book Agency Pvt. Ltd, Kolkata
12. Sashi, V. and Poornima S., Bioresources – Conservation Strategies, 2014, Narosa Publishing House Pvt. Ltd. New Delhi
13. Singh, H.H., Geography and Environment: Issues and Challenges, 2016, Concept Publishing Co. Pvt. Ltd. New Delhi.
14. Vinodan, C., Energy Security Choices for India, 2015, New century Publications
15. National Portal of India
16. https://www.india.gov.in/act-and-rules-related-environment-protection
17. National Disaster Management Authority of India https://ndma.gov.in/en/
18. The legal and regulatory framework for environmental protection in India
19. National Thermal Power Corporation https://www.ntpc.co.in/
20. United States Nuclear Regulatory Commission https://www.nrc.gov/

Any other reference sources as recommended by the course instructor.

Program: B.Sc. (Hons) Biochemistry			Semester: II	
Course: Biomolecules-II			Course Code: USMABC201	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objectives: Continuing with the importance of biomolecules, in Semester II, we begin with the detailed understanding of the basic concepts about amino acids as they are the building blocks of the most important biomolecules in the physiological system-proteins. A biochemist is expected to have a detailed understanding about the structure and function of the standard amino acids, their chemical and physical properties. Amino acids are known ampholytes and this property is responsible for the characteristic ionization behavior of certain amino acids in aqueous solutions.

The learners are briefed about the physiologically active peptides and proteins. Elaborate understanding of the structure and functions of proteins, importance in the physiological system is imparted to the learner. Emphasis is laid on the conceptualization of the structure of proteins, as the structure determines properties of proteins. The concept of denaturation and renaturation of proteins and its physiological significance is also imbibed. The nucleic acids are the blueprint of life and for a biochemist an insight into these polymers is a must. A study of the two types of nucleic acids viz. DNA and RNA including structure of nucleotides, the characteristic features of DNA and RNA molecules, their polymorphism, and various properties of the same would be catered to in the syllabus.

Course Outcomes: After completion of this course, a learner would be able to:

CO1: Perceive the structure of basic amino acids and comprehend the chemical nature as well as reactions of amino acids

CO2: Justify the physical properties to the structure of amino acids gain insight into the ionization and titration curve of amino acids

CO3: Understand the basic structure of a peptides and proteins and develop understanding into the physical and chemical properties of proteins

CO4: Recognize the physiological role of proteins and amino acids in the biological systems.

CO5: Apprehend the organization levels of a protein and appreciate methods for protein estimation.

CO6: Understand the basic structure of nucleic acids

CO7: Develop understanding regarding the physical and chemical properties of nucleic acids

CO8: Grasp knowledge about the chemical reactions of nucleic acids

CO9: Recognize the physiological role of nucleic acids in the biological systems.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Amino acids	10
2	Proteins	10
3	Nucleic acids	10
	Total	**30**
PRACTICALS		**30**

Module	Biomolecules-II	No. of Hours/Credits 30/2
1	**Amino acids**	**10**
	Amino acids Detailed classification based on polarity Nutritional classification Structure- D & L forms of all 20 amino acids Amino acids as ampholytes Zwitterion structure of amino acids and Isoelectric pH	3
	Properties Physical Solubility, UV absorption, concept of Dalton Chemical properties Chemical reactions of amino acids with Ninhydrin and sequencing reactions using Sanger's reagent, Edman's reagent and Dansyl chloride Principles of Colour reactions- Millon's, Sakaguchi, Xanthoproteic, Hopkin Cole	4
	Titration curve and Ionization of Glycine pKa , and pI values of these amino acids Relation between pI, pK_{a_1} and pK_{a_2} for a typical neutral amino acid	3
2	**Proteins**	**10**
	Peptides Definition Formation and characterization of the peptide bond	1
	Functions of Biologically important amines and peptides Histamine and nonapeptides.	1
	Biochemical functions of proteins Classification: Based on chemical nature and solubility, function, and nutrition - with examples. Methods of protein estimation (Biuret and Folin-Lowry)- Principle only	2
	Overview of structural organization of proteins: Primary structure- N terminal and C Terminal of proteins Secondary structure-Types α-helix– example and characteristic features β-pleated structure– example and characteristic features Triple helix – Collagen and its characteristic features Tertiary structure –Myoglobin Quaternary structure- Hemoglobin	4
	Denaturation Denaturing agents- temperature, pH Chemical agents- organic solvents, Urea, β-mercaptoethanol, detergents, heavy metals ***Renaturation***	2
3	**Nucleic acids**	**10**

