Syllabus

For

B.Sc. (Honours) Biochemistry
(Three Year Full Time Programme)

Under

Choice Based Credit System (CBCS)
Learning Outcome Based Curriculum Framework
(LOCF)

DRAFT 2 (15th MAY 2019)
1st COC Meeting: 24th April 2019
Draft 3: (3rd JUNE 2019)
2nd COC Meeting: 4th June 2019

(Syllabus applicable for students seeking admission in the B.Sc.
(Hons) Biochemistry Course from the academic year 2019-20)

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Faculty of Interdisciplinary and Applied Sciences
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New Delhi-110021
PREAMBLE

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. Biochemistry focuses on processes happening at the cellular and molecular level. It is a laboratory based science programme that brings together biology and chemistry. Biochemistry is the study of the components and composition of living things and their assembly and interactions important in sustaining life. By using chemical knowledge and techniques, biochemists attempt to investigate and solve biological problems pertaining to the understanding of physiological processes, their malfunction leading to diseases and subsequent disease diagnostics, prevention, therapy and prognostics. Bachelor’s degree in Biochemistry at University of Delhi endeavors to train students in this classical art of life sciences to create knowledge pool and skilled manpower to take on the challenges that modern biological sciences poses in understanding the emerging dynamics of life processes and the myriads of diseases that threaten mankind.

Education in the 21st century has undergone a paradigm shift, which necessitates frequent updates in any curriculum to reflect the dynamic changes in knowledge outcome, more so for biological sciences where advances are rapid and far-reaching. The revised Choice-Based Credit System (CBCS) curriculum to be introduced in the academic session 2019-2020 conforms to Learning Outcome Based Curriculum Framework (LOCF) and aims at imparting concept based learning with emphasis on skill development and research.

For multi-faceted development of a student, the curriculum includes courses to gain specialization in biochemistry while at the same time sufficient exposure to related and varied subjects and skills. The curriculum emphasizes on several “core” courses (C) that will train students with the basic as well as advanced concepts of the discipline of biochemistry. All students pursuing the Bachelor’s degree with Honours shall study fourteen such core papers across the six semesters. Students pursuing the programme shall also study four Discipline-Specific Elective (DSE) courses in the fifth and sixth semesters, which they will select from a list of such courses based on their individual preferences. These DSE courses will include diverse papers in other areas of life sciences (like Microbiology and Plant Biochemistry) or specialized research oriented courses (like Molecular Basis of Infectious Diseases) or advanced courses of Biochemistry (like Advanced Cell Biology and Advanced Methodologies), which will provide students with wholesome knowledge and requisite skills preparing them for higher studies across the globe. The content of each paper (C and DSE papers) is based on the premise that the fundamental principles and ideas must come across in a clear, easy and concise manner. The course seeks to be diverse and yet will present the essence of biochemistry in a very elegant and focused manner that will build competitive edge not only for professional development in a related area but prepare students for academic pursuits like research and teaching.

The Skill Enhancement Courses (SEC), offered in the third and fourth semesters, emphasizes on hands-on-training and supplements the discipline courses in an appropriate manner to impart students the confidence and required skills in practical aspects of biochemistry to help them choose a future path in either industrial or academic setting. The
SEC courses also include a paper on research methodology that will prepare students appropriately for a future in research.

The Generic Elective Courses (GE) offer inter- and trans-disciplinary students an opportunity to obtain a flavour of Biochemistry in simple and concise terms. It will also help them to switch over to this discipline of study in the future, should they choose to do so. Students opting for these courses learn the basic concepts of Biochemistry right from the first semester onwards, with one paper in each of the first, second, third and fourth semester. Students who join for Honours degree in Biochemistry will opt for Generic Elective courses from other related/unrelated disciplines.

Two value-based courses (Ability Enhancement Compulsory Courses - AECC) in the first and second semester will enable students to improve their knowledge and communication skills.
B.Sc. (Hons) Biochemistry

1. Introduction

Biochemistry is the branch of dynamic science that explores the chemical processes within living organisms/systems. The study of Biochemistry aims to understand how all the molecules that constitute living organisms interact, to maintain and perpetuate life. It deals with the complexity of living organisms, the microscopic and macroscopic structures within organisms that have specific functions and their systems for extracting and transforming energy from the environment. Biochemistry also explains how organisms adapt to their changing environments and gradually evolve.

The teaching of such a dynamic and evolving course is best achieved through Choice-based Credit System (CBCS) since it offers opportunities to provide solid foundation in the core discipline, while allowing freedom to students to select discipline specific courses that augment the learning in core courses. This freedom is further reiterated through flexibility in opting courses that enhance specific skills in the discipline as well as selection of courses from other disciplines / departments that widen the scope for higher education and employability. The Learning Outcome-based Curriculum Framework (LOCF) built into the CBCS offers focus and purpose to the programme providing a platform for self-evaluation by students and teachers in addition to global assessment by all stakeholders. The combination of LOCF and CBCS also allows for lateral movement of students between institutes of higher learning and offers a level playing field for them across the nation.

1a. Nature and Extent of the B.Sc. (Honours) Programme in Biochemistry

Biochemistry is an interdisciplinary science with areas of overlap with Chemistry, Physics and Mathematics. It is a laboratory based science that acts as a bridge between Biology and Chemistry. It also shares boundaries with other interdisciplinary subjects such as Microbiology, Genetics and Biophysics. This course is designed so as to enable the students to gain theoretical knowledge and hands-on experience in the laboratory. The course content is aimed at encouraging students to cultivate keen observational skills and to develop the ability to analyze and interpret experimental data, making them suitable for future careers in higher education and employment in industry and research institutes.

1b. Aims of the Programme

The overall objective of the Bachelors (Honours) Programme in Biochemistry is to enable students to learn and integrate foundational knowledge in Biology and Chemistry that is relevant to Biochemistry and thus prepare them for post-graduate education and/or careers in related industries.

The program aims to:

- Provide students with scholarly experiences, both theoretical and hands-on, that help instil deep interests in learning the chemistry underlying the working of biological systems while developing broad and balanced knowledge and understanding of key biological concepts, principles and theories. The idea is to equip students with appropriate tools of analysis so that they can independently tackle issues and problems in the field of biology and chemistry.
Encourage students to study the structure and function of specific molecules and pathways and their interactions and networking in biological systems with particular emphasis on regulation of chemical reactions in living cells.

Develop in students an inquisitive learning approach to seek answers regarding the complex workings of various physiological systems, cellular multiplication and differentiation and communication within and between cells and organs, and the chemical bases of inheritance and disease.

Empower students to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Biochemistry.

Build concepts in biochemistry that would enable them to undertake further studies in Biochemistry and related areas or in multidisciplinary areas and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

1c. Program Duration, Design and Structure

Duration of the Program:

The BSc Biochemistry course is a three-year degree programme divided into six semesters. Each academic year (July - May) will consist of two semesters. Each semester will be of fifteen weeks duration with one week designated for teaching break to promote co-curricular and co-scholastic activities.

Program Design:

The program has been designed to offer a variety of discipline specific and interdisciplinary courses disseminated through class-room, laboratory and out-of-classroom modes of teaching, monitored through a repertoire of assessment methods. The teaching-learning process will include theory classes of one hour duration and practical classes of two hour duration for every credit offered. The curriculum will be delivered through various methods including classical chalk and talk, power-point presentations, essay writing and quiz contests, audio and video tools, e-learning and e-content, virtual labs, field trips or educational tours, seminars by external experts, workshops and symposiums and class discussions and debates. The learning outcome will be assessed by direct and indirect methods comprising broadly of Internal Assessment or Continuous Evaluation and End-Semester Examination. The internal assessment will include mid-term written tests, multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and debates, essay and report writing. End-semester assessments will include written tests and practical examinations. Each theory paper will carry a maximum of 100 marks, with 25% marks allotted for internal assessment and 75% for end-semester examination. Each practical paper will carry a maximum of 50 marks including experimentation, viva-voce and practical notebook assessment.

Structure of the Programme:

The programme is structured into a variety of courses with different credits, some mandatory while others elective. Broadly, the programme comprises of Core Courses (CC) and elective courses. The core courses are all mandatory courses. The elective courses are of three kinds: Discipline-Specific Elective (DSE), Skill Enhancement Course (SEC) and
Generic Elective (GE). The programme also includes two compulsory Ability Enhancement Courses (AEC).

To successfully complete the program, a student must study fourteen Core Courses, four Discipline-Specific Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement Courses are two-credit courses. A student has to earn a minimum of 144 credits to get a degree in B.Sc. (H) Biochemistry.

The six-credit courses will include theory classes of four credits each and practicals of two credits each. The four-credit courses will comprise of two-credit theory classes and two-credit practical courses. However, the two-credit courses will include only theory classes. One credit is equivalent to one-hour lecture per week for theory classes and two-hour sessions for practical classes. Each batch of students for practical sessions will be of fifteen members. If the number of students exceed fifteen (by at least ten), they will be divided into two equal batches.

It is mandatory for students to study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

Six courses of Discipline-Specific Electives (DSE) are offered in the programme, of which students will opt any two in each of the Semesters V and VI. The DSE courses will be of six credits each (four credits theory and two credits practicals). A particular DSE course will be offered only if the minimum number of students opting for that course is 10.

Generic Elective (GE) courses for the programme will be offered by other departments of the respective college. Students will elect one GE course each in Semesters I, II, III, and IV. The GE courses will be of six credits each (four credits theory and two credits practicals). The Department of Biochemistry will offer seven GE courses for students of other departments in the respective colleges.

From a list of six Skill Enhancement (SE) courses provided, students will undertake two Skill Enhancement (SE) courses of four credits each in Semesters III and IV. The SE courses will be of four credits each (two credits theory and two credits practicals). The two compulsory Ability Enhancement Courses (AEC), AE1 (Environmental Sciences) and AE2 (English communication), will be of two credits each (theory only). Students will undertake one each in Semesters I and II.

2. Learning Outcome-based Approach to Curriculum Planning

The learning outcomes-based curriculum framework (LOCF) for a B.Sc. degree in Biochemistry is intended to provide a broad framework within which the biochemistry programme is designed such that it enables students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honours degree in Biochemistry in the University. It shall subsequently pave the way for periodic updation and review of the programme, all within the boundaries of the set framework. This programme specification is
intended as a reference point for prospective students, current students, examiners and academic and support staff involved in delivering the programme and enabling student development and achievement.

Program learning outcomes are the central organizing features of student learning. They are developed from the complex interaction of a range of competing and complementary factors. Since program learning outcomes can only be achieved and demonstrated through component courses, course learning outcomes and their assessment are integrally related to program learning outcomes. The LOCF in Biochemistry aims to achieve this important aspect of a modern teaching programme.

3. **Characteristic Attributes of a Graduate in Biochemistry**

A graduate in the Biochemistry programme is expected to demonstrate the following attributes:

- **Disciplinary knowledge and skills:** Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Biochemistry and other related fields of study, including interdisciplinary subfields such as life science in general, medicine and clinical biology, plant sciences, biotechnology, microbiology, nutrition, forensics, bioinformatics and environmental science; (ii) ability to use modern instrumentation for chemical and physical analysis of biological samples.

- **Critical thinker and problem solver:** Ability to employ critical thinking and efficient problem solving skills in the various areas of biochemistry and related disciplines.

- **Sense of inquiry:** Biochemistry being the foundation for understanding all biological processes, a graduate in this discipline is expected to seek deeper knowledge by asking relevant/appropriate questions relating to issues and problems in the field of Biochemistry and related areas. It is also envisaged that the course will empower them with the ability to plan, execute and report the results of an experiment or investigation.

- **Research skills:** Capable of identifying a scientific problem, preparing/mobilising appropriate resources required for the project, and execute the project through to completion, while observing responsible and ethical scientific conduct; and biosafety and chemical hygiene regulations and practices.

- **Skilled communicator:** Ability to transmit complex technical information relating to biochemistry in a clear and concise manner in both oral and written formats.

- **Team player/worker:** Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

- **Digitally literate:** Capable of using computers for mining scientific information using modern library search tools from various open source platforms or journals and the ability to use technique specific software to conduct experiments and analyze data. The graduates are expected to be proficient in using computational & visualization tools to study bio-molecular structures, graphing and statistical software to analyze statistical significance of data and report data in the form of graphs, tables or figures.

- **Ethical awareness:** The graduates of this programme will be able to avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism. They will learn to appreciate environmental and sustainability issues and their societal relevance.
• **Lifelong learners:** Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and acquiring fresh skills.

4. **Qualification Description**

The qualification descriptors for B.Sc. (Honours) programme in Biochemistry include the following:

• A student should demonstrate (i) a comprehensive and coherent understanding of the field of Biochemistry, its applications and links to related disciplinary areas of study; (ii) practical knowledge that enables different types of professions related to the discipline, including research and development, teaching, entrepreneurship as well as industrial research abilities; (iii) skills in areas pertaining to current developments in the academic field of study, including a critical understanding of the latest developments in the field of Biochemistry and an ability to use established techniques of analysis.

• Demonstration of a comprehensive knowledge of study material, including current research articles, books and e-books relating to basic and advanced concepts.

• Demonstration of skills in collection of relevant data gathered by reading or experimentation and analysis and interpretation of the data using appropriate methodologies.

• Ability to communicate the results of studies undertaken in an academic field accurately in the form of a paper, oral presentation or report.

• Application of disciplinary knowledge and transferable skills to new or unfamiliar problems and issues and the ability to seek solutions to real-life problems.

• Imbibing the ability to function effectively either independently or as a constituent of a team.

5. **Programme Learning Outcomes (PO)**

The curriculum is designed to achieve the following outcomes:

**PO1:** Inculcate the basic concepts of biochemistry including an understanding of the fundamental biochemical principles and their applications in a systematic, methodical, scientific, evidence-based process. The programme will also provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.

**PO2:** Develop problem solving and analytical skills through case studies, research papers and hands-on-experience, especially integrated into skill enhancement courses.

**PO3:** Students will gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.

**PO4:** Provide requisite knowledge of laboratory safety, data replication and quality control, record keeping and other aspects of “responsible conduct of research”.

**PO5:** Ability to employ modern library search tools to locate and retrieve primary literature on a topic and critically evaluate the literature.

**PO6:** Students will be able to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.
PO7: Students will learn to work collaboratively in a team.
PO8: Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.
PO9: Graduates will be able to apply the major theories and research procedures to contemporary social problems.
P10: The programme will prepare students to plunge into various fields of higher education or related profession in various disciplines, armed with plethora of knowledge, hands-on-experience and scientific attitude, at national and global levels.

6. Teaching-learning processes

The foremost effort of teaching is to impart knowledge to students, factual as well as hypothetical. The manner in which this is communicated to the students determines the success of the teaching process. To be able to see tangible results, it is imperative that the teaching-learning process be bilateral. There are three critical components to the teaching learning process, namely content writing, content delivery and engaging the students to complete the course. A passive flow of information from the teacher to the taught should make way for a vibrant atmosphere of active participation from the students. Teachers participating in the programme would have a well-structured and well-planned lecture ready for the class that should compel the students to concentrate, understand and enjoy the discourse. Students would be encouraged to think independently and ask pertinent questions cultivating out-of-the-box thinking. The link between theory and practical would be made evident, as working with their hands reinforces the concepts first introduced in theory classes.

The traditional chalk and talk method of teaching is simple but very effective. Diagrams or additional material may be shown as slides but with minimum text-rich content. For concepts that are difficult to explain, power point presentations or videos would be used. Some laboratory experiments will be open ended. Students will be divided into small groups to encourage teamwork, healthy competition and to be able to complete the task in stipulated time frames. Students will be taken out of the classroom and into the world of research institutions as well as industries in the form of simple visits or internships or educational tours for maximum benefit. It will help them to correlate what they learn in the classroom with the real world. Additionally, teachers will use MOODLE platform to create lessons and interact with students to create an open and effective two-way communication channel. Digital initiatives such as the Swayam portal, National digital library and open education resources will be used to greatly facilitate blended learning and flipped class rooms encouraging students to be responsible for learning. Group discussions, debates and scientific talks by external experts will be arranged for facile learning. Students will be encouraged to write comprehensive reviews of papers in a particular topic, reports, essays and short projects to augment their writing skills. Students will also be motivated to deliver seminars to strengthen their oratory skills.

7. Assessment methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determine the extent to which students demonstrate desired learning outcomes. Student learning outcomes cannot be ascertained by single evaluation criteria. A combination of direct and indirect assessments would thus be used. Direct methods of assessment will be used for students to demonstrate their learning while indirect methods will
be used to observe students reflect on their learning. Written tests, essays, quiz, presentations and seminars will be used as direct methods of assessment, and indirect methods will include surveys, discussions, debates, participation in scientific meetings and festivals. Embedded assessments, in other words “classroom-based” or “continuous” assessments will be utilized as both a grading instrument as well as data for assessing student learning outcomes. Some examples of assessment methods that will be used are given below:

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Direct or Indirect Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>Regular participation in class activities (Theory and Practicals)</td>
<td>Indirect</td>
</tr>
<tr>
<td>Observations</td>
<td>Information can be collected while observing “events” such as classes, group work, and study sessions.</td>
<td>Indirect</td>
</tr>
<tr>
<td>Performance</td>
<td>Students can be evaluated on participation in practicals, events, presentations, projects. Encourages public speaking skills.</td>
<td>Direct</td>
</tr>
<tr>
<td>Portfolio</td>
<td>Students` work is collected throughout the program which is assessed by faculty using a common scoring guide. Portfolios may contain assignments, reports, class tests, exams, case studies, presentations, practical file record etc.</td>
<td>Direct</td>
</tr>
<tr>
<td>Viva Voce or External Review</td>
<td>An interview conducted by external faculty to gauge the depth of theoretical knowledge, clarity, visualization and hands on practical skills of the student. Instills self-confidence to face interviews in their future careers.</td>
<td>Indirect</td>
</tr>
<tr>
<td>Internally developed class tests</td>
<td>These are shorter tests held periodically through the semester to assess how well the students have grasped the concepts and skills. Also encourages regular attendance.</td>
<td>Direct</td>
</tr>
<tr>
<td>Course Exam</td>
<td>A comprehensive written exam given near the end of every 2 semesters to determine a student’s acquisition and application of a particular type of knowledge or skill, as well as the ability to integrate knowledge.</td>
<td>Direct</td>
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### Structure of B.Sc. (Honours) Biochemistry under CBCS

<table>
<thead>
<tr>
<th>Core Course</th>
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<tbody>
<tr>
<td>BCH C-1:</td>
<td>Molecules of Life</td>
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<td>BCH C-2:</td>
<td>Cell Biology</td>
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<tr>
<td>BCH C-3:</td>
<td>Proteins</td>
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<td>BCH C-4:</td>
<td>Enzymes</td>
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<tr>
<td>BCH C-5:</td>
<td>Metabolism of Carbohydrates and Lipids</td>
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<td>BCH C-6:</td>
<td>Membrane Biology and Bioenergetics</td>
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<td>BCH C-7:</td>
<td>Hormone: Biochemistry and Function</td>
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<td>BCH C-8:</td>
<td>Human Physiology</td>
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<td>BCH C-9:</td>
<td>Gene Organization, Replication and Repair</td>
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<td>BCH C-10:</td>
<td>Metabolism of Amino Acids and Nucleotides</td>
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<tr>
<td>BCH C-11:</td>
<td>Concepts in Genetics</td>
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<tr>
<td>BCH C-12:</td>
<td>Gene Expression and Regulation</td>
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<tr>
<td>BCH C-13:</td>
<td>Genetic Engineering and Biotechnology</td>
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<tr>
<td>BCH C-14:</td>
<td>Immunology</td>
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<tr>
<th>Discipline Specific Elective (Any four)</th>
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<tbody>
<tr>
<td>BCH DSE-1: Nutritional Biochemistry</td>
<td></td>
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<td>BCH DSE-2: Advanced Cell Biology</td>
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<td>BCH DSE-3: Microbiology</td>
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<td>BCH DSE-4: Molecular Basis of Infectious Diseases</td>
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<td>BCH DSE-5: Plant Biochemistry</td>
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<td>BCH DSE-6: Advanced Methodologies</td>
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<th>Generic Elective (Any four)</th>
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<tbody>
<tr>
<td>BCH GE-1: Biomolecules</td>
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<td>BCH GE-2: Techniques in Biochemistry</td>
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<tr>
<td>BCH GE-3: Proteins and Enzymes</td>
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<td>BCH GE-4: Biochemical Correlation of Diseases</td>
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<td>BCH GE-5: Intermediary Metabolism</td>
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<tr>
<td>BCH GE-6: Biochemical Applications in Forensics</td>
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<td>BCH GE-7: Recombinant DNA Technology</td>
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<thead>
<tr>
<th>Ability Enhancement Compulsory Course</th>
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<tbody>
<tr>
<td>AECC-1: English communication</td>
<td></td>
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<tr>
<td>AECC-2: Environmental science</td>
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<tr>
<th>Skill Enhancement Elective Course (Any two)</th>
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<tbody>
<tr>
<td>BCH SEC-1: Biochemical Techniques</td>
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<tr>
<td>BCH SEC-2: Biostatistics</td>
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<td>BCH SEC-3: Research Methodology</td>
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<tr>
<td>BCH SEC-4: Bioinformatics</td>
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<tr>
<td>BCH SEC-5: Microbial Techniques</td>
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# SEMESTER-WISE COURSE STRUCTURE of B.Sc. (Honours) Biochemistry

