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

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**
USBCH 504	**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:

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 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** 3.1 3.2 3.3	**Recombinant DNA Technology I** Introduction to 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; (c) Probes- DNA probes Applications of RDT- Agriculture (Bt Cotton); Medicine(Insulin); GM food	**15**
IV	**4.0**	**Recombinant DNA Technology II**	**15**
	4.1 4.2 4.3 4.4	Isolation of gene: Gene library and c-DNA library; Southern blot; Chimeric DNA Gene Transfer: Transformation, Transfection, Electroporation, Microinjection, Liposome, Microprojectile (in brief) Selection and screening- Antibiotic and colony hybridization DNA Amplification by PCR (Steps, Types, Applications) DNA fingerprinting, DNA sequencing (any one method)	

Learning Resources recommended:

1) Lehninger's- Principles of Biochemistry by David L. Nelson, 4th edition (2017)
2) IGenetics by Russel, 3rd edition (2016)
3) Biotechnology Expanding Horizons by B.D. Singh, 4th edition (2014)
4) 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:

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)

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**
USBCH603	**Biostatics and bioinformatics**	**2.5**
USBCH604	**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	Principles of nutrition	
	1.1.1	Nutrients [Proximate principles, vitamins and minerals (macro and micro- role of Ca, Mg, Na, K and Fe, Zn)], dietary fibre.	
	1.1.2	Nutritional status [malnutrition (protein energy and protein calorie) and over nutrition]	
	1.1.3	Balanced diet	
	1.2.1	Energy Assessment - RQ, BMR;	
	1.2.2	Anthropometry – BMI, Waist:hip ratio;	
	1.2.3	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 3.1.3 3.1.4	General pharmacology Pharmacodynamics, Physicochemical properties of drugs, Drug absorption: through-GIT, pulmonary, renal, placental andblood-brain barrier Bioavailability and Bioequivalence Drug Distribution, Metabolism and Excretion	**15**
	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:

1. Dietetics by B. Srilakshmi, 8th edition (2019)
2. Textbook of pharmacology by FSK Barar, 4th edition (2012)
3. 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:

1) Immunology by Goldsby and Kuby, 3rd edition (2003)
2) Roitt,s essential immunology by Martin and et.al. 13th edition (2019)
3) Introduction to modern virology. Dimmock and et.al.6th edition 2007
4) 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

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.

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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