	Concept and types Structure Generalized structural plan of nucleic acids Structure of purine and pyrimidine bases	2
	Nomenclature used in writing structure of nucleic acids, Phosphodiester bond and 3' and 5' end of nucleic acid Formation of polynucleotide strand with its shorthand representation and concept of 5'-3' reading frame Complementary base pairings Composition of DNA and RNA, Nucleosides, and nucleotides-Definition, general structure and functions ***DNA*** Features of DNA double helix Major and minor groove Physical evidence of DNA helical structure-Details of Rosalind Franklin's experiment Chargaff's rule and its applicability to the physiological system Watson-Crick model-tetranucleotide hypothesis Detailed account of different forms of DNA structure (A, B & Z DNA) ***RNA*** Three major types of RNA Clover leaf model of tRNA m-RNA and rRNA- general account ***Properties- Physical & Chemical*** Detailed understanding of Central dogma of molecular biology: concept of reverse transcriptase Physical properties UV absorbance of DNA & RNA Melting temperature Factors affecting melting temperature Hypo and hyperchromic effect Denaturation and annealing of DNA Chemical reactions Hydrolysis (acid & alkali) Reactions with DPA and Orcinol	3 2 3

RECOMMENDED READING:

Essential Reading:

1. Nelson, D. L. and Cox, M.M Lehninger Principles of Biochemistry, 5th edition, Macmillan Education
2. Rafi MD., Textbook of Biochemistry for Undergraduates, 4th edition, Universities Press
3. U. Satyanarayanan, Biochemistry, 3rd edition, Books & allied (P) Ltd., Kolkata

Suggested Reading

1. Peter Raven, George Johnson and Kenneth Mason and Jonathan Losos and Tod Dunca, Biochemistry, 12th edition, Mc Graw Hill
2. Dr. A.C. Deb, Fundamentals of Biochemistry, 8th edition, New central book agency (P) Ltd.
3. Jeremy M. Berg, John L Tymoczko, Lubert Stryer, Biochemistry, 5th edition, Freeman publishers
4. Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P. Anthony Weil, Harpers illustrated biochemistry, 31st edition, Mc Graw Hill, Lange
5. Cooper, G.M. and Hausman, R.E., The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA
6. Plummer, David T, Introduction to Practical Biochemistry, 3rd edition, Tata Mc. Graw and Hill publishers
7. Sawhney, S.K. and Singh, Randhir, Introductory Practical Biochemistry, 1st edition Narosa Publishing House
8. J L Jain, Sunjay Jai, Nitin Jain, Fundamentals of Biochemistry, 6th edition, S. Chand & Company Ltd.

Any other reference sources as recommended by the course instructor.

Program: B.Sc. (Hons.)-Biochemistry			Semester : II	
Course: Cell Biology-II			Course Code: USMABC202	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objective:

All living beings are made up of fundamental units called cell. The paper highlights the different phases in the life of a cell and the events that take place during the same. The learner is made aware about the different types of cell divisions and the difference between them. It also dwells briefly into the regulation of the cell cycle and the concept of cell death.

The insight into physiology, anatomy, genetics, molecular biology, microbiology and all related field of biology was possible due to advancements in techniques to study biological systems. An insight into various approaches towards biochemical studies using biochemical techniques would be provided to the learner, including the role and significance of model organisms used for the same.

Course Outcomes:

A learner should be able to:

CO1: Appreciate the ultrastructure of nucleus
CO2: Elucidate the cytoskeletal components
CO3: Grasp the different phases of cell cycle
CO4: Understand mitosis and meiosis, their significance and the differences thereof
CO5: Comprehend the different approaches in biochemical studies
CO6: Appreciate the biochemical techniques and their applications
CO7: Gain knowledge about the various model organisms used for study

Outline of Syllabus: (per session plan)

Module	Description	No of hours
1	Cell cycle and cell division	10
2	Components of cytoskeleton and Biochemical techniques-I	10
3	Biochemical techniques-II	10
	Total	**30**
PRACTICALS		**30**

Module	Cell Biology-II	No. of Hours/Credits 30/2
1	**Cell cycle and cell division**	**10**
	Structure and function of the nucleus, nuclear envelope, nuclear pores, nuclear matrix and nucleolus	1
	Phases of cell cycle – G_1, S, G_2, M, cytokinesis	1
	Cell division	4
	Mitosis:	
	Interphase, Prophase, Prometaphase, Metaphase, Anaphase, Telophase, Significance of Mitosis	
	Meiosis:	
	Meiosis-I – Prophase-I (Proleptotene, Leptotene, Zygotene (including synapsis, synaptonemal complex), Pachytene (including crossing over and chiasmata), Diplotene, Diakinesis) Prometaphase-I Metaphase-I, Anaphase-I, Telophase I	
	Meiosis-II – Prophase-II, Metaphase-II, Anaphase-II, Telophase-II, Significance of Meiosis	
	Comparison of Mitosis and Meiosis	1
	Regulation of cell cycle - Restriction point, and checkpoints	2
	Apoptosis and necrosis - brief outline	1
2	**Components of cytoskeleton and Biochemical techniques-I**	**10**
	Cytoskeleton-Structure, types and functions:	2
	Microtubules (axonemal and cytoplasmic)	
	Microfilaments (actin, myosin filaments)	
	Intermediate filaments (Type I to IV)	
	Concept of anchoring junctions, tight junctions and communication junctions – plasmodesmata, gap junctions(cadherins, lectins,)	
	Approaches for Biochemical studies – in vitro, in vivo, ex vivo, ex situ, in situ	1
	Levels of biochemical investigations	1
	Whole organisms, Organ systems, Tissues, Cells, Organelles, Molecules and atoms	2
	Whole animal studies–perfusion studies ,histology and autoradiography: advantages and disadvantages	2
	Whole plant studies – plant growth chambers, hydroponics, advantages and disadvantages	2
	Cell counting and sizing techniques: counting chamber; Pulse height analyser, electronic particle counter, coulter counter	