<table>
<thead>
<tr>
<th>SEMESTER I</th>
<th>SEMESTER II</th>
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<tbody>
<tr>
<td><strong>C1</strong> Molecules of Life</td>
<td><strong>C3</strong> Proteins</td>
</tr>
<tr>
<td><strong>C2</strong> Cell Biology</td>
<td><strong>C4</strong> Enzymes</td>
</tr>
<tr>
<td><strong>AECC1</strong> English/MIL Communication or EVS</td>
<td><strong>AECC2</strong> English/MIL Communication or EVS</td>
</tr>
<tr>
<td><strong>GE-I</strong> Generic Elective <em>(Any one)</em></td>
<td><strong>GE-II</strong> Generic Elective <em>(Any one)</em></td>
</tr>
<tr>
<td>I. Biomolecules (GE-1)</td>
<td>I. Proteins and Enzymes (GE-3)</td>
</tr>
<tr>
<td>II. Techniques in Biochemistry (GE-2)</td>
<td>II. Techniques in Biochemistry (GE-2A)</td>
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<tr>
<td>III. Biochemical Correlation of Diseases (GE-4)</td>
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<td><strong>C5</strong> Metabolism of Carbohydrates and Lipids</td>
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<td><strong>C10</strong> Metabolism of Amino Acids and Nucleotides</td>
</tr>
<tr>
<td><strong>SEC-I</strong> Skill Enhancement Course <em>(Any one)</em></td>
<td><strong>SEC-II</strong> Skill Enhancement Course <em>(Any one)</em></td>
</tr>
<tr>
<td>I. Biochemical Techniques (SEC-1)</td>
<td>I. Bioinformatics (SEC-4)</td>
</tr>
<tr>
<td>II. Biostatistics (SEC-2)</td>
<td>II. Microbial Techniques (SEC-5)</td>
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<tr>
<td>III. Research Methodology (SEC-3)</td>
<td>III. Research Methodology (SEC-3A)</td>
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<td><strong>GE-III</strong> Generic Elective <em>(Any one)</em></td>
<td><strong>GE-IV</strong> Generic Elective <em>(Any one)</em></td>
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<tr>
<td>I. Intermediary Metabolism (GE-5)</td>
<td>I. Biochemical Correlation of Diseases (GE-4A)</td>
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<td>II. Recombinant DNA Technology (GE-7)</td>
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<td>III. Biochemical Applications in Forensics (GE-6)</td>
<td>III. Biochemical Applications in Forensics (GE-6A)</td>
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<tr>
<td><strong>C11</strong> Concepts in Genetics</td>
<td><strong>C13</strong> Genetic Engineering and Biotechnology</td>
</tr>
<tr>
<td><strong>C12</strong> Gene Expression and Regulation</td>
<td><strong>C14</strong> Immunology</td>
</tr>
<tr>
<td><strong>DSE-I</strong> Discipline Specific Elective <em>(Any two)</em></td>
<td><strong>DSE-II</strong> Discipline Specific Elective <em>(Any two)</em></td>
</tr>
<tr>
<td>I. Nutritional Biochemistry (DSE-1)</td>
<td>I. Molecular Basis of Infectious Diseases (DSE-4)</td>
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<tr>
<td>II. Advanced Cell Biology (DSE-2)</td>
<td>II. Plant Biochemistry (DSE-5)</td>
</tr>
<tr>
<td>III. Microbiology (DSE-3)</td>
<td>III. Advanced Methodologies (DSE-6)</td>
</tr>
</tbody>
</table>

**C:** Core Courses *(14); GE:** Generic Elective *(04); AECC:** Ability Enhancement Compulsory Course *(02); SEC:** Skill Enhancement Courses *(02); DSE:** Discipline Specific Elective *(04). Numbers within bracket indicate the total number of courses offered in each category. Courses containing “A” in their course code are repeated in different semesters.
## SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. HONOURS BIOCHEMISTRY

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>COURSES OFFERED</th>
<th>COURSE NAME</th>
<th>CREDITS</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Ability Enhancement Compulsory Course 1</td>
<td>English communication / Environmental Science</td>
<td>2</td>
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<tr>
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<td>Core course 1</td>
<td>Molecules of Life</td>
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<tr>
<td></td>
<td>Core course 2</td>
<td>Cell Biology</td>
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<tr>
<td></td>
<td>Genetic Elective 1</td>
<td>GE – 1</td>
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<tr>
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<td>Generic Elective 1 Practical</td>
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<tr>
<td>II</td>
<td>Ability Enhancement Compulsory Course 2</td>
<td>English communications/Environmental Science</td>
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<td></td>
<td>Core course 3</td>
<td>Proteins</td>
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<td>Core course 3 Practical</td>
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<td>Core course 4</td>
<td>Enzymes</td>
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<td></td>
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<td>Generic Elective – 2</td>
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<tr>
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<td>Generic Elective – 2 Practical</td>
<td>GE-2</td>
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<tr>
<td>III</td>
<td>Core course 5</td>
<td>Metabolism of Carbohydrates and Lipids</td>
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<td>Core course 5 Practical</td>
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<tr>
<td></td>
<td>Core course 6</td>
<td>Membrane Biology and Bioenergetics</td>
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<td>Core course 6 Practical</td>
<td>Membrane Biology and Bioenergetics</td>
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<tr>
<td></td>
<td>Core course 7</td>
<td>Hormone: Biochemistry and Function</td>
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<td>Core course 7 Practical</td>
<td>Hormone: Biochemistry and Function</td>
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<td>Skill Enhancement Course -1</td>
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<td>Generic Elective – 3</td>
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<td>Generic Elective – 3 Practical</td>
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<td>IV</td>
<td>Core course 8</td>
<td>Human Physiology</td>
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<td></td>
<td>Core course 9</td>
<td>Gene organization, replication and repair</td>
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<td>Core course 9 Practical</td>
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<tr>
<td>Core course 10</td>
<td>Metabolism of Amino Acids and Nucleotides</td>
<td>4</td>
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<td>Metabolism of Amino Acids and Nucleotides</td>
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<td>Skill Enhancement Course - 2</td>
<td>SEC-2</td>
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<tr>
<td>Generic Elective - 4</td>
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<tr>
<td>Core course 11</td>
<td>Concepts in Genetics</td>
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<td>Concepts in Genetics</td>
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<tr>
<td>Core course 12</td>
<td>Gene expression and regulation</td>
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<td>Discipline Specific Elective-1</td>
<td>BCH DSE-1</td>
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<tr>
<td>Discipline Specific Elective-2</td>
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<td>Discipline Specific Elective – 2 Practical</td>
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<tr>
<td>Core course 13</td>
<td>Genetic Engineering and Biotechnology</td>
<td>4</td>
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<td>Core course 13 Practical</td>
<td>Genetic Engineering and Biotechnology</td>
<td>2</td>
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<tr>
<td>Core course 14</td>
<td>Immunology</td>
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<td>Core course 14 Practical</td>
<td>Immunology</td>
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<td>Discipline Specific Elective-3</td>
<td>BCH DSE-3</td>
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<td>Discipline Specific Elective-3 Practical</td>
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<td>Discipline Specific Elective-4 Practical</td>
<td>BCH DSE-4</td>
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</tbody>
</table>

Note: 1 Credit is equivalent to 1 hour of teaching per week for theory courses and 2 hour of teaching for practical courses.
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE COURSES
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER
Molecules of Life (BCH C-1)
Semester - I

1. Course Objectives

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. The course will outline the importance of water as a biological solvent and vitamins as vital ingredients of life. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective as well as hands on approach and laboratory techniques.

2.1 Course Learning Outcomes

On successful completion of the course students will be:

- Acquainted with chemical and molecular foundations of life and appreciate the role of water in biological systems.
- Able to comprehend the structure, function and acid base properties of amino acids.
- Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
- Aware of the importance of vitamins in biological systems.
- Able to independently identify and quantitate various biomolecules in the laboratory.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I : The foundations of biochemistry No. of hours : 6

Cellular and chemical foundations of life, Water: unique properties, weak interactions in aqueous systems, ionization of water, buffering action in biological system, water as a reactant and fitness of the aqueous environment.

UNIT II: Amino Acids No. of hours : 8

Structural features and classification; Physical properties, optical properties (Stereoisomerism); Chemical properties (acid base properties, titration curve) of amino acids; Uncommon amino acids and their functions
UNIT III: Carbohydrates and Glycobiology
No. of hours : 16

Monosaccharides - structure of aldoses and ketoses; Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers; Structure of biologically important sugar derivatives, oxidation and reduction of sugars; Formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides; Structure and role of glycoconjugates - proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides); Carbohydrates as informational molecules.

UNIT IV: Lipids
No. of hours : 14

Building blocks of lipids - fatty acids, glycerol, ceramide; Storage lipids - triacyl glycerol and waxes; Structural lipids in membranes – glycerophospholipids; Galactolipids and sulpholipids, etherlipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids; Lipids as signals, cofactors and pigments.

UNIT V: Nucleic Acids
No. of hours : 10

Nucleotides - structure and properties of bases, pentoses, nucleosides; Nucleic acid structure – Watson-Crick model of DNA, forms of DNA; Structure of major species of RNA - mRNA, tRNA and rRNA; Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA; Other functions of nucleotides - source of energy, component of coenzymes and second messengers.

Unit VI: Vitamins
No. of hours : 6

Structure and active forms of water soluble and fat soluble vitamins; Deficiency diseases and symptoms, hypervitaminosis

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers, phosphate and acetate buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates.
6. Qualitative test for lipids.
7. Qualitative test for amino acids, proteins.
8. Qualitative test for nucleic acids.
10. Estimation of vitamin C.
2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Appreciation of the role of water in biological system.</td>
<td>Traditional chalk and board teaching and hands-on-experiments with buffers</td>
<td>Unit assessment by multiple choice questions (MCQ)</td>
</tr>
<tr>
<td>II.</td>
<td>Ability to comprehend the structure, function and acid base properties of amino acids.</td>
<td>Classroom teaching of structures and properties of amino acids and laboratory experiments on titration curves and identification of functional groups</td>
<td>Quiz on amino acid properties and structure. Students will be shown three-dimensional structures of amino acids in power points, which they will identify and relate to properties</td>
</tr>
<tr>
<td>III.</td>
<td>Introduction to the structure, properties and roles of carbohydrates.</td>
<td>Traditional chalk and board teaching; learning properties of carbohydrates through laboratory based identification</td>
<td>Test on structure and functions of carbohydrates</td>
</tr>
<tr>
<td>IV</td>
<td>Appreciation of the varied roles of lipids including distribution in different biological membranes</td>
<td>Traditional teaching of structures of lipids and video presentation of membrane lipids: learning structure and function of lipids and membranes through discussion and power point presentations</td>
<td>Test and MCQ on lipids</td>
</tr>
<tr>
<td>V.</td>
<td>Understanding nucleic acid chemistry and structure.</td>
<td>Chalk and board teaching and presentation on double helix model of nucleic acid structure.</td>
<td>Test and quiz on nucleic acids. Discussion on the history of discovery of double helix of DNA</td>
</tr>
<tr>
<td>VI.</td>
<td>Understanding of the biochemical importance of vitamins and their active forms</td>
<td>Classroom teaching of vitamin structures and their active forms and estimation of vitamin-C in laboratory</td>
<td>Quiz on vitamins, their active forms and deficiency diseases. Revision of the entire course</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. Keywords
Carbohydrates; Lipids; Nucleic acids; Amino acids; Vitamins; Water; Buffers
1. Course Objectives

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. The course also aims to impart understanding of cell cycle, cell death, cell renewal processes and various techniques of cell biology.

2.1 Course Learning Outcomes

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. Students will:

- Learn about cell theory and basic cell structure
- Be introduced to cell fractionation and cell visualization techniques
- Gain knowledge about the structure and function of various cell organelles in a eukaryotic cell
- Acquire knowledge about the composition of cytoskeleton and extracellular matrix
- Acquire insight into cell division and cell death mechanisms

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Introduction to Cell Biology No. of hours: 5

Cell theory, Structure of prokaryotic and eukaryotic cell, exceptions to cell theory, mycoplasma, viruses, viroids, prions, cells as experimental models

UNIT II: Tools of Cell Biology No. of hours: 10


UNIT III: Cell Organelles (structure and function) No. of hours: 17

Nucleus: Structure of nuclear envelope, nuclear pore complex nucleolus and chromatin
Lysosomes: Development of different forms of lysosomes, role in cellular digestion, lysosomal storage diseases Peroxisomes: assembly, functions (H₂O₂ metabolism, fatty acid oxidation), glyoxysomes Mitochondria: structure, endosymbiont theory, genome Chloroplast: structure, endosymbiont theory, genome

UNIT IV: Cell Wall, Extracellular Matrix and Cell Junctions No. of hours: 10

Prokaryotic and eukaryotic cell wall structure; ECM components – proteins, polysaccharides and adhesion proteins; basic concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata)

UNIT V: Cytoskeleton No. of hours: 08

Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies) Microfilaments: Actin and Myosin Intermediate Filaments: different classes. Role of cytoskeletal elements in the entry of infectious agents

UNIT VI: Cell Cycle, Cell Death and Cell Renewal No. of hours: 10

Eukaryotic Cell Cycle, Checkpoints, Cell Division (mitosis and meiosis); Brief overview of apoptosis and necrosis; Types and potency of Stem Cells, Cancer – types, salient features of a transformed cell, causes of cancer. Apoptotic death in relation to cell cycle

PRACTICALS

CREDIT : 2 TOTAL HOURS: 60

1. To study the parts of a microscope
2. Cytochemical staining of proteins by Methylene blue
3. Cytochemical staining of RNA by Methyl Green Pyronin
4. Cytochemical staining of polysaccharides by PAS
5. To study different stages of mitosis by temporary preparation in onion root tip
6. To study different stages of meiosis by temporary preparation in onion flower buds/gasshopper testes
7. To study of cell organelles by using electron micrographs
8. To study of the effect of isotonic, hypotonic and hypertonic solution on cells

2.3 References


Additional Resources:

Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Students will learn about the cell theory and basics of cell structure</td>
<td>Milestones of the development in cell biology will be discussed. Models of cell structure will be shown</td>
<td>Students will be asked to research on this topic. Assignments will be conducted</td>
</tr>
<tr>
<td>II.</td>
<td>Students will be introduced to cell fractionation and cell visualization techniques</td>
<td>Students will be taught by use of video tutorial. They will be taken to various institutes for demonstration of some of the tools taught in class</td>
<td>Quiz will be organized. They will be shown various pictures to identify the various microscopy techniques. Assignment and tests.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will gain knowledge about the structure and function of various cell organelles in a eukaryotic cell</td>
<td>Will be taught by chalk and board method. Students will be shown various power point presentations and videos for concept building</td>
<td>They will be asked to label various parts of organelles. Assignment and tests will be conducted.</td>
</tr>
<tr>
<td>IV.</td>
<td>Students will gain knowledge about the structure of cell wall, components of extracellular matrix and basics of cell junctions</td>
<td>Teaching will be imparted by chalk and board method and by videos.</td>
<td>Students will be assigned the task of retrieving information on the differences in cell wall in various kingdom of life and enlist the components of extracellular matrix.</td>
</tr>
<tr>
<td>V.</td>
<td>Students will acquire knowledge about the structure, composition and significance of cytoskeleton</td>
<td>Chalk and board method of teaching to be employed along with power point presentations and videos.</td>
<td>Students will be assigned the task of retrieving information on cytoskeleton elements and their relation to diseases</td>
</tr>
<tr>
<td>VI.</td>
<td>Students will acquire insight into cell division and cell death mechanisms</td>
<td>Power point presentations, video tutorials and traditional teaching will be utilized. Current research in this area will be discussed in groups</td>
<td>Assignment and tests; identification of different stages of cell division and cell death will be assigned</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)

4. **Keywords**

Cell organelles, Cell wall, Cell-Cell Interactions, Cancerous Cells, Cell-Pathogen interactions, Cell Theory, Cell cycle, Transformed cell
1. Course Objectives

The course aims to introduce “proteins” and their importance to modern biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing important role in disease manifestation and their interventions.

2.1 Course Learning Outcomes

After completion of the course, a student will

- Understand the diverse functions of proteins in a cell
- Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
- Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases
- Be able to describe and discuss the separation and purification techniques used in protein chemistry
- Learn to access and use the databases related to protein sequence and structure
- Understand specialized proteins like membrane proteins, defense proteins and motor proteins
- Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Introduction to amino acids, peptides and proteins No. of hours: 4


UNIT II: Hierarchy of protein structure No. of hours: 18

Importance of primary structure in protein folding. The peptide bond, dihedral angles psi and phi, helices, sheets and turns, Ramachandran map. Motifs and domains. Structures of myoglobin and haemoglobin, α-keratin, silk fibroin, collagen.

UNIT III:  Protein folding and conformational diseases  No. of hours: 6


UNIT IV:  Specialized proteins  No. of hours: 10


UNIT V:  Extraction, purification and characterization of proteins  No. of hours: 18

Solubilization of proteins from their cellular and extracellular locations. Use of mechanical and chemical methods, homogenization, ultrasonication, French press and centrifugation. Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC. Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient. IEF, SDS-PAGE and 2-D electrophoresis.

UNIT VI:  Introduction to Protein Databases  No. of hours: 4

Introduction to protein sequence and structure databases (UNIPROT, SWISS-PROT & PDB), Protein sequence file Format (FASTA) and Visualization softwares.

PRACTICALS

CREDITS: 2  TOTAL HOURS: 60

1. Estimation of proteins using UV-absorbance and Biuret method.
3. Isoelectric pH of casein.
4. Ammonium sulphate fractionation of proteins.
6. SDS-PAGE analysis of proteins.
7. Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB
2.3 References

6. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
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</thead>
<tbody>
<tr>
<td>I.</td>
<td>Appreciation of the significance of proteins in life; Understanding of the classification diversity of functions of proteins; Knowledge of amino acids as building blocks of proteins, their classification and structures</td>
<td>Outlining history of development about proteins through power point presentations and landmark publications; Classification and diversity will be taught by chalk &amp; board method; Stereochemistry models for amino acids structures and power point presentations and videos</td>
<td>Numerical problems related to codes in amino acids, numerical problems relating to the pKa and pI of amino acids.</td>
</tr>
<tr>
<td>II.</td>
<td>Knowledge of hierarchy of protein structures and various aspects of structures and sequencing methods; concepts of subunits with reference to hemoglobin structure</td>
<td>Traditional chalk and board method will be employed along with powerpoint presentations on 3D structures, Ramachandran Map and hierarchy of protein structures; Videos will be shown</td>
<td>Numerical problems on Sequencing will be assigned; Students will download 3D structures from PDB and visualize several aspects of structures using softwares.</td>
</tr>
<tr>
<td>III.</td>
<td>Basic concepts as to how proteins fold and what challenges they face during folding; Knowledge about chaperones that help in protein folding and</td>
<td>Appropriate mix of chalk and board teaching as well as use of Power point presentations for clarity of concepts with images; Research papers will be discussed</td>
<td>Class presentations and case studies will help students understand misfolding diseases; They will be asked to match a few proteins with the diseases they cause due to</td>
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<td></td>
<td>diseases caused due to protein misfolding</td>
<td>misfolding</td>
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<tr>
<td>IV</td>
<td>Students will learn about structural features and differences between fibrous and globular proteins with examples; Structural aspects of membrane proteins and their relation to function</td>
<td>Power point presentations; Chalk and board; Student interaction in class; Case studies with examples of each protein structural class</td>
<td>Images of proteins to identify globular and fibrous proteins will be provided. Transmembrane protein prediction tools will be used by students. Hydropathy plots will be discussed.</td>
</tr>
<tr>
<td>V</td>
<td>Development of understanding of the rationale, basic principles, types of biochemical and biophysical methods for extraction and characterization of proteins</td>
<td>Chalk &amp; board method of teaching followed by class discussions with examples.</td>
<td>Numerical methods to discuss enzyme activity, specific activity will assigned; Practical problems in protein purification will be discussed and assigned in groups</td>
</tr>
<tr>
<td>VI</td>
<td>Students will learn about protein databases and tools available in public domain.</td>
<td>Power point presentations on various databases, protein sequence and structure retrieval to be utilized.</td>
<td>Assignments and Quiz on databases and tools used in protein sequence and structure analysis; Students will be assigned the task of identifying new databases and tools by browsing papers and internet.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Amino acids, Peptides & Proteins; Classification of Proteins; Globular and Fibrous proteins; Protein structure; Denaturation and Renaturation; Techniques in protein separation; Purification of proteins; Protein Folding & Diseases; Specialized Proteins; Protein Databases
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER

Enzymes (BCH C-4)
Semester - II

1. Course Objectives

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

2.1 Course Learning Outcomes

- Students will learn the nature and importance of enzymes in living systems
- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
- Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

2.2 Course Contents

THEORY

CREDITS: 4
TOTAL HOURS: 60

UNIT I: Introduction to enzymes and features of catalysis

General characteristics of enzymes; nature of enzymes - protein and non-protein (ribozymes – RNaseP, self-splicing introns, abzymes). Co-factor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. Enzyme assays-discontinuous, continuous, coupled assays; Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis, factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory. Catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer’s lock and key hypothesis, Koshland’s induced fit hypothesis.

