R.E. Society's
R.P. Gogate College of Arts & Science and R.V. Joglekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Biochemistry Programme
Three Year Integrated Programme
Six Semesters
Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Programme	**B.Sc. Biochemistry**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	1. Biochemistry is central to all areas of the "biological" and "life" science. It aims to provide an understanding of every aspect of the structure and function of living things at cellular level. 2. Being an interdisciplinary subject, it is spanning a wide range of areas like microbiology, plant and animal sciences, genetics, tissue culture, pharmacology, instrumentation, metabolism, environmental science, pathology of diseases and nutrition. 3. This program able one to plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods. 4. It applies contextual knowledge and modern tools of biochemical research for solving problems. 5. It generates ability to engage students in lifelong learning to foster their growth as a successful researcher and establish as an entrepreneur in field of Biochemistry.
Relevance of PSOs to the local, regional, national, and global developmental needs.	1. B.Sc. Biochemistry students can do their masters in Forensic Science, Genetics, Toxicology, Biotechnology, Nutrition and Dietetics, Immunology, Biostatistics and Bioinformatics, Biophysics, etc. 2. The program helps to develop scientific temper and thus can be proved more beneficial for society as scientific development can make a nation or society grow at rapid pace through research. 3. The curriculum offers variety of interdisciplinary subjects and practical exposures which would equip the students to face modern day challenges in science and technology. 4. The learners will be able to recognize features and role of civil services, consultant in medical field, researcher, academician, environmentalist.

	5. This course inclines students towards pharmacology where they can do drug designing. 6. The data in medical field can be enriched by doing medical coding. 7. Agriculture will be benefitted by their work in developing new plant breeds, biofertilizers, biopesticides, etc. 8. Biochemistry plays an important role in nutrition and health and is considered to be a powerful and sustainable tool for the improvement of health, reduction of poverty and hunger in the world. 9. Learning about environmental science develops harmonious relationship between nature and human and need of conserving the resources on Earth. 10. This course cultivates skills for successful career, entrepreneurship and higher studies.

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Evaluation (40M)

Method	**Marks**
Class test (written)	20
Assignment	10
Class performance	10
Question Paper Pattern for Class Test (20M) Duration: 40 Minutes **Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/4 Marks)**	

B) Semester End Evaluation: Paper Pattern-60M (Duration: 2hrs)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment & Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	O (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Bachelor of Science (B.Sc) Biochemistry Programme

Under Choice Based Credit System

Course Structure

F.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

Course Code	Semester I	Credits	Course Code	Semester II	Credits
	Discipline Specific Course (DSC)			***Discipline Specific Course (DSC)***	
	Major: Mandatory			***Major:*** Mandatory	
USBCH101	Biomolecules I	**02**	USBCH201	Biomolecules II	**02**
USBCH102	Introduction to cell biology	**02**	USBCH 202	Introduction to physiology	**02**
USBCH 103	Biochemistry Practical I	**02**	USBCH203	Biochemistry Practical II	**02**

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

No. of Courses	Semester I	Credits
	Major: Mandatory	
USBCH 101	**Biomolecules I**	**02**
USBCH 102	**Introduction to cell biology**	**02**
USBCH 103	**Biochemistry Practical I**	**02**
	TOTAL	**06**

Revised Syllabus of Courses of Bachelor of Science (B.Sc.) Biochemistry Program at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Biomolecules I
Course Code	USBCH101
Class	F.Y.B.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Learner will get acquainted with unique physical and chemical characteristics of water. Also, they will understand its structure and how it enables to function in ways essential to human and other life processes. Students will get idea about how coordinately protein structure is built to support a life. Carbohydrates are primary source of energy. Learning the basic structures of carbohydrate, learner will understand their different functions as a fuel, structural component in a body.

Biomolecules I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Water**	**10**
2.	**Amino acids and protein**	**10**
3.	**Carbohydrates**	**10**
	Total	**30**

Course Outcomes:

At the end of the course, students will be able to-

1. Acquaint the unique properties of the universal solvent - water, essential for life processes.

2. Understand the life constituting bio molecules: proteins, carbohydrates.

3. Familiarize with the structural properties of the biomolecules.

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	Water	1.1 Water: Its effect on Biomolecules Structure and properties of water (hydrogen bonding) 1.1.1 Entropy and dissolution of solute 1.1.2 Effect of non-polar compounds on the structure of water 1.1.3 Weak interactions of biomolecules in aqueous solutions 1.2 Ionization of water, weak acids and weak bases 1.2.1 pH: pH scale, H^+ and OH^- concentrations 1.2.2 Weak acids and bases and their dissociation constants K_a & K_b 1.2.3 Buffers- definition, action, physiological buffers-any 2 examples 1.3 Solutions: Problems based on solution preparation	10

2.	Amino acids and protein	2.1 Amino acids 2.1.1 Amino acid structure- D & L forms of all 20 amino acids 2.1.2 Detailed classification based on polarity, essential and non-essential amino acids 2.1.3 Physical and chemical properties, Chemical reactions of amino acids with Ninhydrin 2.2 Peptides and Proteins 2.2.1 ASBC- APS classification on the basis of shape and function 2.2.2 Primary structure -Formation and characterization of the peptide bond 2.2.3 Secondary structure -Alpha helix and beta sheet 2.2.4 Tertiary and Quaternary structures- an introduction with one example of each 2.2.5 Protein denaturation	10

3.	Carbohydrates	3.1 Definition, Classification, and functions of carbohydrates (mono-, oligo-, polysaccharides) 3.2 Monosaccharides 3.2.1 Classification in terms of aldoses and ketoses 3.2.2 Structures of glucose, fructose, galactose, mannose, and ribose 3.2.3 Properties: a) Physical- isomerism D & L, optical; epimers; anomers b) Chemical reactions – i) oxidation to produce aldonic. Aldaric and uronic acids (with respect to glucose); ii) Benedict's test, enediol formation (with respect to glucose and fructose) iii) osazone formation (with respect to glucose) iv) orcinol (with respect to ribose) 3.3 Disaccharides 3.3.1 Occurrence and structure of maltose, lactose and sucrose 3.3.2 Formation of glycosidic bonds 3.4 Polysaccharides 3.4.1 Classification based on function. storage and structure a) Composition: homo & hetero. with examples b) Storage: starch and glycogen - action of amylase on starch c) Structural: cellulose. Chitin	10

Learning Resources recommended:

1. Lehninger Principles of Biochemistry.M.M. Cox. 7th edition, 2017.
2. Biochemistry. U. Sathyanarayana, U. Chakrapani. 4th edition, 2014.
3. Biochemistry. Garrett and Grishman. 6th edition. 2016
4. Harper's Illustrated Biochemistry. 31st Edition. by Rodwell, Bender, et al. 2018.
5. Biochemistry. Gregory Gatto Jeremy M. Berg, Lubert Stryer, John Tymoczko, 9th edition, 2019

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment/ Presentation/ Open Book Test/ Chart Preparation	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Introduction to cell biology
Course Code	USBCH102
Class	F.Y.B.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Origin of Life is considered as one of the most important phenomena that happened in the history of biology. Studying this phenomena learners will get to know about the existence of atmosphere, special gases, different forms of species. They also understand how the Earth became habitable step by step. Studying structure of cell will help them understand how different cells can cope with differing circumstances or handle similar circumstances using different approaches.

Introduction to cell biology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Origin of Life & Evolution**	**10**
2.	**The cell**	**10**
3.	**Cell Cycle and cell division**	**10**
	Total	**30**

Course Outcomes:

At the end of the course, students will be able to-

CO1: Familiarize about the origin of life and take them through the process of evolution.

CO2: Focus on Cell as the basic unit of life which is the center for all biochemical processes.

CO3: understand that cell division is a key to life. It focuses on growth, development and repair is maintained by cell division.

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	Origin of Life & Evolution	1.1 Big bang theory, Theories on the origin of life: Abiogenesis, Heterotroph hypothesis, RNA world, protein world, Miller's experiment, Formation of the first cell, endosymbiotic theory 1.2 Evolution - Darwinian theory, Modern synthetic theory of evolution and its factors: Gene mutations (recombination), heredity, natural selection and isolation 1.3 Biological evidences: Fossil record, chemical and anatomical similarities of related life forms, geographic distribution of related species, genetic changes in living organisms over generations and Mechanism of evolution, Gene flow and genetic drift 1.4 Hardy-Weinberg Equation	10

2	The cell	2.1 Structural organization of cells 2.1.1 Prokaryotic, Eukaryotic (plant & animal) and yeast cells- comparative overview 2.2 Cell wall structure (plant), cell membrane (fluid mosaic model) Cytoskeleton: microtubules & microfilaments 2.3 Cell organelles: Structure and function 2.3.1 Mitochondrion: Organization of the mitochondria genome 2.3.2 Chloroplast: Organization of the chloroplast genome, other plastids 2.3.3 Ribosome: 2.3.4 Endoplasmic reticulum 2.3.5 Golgi apparatus 2.3.6 Peroxisome & Lysosome 2.3.7 Nucleus: nuclear envelope, nuclear pores, nuclear matrix and Nucleolus	10

3	Cell Cycle and cell division	3.1 Cell cycle and regulation 3.2 Cell division 3.2.1 Binary fission 3.2.2 Mitosis and Meiosis- Different phases and Comparative overview of mitosis and meiosis 3.3 Apoptosis 3.4 Cell-cell interactions	10

Learning Resources recommended:

1. Biology, Genetics, Molecular Biology: Evolution and Ecology P.S. Verma.2012.
2. Molecular Biology of the Cell Bruce Alberts. 4th edition.2002
3. The cell: A molecular approach. Geoffrey M. Cooper, Robert E. Hausman. 7th edition, 2015
4. Karp's Cell Biology Paperback .Gerald Karp, Janet Iwasa. Global edition, 2018

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment/ Presentation/ Open Book Test/ Chart Preparation	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	Unit	Marks
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Practicals based on USBCH101 and USBCH102
Course Code	USBCHP01
Class	F.Y.B.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Students will be acquainted with good laboratory practices. Upon successful completion, student develops skills in handling instruments and understands its applications in laboratory and research work.

Course Outcomes:

At the end of the course, students will be able to-
CO1: Provide familiarity with basic biochemistry laboratory techniques.

CO2: Understand the characteristics of different biomolecules with different reagents.

CO3: Familiarize with different staining methods.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for two groups: A and B from this course.

7. Semester End Practical Examination will be of 6 hours.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever applicable.

Curriculum:

Group	Title	Learning Points	No of Lectures
A	Basic Biochemistry	1. Numericals based on ways of expressing concentration of solution. 2. Introduction to laboratory glassware. 3. Preparation & Standardization of laboratory reagents i. Primary standards - 0.1N oxalic acid ii. Secondary standards - 0.1N NaOH, 0.1N HCl 4. Preparation of buffers – i. acetate buffer ii. phosphate buffer 5. Determination of pKa of glycine 6. Qualitative tests for Carbohydrates i. Monosaccharides (glucose and fructose), ii. Disaccharides (lactose, maltose and sucrose) iii. Polysaccharides (starch and dextrin) 7. Qualitative test for amino acids 8. Effect of heat, organic solvents and ammonium sulphate on proteins	25
B	Cell Biology	1. Effect of isotonic, hypertonic and hypotonic solutions on cells – onion peel 2. Staining of bacterial yeast cells (negative staining 3. Gram staining 4. Observation of fungi and algae 5. Permanent slides/ diagrams or electron micrograph of organelles-nucleus, mitochondria and chloroplast 6. Study of stages of mitosis using onion root tips 7. Permanent slides of mitosis and meiosis 8. Observation and study of V.S. and T.S. of cells of plant's stem	25

C	Demonstration Experiment	1. pH meter – working of a pH meter and Determination of pH of different samples 2. Demonstration of weighing balance. 3. Introduction to Compound microscope and Parts and maintenance of Microscope	10

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (Exam Pattern) (60 Marks - 4 hours)

Q.No	**Group**	**Title**	**Method**	**Marks**
1	A	Basic Biochemistry	Experiment performance as per practical exam paper	30
2	B	Cell Biology	Experiment performance as per practical exam paper	30

Revised Syllabus of Courses of Bachelor of Science (B.Sc.) Biochemistry Program at Semester II with Effect from the Academic Year 2023-2024

No. of Courses	Semester II	Credits
	Major: Mandatory	
USBCH201	**Biomolecules II**	**02**
USBCH202	**Introduction to Physiology**	**02**
USBCH203	**Biochemistry Practical II**	**02**
	TOTAL	**06**

Name of the Course	Biomolecules II
Course Code	USBCH201
Class	F.Y.B.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Lipids play such an essential role in the body; it is very important to understand the structure and function of lipids. This understanding helps in solving several metabolism-related problems. DNA is molecule which contains genetic information. An understanding and appreciation of the structure and function of DNA has opened up many areas of research, such as genetic engineering, forensic science.

