ST. XAVIER'S COLLEGE (AUTONOMOUS), AHMEDABAD-9
FACULTY OF SCIENCE

DEPARTMENT OF BIOCHEMISTRY – BIOTECHNOLOGY

SEMESTER – III SYLLABUS

OF

BSc BIOCHEMISTRY (HONOURS)

BASED ON UNDERGRADUATE CURRICULUM FRAMEWORK (NEP – 2020)

(Effective from Academic Year 2023)

Programme Outcomes

PO1. Create a strong knowledge domain/ expertise

PO2. Develop critical thinking, Problem solving and research aptitude

PO3. Skill development

PO4. Encouraging social interaction, service learning and develop equity centred national development (Social Extension work)

PO5. Self-directed and lifelong learning

PO6. Developing employability and entrepreneurial skills

PO7. Promoting Ecological sustainability development

PO8. Nurturing creativity and humane values

Programme Specific Outcome for BSc Biochemistry

PSO1. Comprehensive and Procedural Knowledge: Discuss and interpret the basic concepts of all subjects under the aegis of current multidisciplinary Biochemistry to translate and apply the same for professional, entrepreneurial and societal benefits.

PSO2. Skill development: Learn wide – ranging technical skills inclusive of digital learning skills through laboratory sessions/ research projects and develop self-directed experiential learning with an objective to associate biochemistry with improving life, industrial applications and environment.

PSO3. Critical thinking, Creativity and Problem Solving: Develop competence to solve problems in familiar and non – familiar context especially to alleviate stress in all life forms, develop an analytical mind to use information from various sources and create plans/models to come up with innovations in the field of Biochemistry.

PSO4. Communication and Collaboration: Ability to communicate the understanding of the learning to others confidently and precisely, interact with diverse multicultural groups working in the subject area as well as collaborate to achieve goals that have a wider outreach.

PSO5. Leadership, Lifelong learning and ethics: Extend the applicability of Biochemistry to service learning and nation development through awareness programmes/ action - oriented projects in health, nutrition, and environment; be accountable, responsible and conscientious in leading roles both in profession and personal space.

Curriculum Framework for Semester – III BSc (Hon.) Biochemistry and BSc Biochemistry with Vocational Biotechnology

Course	Title	Content	Hours /week	Credit
DSC-1 (Theory)	BC – 3501 Concepts in Microbiology	Unit 1: Basic Structure of Microbes Unit 2: Microbial Growth and Nutrition Unit 3: Microbial Control Unit 4: Applied Microbiology	4 hrs	4
DSC – 2 (Theory)	BC – 3502 Molecular Physiology	Unit 1: Hormone signalling mechanisms Unit 2: Circulatory and Respiratory System Unit 3: Muscle movement in body systems Unit 4: Secretions and Absorption	4 hrs	4
DSC - 3 (Lab)	BC – 3503 Microbiology, Blood and Urine Analysis	Practical based as per Theory syllabus.	8 hrs	4
SEC (For Biochem and VBT)	BC – 3650 Biophysical Techniques - III	U-1: Electrophoresis U-2: Advanced Techniques	2 hrs	2
MDC *Offered to students of other Major Discipline*	MDC – 201_1C (Sem 3) Nutrition and Health	U-1: Food groups and diet U-2: Nutrients in food U-3:Food adulteration and Food safety standards U-4: Activity Modules	4 hrs	4
AEC	English	(To be chosen by the students from a basket of courses offered)		2
VAC	Value Added Courses	(To be chosen by the students from a basket of courses offered)		2
Total Credits				22

BSC. (HONS.) BIOCHEMISTRY SYLLABUS

SEMESTER – III

Major Discipline Course – 1: Concepts in Microbiology

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BC – 3501 Concepts in Microbiology	4 (60 hr)	0	0	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

The knowledge from this course can help in the following:

a) The students could pursue a career in industries that specialize in synthesis of various chemical components like acetic acid, enzymes, antibiotics, drugs etc.
b) The students can carry out basic research in Microbiology and Biotechnology, which in turn can be of great help in the commercialization of various microbial products.
c) Students can also go in for Medical Laboratory Technique Courses, opening opportunities in hospitals and pathological laboratories.
d) Basic knowledge of microbiology is required for Fermentation Technology which is a basic technology used in many Pharmaceutical and Biotech companies.
e) Explore the field of genetic engineering as microbes can be used as tools
f) Entrepreneurial start-ups for small scale industries like production of biofertilizers, fermented foods etc.