UNIT II: Enzyme kinetics

Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics, mono-substrate reactions. Michaelis-Menten equation, Lineweaver-Burk

**UNIT III: Enzyme inhibition**  
No. of hours: 8

Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Substrate inhibition. Structural analogs (allopurinol, methotrexate and trimethoprim). Mechanism based inhibitors ($\beta$-lactam antibiotics, difluoromethyl ornithine), clinical importance of enzyme inhibitors.

**UNIT IV: Mechanism of action of enzymes**  
No. of hours: 12


**UNIT V: Regulation of enzyme activity**  
No. of hours: 10


**UNIT VI: Applications of enzymes**  
No. of hours: 10

Enzymes as reagents (glucose oxidase, cholesterol oxidase); Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); Enzyme linked immunoassay (ALP and HRP); Enzyme therapy (streptokinase); Enzymes in research (Taq polymerase, restriction endonucleases). Immobilized enzymes and industrial applications of enzymes.

**PRACTICALS**

**CREDITS: 2**  
**TOTAL HOURS: 60**

1. Partial purification of an enzyme using bulk methods or chromatography
2. Assay to determine enzyme activity and specific activity
3. Progress curve plot for an enzyme
4. Effect of pH/temperature on enzyme activity
5. Determination of $K_M$ and $V_{max}$ using Lineweaver-Burk plot
6. Calculation of inhibitory constant ($K_i$) for an enzyme
7. Continuous assay of an enzyme
2.3 References


Additional Resources:


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<th>Unit No.</th>
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<tbody>
<tr>
<td>I</td>
<td>Knowledge about the basic properties and characteristics of enzymes and their action; insights into the factors affecting enzyme activity.</td>
<td>Historical perspectives; Power point presentations; Teaching using chalk and board;</td>
<td>Oral questions will be asked in the class. Assignments to classify enzymes, determine specific activity and reaction rates.</td>
</tr>
<tr>
<td>II</td>
<td>Students will learn about the kinetics of enzyme catalyzed reactions and bisubstrate reactions</td>
<td>Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class; Recent papers will be discussed</td>
<td>Class test will be conducted for internal assessment; Numerical problems assigned for enzyme kinetics.</td>
</tr>
<tr>
<td>III</td>
<td>Outline of the inhibitors of enzymes and their clinical importance.</td>
<td>Significance of inhibitors will be discussed with use of research papers; Classical chalk and board teaching and power point presentations</td>
<td>Various analytical problems will be assigned to students related to enzyme inhibition. Students will identify examples of inhibitors of various kinds.</td>
</tr>
<tr>
<td>IV</td>
<td>Understanding of the mechanism of enzyme action and the role of coenzymes in catalysis.</td>
<td>Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class</td>
<td>Demonstration by students with the help of models to test their understanding.</td>
</tr>
<tr>
<td>V</td>
<td>Students will learn how enzymes are regulated</td>
<td>Teaching using chalk and board method along with</td>
<td>Problems will be assigned to test student’s analytical</td>
</tr>
</tbody>
</table>
and the importance of enzyme regulation in the cellular context.  

Power point presentations and video tutorials.  

ability. Class tests will be conducted for internal assessment. Students will discuss methods of regulation in groups.

| VI | Detailed knowledge of the various applications of enzymes in medicine and research. | Teaching using chalk and board; Oral discussion sessions in the class; Videos. | Assignment of a small project on identifying a specific application of any enzyme and tracings its development and current use. |

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keyword**

   Enzymes, Catalysis, Specific activity, Mechanism of action, Vitamins, Isoenzymes
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER
Metabolism of Carbohydrates and Lipids (BCH C-5)
Semester - III

1. Course Objective

The objective of this course is to provide an understanding of metabolism of carbohydrates and lipids, the enzymes involved in various metabolic pathways and regulation of metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

2.1 Course Learning Outcomes

The learners will be able to:

- Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Gain a detailed knowledge of various catabolic and anabolic pathways
- Understand the regulation of various pathways
- Gain knowledge about the diseases caused by defects in metabolism with emphasis on the metabolic control

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Glycolysis, and pentose phosphate pathway No of hours: 12


UNIT II: Additional pathways in carbohydrate metabolism No of hours: 12

Glycogen synthesis, glycogen breakdown, regulation of glycogen metabolism, gluconeogenesis. Glycogen storage diseases; Von Gierke, Pompe, Cori and McArdle. Gluconeogenesis. Photosynthesis dark reaction: Calvin cycle, regulation, Photo respiration, C4 and CAM pathways in plants.
UNIT III: Citric acid cycle
No of hours: 10
Overview of citric acid cycle, synthesis of acetyl Coenzyme A, enzymes of citric acid cycle, regulation of citric acid cycle, anaplerotic reactions, amphibolic nature, Malate aspartate shuttle, Glyceraldehyde-3-phosphate dehydrogenase shuttle, Glyoxylate cycle in plants. Signaling pathways, regulation of carbohydrate metabolism by hormones, diseases associated with metabolic irregularities.

UNIT IV: Degradation of lipids
No of hours: 10
Lipid digestion, absorption and transport. Fatty acid oxidation: transport to mitochondria, activation of fatty acids, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and α oxidation. Ketone-body metabolism.

UNIT V: Synthesis of lipids
No of hours: 10
Transport of mitochondrial Acetyl Co A to cytosol, Fatty acid synthase complex enzyme. Synthesis of saturated, unsaturated, odd and even chain fatty acids, regulation of fatty acid metabolism. Synthesis of glycerophospholipids and sphingolipids. Cholesterol metabolism, diseases associated with abnormal lipid metabolism.

UNIT VI: Regulation of metabolism
No of hours: 06
Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis.

PRACTICALS
CREDIT : 2
TOTAL HOURS : 60

1. Estimation of blood glucose.
2. Sugar fermentation by microorganisms.
3. Assay of salivary amylase.
4. Isolation of lipids from egg yolk and separation by TLC.
5. Cholesterol estimation.

2.3 References

### 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

<table>
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<tbody>
<tr>
<td>I.</td>
<td>Students will learn the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways. Glycolysis and gluconeogenesis.</td>
<td>Traditional chalk and black board method, Audio visual presentation. Class room discussion.</td>
<td>Assignment, question answers, MCQ, unit -test and practical assessment through experiment.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will be taught Glycogen synthesis, breakdown, glycogen storage diseases, Calvin cycle, C3 and C4 plants.</td>
<td>Traditional chalk and black board method with examples and reactions and experiments</td>
<td>Assignment, question answers, MCQ, unit –test and practical assessment through experiment.</td>
</tr>
<tr>
<td>III.</td>
<td>The students will learn about Overview, enzymes and regulation of citric acid cycle and Glyoxylate cycle in plants. They will also learn about Signaling pathways and regulation of carbohydrate metabolism by hormones, diseases associated with metabolic irregularities.</td>
<td>Traditional chalk and black board method with examples and reactions along with experiment.</td>
<td>Assignment, question answers, MCQ, unit -test and practical assessment through experiment.</td>
</tr>
<tr>
<td>IV.</td>
<td>The students will learn Lipid digestion, Fatty acid oxidation, and Ketone-body metabolism.</td>
<td>Traditional chalk and black board method with examples and reactions</td>
<td>Assignment, question answers, MCQ, unit -test , practical assessment through experiment and midterm examination.</td>
</tr>
<tr>
<td>V.</td>
<td>The students will learn about the transport of mitochondrial Acetyl Co A, Synthesis of saturated, unsaturated, odd and</td>
<td>Traditional chalk and black board method with examples and reactions along with experiment.</td>
<td>Assignment, question answers, MCQ, unit -test and practical assessment through experiment.</td>
</tr>
</tbody>
</table>
even chain fatty acids and regulation of fatty acid metabolism. Synthesis of glycerophospholipids and sphingolipids. Cholesterol metabolism, diseases associated with abnormal lipid metabolism.

| VI. | The students will learn Well-fed state, early fasting state, fasting state, early re-fed state in metabolism. | Traditional chalk and black board method with examples and reactions along with experiment | Assignment, question answers, MCQ, unit-test and practical assessment through experiment. |

(*Assessment tasks enlisted here are indicative in nature) 

4. Keywords

Metabolism, Carbohydrates, Lipids, Glycolysis, Citric acid cycle, Allosteric regulation, Fatty acid oxidation, Ketone bodies, Starve feed cycle, Blood glucose regulation
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER
Membrane Biology and Bioenergetics (BCH C-6)
Semester III

1. Course Objective

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. The course will introduce students to the basic tenets of Bioenergetics and detail out the molecular mechanisms of oxidative phosphorylation and photophosphorylation.

2.1 Course Learning Outcomes

On successful completion of the course, students will:

- Understand the general composition and structure of biomembranes.
- Understand the basic properties of membranes such as membrane fluidity.
- Have knowledge about the various types of membrane transport mechanisms.
- Understand the basic tenets of Bioenergetics.
- Understand the concept of chemi-osmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis.
- Understand the basic mechanisms of photophosphorylation in plants and microbes.

2.2 Course Contents

THEORY

CREDITS: 4  TOTAL HOURS: 60

UNIT I: Membrane composition and structure  No. of hours: 12


UNIT II: Membrane dynamics  No. of hours: 8

architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

UNIT III: Membrane transport No. of hours: 12


UNIT IV: Introduction to Bioenergetics No. of hours: 8

Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, and phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, PEP, I,3 BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

UNIT V: Oxidative phosphorylation No. of hours: 10


UNIT VI: Photophosphorylation No. of hours: 10


PRACTICALS

CREDIT: 2 TOTAL HOURS: 60

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. Preparation of RBC ghost cell.
4. Study the photosynthetic O2 evolution in hydrilla plant.
5. Isolation of chloroplast from spinach leaves and estimation of chlorophyll content.
6. Study the Hill reaction by using artificial electron acceptor.
7. Separation of photosynthetic pigments by TLC.
8. Separation of RBC membrane proteins by SDS-PAGE.
9. Isolation of mitochondria from liver and assay of marker enzyme SDH.
2.3 References


Additional Resources:


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I.</td>
<td>Understand the general composition and structure of biomembranes. To study various membrane model systems and their application.</td>
<td>Traditional chalk &amp; board method with powerpoint presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students to do comparative study of various cellular and subcellular membranes.</td>
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</tr>
<tr>
<td>II.</td>
<td>Understand membrane fluidity, and various techniques used to study membrane fluidity.</td>
<td>Traditional chalk &amp; board method with powerpoint presentations</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td>III.</td>
<td>Have knowledge about the various types of membrane transport mechanisms.</td>
<td>Traditional chalk &amp; board method with powerpoint presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture. Mid-term exam.</td>
</tr>
</tbody>
</table>
**IV.** Understand the basic tenets of Bioenergetics.

Traditional chalk & board method with powerpoint presentations. Numerical problems relating to free energy change, entropy, etc., to be done in class to explain spontaneous, endothermic, exothermic reactions. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture.

**V.** Understand the concept of chemiosmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis.

Traditional chalk & board method with powerpoint presentations. Numerical problems relating to standard redox potential, proton motive force done in class. Videos of rotational catalysis shown. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture.

**VI.** Understand the basic mechanisms of photophosphorylation in plants and microbes.

Traditional chalk & board method with powerpoint presentations. Numerical problems relating to photophosphorylation efficiency done. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture. Power point presentation by students.

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Membrane asymmetry, Membrane fluidity, ATPase, Ion channels, Ionophores, PMF, Oxidative phosphorylation, Photophosphorylation.
1. Course Objectives

The course is designed to provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response. The course will enable students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. It imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function. It outlines the consequences of any hormonal imbalances with special emphasis on human diseases. The course will also prepare a student for postgraduate studies in any course related to molecular medicine.

2.1 Course Learning Outcomes

On successful completion of the course, a student will:

- Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
- Understand the role of endocrine system in maintaining ionic and glucose homeostasis
- Be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
- Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction
- Be prepared for interpreting clinical parameters in a real life situation

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Introduction to Endocrinology and Cellular signaling No of hours: 17

UNIT II: Hypothalamic- Hypophysial system:  No. of hours: 5


UNIT III: Hormones regulating Metabolism, Calcium homeostasis and Growth:  No. of hours: 14


UNIT IV: Hormones of the Adrenals:  No. of hours: 8


UNIT V: Pancreatic and GI Tract Hormones:  No. of hours: 10

Cells involved in the release of gastrointestinal hormones; the gastrin family of hormones and CCK: the secretin family of hormones; Incretins; Ghrelin; Summary of hormone metabolite control of GI function. Hormones of the Pancreas: Structure, synthesis, physiology and biochemical actions of insulin and glucagon. Adipocyte hormones: Adiponectin and leptin; Appetite and satiety control. Pathophysiology - Type I and type II Diabetes mellitus.

UNIT VI: Reproductive Hormones:  No. of hours: 6

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based contraception.

PRACTICALS

CREDIT: 2  TOTAL HOURS : 60

1. Glucose tolerance test.
2. Estimation of serum Ca$^{2+}$.
3. Estimation of serum T4
4. HCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I.</td>
<td>Students will be able to differentiate between a hormone and a factor. They will understand various types of cellular signaling, learn about classical and modern endocrine methodologies. They will understand the concept of signal, reception, transduction, amplification and response, Scathard analysis, signal transduction and steroid receptors.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding.</td>
<td>Students will be given questions that are application based and require analytical skills. Internal assessment tests will be held.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will understand the anatomical and functional significance of the hypothalamic pituitary axis, learn about the anatomy, histology and secretions of the hypothalamus and anterior pituitary, concept of hormonal feedback regulation. They will also gain insight into the posterior pituitary anatomy and</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding.</td>
<td>Conduct of Internal assessment tests. Students will be given to prepare power point presentation on the assigned topics related to the class teachings.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn about the synthesis, structure and biochemical functions of the thyroid gland secretions, understand the factors that monitor calcium homeostasis in the human body. Students will learn about growth and the hormonal networks that regulate growth and repair.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Practical analysis of serum samples for understanding diagnosis of thyroid hormone pathophysiology. Practical analysis of serum samples for understanding diagnosis of imbalances in calcium homeostasis.</td>
<td>Internal assessment tests will be conducted. Students will be asked to analyze case studies. Open book tests will be held to promote self-learning.</td>
</tr>
<tr>
<td>IV.</td>
<td>Students will be able to appreciate the significance of the adrenal histology with respect to synthesis of cortical and medullary hormones. The concept of blood pressure regulation and electrolyte balance governed by RAA system will be understood. They will also understand role of medullary hormone epinephrine in flight and flight response, general adaptation syndrome and the biochemical changes during acute and chronic stress.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions with case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding.</td>
<td>Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentation on any topic of interest relating to hormone biochemistry. Internal assessment tests will be conducted.</td>
</tr>
<tr>
<td>V.</td>
<td>Students will gain knowledge about histology of gastrointestinal tract with respect to regulation secretion of gastrointestinal hormones, regulation of satiety and appetite by adipose tissue and GIT secretions. Students will also learn about regulation of glucose homeostasis and role of hormones and other factors in the same. Students will get an insight into dysregulations that lead to pathophysiologies like anorexia, bulimia, diabetes, obesity and metabolic syndrome.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Practical assessment of glucose homeostasis by RBG and GTT.</td>
<td>Internal assessment tests will be conducted. Discussions using case studies will be conducted.</td>
</tr>
</tbody>
</table>
### VI. Students will understand the role of sex hormones in the development of primary and secondary sexual organs and characteristics, hormonal regulation of menstrual cycle, gestation, parturition and lactation. Students will also learn about hormonal contraception.

### Teaching will be conducted both through black board mode and power point presentation mode.

### Regular oral evaluation will be done. Internal assessment tests will be conducted

**Assessment tasks enlisted here are indicative in nature**

#### 4. Keywords

Cellular communication, signal transduction, hypothalamic-hypophysial axis, growth hormone, thyroxine, adrenal hormones, calcium and glucose homeostasis, reproductive hormones.
1. **Course Objectives**

The objective of the course in human physiology is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It also outlines the factors and biochemical events that disrupt homeostasis leading to pathophysiology. The course will prepare students for higher education in any field related to molecular medicine.

2.1 **Course Learning Outcomes**

On successful completion of this core paper, students should be able to:

- Understand the basic organization and homeostatic control of the human body from the cell itself to organ systems and the functioning of the whole body.
- Comprehend and appreciate the importance of the fluid components of the body in regulating and connecting the various organ systems; particularly the heart and vascular system.
- Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes.
- Get a holistic understanding of the different organ systems with respect to their basic functioning, which involves both integrative learning and the regulatory roles of the Nervous and Endocrine system.
- Develop in students an inquisitive learning approach to seek answers regarding the complex workings of brain.
- Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases.
- Perform and analyze various physiological tests that examine the function of various systems of the human body.

2.2 **Course Contents**

**THEORY**

**CREDITS: 4**

**TOTAL HOURS: 60**

**UNIT I: Introduction to Human body and Understanding Homeostasis**  No. of hours: 3

Physiology: overview and definition, levels of structural organization, organ system. Body fluid compartments: intracellular, extracellular and interstitial fluid. Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms).
UNIT II: Blood, Heart and Circulation:  No. of hours: 16

Components of blood: Plasma - Composition, SPE - electrophoretic pattern of serum proteins, major plasma proteins and their role, Erythrocytes- erythropoiesis, function and metabolism, Leukocytes, Platelets- structure and function; Hemostasis and its molecular mechanism, role of platelets in coagulation, role of vitamin K in coagulation, Anticlotting and fibrinolytic systems. Anemias: definition and types (Hemolytic, hemorrhagic, megaloblast, pernicious, iron deficiency and aplastic anemia), polycythemia, Hemophilia and Thrombosis.

Anatomy of heart. Automacity of the cardiac muscle conducting fibres; Physiology of cardiac contracting muscle fibres, Relationship between cardiac cycle, heart sound, ventricular volumes and the ECG. Control of Heart rate and stroke volume. The vascular system: Arteries, arterial blood pressure and its measurement, Capillaries and bulk flow across the capillary walls, Veins and determination of venous pressure. Regulation of systemic arterial pressure. Long term and short-term regulation of cardiac efficiency and blood pressure. Hypertension, congestive heart disease, atherosclerosis, Heart failure and myocardial infarction.