Biomolecules II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Lipids**	**10**
2.	**Nucleic acid and RNA**	**10**
3.	**DNA**	**10**
	Total	**30**

Course Outcomes:

At the end of the course, students will be able to-
CO1: Develop an interest in the learner in human nutrition for sustaining life.

CO2: Understand the life constituting bio molecules: Lipids, nucleic acids.

CO2: Understand basic structure of DNA.

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	Lipids	1.1 Definition, Bloor's classification, functions of Lipids 1.2 Fatty acids and Triacylglvcerol 1.2.1 Classification & Chemistry, Saturated fatty acids - classification of C2 to C20: even carbon: Common and IUPAC names. Unsaturated fatty acids MUFA, PUFA (2.3.4 double bonds) Omega – 3, 6, 9 fatty acids. Triacyl glycerol - simple and mixed - names and structure 1.2.2 Chemical Reactions of fats Saponification, Iodination, Ozonolysis, Auto-oxidation, Rancidity Definition & significance - Acid number, Saponification number, Iodine number, Reichert - Meissl number 1.3 Compound Lipids Functions of glycerophospholipids (PE, PC, PL) Phosphosphingolipids (ceramide, sphingomyelin), Glycolipids /Cerebrosides (gluco- & galactocerebrosides) 1.4 Steroids Cholesterol structure and biochemical significance.	10
2	Nucleic Acid and RNA	2.1 Structure - Purine & Pyrimidine bases, ribose, deoxyribose, nucleosides andnucleotides (ATP, CTP, GTP, TTP, UTP) Formation of polynucleotide strandwith its shorthand Representation 2.2 RNAs (various types in prokaryotes and eukaryotes) mRNA & rRNA - generalaccount, tRNA - clover leaf model, Ribozymes 2.3 Reaction of RNA with Orcinol	10

3	DNA	3.1 Physical evidence of DNA helical structure. Chargaff's rules (chemical evidence), Watson-Crick model of DNA & its features 3.2 Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density, UV absorption), Hypochromism, hyperchromism,denaturation of DNA. 3.3 Reaction of DNA with DPA	10

Learning Resources recommended:

1. Lehninger Principles of Biochemistry M.M. Cox. 7th edition, 2017.
2. Biochemistry. U. Sathyanarayana, U. Chakrapani. 4th edition, 2014.
3. Fundamentals of Biochemistry by J. L. Jain, 7th edition, 2016.
4. Harper's Illustrated Biochemistry by Rodwell, et.al 31st edition, 2018.

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	20
Assignment/ Presentation/ Open Book Test/ Chart Preparation	10
Class performance and attendance	10

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	Unit	Marks
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

5. All questions will be compulsory and may be divided into sub-questions.
6. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
7. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
8. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Introduction to physiology
Course Code	USBCH202
Class	F.Y.B.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Physiology is an experimental scientific discipline and is of central importance in medicine and related health sciences. It provides a thorough understanding of normal body function, enabling more effective treatment of abnormal or disease states.

Introduction to physiology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Physiology of digestion and absorption**	**10**
2.	**Physiology of respiration**	**10**
3.	**Physiology of Excretion**	**10**
	Total	**30**

Course Outcomes:

At the end of the course, students will be able to-
CO1: Understand biological process in human body.

CO2: Learn Anatomy and physiology of vital systems.

CO3: Understand the possible diseases related to digestion, respiration and excretion.

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	Physiology of digestion and absorption	1.1 Parts and Functions of gastrointestinal tract (GIT) 1.2 Organs and Glands associated with GIT Secretions and Juices of GIT (Saliva, Gastric juice, Intestinal juice, pancreatic and Bile juice) 1.3 Digestion and Absorption of carbohydrates 1.4 Digestion and Absorption of Lipids 1.5 Digestion and Absorption of Proteins 1.6 Disorders-Peptic ulcer, Lactose Intolerance	10
2	Physiology of respiration	2 .1 Respiratory system, 2.2 Breathing - inspiration and expiration, 2.3 Composition of air and partial pressure of gases 2.4 Physical exchange of gases 2.4.1 Transport of oxygen 2.4.2 Transport of carbon dioxide 2.5 Respiratory disorders – cyanosis, respiratory acidosis and alkalosis	10
3	Physiology of Excretion	3. 1 Excretory system in different animals 3.2 Structure of the nephron: 3.2.1 Bowman's capsule & glomerulus - Structure & function, (ultrafiltration, pressures involved, GFR, regulation of GFR); 3.2.2Renal tubule - structure & function (proximal and distal convoluted tubules and Henle's loop) 3.3 Urine formation: Reabsorption / Secretion of glucose, Na+, K+, HCO3, Cl- and H+ renal threshold, 3.4 Excretory disorder: Nephritis	10

Learning Resources recommended:

1) Guyton and Hall Textbook of medical Physiology. John E. Hall 4th edition.2015
2) Harper's Illustrated Biochemistry. 31st Edition. by Rodwell, Bender, et al. 2018.
3) Tortora's principles and physiology. Gerard Tortora and Bryan Derrickson Global edition 2016

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment/ Presentation/ Open Book Test/ Chart Preparation	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Practicals based on USBCH201 and USBCH202
Course Code	USBCHP02
Class	F.Y.B.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	The course objective is to provide experimental practice of qualitative, quantitative analysis of Biomolecules. This is also to give skills in handling basic instruments. Students will understand their principle and applications.

Nomenclature: Practicals based on USBCH201 and USBCH202

Course Outcomes:

CO1: Understand good laboratory practices.

CO2: Prepare charts and models of vital systems of human body for better understanding.

CO3: Understand qualitative estimation of body fluids.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for two groups: A and B from this course.

7. Semester End Practical Examination will be of 6 hours.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever applicable.

Curriculum:

Group	Title	Learning Points	No of Lectures
A	Study of Biomolecules	1. Qualitative tests for lipids a) Miscibility test b) Saponification test c) Unsaturation test d) Sudan black dye test e) Salkowski test for cholesterol 2. Determination of SAP value of given oil sample 3. Determination of Acid value of give oil sample 4. Formation of soap. 5. Study of models of DNA and RNA structure 6. Staining of DNA and RNA (methyl green: pyronine) using onion peel 7. Qualitative tests for DNA (DPA) & RNA (Orcinol) (Neumann's test for presence of phosphorus) 8. Isolation of DNA from onion cell	25

B	Physiology	1. Identification of organs / parts of digestive system 2. Qualitative analysis for Proteins (albumin, peptone, gelatin and casein - any four proteins) 3. Estimation of total acidity of gastric juice 4. Identification of organs / parts of respiratory system 5. Identification of organs / parts of excretory system 6. Analysis of the action of salivary α - amylase action on starch 7. Concept of Dialysis: i. Ammonium sulphate precipitation ii. Dialysis (Test with $BaCl_2$ for presence of sulphatein the buffer or water outside) 8. Urine analysis: i. Normal Constituents - a. Inorganic constituents: SO_4^{-2} ($BaCl_2$), Cl^- ($AgNO_3$), b. Organic constituents: Urea, Uric acid, Creatinine ii. Abnormal constituents - a. Glucose by Benedict's test b. Proteins by Hellers ring test c. Bile salts by Smith's test d. Ketone Bodies by Rotheras test e. Blood by microscopic examination	25
C	Demonstration Experiment	1. Introduction to Colorimeter 2. Introduction to Phase Contrast Microscopy	10

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivan, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)
5. Guyton and Hall Textbook of medical Physiology by John E. Hall 13th edition (2015)

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (Exam Pattern) (60 Marks - 4 hours)

Q. No	**Group**	**Title**	**Method**	**Marks**
1	A	Study of Biomolecules	Experiment performance as per practical exam paper	30
2	B	Physiology	Experiment performance as per practical exam paper	30

Bachelor of Science (B.Sc.) Biochemistry Program

Under Choice Based Credit System

Course Structure

S.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

No. of Courses	Semester III	Credits
USBCH301	**Bio-organic Chemistry and Biophysical methods-I**	**02**
USBCH302	**Fundamentals of Genetics and Physiology**	**02**
USBCH303	**Applied Biochemistry I**	**02**
USBCHP304	**Practical P3**	**03**
	TOTAL	**09**

Name of the Course	Bio-organic Chemistry and Biophysical methods-I
Course Code (Refer to student handbook)	USBCH301
Class	S.Y.B.Sc.
Semester	III
No of Credits	3
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Bioorganic chemistry focuses on implanting physical and chemical methods in the study of biological process. After studying bioorganic and biophysical methods, students will get acquainted about how a biomolecule structure is studied and how investigation of biochemical reaction is studied.

Bio-organic Chemistry and Biophysical methods-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Acids, bases, buffers and ionic equilibria**	**15**
2.	**Physicochemical principles**	**15**
3.	**Microscopy**	**15**
	Total	**45**

Nomenclature: Bio-organic Chemistry and Biophysical methods-I

Course Outcomes:

At the end of the course, students will be able to-
CO1: Understand the concept of acids, bases, importance of buffer system in humans.
CO2: Acquire the knowledge and understanding of the physicochemical principles and their role in human physiology.
CO3: Identify and describe the parts of microscope. To study the distinguishing features, principal components and applications of various types of light and electron microscope

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Acids, bases, buffers and ionic equilibria**	**15 Lectures**
1.1	Definition – pH, pK, pKw, isoelectric pH, buffer, buffering capacity	
1.2	Derivations: Ionic product of water, Hendersen–Hasselbalch equation,	
1.3	Relation between pI, $pKa_1$and $pKa_2$for a neutral, acidic and basic amino acid	
1.3.1	Ionization and titration curves of glycine, lysine and aspartic acid; pKa, pHm, and pI values of these amino acids	
1.3.2	Sorensen's reaction and formol titration of amino acids	
1.4	Physiological buffers: Hb - HHb, carbonate-bicarbonate, phosphate and protein	
1.5	Numerical on above concepts.	
Unit II:	**Physicochemical principles**	**15 Lectures**
2.1	Diffusion and osmosis	
2.1.1	Ways of expressing solute concentration - mole, molal, normal, percent, activity & ionic strength.	
2.1.2	Diffusion & diffusion coefficient and factors affecting diffusion of solute in solution	
2.1.3	Osmosis - Vant Hoff's law of osmotic pressure law &mathematical expression (no derivation), mechanism of osmosis, role of osmosis in physiology.	
2.1.4	Renal dialysis: Principles and process	
2.2	Colloids and viscosity	
2.2.1	Colloidal state in relation to surface forces, surface area, electrical charge, precipitation and	

	flocculation.	
2.2.2	Surface tension and its measurement, factors affecting surface tension Eg. Role of bile in digestion	
2.2.3	Viscosity - definition, measurement; Donnan membrane equilibrium, relation between Donnan equilibrium and osmotic pressure.	
Unit III:	**Microscopy**	**15 Lectures**
3.1	History, Basic principles of microscopy, of light and colour.	
3.2	Dissection and compound microscope: Construction and parts of a microscope, function of each part, levels of magnification, concept of refractive index and role of oil in magnification	
3.3	Specialized microscopy I	
3.3.1	Differential interference contrast (DIC),	
3.3.2	Phase contrast,	
3.3.3	Dark Field	
3.4	Specialized Microscopy II	
3.4.1	Simple fluorescence microscopy	
3.4.2	Confocal microscopy	
3.4.3	Electron microscopy • Principle, applications and comparative study • Types - SEM and TEM	

Learning Resources recommended:

1. Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
2. Biochemistry by Donald Voet, 3rd Edition (2004)
3. Fundamentals of Biochdemistry by Jain and Jain, 1st multicolor edition (2009)
4. Principles and techniques of Biochemistry and molecular biology by Wilson and Walker 6th edition (2005)

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary

Name of the Course	Fundamentals of genetics and physiology-I
Course Code (Refer to student handbook)	USBCH302
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Genetics is concerned with heredity and variation. I t occupies central position in modern biology. Basic genetic study can be implemented in designing therapies and genetic investigation. Clinical biochemistry studies help in diagnosis and management of disease. Learning body fluids may be useful in solving medical case studies. Students will learn how the vital components are transported in the body with respect to their structure, function and regulation.

Fundamentals of genetics and physiology-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Genetics: I**	**15**
2.	**Blood and Body Fluids**	**15**
3.	**Biological transport mechanisms**	**15**
	Total	**45**

Nomenclature: Fundamentals of genetics and physiology-I

Course Outcomes:

At the end of the course, students will be able to-
CO1: Explain derivatives from Mendel's model of the inheritance of traits. Understands deviation of Mendel's genetics.
CO2: Understand composition of blood and body fluids and their functions.
CO3: Illustrate the mechanism of membrane transport in plant and animal cell.

