PONDICHERRY UNIVERSITY

(A CENTRAL UNIVERSITY)

NEP REGULATIONS
&
SYLLABUS & REGULATIONS FOR
B.Sc. (Honors) Biochemistry
(2023-24 onwards)

[Affiliated Colleges]

TABLE OF CONTENTS

PONDICHERRY UNIVERSITY
BACHELOR OF SCIENCE IN BIOCHEMISTRY

1. PREAMBLE

This Bachelor of Biochemistry course is a branch of science that explores the chemical processes within and related to living organisms. It is designed to provide the student with a comprehensive understanding of biochemical mechanism at cellular and molecular level, covering a wide array of foundational concepts. This curriculum is also crafted to equip the students with the knowledge and skills necessary to excel in the ever-evolving field of Biochemistry. A trained biochemist employs chemical knowledge and bio-analytical skills, in order to unravel biological problems pertaining to physiological processes, diseases related to their malfunctions, diagnostics, prevention, therapy and prognostics. Considering far-reaching advances in modern biology in 21st century, it is imperative to incorporate emerging concepts of biochemistry in academic curriculum. The proposed pattern is designed for multi-faceted development of students, giving the freedom to choose a combination of courses of study from Biochemistry as well as from the allied disciplines. While 14 discipline Specific Courses with 70 credits (12 with practical components for 61 credits and 3 without practical for 9 credits), three discipline specific Electives (9 credits) provide fundamental and advanced courses in Biochemistry, two vocational courses for 6 credits, research project in VIII semester provides much needed orientation and exposure to experimental research. With the Biochemistry major, the candidate can choose a minor from other disciplines such as Botany, Zoology, Environmental science, physics, Electronics, Mathematic, and other allied disciplines for 34 credits, depending on the subject's expertise available in the respective College, University or Institutions. Further, 24 credit courses shall be from ability enhancement courses (during first two years), and 4 credits shall be from compulsory environmental studies and Constitution of India. Skill enhancement courses for 8 credits earned over first six semesters include Digital fluency, Artificial intelligence, and Cyber security, and Professional communication. Value based courses of Physical education and health and wellness for 12 credits provide opportunities for personality development. The curricular framework approved by the Karnataka State Higher Education Council and Govt. of Karnataka as part of National Education Policy (NEP-2020) programme shall thus provide understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biochemistry equipping students with requisite knowledge, skill and personality.

2. PROGRAMME OBJECTIVES

The B.Sc. programme in Biochemistry is intended to:

- Impart basic biological and chemical knowledge for developing a strong foundation in the field of biochemistry.
- Make students familiar with essential scientific techniques and empower them with hands-on training to independently carry out scientific experiments.
- Inspire students to perform scientific enquiry, acquire vertical knowledge and develop scientific temperament.
- Kindle interest in exploring the subject in depth, encouraging them to take up higher studies in life sciences.
- Provide the academic and professional skills required for a successful career.

3. PROGRAMME OUTCOMES

Upon successful completion of this course, students will:

- Understand the fundamental chemical principles that govern biological systems.
- Attain critical thinking and the laboratory skills necessary to conduct and interpret basic scientific experiments.
- Acquire core knowledge in the basic areas of biochemistry, as well as horizontal knowledge in related life science fields.
- Use this knowledge to pursue either higher education or employment in various fields, or start their own businesses.

4. DEFINITIONS

Terms used in the NEP Regulations shall have the meaning assigned to them as given below unlessthe context otherwise requires:

i. **Credit:** A credit is the number of hours of instruction required per week for the given subjectin a given semester of 16-18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice or field work or community engagement and service per Semester.

ii. **Academic Year:** Means the year starting on 1st day of July and ends on the 30th day of June succeeding year.

iii. **Residence time:** Means the time a student spends for attending classes in the College/Institution(either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.

iv. **Semester:** Means 18 weeks (90 Working days) of teaching-learning session of which two weeks shall be set apart for examinations and evaluation.

v. **Grade**: Means a letter grade assigned to a student in a course for his/her performance at academicsessions as denoted in symbols of: O(Outstanding), A+(Excellent), A(Very good), B+(Good), B(Above average), C(Average), P(Pass), F(Fail) and Ab(Absent) with a numeric value of O=10, A+=9, A=8, B+=7, B=6, C=5, P=4, and F=0, Ab=0.

vi. **Grade Point Average (GPA):** Means an average of the Grades secured by a student in all coursesin a given academic session duly weighted by the number of credits associated to each of the courses.

vii. **Cumulative GPA (CGPA):** Means the weighted average of all courses the student has taken in the entire programme of study.

viii. **Common courses:** Means the set of courses that all students who are admitted are required to study; these courses include, Languages (English- Modern Indian languages), NEP specific courses viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, and Digital & Technological solutions.

ix. **Major Discipline Courses:** Means the core subjects mandatory for the Computer Science discipline. These courses are common across all specializations of Computer Science.

x. **Minor Discipline Courses:** Means allied/elective/specialization specific subjects of Computer Science discipline. Based on the set of Minor Discipline Courses the candidate study, specialization in Computer Science will be awarded. e.g. B.Sc. (Computer Science) with minor discipline courses in Artificial Intelligence and Machine Learning will be awarded B.Sc. Computer Science with Specialization in AI&ML.

xi. **Credit Requirements:** For a Degree/Diploma/Certificate Programme means the minimumnumber of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be.

xii. **Exit option:** Means the option exercised by the student, to leave the Programme at the end of any given Academic year.

xiii. **Lateral entry:** Means a student being admitted into an ongoing Programme of the Universityotherwise than in the 1st year of the programme.

xiv. **Vocational Studies/Education:** Means set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc. **(These courses are expected to enable students to incorporate the learned skills in daily life and start up entrepreneurship.)**

xv. **Skill-based learning/project:** Means activities designed to understand the different socio- economic contexts, first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.

xvi. **Work-based internship:** Means structured internships with Software Companies, Research and Higher Educational Institution Laboratories, Corporate offices, etc. which will further improve employability.