UNIT III: Life Processes:  No. of hours: 22


UNIT IV: Muscle  No. of hours: 04


UNIT V: Reproductive Physiology:  No. of hours: 06

UNIT VI: Neurophysiology: No. of hours: 09


PRACTICALS

CREDITS: 2 TOTAL HOURS: 60

1. Hematology:
   a. Packed Cell Volume, Bleeding Time and Clotting time.
   b. Preparation of blood smear and Differential leucocyte count.
   c. Enumeration of Blood cells: RBC and WBC counting, Calculation of blood Indices.
   d. Estimation of hemoglobin

2. Determination of total iron binding capacity.
3. Pulmonary function tests, spirometry and measurement of blood pressure.
4. Separation of isoenzymes of LDH by electrophoresis.
5. Case studies: Renal clearance, ECG, LFT, EEG (any two)

2.3 References


Additional Resources

# 3. Teaching Learning Process and Assessment Methods

## Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I.</td>
<td>Understanding the concept of homeostasis and the mechanism for maintaining it; Learning the importance of different fluid components in the human body; Comparing the different extracellular fluids with respect to composition and function.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode; Using online data to discuss the importance of fluid compositions in diagnosis.</td>
<td>Internal assessment tests; Students will be given questions that are application based and require analytical skills</td>
</tr>
<tr>
<td>II.</td>
<td>Learning the importance of plasma compositional variations as an important diagnostic tool. Understanding the biochemistry and physiological role of RBC. Learning the biochemistry of blood coagulation and the factors that lead to bleeding and coagulation pathopysiologies. Understand the anatomy, physiology and biochemistry of cardiac function. Understand the biophysics of movement of blood through the vasculature. Discuss and appreciate the factors that lead to pathophysiology of the cardiovascular system.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Hematological practical’s as an important diagnostic tool for anemias, infections and bleeding disorders.</td>
<td>Conduct of Internal assessment tests Case study with hematological reports.</td>
</tr>
<tr>
<td>III.</td>
<td>Learning the anatomy, physiology and biochemistry of pulmonary respiration and transport of oxygen for cellular utilization. Understand the importance of renal excretion of nitrogenous wasted by learning the process of urine formation. Understand the process of ingestion, digestion and assimilation of food. Learn to correlate biochemical mechanism to the manifestation of symptoms associated with the pathophysologies related with the three important life</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions with case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding</td>
<td>Internal assessment tests will be conducted Analyzing case studies. Open book tests to promote self-learning.</td>
</tr>
</tbody>
</table>
### IV. Understanding the biochemical mechanism that underlie the contraction of skeletal muscles.

| IV. Understanding the biochemical mechanism that underlie the contraction of skeletal muscles. Comparing the differences in smooth, skeletal and cardiac muscle with respect to anatomy mechanism of contraction and regulation. | Teaching will be conducted both through black board mode and power point presentation mode. | Internal assessment tests will be conducted. |

### V. Comparing the cell biology and physiology of spermatogenesis versus oogenesis.

| V. Comparing the cell biology and physiology of spermatogenesis versus oogenesis. Understanding the mechanism that define, spermatogenesis, spermiogenesis, semen composition and capacitation. Learning the process of cellular development that support and regulate oogenesis. Understanding acrosomal reaction, cortical response and polyspermy that ensure proper fertilization. Understanding the physiological processes involved in implantation, placentation and parturition. | Teaching will be conducted both through black board mode and power point presentation mode. Discussions using case studies will be conducted. | Internal assessment tests will be conducted. Analysis of case studies. |

### VI. Understand the cellular composition and anatomy of the central and peripheral nervous system.

| VI. Understand the cellular composition and anatomy of the central and peripheral nervous system. Learning the process of synthesis, composition and function of CSF. Understand the mechanism of generation, propagation and regulation of action potentials. Learning about the neurophysiology and chemistry of sensory perception, learning and memory and sleep. | Teaching will be conducted both through black board mode and power point presentation mode. | Internal assessment tests will be conducted. A PowerPoint presentation on any topic of interest relating to Neurophysiology and chemistry. |

(**Assessment tasks enlisted here are indicative in nature)**

4. **Key words**

Physiology, Homeostasis, life processes, heart, neurophysiology, reproduction
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER
Gene Organization, Replication and Repair (BCH C-9)
Semester - IV

1. Course Objectives

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

2.1 Course Learning Outcomes

- Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, supercoiling of DNA and its significance
- Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
- Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage

2.2 Course Contents

THEORY

CREDIT : 4 TOTAL HOURS: 60

UNIT I: Structure of DNA No. of hours: 10

Building blocks of DNA structure, Watson and Crick model, features of the double helix, various forms of DNA, denaturation and renaturation of DNA, hyperchromicity, melting temperature, factors affecting T_m of DNA molecules. Supercoiling of DNA, linking number, topoisomerases and their classification. Topoisomerase inhibitors and their clinical importance.

UNIT II: Genes and genomic organization No. of hours: 10

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA, centromere and telomere sequences. Nucleosome structure and packaging of DNA into higher order structures.

UNIT III: Replication of DNA No. of hours: 16

General features of replication, the chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, E coli DNA polymerases, stages of replication-initiation, elongation and termination, origin of replication, relationship
between replication and cell division, replication in eukaryotes, end replication problem, telomerase, various modes of replication. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

UNIT IV: Recombination and transposition of DNA

No. of hours: 12

Homologous recombination, biological role and models for homologous recombination, proteins and enzymes in homologous recombination, site-specific recombination, serine and tyrosine recombinases. Transposition, the three classes of transposable elements-DNA transposons, virus-like retrotransposons and poly-A retrotransposons. DNA transposition by cut and paste and replicative mechanism.

UNIT V: Molecular basis of mutations

No. of hours: 6


UNIT VI: Various modes of DNA repair

No. of hours: 6


PRACTICALS

CREDITS : 2

TOTAL HOURS : 60

1. To hydrolyze DNA and separate nucleotide bases by paper chromatography
2. To plot ultraviolet absorption spectrum of DNA
3. Determination of DNA concentration by A_{260nm}
4. Determination of the melting temperature
5. Isolation of chromosomal DNA from *E. coli* cells

2.3 References

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Students will learn about the complexity of DNA double helix structure, melting of DNA and understand the importance of supercoiling of DNA.</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Oral questions will be asked in the class. Problems will be assigned to test student’s analytical ability.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will understand the organization of DNA and how a long DNA molecule gets packaged in a small cell.</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Regular question-answer sessions in the class. Class tests will be conducted for internal assessment.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn about the details of DNA replication and importance of various proteins and enzymes involved in replication and application of inhibitors</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Students will be challenged with analytical problems, puzzles and assignments related to replication of DNA.</td>
</tr>
<tr>
<td>IV</td>
<td>Students will understand the mechanism and importance of homologous and site specific recombination and transposition.</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Interactive discussions, regular question-answer and quiz sessions in the class, demonstration by students with the help of models to test and improve their understanding.</td>
</tr>
<tr>
<td>V</td>
<td>Students will learn about DNA mutations and understand how DNA can be damaged by chemical mutagens and radiation.</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Regular class interaction and analytical problem solving in the class. Class tests will be conducted for internal assessment.</td>
</tr>
<tr>
<td>VI.</td>
<td>Students will learn about various strategies of DNA repair and diseases associated with DNA repair problems.</td>
<td>Teaching using chalk and board; Power point presentations; Oral discussion sessions in the class</td>
<td>Various analytical problems will be assigned to students related to DNA repair and related disorders.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

DNA, Double helix, Supercoiling, Recombination, Transposition, DNA Repair
1. **Course Objective**

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these molecules with respect to health diseases in addition to providing overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

2.1 **Course Learning Outcomes**

At the end of the course the students will be able to:

- Extend their school level concepts of nitrogen cycle to understand the mechanism by which nitrogen is fixed by microbes and how it’s incorporation in diet is critical to human nutrition as well as comprehend the mechanism by which ammonia is incorporated in biomolecules
- Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases
- Gain knowledge of how amino acids are converted into a variety of precursors
- Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
- Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism

2.2 **Course Contents**

**THEORY**

CREDITS: 4 \hspace{1cm} TOTAL HOURS: 60

**UNIT I: Overview of Nitrogen and Amino Acid Metabolism** \hspace{1cm} No. of hours: 8


**UNIT II: Catabolism and Biosynthesis of Amino Acids** \hspace{1cm} No. of hours: 18

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria

**UNIT III: Precursor Functions of Amino Acids**

No. of hours: 8

Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

**UNIT IV: Biosynthesis, Degradation of Purine and Pyrimidine Nucleotides**

No. of hours: 14

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

**UNIT V: Deoxyribonucleotides and Synthesis of Nucleotide Triphosphate and Co-enzymes**

No. of hours: 6

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

**UNIT VI: Integration of Metabolism**

No. of hours: 6

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

**PRACTICALS**

**CREDITS : 2**

**TOTAL HOURS : 60**

1. Assay of serum transaminases – SGOT and SGPT.
2. Estimation of serum urea.
3. Estimation of serum uric acid.
5. Estimation of bilirubin
6. Assay of glutamate dehydrogenase

**2.3 References**

### Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
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<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Students will learn about the concepts of nitrogen cycle, nitrogen fixation and assimilation, importance of nitrogen in human nutrition and its deficiency-associated disorders. Besides, students will be introduced to metabolic fates of amino groups, various metabolic cycles, their regulation and inherited defects of urea cycle.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and powerpoint presentation mode.</td>
<td>Internal assessment tests (midterm and end-term) will be conducted.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will gain insight into the breakdown and synthesis of amino acids. Further, the students will gain knowledge about various disorders related to amino acids.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and powerpoint presentation mode.</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on different topics specially disorders and will be asked to deliver a power-point presentation on the assigned topics.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn how amino acids are converted into a variety of precursors, such as creatine and creatinine, polyamines catecholamines, neurotransmitters and porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to</td>
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<tr>
<td>IV</td>
<td>Students will gain insight into <em>de novo</em> synthesis and degradation of purine and pyrimidine nucleotides, regulation and salvage pathways. Further, the students will learn about the inhibitors of nucleotide metabolism and disorders related to purine and pyrimidine metabolism.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.</td>
</tr>
<tr>
<td>V.</td>
<td>Students will gain knowledge about biosynthesis of deoxyribonucleotides, its regulation and conversion to triphosphates, Further they will also learn about the biosynthesis of coenzyme nucleotides.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.</td>
</tr>
<tr>
<td>VI.</td>
<td>Students will learn about the integration of various metabolic pathways and their cross-talk in specific tissues like brain, muscle, and liver.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.</td>
</tr>
</tbody>
</table>
4. Keywords

Nitrogen Balance, Protein calorie malnutrition, Transamination, Amino acid metabolism, Purine and Pyrimidine Metabolism, Porphyrin metabolism, Urea cycle, Metabolic disorders, Integration of metabolism
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)  
CORE PAPER  
Concepts in Genetics (BCH C-11)  
Semester – V

1. Course Objectives

The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of transmission genetics, molecular and developmental genetics, mapping techniques, chromosomal aberrations and population genetics. Students will gain a hands-on training experience of culturing and conducting experiments on the genetic model system Drosophila melanogaster. The course also works as preparation for further studies in a Master’s programme in molecular biology or related topics.

2.1 Course Learning Outcomes

On successful completion of the course, the students will be:

- Understanding the principles of Mendelian genetics, extensions and applications
- Learning and appreciating the various factors that confer genotypic and phenotypic variability.
- Using the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.
- Able to use statistical tools to analyze biological data.
- Able to apply the principles of transmission and inheritance in real life situations.

2.2 Course Contents

THEORY

CREDITS: 4  
TOTAL HOURS: 60

UNIT I: Principles of heredity and transmission genetics:  
No of hours: 16

Mendelian genetics and chromosomal basis of heredity: Mendelian laws and ratios, Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences; Extensions to Mendelian genetics: Complementation test giving examples from Drosophila eye colour mutants. Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy; Human pedigree analysis: Pedigree conventions, characteristics of dominant and recessive inheritance; sex linked, sex influenced and sex limited traits. Applications of pedigree analysis.
UNIT II: Genetics of bacteria and viruses  
No. of hours: 7


UNIT III: Linkage, crossing over and mapping techniques:  
No. of hours: 10

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in Drosophila, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

UNIT IV: Molecular genetics  
No. of hours: 12


UNIT V: Chromosomal aberrations  
No. of hours: 7

Variations in chromosome number: aneuploidy and polyploidy. Variations in chromosome structure- inversions, deletions, duplications and translocations.

UNIT VI: Quantitative, Population and Evolutionary Genetics  
No. of hours: 8

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hybrid vigor. Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle. Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

PRACTICALS

CREDITS : 2  
TOTAL HOURS : 60

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in Drosophila for studying autosomal and sex linked inheritance.
5. PTC testing in a population and calculation of allelic and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab)
2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Understanding Mendal's laws and ratios.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode.</td>
<td>Internal assessment tests.</td>
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<tr>
<td></td>
<td>Understand relationship between genetic inheritance, generation of variation and cell division.</td>
<td>Students will be practically shown examples from crosses of different Drosophila eye colour mutant strains for explaining complementation test.</td>
<td>Students will be given questions that are application based and require use of statistical tools like probability and chi-square analysis and hypothesis testing for goodness of fit.</td>
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<td></td>
<td>Relating genes to chromosomes- chromosomal basis of heredity</td>
<td>Use of statistical tools in testing genetic hypothesis.</td>
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<tr>
<td></td>
<td>Use of statistical tools in testing genetic hypothesis.</td>
<td>Complementation test relating extensions to Mendalian ratios due to allelic variations.</td>
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<tr>
<td></td>
<td>Complementation test relating extensions to Mendalian ratios due to allelic variations.</td>
<td>Understand gene interactions- both epistatic and non-epistatic.</td>
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<td></td>
<td>Understand gene interactions- both epistatic and non-epistatic.</td>
<td>Concept of Penetranace, expressivity, phenocopy and pleiotropy.</td>
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<tr>
<td></td>
<td>Concept of Penetranace, expressivity, phenocopy and pleiotropy.</td>
<td>Understanding how to draw a human pedigree chart and analyze it for determining inheritance patterns.</td>
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<tr>
<td></td>
<td>Understanding how to draw a human pedigree chart and analyze it for determining inheritance patterns.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode.</td>
<td>Conduct of Internal assessment tests.</td>
</tr>
<tr>
<td></td>
<td>Basics of bacterial and viral.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode.</td>
<td>Powerpoint.</td>
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<tr>
<td>III.</td>
<td>Understand the of concept of recombination and linked genes</td>
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<td></td>
<td>Use recombination frequencies to determine gene order and distance</td>
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<td>Genetic mapping in eukaryotes using test crosses</td>
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<td></td>
<td>Gene to centromere mapping with ordered tetrads and cytogenetic mapping</td>
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<td></td>
<td>Detection of linked loci by pedigree analysis in humans and the concept of LOD score</td>
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<td></td>
<td>Somatic cell hybridization for locating gene on a chromosome</td>
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<td></td>
<td>Physical mapping using molecular markers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>IV</th>
<th>Understand the difference in the genetic basis of sex determination in Humans, <em>Drosophila and C.elegans</em>.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Understand the role of maternal effect genes on axis formation during development using <em>Drosophila</em> as a model of study</td>
</tr>
<tr>
<td></td>
<td>Role of zygotic and homeotic genes in development using <em>Drosophila</em> as a model of study</td>
</tr>
<tr>
<td></td>
<td>Genetic control of flower development in <em>Arabidopsis</em>, Nonnuclear inheritance and its role in determination of phenotypes</td>
</tr>
</tbody>
</table>

| Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding |
| Teaching will be conducted both through black board mode and power point presentation mode. |
| Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding |
| Numerical problems for genetic mapping using three point cross would be given for practice in class. |

<p>| Presentation on the assigned topics. |
| Students will be given questions that are application based and require analytical skills |
| Teaching will be conducted both through black board mode and power point presentation mode. |
| Questions on drawing a genetic map with gene order, map distance, and centromere mapping |
| Internal assessment tests will be conducted |
| A PowerPoint presentation on any topic of interest relating to the concept of Epigenetics, non-nuclear inheritance and sex determination. |</p>
<table>
<thead>
<tr>
<th>Epigenetic phenomenon like dosage compensation and Genomic Imprinting.</th>
<th>Teaching will be conducted both through black board mode and power point presentation mode. Discussions using case studies will be conducted to help students understand the karyotype analysis.</th>
<th>Internal assessment tests will be conducted Analysis of case studies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. Students will learn about various structural and numeric chromosomal aberrations possible in both plants and animals. Understand the disadvantages as well as some advantages of such aberrations.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions using case studies will be conducted to help students understand the karyotype analysis.</td>
<td>Internal assessment tests will be conducted Analysis of case studies.</td>
</tr>
<tr>
<td>VI. Understand the concept of polygenic inheritance, additive gene effect, OTL, heterosis and hybrid vigor. Understand concept of gene pool, allelic and genotypic frequencies. Understand Hardy Weinberg principle and its limitations. Understand concept genetic drift, founder effect, genetic bottleneck. Factors that influence gene flow, fitness of a population and speciation.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions using population genetics based case studies will be conducted. Practical collection of data from population to test Hardy-Weinberg principle.</td>
<td>Internal assessment tests will be conducted Numerical analysis and case study analysis.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Mendalian genetics, Allelic and gene interaction, Gene mapping, Microbial genetics, Pedigree analysis, Epigenetics, Quantitative, Development, Population and Evolutionary Genetics
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
CORE PAPER
Gene Expression and Regulation (BCH C-12)
Semester - V

1. **Course Objective**

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills.

2.1 **Course Learning Outcomes**

After completion of the course students will:

- acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes
- learn about the features of the genetic code and various experimental approaches used to crack the code
- develop understanding of the molecular basis of RNA processing and RNA splicing
- learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms

2.2 **Course Contents**

**THEORY**

<table>
<thead>
<tr>
<th>CREDIT : 4</th>
<th>TOTAL HOURS : 60</th>
</tr>
</thead>
</table>

**UNIT I: Transcription in prokaryotes**  
No. of hours : 8

Comparison between transcription and DNA replication, RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as antimicrobial drugs.

**UNIT II: Transcription in eukaryotes**  
No. of hours : 8

Comparison between prokaryotic and eukaryotic transcription. The three classes of eukaryotic RNA polymerases, transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications
UNIT III: RNA Processing  
No. of hours : 8
Various types of RNA processing- polyadenylation and capping, processing of rRNA and tRNA. Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling and RNA editing.

UNIT IV: Translation of proteins  
No. of hours : 16

UNIT V: Regulation of gene expression in prokaryotes  
No. of hours : 10
Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon. Regulatory RNAs in bacteria, small RNA and riboswitches.

UNIT VI: Regulation of gene expression in eukaryotes  
No. of hours : 10
Gene regulation by chromatin remodeling, regulation of galactose metabolism in yeast, action of enhancers and insulators, working of activators and repressors, concept of combinatorial control. Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA.

PRACTICALS

CREDITS : 2  
TOTAL HOURS: 60

1. Estimation of RNA by Orcinol Method
2. Extraction of total nucleic acids from plant tissue
3. To study growth curve and diauxic growth curve effect in E. coli
4. Isolation of total RNA from bacteria/yeast
5. To study the effect of inhibitors on protein synthesis

2.3 References

### Additional Resources:


### Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
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</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>The student will learn about the difference between DNA replication and transcription, different RNA polymerases and details of bacterial transcription and applications of transcription inhibitors</td>
<td>Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion</td>
<td>Problem solving assignments, regular question answer sessions, MCQs and unit-test for internal assessment</td>
</tr>
<tr>
<td>II.</td>
<td>The students will learn to compare between prokaryotic and eukaryotic transcription, key features of the three classes of eukaryotic RNA polymerases, different promoters and use of various inhibitors.</td>
<td>Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion</td>
<td>Regular question-answer sessions in the class, learning exercises through quiz and puzzles, analytical question solving to improve their understanding.</td>
</tr>
<tr>
<td>III.</td>
<td>The students will learn RNA processing, chemistry of splicing, various types of splicing and RNA editing</td>
<td>Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion</td>
<td>Oral questions will be asked in the class. Problems will be assigned to test student’s analytical ability.</td>
</tr>
<tr>
<td>IV.</td>
<td>The students will learn about the salient features of genetic code, triplet nature, wobble in the anticodon. Experimental approaches used to decipher the genetic code. Stages of translation and inhibitors of translation</td>
<td>Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion</td>
<td>Students will be challenged with analytical problems, puzzles and assignments related to genetic code and other topics covered in the class.</td>
</tr>
</tbody>
</table>
### V.
The students will gain knowledge about regulation of gene expression in prokaryotes, concept of operon, regulatory RNA and riboswitches.

<table>
<thead>
<tr>
<th>Method of Teaching</th>
<th>Various analytical problems will be assigned to students related to prokaryotic gene expression, oral question answer sessions will be held in the class.</th>
</tr>
</thead>
</table>

| Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion |

### VI.
The students will learn about regulation of gene expression in eukaryotes, working of activators and repressors and small RNA mediated silencing mechanisms.

<table>
<thead>
<tr>
<th>Method of Teaching</th>
<th>Regular class interaction and analytical problem solving related to gene expression and silencing. Class tests will be conducted for internal assessment</th>
</tr>
</thead>
</table>

| Traditional chalk and board method of teaching, audio visual presentation with appropriate examples and regular class room discussion |

(*Assessment tasks enlisted here are indicative in nature)

### 4. Keywords

RNA, Transcription, Translation, Genetic code, Gene expression, Operon
1. Course objectives:

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes. Applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course.

2.1 Course Learning Outcome

The students will be able to understand:

- The process for isolation and engineering of DNA using restriction and modification enzymes.
- Use of cloning and expression vectors.
- The methods for creation of genomic and cDNA libraries, their applications and use.
- Understanding the methods for protein production and their application in industrial production systems.

2.2 Course Contents

THEORY

CREDITS: 4  TOTAL HOURS: 60

UNIT I: The basic principle of gene cloning  No of hours: 10

Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules. Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters, homopolymer tailing, Synthetic oligonucleotides.

UNIT II: Cloning vectors for prokaryotes and eukaryotes  No of hours: 12

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on E. coli plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage, and in vitro packaging. Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectors BAC and YAC.

UNIT III: Introduction of DNA in cells, selection for recombinants and clone identification  No of hours: 10

from gene library, colony and plaque hybridization probing, Southern and Northern hybridization, methods based on detection of the translation product of the cloned gene.

UNIT IV: Expression of cloned genes

No of hours: 06

Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Hybrid promoterstrc, tac, λpL and T7 promoter based expression vectors. Challenges in producing recombinant protein in E. coli. Production of recombinant protein by eukaryotic cells. Fusion tags such as, poly-histidine, glutathione, maltose binding protein and their role in purification of recombinant proteins.

UNIT V: Polymerase chain reaction and DNA sequencing

No of hours: 10

Fundamentals of polymerase chain reaction, Types of PCR; hot start, multiplex, reverse transcriptase PCR and Nested PCR, quantitative PCR, Primer, designing for PCR. Cloning PCR products. DNA sequencing by Sanger’s method including Automated Sanger’s DNA sequencing. Introduction to Next Generation Sequencing.