3	**Biochemical techniques-II**	**10**
	Model organisms for biochemical investigation (e.g. *E.coli*, yeast, *Dictyostelium*, *C. elegans*, *Drosophila*, *Arabidopsis*)	3
	Model systems to study membranes: Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems.	2
	Techniques for Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme, organic solvent), temperature	2
	Separation techniques- concept of - dialysis, electrodialysis, ultrafiltration and analytical and preparative separations	1
	Cell Fractionation – Preparation of tissue homogenate, choice of media, organelle isolation; Ammonium sulphate precipitation and applications	2

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Peter Raven and George Johnson and Kenneth Mason and Jonathan Losos and Tod Duncan, Biology, 12th edition, Tata McGraw-Hill publication
2. W. K. Purves, D. Sadava, G. H. Orians and H. C. Heller, Life: the science of biology, 7th edition, W. H. Freeman & Co
3. U Satyanarayan, Biochemistry, 5th edition, Elsiever

Suggested Reading

1. J David Rawn, Biochemistry, 2nd edition, Nell Patterson Publishers
2. Williams. B and Wilson K, A Biologists Guide to Principles and Techniques of Practical Biochemistry, 2nd edition, Edward Arnold publisher
3. Upadhyay; Upadhyay, Biophysical Chemistry Principle and Techniques, 2nd edition, Nath, Himalaya Publishing House
4. Keith Wilson & John Walker, Practical Biochemistry principle and technique, 5th edition, Cambridge University
5. P S Verma, Cell Biology, Genetics, Molecular Biology 2nd edition, S. Chand and Company

Any other reference sources as recommended by the course instructor.

	Practical USMABCP212 includes Practicals of USMABC201 and USMABC202	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC201	
1.	Identification of nucleic acids: a) Orcinol test b) DPA test	
2.	Isolation of DNA from onion	
3.	Color reactions of amino acids	
4.	Qualitative analysis and identification of proteins: a) Peptone b) Albumin c) Gelatin d) Casein	
5.	Calculation of pI of amino acids of neutral amino acids	
6.	Isoelectric precipitation of casein.	
7.	Protein denaturation using physical and chemical agents.	
8.	Demonstration of titration curve of glycine	
	Practicals USMABC202	
1.	Study of mitosis in onion root tip	
2.	Permanent slides of Mitosis and meiosis- comparative overview	
3.	Staining of proteins by Methylene blue	
4.	Staining of epithelial cells by methylene blue	
5.	Staining of Barr body by Giemsa stain/methylene blue	
6.	Cytochemical staining of polysaccharides by PAS	
7.	Cytochemical staining of RNA by Methyl Green	
8.	Dialysis using artificial membrane	
9.	Cell count using haemocytometer	
10.	Isolation of DNA from onion	
11.	Demonstration of ammonium sulphate precipitation using chart	
	Industrial visit	

Program: B.Sc. (Hons.) Biochemistry			Semester: II	
Course: Bio-organic Chemistry-II			Course Code: USMABC203	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objectives:

Science is a continuing human effort to categorize knowledge for describing and understanding nature. For the sake of convenience science is sub-divided into various disciplines. One such discipline is stereochemistry. Stereochemistry spans the entire spectrum of organic, inorganic, biological, physical chemistry and includes methods for determining and describing these relationships; the effect on the physical or biological properties these relationships impart upon the molecules in question, and the manner in which these relationships influence the reactivity of the molecules in question.

The curriculum of biochemistry for the first year aims to create an understanding of viability of a cell in a tissue, organ, organ system and thus an organism. The study of colligative properties like viscosity, surface tension, colloidal nature, transport through diffusion as well as osmosis along with absorption and adsorption is the foundation to understand biochemistry, and applications of the same are multiple in biological systems.

Course Outcomes:

After completion of this course, a learner would be able to:

CO1: Correlate and describe the stereochemical properties of organic compounds and reactions.

CO2: Acquire knowledge about chirality, enantiomerism, diastereomerism, their relative and absolute configurations

CO3: Understand stereochemistry of important biochemical compounds and learn about the various stereo chemical descriptors (cis-trans, E/Z, D/L, d/l, erythro/threo, R/S and syn/anti) given to organic molecules

CO4: Categorize the types of diffusion and understand the significance of gaseous exchange

CO5: Comprehend the underlying principles of the osmosis and correlate osmosis and diffusion as being dependent on one another

CO6: Account for the concepts of adsorption and absorption and appreciate the phenomenon of surface tension and viscosity

CO7: Interpret the dependence of factors governing surface tension and colloidal state of matter

CO8: Appreciate the applications of these physiochemical principles in biological systems.