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Genetics: I**	**15 lectures**
1.1	**History**: Contributions of Mendel, Bateson, Hardy-Weinberg, Garrod, Morgan, Griffith, Beadle and Tatum, Avery, Mac Leod, Mc Carthy, Lederberg, Tatum, Barbara Mclintock, Hershey & Chase, Watson &Crick.	
1.2	**Mendelian genetics**: Mendel's experiments - Monohybrid, Dihybrid crosses, Laws of inheritance	
1.3	Dominance, recessivity, codominance, incomplete semi-dominance, lethal genes	
1.4	Gene interaction -Epistasis, types of epistasis, multiple alleles, maternal effects	
1.5	Numerical on above concepts	
Unit II:	**Blood and Body Fluids**	**15 lectures**
2.1	**Fluid compartments of the body**–ICF and ECF	
2.2	**Blood**: Composition, characteristics and function; roleof plasma proteins, Starlings hypothesis; blood clotting and factors involved	
2.3	**Bile**: Composition, characteristics and function; storage	
2.4	**Urine**: Composition–normal and abnormal constituents; formation of urine.	
2.5	**Lymph**: Composition, Formation and Circulation	

Unit III:	**Biological transport mechanisms**	**15 lectures**
3.1	**Transport in plants**: Role of xylem and phloem	
3.2	**Transport in blood:**	
3.2.1	Transport of gases CO_2 and O_2, Role of hemoglobin,O_2 dissociation curves, Bohr effect Chloride shift	
3.2.2	Transport of Metabolites: transport of lipids – lipoproteins and their types, role of plasma protein, albumin in transport of metabolites and drugs	
3.2.3	Transport of Ions: Fe -Ferritin and transferrin and calcium	
3.3	**Transport across cell membranes**	
3.3.1	Channel proteins and Carrier proteins	
3.3.2	Passive transport (simple and facilitated diffusion) with suitable examples; concept of symport, antiport,uniport, Endocytosis and Exocytosis – with one example each	
3.3.3	Active transport: primary–Na^+&K^+ pump, secondary Glucose-amino acid transport, types of glucose transporters (GLUT 1 to GLUT 4), aquaporins, ion channel inhibitors like gramicidin and valinomycin	

Learning Resources recommended:

1) IGenetics by Russel, 3rd edition (2016)
2) Advance in Biotechnology by Jogdand, 2nd edition (2007)
3) Guyton and Hall Textbook of medical Physiology. John E. Hall 13th edition.2015

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., types of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Applied Biochemistry-I
Course Code (Refer to student handbook)	USBCH303
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Infections have played a central role in the lives of humans. Studying the characteristics of these infections and causative agents will help in improving public health. Tissue culture has wide range of applications, plant tissue culture technique and its utility as a research tool will impart knowledge to the learner. Various industrial products are formed by the fermentation technology. Students will understand the basics of one these most important industrial technique.

Applied Biochemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Microbiology in Human Health and Diseases**	**15**
2.	**Cell and Tissue Culture**	**15**
3.	**Industrial Biochemistry**	**15**
	Total	**45**

Nomenclature: Applied Biochemistry-I

Course Outcomes:

At the end of the course, students will be able to-
CO1: Course gives knowledge of medical microbiology, and introduction to virology. learner will learn about different microbial disease, their pathophysiology and clinical manifestation.
CO2: Introduce students to the principles and practical considerations of animal and plant tissue culture.
CO3: Student will learn structure function of fermenter, biosensors. Learners also get acquainted with Application and immobilized techniques of enzymes.

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Microbiology in Human Health and Diseases**	**15 lectures**
1.1	Beneficial Microorganism: Lactobacillus, Normal flora of human gut, Probiotics, Yeast, Nitrogen fixing bacteria (Rhizobium and Azotobacter)	
1.2	Harmful microorganisms:	
1.2.1	Air borne- *Mycobacterium tuberculae*(Tuberculosis), *Corynebacterium diptheriae*(Diptheria), *Candida* sp.,*Haemophilus influenza*e (Influenza), morbillivirus (measles)	
1.2.2	Water borne- *Shigella sp.* (Dysentery), *Vibrio cholerae* (Cholera), *Salmonella sp.* (Enteric fever), *Hepatitis virus*	
1.2.3	Food borne- *Staphylococcus aureus, Clostridiumbotulinum (Botulism)*	
1.2.4	Soil borne- *Clostridium tetani*	
1.3	Virology- General structure of a typical virus, classification of viruses based on genome (DNA, RNA); symmetry (helical, icosahedral, complex), host (bacteria, plant, animal, insect); Lytic and Lysogenic cycle	
Unit II:	**Cell and Tissue Culture**	
2.1	Plant Tissue Culture:	
2.1.1	History, Introduction or definition (explants, callus, dedifferentiation, re-differentiation) concept of totipotency	
2.1.2	Culture techniques; Types of culture (Callus culture, Organ culture, protoplast culture, cell culture)	

2.1.3	Applications: secondary metabolites in plant culture, Micropropagation	**15 lectures**
2.2	Animal Cell Culture:	
2.2.1	History, Introduction to Primary cell culture, Celllines (Finite and continuous)	
2.2.2	Culture techniques used for primary culture,	
2.2.3	Stem cell culture, Animal Organ Culture, Whole embryoculture	
2.2.4	Applications: hybridoma (monoclonal antibody), production of Vaccines	

Unit III:	**Industrial Biochemistry**	**15 lectures**
3.1	Basics of fermentation	
3.1.1	Typical Fermenter, Types of Fermenters (CSTF, Bubblecap, Airlift, Fluidized Bed reactor)	
3.1.2	Industrial production of wine, penicillin	
3.2	Immobilized Enzyme: Introduction, Methods of immobilization (entrapment, adsorption, covalent binding, microencapsulation, cross linking)	
3.2.1	Stabilization of soluble enzyme (solvent and substrate stabilization, enzyme stabilization by polymer. Salts and chemical modification)	
3.3.2	Applications	
3.3	Biosensors: Features of Biosensors, classification based on transducers, applications	
3.4	Single Cell proteins and their applications	

Learning Resources recommended:

1 General Microbiology. Roger Stainer 5th edition .1999
2 Introduction to modern virology. Dimmock and et.al.6th edition 2007
3 Biotechnology Expanding Horizons by B.D. Singh, 4th edition 2014
4 Advance in Biotechnology by Jogdand, 2nd edition 2007

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Practicals based on USBCH301, USBCH302 and USBCH303
Course Code (Refer to student handbook)	USBCHP03
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Practical
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Students will be acquainted with the basic techniques of enzyme isolation. They will learn to handle pH meter and viscometer. Learner will also learn case studies based on Mendel's law. Course will also improve their microbial techniques and learn how to connect these skills in industrial applications.

Nomenclature: Practicals based on USBCH301, USBCH302 and USBCH303

Course Outcomes:

At the end of the course, students will be able to
CO1: Perform experiments successfully and use safe lab practices.
CO2: Acquire knowledge and skills for development of analytical approach for problem solving in the lab and also at the actual field.
CO3: Get hands on training of basic microbiological techniques.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for three groups: P301, P302 and P303 from this course.

7. Semester End Practical Examination will be of 9 hours and it is scheduled in 1and a half day.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever is applicable.

Curriculum:

Unit	Title	Learning Points	No of Lectures
USBCHP03	P301	1. a] Preparation of beta Amylase/Urease/Invertase extract demonstration of theactivity Qualitatively. b] Determination of the Achromic point of Salivary Amylase. 2. Preparation of Buffers and measurement of pH using pH papers and pH meter. 3. Acid – Base titration of a polyprotic acid [H_2CO_3/H_3PO_4/Glycine hydrochloride] 4. a] A study of some methods of cell rupture: effect of hypo, hyper and isotonicsolutions on cells of the onion peel /plant cell (Hydrilla/ Vallisneria/ Spirogyra) b] Effect of organic solvents on cell rupture 5. Determination of the Viscosity of sucrose solution using Ostwald's Viscometer. 6. Demonstration: Potato Osmometer: Osmosis through semipermeable membrane	**15**
	P302	1. Mendel's Laws: a] Problems based on the laws b] case studies based on the laws 2. A study of Human Karyotypes. 3. Isoelectric precipitation of Casein using an indicator. Field visit /Assignment on vermiculture, organic farming, composting, biogas plant followed by a detailed report of at least one [the visit is recommended with the report, but in case it is not possible an assignment is mandatory	**15**
	P303	1. Demonstration of the working of an autoclave and a hot air oven. 2. Optimization of curd – a demonstration. 3. Sterility testing of air by plate exposure technique. [in sterile zone, in lab] and of tapwater. 4. A study of various culture inoculation methods. (Streak plate, pour plate and spreadplate methods).	**15**

		5. Cell count in a culture medium using optical density 6. Determination of the zone of inhibition of microorganisms using the agar wellmethod and disc method. 7. Flow sheet diagrams of industrial preparation of: a vitamin, an antibiotic, a fooditem, an enzyme and an alcohol.	

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Continuous Internal Evaluation (60M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course assessed for internal marks during regular practical session	**30**
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	**15**
Viva	**15**

B. Semester End Evaluation (Exam Pattern) (90 Marks - 4 hours)

Q. No.	**Title**	**Method**	**Marks**
1	P301	Experiment performance as per practical exam paper	30
2	P302	Experiment performance as per practical exam paper	30
3	P303	Experiment performance as per practical exam paper	30

Bachelor of Science (B.Sc.) Biochemistry Program

Under Choice Based Credit System

Course Structure

S.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

No. of Courses	Semester IV	Credits
USBCH401	**Bio-organic Chemistry and Biophysical methods-II**	**02**
USBCH402	**Fundamentals of Genetics and PhysiologyII**	**02**
USBCH 403	**Applied Biochemistry II**	**02**
US BCH P404	**Practical P4**	**03**
	TOTAL	**09**

Name of the Course	Bio-organic Chemistry and Biophysical methods-II
Course Code (Refer to student handbook)	USBCH401
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Chemical reactions within the cells occur in presence of biocatalyst i.e., enzyme. Course gives review of basic enzymatic concepts, enzyme kinetics and enzyme regulation. The course illustrates how endocrine system work in normal physiology and disease condition. Learner will also learn about endocrine pathways controlling reproduction, growth, development, stress and metabolism. Students understand different animal and plant models used in the scientific study and also get idea about cell fractionation methods used in biotechnology.

Bio-organic Chemistry and Biophysical methods-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Enzymology**	15
2.	**Plant growth regulators and endocrinology**	15
3.	**Approaches to Biochemical investigations**	15
	Total	45

Nomenclature: Bio-organic Chemistry and Biophysical methods-II

Course Outcomes:

At the end of the course, students will be able to-
CO1: Have a deeper insight in to the fundamental's enzyme properties, nomenclatures, characteristics and mechanisms
CO2: Describe structure, functions and the mechanism of action of enzymes. Learning kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity
CO3: Overview human endocrinology and plant growth regulators.
CO4: Acquire knowledge about the basics and latest developments in Biochemical investigation tools and importance of plant and animal model in biochemical investigation

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Enzymology**	15 lectures
1.1	Definition – Enzyme, coenzyme, cofactor, apoenzyme, holoenzyme, prosthetic group, active site , enzyme specificity, Turnover number, specific activity, Katal, IU.	
1.2	IUB / EC classification upto one digit. Enzyme specificity Fischers lock & key and Koshlands induced fit theories	
1.3	Activation energy, mechanism of enzyme action (concept of active site, single and bi- substrate reaction), factors affecting enzyme activity – substrate concentration, pH, temperature	
1.4	Enzyme kinetics – Derivation of Michaelis - Menten equation and Lineweaver Burk plot for mono-substrate reactions and numerical problems based on them.	

1.5	Enzyme inhibition – Reversible and Irreversible; competitiveand noncompetitive, (one example of each) Numerical problems on above.	
Unit II:	**Plant growth regulators and endocrinology**	15 lectures
2.1	Plant growth regulators- Structure and function of- auxins, gibberellins, cytokinin's, ethylene and abscisic acid.	
2.2	Definition of hormones, hormone receptor, endocrine & exocrine glands	
2.3	Classification of hormones on the basis of:	
2.3.1	Distance of target tissue - autocrine, paracrine, endocrine. Hierarchal organization of the mammalian endocrine system	
2.3.2	Chemistry - One example for each sub class.	
2.4	Chemistry & physiological role of thyroxine, oxytocin & vasopressin, Physiological role of glucocorticoids, FSH, LH, Estrogen, Progesterone (Reproductive cycle) Mode of action of steroid hormones and epinephrine. (Amplification cascade Only till the level of protein kinase A) G protein not to be covered.	
Unit III:	**Approaches to Biochemical investigations**	15 lectures
3.1	Whole animal and plant studies - the advantages and disadvantages of any four model systems for biochemical investigation (e.g. *E.coli*, yeast, *Dictyostelium*, *C. elegans*, Drosophila, *Arabidopsis)*	
3.2	Organ & tissue studies	
3.3	Isolated and cultured tissue and cell techniques: isolation, culture and counting of cells.	
3.4	*Cell Fractionation*	
3.4.1	Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme,organic solvent), temperature.	
3.4.2	Choice of suspension medium (Isotonic & hypotonicsolution, PBS) and separation methods.	