UNIT VI: Applications of genetic engineering in Biotechnology

No of hours: 12

Site–directed mutagenesis, Protein engineering (T4-lysozyme), yeast two hybrid systems, Production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy (SCID), Applications in agriculture – Bt cotton, glyphosate herbicide resistant crops, ethical concerns.

PRACTICALS

CREDITS : 2

1. Transformation of E. coli cells with plasmid DNA.
2. Isolation of plasmid DNA from E. coli cells.
3. Digestion of plasmid DNA with restriction enzymes.
4. Amplification of a DNA fragment by PCR.
5. Complementation of β–galactosidase for Blue and White selection.

2.3 References

3. **Teaching Learning Process and Assessment Methods**

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Students will learn about the significance of Restriction and Modification System, properties and uses of different restriction and modification enzymes and DNA as well as Methods to ligate DNA molecules.</td>
<td>Describe different systems, and their applications with case studies using Chalk and board along with power point presentations.</td>
<td>The students will be given home assignment at the end of first unit.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will learn about the biology of different types of vectors systems including plasmids and bacteriophages used in prokaryotes and eukaryotes along with their applications.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any.</td>
<td>The students will undergo internal test with syllabus covered in the two units and their answers will be discussed in the following class.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will know about DNA transfer to cells, distinguishing between recombinants and non-recombinants and to identify a specific clone among many clones in a library.</td>
<td>Chalk and board along with power point presentations, regular question answer activities. Consultation of text books.</td>
<td>The students will be given home assignment at the end of third unit.</td>
</tr>
<tr>
<td>IV</td>
<td>Students will earn about the signals that promote expression of heterologous proteins from expression vectors and their purification from the medium.</td>
<td>Concepts will be taught using chalk and board and notes; Power point presentations for images for clarity of concepts;</td>
<td>The students will undergo internal test with syllabus covered in the third and the fourth units and their answers will be discussed in the following class.</td>
</tr>
<tr>
<td>V.</td>
<td>Students shall become aware of the basic process of PCR, different types of PCR and DNA sequencing techniques</td>
<td>Teaching using chalk and board; Oral discussion sessions in the class.</td>
<td>The students will be given home assignment at the end of fifth unit.</td>
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<tr>
<td>VI.</td>
<td>The students shall be able to understand how theoretical knowledge of RDT translates into production of commercially useful proteins that are used in medicine and about creating GMOs, while maintaining strong ethics</td>
<td>Teaching and learning activity will mainly include extensive discussions; chalk and board teaching; Discussion about principle and logic behind each methods and experiment.</td>
<td>The students will undergo internal test with syllabus covered in the fifth and the sixth units and their answers will be discussed in the following class.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Key Words:**

Genetic Engineering, Recombinant Proteins expression and purification, Biotechnology, cloning
1. **Course Objective**

   This course describes the molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, the molecular events leading to the generation of antibody, humoral and cell mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.

2.1 **Course Learning Outcomes**

   Upon completion of this course, a student will be able to:

   - Trace the history and developments in immunology.
   - Have an overview of the immune system including cells, organs and receptors.
   - Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity.
   - Understand Antigens & its Recognition, antigen processing and presentation.
   - Understand the structure & functions of different classes of Immunoglobulins, and understand the genetic basis of antibody diversity.
   - Define the cellular and molecular pathways of humoral and cell-mediated immune responses.
   - Describe the mechanisms involved in different types of hypersensitivity.
   - Explain the principles of tolerance and autoimmunity.
   - Understand Immunotherapies and basic concept of Vaccines.
   - Summarize role of immunity in protection against pathogens.

2.2 **Course contents**

**THEORY**

**CREDITS: 4**  
**TOTAL HOURS: 60**

**UNIT I: Immune System and Innate Immunity**  
**No. of hours: 10**

UNIT II: Antigens and Antibody  
No. of hours: 12

Antigens, carriers, adjuvants and haptens, factors responsible for immunogenicity, B and T cell epitopes. Structure, classes and subclasses of immunoglobulins (Ig, Ig fold), effector functions of antibody, antigenic determinants on Ig, Ig super family. Monoclonal antibodies production and applications

UNIT III: Biology of the B Lymphocyte & Humoral Immunity  
No. of hours: 10

Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, mechanisms of antibody diversity. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations

UNIT IV: Biology of the T Lymphocyte & Cell Mediated Immunity  
No. of hours: 12

General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor (TCR) and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NK - T cells and antibody dependent cellular cytotoxicity (ADCC).

UNIT V: Autoimmunity and Hypersensitivity  
No. of hours: 10

Self-tolerance and possible mechanisms of induction of autoimmunity, Organ specific and systemic autoimmune diseases, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity

UNIT VI: Transplantation Immunology and Vaccines  
No. of hours: 6

Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines

PRACTICALS

CREDITS : 2  
TOTAL HOURS: 60

1. Isolation of lymphocytes from blood / spleen.
2. Purification of immunoglobulins
3. Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID).
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immunosorbent assay (ELISA) & DOT ELISA
2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Students will be taught about the historical perspective of immunology, They will learn about the cells and organs of the immune system and innate immune mechanisms..</td>
<td>Chalk and board method will be used and powerpoint presentation for depicting the structure of cells and hematopoiesis</td>
<td>Students will be asked to correlate the importance of immunity and health by asking them to site examples from their experience</td>
</tr>
<tr>
<td>II.</td>
<td>Students will be explained the concept of foreign molecules acting as antigens. What are antibodies and their basic structure will be dealt with. Will focus on how antigen and antibody can interact with each other</td>
<td>Chalk and board method will be used and powerpoint presentation for depicting the structure of antibodies</td>
<td>MCQ based assignments will be given to students to check their understanding of the subject. Students will be asked to come up with examples where antigen – antibody interactions can be utilized for diagnostic purposes. This will help them to understand the importance of these components of the immune system.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will understand how antibodies are generated in the body. They will understand the importance of humoral response in infections</td>
<td>Chalk and board method will be used and powerpoint presentation for understanding antibody diversity and production</td>
<td>Discussion related to transcription and translation of proteins will be held and comparisons with antibody production will be highlighted. Class tests will be taken.</td>
</tr>
</tbody>
</table>
IV. Students will be exposed to the cellular arm of immunity. The various cells which participate in cellular response will be dealt with. Cytotoxic action of T cells will be discussed.

Chalk and board method will be used and powerpoint presentation for understanding. The interaction between various cells

Students will be asked to focus on the functioning of T cell as opposed to B cells. Certain articles related to these basic concepts will be discussed in groups.

V. Students will understand the importance of regulated immune response. What will happen if the immune response is exaggerated will be explained with examples. The concept of autoimmunity will also be explained.

Chalk and board method will be used and supplemented with powerpoint presentation.

Interaction with students will be held in form of some case studies. Quiz will be held.

VI. Importance of immunity will be highlighted by explaining the importance of vaccines and transplantation of organs.

Chalk and board method will be used and supplemented with powerpoint presentation.

Students will be asked to read articles related to immunity and its intervention in medicine and group presentation on these topics will be encouraged.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES
1. **Course Objective**

This course provides students with knowledge and understanding of the characteristics, function, assimilation, distribution and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

2.1 **Course Learning Outcomes**

At the end of the course, the students are expected to:

- Critically analyze and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
- Appreciate the biochemical underpinning of human nutrition in maintaining health.
- Demonstrate understanding of the biochemical basis of essentiality of macro and micronutrients and their nutritional deficiencies.
- Be aware of techniques used in the assessment of nutritional status and nutritional disorders.
- Understand drug nutrient interactions.

2.2 **Course Contents**

**THEORY**

**CREDITS:** 4  
**TOTAL HOURS:** 60

**UNIT I: Introduction to Nutrition and Energy Metabolism**  
No. of hours: 6

Defining nutrition, role of nutrients. Unit of energy, biological oxidation of foodstuff. Physiological energy value of foods, SDA. Measurement of energy expenditure, BMR and RMR- factors affecting BMR. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

**UNIT II: Macronutrients**  
No. of hours : 20


UNIT III: Micronutrients: Vitamins No. of hours : 12
Vitamin A, D, E, K and dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME). Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); role as cofactor in amino acid modifications. The B Complex vitamins- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); Thiamine -TPP role in metabolism and deficiency disease; Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP; Vitamin B6-conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms; Vitamin B12 and folate - metabolic role, homocysteine cycle, Biochemical basis for deficiency symptoms.

UNIT IV: Micro Minerals and trace elements No. of hours : 10
Calcium, Iron and Phosphorus- Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources.

UNIT V: Assessment of Nutritional status No. of hours : 6
Direct methods of assessment- Anthropometric measurements; Biochemical assessment; clinical signs; dietary records and nutrient intake. ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

UNIT VI: Food-drug interactions and Nutraceuticals No. of hours : 6

PRACTICALS
CREDITS: 2 TOTAL HOURS: 60
1. Anthropometric identifications for nutrition related diseases
2. Blood Lipid profile
4. Estimation of vitamin in drugs/food/serum.
5. Estimation of minerals in drugs/food/serum.
6. Glycosylated haemoglobin
7. Nutritive value of foods
8. Case studies.

2.3 References


3. Teaching Learning Process and Assessment Methods

<table>
<thead>
<tr>
<th>Unit No.</th>
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</tr>
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<tbody>
<tr>
<td>I.</td>
<td>Students will learn about the basic concepts of nutritional biochemistry that are important for an understanding of human nutrition.</td>
<td>Chalk and board teaching for basic concepts</td>
<td>Assessment through regular discussion, Quiz and solving numerical problems on energy expenditure</td>
</tr>
<tr>
<td>II.</td>
<td>Students will understand the biochemical basis and nutritional importance of macronutrients. They will learn the importance of gut biome in maintenance of health and the role of dietary fiber in maintaining a good gut microbiome and will understand the concepts of diet composition in governing nutrient assimilation</td>
<td>Chalk and board teaching and power point presentation on essential macronutrients</td>
<td>Regular oral question answer sessions in class, case study evaluations and Internal assessment test</td>
</tr>
<tr>
<td>III.</td>
<td>Students will understand the ADME and essentiality of fat and water soluble vitamins. They will also learn the biochemical mechanisms for the symptoms of vitamin deficiencies and excesses</td>
<td>Chalk and board teaching, power point presentation on essential vitamins and their deficiency disorders, historical perspective on nutritional deficiencies Practical diagnosis of any one vitamin deficiency.</td>
<td>Oral question-answer sessions in class, assessment through test/quiz and case study analysis.</td>
</tr>
<tr>
<td>IV</td>
<td>Students will appreciate the importance of mineral macronutrients with special emphasis on calcium and iron</td>
<td>Chalk and board teaching of the basic concepts and presentations on regulation of micromineral homeostasis. Practical diagnosis of any one mineral deficiency.</td>
<td>Test and assignment Case study analysis. Power point presentations on chemistry of vitamins.</td>
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<tr>
<td>V</td>
<td>Students will get acquainted with the techniques used in the assessment of nutritional status and nutritional disorders.</td>
<td>Chalk and board teaching and discussion on case studies bases on anthropometry and biochemical estimations Anthropometric assessment- Practical class. Practical assessment of oxidative stress.</td>
<td>Assessment test and case study evaluation</td>
</tr>
<tr>
<td>VI.</td>
<td>Students will gain knowledge about drug nutrient interactions.</td>
<td>Power point presentation and chalk and board teaching.</td>
<td>Test/quiz on various groups of drugs and their effect on nutrient availability Power point presentations Onnutraceuticals.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Nutrition, macro nutrients, micro nutrients, nutrient assessment, nutrient deficiency
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES
Advanced Cell Biology (BCH DSE-2)
Semester - V

1. **Course Objective**

The course aims to provide advanced knowledge of the function of cellular organelles, the structure and function of cytoskeleton and its role in motility. The course will also provide details of cellular interaction with cells and tissues around and the molecular regulation of cell growth and cell death. The course will outline the molecular details of the origin of cancer and the diagnosis and treatment.

2.1 **Course Learning Outcomes**

The learning outcomes will be as follows:

- Students will develop understanding of the principle and application of some of the classical and advanced cell biology techniques
- Students will be able to describe the role of organelles in the secretion of mature proteins and key role of the cytoskeleton in the living cell.
- Students will be able to understand the factors regulating mitosis, meiosis, apoptosis and necrosis. They will also be able to comprehend the role and therapeutic value of stem cells.
- Students will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

2.2 **Course Contents**

**THEORY**

<table>
<thead>
<tr>
<th>CREDITS: 4</th>
<th>TOTAL HOURS: 60</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT I:</strong> Advanced Methods in Cell Biology</td>
<td>No. of hours: 6</td>
</tr>
</tbody>
</table>

Principle and application of ultracentrifugation

| **UNIT II:** Protein Sorting and Secretory Pathway | No. of hours: 16 |

Transport of proteins across nuclear envelope; Regulation of nuclear protein import and export. Overview of the endomembrane system; Targeting, modification and sorting of proteins from and into Endoplasmic Reticulum; Synthesis and targeting Mitochondrial protein; Chloroplast Proteins and Peroxisomal proteins; Mechanism of Vesicular Transport; Coat Proteins and Vesicle Budding; Vesicle Fusion; Targeting of Proteins
UNIT III: Cytoskeleton and Cell Motility  
No. of hours: 10

Function and origin of the cytoskeleton; Organization and assembly of Actin Filaments and Myosin; Assembly and organization of Microtubules and Intermediate Filaments; Motor proteins of microtubules and their functions. Cell movement.

UNIT IV: Cell Division and its Regulation  
No. of hours: 10

Overview of the cell cycle; Eukaryotic cell cycle; Events of Mitotic Phase; Cytokinesis; Events of Meiosis And Fertilization; Regulation of Cell Division and Cell Growth;

UNIT V: Cell Death and its Regulation  
No. of hours: 8


UNIT VI: Molecular Basis of Cancer Biology  
No. of hours: 10

Development and causes of cancer; Genetic basis of cancer; Oncogenes, Tumor Viruses; Molecular approach to cancer treatment.

PRACTICALS

CREDITS: 2  
TOTAL HOURS: 60

1. Techniques of Plant /Animal Tissue Culture
2. Study of pinocytosis by paramecium under microscopy
3. Calculating viability of cells after exposure the bacterial culture to UV rays
4. Preparing temporary mount of nerve cell from mammalian spinal cord
5. Differential centrifugation of cell and validation of separated organelles by enzyme markers
7. Demonstration of phagocytosis/apoptosis by fluorescent label under fluorescent microscope

2.3 References


Additional Resources:


3. **Teaching Learning Process and Assessment Methods**

   **Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>The students will be given an in-depth understanding of the principles, working, application and limitations of various advanced techniques used in cell biology.</td>
<td>Basic concepts will be explained with the help of power point presentations/chalk board teaching along with informative audio-visuals. The students will be taken to prestigious institutes during educational trips to further help them grasp the concepts taught to them in class.</td>
<td>Internal assessment tests and quiz will be conducted. Students will be assigned various topics and will be asked to deliver a power point presentation on the assigned topics.</td>
</tr>
<tr>
<td>II.</td>
<td>The students will gain knowledge regarding the roles various organelles in protein sorting in the cell. They will also learn about the mechanisms involved in vesicular transport and cell-cell/cell-virus fusion.</td>
<td>The students will be made to correlate the advanced techniques learnt by them in the previous unit with the organelles learnt in this unit with the help of electron micrograph diagrams of the various organelles of the cell. They will be given an insight into the original experiments conducted by scientists to discover the protein sorting and secretory pathways of the cell. The students will be taught using power point presentations and chalk board teaching.</td>
<td>The students will be assessed by assignments and internal tests. They will be required to identify the various pathways adopted by the proteins for proper folding and reaching correct destination. They will also be tested on their understanding of difference between the various types of vesicular transport as well as steps involved in fusion of cells/cell-virus.</td>
</tr>
<tr>
<td>III.</td>
<td>The students will learn about the organization and assembly of the components of the cytoskeleton like the actin and myosin filaments; the microtubules and</td>
<td>The students will be taught the basic concepts regarding the various components of the cytoskeleton and their role in cell motility by using power point presentations and chalk board teaching.</td>
<td>The students will be assessed by assignments and internal tests. Tests in the form of quiz will be held and students will mention the characteristics of each of the components of the</td>
</tr>
</tbody>
</table>
Intermediate as well as the cilia and flagella. They will also learn about the various mechanism of action of the factors contributing to cell motility.

**IV**
The students will learn the salient features and phases of cell cycle. They will understand the various events that lead to the progression of cell division – both mitosis and meiosis. They will also understand basic differences between the two types of cell division, and the cell types associated with these divisions.

Basic concepts will be explained with the help of power point presentations /chalk board teaching along with informative audio-visuals.

The students will observe the various stages of cell division under the microscope, using various samples.

The students will be tested by asking them to prepare slides identify specific stages of cell division observed by them, and its significance in cell division.

The students will also be assessed with assignments and internal tests.

**V.**
Students will learn the basic concept of cell death and the importance of programmed cell death. They will also understand the various types and importance of stem cells along with their application in therapeutic cloning.

Basic concepts will be explained with the help of power point presentations /chalk board teaching along with informative audio-visuals.

Group discussions will be conducted to elucidate the importance of stem cells in therapeutics.

The students will also be assessed with assignments and internal tests.

**VI.**
The students will learn the basic concepts of cancer biology and understand how and why cancer develops in a system. They will also learn about the currently used approaches towards cancer treatment.

Basic concepts will be explained with the help of power point presentations /chalk board teaching along with informative audio-visuals.

Internal assessment tests and quiz will be conducted.

Students will be given assignments outlining the various sources of carcinogens in our surroundings. The assignment will also require them to enlist the various food items that are popularly said help prevent...
4. Keywords

Ultracentrifugation, FACS, FRET, Confocal Microscopy, Electron microscopy, Plant tissue culture, Animal tissue culture, Immunohistochemistry, Cell-Cell fusion, Posttranslational modification of proteins, secretory pathway, endocytosis, phagocytosis, autophagy, Cytoskeleton, Cilia, Flagella, Cell-Cell interaction, Cell matrix interaction, extracellular matrix, mitosis, meiosis, MPF, Apoptosis, Necrosis, Stem cell application, Cancer, Oncogenes, Tumor virus, cancer treatment
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE) 
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES 
Microbiology (BCH DSE-3) 
Semester - V

1. Course Objectives

The objective of the course is to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. The course also aims to make the students aware of both pathogenic as well as beneficial microbes to prepare students for higher education in microbiology-related disciplines.

2.1 Course Learning Outcomes

On successful completion of this paper, students should be able to:

- Identify different microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc.
- Carry out research using microbes.
- Test microbial culture for antibiotic resistance.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: History of Microbiology No. of hours: 8


UNIT II: Diversity of Microbial world and Microbial Cell organization No. of hours: 14

Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution, occurrence and morphology. Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, mechanism of Gram’s staining. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.
UNIT III: Microbial Nutrition and Growth

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

UNIT IV: Pathogenicity of Microorganisms and Antimicrobial Chemotherapy

Introduction to pathogenic microbes; Bacteria, Viruses, Algae, protozoa and fungi. General Characteristics of antimicrobial drugs, determining the level of microbial activity: dilution susceptibility test and disc diffusion test. Range of activity and mechanism of action of penicillin, vancomycin and tetracycline.

UNIT V: Food and Industrial Microbiology

Importance of microbiology in food and industries; Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer. Single cell proteins. Treatment of waste water (Municipal treatment plant) and sewage. Bioremediation and biodegradation.

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. To prepare and sterilize the culture media for the growth of microorganisms
2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml
3. To stain bacteria using methylene blue.
4. To perform gram staining
5. To prepare temporary mount of algae (spirogyra)
6. To prepare temporary mount of fungi (Penicillium)
7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

2.3 References


Additional Resources:


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Students will be able to understand the historical development and contributions of various scientists in the field of microbiology</td>
<td>Power point presentations and blackboard teaching. General discussion with students about the topic taught to understand their knowledge.</td>
<td>Class test will be taken. Questions related to the topic will be given in the form of assignment</td>
</tr>
<tr>
<td>II.</td>
<td>Students will be able to understand the existence and diversity of the microbial world. They will get familiarize with the Gram staining techniques</td>
<td>Power point presentations and blackboard teaching. Hands on experience on gram staining technique during practical classes</td>
<td>Class test will be taken at the end of module. Questions related to the topic will be given in the form of assignment. Students will also be assessed based on their ability to prepare gram-stained slides.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn about the nutritional requirements of microorganisms. They will also learn about the various physical and chemical methods used for the control of microbial growth.</td>
<td>Blackboard teaching, principal and working of some of the instruments will be explained using online resources. Experience on handling various instruments during practical classes</td>
<td>Students will be assessed by asking oral questions and also assessed during practical classes for the preparation of media and handling of instruments</td>
</tr>
<tr>
<td>IV</td>
<td>Students will gain knowledge about pathogenic microbes and characteristic features of antimicrobial drugs.</td>
<td>Blackboard teaching. General discussion with students about the existence of disease causing microbes in our day-today life.</td>
<td>Class test will be taken at the end of module. Assignment will be given to understand the concept of mechanism of action of different antimicrobial drugs.</td>
</tr>
<tr>
<td>V.</td>
<td>Students will be able to understand the industrial applications of microbes</td>
<td>Blackboard teaching. Powerpoint presentation and oral discussions in the class</td>
<td>Students will be evaluated on the basis of presentations and assignments</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Microorganisms, diversity, culture, Pathogenicity, industrial applications
1. **Course Objective**

The course aims to provide knowledge about various microbial infectious agents that cause diseases in humans, the concepts of treatment and the biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and re-emergence of diseases and idea of bio-terrorism and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

2.1 **Course Learning Outcomes**

- Students will understand various classes of pathogens and their mode of action and transmission.
- Students will be exposed to molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed.
- Students will gain insight into host immune responses that ensue subsequent to infection.
- Students will learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in Indian subcontinent.