II. Course Learning Outcomes

By the end of the paper, a student should be able to:

CO 1: Corelate the morphology of a prokaryotic cell and the fine structure of its organelles with its functions
CO 2: Differentiate between eubacteria, archaebacteria, fungi, algae and viruses and comprehend their economic importance.
CO 3: Understand the basic growth requirements and parameters of bacteria in order to culture them *in vitro* for research, industrial applications, beneficial products that can enhance quality of life.

CO 4: Design methodologies to control the growth of microbes by various sterilization techniques and chemotherapeutic drugs. For example: Milk is pasteurized to ensure that its shelf life is long; keeping surgical tools and rooms free of pathogens etc.

CO 5: Analyze the role of microbes as tools to minimise use of chemicals, improvise waste water treatment and decreasing environmental pollution by biodegradation.

III. Course Content

Unit 1: Basic structure of microbes (1 Credit)

Cell morphology and fine structure of bacteria; Size, shape and arrangement of bacteria; study of organelles: Structure, chemical composition and functions of – cell wall, cell membrane, flagella, mesosomes, fimbriae and pilli, capsules, ribosomes, intracellular inclusions and endospores. Identification of bacteria based on cell morphology and fine structure.

Salient features and economic importance of Archeabacteria, rickettsia, fungi, algae, and viruses

Unit 2: Microbial growth and nutrition (1 Credit)

*Growth and Nutrition***:** Definition and calculation of generation time, Growth curve, diauxic growth curve. Measuring bacterial growth (SPC, serial dilution, direct microscopic count); Effect of various factors on growth and reproduction of bacteria: temperature, osmotic pressure, radiation, hydrostatic pressure, mechanical impact, surface tension (define types based on specific requirement e.g. thermophilic); Cultivation of anaerobes, pure culture isolation and preservation.

Nutritional requirements and broad categories of bacteria (auxotrophs, lithotrophs etc)

Preparation of media, Types of media (Natural, empirical, synthetic, defined, special media)

Unit 3: Microbial Control (1 Credit)

Control of microorganisms: Definition of terms: sterilization, disinfection, microbicidal, microbiostasis, sepsis and asepsis, antiseptic. Factors affecting; Sterilization and disinfection by physical means: moist, dry heat, radiations and filtration; Sterilization and disinfection by chemical means: characteristics of an ideal antimicrobial agent, phenol coefficient. Mode of action and uses of: halogen and halogen compounds, compounds of heavy metals, phenols and its derivatives, alcohol, detergents. Chemosterilant gases (formaldehyde, ethylene oxide, beta propiolactone); Chemotherapeutic agents: Mode of action, limitations and uses of: penicillin, streptomycin, tetracyclins, polymixins, choramphenicol, cephamines, sulfa drugs

Unit 4: Applied Microbiology (1 Credit)

Microbiology of Milk: pasteurization and sterilization, microbial analysis of milk (SPC, MBRT)

Role of microorganisms in fermented dairy products (butter, cheese, curd and yoghurt).

Microbiology of water and sewage: Definition of potable water, index organisms of fecal contamination and their significance. Microbial analysis of water: SPC, filtration. MTFT, MPN.

Sewage microbiology: BOD and COD - definition and significance. Sewage treatments: Primary, secondary (trickling filters, activated sludge process, oxidation ponds) and advanced treatments. Solids processing. Biofertilizers: Bioremediation and phytoremediation, Soil microbiology.

IV. Recommended Learning Resources

1. Atlas R: Microbiology:Fundamentals and Applications (2^{nd}ed)
2. Frobisher, Hinsdill, Crabtree, Goodheart: Fundamentals of Microbiology
3. Pelczar Reid: Microbiology (5^{th}ed)
4. Prescott: General Microbiology.
5. Scheeler and Bianchi: Cell Biology
6. Stainer, Adelber,Ingraham: General Microbiology

V. Pedagogy

1. Classroom engagement through lectures and PowerPoints
2. Lecture videos and online resources
3. Workbooks/Group activities/Assignments/Class Tests

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

ASSESSMENT CRITERIA	INTERNAL EVALUATION	EXTERNAL EVALUATION
Continuous Internal Assessment (CIA) I and II	**35**	**-**
Assignment (Research element)*	**10**	**-**
Attendance	**05**	**-**
End Semester Exam	**-**	**50**
Total	**50**	**50**

**The assignment comprises writing a short review article by reading, interpreting and analysing data given in selected research articles.*

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(Effective from Academic Year 2023)

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Programme Specific Outcome for BSc Biochemistry