Learning Resources recommended:

1. Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
2. Enzymes: Biochemistry, Biotechnology, cilincal biochemistry. Plummer and Bonner. 2nd edition 2007
3. Guyton and Hall Textbook of medical Physiology. John E. Hall 13th edition.2015
4. Biochemical Methods of analysis.; theory and applications. Saroj Dua and Neera Garg. 2010.

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Fundamentals of genetics and physiology-II
Course Code (Refer to student handbook)	USBCH402
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Learner will understand basic structure of chromosome and different modes of gene recombination. Students will get integrated aspects of physiology, anatomy and biochemistry of muscles and nervous system.

Fundamentals of genetics and physiology-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Genetics: II**	**15**
2.	**Movement and locomotion**	**15**
3.	**Neurophysiology**	**15**
	Total	**45**

Nomenclature: Fundamentals of genetics and physiology-I

Course Outcomes:

At the end of the course, students will be able to-
CO1: Critically understand the components of DNA and the process of sequencing structural properties of chromosome. Learners will also get an overview about recombination in prokaryotes.
CO2: Learners will understand movement and locomotion in plant and human body as well as well as structure and functions of muscle in posture joint stability and heat production.
CO3: Course covers basic principle of nervous system, neuron signaling, interactions and structure and functions of neurotransmitters.

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Genetics: II**	15 lectures
1.1	**Genome organization**	
1.1.1	Prokaryotic Genome: Nucleoid structure	
1.1.2	Eukaryotic chromosomes: Packaging of DNA(upto Solenoid structure), DNA supercoiling, Topoisomerase, Chromatin structure -Euchromatin, Heterochromatin, structure of condensed chromatin, Centromere, kinetochore, telomere, Comparison of chromosomal structure in prokaryotes and Eukaryotes	
1.2	**Recombination in prokaryotes**	
1.2.1	Transformation: Transformation in *S. pneumoniae*	
1.2.2	Transduction: General features with one example	
1.2.3	Conjugation: Mechanism F+, F- and Hfr strain	
Unit II:	**Movement and locomotion**	
2.1	**Movement in plants**	
2.1.1	Movements of Locomotion Spontaneous: Ciliary, Amoeboid,Cyclosis (Rotation, Circulation) Induced: Chemotaxis, Phototaxis, Thermotaxis	

2.1.2	Movements of Curvature: Mechanical: hygroscopic movements Vital:i)Spontaneous-movements of growth(nutation, circumutation, Hyponasty, epinasty); movements of variation ii)Induced–Tropic-hapto/geo/hydrotropism; Nastic–seismonasty, Nyctynasty	15 lectures
2.2	**Muscle contraction**	
2.2.1	Structural organization of a muscle fibre, myofibril	
2.2.2	Contraction and Relaxation of Muscles; -mechanisms, other types of contractions, twitch, tetanus, Isotonic, Isometric regulation of Muscle contraction	
Unit III:	**Neurophysiology**	15 lectures
3.1	**Nervous System Classification:** CNS, PNS; Components: Neurons (3types) and Neuroglia(6types)–structure andfunction, Axonal transport	
3.2	**Nerve impulse transmission:** Resting Membrane Potential, ion channels [voltage and ligand gated], Action Potential (depolarization, polarizationand refraction period), propagation of action potential (salutatory & continuous conduction)	
3.3	**Synaptic transmission**: Physiological anatomy of a synapse: – Electrical & Chemical synapses, Excitatory & inhibitory postsynaptic potentials, Agonists & Antagonists, inactivation of neurotransmitter	
3.4	**Neurotransmitters**: Structure and function of acetylcholine, catecholamines, GABA, glutamate, glycine	

Learning Resources recommended:

1) IGenetics by Russel, 3rd edition (2016)
2) Tortora' s principles and physiology. Gerard Toratora and Bryan Derrickson Global edition 2016
3) Plant physiology and biochemistry. H.S. Shrivastava. 2005.

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary

Name of the Course	Applied Biochemistry-II
Course Code (Refer to student handbook)	USBCH403
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	This course will expand the knowledge of soil and water treatment that can sustainably remediate pollution issue. This course will give idea about basic principle, ideal characteristics and evaluation technique of pharmacology.

Applied Biochemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Trends in Biotechnology**	**15**
2.	**Introduction to Pharmacology**	**15**
3.	**Resource management**	**15**
	Total	**45**

Nomenclature: Applied Biochemistry-II

Course Outcomes:

At the end of the course, students will be able to-
CO1: This course is intended to expand learner's knowledge of alternative methods of soil and ground water treatment that can sustainably remediate the issue.
CO2: Learners will understand the basic concepts of pharmacology which forms the basis for making clinical decisions in pharmacological management of commonly occurring health issues.
CO3: The course deals with various environmental issues and solutions to treat those problems using innovative and sustainable ideas.

Curriculum:

UNIT	TITLE AND LEARNING POINTS	NO. OF LECTURES
Unit I:	**Trends in Biotechnology:**	**15 lectures**
1.1	*Bioremediation:*	
1.1.1	Introduction to terms – Bioremediation, Biotransformation, Xenobiotics, Recalcitrant xenobiotics, Biomagnification, Factors affectingbioremediation	
1.1.2	Types of Bioremediations (*Insitu*, *Exsitu)*; Types of reactions (Aerobic, anaerobic, sequential)	
1.1.3	Applications of Biodegradation - hydrocarbons, (Oil spills) Pesticides and herbicides, Heavy metals (Uranium) contaminated soil and waste land, Ground Water; Genetically Engineered Microbes in bioremediation.	
1.2	Biopesticides:	
1.2.1	Introduction; Types of Biological Control (Classical,inoculation, Inundation);	
1.2.2	Examples each of Bacterial, Viral, Fungal and Protozoal	
1.3	Biofungicide: Examples and applications	
1.4	Biofertilizers: Examples and applications	

Unit II:	**Introduction to Pharmacology**	**15 lectures**
2.1	Scope of pharmacology	
2.2	Sources, Classification, Chemical & physical properties of drug and Nomenclature of drugs	
2.3	Dosage forms and routes of drug administration; Factors affecting dosage and drug delivery	
2.4	Pharmacokinetics: LD_{50}, ED_{50}, Half Life, Loading dose, Maintenance dose (Explanation of terms only); Therapeutic index	
2.5	Novel Drug delivery system (NDDS):	
2.5.1	2.5.1 Transdermal and oral modes	
2.5.2	2.5.2 Liposomes and nanoparticles	
Unit III:	**Resource management**	**15 lectures**
3.1	Solid waste: Types of waste, treatment, recycling	
3.2	Waste water- sewage-	
3.2.1	Composition of sewage, types of sewage, detection of pathogenic organism of sewage; preliminary treatment, primary treatment	
3.2.2	Secondary treatment; tertiary treatment, disinfectant	
3.2.3	Sludge treatment and disposal; waste water collectionvs sewage treatment in developing countries	
3.3	Biomass and Bio energy production	
3.3.1	Biofuel and Biomass: Fossil fuel; Energy rich crops (sugar and starch; wood-rich; petroleum plants); Animal energy; Sources of biofuel, its cultivation andextraction process	
3.3.2	Biogas: Production, Composition, Applications. Gobar gas. [MSW and LFG, Renewable natural gas, NG vehicle]	

Learning Resources recommended:

1. Textbook of pharmacology by FSK Barar, 4th edition (2012)
2. Textbook of Medical Biochemistry by M.N. Chatterjee & Rana Shinde, 6th edition (2007)
3. Industrial waste water treatment. A.D. Patwardhan. 1st edition 2017.

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	**20**
Assignment	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions options.
4. Diagrams or flowcharts should be drawn wherever necessary

Name of the Course	Practicals based on USBCH401, USBCH402 and USBCH403
Course Code (Refer to student handbook)	USBCHP04
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Practical
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Student will learn about fundamentals of clinical biochemistry. They will get to know about significance of clinical lab tests and how abnormal sample can be estimated. Different water quality analysis should be performed to decide portability of water.

Nomenclature: Practicals based on USBCH401, USBCH402 and USBCH403

Course Outcomes:

At the end of the course, students will be able to
CO1: understand basic principles of microbiology and its use in differentiating features of muscle tissues.
CO2: know normal and abnormal hematological lab findings to predict the diagnosis of hematological disorders and diseases.
CO3: get hands on training on isolation, immobilization of enzyme technique and microbiological techniques for analyzing the properties of effluent.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for three groups: P401, P402 and P403 from this course.

7. Semester End Practical Examination will be of 9 hours and it is scheduled in 1and a half day.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever

is applicable.

Curriculum:

Unit	Title	Learning Points
USBCHP04	P401	1) Parts and maintenance of a microscope. 2) A study of electron micrographs of cell organelles. 3) Permanent slides of Muscle tissue 4) Recrystallization of Benzoic acid and determination of its yield. 5) Ammonium sulphate fractionation of protein and its estimation by a suitablemethod. 6) Field visit/ assignment on any topic from the syllabus.
	P402	1) Blood Experiments: i. Determination of total RBC count ii. Determination of total WBC count 2) Urine analysis : i] Normal constituents - Urea, Uric acid, Chloride ii] Abnormal constituents – Glucose, Protein Ketone bodies, bile salts and bilepigments. iii] Titratable acidity [using neutral red or phenol red] 3) Bile : ***i] Detection of Bilirubin [Iodine test / Gmelin's Nitric acid test / Fouchet's test]ii] Detection of Bile salt [Pettenkofer's test. Hays sulphur test]*** 4) A demonstration of online muscle twitch. 5) Demonstration of plant movement. [A project to be handled in a group. Each group to plan and execute the experiment in any way they choose. Results to be presentedto the class during a practical turn.]
	P403	1) Isolation of DNA from Onions and confirmation by DPA test 2) Determination of the Minimum Inhibitory Concentration of any one disinfectant. 3) Determination of the potability of water by conducting a coliform count. [MPN] 4) Gram stain of sewage. 5) Determination of the Chemical Oxygen demand of an effluent / sewage. 6) Preparation of immobilized yeast/ amylase and determination of enzyme activity.

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Continuous Internal Evaluation (60M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed	**30**
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	**15**
Viva	**15**

B. Semester End Evaluation (Exam Pattern) (90 Marks - 4 hours)

Q.No.	**Title**	**Method**	**Marks**
1	P401	Experiment performance as per practical exam paper	30
2	P402	Experiment performance as per practical exam paper	30
3	P403	Experiment performance as per practical exam paper	30

Revised Syllabus of Courses of

Bachelor of Science (B.Sc.) Biochemistry Program

Under Choice Based Credit System

Course Structure

T.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

No. of Courses	Semester V	Credits
USBCH501	**Metabolism and analytical technique's-I**	**2.5**
USBCH502	**Environmental science**	**2.5**
USBCH 503	**Genetic and recombinant technology**	**2.5**
US BCH P06	**Immunology and physiology I**	**2.5**
USBCHP05	**Practical course**	**3**
USBCHP06	**Practical Course**	**3**

Name of the Course	Metabolism and Analytical techniques-I
Course Code (refer to student handbook)	USBCH501
Class	T.Y.B.Sc.
Semester	V
No of Credits	2.5
Nature	Theory
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The current course helps learner to understand rale played by vitamins in maintaining health and body functions via studying their structure, sources, daily requirement and the role played in the metabolism. Metabolism impacts all cellular functions and plays a fundamental role in biology. Learner will also learn how it gets distributed in various diseases such as Type II diabetes, carbohydrate metabolism and electron transport chain. Chromatography is an important biophysical technique that enables separation, identification and purification of the components of a mixture from quantitative and qualitative analysis.