**THEORY**

**CREDITS: 4**

**TOTAL HOURS: 60**

**UNIT I: Infectious diseases: an introduction**

No. of hours : 7

Classification of infectious diseases, Nosocomial infections; Patterns of Disease; Measuring infectious disease frequency; Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens. Safety measure when working with pathogen biosafety levels, infection and evasion.

**UNIT II: Strategies for management of infectious diseases**

No. of hours : 4

Role of drugs, vaccines, hygiene and sanitation in prevention, transmission control and treatment of infectious diseases.

**UNIT III: Diseases caused by bacteria**

No. of hours : 20

Classification of bacterial pathogens based on structure and nutritional requirements; Overview of bacterial virulence factors and host pathogen interactions; detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, diagnostics, therapeutics and vaccines, drug resistance and implications on public health. Other bacterial diseases - virulence factors, host pathogen interaction.
symptoms, diagnosis, vaccines and drugs against - Typhoid, Diphtheria, Pertussis, Tetanus, Botulism Cholera, Anthrax and Pneumonia

UNIT IV: Diseases caused by viruses

Structure of viruses, Baltimore system for virus classification; Overview of viral virulence factors and host pathogen interactions; detailed study of AIDS: history, causative agent, pathogenesis, diagnostics, drugs; other viral diseases including hepatitis, Influenza (Antigenic shift and antigenic drift), Rabies, Dengue and Polio; Chicken Pox, Herpes Virus

UNIT V: Diseases caused by parasites

Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development. Other diseases including Leishmaniasis and Amoebiasis, Giardiasis and Trypanosoma infections

UNIT VI: Diseases caused by fungi

Fungal diseases such as Candidiasis, Sporotrichosis, Aspergillosis and Ring worm: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment

PRACTICALS

CREDITS: 2  TOTAL HOURS: 60

1. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample
2. WIDAL test
3. Gram staining
4. Acid fast staining
5. Permanent slides of pathogens: Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
6. MIC determination using Kirby Bauer / Alamar Blue assay
7. Fungal staining
8. Research and presentation on current trends in infectious diseases

2.3 References

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Course Learning Outcomes</th>
<th>Teaching and Learning Activity</th>
<th>Assessment Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Students will develop an understanding of important terminologies used in infectious diseases. They will develop an understanding of transmission of pathogens and will gain insight into host immune responses that ensue following infection. They will understand the importance of biosafety equipment for people who work on infectious disease causing pathogens</td>
<td>Revision of concepts covered in the previous class will be done. This will be followed by traditional chalk and board teaching aided with Power Point presentations</td>
<td>Group discussion and quiz will be conducted, and students will be given assignments</td>
</tr>
<tr>
<td>II.</td>
<td>Students will learn the strategies used for management of infectious diseases i.e. prevention, transmission control and treatment of infectious diseases</td>
<td>Revision of concepts covered in the previous class will be done. This will be followed by traditional chalk and board teaching aided with Power Point presentations</td>
<td>Class tests will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn classification of bacteria and study various bacterial virulence factors. Students will understand the pathophysiology of the Mycobacterium and study ways to prevent and treat Tuberculosis. They will also learn about various bacterial diseases (Typhoid, Diphtheria, Pertussis, Tetanus, Botulism, Cholera, Anthrax, Pneumonia) their molecular mechanisms and intervention strategies</td>
<td>Revision of concepts covered in the previous class will be done. This will be followed by traditional chalk and board teaching aided with Power Point presentations</td>
<td>Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics</td>
</tr>
<tr>
<td>IV</td>
<td>Students will learn about Baltimore classification</td>
<td>Revision of concepts covered in the previous class will be done.</td>
<td>Group discussion, Class tests will be conducted,</td>
</tr>
</tbody>
</table>
Students will learn about various viral diseases (Chicken Pox, Herpes, Rabies, Dengue and Polio) their molecular mechanisms, diagnosis and intervention strategies. This will be followed by traditional chalk and board teaching aided with Power Point presentations and students will be given assignments and will be asked to give PowerPoint presentations on the assigned topics.

**V.** Students will learn about various parasitic diseases, host parasite interaction, their molecular mechanisms of infection, diagnosis and intervention strategies. Revision of concepts covered in the previous class will be done. This will be followed by traditional chalk and board teaching aided with Power Point presentations. Quiz, Class tests will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics.

**VI.** Students will learn about various fungal diseases, their molecular mechanisms, diagnosis and intervention strategies. Revision of concepts covered in the previous class will be done. This will be followed by traditional chalk and board teaching aided with Power Point presentations. Class tests will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics.

**Assessment tasks enlisted here are indicative in nature**

4. **Keywords**

Infection, Pathogen, Immune response, Diagnosis, Vaccines, Diseases
1. Course Objectives

The course aims at providing deep understanding of metabolic processes in plants and the role of different biosynthetic pathways in plant growth and development. The course will also impart basic concepts and applications of plant tissue culture.

2.1 Course Learning Outcomes

Successful completion of this course will provide students with the following learning outcomes:

- Understanding of plant cell structure and organization.
- Understanding of the biochemical processes and metabolic pathways specific to plants, including photosynthesis, photorespiration, cell wall biosynthesis, nitrogen fixation and assimilation and plant secondary metabolism.
- Gaining insight on how plants have evolved to cope up with the different stress conditions.
- Understanding of the basic concepts of plant tissue culture and its application in generating transgenic crops.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Introduction to plant cell structure and carbon fixation No. of hours: 16

Introduction to Plant cells, Plasma membrane, Vacuole and Tonoplast membrane, Cell wall, Plastids and Peroxisomes. Photosynthesis and Carbon assimilation. Structure of PSI and PSII complexes. Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, Synthesis of polysaccharides in plants.

UNIT II: Respiration No. of hours: 12

Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.
UNIT III: Nitrogen metabolism 

Biological nitrogen fixation by free living and in symbiotic association; Structure and function of the enzyme nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

UNIT IV: Regulation of plant growth and stress physiology 

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases).

UNIT V: Secondary metabolites and toxins 

Representative alkaloid group and their amino acid precursors, function of alkaloids. Examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

UNIT VI: Plant tissue culture and biotechnology 

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

PRACTICALS

CREDITS: 2 

1. Induction of hydrolytic enzymes proteinases/amylases/lipase during germination  
2. Extraction and assay of urease from Jack bean  
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables.  
4. Separation of photosynthetic pigments by TLC.  
5. Culture of plants (explants).

2.3 References

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>I.</td>
<td>Students will be introduced to structure of a plant cell, plasma membrane, cell wall and role of organelles like vacuole and tonoplast membrane, plastids and peroxisomes in plants. Further students will gain detailed knowledge on the process of photosynthesis understanding structure of PSI and PSII complexes, light reaction, cyclic and non-cyclic photophosphorylation. Students will also learn carbon fixation by Calvin cycle (C3 cycle) and its regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Further, they will learn how photo inhibition affects the process of photosynthesis. Photosynthetic carbon reduction (PCR) cycle and synthesis of polysaccharides in plants will also be covered.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment tests (midterm and end-term) will be conducted.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will gain insight of respiration in plants and how it is different from animal respiration. Students will be given an overview of glycolysis, alternative reactions of plant glycolysis and its regulation. Further, the students will understand the importance of</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment test (end term) will be conducted. Students will be given assignment on different topics specially disorders and will be asked to deliver a power-point presentation on the assigned topics.</td>
</tr>
</tbody>
</table>
### III.

Students will learn in detail about how biological nitrogen fixation is carried out by free living and symbiotic bacterial associations with detailed understanding of structure and function of the enzyme nitrogenase. Students will gain insight of nitrate and nitrite reductase and their role in nitrate assimilation. This unit will also emphasize on primary and secondary ammonia assimilation in plants; ammonia assimilation by glutaminesynthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Further, they will be introduced to role of seed storage proteins in legumes and cereals.

Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.

Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.

### IV.

Students will gain insight of plant hormones and their effect on plant growth and development. Students will also understand how plants respond to various abiotic and biotic stresses like water deficit and drought resistance, flooding, temperature stress, salt stress, ion toxicity, pollution stress and potential biotic stress (insects and diseases).

Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.

Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.

### V.

Students will learn about the significance of secondary metabolites and...
toxins in plants with the help of examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin. It will also help the students understand the biological role of plant phenolics and terpenoids.

class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.

be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics.

| **VI.** Students will gain knowledge about basic cell and plant tissue culture techniques. This will help them learn the concept of organ and explant culture, callus culture, cell suspension culture and protoplast culture. Concepts related to plant regeneration pathways: organogenesis and somatic embryogenesis will be imparted to the students. Further, it will help students acquire knowledge about applications of cell and tissue culture in generation of transgenic plants. | Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode. | Internal assessment test (end term) will be conducted. Students will be given assignment on various topics and will be asked to deliver a power-point presentation on the assigned topics. |

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology, plant tissue culture.
1. Course Objectives

The objective of the course is to provide students with a sound background of latest techniques used in biochemistry research and to provide them with an understanding of the principles underlying these techniques. The course is designed to impart laboratory skills in the form of practical exercises so that students can apply this knowledge to augment their research acumen and improve their understanding of the subject.

2.1 Course Learning Outcomes

- Students will acquire knowledge about the principles and applications of latest methods used to analyze nucleic acids and proteins.
- Students will learn about the principle and applications of microscopy and various cell biology techniques.
- Students will also be exposed to various methods of labeling DNA, proteins and whole cells and their applications in research.
- The course will also provide them an opportunity for hands-on-experience to develop their laboratory skills expected of any biochemist working in a research lab.

2.2 Course Contents

THEORY

CREDITS: 4
TOTAL HOURS: 60

UNIT I: Methods for analysis of nucleic acids
No. of hours: 20

Hybridization methods: Southern blotting, Northern blotting, In situ hybridization, Colony hybridization. Binding of nucleic acids with protein: DNA pull down assays, Electrophoretic Mobility Shift Assay (EMSA), DNA footprinting, Primer Extension, Chromatin immunoprecipitation (ChIP), ChIP on ChIP. Gene expression analysis: Reporter assays - example luciferase assay, DNA Microarrays, RNA seq.

UNIT II: Methods for analysis of proteins
No. of hours: 20

Protein-Protein Interaction: Immunoprecipitation, Co-Immunoprecipitation (Co-IP), Pull down assays, Yeast two hybrid, Protein fragment complementation assay, Western blotting, Far western blotting, Protein microarrays, ELISA. Protein Separation: Ioelectric focusing, 2D protein gel electrophoresis, 2D-DIGE, Pulse field Electrophoresis; Structural Analysis: Mass Spectrometry, MS/MS, LC/MS.
UNIT III: Microscopy based methods

No. of hours : 6

Fluorescence microscopy, Scanning electron microscopy, Transmission electron microscopy, Confocal microscopy

UNIT IV: Cell Biology techniques

No. of hours : 8

Cell culture and transfection, Immunohistochemistry, Immunofluorescence, Flow cytometry, FACS, TUNEL assay, Non-invasive scanning of soft tissue

UNIT V: Labeling methods

No. of hours : 6

Radioactive and Non-radioactive labeling: DNA, Proteins, Whole cells, Fluorescent labeling. DNA, Proteins, bacteria, living cells; Metabolic labeling, Pulse chase analysis

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Western Blotting
2. Southern hybridization
3. Labeling DNA with Biotinylated primers using PCR
4. EMSA (virtual lab)
5. Protein Pull down assay
6. Virtual lab on Microarray profiling or 2D-DIGE

2.3 References

3. Teaching Learning Process and Assessment Methods

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>I.</td>
<td>The student will learn about the methods used in analysis and manipulation of nucleic acid</td>
<td>Classroom teaching with visual aids, power point presentations, videos, discussions on applications</td>
<td>Quizzes, assignments and analytical problem solving questions</td>
</tr>
<tr>
<td>II.</td>
<td>The student will understand about the various techniques involving protein-protein interactions, their separation, and structural characterization</td>
<td>Classroom teaching with visual aids, power point presentations, experimental data from journals, discussions</td>
<td>Assignments, class tests, analytical questions</td>
</tr>
<tr>
<td>III.</td>
<td>The students will get familiar with microscopy based techniques and their application</td>
<td>Presentations, classroom teaching, audio &amp; visual aids, trip to a facility</td>
<td>Assignments, class tests, class presentations, Mid-term assessment</td>
</tr>
<tr>
<td>IV.</td>
<td>The students will understand the basics and application of various techniques in the field of cell biology</td>
<td>Powerpoint presentations, trip to a facility to show instruments, audio &amp; visual aids</td>
<td>Assignments, class tests, class presentations</td>
</tr>
<tr>
<td>V.</td>
<td>The students will learn about the different ways to label cells, microbes, proteins and DNA</td>
<td>Classroom teaching, presentations, discussions to learn how these methods are applied all the previous units</td>
<td>Assignments, class tests, presentations on applications etc. Internal assessment tests will be conducted</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Southern Blotting, Colony hybridization, DNA footprinting, EMSA, Western Blotting, Immunoprecipitation, Pull down assay
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
1. **Course Objectives**

The objective of the course is to provide students with an understanding of biomolecules, the basic building blocks that are vital for various life forms, focusing on their key properties, biological roles and functions. The course also aims to outline organic and physical aspects of biomolecules.

2.1 **Course Learning Outcomes**

- Students will acquire knowledge about structure and function of proteins, RNA, DNA, carbohydrates and co-enzymes
- The course will provide an understanding of how structure of biomolecules determine their chemical properties
- Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of each biomolecule

2.2 **Course Contents**

**THEORY**

**CREDITS: 4**

**TOTAL HOURS: 60**

**UNIT I: Biomolecules in their cellular environment**

No. of hours : 7

The cellular basis of life, structure and function of a cell and its subcellular components (eukaryotes, prokaryotes); Physical properties and structure of water molecule, pH, Buffers, biological buffer systems (body fluids and their principal buffers)

**UNIT II: Amino Acid and Peptides**

No. of hours : 11

Introduction, general nature of amino acids, classification of amino acids, importance of amino acids, modified and standard amino acids, physical and optical properties of aminoacids, ionization of amino acids, buffering of amino acids, peptide bond, biologically important peptides. Introduction to chromatography, separation of amino acid by paper chromatography

**UNIT III: Carbohydrate Chemistry**

No. of hours : 11

Introduction; Definition, classification and functions of carbohydrates, monosaccharides, disaccharides, polysaccharides, homo polysaccharides, hetero polysaccharides; Structure of glucose, isomerism; keto aldo, D-and L- isomerism, optical isomerism, epimerism,
anomerism, Mutarotation, chemical properties of monosaccharides, action of strong acids, alkalis, oxidation, reduction, osazone formation glycoside formation; Derivatives of monosaccharides, phosphoric acid ester, amino sugar, deoxy sugar, sugar acids, sugar alcohols, disaccharides maltose, lactose, sucrose. Homo polysaccharides - starch, glycogen, cellulose, dextrin; Hetero polysaccharides - types of glycosoaminoglycans and functions of glycoproteins

UNIT IV: Chemistry of Lipids No. of hours: 11

Introduction; Definition, classification and functions of lipids; Fatty acids; Essential fatty acids; Reactions of lipids; Triacylglycerol or neutral fat; phospholipids glycolipids; cholesterol; Eicosaanoids; prosatglandins; lipoprotein

UNIT V: Chemistry of Nucleic Acid No. of hours : 11

Introduction, nucleic acid, nucleotide, biologically important nucleotides, synthetic analogues of nucleotides or antimitabolites; DNA structure and function; Types of DNA; Organization of DNA; RNA structure and function

UNIT VI: Vitamins and Coenzymes No. of hours : 8

Definition and classification of vitamins, water soluble vitamins, fat soluble vitamins, occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomoleculeus (heme, porhurins and cyanocobalamine) and their biological role

PRACTICALS

CREDITS: 2 TOTAL HOURS: 60

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography
7. Estimation of ascorbic acid in fruit juices

2.3 References

### 3. Teaching Learning Process and Assessment Methods

#### Facilitating the Achievement of Course Learning Outcomes**

<table>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Student will learn the fundamental concepts of cellular basis of life, cellular structure of prokaryotes and eukaryotes. They will also learn the role of water in design of these molecules.</td>
<td>Chalk and board method will be used and power point presentation for depicting the structure of cells and role of water in design of these molecules.</td>
<td>Students will be asked to correlate the importance of these molecules from their cells by take home assignments.</td>
</tr>
<tr>
<td>II</td>
<td>Students will gain insight into basic structures, chemistry and property of amino acids along with derivatives of amino acids. They will be introduced to chromatography</td>
<td>Chalk and board method will be used. Power point presentation for understanding these structure and their role.</td>
<td>MCQ based assignments will be given to students to check their understanding.</td>
</tr>
<tr>
<td>III</td>
<td>Understanding of the basic chemistry, structure and classification of all types carbohydrates, along with their biological role.</td>
<td>Chalk and board method and power point presentation will be used for describing these structures distribution &amp; their biological role.</td>
<td>MCQ based assignment will be given to students. Structures will be shown for them to identify the type and class of carbohydrate</td>
</tr>
<tr>
<td>IV</td>
<td>Students will learn about the basic building blocks of lipids and the different categories of lipids in the body with main emphasis being on understanding their structure. They will also be exposed to some aspects of function of the different lipids in the body including their role as cofactors, pigments and signaling molecules.</td>
<td>Learning of individual students will be conducted by a traditional chalk and board method and supported by power point slides wherever appropriate.</td>
<td>Multiple choice questions, take home assignments and regular Q&amp;A sessions during class.</td>
</tr>
<tr>
<td>V</td>
<td>Students will learn the basic aspects of the structure of DNA and RNA along with unusual structures of DNA. Students will also be made aware of the other roles that nucleotides can play in the body.</td>
<td>Regular question answer sessions in the class to encourage student participation. Regular chalk and board teaching will be used.</td>
<td>Students’ knowledge will be assessed via regular quizzes and take home assignments</td>
</tr>
</tbody>
</table>
Students will learn about the nutritional roles of all water soluble and lipid soluble vitamins in the body along with their occurrence. They will also be made aware of how vitamins are crucial in metabolism of the body.

Students will be communicated to mainly using chalk and board method with occasional support taken from structures projected on transparencies or power point slides.

Assessment of the student learning will be done by home exams, multiple choice quizzes and take home assignments. They will review research papers as well.

(*Assessment tasks enlisted here are indicative in nature)

4. Keywords

Buffer, Amino Acids, Glucose, Disaccharides, Polysaccharides, Lipids, Nucleic Acids, Vitamins, Chromatography
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERAL ELECTIVE (GE) COURSES
Techniques in Biochemistry (BCH GE-2)
Semester - 1

1. Course Objectives

The objective of the course is to introduce various techniques to students that are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better execution of these techniques.

2.1 Course Learning Outcomes

- Students will acquire knowledge about the principles and applications of spectroscopic and chromatography techniques used in a biochemistry lab.
- Students will learn about the principle and application of electrophoresis, centrifugation techniques, cell culture and microscopic techniques.
- It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a research lab.

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Spectroscopic Techniques


UNIT II: Chromatography


UNIT III: Electrophoresis

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic
acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, isoelectric focusing of proteins.

UNIT IV: Centrifugation  
No. of hours: 8

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation- zonal and isopycnic.

UNIT V: Microbiological/Cell culture techniques  
No. of hours: 5

Types of media, selective and enrichment media, sterilization methods, bacterial culturing, CFU determination, growth curves, Generation/doubling times, cell counting, viable and non-viable. Growth and maintenance of cultures, biosafety cabinets, CO₂ incubator. Staining procedures, plating and microtomy.

UNIT VI: Microscopy  
No. of hours: 5

Principle of light microscopy, phase contrast microscopy, fluorescence microscopy. Permanent and temporary slide preparation, histology and staining.