5. AWARD OF UG DEGREE/DIPLOMA/CERTIFICATE

Four years B.Sc. Degree programme shall have options for earning a UG Certificate/ Diploma/ Degree/ Degree with Honors based on the exit option exercised by the candidates.

6. DURATION OF THE COURSE

The Curriculum Framework designed by UGC for implementing NEP 2020 specifies that all Undergraduate (UG) degree programmes are to be for a period of either 3 years or 4 years leading to the award of UG Degree of UG(Hons)Degrees.

All UG courses shall focus on conceptual understanding and development of critical thinking in a given field of Study, incidentally the skills such as communication, teamwork, and leadership shall be embodied in Teaching-learning process to facilitate for career option in the given field of specialization.

7. AGE LIMIT

The rules as applicable to other Under Graduate courses as prevailing in Pondicherry University.

8. ELIGIBILITY FOR ADMISSION

Candidates for admission to B.Sc./B.Sc. (Hons.) Biochemistry shall require to have passed H.Sc. (or +2) or its equivalent with Botany/Zoology/Biology as one of the subjects of study, conducted by the Government of Tamil Nadu or any other equivalent system recognized by the Government of Puducherry based on the admission criteria laid down by Pondicherry University are eligible to apply.

9. LATERAL ENTRY

As per NEP, students have a choice of entry into the Programme of study. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students. The guidelines for lateral Entry are as follows:

1. Lateral Entry for II Year B.Sc. /B.Sc. (Hons.) Biochemistry:
   Student should complete **UG certificate in Biochemistry from** any University.
2. Lateral Entry for III Year B.Sc. /B.Sc. (Hons.) Biochemistry:
   Student should complete **UG Diploma course in Biochemistry** from any University.
3. Lateral Entry for IV Year B.Sc. (Hons.) Biochemistry:
   Student should complete **B.Sc. Biochemistry** from any University.

10. PEDAGOGICAL APPROACHES

a) Lecture Courses	Regular classroom lectures by qualified / experienced Expert Teachers • These Lectures may also include classroom discussion, demonstrations, case analysis • Use of Models, Audio-Visual contents, Documentaries, PPTsmay supplement.
b) Tutorial Courses	Problem solving Exercise classes guided discussion, supplementaryreadings vocational training, etc.
c) Practical / Lab work	Practical Lab activity with Theoretical support Mini projects, Activity based engagement, Program executions, Data processing and presentation exercise.
d) Seminar Course	A course requiring student to design and participate in discussions, Group Discussions, Elocution and Debate, Oral Communication Paper presentations, Poster Presentation, Role play participation, Quiz competitions, Business plan preparation/presentation, etc.
e) Internship course	Courses requiring students to *Learn by Doing* in the workplace external to the educational Institutions. Internships involve working in Software Companies, Research and Higher Educational Institution Laboratories, Corporate Offices, etc. All Internships should be properly guided and inducted for focused learning.

f) Research Project	Students need to study and analyze the recent research publicationsfrom indexed/peer reviewed journals in their area of specialization. Outcome of the study and analysis need to be presented as a thesis or research report with necessary experimental results.

11. ACADEMIC AUDIT OF COURSES

Internal Quality Assurance Cell at every institution is expected to supervise the implementation of NEP Regulations in these programmes. Availability of required number of Classrooms, Faculty rooms, Labs, Library facilities, Computer Centre and recruitment of Faculty members, allocation of funds for running the Science Labs/Computer Centre etc., is the responsibility of the College Administration.

12. COURSE STRUCTURE

All Academic Programmes offered under NEP shall be offered in terms of credits. Each course/subject in a given Programme of study shall carry certain number of credits which will be awarded on completion of the said course.

12.1 EXIT OF THE COURSE: NEP 2020 introduces the facility to breakdown the Programme of study at Undergraduate (UG) level after completion of every year of study. The students will be awarded the following:

1. Students who opt to exit after completion of first year will be awarded **UG Certificate in Biochemistry** provided they have earned a minimum of 42 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the first year.
2. Students who opt to exit after completion of second year will be awarded **UG Diploma in Biochemistry** provided they have earned a minimum of 84 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the Second year.
3. Students who opt to exit after completion of third year will be awarded **UG degree (B.Sc. in Biochemistry)**, provided they have earned a minimum of 124 credits.
4. Students who exit after completion of fourth year will be awarded either **B.Sc. (Hons.) Biochemistry**, provided they have earned a minimum of 164 credits or

B.Sc. (Hons. with Research) Biochemistry, provided they have earned a minimum of 164 credits with Research Project.

12.2 MEDIUM OF INSTRUCTION

The medium of instruction for B.Sc. Biochemistry **shall be in English**.