Metabolism and Analytical techniques-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Role of vitamins and minerals in metabolism**	15
2.	**Bioenergetics & Oxidative Phosphorylation**	15
3.	**Carbohydrate metabolism**	15
4.	**Chromatography**	15
	Total	60

Nomenclature: Metabolism and Analytical techniques-I

Course Outcomes:

At the end of the course the learner should:

CO1: understand simple concepts related to metabolism, metabolic roles played by vitamins and minerals, appreciate the correlation between energy molecules, reducing equivalents and pathways
CO2: comprehend the catabolism and anabolism of carbohydrates and the disorders associated with these biomolecules.
CO3: have learnt the principle, working and applications of chromatography technique and be able to appreciate the contribution of this technique to the study of various biomolecules

Curriculum:

UNIT		TITLE AND LEARNING POINT	NO. OF LECTURES
I	**1.0**	**Role of vitamins and minerals in metabolism**	**15**
	1.1 1.1.1 1.2 1.2.1 1.2.2	**Minerals as cofactors:** Iron, Calcium, Magnesium, Zinc, Selenium, Molybdenum. **Vitamins as Coenzymes**: Water soluble vitamins –Thiamin, Riboflavin, Niacin, Pyridoxine, Biotin, Lipoic acid: Chemistry of the Vitamin and its coenzyme form [structure not to be done, only group involved in its activity] and one biochemical role; Fat soluble vitamins A, D, E, K: Vitamin A – Chemistry, Wald's Visual cycle and role of Rhodopsin (with structure), Transducin, cGMP in vision;Vitamin D – role in Ca absorption and mobilization; Vit E and Vit K– physiological role (Vitamins D, E, K no structures)	
II	**2.0**	**Bioenergetics & Oxidative Phosphorylation**	**15**
	2.1	**Bioenergetics:** Concept of free energy; Respiratory electron transport chain – Carriers [basic chemistry, redox potentials, orientation on the membrane, sequence}; Q cycle in Complex III; Inhibitors of electron transport - Antimycin A , Amytal, Rotenone, CN, Azide,CO; Barbital Malate-Aspartate shuttle and Glycerol phosphate shuttle	
	2.2.	**Oxidative phosphorylation** –Chemiosmotic hypothesis, Proton motive force; Structure of ATP synthase, Uncoupler-of ETC andOxidative phosphorylation [DNP]	
	2.3	**Photosynthesis** – Light and dark reactions, Z scheme and electroncarriers, photophosphorylation [linear and cyclic]; Calvin cycle – schematic with enzymes; Photorespiration	
	2.4	Bioluminescence. Phenomenon and its biological significance.Applications of Bioluminescence	
III	**3.0**	**Carbohydrate metabolism**	**15**
	3.1.	Catabolism – Cellular location, sequence of reactions, labelling of carbon atom, and energetics of: Glycolysis (aerobic and anaerobic); Oxidation of pyruvate, Krebs cycle; Glyoxylate pathway;	

		Glycogenolysis – [schematic – no structures, but with enzymes andcoenzymes]	
	3.2	Anabolism – HMP shunt (Cellular location, sequence of reactions,multifunctional nature); Gluconeogenesis, Glycogenesis – [schematic – no structures, but with enzymes and coenzymes]	
	3.3	Disorders of carbohydrate metabolism: • Galactosemia, Fructosemia, Lactose intolerance	
IV	**4.0**	**Chromatography**	**15**
	4.1 4.1.1 4.2. 4.3	**Chromatography** Principle, Theoretical plates, Technique and Applications of the following kinds of chromatography: Partition chromatography (Paper), Adsorption Chromatography (TLC and column); Ion exchange chromatography and Gel filtration Principle and applications of GLC, HPLC, HPTLC, Affinity chromatography, Numerical problems based on above concept	

Learning Resources recommended:

5. Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
6. Biochemistry by Donald Voet, 3rd Edition (2004)
7. Fundamentals of Biochdemistry by Jain and Jain, 1st multicolor edition (2009)
8. Principles and techniques of Biochemistry and molecular biology by Wilson and Walker 6th edition (2005)

Evaluation Pattern

A. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment/ Presentation/ Open Book Test/ Chart Preparation	**10**
Class performance and attendance	**10**

B. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Environmental Science
Course Code (Refer to student handbook)	USBCH502
Class	T.Y.B.Sc.
Semester	V
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course is designed to give through understanding of causes and prevention of different pollutions. Pupil will understand environmental sustainability. Learners will get to know about various ways of environmental monitoring.

Environmental Science

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Air**	**15**
2.	**Water & Water treatment**	**15**
3.	**Soil & Noise**	**15**
4.	**Energy, Industrial Pollutants and Environmental Monitoring**	**15**
	Total	**60**

Nomenclature: Environmental Science

Course Outcomes:

At the end of the course the learner should:
CO1: aware of our environment.
CO2: sensitized to the challenging environmental issues and problems
CO3: motivated to address the environmental problems and to work towards finding solutions to these problems.

Curriculum:

UNIT		TITLE AND LEARNING POINT	NO. OF LECTURES
I	**1.0**	**Air**	**15**
	1.1 1.1.1 1.1.2 1.1.3	Atmosphere Composition and structure of atmosphere Particles, ions and radicals in the atmosphere Chemical and photochemical reactions in the atmosphere [reactions of oxygen, ozone, sulphur dioxide, nitrogen oxide and organic compounds]	
	1.2.1	Air Pollutants – CO, Oxides of Nitrogen, SO_2, hydrocarbonsand photochemical smog, Greenhouse gases, suspended particulate matter [sources and effect of] , depletion of ozone	
II	**2.0**	**Water & Water treatment**	**15**
	2.1 2.1.1	Water Hydrosphere- characteristics and the water cycle	
	2.2 2.2.1 2.2.2	Water Pollution Organic pollutants [pesticides, insecticides, detergents, oil spills, toxic organic chemicals] Inorganic pollutants [heavy metals – Hg, Pb, As, Cd] Thermal pollution of water	
	2.3 2.3.1 2.3.2	Water treatment: Criteria for water purity, Water purification [preliminary,primary, secondary, tertiary-chlorination, ion exchange]	
III		**Soil & Noise**	**15**
	3.1	Soil	
	3.1.1	Composition of soil,	
	3.1.2	Nitrogen cycle	
	3.1.3	Types of soil pollution – acidification, agrochemical pollution,	
		salinization, and contamination by metalliferous wastes	
	3.2	Noise and its measurement	
	3.2.1	Classification of Noise	
	3.2.2	Causes and consequences of Noise pollution	

IV	**4.0**	**Energy, Industrial Pollutants and EnvironmentalMonitoring**	**15**
	4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5	Energy Conventional Sources: Coal, Coke, Natural gas (CNG), Petroleum products (Petrol, Diesel, Kerosene, Oils, Naphtha) Non-Conventional Sources: Solar, Geothermal, Tidal, Hydroelectric power, nuclear energy, Biofuels, Natural gas (Synthetic Natural Gas)	
	4.2 4.2.1 4.2.2 4.2.3 4.2.4	Industrial pollutants (Sources and remedial measures) Polymers and Plastics Asbestos Poly Chlorinated Biphenyls Mining – Acid mine drainage	
	4.3 4.3.1 4.3.2	Environmental monitoring Approaches used to monitor the environment-air, water and soil. [Principles and Significance only. Protocols for each factor – not required] Remote Sensing	

Learning Resources recommended:

1) Environmental Chemistry by A.K.De, 7th edition (2007)
2) Environmental pollution Monitoring and control by S.M. Khopkar, 2nd edition (2018)
3) Handbook of environmental monitoring by Emma Layer (2015)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Genetics and Recombinant DNA Technology
Course Code (Refer to student handbook)	USBCH503
Class	T.Y.B.Sc.
Semester	V
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course gives idea about central dogma of life. It helps learners to understand about different methods used in genetic engineering and how recombinant DNA technology is playing a vital role in improving health conditions by developing new vaccines and pharmaceuticals.

Genetics and Recombinant DNA Technology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**DNA Replication & Repair**	**15**
2.	**Transcription & Translation**	**15**
3.	**Recombinant DNA Technology I**	**15**
4.	**Recombinant DNA Technology II**	**15**
	Total	**60**

Nomenclature: Genetics and Recombinant DNA Technology

Course Outcomes:

At the end of the course the learner should:

CO1: be able to appreciate the experiments carried out by various scientists to prove DNA as the genetic material, understand the mechanism of DNA replication and comprehend how DNA damage can lead to detrimental effects and how DNA repair systems in the cells try to prevent mutations before being inherited.

CO2: understand the mechanisms of DNA transcription and translation in prokaryotes

CO3: understand the basic tools required and know the techniques of recombinant DNA technology, their applications and the use of the technology for the benefit of society.

Curriculum:

UNIT		TITLE AND LEARNING POINT	NO. OF LECTURES
I	**1.0**	**DNA Replication & Repair**	**15**
	1.1	**Replication of DNA (in prokaryotes)** - Models of DNA replication: Semi-conservative, Dispersive & Conservative; Modes of DNA replication: Theta & rolling circle; Enzymes (pol I, II and III) and accessory proteins; Mechanism of semi-conservative replication;	
	1.2	**Mutations:** Point and Gross- Structural (Deletion, Duplication, Inversion, Translocation, insertion); Numerical (Euploidy, Aneuploidy)	
	1.3	**DNA repair**: Direct, Photoreactivation O6 - methyl guanine DNA methyl transferase, Excision repair, Mismatch repair, Recombination repair, SOS-error prone repair	
II	**2.0**	**Transcription & Translation**	**15**
	2.1	**Transcription** - in prokaryotes, prokaryotic RNA polymerase and promoter; mechanism of RNA transcription: Initiation, elongation and termination; processing of tRNA, rRNA, mRNA(prokaryotes and eukaryotes)- concept of split genes, reverse transcription. Role of Inhibitor- Rifampicin, Actinomycin D	

	2.2	**Translation (protein biosynthesis) in prokaryotes** – Genetic code, mechanism of translation: Activation of amino acids, chaininitiation, elongation & termination: Post translational modifications of proteins Inhibitors and mode of action: Puromycin, Chloramphenicol,cycloheximide, tetracycline	
III	**3.0**	**Recombinant DNA Technology I**	**15**
	3.1	Introduction to	
	3.2	RDTTools for RDT (a) Enzymes- Restriction endonucleases, ligases, terminaltransferases, reverse transcriptase: (b) Cloning and Expression Vectors- Plasmid, pBR 322, PUC-19, Bacteriophage – Lambda phage; Cosmid; Artificial Chromosomes (BAC and YAC); Shuttle vectors;	
	3.3	(c) Probes- DNA probes Applications of RDT- Agriculture (Bt Cotton); Medicine(Insulin); GM food	
IV	**4.0**	**Recombinant DNA Technology II**	**15**
	4.1	Isolation of gene: Gene library and c-DNA library; Southern blot; Chimeric DNA	
	4.2	Gene Transfer: Transformation, Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief) Selection and screening- Antibiotic and colony hybridization	
	4.3	DNA Amplification by PCR (Steps, Types, Applications)	
	4.4	DNA fingerprinting, DNA sequencing (any one method)	

Learning Resources recommended:

4) Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
5) IGenetics by Russel, 3rd edition (2016)
6) Biotechnology Expanding Horizons by B.D. Singh, 4th edition (2014)
7) Advance in Biotechnology by Jogdand, 2nd edition (2007)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Immunology and pathophysiology-I
Course Code (refer to student handbook)	USBCH504
Class	T.Y.B.Sc.
Semester	V
No of Credits	2.5
Nature	Theory
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Undergraduate immunology course provides students with basic idea about immunology, different cells and organs involved in immunology and how it protects us from various life-threatening infectious diseases. Course also deals with how abnormal chemical reactions cause metabolic disorders. Learners will know about clinical manifestations of these diseases. Learners will get acquainted with causes and progression of cancer. They will learn about safe method of prevention and detection.

Immunology and pathophysiology-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Human immune system**	**15**
2.	**Antigen- Antibody interactions**	**15**
3.	**Pathophysiology of metabolic and other disorders**	**15**
4.	**Cancer**	**15**
	Total	**60**

Nomenclature: Immunology and pathophysiology-I

Course Outcomes:

At the end of the course the learner should:

CO1: understand the overall organization of the immune system, appreciate the structure and function of antibodies, relationship between innate and adaptive systems and humoral and cell mediated immunity.

CO2: learn the normal and abnormal metabolic pathways of bio-molecules (carbohydrates, proteins, lipids) and diseases related.

CO3: be able to discuss pathophysiology and etiology of different diseases and in born errors.

CO4: understand basic aspects of cancer biology and familiarize with elementary facets of carcinogenesis and types of cancer along with therapy to treat the cancer.