PRACTICALS

CREDITS: 2  
TOTAL HOURS: 60

1. Verification of Beer’s Law
2. Estimation of proteins by Biuret/Lowry method
3. Separation of amino acid acids by TLC/paper chromatography
4. To perform agarose gel electrophoresis
5. To isolate mitochondria by differential centrifugation
6. Visualization of cells by methylene blue

2.3 References


Additional Resources:


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I</td>
<td>Students will learn about the principle and applications of spectrophotometry and fluorimetry.</td>
<td>Teaching using chalk and board; Oral discussion sessions in the class. Powerpoint presentations.</td>
<td>Problems will be assigned related to Beer’s Law and Lambert’s Law to test the understanding of students.</td>
</tr>
<tr>
<td>II</td>
<td>Students will learn the principle of various chromatographic techniques like gel filtration, Ion exchange.</td>
<td>Teaching using chalk and board; Oral discussion sessions in the class. Powerpoint presentations.</td>
<td>Practical exercises are designed whereby the students get hands on experience with these chromatography techniques.</td>
</tr>
<tr>
<td>III</td>
<td>Students will learn about electrophoretic techniques, their principle and applications in analyzing proteins and nucleic acids.</td>
<td>Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class</td>
<td>Various analytical problems will be assigned to students related to electrophoretic separation.</td>
</tr>
<tr>
<td>IV</td>
<td>Students will learn about the basic rules of sedimentation, various types of centrifuges and rotors.</td>
<td>Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class</td>
<td>Demonstration with the help of centrifuges and rotors to improve their understanding.</td>
</tr>
<tr>
<td>V</td>
<td>Students will learn and understand the different cell culture and microbiological techniques used in biochemistry.</td>
<td>Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class</td>
<td>Various analytical problems will be assigned to students related to cell counting.</td>
</tr>
<tr>
<td>VI</td>
<td>Students will learn about various microscopes and slide preparation, histology and staining techniques.</td>
<td>Teaching using chalk and board; Oral discussion sessions in the class</td>
<td>Various analytical problems will be assigned to students related to working of microscope.</td>
</tr>
</tbody>
</table>

4. Keywords

Spectrophotometry, Chromatography, Proteins, Nucleic Acids, Centrifugation and Electrophoresis
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Proteins and Enzymes (BCH GE-3)
Semester - II

1. Course Objectives

The objective of this course is to provide overview of protein biochemistry and enzymology to undergraduate students with diverse science backgrounds, since proteins and enzymes are the most versatile functional entities in life with applications in various life sciences research as well as in industry and biomedicine. The biochemical, structural, functional and aspects of interaction of proteins and enzymes will be introduced in this course.

2.1 Course Learning Outcomes

On successful completion of the course students will be:

- Familiar with unique features and characteristics of proteins and enzymes and their applications in research, medicine and industry.
- Aware of the relationship between three-dimensional structure of proteins and enzymes and their functions.
- Able to comprehend the basic mechanism of action of enzymes and their remarkable regulation
- Aware of the principles of protein isolation, purification and characterization
- Able to gain hands-on-experience in handling proteins and enzymes from various sources, thus improving their ability of learning and imbibing the basic concepts.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Introduction to proteins and their structural organization No. of hours :10


UNIT II: Three-dimensional structures and protein folding No. of hours: 12


UNIT III: Isolation, purification and analysis of proteins  No. of hours: 8

Ammonium sulphate fractionation, centrifugation dialysis. Ion-exchange chromatography, molecular sieve chromatography, affinity chromatography. HPLC and FPLC. Gel electrophoresis: SDS-PAGE, IEF and 2-D electrophoresis.

UNIT IV: Introduction to enzymes, their characteristics and kinetics  No. of hours: 12


UNIT V: Mechanism of enzyme action and enzyme regulation  No. of hours: 10


UNIT VI: Applications of enzymes  No. of hours: 8


PRACTICALS

CREDITS: 2  TOTAL HOURS:60

1. Estimation of proteins by Biuret / Lowry / Bradford method and UV absorbance measurements.
2. Ammonium sulphate fractionation of crude homogenate from germinated mung beans
3. Enzyme activity assay (acid phosphatase)
4. Progress curve of enzyme
5. Effect of pH / temperature on enzyme activity
6. Determination of $K_m$ and $V_{max}$ using Lineweaver-Burk plot.
7. SDS-PAGE analysis of proteins
2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<th>Teaching and Learning Activity</th>
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<tbody>
<tr>
<td>I</td>
<td>Students will gain knowledge about the building blocks of proteins i.e. amino acids and understand about the structural organization of proteins.</td>
<td>Students will be taught using power point presentations, chalk and board. In class oral discussion sessions will be conducted.</td>
<td>Oral questions will be asked in the class. Assignment and tests will be given.</td>
</tr>
<tr>
<td>II</td>
<td>Students will understand about the characteristics of tertiary and quaternary structures, 3D structure of Hemoglobin and Myoglobin. They will also understand the concept of protein folding (denaturation and renaturation).</td>
<td>They will be taught using power point presentations, chalk and board. The use of E-learning through online Web and Video courses will be included.</td>
<td>Internal assessment will be done on the basis of quiz and class tests.</td>
</tr>
<tr>
<td>III</td>
<td>Students will acquire knowledge about the basic concepts of various techniques used for isolation, purification and analysis of proteins.</td>
<td>Students will be taught using chalk and board. A visit to a Research Lab. for the demonstration/hands-on-experience of protein purification techniques will be planned to enhance their ability of learning and imbibing the basic concepts.</td>
<td>Students will be assigned different techniques and will be asked to deliver a power point presentation. Various analytical problems will be assigned to students related to purification of proteins.</td>
</tr>
<tr>
<td>IV</td>
<td>Students will learn about enzyme catalysis, role of coenzymes, cofactors and different aspects of enzyme kinetics. They will understand about different types of enzyme inhibitors, role of drugs as enzyme inhibitors and the respective mechanism.</td>
<td>They will be shown power point presentations and will be taught using chalk and board. The use of E-learning through online Web and Video courses will be included for the better understanding of the enzyme kinetics.</td>
<td>Regular question-answer sessions in class will be conducted. Internal assessment will include problems/numericals based on enzyme kinetics.</td>
</tr>
<tr>
<td>V</td>
<td>Students will understand the basic mechanism of enzyme action and enzyme regulation.</td>
<td>Students will be shown power point presentations and will be taught using chalk and board. Oral discussion sessions in the class will be conducted.</td>
<td>They will be assessed on the basis of assignments and class tests.</td>
</tr>
<tr>
<td>VI</td>
<td>Students will learn about diverse applications of enzymes in research, diagnostics, therapy and Industry.</td>
<td>Teaching using chalk and board will be done. Oral discussion sessions in the class will be conducted.</td>
<td>Students will undergo internal test for the syllabus covered in Unit 1-V and their answers will be discussed in the following class. Quiz will be conducted. Various analytical problems will be assigned to students based on enzyme applications.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Proteins, Enzymes, Protein structure, Protein folding, Enzyme kinetics, Enzyme regulation
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
GENERIC ELECTIVE (GE) COURSES
Biochemical Correlations of Diseases (BCH GE-4)
Semester - II

1. Course Objective

This course provides students with knowledge and understanding of various human diseases. It will introduce the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that are employed for preventing infectious and non-infectious diseases.

2.1 Course Learning Outcomes

- Students will develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
- Students will gain insight into various disorders associated with imbalanced diet and poor lifestyle.
- Students will learn various strategies employed for preventing various human diseases.
- Students will understand the molecular basis of microbial pathogenicity, drug resistance and implications in public health management.
- Students should be able to handle and solve analytical problems related to theory classes.

2.2 Course Contents

THEORY

CREDITS: 4 TOTAL HOURS: 60

UNIT I: Inherited metabolic diseases No. of hours: 8

UNIT II: Nutritional deficiency and lifestyle based diseases No. of hours: 16
Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes Mellitus-II, Inflammatory Bowel Disease (IBD).

UNIT III: Hormonal imbalances No. of hours: 8
Hormonal imbalances leading to disease: Diabetes Insipidus, Acromegaly, Gigantism, Dwarfism, Goitre, Cretinism, Cushing and Conn’s syndrome, Addison’s disease.
UNIT IV: Autoimmune diseases


UNIT V: Diseases caused due to misfolded proteins

Alzheimer’s, Huntington’s diseases, Kuru, Creutzfeldt-Jakob disease, Sickle Cell anaemia, Thalassemia.

UNIT VI: Infectious diseases


PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Lipid Profile: Triglyceride, Cholesterol
2. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
3. Haemoglobin estimation
4. Blood pressure measurement
5. Calcium estimation
6. Estimation of glucose

2.3 References

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I.</td>
<td>The students will understand the concepts of metabolism of macromolecules and the diseases related to metabolic errors. The students will also understand the biochemical basis of diseases related to inherited metabolic disorders.</td>
<td>Traditional chalk and board method and illustrations through powerpoint presentations. Discussion of case studies</td>
<td>Students will be assigned the task of identifying examples of abnormal enzymes that directly relate to each feature of metabolic disorders. A host of characteristics and features will be provided to students and they will need to match them with the type of metabolic disorder. They will encouraged to participate in group discussions related to topics thought in class.</td>
</tr>
<tr>
<td>II.</td>
<td>The students will develop understanding of the importance of balanced diet, regular exercises and healthy lifestyle. They will gain insight into various disorders associated with imbalanced diet and poor lifestyle. The students will understand the importance of micronutrients and disorders associated with deficiency of minerals and vitamins. The students will also learn about life style disorders.</td>
<td>Explaining each topic through power point presentations / chalk and board teaching. Discussion of case studies.</td>
<td>Group discussions and class tests will be held. Assignments on classification of diseases in various macromolecule and micromolecule deficient disorders. Signs and symptoms of diseases will be provided and students will be asked to match them with the type of nutrient disorders. Students will also be given assignments on matching the symptoms with the diseases.</td>
</tr>
<tr>
<td>III.</td>
<td>The students will understand the importance of hormones in our daily life. They will gain insight into various diseases/diseases associated</td>
<td>Traditional chalk and board method and powerpoint presentations.</td>
<td>Students will be given assignments to match symptoms with the correct disease/disorders. Group discussions and Tests will be held.</td>
</tr>
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with the imbalance of hormonal levels.

IV The students will learn about induction of an appropriate immune response and the diseases associated with induction of an inappropriate immune response. They will understand the concept of immune recognition - self and nonself.  

| IV | The students will learn about induction of an appropriate immune response and the diseases associated with induction of an inappropriate immune response. They will understand the concept of immune recognition - self and nonself. | Traditional chalk and board method with powerpoint presentations. Few case studies will also be discussed. | Pre-lecture quiz to evaluate student’s understanding of previous lecture. Signs and symptoms of diseases will be provided and students will be asked to classify them in various types of autoimmune diseases. |

V. Students will understand the significance of appropriate folding of proteins and the diseases caused due to misfolding of proteins.  

| V. | Students will understand the significance of appropriate folding of proteins and the diseases caused due to misfolding of proteins. | Illustrations through powerpoint presentations and through regular chalk and board method. Discussion of case studies. | Group discussions. Quiz, Assignments. Signs and symptoms of diseases will be provided and students will be asked to classify them in diseases caused by misfolding of proteins. Internal assessment test. |

VI. Students will gain knowledge about various microbial infectious agents such as bacteria, virus, parasites and protozoans that cause diseases in humans. Students will gain insight into host immune responses that ensue following infection.  

| VI. | Students will gain knowledge about various microbial infectious agents such as bacteria, virus, parasites and protozoans that cause diseases in humans. Students will gain insight into host immune responses that ensue following infection. | Traditional chalk and board method with powerpoint presentations. | Pre-lecture quiz to evaluate student’s understanding of previous lecture. Assessment tests (end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a powerpoint presentation on the assigned topics. |

(**Assessment tasks enlisted here are indicative in nature**)

4. **Keywords**

Lifestyle and metabolic disorders, nutritional deficiency, hormonal disorder, autoimmunity and infectious diseases.
1. **Course Objectives**

The objective of this course is to provide the students an understanding of the major metabolic pathways associated with biomolecules within a cell and their regulation. It will also provide knowledge about the possible correlation between various metabolic pathways.

2.1 **Course Learning Outcomes**

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

- Understand the basics of metabolic pathways
- Understand the pathways involved in catabolism and biosynthesis of glucose.
- Understand the mechanism of ATP synthesis.
- Understand the biosynthesis and degradation of glycogen
- Understand the metabolism of fatty acids, amino acids, and nucleotides
- Develop an understanding of metabolic integration

2.2 **Course Contents**

**THEORY**

| CREDITS: 4 | TOTAL HOURS: 60 |

**UNIT I: Glycolysis and gluconeogenesis**

No. of hours: 12

Nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency. Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Pentose phosphate pathway, importance of various pathways and their regulation

**UNIT II: Citric acid cycle and oxidative phosphorylation**

No. of hours: 12

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.
UNIT III: Glycogen metabolism No. of hours: 8

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. Diseases associated with the abnormal carbohydrate metabolism.

UNIT IV: Fatty acid and amino acid degradation No. of hours: 12

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Fatty acids activation, regulation of fatty acid oxidation. Protein degradation to amino acids, Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation. Diseases associated with the abnormal metabolism.

UNIT V: Nucleotide metabolism No. of hours: 10

Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion. Diseases associated with the abnormal metabolism

UNIT VI: Integration of metabolism No. of hours: 6

Brief role of hormones - insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, Increase in gluconeogenesis and muscle protein breakdown.

PRACTICALS

CREDITS: 2 TOTAL HOURS: 60

1. Estimation of glucose
2. Alcohol fermentation by yeast.
3. H₂S production, indole production and ammonia production by bacteria.
4. Urea estimation.
5. Uric acid estimation.
6. Estimation of creatinine

2.3 References

### 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Understanding the concept of metabolism. Understand Glycolysis, gluconeogenesis and Pentose phosphate pathway and their regulation.</td>
<td>Traditional chalk &amp; board method with power-point presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td>II.</td>
<td>Understand the citric acid cycle and ATP synthesis by oxidative phosphorylation.</td>
<td>Traditional chalk &amp; board method with power-point presentations</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td>III.</td>
<td>Have knowledge about glycogenolysis and glycogenesis and their reciprocal regulation</td>
<td>Traditional chalk &amp; board method with power-point presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td>IV</td>
<td>Understand the β-oxidation of fatty acids and its regulation.</td>
<td>Traditional chalk &amp; board method with power-point presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
<tr>
<td>V.</td>
<td>Understand de novo and salvage pathways of nucleotide Biosynthesis and Degradation.</td>
<td>Traditional chalk &amp; board method with power-point presentations.</td>
<td>Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.</td>
</tr>
</tbody>
</table>
VI. Understand the concept of metabolic integration.

Traditional chalk & board method with power-point presentations.

Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students understanding of previous lecture.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Glycolysis, De novo salvage pathway, TCA, catabolism, anabolism, integrative pathways, nucleotide metabolism, beta oxidation, glycogen metabolism, gluconeogenesis.
1. **Course Objectives**

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem solving skills for real life situation. The course will keep abreast with all recent developments and emerging trends in forensic science thus helping interested students take up forensic science as future course of study.

2.1 **Course Learning Outcomes**

- Students will learn the fundamental concepts and principles of forensic science and their significance.
- Students will understand how a forensic investigation is initiated through preservation of evidences, as well as chemical, physical and biological methods of their analysis including analysis of DNA and other bodily fluids.
- Students will learn how to establish identity of an individual by document evaluation, fingerprints, footprints, DNA analysis etc.
- Students will obtain hands-on-experience in some of the basic biochemical processes involved in forensic investigation.

2.2 **Course Contents**

**THEORY**

**CREDITS: 4**

**TOTAL HOURS: 60**

**UNIT I: Introduction to forensic sciences**

Basic Principles and Significance; History and Development of Forensic Science; Defining the scene of investigation; Collection, Packaging, Labelling and Forwarding of biological exhibits to forensic laboratories; Preservation of biological evidence; Importance of Health and Safety Protocols in sample collection and analysis.

**UNIT II: Biological science and its application in investigation**

Biochemical analysis of various biological evidences like blood, semen & other biological fluids, viscera, bite marks, hair (animal and human), fibres & fabrics, pollen and soil; Establishment of identity of individuals - fingerprints, footprints, blood and DNA analysis, anthropology – skeletal remains, Odontology; Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death, case studies.
UNIT III: Chemical science and its application in investigation  No. of hours: 15

Detection of drugs of abuse and narcotics in biological samples; Toxicological examination of viscera, detection of petroleum products, food adulteration; Analysis of inks and their use in questioned document identification, blood splatter analysis, stain analysis, case studies.

UNIT IV: Recent advances in forensics  No. of hours: 15

*Narco analysis:* theory, forensic significance, future prospect; *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique; *Polygraph:* Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test; *Facial reconstruction:* Method and technique, facial reconstruction in forensic identification; *DNA Finger Printing:* DNA Introduction, source of DNA in Forensic case work, Extraction of DNA, Techniques of DNA fingerprinting-RFLP, STR, PCR. DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, case studies.

PRACTICALS

CREDITS: 2  TOTAL HOURS: 60

1. TLC method for differentiation of ink/drugs
2. Fingerprint development from various surfaces
3. Handwriting identification based on class characteristic and individual characteristics
4. Microscopic examination of hair/fibre/pollen/diatom
5. Examination of blood samples: Blood grouping, DNA finger printing, Blood splatter analysis.
6. Examination of urine samples: Identification of drugs.
7. Field trip to a forensic laboratory.

2.3 References

1. Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.
2. Henry Lee’s Crime Scene Handbook by Henry C Lee
3. Forensic Biology by Shrikant H. Lade
4. Crime Scene Processing and Laboratory Work Book by Patric Jones
5. Forensic Science: An Introduction to Scientific and Investigative Techniques 3rd ed.by Stuart H. James
7. Compute Crime and Computer Forensic by Dr. R.K. Tiwari
8. Handbook of Forensic Psychology Dr. Veerraghavan
9. Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.
### 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I.</td>
<td>To appreciate the development that has happened over the past few decades in the field of forensic sciences. Learning to observe a crime scene for identification of relevant evidences and samples for forensic analysis. Understand the importance of method for collection, packaging and preservation of samples to ensure reliability of data generated.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Use models of crime scenes for practical training on sample identification and collection.</td>
<td>Internal assessment tests. Students will be given questions that are application based and require analytical skills.</td>
</tr>
<tr>
<td>II.</td>
<td>To understand the importance of precision, reproducibility and accuracy in identification of a biological sample. To learn different methods that can be used to identify with accuracy the age, sex and identity of an individual in a forensic investigation. To learn different methods that can be used to identify time and cause of death.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions on case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Practical training on microscopic identification of various biological samples, finger print development from surfaces and identification of fingerprints.</td>
<td>Conduct of Internal assessment tests PowerPoint presentation on the assigned topics.</td>
</tr>
<tr>
<td>III.</td>
<td>To understand methods used to analyse samples for drug testing, ink and stain testing and document and handwriting verification.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Practical analysis of urine samples for drug tests. Practical analysis of inks.</td>
<td>Internal assessment tests will be conducted Analyzing case studies. Open book tests to</td>
</tr>
<tr>
<td>IV</td>
<td>To understand the physiology and biochemistry behind tests like Narcoanalysis, polygraphy, lie detection and facial reconstruction. To learn the importance of DNA fingerprinting in forensic investigations</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Discussions with case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Practical exercises on DNA fingerprinting.</td>
<td>Internal assessment tests will be conducted A PowerPoint presentation on any interesting case study and the use of forensic technology in investigation.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

   Forensic biology; blood samples; blood grouping; blood splatter analysis; toxicology; narco-analysis; DNA fingerprinting; fingerprints, brain mapping; EEG; polygraph; odontology; forensic entomology.
1. **Course Objectives:**

   The objective of the course is to teach basics of theory and practical aspects of recombinant DNA technology and the various techniques for DNA manipulation in prokaryotes and eukaryotes. The course will also outline the applications of this knowledge for the development of diagnostics, therapeutics and vaccines.

2.1 **Course Learning Outcomes:**

   The students after completing this course will be able to understand:

   - Principles and importance of gene cloning
   - Various methods for screening of recombinants and identification of cloned gene
   - Polymerase chain reaction and DNA sequencing
   - Recombinant gene expression system
   - Application of recombinant technology in the production of Biopharmaceutical processes and products such as insulin, vaccines and DNA fingerprinting.

**THEORY**

**CREDITS: 4**

**TOTAL HOURS: 60**

**UNIT I: Introduction to recombinant DNA technology**

No. of hours: 8

Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis.

**UNIT II: Cloning vectors for prokaryotes and eukaryotes**

No. of hours: 12

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for *E. coli* like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage, Ti plasmid, BAC and YAC.

**UNIT III: Introduction of DNA into cells and selection of recombinants**

No. of hours: 12


**UNIT IV: Polymerase chain reaction and DNA sequencing**

No. of hours: 08

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger’s method and automated DNA sequencing.
UNIT V: Expression of cloned genes  
No. of hours: 12

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

UNIT VI: Applications of genetic engineering in biotechnology  
No. of hours: 12

Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.

PRACTICALS

CREDITS: 2  
TOTAL HOURS: 60

1. DNA estimation by UV spectrophotometry.
2. Isolation of plasmid DNA from *E. coli*.
3. Restriction digestion and agarose gel electrophoresis.
4. Amplification of a DNA fragment by PCR.