13. Break up of Credits and Courses:

NEP Framework has specified the minimum number of credits that a Bachelor student has to earn in ¾ year period. Table I specifies the number of credits and number of courses that a 3 year UG student and a four year UG (Hons) Degree student is expected to complete in 3 and 4-year duration respectively.

TABLEI
BREAKUP OF CREDITS AND COURSES

Sl. No.	Component	3 Year Degree	4 Year Hons Degree
1.	Major Disciplinary Courses	60 Credits (15 Courses of 4 credits each)	80 Credits (20 Courses of 4 credits each)
2.	Minor Disciplinary Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 credits each)
3.	Multi-Disciplinary Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
4.	Ability Enhancement Courses	12 Credits (4 courses of 3 credits each)	12 Credits (4 courses of 3credits each)
5.	Skill Enhancement Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
6.	Common Value-added courses	8 Credits (4course of 2credits each)	8 Credits (4 course of 2 credits each)
7.	Winter Project / Internship Community Engagement	2 Credits (1 field-based course)	2 Credits (1 field-based course)
8.	Research Dissertation Projec	-	12 Credits (Project report & background subjects)
9.	Total credits required	124 Credits	164 Credits

Every Undergraduate (UG) programme offered by a College shall confirm to the Structure specified by the UGC's Framework, 2023. A student of 3 year UG programme is mandated to complete a minimum of 124 credits and the student of 4 year Honors degree shall complete 164 credits. An UG student shall complete the following courses under different heads as listed below:

1. Major Disciplinary Courses
2. Minor Disciplinary Courses
3. Multi Disciplinary Courses
4. Ability Enhancement Courses
5. Skill Enhancement Courses
6. Value added/Common Courses
7. Internships and Community Service based projects

14. NEP Classification of Courses:

i. Major Disciplinary courses (MJD): (60/80 Credits)

Major disciplinary courses are subject specific compulsory subjects that a student has to complete to obtain the UG / UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits.

All discipline specific major courses shall be designed for 4 credits each with one/two additional hours or guidance of teaching at Tutorials/Practicals. UG programmes may be offered in a single major discipline or in Multiple Major disciplines giving equal weightage in credits. For example, a B.Sc. course may be in a single discipline like B.Sc. (Maths) or with multiple major disciplines like B.Sc. (Maths, Physics & Chemistry).

i) Minor Disciplinary Course (MID): (24/32 Credits)

Minor disciplinary courses refer to those subjects which are Allied / Specialisation / Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. For example, a B.A. (Political Science) student

shall study allied subjects like Public Administration, Sociology as these subjects have inter linkages with the Major Disciplinary subjects.

ii) Multi-Disciplinary Courses (MLD): (9 Credits)

All undergraduate students are mandated to pursue 9credits worth of courses in such Multi-disciplinary areas/Courses out of 9/10 NEP defined subjects. Colleges may identify any 3 multiple disciplinary streams listed below based on availability of resources and manpower.

a) Natural Sciences
b) Physical Sciences
c) Mathematics & Statistics
d) Computer Science/Applications
e) Data Analysis
f) Social Sciences
g) Humanities
h) Commerce & Management
i) Library Science
j) Media Sciences, etc.

Students are expected to learn basic/introductory courses designed by other departments for this purpose. Colleges may list any 3 introductory courses (one each in Natural Sciences, Physical Sciences, Humanities) for uniform adoption of all UG students.

iii) Ability Enhancement (AEC) courses: (8 Credits)

All Undergraduate (UG)students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, and writing skills. These courses are expected to enhance the ability in articulation and presentation of their thoughts at workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline. E.g. A course in Business Communication is more appropriate in place of literature/prose/poetry.

a) English /Language

Ability Enhancement Course	
1. English Language a. English Language & Literature – 1 and 2 b. Functional English–1&2 c. Communicative English–1&2	II. Indian Language (two courses) a. Indian language & Literature – 1 and 2 b. Functional language–1 &2 c. Communicative language-1&2

iv) Skill Enhancement Course: (9 Credits)

These courses focus at imparting practical skills with hands-on Training. In order to enhance the employability of students, Colleges are expected to design such courses that they deem fit for their students for better employment/entrepreneurship/career development, e t c . Colleges may also outsource the Skill Enhancement Courses to AICTE approved agencies for conducting short term Training Workshops, Skill India initiatives of GOI and approved Trades by Skill development of corporation are to be considered. Short term courses.

v) Value Added Common courses (VAC): (8 Credits)

Under NEP, the UGC has proposed for 6 to 8 credits worth of common courses which are likely to add value to overall knowledge base of the students. These courses include:

a) Understanding India

b) Environmental Studies/Education

c) Digital Technologies

d) Health, Wellness, Yoga Education, Sports & Fitness

The course structure and coverage of topics are suggested by UGC in its draft documents, colleges/UG Boards of Studies may design the methodology for conducting these value-added courses.

vi) Summer Internship (2 to 4 Credits)

As per the UGC guidelines all UG students should be exposed to 4 to 6-week Summer Internship in an industrial organizations / Training Centres / Research Institution, etc. Such Summer Internship is to be

conducted in between 4th Semester and 5th semester. A review of report and award of grade based on Work based learning by students is to be recorded during the 5thSemester.

a) Community Engagement and Service (CES) (2 Credits)

All UG students are also mandated to participate in a 15 days community engagement activity during their winter vacation between 5th and 6th Semesters. This Community engagement activity is expected to expose the students to social problems of neighbourhood village students may prepare a report on the activities carried out for a award of 2 credits.