Curriculum:

UNIT		TITLE AND LEARNING POINT	NO. OF LECTURES
I	**1.0**		**15**
	1.1 1.1.1 1.1.2 1.1.3 1.1.4	Types of Immunity Innate immunity – Anatomical barriers, physiological barriers, Characteristics of Inflammation, phagocytosis [no mechanism] Adaptive immunity – Active & Passive Humoral & Cell mediated immunity	
	1.2 1.2.1 1.2.2	Organs of the immune system: Primary lymphoid organs: Thymus, Bone marrow Secondary lymphoid organs: Lymphatic system, Lymph nodes, Spleen, MALT.	
	1.3 1.3.1 1.3.2	Cells of the immune system: Lymphocytes – B cells and T cells, Natural killer cells – Mononuclear phagocytes, Granulocytes, Antigen presenting cells. Clonal selection & immunologic memory.	
	1.3.3	Cytokines: biological functions of IL1, tumor necrosis factor-alpha, interferon –alpha, IL2, interferon-gamma.	
II	**2.0**	**Antigen- Antibody interactions**	**15**

	2.1	Antigens: Antigenicity, immunogenicity, epitope, factorsdetermining immunogenicity, Haptens. Antibodies: Fine structure of immunoglobulin, Antibody- mediated functions, Antibody classes, Monoclonal antibodies(concept, production and applications)	
	2.2	Antibody diversity*:* Multigene organization of immunoglobulingenes – Lambda, kappa & heavy chain Light chain DNA – VJ rearrangements Heavy chain DNA - VDJ rearrangements	
III	**3.0**	**Pathophysiology of metabolic and other disorders**	**15**
	3.1 3.1.1 3.1.2	Metabolic disorder Inborn error: With respect to Etiology and Clinical manifestations Carbohydrate Metabolism: Glycogen storage disease Type I & III.	
	3.1.3 3.1.4	Amino acid Metabolism: Albinism, Phenylketonuria, Maple syrup urine disease, Alkaptonuria Lipid Metabolism: Tay Sach's disease, Niemann-Pick diseases, Fabry's disease	
	3.2 3.2.1 3.2.2 3.2.3 3.2.4 3.2.5	Blood related diseases*:* Iron deficiency anemia. Sickle cell anemia. Thalassemia. Pernicious anemia Hemophilia A and B	
	3.3 3.3.1	Cardio Vascular System and related diseases*:* Hypertension, Arteriosclerosis and Atherosclerosis	
IV	**4.0**	**Cancer**	**15**
	4.1 4.2 4.3 4.4 4.5 4.6	Biology of Cancer. Physiology of Cancer cells. Causes of cancer Carcinogens: Types (Physical, Chemical and Biological, Environmental Factor); AMES test Oncogenes and activation of oncogenes Genetics of cancer with reference to p53 and Bcl2. Cancer therapy (Chemo – purine, pyrimidine and folate analogs) Cancer and the cell cycle	

Learning Resources recommended:

1. Immunology by Goldsby and Kuby, 3rd edition (2003)
2. Roitt,s essential immunology by Martin and et.al. 13th edition (2019)
3. Inborn errors of Metabolism by Lee and Scaglia, 1st edition (2015)
4. Karp's Cell and Molecular Biology by Iwasa and Marshall, 8th edition (2015)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Practicals based on USBCH501 and USBCH502
Course Code (Refer to student handbook)	USBCHP05
Class	T.Y.B.Sc.
Semester	V
No of Credits	3
Nature	Practical
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In this practical course, learners will get hands on training on a. Chromatographic separation b. Enzymology c. Volumetric estimation d. pH and conductance

Nomenclature: Practicals based on USBCH501 and USBCH502

Course Outcomes:

CO1: Learn to develop a plan of work based on aim and objectives

CO2: Perform the practical work effectively using oral and written means

CO3: Understand the concept behind the practical and analyze and conclude the results

CO4: Get hand on training on pH and conductivity meter while thoroughly understand chromatographic separation, enzymology and volumetric estimation.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for three groups: P501, P502 and P5S03 from this course.

7. Semester End Practical Examination will be of 9 hours and it is scheduled in 1and a half day.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever is applicable.

Curriculum:

Unit	Title	Learning Points
USBCHP05	USBCH501	1) Determination of the optimum pH of β-Amylase. 2) Determination of Km of β-Amylase from sweet potato. 3) Determination of the activity and specific activity of β-Amylase from sweet potato. 4) Effect of an inhibitor (eg. EDTA) on Amylase activity. 5) Estimation of glucose by Benedict's method. 6) Separation of sugars by circular paper chromatography 7) Demonstration Experiments Separation of plant pigments by adsorption column chromatography (eg. Silica/Alumina)
	USBCH502	1) Determination of the pH of water/effluent/soil using a pH meter. 2) Determination of the conductance of water / effluent. 3) Estimation of organic content of soil – Diphenylamine method. 4) Estimation of lead by the EDTA method. 5) Estimation of copper by the Isoamyl alcohol method. 6) Determination of salinity of / chlorides in water - Silver nitrate method. 7) Determination of the Chemical Oxygen Demand of water/effluent by the potassium dichromate method

Learning Resources recommended:

5. Biochemical Calculation by Segel, 2nd edition (2010)
6. Biochemical Methods by Sadashivam, 2nd edition (2005)
7. Introductory Practical Biochemistry by Sawhney and Singh (2001)
8. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (60M)

C.

Q. No.	**Title**	**Method**	**Marks**
1	Practicals based on USBCH501	Experiment performance as per practical exam paper	30
2	Practicals based on USBCH502	Experiment performance as per practical exam paper	30

Name of the Course	Practicals based on USBCH503 and USBCH504
Course Code (Refer to student handbook)	USBCHP06
Class	T.Y.B.Sc.
Semester	V
No of Credits	3
Nature	Practical
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In this practical course, learners will get hands on training on a. Colorimetric estimation b. Isolation c. Volumetric estimation d. Hematology

Nomenclature: Practicals based on USBCH503 and USBCH504

Course Outcomes:

CO1: Learn to develop a plan of work based on aim and objectives

CO2: Perform the practical work effectively using oral and written means

CO3: Understand the concept behind the practical and analyze and conclude the results

CO4: Get hands on training on colorimetric estimation, isolation, volumetric estimation, and hematology.

Curriculum:

Unit	Title	Learning Points
USBCHP06	USBCH503	1) Estimation of glucose by DNSA method. 2) Estimation of glucose by the Folin Wu method. 3) Determination of the Hemoglobin content by the Sahli's hemoglobinometer. 4) Determination of blood groups. 5) Detection of Ca^{+2} and Mg^{+2} ions in by the Eriochrome Black T-EDTA method. 6) Estimation of phosphorus by Fiske and Subbarao method
	USBCH504	1) Isolation of starch from sweet potato. 2) Extraction of lipid from oil seeds by the cold percolation method. 3) Estimation of DNA by the Diphenylamine method 4) Isolation and spooling of DNA from onion / moong

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (60M)

Q. No.	**Title**	**Method**	**Marks**
1	Practicals based on USBCH503	Experiment performance as per practical exam paper	30
2	Practicals based on USBCH504	Experiment performance as per practical exam paper	30

Bachelor of Science (B.Sc.) Biochemistry Program

Under Choice Based Credit System

Course Structure

T.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

No. of Courses	Semester VI	Credits
USBCH601	**Metabolism and analytical technique's-II**	**2.5**
USBCH602	**Nutrition and pharmacology**	**2.5**
USBCH 603	**Biostatics and bioinformatics**	**2.5**
US BCH 604	**Immunology and physiology II**	**2.5**
USBCHP07	**Practical course**	**3**
USBCHP08	**Practical Course**	**3**

Name of the Course	Metabolism and Analytical techniques-II
Course Code (Refer to student handbook)	USBCH601
Class	T.Y.B.Sc.
Semester	VI
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Metabolism impacts all cellular functions and plays a fundamental role in biology. Learners will understand the metabolic pathways of lipids and nucleic acids. Spectrophotometry is an important biophysical technique that enables separation, identification and purification of the components of a mixture from quantitative and qualitative analysis. Electrophoresis technique is used for detection of protein and nucleic acids.

Metabolism and Analytical techniques-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Lipid metabolism**	15
2.	**Amino acid & protein metabolism, Hormones & Signal transduction**	15
3.	**Centrifugation and Spectrophotometry**	15
4.	**Electrophoresis & Radioactivity**	15
	Total	60

Nomenclature: Metabolism and Analytical techniques-II

Course Outcomes:

At the end of the course the learner should:

CO1: understand breakdown and synthesis of fatty acids and amino acids and appreciate experiments carried out by scientists to enable understand the pathways and cycles of metabolism.

CO2: understand basic concepts related to metabolism, be familiar with the various metabolic pathways and should be able to appreciate the importance of enzymes and coenzymes in pathophysiology of diseases

CO3: be able to appreciate the various hormones, their actions, regulations and clinical significance.

CO4: have learnt the principle, working and applications of various analytical techniques and be able to appreciate the contribution of these techniques (colorimeter/ spectrophotometer, Centrifuges, electrophoresis and radioisotopes) as tools in understanding the structure and function of biomolecules.

Curriculum:

UNIT		TITLE AND LEARNING POINT	NO. OF LECTURES
I	**1.0**	**Lipid metabolism**	**15**
	1.1	Lipid metabolism – Catabolism - Knoop's experiment; Beta oxidation of even carbonsaturated fatty acids (C4 to C20) Energetics of fatty acid oxidation. Beta oxidation of odd carbon chain fatty acid	
	1.2	Anabolism – FAS complex; Fatty acid biosynthesis (palmitic acid); Ketone body formation, utilization, and the physiologicalsignificance of Ketone bodies in Diabetes mellitus, Starvation, Pregnancy and Alcoholism.	
II	**2.0**	**Amino acid & protein metabolism and Hormones & Signaltransduction**	**15**
	2.1	Amino acid and protein metabolism – Reactions of amino acids – Transamination [GOT/GPT and mechanism of transamination] ; Decarboxylation [His, Trp, Glu,and mechanism of decarboxylation] , Deamination [oxidative – NAD(P) linked dehydrogenases and D & L - Amino acid oxidases, Non oxidative – Asp, Cys, Ser]	
	2.1.2	Glucogenic and ketogenic amino acids	
	2.1.3	Urea cycle – Cellular location, sequence of reactions, Labeling ofN atom, transport of NH_3	
	2.2 2.2.1	**Hormone action and signal transduction** Hormone receptors (membrane and intracellular)	
	2.2.2	Introduction to G protein, G protein coupled receptor, Effect of epinephrine on glycogen synthesis and breakdown: amplificationcascade with G proteins, cAMP (as second messenger), adenylatecyclase, kinases	
	2.2.3	IP3 and Calcium as second messenger	
III	**3.0**	**Centrifugation and Spectrophotometry**	**15**
	3. 1 3.1.1 3.1.2 3.1.3	**Centrifugation** RCF, RPM and derivation of an equation relating the two; Nomogram; Sedimentation coefficient and factors affecting;Derivation of sedimentation velocity, Wall effect Types and applications of centrifuges – Clinical, High speed,Ultra centrifuge - preparative and analytical. Types of centrifugation and its applications– Differential, Ratezonal, Isopycnic, Types of rotors	

	3.1.4	Preparation of density gradient, Sample application, choice ofrotors, Recovery pf sample Numerical problems based on above concepts	
	3.2 3.2.1. 3.2.2 3.2.3	**Spectrophotometry** Beer-Lambert law, derivation, limitations & applications in theestimation of sugar [DNSA] and protein [Biuret]; concepts of Lambda max; determination of molar extinction coefficient Construction and working of a simple colorimeter and UV/ Visspectrophotometer Numerical problems based on the above concepts	
IV	**4.0**	**Electrophoresis & Radioactivity**	**15**
	4.1 4.1.1 4.1.2 4.1.3 4.1.4 4.1.5 4.1.6	**Electrophoresis** Principle: Factors affecting the rate of migration of sample in anelectric field Moving boundary and Zone electrophoresis; Components ofelectrophoresis unit/apparatus Various support media - paper, cellulose acetate, agar, agaroseand polyacrylamide Technique of electrophoresis with staining/visualization method • agarose electrophoresis for separation of DNA • Native PAGE for separation of proteins • SDS PAGE for molecular weight determination; • Discontinuous electrophoresis • Other applications of electrophoresis: blotting techniques-Southern, Northern, and Western Isoelectric Focusing of protein	
	4.2	**Radioactivity-** Isotopes, Radioactive decay; Decay constant;Half-life; Measurement of radioactivity (principle)	

Learning Resources recommended:

1. Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
2. Biochemistry by Donald Voet, 3rd Edition (2004)
3. Fundamentals of Biochemistry by Jain and Jain, 1st multicolor edition (2009)
4. Biophysical Chemistry by Nath and Upadhyay, Revised edition (2009)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Nutrition and Pharmacology
Course Code (Refer to student handbook)	USBCH602
Class	T.Y.B.Sc.
Semester	VI
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Study is mainly focused on food, health and management of diseases. Learners will understand how health issues are attributed to poor diet and nutrition. It summarizes science of food. Students will be acquainted with interdisciplinary field of pharmacology where they explore many aspects of drug discovery, development and preclinical drug safety.