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DSC - 3 (Lab)	BC – 3503 Microbiology, Blood and Urine Analysis	Practical based as per Theory syllabus.	8 hrs	4
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MDC *Offered to students of other Major Discipline*	MDC – 201_1C (Sem 3) Nutrition and Health	U-1: Food groups and diet U-2: Nutrients in food U-3:Food adulteration and Food safety standards U-4: Activity Modules	4 hrs	4
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Total Credits				22

BSC. (HONS.) BIOCHEMISTRY SYLLABUS

SEMESTER – III

Major Discipline Course – 2: Molecular Physiology

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BC – 3502 Molecular Physiology	4 (60 hr)	0	0	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

The knowledge from this course can help in the following:

a) An ability to carry out basic research in understanding various physiological actions in cells.
b) Work in research institutions, hospitals which are involved in finding molecular targets to treat diseases.
c) Opportunities to work in companies that are into discovery of drugs that target cells at the molecular level for therapeutics
d) Work as skilled technicians in pathological laboratories, blood banks and hospitals.

II. Course Learning Outcomes

By the end of the paper, a student should be able to:

CO 1: Evaluate the mechanism of regulation by signal molecules such as hormones leading to appropriate physiological responses in the cells and body, which in turn can be target for treatment of various ailments

CO 2: Analyze the molecular mechanisms involved in blood clotting, production of erythrocytes, leucocytes and thrombocytes, giving an insight into molecular mechanisms that could be induced to enhance production of cells *in vitro.*

CO 3: Understand the underlying molecular mechanisms involved in movement of different muscle types to facilitate specific functions; secretions and absorption in the body to aid digestion, circulation and excretions and correlating with associated diseases.

CO 4: Appreciate experiments carried out by scientists to enable comprehend and evaluate the basic concepts involved in signalling, transport, regulation and movement.

III. Course Content

Unit 1: Hormone signalling mechanisms

Classification of hormones, Characteristics of hormones; Hormone receptors;
Mode of action of hormones: cAMP, calcium, IP_3, DAG, receptor kinases, cGMP, NO and gene activation; Regulation by feedback mechanisms e.g. Thyroid hormones, TSH and TRH;
Synthesis and regulation of Insulin, glucagon, thyroid hormone, estrogen, and growth hormone.

Unit 2: Circulatory and Respiratory System

Hematopoeisis: Erythropoesis, Thrombocyte formation and leucopoesis.
Hemostasis: Vasoconstrictions, Platelet plug formation, Clot – Clotting factors; intrinsic and extrinsic pathways for blood clotting. Clot retraction.
Role of surface tension in inhalation; (Theory of surface tension and its measurement); Role of hemoglobin in oxygen transport, dissociation curve of oxyhemoglobin and its significance. Bohr's effect, transport of oxygen and carbon dioxide, chloride shift.
Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Role of lung and kidney in regulation of acid base balance.

Unit 3: Muscle movement in body systems

Excitation and contraction of muscles – molecular organization of muscle, proteins of contractile element; their organization and role in contraction; Energy for contraction. Theories of contraction; Hormonal regulation.
Cardiac physiology- circulation, electrophysiology of heart. Measurement of blood pressure, hypo and hypertension.
Regulation of striated and smooth muscle movement in the GI tract for propulsion and mixing.

Unit 4: Secretions and Absorption

Salivary secretions and its regulation, gastric secretions and its regulation, pancreatic secretions and its regulation; Biliary secretions and its regulation; Secretions of the small intestine and its regulation; Absorption processes in the small intestine and large intestine; Transport of nutrients after absorption; Examples of disorders due to anomalies in regulation.
Functions of glomerular membrane and glomerular filtration rate (GFR), selective reabsorption and secretion, active passive transport of various substances (sugars, amino acids, urea and creatinine), mechanism of urine formation; Role of hormones in regulation.

IV. Recommended learning Resources

1. Best and Taylor: Physiological basis of Medical practice
2. Bhagavan NV: Medical Biochemistry (4^{th}ed), Jones and Bartlett Publishers
3. Charterjee: Human Physiology Vol. 1 and 2.
4. Chatterjee and Shinde: Text book of Medical Biochemistry
5. Das AK: Human Physiology
6. Ganong WF: Review of Medical Physiology (12^{th}ed). Lange Medical Publishers

7. Guyton AG and Hall JE: Text book of Medical Physiology (11th ed) Harcourt Asia.
8. Murray RK, Granner DK, Mayes PA and Rodwell, VW: Harper's Biochemistry (25th ed) 2000, Prentice Hall publishers.
9. Sherwood: Human Physiology (5th ed) 2004
10. Talwar PC: Text book of Biochemistry and Human Physiology
11. Tortora G and Derrickson B: Principles of Anatomy and Physiology (14th ed) 2014. John Wiley and sons.
12. Sembulingam K and Sembulingam P: Essentials of Medical Physiology (6th ed) 2012. Jaypee Brothers Medical Publishers

V. Pedagogy

1. Classroom engagement through lectures and PowerPoints
2. Lecture videos and online resources
3. Workbooks/Group activities/Assignments/Class Tests
4. Problem solving, and group projects. Assignments will be designed such that students inculcate the habit of reading reference books and science journals.