15. EVALUATION:

Total Marks: 100

All Credit courses are evaluated for 100 marks. Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks. In case of Practicals, Project work, etc., it is 50:50 marks for Internal and End-Semester Exams.

Breakup of Internal Assessment Marks:

Total Internal Assessment mark for a theory subject is 25 marks. The breakup is:

a)	Mid Semester Exam (one) -20 Marks
b)	Percentage of Attendance-5 Marks
Total - 25Marks	

Marks for Attendance are as follows:

Below75%	0
75%-80%	1
80%-85%	2
85%-90%	3
90%-95%	4
95%-100%	5

Internal Test Scheme:

Principal of the College schedules the Mid-Semester Exam for all courses during 8/9th week of start of classes. All faculty members are expected to conduct this Mid-Semester exam for 1.30 hr duration and evaluate, upload the marks to Controller of Examinations of University. Colleges are also requested to preserve the answer books of Mid-Semester exams until declaration of results by the University.

Internal Assessment marks for Practicals / Project work / Internships subjects:

Faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The breakup is as follows:

a) Observation note / Demo note/ Work dairy / etc.	20
b) Practical Record/ Internship Report / etc.	30
Total	**50**

End-Semester University Exam:

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on University calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams mostly during 15/16th week of the Semester. Question Papers shall be set externally based on BOS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end-semester exams. The breakup of end semester marks:

a) Theory subjects: (Sec A, Sec B and Sec C) Questions from all units of syllabus	75marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	50marks

Consolidation of Marks and passing Minimum:

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in end-semester examination. The total marks will be converted into letter grades as shown in the following Table 2. As per NEP Regulations, the passing minimum is 50% marks (IA + End semester put together) However, Pondicherry University considers 40% marks as pass during first 3 years of study and students who secured less than 50 will be awarded 'P' (Pass Grade)

Arrear Exam:

A student who failed to secure 40% marks in aggregate is declared as Failed and he is eligible to take up supplementary examination by registering to the said course in the following Semester. All other candidates who failed due to shortage of attendance, those who are seeking to improve the grade shall repeat the course.

Letter Grades and Calculation of CGPA:

Total Marks Secured by a student in each subject shall be converted into a letter grade. UGC Framework has suggested a Country wide uniform letter grades for all UG courses. The following Table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

TABLE–2

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of IA and Semester End) would be categorized for relative grading. The ranges of marks for each grade would be worked as follows:

Highest marks in the given subject = X

Cut of marks for grading purpose =50marks

Passing mark (for 3 years of UG) =40

Number of grades (excepting P grade) (O, A+, A, B+, B, C)=6

Range of marks =K

$$K = \frac{x - 50}{G}$$

The following table given the range of marks and letter grades. According to K value, one of the following grading schemes will be followed.

(i) If K ≥ 5, then the grades shall be awarded as given in Table II.

Table II

Range of Marks in%	**Letter Grade Points for**	**Letter Grade Points for**
X to (X-K) +1	O	10
(X-K) to(X-2K) +1	A+	9
(X-2K) to (X-3K) +1	A	8
(X-3K) to (X-4K) +1	B+	7
(X-4K) to (X-5K) +1	B	6
(X-5K) to 50	C	5
40 –49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K < 5, then the grades shall be awarded as given in Table III.

Table III		
Range of Marks in%	**Letter Grade Points for**	**Letter Grade Points for**
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below40	F	0
Absent (lack of attendance)	Ab	0

Calculation of Semester Grade Point average and CGPA:

Semester Grade Point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carry.

Cumulative Grade Point Average (CGPA) CGPA shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,

i.e. **SGPA**(Si)=Σ(CixGi)/ΣCi

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th}course.

(i) **Example for Computation of SGPA where candidate has not failed in any course.**

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30
I	Course5	3	C	5	3X5=15
I	Course6	4	B	6	4X6=24
		20			139
	SGPA				139/20=6.95

(ii)Example for Computation of SGPA where candidate has failed in one course.

Semester	**Course**	**Credits**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30
I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			115
	SGPA				115/20=5.75

(ii) **Example for Computation of SGPA where candidate has failed in two courses.**

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	F	0	3X0=00
I	Course4	3	B	6	3X6=18
I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			85
	SGPA				85/20=4.25

The CGPA shall also be calculated in similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

Declaration of Results:

Controller of Examinations (COE) of the University shall declare the results of given UG programme following the CGPA secured by students by the end of 6^{th} Semester.

PASS CLASSES

Range of CGPA	Result
9.0 above	First Class with distinction
6.0 above	First Class
5.0 Below5.99	Second Class
4.0 4.99	Pass Class

SCHEME OF EXAMINATION (Practical Paper)
Total Marks: 100: (Internal: 50 & External: 50)

INTERNAL EXAMINATION: Maximum Marks: 50

- Components of Internal Evaluation (50 Marks)

1. Attendance - 5 marks
2. Observation Notebook/Demonstration – 5 marks
3. Model Practical Exam -10 marks
4. Record – 30 marks

END-SEMESTER PRACTICAL EXAMINATION: Maximum marks: 50

Question Paper Pattern for End Semester Practical Examination (50 Marks)

1. Question I – 20 marks
2. Question II - Spotters -10 marks
3. Record – 20 marks

(Submission of practical record for the End Semester Practical Examination is mandatory])

SCHEME OF EXAMINATION (Theory Paper)
Total Marks: 100 (Internal: 25 & External: 75)

INTERNAL EXAMINATION: Maximum Marks: 25.