Nutrition and Pharmacology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Nutrition**	**15**
2.	**Diet Management**	**15**
3.	**Pharmacology**	**15**
4.	**Mechanism of Drug Action and Therapeutic drugs**	**15**
	Total	**60**

Nomenclature: Nutrition and Pharmacology

Course Outcomes:

CO1: be able to appreciate the role of nutrients in diet to understand nutritional status and concept of balanced diet which will help to identify the overall nutrition to be given to men and women at various age groups.

CO2: be familiarized with dietary management in diseases

CO3: be able to utilize critical thinking skills in discussing the concept of pharmacokinetics and pharmacotherapy.

CO4: be able to explain various therapeutic drugs in use.

Curriculum:

UNIT		TOPIC AND LEARNIMG POINTS	NO. OF LECTURES
I	**1.0**	**Nutrition**	**15**
	1.1 1.1.1 1.1.2 1.1.3	Principles of nutrition Nutrients [Proximate principles, vitamins and minerals (macro and micro- role of Ca, Mg, Na, K and Fe, Zn)], dietary fibre. Nutritional status [malnutrition (protein energy and protein calorie) and over nutrition] Balanced diet	
	1.2.1 1.2.2 1.2.3	Energy Assessment - RQ, BMR; Anthropometry – BMI, Waist:hip ratio; Protein quality indices: Chemical score of amino acids, Protein Deficiency Corrected Amino Acid Score, Net Protein utilization	
II	**2.0**	**Diet Management**	**15**
	2.1	Concepts like Balanced diet, Meal planning.	
	2.2	Nutrition during pregnancy, lactation, infancy, toddlerhood,preschool stage, school going children, and adolescence, adulthood and geriatric	
	2.3	Dietary Management in :- Obesity, Diabetes Mellitus,Hypertension, Peptic ulcer , Obstructive Jaundice	
III	**3.0**	**Pharmacology**	
	3.1 3.1.1 3.1.2	General pharmacology Pharmacodynamics, Physicochemical properties of drugs, Drug absorption: through-GIT, pulmonary, renal,	**15**

	3.1.3 3.1.4	placental andblood-brain barrier Bioavailability and Bioequivalence Drug Distribution, Metabolism and Excretion	
	3.2	Bioassays: Preclinical and clinical evaluation,Therapeutic drug monitoring	
	3.3	Pharmacokinetics: LD_{50}, ED_{50}, Half Life, Loading dose, Maintenance dose,Therapeutic dose, Therapeutic Index, Drug plasma concentration, Volume of distribution, Clearance	
IV	**4.0**	**Mechanism of Drug Action and Therapeutic drugs**	
	4.1 4.2 4.2.1 4.2.2 4.2.3	Mechanism of action of drugs: i. Specific interaction – receptor mediated ii. Partially specific – drugs via enzymes iii. Nonspecific interactions – antimetabolites and antiseptics iv. Through Antibodies v. Placebo effects Therapeutic drugs: (Mechanism of action and adverse effects)Anti-inflammatory – non steroid anti-inflammatory NSAID [Ibuprofen], Salicylates – [Aspirins] Cardiovascular drugs- CVS [Ca channel blocker-Amlodipine,and Beta blocker – Proprenolol Antibiotic – Penicillin and Sulphonamide Antacid- Proton pump blocker –Omeprazole	**15**

Learning Resources recommended:

4. Dietetics by B. Srilakshmi, 8th edition (2019)
5. Textbook of pharmacology by FSK Barar, 4th edition (2012)
6. Textbook of Medical Biochemistry by M.N. Chatterjee & Ranashinde, 6th edition (2007)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Biostatistics and Bioinformatics
Course Code (Refer to student handbook)	USBCH603
Class	T.Y.B.Sc.
Semester	VI
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Introduction to Basic concepts of Biostatistics is aim at making learners familiar to various treatments that an experimental data can be given which will help build the foundation for the future research studies that they may pursue in future career. In this course, elementary level understanding of the tools and methods of assessment are covered. Bioinformatics in the given course helps learners in utilizing data mining techniques and enhancing its applications in acquiring biological data.

Biostatistics and Bioinformatics

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Biostatistics and descriptive statistics**	**15**
2.	**Bioinformatics**	**15**
3.	**Hypothesis testing**	**15**
4.	**Hypothesis testing**	**15**
	Total	**60**

Nomenclature: Biostatistics and Bioinformatics

Course Outcomes:

CO1: understand the basic principles of probability and how they relate to biostatistics.

CO2: become familiar with the mathematical and statistical theory underlying the applications of biostatistical methods to interpret statistical results correctly, effectively and in context.

CO3: be able to interpret relationships among living things and analyze and solve biological problems, using basic biological concepts, grounded in foundational theories with the help of bioinformatics tools.

CO4: be able to apply existing software effectively to extract information from large databases and to use this information in biological sciences

Curriculum:

UNIT		TOPIC AND LEARNIMG POINTS	NO. OF LECTURES
I	**1.0** 1.1.1 1.1.2 1.1.3	**BIOSTATISTICS AND DESCRIPTIVE STATISTICS** Introduction: scope and applications of biostatistics Common statistical terms: Sources, nature and presentation of data; Measurement and scales of measurement Descriptive statistics: Measures of central tendency- Mean, Median and mode	**15**
	1.2	Measures of dispersion- Range, percentiles, variance, SD, Meandeviation,	
	1.3	**Probability** Concept of probability: definition Probability distribution: normal distribution and normal Curve,Asymmetric distribution Statistical problems based on the above concepts	
II	**2.0**	**BIOINFORMATICS**	**15**
	2.1	**Bioinformatics:** Definition, Aims and History of Bioinformatics Applications of Bioinformatics in – Sequence analysis, Molecularmodeling and drug designing, Phylogeny/evolution, Ecology & population studies, Medical informatics and agriculture. Introduction to Genomics and Proteomics Databases- Definition & types – Public domain database, Sequence database, Structural database, Motif database, Genome database, Proteome database, Annotated sequence database. Fullform & function in brief of - GenBank, EMBL, PIR, SWISS PROT, PDB, GDB. Sequence analysis Tools - Explain the following terms in brief -BLAST, FASTA, L-ALIGN, CLUSTAL- X & W, RASMOL, Software for protein sequencing - PROSPECT, AMMP, COPIA(Explanation of the terms in brief) Micro-array analysis-concept and applications	
III	**3.0**	**HYPOTHESIS TESTING**	**15**
	3.1 3.2 3.3 3.4	- Introduction; Single population mean, difference between population means Type I and Type II errors, One-tailed and two tailed tests Z-test Statistical problems based on the above concepts	

IV	**4.0** 4.1 4.2	**HYPOTHESIS TESTING** t-test- Paired and unpairedChi-square Statistical problems based on the above concepts	**15**

Learning Resources recommended:

1. Introduction to biostatistics (A textbook of Biometry) by Dr. Pranab Kumar Banerjee, 4th edition (2022)
2. Biostatistics by Arora, revised edition (2016)
3. Methods in Biostatistics by BK Mahajan, 7th edition (2010)
4. Bioinformatics Methods and Applications by Rastogi, 5th edition (2022)

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Immunology and pathophysiology-II
Course Code (Refer to student handbook)	USBCH604
Class	T.Y.B.Sc.
Semester	VI
No of Credits	2.5
Nature	Theory
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Undergraduate immunology course provides students with basic idea about immunology, different cells and organs involved in immunology and how it protects us from various life-threatening infectious diseases. Course also deals with how abnormal chemical reactions cause metabolic disorders. Learners will know about clinical manifestations of these diseases. They will learn about safe method of prevention and detection. They will be able to explain the structure and pathophysiology of HIV and other viruses.

Immunology and pathophysiology-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	**Antigen- Antibody interactions & Complement system**	**15**
2.	**Major histocompatibility complex &Transplant immunology**	**15**
3.	**Pathophysiology of viral diseases**	**15**
4.	**Endocrine Diseases & Ageing**	**15**
	Total	**60**

Nomenclature: Immunology and pathophysiology-II

Course Outcomes:

CO1: understand the pathways that activate the complement system.
CO2: be familiar with the MHC; its structure and classes, specific role of each class of MHC and importance in immune response and graft rejection.
CO3: grasp a contemporary understanding of classification, structure and mechanism of replication of viruses along with pathophysiology symptoms and preventive measures of AIDS.
CO4: understand the basic concepts of demography and epidemiology of aging and pathophysiology and issues in common diseases of older people

Curriculum:

Unit No	Topic No	Topics	No. of L
I	**1.0**	**Antigen- Antibody interactions & Complement system**	**15**
	1.1 1.1.1 1.1.2 1.1.3 1.1.4 1.1.5	Antigen- Antibody interactions: Forces involved, antibody affinity, antibody avidity. Precipitation reactions – Oudins, Ouchterlony Agglutination reactions: Blood typing, bacterial agglutination, Passive agglutination, agglutination inhibition, Coomb's test. Immunoelectrophoretic. Principles of Radioimmunoassay, ELISA, Immunofluorescence	
	1.2 1.2.1 1.2.2 1.2.3	Complement Components of complement; Complement activation – Classical & alternate pathway; formation of membrane attack complex. Biological consequences of complement activation. [in brief]	
II	**2.0**	**Major histocompatibility complex &Transplant immunology**	**15**
	2.1. 2.1. 1 2.1.2	Major histocompatibility complex: MHC polymorphism & organization of MHC genes- class I & class II; Cellular distribution & structure of class I & II molecules; Self MHC restriction of T cells. Role of antigen presenting cells.	
	2.2	Transplant immunology: Types of transplant; immunological basis of allograft rejection.	
	2.3	Autoimmunity: Organ specific –Myasthenia gravis; Hashimoto's thyroiditis, Insulin dependent diabetes mellitus Systemic – Rheumatoid arthritis, Multiple sclerosis, Systemic	

		lupus erythematosus (immunological basis of these autoimmune diseases)	
III	**3.0**	**Pathophysiology of viral diseases**	**15**
	3.1 3.2	Structure and mechanism of replication in: 1. Vaccinia 2. Polio 3. Influenza 4. Hepatitis Rabies or Ebola virus AIDS: Structure and genetics basis of AIDS virus. Replication of AIDS Virus. Symptoms and Causes of AIDS.AIDS Therapy.	
IV	**4.0**	**Endocrine Diseases & Ageing**	**15**
	4.1 4.1.1 4.1.2 4.1.3	Endocrine diseases*:* Diabetes mellitus. Hyper and Hypothyroidism, Cushing's syndrome, Acromegaly	
	4.2	Diabetes insipidus.	
	4.2	Ageing: Definition of ageing. Molecular changes during ageing. Theories of Ageing.	
	4.3	Alzheimer's disease, Parkinson's diseases	

Learning Resources recommended:

4) Immunology by Goldsby and Kuby, 3rd edition (2003)
5) Roitt,s essential immunology by Martin and et.al. 13th edition (2019)
6) Introduction to modern virology. Dimmock and et.al.6th edition 2007
7) Guyton and Hall Textbook of medical Physiology. John E. Hall 13th edition.2015

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ short answers (Concept based Questions) (1/2/3/4 Marks each)	**20**
Assignment	**10**
Class performance	**10**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
Q.1	1	12
Q.2	2	12
Q.3	3	12
Q.4	4	12
Q.5	Based on all units	12

Guidelines for paper pattern for semester end evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions
4. Diagrams or flowcharts should be drawn wherever necessary.

Name of the Course	Practicals based on USBCH601 and USBCH602
Course Code (refer to student handbook)	USBCHP07
Class	T.Y.B.Sc.
Semester	V
No of Credits	3
Nature	Practical
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	a. Chromatographic separation b. Enzymology c. Volumetric estimation d. Immunology

Nomenclature: Practicals based on USBCH601 and USBCH602

Course Outcomes:

CO1: Learn to develop a plan of work based on aim and objectives
CO2: Perform the practical work effectively using oral and written means
CO3: Understand the concept behind the practical and analyze and conclude the results
CO4: Get hand on training on immunology practicals while thoroughly understand chromatographic separation, enzymology and volumetric estimation.

Instructions for learners:

1. All measurements and readings should be written with proper units.

2. Skill of doing the experiment and understanding Biochemistry concepts should be more important than the accuracy of final result.

3. In order to appear for Semester End Examination of this course, 75% of all the experiments should be completed compulsorily and learners are required to report all these experiments in the journal of this course (Biochemistry practical journal of first semester).

4. After completing all required number of experiments of this course and recording them in journal, learner will have to get their journal certified from the head of the Biochemistry department and produce the certified journal at the time of Semester End Examination of this course.