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

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Total Credits				22

BSC. (HONS.) BIOCHEMISTRY SYLLABUS

SEMESTER - III

Major Discipline Course – 3: Microbiology, Blood and Urine Analysis

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BC – 3503: Microbiology, Blood and Urine Analysis	0	0	4 (120 hr)	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

The learning objectives of this paper is as follows:

a) To be able to develop a skill set to carry out hematology based studies such as blood cell count, ESR, Hb estimate etc.
b) To enhance skills in basic microbiology techniques and qualitative analysis of urine samples to comprehend pathophysiology of ailments.
c) Students should understand the principles, theory, protocol and calculations for each experiment and apply them for research or small projects.
d) They should discern the importance of precision and accuracy in reagent preparations and designing of experiments.
e) The analysis and interpretation of each laboratory experiment should be able to initiate logical thinking and accountability, especially if the samples being studied are related to clinical and nutritional studies.
f) The skill set should enhance their knowledge and employability.

II. Course Learning Outcomes

The main objective of the course will be to build the basic foundation as well as skill in the subject of biochemistry.
By the end of the paper, a student should be able to:

CO 1: Appraise the importance of various instruments used in biochemistry.
CO 2: Corelate principles with protocols of the experiments
CO 3: Analyze qualitative as well as quantitative data to interpret the results.

CO 4: Develop skills to handle, stain, culture, preserve and carry out assays related to microbes.
CO 5: Design and standardize experimental protocols.

III. Course Content (Laboratory Experiments)

Basic techniques in Microbiology

1. Introduction to stains and staining procedures
2. Monochrome staining(Positive and negative)
3. Gram staining
4. Capsule staining
5. Metachromatic granules staining
6. Spore staining(optional)
7. Methylene blue reduction test
8. Antibiotic assay by agar cup method
9. Antibiotic assay by disc/ditch method
10. Identification of microorganisms and Fermentation tests for microorganisms
11. Study of growth characteristics of microorganisms*

Urine Analysis

1. Physical parameters of Urine
2. Normal chemical constituents of Urine
3. Detecting abnormal and pathological constituents of Urine

Basic Hematology

1. Red blood cell count
2. White blood cell count
3. Differential counting
4. Estimation of Hb by Sahli's method
5. Determination of ESR
6. Determination of PCV
7. Determination of bleeding time, clotting time and blood group

IV. Recommended Learning Resources

1. Plummer: An introduction to practical Biochemistry
2. Thomas and Schalkhammer: Analytical Biochemistry, 2002
3. Varley H: Practical Clinical Biochemistry
4. Wharton and McCarty: Experimental methods in Biochemistry
5. Willard and Merrit: Instrumental methods of analysis.
6. Seeley HW and Van Denmark PJ: Microbes in Action
7. Wistreich GA and Lechman MD: Laboratory Exercise in Microbiology
8. Oser: Hawk's Physiological Chemistry (14^{th}ed)
9. Sheela Sharma: Experiments and Techniques, 2007.

V. Pedagogy

1. Explanation of each laboratory experiment emphasising on the use of different reagents and instruments
2. Problem solving, group activities and presentations. There are defined activities for every laboratory experiment in the journal, which encourages self-learning, peer learning, team work, developing presentation skills and reading from science articles and research papers.
3. Learning outcome based questions, which develops reading and writing skills and lab tests

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

ASSESSMENT CRITERIA	INTERNAL EVALUATION	EXTERNAL EVALUATION
Internal Practical Examination*	**35**	**-**
Assignment (Research element)**	**10**	**-**
Attendance	**05**	**-**
End Semester Practical Exam	**-**	**50**
Total	**50**	**50**

***The internal practical exam will entail the students to answer a question paper based on the experiments in their journal, to perform two experiments and give a viva voce (optional). The journal duly completed and signed will also carry weightage.*

***The assignment comprises group activities that need the students to review literature, collate and present the data or carry out a short project, collate, interpret and present the data either as an oral presentation or a poster presentation and/or a documented report.*