- Mid-Semester Examination for 1.30 Hours duration shall be taken: 20 Marks
- Attendance: 5 Marks

EXTERNAL EXAMINATION: Maximum Marks: 75.

- Examinations shall be in three sections.
- Section-A for 20 Marks, Section –B for 25 Marks and Section-C for 30 Marks.

16. Question Paper Pattern for End Semester Theory Examination

SECTION – A: (10 x 2 = 20 Marks)

- It is of short answer type. Each question carries 2 marks.
- 10 questions to be given by selecting 2 questions from each unit.
- Candidate should Answer all the questions.

SECTION – B: (5 x 5 = 25 Marks)

- It is of short answer type. Each question carries 5 marks.
- 5 questions to be given with either or choice, 1 question from each unit
- Candidate should answer all 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions to be given. One question from each unit.
- Candidate should answer 3 out of 5 questions.

17. MINIMUM CREDITS REQUIREMENT

S.No	Component	3-year UG			4-year UG (Honors / Honors With research)		
		Credits	Courses	Cr/Course	Credits	Courses	Cr/Course
1	Major Disciplinary/ Interdisciplinary Courses	56	14	4	76	19	4
2	Minor Disciplinary/ Interdisciplinary Courses	24	6	4	32	8	4
3	Multi-Disciplinary Courses	9	3	3	9	3	3
4	Ability Enhancement Courses	8	4	2	8	4	2
5	Skill Enhancement Courses	9	3	3	9	3	3
6	Value-added courses	8	4	2	8	4	2
7	Summer Internship (MJD11)	4	1	4	4	1	4
8	Community Engagement and	2	1	2	2	1	2

	Service						
9	Research Project/Dissertation	--	--	--	12	Project or 3 Courses##	
Total		**120**			**160**		

##Note: Honors students not undertaking research will do 3 courses for 12credits in lieuof a research project/Dissertation.

- MJD: Major Disciplinary (Compulsory – Hardcore Subjects)
- MID: Minor Disciplinary (Specialization Specific – Softcore Subjects)
- MLD: Multi-Disciplinary
- AEC: Ability Enhancement Courses
- SEC: Skill Enhancement Courses
- VAC: Value Added Courses
- SG: Specialization Group
- Course Code: CA1MJ01(E) (CA- B.Sc. Computer Application, 1-Semester, MJ-Component,01-Course Number in the respective component, E-Elective)

18.CURRICULUM

FIRST SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 1	BC1MJ01	Biological Sciences	4	3		2
2	MID 1	BC1MI01	One course from MID streams (Table 2)	4	3		2
3	MLD 1		One course from the MLD streams (Table 3)	3	4		
4	AEC 1	BC1AE01	English I	2+1	2		2
5	SEC 1	BC1SE01	One course from SEC streams (Table 5)	3			4
6	VAC 1	XX1VA01	Understanding India	2	4		
7	VAC 2	YY1VA02	Environmental Studies/Education	2	4		
Total				20	30 Hours		

SECOND SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 2	BC2MJ02	Cell Biology	4	3	1	2
2	MID 2	BC2MI02	One course from MID streams (Table 2)	4	4		
3	MLD 2		One course from the MLD streams except the stream chosen in MLD 1 (Table 3)	3	4		
4	AEC 2	BC2AE02	Indian Language I	2+1	2		2
5	SEC 2	BC2SE02	One course from SEC streams except the stream chosen inSEC 1 (Table 5)	3			4
6	VAC 3	XX2VA03	Health & Wellness/Yoga Education	2	4		
7	VAC 4	CS2VA04	Digital Technologies	2	4		
Total				20	30 Hours		

THIRD SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 3	BC3MJ03	Biomolecules	4	3	1	2
2	MJD 4	BC3MJ04	Plant & Animal Physiology	4	3	1	2
3	MID 3	BC3MI03	One course from MID streams (Table 2)	4	4		
4	MLD 3		One course from the MLD streams except the streams chosen in MLD1 and MLD2 (Table 3)	3	2		2
5	AEC 3	BC3AE03	English II	2+1	2		2
6	SEC 3	BC3SE03	One course from SEC streams except stream chosen in SEC 1 & 2 (Table 5)	3			4
Total				20	28 Hours		

FOURTH SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 5	BC4MJ05	Enzymology	4	3	1	2
2	MJD 6	BC4MJ06	Intermediary Metabolism I	4	4		
3	MJD 7	BC4MJ07	Analytical Biochemistry	4	3	1	2
4	MID 4	BC4MI04	One course from MID streams (Table 2)	4	4		
5	AEC 4	BC4AE04	Indian Language II	2+1	2		2
6	Project	BC4PR01	Community Engagement and Service	2			6
Total				20	30 Hours		

FIFTH SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 8	BC5MJ08	Intermediary Metabolism II	4	3	1	2
2	MJD 9	BC5MJ09	Human Physiology	4	3	1	2
3	MJD 10	BC5MJ10	Microbiology	4	3	1	2
4	MID 5	BC5MI05	One course from MID streams (Table 2)	4	4		
5	MJD 11	BC5MJ11	Summer Internship	4			6
Total				20	28 Hours		