2.3 References


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Students will be introduced to purpose and importance of gene cloning, Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis.</td>
<td>Teaching will be conducted through both black board mode and power point presentation mode. They are also encouraged to attend the practicals for the better understanding of the techniques.</td>
<td>MCQ tests, assignments, Analytical questions</td>
</tr>
<tr>
<td>II.</td>
<td>Students will gain insight of different vectors used for gene cloning like pBR322, pUC8, pGEM3Z, Cloning vectors based on M13 and λ bacteriophage. Plant vectors like Ti plasmid, high capacity vectors like BAC and YAC.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Regular classroom teaching, visual aids, discussions</td>
<td>Students will be given assignment on different topics and will be asked to deliver a power-point presentation on the applications of vectors, MCQ tests and quizzes to assess regular understanding of the topic</td>
</tr>
</tbody>
</table>
### III.

Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.  

mid-term tests will be conducted.

### IV.
Students will gain insight of principle of polymerase chain reaction, designing primers for PCR, DNA sequencing by Sanger’s method and automated DNA sequencing.  

Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted through both black board mode and power point presentation mode.  

Assignments and presentations, analytical problems and class tests.

### V.
Students will learn about the Vectors used for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.  

Presentations, Classroom Teaching, connect with practicals, discussions  

Presentations and assignments

### VI.
Students will gain knowledge about the various application of recombinant DNA technology through various examples like Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.  

Visual aids, Presentations, Classroom Teaching and discussions.  

Internal assessment test (end term) will be conducted.

**Assessment tasks enlisted here are indicative in nature**

### 4. Key Words

Genetic Engineering, Recombinant Proteins, Biotechnology
B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
1. **Course Objectives**

The objective of the course is to introduce to the students, various techniques that are used in a biochemistry lab and to provide them with an understanding of the principle underlying these techniques and laboratory skills in the form of practical exercises so that students can apply this knowledge to pursue research.

2.1 **Course Learning Outcomes**

The course is designed for undergraduate students to learn the basic concepts of various techniques used in Biochemistry. The course will enable students to:

- Acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
- Learn about the principle and applications of electrophoresis and centrifugation techniques.
- Obtain hands-on-experience and laboratory skills expected of any biochemist working in a research lab.

**THEORY**

**CREDITS: 2**

**TOTAL HOURS: 30**

**UNIT I: Spectroscopic Techniques**  
No. of hours: 6


**UNIT II: Chromatography**  
No. of hours: 10

Introduction to chromatography. Principle and applications of Paper Chromatography, Thin Layer Chromatography, Ion-Exchange Chromatography, Gel filtration and Affinity Chromatography.

**UNIT III: Electrophoresis**  
No. of hours: 8

UNIT IV: Centrifugation


PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Determination of absorption maxima ($\lambda_{max}$) of small molecules and macromolecules.
2. Verification of Beer’s Law.
3. Determination of molar extinction coefficient.
4. Separation of amino acid acids/sugars by thin layer chromatography (TLC)
5. Separation of proteins by gel filtration chromatography
6. Separation of protein by ion-exchange chromatography
7. Separation of nucleic acids using agarose gel electrophoresis
8. Separation of protein by SDS-PAGE.

2.3 References


Additional Reading


3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tr>
<td>I</td>
<td>Students will learn about the principle and applications of spectrophotometry and flourimetry.</td>
<td>Teaching using chalk and board; Oral discussion sessions in the class. Powerpoint presentations.</td>
<td>Problems will be assigned related to Beer’s Law and Lambert’s Law to test the understanding of students.</td>
</tr>
</tbody>
</table>
Students will learn the principle of various chromatographic techniques like gel filtration, Ion exchange. Teaching using chalk and board; Oral discussion sessions in the class. Powerpoint presentations. Practical exercises are designed whereby the students get hands on experience with these chromatography techniques.

Students will learn about electrophoretic techniques, their principle and applications in analyzing proteins and nucleic acids. Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class. Various analytical problems will be assigned to students related to electrophoretic separation.

Students will learn about the basic rules of sedimentation, various types of centrifuges and rotors. Power point presentations; Teaching using chalk and board; Oral discussion sessions in the class. Demonstration with the help of centrifuges and rotors to improve their understanding.

4. Keywords

Spectrophotometry, Chromatography, Proteins, Nucleic Acids, Centrifugation and Electrophoresis
1. Course Objectives

The primary objective of this course is to provide understanding about the principles of biological data collection, statistical analysis and presentation. The course will also provide hands-on-experience through practicals that are well correlated with the theory topics and are designed to support skill oriented learning outcomes in the management of biological data.

2.1 Course Learning Outcomes

Learners will be able to:

- Understand the principles of biological data collection, statistical analysis and presentation.
- Appreciate various factors that influence the type of sample collected and sample size.
- Analyze and interpret biological data using appropriate statistical tools
- Apply the principles of biological data management in real life situations
- Improvise their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education.

THEORY

CREDITS: 2 TOTAL HOURS: 30

UNIT I: Data Collection and Presentation  No. of hours: 4

Importance of statistical analysis in biological data management. Sampling schemes – Simple Random sampling, Systemic sampling, Stratified sampling, Cluster sampling, Non probability sampling; Types of numerical data – nominal data, ordinal data, ranked data, discrete data, continuous data; Modes of presenting data: Frequency distributions, Relative frequency.

UNIT II: Measures of central tendency and analysis of variance  No. of hours: 12

Mean, median, mode; Co-efficient of variation and standard deviation; Range and interquartile range; Grouped mean and grouped variance; Frequency distributions; One way ANOVA; Two-way ANOVA; AMOVA; student’s t test

UNIT III: Probability  No. of hours: 4

Operations on events, Venn diagrams, Conditional Probability; Probability distributions.
UNIT IV: Hypothesis Testing  No. of hours: 4

General concepts – Null hypothesis, alternative hypothesis, Rejection of hypothesis; Type I and Type II errors; P value and sample size estimation.

UNIT V: Regression and Correlation  No. of hours: 6

Chi Square Test – Observed and expected frequencies, Calculating p values, assumptions of a chi square goodness of fit; Correlation –Two-way scatter plot, Pearson’s correlation coefficient; Regression – regression concepts, simple linear regression; Calculation of R^2 and \( \rho \).

PRACTICALS

CREDITS: 2  TOTAL HOURS: 60

1. Collection of data - Random sampling method; Stratified sampling method; Cluster sampling method
2. Data representation - Frequency and relative frequency distribution table, Plotting different biological data in a best representative graphical format.
3. Data analysis - Calculating Mean, median, mode, variance, standard deviation and standard error for a given data set. Standard t-test for grouped samples. Analysis of 2 way variance
4. Chi square goodness of fit test. Regression analysis and calculating regression coefficient
5. Learning to analyze data using SPSS or R software
6. Project assignment.

2.3 References


Additional Resources:

### 3. Teaching Learning Process and Assessment Methods

**Facilitating the Achievement of Course Learning Outcomes**

<table>
<thead>
<tr>
<th>Unit No.</th>
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<tbody>
<tr>
<td>I.</td>
<td>Understand the principles of biological data collection and presentation, earn and appreciate various factors that influence type of sample collected and sample size.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Exercises on Collection and presentation of data. Field exercises on collection of data.</td>
<td>Internal assessment tests. Students will be given questions that are application based and require analytical skills.</td>
</tr>
<tr>
<td>II.</td>
<td>Analyze and interpret biological data using simple statistical tools like mean, median, mode, variance and standard deviation. Apply the principles of biological data management in real life situations. Improve their computational, mathematical and computer skills by learning to use ANOVA, AMOVA and student t-test on free access statistical software.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Exercises on statistical analysis of biological data. Learning to analyze data using SPSS or R software.</td>
<td>Conduct of Internal assessment tests. Students will be given questions that are application based and require analytical and computational skills.</td>
</tr>
<tr>
<td>III.</td>
<td>Understand the concept of probability and the importance and use of probability in analyzing biological data.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode.</td>
<td>Students will be given questions that are application based and require analytical and computational skills.</td>
</tr>
<tr>
<td>IV</td>
<td>Learn and appreciate various factors that influence stating and formulating a hypothesis, relevance to type of sample collected and sample size.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Analyzing case studies to understand hypothesis formulation.</td>
<td>Formulate a hypothesis on any are/topic of interest, determine appropriate sample size and collect data.</td>
</tr>
<tr>
<td>V</td>
<td>Understanding how to manage data for a goodness of fit chi-square test versus an interdependence chi-square test. Learn and appreciate various factors that influence the use of correlation and regression analysis for biological data.</td>
<td>Teaching will be conducted both through black board mode and power point presentation mode. Exercises on statistical analysis of biological data. Learning to analyze data using SPSS or R software.</td>
<td>Internal assessment tests will be conducted. Analyze data collected using appropriate statistical tools and present the data.</td>
</tr>
</tbody>
</table>

### 4. Keywords

Statistical analysis, biological data collection, sampling, data presentation, measures of central tendency, ANOVA, chi-square, regression
1. Course Objectives

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

2.1 Course Learning Outcomes:

By studying this paper students will be able to:

- Define research, learn the importance of research and its link with theoretical knowledge
- Describe the research process and the principle activities, skills and ethics associated with the research process
- Describe and compare the major quantitative and qualitative research methods
- Construct an effective research proposal
- Understand the importance of research ethics use the computer software for organization and analysis of data.
- Develop skills in the art of scientific writing and oral presentation

2.2 Course Contents

THEORY

CREDITS: 2 TOTAL HOURS: 30

UNIT I: Objectives of research No. of hours: 4

Definition, objectives, types of research, classification, various phases of research.

UNIT II: Research proposals and literature survey No. of hours: 6

Research proposal and aspects, Review of literature using appropriate sources – reviews, patents, research papers, books.

UNIT III: Basic principles of research design No. of hours: 6

Types of research designs – exploratory, descriptive, experimental, survey and case study.
UNIT IV: Experimental, sampling design and data collection  No. of hours: 6

Sample - types, criteria, characteristics and steps; Tools and techniques to execute experiments; Observation, questionnaire, interview

UNIT V: Interpretation, report writing and the art of oral presentation  No. of hours: 4

Report writing, format of publications in research journals, how to present papers and research findings

UNIT VI: Bioethics and Plagiarism in Research  No. of hours: 4

Biosafety and Ethics - compliance and concerns; Plagiarism; Citation and acknowledgement

PRACTICALS

CREDITS: 2  TOTAL HOURS: 60

1. Writing of a mini-review paper
2. Design of a research survey on a specific problem
3. Idea presentations in small groups

2.3 References

3. Research Methods The Basics -Nicholas Walliman

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Students will be able to define research and understand its objectives. They will recognize the various types and classes of research.</td>
<td>Teaching will be conducted through both black board mode and power point presentation mode.</td>
<td>Internal assessment tests will be conducted. Group discussions will be assigned.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will gain insight about the importance of</td>
<td>Group discussions; Idea presentations; Proposing a</td>
<td>Assign group discussion on specific topics; Will be</td>
</tr>
</tbody>
</table>
Research proposals and literature survey. They will be made capable in identifying broad area of research and write research proposal. They will be able to review literature using a wide variety of sources like web and libraries.

<table>
<thead>
<tr>
<th>III.</th>
<th>Students will learn the basic principles of research design and its various types.</th>
<th>Group discussions; Idea presentations; Design a proposed research topic</th>
<th>Internal assessment tests will be conducted. Report/paper writing will be assigned.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV.</td>
<td>Students will gain insight about the experimental, sampling design and data collection. They will learn a variety of ways to collect the samples. They will be able to devise optional plans, tools and techniques for experimental design and its execution.</td>
<td>Plan the sampling and data collection method of their proposed topic of research. Learn the proper way of data reporting and its record keeping.</td>
<td>Internal assessment tests will be conducted. Group discussions; Paper presentation; Seminars</td>
</tr>
<tr>
<td>V.</td>
<td>Students will gain knowledge about data interpretation, report writing and the art of oral presentation. They will not only be able to understand the format of report writing but also scientific publications.</td>
<td>Learn the skill of report and publication writing in their proposed topic of research based on input from teachers.</td>
<td>Will be assigned writing of small reports and defending them orally. They will be encouraged to present scientific papers as well.</td>
</tr>
<tr>
<td>VI.</td>
<td>Students will learn about the role of bioethics and plagiarism in Research. They will be educated to follow ethics compliance and concerns. They will be educated about the concept of Citation and acknowledgement. Articles on these issues will be provided to students. Classical mode of chalk and board teaching as well as power point presentations will be used. Experts in these areas will be invited to deliver lectures.</td>
<td>Students will be assigned the task of retrieving bioethics, plagiarism, ethical issues related policies of the government or of institutions. They will be assigned the task of identifying citations of publications of faculties.</td>
<td></td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)

4. **Keywords**

Research methodology; Patents; Plagiarism; Ethics; Biosafety; Report writing

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1. **Course Objectives**

The objective of this course is to impart basic understanding of bioinformatics and computational biology. The course will introduce the broad scope of bioinformatics by discussions on the theory and practices of computational methods in biology. This course also aims to provide students with a practical hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

2.1 **Course Learning Outcomes**

After completion of the course, a student will:

- Understand the basics of bioinformatics and computational biology and develop awareness of the interdisciplinary nature of this field.
- Gain the ability to use several softwares/tools in biology
- Gain confidence to discuss, access and use biological databases in public domain
- Understand protein structure using visualization softwares
- Be able to gain understanding of sequence alignments
- Be able to analyze phylogeny using alignment tools
- Comprehend the fundamental aspects of *in-silico* protein structure prediction
- Understand how theoretical approaches can be used to analyze biological systems
- Obtain knowledge on applications of bioinformatics from genomes to personalized medicine.

2.2 **Course Contents**

**THEORY**

**CREDITS: 2**

**TOTAL HOURS: 30**

**UNIT I: Introduction to bioinformatics**

No. of hours: 2


**UNIT II: Biological databases and data retrieval**

No. of hours: 4

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot,
TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Organism specific databases (E. coli, yeast, Arabidopsis, mouse, Drosophila Melanogaster), Structure viewers (Ras Mol, J mol) and File formats.

UNIT III: Sequence alignment & phylogeny

Similarity, identity and homology. Concept of Alignment – local and global alignment, pairwise and multiple sequence alignments, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW, Definition of phylogeny and its importance, Methods of Phylogenetic tree generation, Phylip

UNIT IV: Genomics

Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, Genome annotation, gene prediction approaches and tools.

UNIT V: Protein sequence, structure prediction and analysis

Protein Structure - Primary, Secondary and Tertiary structure, Protein structure prediction methods: Homology modeling, Fold recognition and ab-initio methods, Ramachandran plot.

PRACTICALS

CREDITS: 2 TOTAL HOURS: 60

1. Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept.
2. Structure download (protein and DNA) from PDB and Molecular viewer by visualization software (Pymol / Rasmol/Jmol)
3. BLAST suite of tools for pairwise alignment
4. Multiple sequence alignment (CLUSTALW/TCoffee) and construction of guide trees
5. Gene prediction using GENSCAN/GLIMMER
6. Primary sequence analyses (Protparam) and Secondary structure prediction (GOR, nnPredict).
7. Tertiary structure prediction (SWISSMODEL) and Protein structure evaluation - Ramachandran map (PROCHECK)

2.3 References


Additional Reading


3. Teaching Learning Process and Assessment Methods

   Facilitating the Achievement of Course Learning Outcomes**

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<tbody>
<tr>
<td>I.</td>
<td>Students will be familiarized with the concept of Bioinformatics &amp; Computational with its applications in biology</td>
<td>Outlining history of development about Bioinformatics through power point presentations and chalk &amp; board method;</td>
<td>Research review articles discussion &amp; class presentations</td>
</tr>
<tr>
<td>II.</td>
<td>Students will learn about Biological Databases and the types of databases. They will also understand various file formats used for sequence and structure analysis</td>
<td>Traditional chalk &amp; board method with powerpoint presentations on biological databases</td>
<td>Computer assisted quizzes, assignments.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn about sequence alignment methods. Pairwise and multiple sequence alignment will be discussed in detail with examples of BLAST and CLUSTALW. They will also learn methods for phylogeny</td>
<td>Chalk and board and notes; Power point presentations for images for clarity of concepts; Research papers will be discussed</td>
<td>Class presentations and assignments will help students understand phylogeny</td>
</tr>
<tr>
<td>IV</td>
<td>Students will understand different applications of genomics in gene prediction. Functional Genomics &amp;</td>
<td>Power point presentations; Chalk and board; Student interaction in class</td>
<td>Assignments &amp; Quiz</td>
</tr>
</tbody>
</table>
Comparative Genomics will be discussed

| V. | Students will learn the various approaches for protein tertiary structure prediction, tools used and validation methods employed. | Chalk & board method & Powerpoint presentations | Assignments & Class presentations with hands on computer training |

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

   Biological Databases, NCBI, PDB, Visualization Softwares, Sequence Alignment, BLAST, Gene Prediction, Secondary Structure Prediction, Protein Structure Prediction.
1. **Course Objectives**

This course aims to impart basic understanding of microbial techniques by hands-on-experience on working with microorganisms. It will also provide knowledge about various control methods for the growth of microbes and the characteristic features of different microbes.

2.1 **Course Learning Outcomes**

After completion of this course, a student will be able:

- To visualize and identify various microorganisms
- To culture microorganisms in aseptic conditions
- To prepare and sterilize different types of media
- To maintain different types of cultures
- To carry out research using microorganisms.
- To learn the principles behind and importance of sterilization while working in varied areas of biology in various laboratories.

2.2 **Course Contents**

**THEORY**

**CREDITS: 2**

**TOTAL HOURS: 30**

**UNIT I: Introduction**

No. of hours: 4


**UNIT II: Microbial nutrition and growth**

No. of hours: 8

UNIT III: Control of microorganisms by physical and chemical methods  
No. of hours: 6

Mechanism of Dry Heat, Moist Heat, Hot air oven, Filtration and Radiations, Use of Phenolics, alcoholics, halogens, heavy metals, aldehydes and gases for sterilization.

UNIT IV: Bacterial, Fungal and Algal cell organization and staining  
No. of hours: 8

Overview of characteristic features of bacterial, fungal and algal cell. Composition and detailed structure of gram- positive and gram- negative cell wall. Simple staining and negative staining of bacteria. Mechanism of gram staining.

UNIT V: Introduction to Viruses  
No. of hours: 4


PRACTICALS

CREDITS: 2  
TOTAL HOURS: 60

1. Microbiology Laboratory: Basic rules and requirements.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of glassware for microbiological work, cotton plugs, medium and their sterilization.
4. Sterilization of heat sensitive material by filtration.
5. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
6. Study of different shapes of bacteria, fungi and algae using permanent slides/pictographs
7. To stain bacteria using crystal violet/methylene blue.
8. To perform Gram’s staining.
9. To prepare temporary mount of algae.
10. To prepare temporary mount of fungi.
11. Isolation of pure cultures of bacteria by streaking method.
12. Enumeration of colony forming units (CFU) count by spread plate method/pour plate
13. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs.

2.3 References


**Additional Resources:**


3. **Teaching Learning Process and Assessment Methods**

**Facilitating the Achievement of Course Learning Outcomes**

<table>
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<tr>
<td>I.</td>
<td>Students will gain overall knowledge and understand the significance of microbiology as a discipline</td>
<td>Chalk and board teaching method, regular question-answer activities. Consultation of text books and reviews</td>
<td>Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a powerpoint presentation on the assigned topics.</td>
</tr>
<tr>
<td>II.</td>
<td>Students will gain insight into nutrient requirements of microbes, microbial growth and different types of cultures and media used for the growth of microbes.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding of the particular topic. Teaching will be conducted both through black board mode and powerpoint presentation mode.</td>
<td>Assessment through class test at the end of the module. Questions will be given as a part of the assignment. Students will also be assessed on the basis of their performance and involvement during practical classes.</td>
</tr>
<tr>
<td>III.</td>
<td>Students will learn about the control of microorganisms by various physical and chemical methods.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding of the particular topic. Teaching will be conducted both through black board mode and powerpoint presentation mode.</td>
<td>Assessment through interactive discussion in the class and periodic question-answer sessions during teaching.</td>
</tr>
<tr>
<td>IV.</td>
<td>Students will learn about the bacterial, fungal and algal cell organization and staining.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding of the particular topic. Teaching will be conducted both through</td>
<td>Assessment through class test at the end of the module. Questions will be given as a part of the assignment.</td>
</tr>
<tr>
<td>V.</td>
<td>Students will learn about general characteristics of viruses and subviral particles like viroids, prions and virusoids.</td>
<td>Students will be asked to orally revise the previous class before every new class helping them in better understanding of the particular topic. Teaching will be conducted both through black board mode and powerpoint presentation mode.</td>
<td>Students will be evaluated through class discussion and their performance and involvement during practical classes.</td>
</tr>
</tbody>
</table>

(**Assessment tasks enlisted here are indicative in nature)**

4. **Keywords**

Microorganisms, microbial growth, staining, culture, media