Outline of Syllabus: (per session plan)

Unit	Description	No of Hours
1	Stereochemistry-I	10
2	Physicochemical Properties-I	10
3	Stereochemistry and Physicochemical Properties-II	10
	Total	**30**
PRACTICALS		**30**

Module	Bio-organic Chemistry-II	No. of Hours/Credits 30/2
1	**Stereochemistry-I**	**10**
	Isomerism: Types of isomerism Structural isomerism (chain, position and functional) and Stereoisomerism	1
	Stereochemistry and stereoisomerism: Optical activity of chiral compounds Chiral carbon atom-symmetry and dissymmetry, chirality Specific rotation, measurement of specific rotation by polarimeter, racemisation (general principle) Resolution of Racemic mixtures Relative and absolute configuration Nomenclature of enantiomers: cis-trans, E/Z, D/L, d/l, erythro/threo, R/S and syn/anti	5
	Configuration and conformation: Differences between the two Representation of configuration by "flying wedge formula" Projection by Fischer, Newman and Sawhorse The interconversion of the formulae Diastereomerism (Geometrical isomerism) Molecules with two or more chiral-centres, Meso structures	4
2	**Physicochemical properties-I**	**10**
	Adsorption and absorption: Detailed comparative account Applications	2
	Diffusion Simple and facilitated diffusion with examples, Diffusion of gases (CO_2 and O_2) Fick's law (NO derivation) Definition of diffusion coefficient & factors affecting diffusion	3
	Osmosis Mechanism of osmosis Osmolarity and tonicity with physiological examples (RBC, aquatic life, use of preservatives and herbicides) Comparative account of osmotic and oncotic pressure. Vant Hoff's law of osmotic pressure (law & mathematical expression-no derivation) Numerical based on the above concept Role of diffusion and osmosis in physiology- e.g. Renal dialysis	3
	Viscosity	2

	Concept Factors affecting viscosity Principles of measurements Application to physiology	
Unit 3	**Stereochemistry and Physicochemical Properties-II**	**10**
	Conformation analysis of alkanes (ethane, propane and n-butane): Relative stability with energy diagrams. ***Conformation of sugars, monosaccharides, disaccharides:*** Mutarotation, conditions for optical isomerism ex: glyceraldehyde, lactic acid, tartaric acid ***Surface tension*** Concept Factors affecting surface tension Role of bile in digestion ***Colloids*** Concept of colloid Solution and suspension Classification based on dispersion and dispersed phase, molecular size Factors affecting colloidal state (surface forces, surface area, electrical charge) Donnan membrane equilibrium Application to physiology	2 2 2 4

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. R. T. Morrison & R. N. Boyd, Organic Chemistry, 5th edition, Prentice Hall
2. Upadhyay and Upadhyay, Biophysical Chemistry- Principles and Technique, 2nd edition Himalaya Publishing House
3. E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen, Textbook of biochemistry, 4th edition, MacMillan, New York
4. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition,S. Chand & Co Ltd.

Suggested Reading:

1. Nelson, D. L. and Cox, M.M, Lehninger Principles of Biochemistry, 5th edition, Macmillan Education
2. L. Finar, Organic Chemistry (Vol. I & II), 6th edition, Pearson Publication
3. Eliel and Wilen, Stereochemistry of Organic Compounds, Wiley Publications
4. Kalsi, P. S, Stereochemistry Conformation and Mechanism, 8th edition, New Age International Publishers
5. Ahluwalia, V.K. & Aggarwal, R, Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Illustrated edition, University Press

Any other reference sources as recommended by the course instructor.

Program: B.Sc. (Hons.) Biochemistry			Semester : II	
Course: Chemistry-II			Course Code: USMABC204	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objective:

Energy is key to life. It is associated with all the biochemical events occurring inside a living being, thus making thermodynamics crucial for a biochemist to understand. This paper helps the learner comprehend energy with respect to a biochemical system, appreciate its significance and understand the laws that govern them.

While thermodynamics deals with direction of a reaction, chemical kinetics is concerned with understanding the rates of chemical reactions. It dwells into understanding of different orders of reactions, its measurement and factors that affect the same.

Titrimetry is another valuable technique that is often employed for determination and analysis of wide variety of biomolecules. The paper familiarizes the learner with the common aspects of titrimetry and the concepts, principles and applications associated with the same.