SIXTH SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 12	BC6MJ12	Molecular Biology	4	3	1	2
2	MJD 13	BC6MJ13	Immunology	4	3	1	2
3	MJD 14	BC6MJ14	Clinical Biochemistry	4	3	1	2
4	MJD 15	BC6MJ15	Genetics	4	4		
5	MID 6	BC6MI06	One course from MID streams (Table 2)	4	4		
Total				20	26 Hours		

SEVENTH SEMESTER (Honors)							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 16	BC7MJ16	Endocrinology	4	4		
2	MJD 17	BC7MJ17	Genetic Engineering	4	3	1	2
3	MJD 18	BC7MJ18	Cellular basis of diseases	4	3	1	2
4	MID 7	BC7MI07	One course from MID streams (Table 2)	4	3		2
5	MID 8	BC7MI08	One course from MID streams (Table 2)	4	4		
Total				20	25 Hours		

EIGHTH SEMESTER B.Sc. Biochemistry (Hons)							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 19	BC8MJ19	Genomics & Proteomics	4	3	1	2
2	MJD 20	BC8MJ20	Cell Culture Technology	4	3	1	2
3	MJD 21	BC8MJ21	Introduction to Drug Discovery	4	3	1	
4	MJD 22	BC8MJ22	Introduction to Stem Cell Technology	4	3	1	
5	MJD 23	BC8MJ23	Cell Signaling	4	3	1	
Total				20	24 Hours		

EIGTH SEMESTER – B.Sc. Biochemistry (Hons with Research Project)							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 19	BC8MJ19	Genomics & Proteomics	4	3	1	2
2	MJD 20	BC8MJ20	Cell Culture Technology	4	3	1	2
3	MJD 24	BC8MJ24	Research Project	4			
4	MJD 25	BC8MJ24	Project Report	4			
5	MJD 26	BC8MJ24	Project Viva-voce	4			
Total				20	24 Hours		

Table 1: List of Major Disciplinary Courses			
S.No	**Component**	**Course Code**	**Title of the Course**
I SEMESTER			
1.	**MJD 1**	**BC1MJ01**	**Biological Sciences**
II SEMESTER			
2.	**MJD 2**	**BC2MJ02**	**Cell Biology**
III SEMESTER			
3.	**MJD 3**	**BC3MJ03**	**Biomolecules**
4.	**MJD 4**	**BC3MJ04**	**Plant and Animal Physiology**
IV SEMESTER			
5.	**MJD 5**	**BC4MJ05**	**Enzymology**
6.	**MJD 6**	**BC4MJ06**	**Intermediary Metabolism I**
7.	**MJD 7**	**BC4MJ07**	**Analytical Biochemistry**
V SEMESTER			
8.	**MJD 8**	**BC5MJ08**	**Intermediary Metabolism II**
9.	**MJD 9**	**BC5MJ09**	**Human Physiology**
10.	**MJD 10**	**BC5MJ10**	**Microbiology**
11.	**MJD 11**	**BC5MJ11**	**Summer Internship**
VI SEMESTER			
12.	**MJD 12**	**BC6MJ12**	**Genetics**
13.	**MJD 13**	**BC6MJ13**	**Molecular Biology**
14.	**MJD 14**	**BC6MJ14**	**Immunology**
15.	**MJD 15**	**BC6MJ15**	**Clinical Biochemistry**
VII SEMESTER			
16	**MJD 16**	**BC7MJ16**	**Endocrinology**
17	**MJD 17**	**BC7MJ17**	**Genetic Engineering**
18	**MJD 18**	**BC7MJ18**	**Cellular basis of disease**
VIII SEMESTER			
19	**MJD 19**	**BC8MJ19**	**Genomics & Proteomics**
20	**MJD 20**	**BC8MJ20**	**Cell Culture Technology**
Project/MJD			
21	**MJD 21**	**BC8MJ21**	**Introduction to Drug Discovery**
22	**MJD 22**	**BC8MJ22**	**Introduction to Stem Cell Technology**
23	**MJD 23**	**BC8MJ23**	**Cell Signaling**
24	**MJD 24**	**BC8MJ24**	**Research Project**
25	**MJD 25**	**BC8MJ25**	**Project Report**
26	**MJD 26**	**BC8MJ26**	**Project Viva-voce**

Table 2 (A): List of Minor Courses (Stream 1- within the Department)				
S.No	**Semester**	**Component**	**Course Code**	**Title of the Course**
1.	**I**	**MID 1**	**BC1MI01E1**	**Chemical foundation of Biochemistry**
2.	**II**	**MID 2**	**BC2MI02E1**	**Plant Biochemistry**
3.	**III**	**MID 3**	**BC3MI03E1**	**Nutritional Biochemistry**
4.	**IV**	**MID 4**	**BC4MI04E1**	**Biostatistics & Scientific writing**
5.	**V**	**MID 5**	**BC5MI05E1**	**Pharmaceutical Biochemistry**
6.	**VI**	**MID 6**	**BC6MI06E1**	**Biochemical Toxicology**
7.	**VII**	**MID 7**	**BC7MI07E1**	**Bioinformatics**
8.	**VII**	**MID 8**	**BC7MI08E1**	**Research Methodology**