5. A learner will be allowed to appear for the Semester End Examination of this course, only if learner submits a certified journal of this course or a certificate from the head of the Biochemistry department that the learner has completed this practical course as per the minimum requirements.

6. For Semester End Examination, the learner will be separately examined for three groups: P501, P502 and P5S03 from this course.

7. Semester End Practical Examination will be of 9 hours and it is scheduled in 1and a half day.

8. Evaluation in viva voce will be based on all practicals from this course.

9. While evaluating practical, weightage will be given to observations, diagram, tabular representation, experimental skills and procedure, graph, calculation and result, whichever is applicable.

Curriculum:

Unit	Title	Learning Points
USBCHP07	**USBCH601**	1) Separation of amino acids by circular paper chromatography 2) Estimation of Ascorbic acid Iodimetrically. 3) Determination of the optimum pH of Acid phosphatase / Urease. 4) Determination of the Km of Acid phospahatase / Urease. 5) Estimation of lactose by Cole's ferricyanide method 6) Estimation of glucose Iodometrically 7) Demonstration Experiments: Separation of plant pigments/ Oils by Thin Layer Chromatography
	USBCH602	1) Estimation of fluoride in water by the Alizarin red method 2) Determination of the Dissolved Oxygen content of water/effluent by the Winkler's Iodometric method - Azide modification. 3) Determination of the Biological Oxygen Demand of water/effluent 4) Determination of the acidity and alkalinity of water/ effluent. 5) Estimation of $CaCO_3$ of soil - Bromothymol Blue method 6) Immunoprecipitation reaction of antigen and antibody. 7) Diagnostic test for typhoid - Widal Qualitative 8) Diagnostic test for typhoid - Widal Quantitative

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (60M)

Q. No.	**Title**	**Method**	**Marks**
1	Practicals based on USBCH601	Experiment performance as per practical exam paper	30
2	Practicals based on USBCH602	Experiment performance as per practical exam paper	30

Name of the Course	Practicals based on USBCH603 and USBCH604
Course Code (Refer to student handbook)	USBCHP08
Class	T.Y.B.Sc.
Semester	V
No of Credits	3
Nature	Practical
Type (Applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	a. Biostatistics b. Monograph c. Colorimetric estimation d. Isolation

Nomenclature: Practicals based on USBCH603 and USBCH604

Course Outcomes:

CO1: Learn to develop a plan of work based on aim and objectives
CO2: Perform the practical work effectively using oral and written means
CO3: Understand the concept behind the practical and analyze and conclude the results
CO4: Get hands on training on colorimetric estimation, isolation, Monograph preparation
CO5: Increase Biostatistics problems solving ability.

Curriculum:

Unit	Title	Learning Points
USBCHP08	**USBCH603**	1) Estimation of protein by the Folin-Lowry method. 2) Estimation of iron by Wong's method. 3) Monograph of acetyl salicylate (identification, assay and purity as per IP) 4) Monograph of sucrose (identification, assay and purity as per IP) 5) Demonstration Experiments: Separation of serum proteins by PAGE
	USBCH604	1) Biostatistics – Problems 2) Isolation of RNA yeast / liver 3) Isolation of casein from milk. 4) Estimation of RNA by Orcinol method. 5) Demonstration Experiment 6) Isolation of plasmids 7) Agarose gel electrophoresis 8) Chromosomal DNA and Plasmid DNA

Learning Resources recommended:

1. Biochemical Calculation by Segel, 2nd edition (2010)
2. Biochemical Methods by Sadashivam, 2nd edition (2005)
3. Introductory Practical Biochemistry by Sawhney and Singh (2001)
4. Practical Biochemistry by David Plummer, 3rd edition (2007)

Evaluation Pattern

A. Internal Evaluation (40M)

Method	**Marks**
Performance and engagement during practical sessions: • Skills, precision, accuracy, safety measures, individual and/or collaborative working while performing practical • Ability to record proper observations, to analyze data, to plot graph and to draw meaningful conclusions of experiments • Submission of journal within a week after every practical session Based on above criteria, each experiment of this course will be assessed during regular practical session	20
Overall performance (attendance, punctuality, sincerity for practical sessions throughout semester)	10
Viva	10

B. Semester End Evaluation (60M)

Q. No.	**Title**	**Method**	**Marks**
1	Practicals based on USBCH603	Experiment performance as per practical exam paper	30
2	Practicals based on USBCH604	Experiment performance as per practical exam paper	30

R. E. Society's
R. P. Gogate College of Arts and Science & R. V. Joglekar College of Commerce, Ratnagiri (Autonomous)

Department of Biochemistry

Bachelor of Science (B.Sc) Biochemistry Programme
Under Choice Based Credit System
Course Structure

F.Y.B.Sc.

(To be implemented from Academic Year- 2023-24)

CourseCode	Semester I	Credits	Course Code	Semester II	Credits
	Open elective			***Open elective***	
USOE105	Biochemistry in Health and Diseases	**02**	USOE205	Biochemistry in Health and Diseases	**02**

Name of the Course	Biochemistry in Health and Diseases
Course Code (refer to student handbook)	USOE105 USOE205
Class	F.Y.B.Sc.
Semester	I & II
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	OE
Highlight revision specific to employability/ entrepreneurship/ skill development	This open elective course can be offered to the students of various streams. Students will understand the importance of being healthy in the current environment. They will understand the causes and treatment of various diseased states. Learners will get an idea about how proper nutrition is important to keep ourselves healthy.

Nomenclature: Biochemistry in Health and Diseases

Course Outcomes:

At the end of the course the learner should:

CO1: Get knowledge about health and various terminologies used in health and disease conditions.

CO2: Differentiate between communicable and non-communicable diseases

CO3: Be able to promote Health and treatments for various diseases and disorders.

Curriculum:

UNIT	TOPIC AND LEARNING POINTS	HOURS
1	**Health and wellness**	**10**
1.1	WHO definition of health, Health and hygiene, General health care, Factors affecting health, Indices and evaluation of health, Disease patterns in developed and developing world; Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards.	
1.2	Disease conditions: Acute disease, chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease.	
1.3	Treatment: Psychotherapy, Medications, Surgery, Medical devices, and Self-care.	
1.4	Dimensions of Health: Physical, Mental, Spiritual, Emotional, Environmental, and Philosophical.	
2	**Diseases and disorders**	**10**
2.1	Communicable diseases: Tuberculosis, Cholera, Typhoid, Conjunctivitis.	

2.2	Non-communicable diseases: Malnutrition: Undernutrition, Overnutrition; Nutritional deficiencies; Anemia, Iodine deficiency, Fluorosis.	
2.3	Sexually transmitted diseases (STD): Information, statistics, and treatment guidelines for STD, Prevention: Syphilis, Gonorrhea, AIDS.	
2.4	Lifestyle disorders: Obesity, Liver cirrhosis, Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention)	
3	**Health and awareness**	**10**
3.1	Preventing drug abuse, Oral health promotion by tobacco control.	
3.2	Mental hygiene and mental health: Concepts of mental hygiene and mental health, Characteristics of mentally healthy person, Warning signs of poor mental health, Promotive mental health, strategies and services, Ego defense mechanisms and implications, Personal and social adjustments, Guidance and Counseling.	
3.3	Infection control: Nature of infection, Chain of infection transmission, Defenses against infection transmission	

Learning Resources recommended:

1. Modern Nutrition in Health and Disease, 2006, 10th Edition, Maurice E. Shils, Moshe Shike, A Catharine Ross.

2. Clinical Biochemistry and Metabolic Medicine, 2012, Eighth Edition, Martin Andrew Crook, CRC Press,

3. Nutrition and Health in Developing Countries, 2000, Editors: R. Semba and M.W. Bloem, Humana Press.

Evaluation Pattern

C. Continuous Internal Evaluation (40M)

Method	**Marks**
Class test (written) Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines/ Short answers (Concept based Questions) (1/2/3/ 4 Marks)	20
Assignment/ Presentation/ Open Book Test/ Chart Preparation	10
Class performance and attendance	10

D. Semester End Evaluation (Paper Pattern) (60M)

Question No	**Unit**	**Marks**
Q.1	1	15
Q.2	2	15
Q.3	3	15
Q.4	Based on all units	15

Guidelines for paper pattern for semester end evaluation:

5. All questions will be compulsory and may be divided into sub-questions.
6. Descriptive type of questions, problem solving / numerical based questions, etc., will contain internal options.
7. MCQs, fill in the blanks, answer in one or two lines, match the following, true or false, etc., type of questions.
8. Diagrams or flowcharts should be drawn wherever necessary.

R. E. Society's
R. P. Gogate College of Art and Science and
R. V. Joglekar College of Commerce, Ratnagiri
(Autonomous)

Bachelor of Science (B.Sc) Biochemistry Programme
Under Choice Based Credit System
Course Structure
(To be implemented from Academic Year- 2023-24)

Add on course Syllabus 2023-24
Introduction to Biostatistics

Name of the Course	Add on course on Introduction to Biostatistics (Certificate Course)
Course Code	
Class	Optional to SY and TY students
Semester	-
No of Credits	02
Nature	Theory
Type (applicable to NEP only)	Add on course
Highlight revision specific to employability/ entrepreneurship/ skill development	Introduction to basic concepts of Biostatistics is aimed at making learners familiar to various treatments that an experimental data can be given which will help build the foundation for the future research studies that they may pursue in future career. In this course, elementary level understanding of the tools and methods of assessment are covered.

Nomenclature: Add on course on Introduction to Biostatistics

Course Outcomes:

At the end of the course the learner should:
CO1: get knowledge about various analysis techniques in statistics which can be applicable to validate the biological data.

CO2: be able to apply the methods for better understanding of observations and graphical interpretations from research papers.

CO3: be able to interpret relationships among living things and analyze and solve biological problems, using basic biological concepts.

Curriculum:

Sr. No.		Topic	No. of Lectures
Unit 1: Introduction to Biostatistics			**6 lectures**
01.	a)	Scope and Applications of Biostatistics	1 lecture
	b)	Common Statistical terms	2 lectures
	c)	Representation of data: • Graphical representation • Tabular representation	3 lectures
Unit 2: Descriptive Biostatistics			**10 lectures**
02.	a)	Measures of central tendency: • Mean • Median • Mode	6 lectures
	b)	Measures of dispersion: • Range • Mean deviation • Standard deviation • Variance • Standard error	4 lectures
Unit 3: Biostatistical Hypothesis testing			**11 lectures**
03.	a)	Introduction: • Important terms • Process of hypothesis testing • One tailed and two tailed tests • Type I and Type II error	2 lecture
	b)	Z- test	1 lecture
	c)	Student's t- test • Paired • Unpaired	3 lectures
	d)	chi-square test • Goodness of fit • Independence of attributes	5 lectures
Unit 4: Practical: Introduction to Microsoft Excel			**3 lectures**

Learning Resources recommended:

- Introduction to biostatistics (A textbook of Biometry) by Dr. Pranab Kumar Banerjee, 4th edition (2022)
- Biostatistics by Arora, revised edition (2016)
- Methods in Biostatistics by BK Mahajan, 7th edition (2010)

Evaluation Pattern:

- At the end of the course, it is mandatory to appear for the final written exam of 50 marks.
- Attendance should be at least 75%.

Bachelor of Science (B.Sc.) Biochemistry Programme with six semesters course structure curriculum was approved by following BoS members in the hybrid mode meeting held on 14/10/2023 at 2.30 p.m.

Ratnagiri Education Society's
R. P. Gogate College of Arts and Science and R. V. Jogalekar College of Commerce
(Autonomous), Ratnagiri

Meeting of BoS in Biochemistry

Date	14/10/2023
Time	2.30 p.m.
Venue	Meeting hall
Mode	Hybrid

Attendance

Sr. No.	Name and type of the Member	Present mode Online / Offline	Signature
1	Name: Dr. Varsha A. Ghadyale Head of the Department (Chairman)	Offline	Ghadyale
2	Name:Dr. Prashant S. Ratnaparkhi (VC nominee)	Online	
3	Name: Dr. Ashok D. Chougale (outside the parent university)	Online	
4	Name: Dr. Rhishikesh S. Dhanve (outside the parent university)	Online	
5	Name:Mr. Ganesh R. Ankush Representative from industry/corporate sector/ any other organisation	Online	
6	Name: Mr. Prathamesh G. Tarve Alumnus	Online	
7	Name: Mr. Sudhir B. Gadgil Department faculty member (1)	offline	
8	Name: Mrs. Shweta O. Patwardhan Department faculty member (2)	Offline	14.10.23
9	Name: Mr. Pratik Shitut expert for special courses	Offline	Shitut 14/10/23