Course Outcomes:

A learner should be able to:

- **CO1:** Comprehend the concept of State and Path functions, extensive and intensive properties
- **CO2:** Understand the laws of thermodynamics.
- **CO3:** Gain insight into laws of thermochemistry.
- **CO4:** Appreciate the significance, applications, principle, working, advantages and limitations of different types of titrimetric analysis.
- **CO5:** Derive and manifest the significance of equilibrium constant.
- **CO6:** Deduce order for reaction and its mechanism.
- **CO7:** Apply the learned concepts in thermodynamics, thermochemistry and chemical kinetics.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Thermodynamics	10
2	Thermochemistry and Titrimetry	10
3	Chemical kinetics	10
	Total	**30**
PRACTICALS		**30**

Module	Chemistry- II	No. of Hours/Credits 30/2
1	**Thermodynamics**	**10**
	Thermodynamic terms: System, Surrounding, Boundaries, Sign Conventions, State Functions Isolated, Closed and open systems, ***Laws of Thermodynamics*** Zeroth law- Statement, Internal Energy and Enthalpy, Significance, examples First law of Thermodynamics: Concept of heat, work, internal energy, and statement of first law; enthalpy, entropy, relation between heat capacities; Isothermal and adiabatic conditions; Statement of law Second Law: need for a Second law, spontaneity and physical significance of free energy; equations statement of the second law of thermodynamics Calculation of entropy change for reversible and irreversible processes (for ideal gases) Gibbs–Helmholtz equation Third Law: Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy Thermodynamic derivation of equilibrium constant ***Numericals based on above concept***	1 2 2 2 2 1
2	**Thermochemistry and Titrimetry**	**10**
	Thermochemistry Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data Effect of temperature (Kirchhoff's equations) on enthalpy of reactions Numericals based on above concept ***Titrimetric Analysis***	5 5
	Concepts – Titration ,Titrant , titrand, End point, Equivalence point, Titration Error , Indicator with types and examples of each Primary and Secondary standard - characteristics and examples Types of Titration: Acid–Base, Redox, Precipitation, Complexometric,	

	Volhard's titration Determination of End point by using i. Indicators causing colour change ii. Change in potential, (by potentiometry) iii.Change in conductance (by conductometry) Redox titration - Iodometric and Iodimetric Precipitation Titration - Introduction, example and significance Principle of complexometric EDTA titration, metal ion indicators (examples), masking and demasking reactions Advantages & limitations of – indicators, potentiometric and conductometric titrations, Applications in Titrimetry – biochemical analysis – (two for each type of titration)	
3	**Chemical kinetics**	**10**
	Chemical Kinetics Rate of Reaction, rate constant, Measurement of Reaction Rates Order & Molecularity of reaction Integrated rate equation of zero, first, second, fractional and pseudounimolecular order reactions, (with equal initial concentration of reactants) Determination of order of reaction by a) Graphical Method b) Half Time method c) Ostwald's Isolation Method and d)Integration method Temperature dependence of rate constant: Arrhenius equation, energy of activation. Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. – explanation with suitable examples ***Numericals on above concepts***	8 2

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RECOMMENDED READING:

Essential Reading:

1. P. W. Atkins, & J. de Paula, Physical Chemistry, 10th edition, Oxford University Press
2. Laidler K.J., Chemical Kinetics, 3rd edition, Pearson Education India

Suggested Reading

1. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Shriver and Atkins' Inorganic Chemistry, 6th edition, Oxford University Press
2. B. K. Sharma, Instrumental methods of Chemical Analysis, 21st edition, Goel publish. house
3. Puri, Sharma and Pathania, Principle of Physical Chemistry, 48th edition, Vishal Publishing Co.
4. Ahluwalia, V.K. & Aggarwal, R., Comprehensive Practical Organic Chemistry, Illustrated edition, Universities Press

Any other reference sources as recommended by the course instructor.

	Practical USMABCP234 includes Practicals of USMABC203 and USMABC204	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC203	
1.	Concept and preparation of primary and secondary standards- Oxalic acid, Succinic acid, KHP, NaOH, HCl	
2.	Standardization of laboratory reagents: Oxalic acid vs NaOH vs HCl	
3.	Standardization of laboratory reagents: Succinic acid vs NaOH vs H_2SO_4	
4.	Study of the principle, instrumentation and applications of certain commonly used instruments in biochemical laboratory: (Thermometer, Polarimeter, Magnetic stirrer, Vortex mixer, Micropipette)	
5.	Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.	
6.	Determination of viscosity of the given liquid using Ostwald's viscometer	
7.	Effect of surfactants on surface tension of water.	
8.	Adsorption of oxalic acid on activated charcoal.	
9.	Determine the surface tension of aqueous solutions by (i) drop number (ii) drop weight method.	
10.	Estimation of sodium carbonate using standardized HCl.	
11.	Estimation of carbonate and hydroxide present together in a mixture	
	Practicals USMABC204	
1.	**Thermodynamics**	
i)	To determine the rate constant for the hydrolysis of ester using HCl as catalyst	
ii)	To determine enthalpy of dissolution of salt (like KNO_3	
2.	**Titrimetry**	
i)	Titration of Na_2CO_3 + $NaHCO_3$ mixture vs HCl using phenolphthalein and methyl orange indicators.	
ii)	Titration of HCl + CH_3COOH mixture vs NaOH using conductometric method	
3.	**Chemical Kinetics**	
i)	To study the kinetics of iodine-persulphate reaction	
ii)	To study the kinetics of saponification of ester	
iii)	Determination of E0 of Fe+3/Fe2+ couple in the hydrogen scale by potentiometric titration of ferrous ammonium sulfate solution using KMnO4, or, K2Cr2O7 as standard.	
iv)	Kinetics of Acid hydrolysis of methyl acetate with hydrochloric acid.	
v)	To study the kinetics of inversion of sucrose using polarimeter. (DEMO ONLY)	