Table 2 (B): List of Minor Courses (Stream 2 –16 credits within the Department &16 credits within the school)				
S. No	**Semester**	**Component**	**Course Code**	**Title of the Course**
1.	**I**	**MID 1**	**BC1MI01E2**	**Fundamentals of Biochemistry**
3.	**II**	**MID 2**	**BC2MI02E2**	**Basic Concepts in Nutrition**
4.	**III**	**MID 3**	**BC3MI03E2**	**Lifestyle disorders & Management**
5.	**IV**	**MID 4**	**BC4MI04E2**	**Microbiome**

Table 2 (C): List of Minor Courses (Stream 3 – For other Schools)				
S.No	**Semester**	**Component**	**Course Code**	**Title of the Course**
1.	**I**	**MID 1**	**BC1MI01E3**	**Biodiversity**
2.	**II**	**MID 2**	**BC2MI02E3**	**Concepts of Diet Therapy**
3.	**III**	**MID 3**	**BC3MI03E3**	**Lifestyle diseases**
4.	**IV**	**MID 4**	**BC4MI04E3**	**Ecology & Environment**

Table 3: List of Multi-disciplinary Courses from Table 8			
S.No	**Component**	**Course Codezs/**	**Title of the Course**
1.	**MLD 1**	**XX1ML01**	**Natural Science (Biology / 5 options)**
2.	**MLD 2**	**XX2ML02**	**Physical Science – (Biophysics / 6 options)**
3.	**MLD 3**	**XX3ML03**	**Computer Science & Applications – (Introduction to Python programming / 2 options)**

Table 4: List of Ability Enhancement Courses			
S.No	**Component**	**Course Code**	**Title of the Course**
1.	**AEC 1**	**XX1AE01**	**English I**
2.	**AEC 2**	**XX2AE02**	**Indian Language I**
3.	**AEC 3**	**XX3AE03**	**English II**
3.	**AEC 4**	**XX4AE04**	**Indian Language II**

Table 5: List of Skill Enhancement Courses			
S.No	**Component**	**Course Code**	**Title of the Course**
1.	**SEC 1**	**BC1SE01E1**	**Biochemistry Laboratory Skills I**
		BC1SE01E2	**Phytochemistry of Medicinal Plants**
2.	**SEC 2**	**BC2SE02E1**	**Biochemistry Laboratory Skills II**
		BC2SE02E2	**Herbal Technology**
3.	**SEC 3**	**BC3SE03E1**	**Microbiological Laboratory Skills**
		BC3SE03E2	**Basics of Medical Coding**

Table 6: List of Value-Added Courses			
S.No	**Component**	**Course Code**	**Title of the Course**
1.	**VAC 1**	**XX1VA01**	**Understanding India**
2.	**VAC 2**	**XX1VA02**	**Environmental Sciences / Education**
3.	**VAC 3**	**XX2VA03**	**Health & Wellness / Yoga Education**
4.	**VAC 4**	**CS2VA04**	**Digital Technologies**

Table 7: Project (WP/ Summer Internship/Research Project)			
S.No	**Component**	**Course Code**	**Title of the Course**
1.	**Project**	**BC4PR01**	**Community Engagement and Service**
2.		**BC5PR02**	**Summer Internship**
3.		**BC8PR03**	**Research Project**

*Table 8: MLD 1 / MLD 2 / MLD 3 in Sem 1 / Sem 2 / Sem 3			
S.No	**Streams**	**Course Code**	**Title of the Course**
1.	**Natural Science**		Biology
2.			Botany
3.			Zoology
4.			Biotechnology
5.			Biochemistry
6.	**Physical Sciences**		Chemistry
7.			Physics
8.			Biophysics
9.			Astronomy
10.			Astrophysics
11.			Earth and Environmental Sciences
12..	**Social Sciences**		Political Sciences
13.			History
14.			Social work
15.			Sociology
16.	**Humanities**		Anthropology
17.			Psychology
18.			Economics
19.	**Computer Science & Applications**		Introduction to Python Programming
20.			Programming for Mobile Devices
*Courses will be announced after the approval of the respective boards.			

ANNEXURE II

19. SEMESTER WISE CREDITS AND HOURS OF WORK AS PER NEP

SEMESTER I

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 1	Major Disciplinary course (compulsory)	MJD-1: **Biological Science**	4	3(L)+2(P)
MID1	Minor Disciplinary Courses	MID-1: **Chemical Foundation of Biochemistry**	4	3(L)+2(P)
MLD 1	Multi-Disciplinary courses	MLD-1: Natural Science	3	4 (T/P)
AEC I & II	Ability Enhancement courses I & II English or Indian Language	AEC-1(A): Basic Language and Literature	2+1	4
		AEC-1(B): Functional Language		
		AEC-1(C): Spoken communication		
		AEC-2(A): Basic Language and Literature		
		AEC-2(B): Functional Language		
		AEC-2(C): Spoken communication		
SEC	Skill Enhancement Course (Anyone)	SEC-1(A): **Biochemistry Laboratory Skills I**	3	4 (T/P)
		SEC-1(B): **Phytochemistry of medicinal plants**		
VAC	NEP Value Added common courses I & II (compulsory)	VAC-1. Understanding India	2	4
		VAC-2. Environmental Studies	2	4
		Total Credits / Total Hours of Work	**20/21 Credits**	**30 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25.