Program: B.Sc. (Hons.) (Biochemistry)			Semester: II	
Course: Microbiology-II			Course Code: USMABC205	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE)**	**End Semester Examinations (ESE)**
2	-	2	25%	75%

Learning Objectives:

Microorganisms play significant role in everyday life and has lot of applications in various fields which underlines the need to study Microbiology. After gaining knowledge of fundamental concepts in microbiology, this paper aims at teaching some more concepts about this fascinating subject. Microbes are not always harmful or pathogenic but can be useful too, and the learner will be acquainted with the same. They will be able to get knowledge of various sterilization techniques and industrial fermentations. The microorganisms play key roles in nutrient cycling, biodegradation, climate change, cause and control of disease. The versatility of microorganisms can be utilized in many ways: making life-saving drugs, the manufacturing biofuels, cleaning up pollution, industrial production of many useful products. The microbial biotechnology has got many applications which are used in day to day life. It is aimed at using microbes for beneficial purposes. The learners will be made aware of some of these applications. The concepts of good laboratory practices and biosafety, have been introduced to make the learners aware about the importance of practices to be followed while working in the laboratory and also about the biological hazards and safety measures.

Course Outcomes:

After completion of the course, students would be able to:

CO1: Gain knowledge of sterilization, disinfection and antiseptics.
CO2: Understand the use of microbes for beneficial purposes.
CO3: Learn about epidemiology and public health awareness.
CO4: Get introduced to the antimicrobials and the tests carried out for it.
CO5: Realize the importance of microbiology in food and industry.
CO6: Learn about the basics of the fermentation technology and types of fermenters.
CO7: Comprehend the downstream processing and recovery of product.
CO8: Acquire knowledge of good laboratory practices and biosafety

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Control of Microorganisms	10
2	Industrial Fermentations	10
3	Epidemiology and GLP	10
	Total	**30**
PRACTICALS		**30**

Module	Microbiology- II	No. of Hours/Credits 30/2
1	**Control of Microorganisms**	**10**
	Sterilization, Disinfection and Sanitization	3
	Comparative account of cleaning, decontamination, disinfection, sterilization	
	Properties of an ideal disinfectant	
	Evaluation of disinfectant :bactericidal and bacteriostatic	
	Dilution susceptibility test and Disc diffusion test	
	Antiseptics and uses	
	Physical agents	2
	a) Heat – moist and dry, b) Radiation, c) Temperature,	
	d) Filtration, e) Osmotic pressure, f) Desiccation	
	Chemical agents	2
	a)Phenolics, b) Halogens, c) Heavy metals, d)	
	Sterilizing gases, e) Quaternary ammonium compounds,	
	f) Surface active agents/ detergents	
	Disinfection of surfaces, spillages, safety cabinets, rooms, skin	1
	Antimicrobial Agents	
	General Characteristics of antimicrobial drugs,	
	Factors affecting the effectiveness of antimicrobial agents	2
	Industrial Sterilization	
	Principles of Sterilization	
	Sterilization of equipments	
	Sterilization of production media	
	Sterilization of air	
2	**Industrial Fermentations**	**10**
	Primary (Crowded plate technique, Auxanography, Enrichment culture technique, Use of indicator dye) secondary screening,	3
	Types of fermentations (Solid state, semi-solid, submerged)	
	Inoculation media,	2
	Production media	
	Characteristics of an ideal fermentation medium	
	Raw Materials-Saccharine, Starchy, Nitrogenous, cellulosic,	
	Hydrocarbons and Vegetable oils	
	Preparation of inoculum	2
	Fermentors:	
	Design of a typical fermenter	
	Types (Batch, Continuous, fluidized bed, packed bed)	
	Operation of a fermentor; Inoculation, Aeration, Agitation	
	Applications of microbiology in industries	3
	Preparation of fermented food products-yoghurt, curd and cheese.	

	Preparation of alcoholic beverages-wine and beer. Vit B12 Penicillin Enzymes-Amylase/Protease	
Unit 3	**Epidemiology and Good Laboratory practices (GLP)**	**10**
	Epidemiology and public health awareness The Epidemiology of Infectious Diseases and their control Epidemiological terminology: Epidemiology, sporadic diseases, Index Case, Outbreak, endemic diseases, Hyper endemic Diseases, Epidemic Diseases, Pandemic Disease (with examples) ***Transmission of Disease*** Contact transmission, Vehicle Transmission and vectors ***Microbiology Good Laboratory practices (GLP) and biosafety*** Means of laboratory infection Potentially hazardous procedures Responsibility and Risk Assessment Restricted access Safety equipments	5 2 3

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Pelczar Michael J.; Chan Jr., E.C.S., Krieg, Noel R, Microbiology, 5th edition, TMH
2. A. H. Patel, Industrial microbiology, 1st edition, Macmillan India Ltd

Suggested Reading:

1. Wiley JM, Sherwood LM and Woolverton CJ., Prescott's Microbiology, 9th edition, McGraw Hill International
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP, Brock Biology of Microorganisms, 14th edition, Pearson International
3. L. E. Casida, Industrial microbiology, 2nd edition, New age international publishers.
4. A.J. Salle, Fundamental Principles of Bacteriology, 7th edition, Tata Mc Graw Hill Publishing Company
5. U. Satyanarayan, Biotechnology, 2nd edition, Allied Book Publishing

Any other reference resources as recommended by the course instructor.

Program: B.Sc. (Hons.) Biochemistry			Semester: II	
Course: Basic Computer Programming			Course Code: USMABC206	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objectives:
The objective of this paper is to introduce various concepts of programming to the students using Python.

Course Outcomes:
The learners will be able to:

CO1: Students should be able to understand the concepts of programming before actually starting to write programs.

CO2: Students should be able to develop logic for Problem Solving.

CO3: Students should be made familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.

CO4: 4) Students should be able to apply the problem solving skills using syntactically simple language i.e. Python (version: 3.X or higher)

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Introductory concepts of Python	10
2	Python Constructs– Conditions and Loops	10
3	Python dictionary and user-defined functions	10
	Total	**30**
	Practicals	**30**

Module	Basic Computer Programming	No. of Hours/Credits 30/2
1	**Introductory concepts of Python**	**10**
	Working with Python : Understanding Python variables Python basic Operators ***Python Data Types*** Declaring and using Numeric data types: int, float, complex Using string data type and string operations Defining list and list slicing, Use of Tuple data type	2 8
2	**Python Constructs – Conditions and Loops**	**10**
	Conditional blocks Using if, else and elif Simple for loops in python For loop using ranges, string, list and dictionaries Use of while loops in python Loop, continue, break ***Building blocks of python programs*** Understanding string in built methods List manipulation using in built methods	5 5
3	**Python dictionary and user-defined functions**	**10**
	Dictionary manipulation Programming using string, list and dictionary in built functions ***User Defined Functions*** Advantages of functions function parameters, formal parameters, actual parameters, global and local variables. Programming using functions Anonymous functions. List comprehensions	3 7

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

Essential Reading:

1. Charles Dierbach, Introduction to Computer Science using Python, 2013, Wiley
2. Paul Gries, et al., Practical Programming: An Introduction to Computer Science Using Python 3, 2014, Pragmatic Bookshelf, 2/E

Suggested Reading

1. Magnus Lie Hetland, Beginning Python: From Novice to Professional, 2015, Apress
2. Paul Gries , Jennifer Campbell, Jason Montojo, Practical Programming: An Introduction to Computer Science Using Python 3, 2014, Pragmatic Bookshelf, 2/E
3. Adesh Pandey, Programming Languages – Principles and Paradigms, 2018, Narosa

Any other reference sources as recommended by the course instructor.

	Practical USMABCP25%6 includes Practicals of USMABC205 and USMABC206	
	Practical (Hours per week)	**Credit**
	4	**2**
	Practicals USMABC205	
1.	Demonstration of autoclave	
2.	Demonstration of hot air oven	
3.	Determination of level of antimicrobial activity- Dilution susceptibility test	
4.	Determination of minimum inhibitory concentration	
5.	Determination of Zone of inhibition i) Agar well method ii)Disc diffusion method	
6.	Flow sheet diagram of industrial preparation of: an antibiotic, a food item, a vitamin, an enzyme.	
7.	Routine analysis of water: Standard Plate Count Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test	
8.	Growth curve- effect of pH, temp	
9.	Flow sheet diagram of industrial preparation of: an antibiotic, a food item, a vitamin, an enzyme.	
	Practicals USMABC206	
1.	Installing and setting up the Python IDLE interpreter. Executing simple statements like expression statement (numeric and Boolean types), assert, assignment, delete statements; the print function for output.	
2.	Python commands based on datatypes, typecasting, built-in functions and modules.	
3.	Programs based on lists, conditional constructs, the for statement and the range function; interactively using the built-in functions len, sum, max, min	
4.	Programs related to string manipulation	
5.	Programs based on the while statement; importing and executing built-in functions from the time, math and random modules	
6.	Programs related to dictionaries	
7.	Programs using list comprehensions and anonymous functions	
8.	Programs using the built-in methods of the string, list and dictionary classes	
9.	Programs based on user-defined functions	

Program: B.Sc. (Hons.) Biochemistry			Semester: II	
Course: Communication Skills			Course Code: USMABC207	
Teaching Scheme			Evaluation Scheme	
Lecture (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment and Evaluation (CAE)	End Semester Examinations (ESE)
2	-	2	25%	75%

Learning Objectives:

Communication skills have evolved into one of the key factors in the wellbeing and growth of an individual. Professional success of an individual is also significantly impacted by the effectiveness of that person's communication. This paper focuses on developing a deep understanding of the fundamentals of communication, and to improve communication skills by appreciating the importance of listening and learning essential techniques to improve the same. Also, the paper aims to develop various communication skills of the learner like listening skills, report writing, public speaking, effective presentation, speaking skills, writing skills and interacting skills. The paper will similarly help the learners to determine the right tools to use for professional communication and achieve proficiency in inter-personal and group communication.

Course Outcomes:

After completion of this course, a learner would be able to:

CO1: Communicate effectively in english with appropriate body language making use of correct and appropriate vocabulary and grammar in an organized set up and social context.

CO2: Have the knowledge about the elements of effective communication skills

CO3: Understand impactful writing and will have knowledge towards the functional aspects of language

CO4: Appreciate the significance of speech communication.

CO5: Possess the knowledge of employment communication

CO6: Evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments

CO7: Correspond effectively using various types of writings like letters, memos etc.

CO8: Enhance language proficiency by providing adequate exposure to reading and writing skills.

Outline of Syllabus: (per session plan)

Module	Description	No. of Hours
1	Communication skills-I	10
2	Communication skills-II	10
3	Communication skills-III	10
	Total	**30**
TUTORIALS		**30**

Module	Communication Skills	No. of Hours/Credits 30/2
1	**Communication skills-I**	**10**
	Basic Language Skills: Grammar, Articles, prepositions, conjunctions Transformation of Sentences (Simple, Compound, Complex) Tenses, Subject-Verb agreement, Question Tags, Direct and Indirect Speech, Voice, Antonyms, Synonyms, Use of Thesaurus, Suffixes, Prefixes, Root words, Homophones, homonyms, Collocation, Changing the Class of Words ***Fundamentals of Communication*** Definitions Communication Elements --Verbal and non-Verbal Communications Scope of Communication and Communication as part of Science 7C's of communication Barriers to communication & distinct features of speech ***Spoken English Communication*** Speech Drills, Pronunciation and accent Stress and Intonation	4 4 2
2	**Communication skills-II**	**10**
	Listening Skills The process, importance and types of listening Effective Listening: Principles and Barriers Active listening Language and communication; communication cycle Differences between speech and writing Listening pre-recorded English language-Language Lab ***Public Speaking:*** Presentation Techniques; Use of quotations and anecdotes Organizing a seminar/symposium/workshop/conference: Greetings for different occasions, Welcome Address and Vote of Thanks, Body Language, Interview ***Mechanics of Writing:*** Linking Devices: Use of connectors, Sentences and paragraphs Essay-writing, Letter-writing	4 4 2
3	**Communication skills-III**	**10**
	Written English communication Types of written communications Functions, advantages, and limitations of written communication Light house technique ***Resume:***	3

	Content of a good Resume Guidelines for writing resume Types of resume ***Cover letters*** – Formats, Different types of Cover letter ***Report-Writing:*** Types of Business Reports Structure of Reports Gathering Information Organization of the Material Newspaper Reports Minutes of the Meeting Summarizing, Note-Making and Note-Taking E-Mail English and Drafting an official email Creative Writing: Blogging: fashion, travel, food, culture, personal blogs	3 4

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RECOMMENDED READING:

Essential Reading:

1. Rayudu C.S, Communication, 1st edition, Himalaya Publishing House
2. Rajendra Pal, Essentials of Business Communication, 13th revised, Sultan Chand and Sons
3. V Sasikumar and PV Dhamija, Spoken English, 5th edition, Tata McGraw Hill
4. Grant Taylor, English Conversation Practice, Indian edition, Tata McGraw Hill
5. R Datta Roy and KK Dhir, Communication Skills, 1st edition, Vishal Publication

Suggested Reading

1. John Neilson, Effective communication skills: The foundations for change, 1st edition, Xlibris Us
2. John O. Greene, Handbook of communication and social interaction skills, 1st edition, Routledge
3. Meeta Ghosh, Business Communication Skills, 1st edition, Pearson Education
4. Rajesh Kumar, English Language Communication Skills: Lab Manual cum Workbook, 2014 edition, Cengage Learning India
5. Mohan Krishna & Banerji, Meera, Developing Communication Skills, 2nd edition, Trinity press
6. Mallika Nawal, Business Communication, 1st edition, Cengage Learning India
7. Shalini Kalia, Shailja Agarwal, Business Communication: A Practice-Oriented Approach, 1st edition, Wiley

Any other reference sources as recommended by the course instructor.