SEMESTER II

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 2	Major Disciplinary courses (compulsory)	MJD-2: **Cell Biology**	4	3(L)+ 1(T)+ 2(P)
MID2	Minor Disciplinary courses	MID-2: **Plant Biochemistry**	4	4
MLD2	Multi-Disciplinary courses (compulsory)	MLD-2: Physical Science	3	4(L/P)
AEC III &IV	Ability Enhancement courses III & IV English or Indian Language	AEC-3(A): Basic Language and Literature	2+1	4
		AEC-3(B): Functional Language		
		AEC-3(C): Spoken communication		
		AEC-4(A): Basic Language and Literature		
		AEC-4(B): Functional Language		
		AEC-4(C): Spoken communication		
SEC	Skill Enhancement Course (Any one)	SEC-2(A): **Biochemistry Laboratory Skills II**	3	4 (L/P)
		SEC-2(B): **Herbal Technology**		
VAC	NEP Value added common courses I & II (compulsory)	VAC-3: Health & Wellness/ Yoga Education	2	4
		VAC-4: Digital Technology (Theory/Field based)	2	4
		Total Credits / Total Hours of Work	**20/21 Credits**	**30 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25.

UG Certificate in Biochemistry: Students exiting the programme after two semesters and securing **40/42 credits** will be awarded UG Certificate.

SEMESTER III

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD3	Major Disciplinary courses (compulsory)	MJD3: **Biomolecules**	4	3(L)+1(T)+2(P)
MJD4		MJD4: **Plant & Animal Physiology**	4	3(L)+1(T)+2(P)
MID3	Minor Disciplinary courses	MID-3: **Nutritional Biochemistry**	4	4
MLD3	Multi-Disciplinary Course (compulsory)	MLD-3: Computer Science & Applications – (Introduction to Python programming / 2 options	3	4(L/P)
AEC V &VI	Ability Enhancement courses V&VI English or Indian Language	AEC-5(A): Basic Language and Literature	2+1	4
		AEC-5(B): Functional Language		
		AEC-5(C): Spoken communication		
		AEC-6(A): Basic Language and Literature		
		AEC-6(B): Functional Language		
		AEC-6(C): Spoken communication		
SEC	Skill Enhancement Course (Anyone)	SEC-3(A): **Microbiological Laboratory Skills**	3	4(L/P)
		SEC-3(B): **Basics of Medical Coding**		
		Total Credits / Total Hours of Work	**20/21 Credits**	**30 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25

SEMESTER IV

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD5 MJD6 MJD7	Major Disciplinary courses (compulsory)	MJD5: **Enzymology** MJD6: **Intermediary Metabolism I** MJD7: **Analytical Biochemistry**	4 4 4	3(L)+1(T) +2(P) 4 3(L)+1(T) +2(P)
MID4	Minor Disciplinary courses	MID-4: **Biostatistics & Scientific writing**	4	4
AEC VII &VII I	Ability Enhancement courses VII & VIII English or Indian Language	AEC-7(A): Basic Language and Literature AEC-7(B): Functional Language AEC-7(C): Spoken communication AEC-8(A): Basic Language and Literature AEC-8(B): Functional Language AEC-8(C): Spoken communication	2+1	4
Project	WP/Internship	Community Engagement	2	6
		Total Credits / Total Hours of Work	**21 Credits**	**30 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Pra
ctical hours and conducted in batches if student strength exceeds 25

Diploma in Biochemistry: Students exiting the programme after four semesters and securing **80/84 credits** will be awarded UG Diploma provided they secure additional 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 9 credits from skill-based courses earned during first year and second year.

SEMESTER V

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 8	Major Disciplinary courses (compulsory)	MJD8: **Intermediary Metabolism II**	4	3(L)+1(T)+2(P)
MJD 9		MJD9: **Human Physiology**	4	3(L)+1(T)+2(P)
MJD10		MJD10: **Microbiology**	4	3(L)+1(T)+2(P)
MID5	Minor Disciplinary courses	MID-5: **Pharmaceutical Biochemistry**	4	3+1
SKD	Skill Development Course	MJD11–Summer Internship	4	6
		Total Credits / Total Hours of Work	**20 Credits**	**28 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Pra
ctical hours and conducted in batches if student strength exceeds 25

SEMESTER VI

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD11	Major Disciplinary courses (compulsory)	MJD12: **Molecular Biology**	4	3(L)+1(T) 2(P)
MJD12		MJD13: **Immunology**	4	3(L)+1(T) 2(P)
MJD13		MJD14: **Clinical Biochemistry**	4	3(L)+1(T) 2(P)
MJD14		MJD15: **Genetics**	4	4
MID6	Minor Disciplinary courses	MID-6: **Biochemical Toxicology**	4	4
		Total Credits / Total Hours of Work	**20 Credits**	**26 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25

B.Sc.Biochemistry: Students who want to undertake 3-year UG programme will be awarded UG Degree (B.Sc. in Microbiology) after six semesters upon securing **120/124 credits**.

SEMESTER VII

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD15	Major Disciplinary courses (compulsory)	MJD16: **Endocrinology**	4	4
MJD16		MJD17: **Genetic Engineering**	4	3(L)+1(T)+2 P
MJD17		MJD18: **Cellular basis of diseases**	4	3(L)+1(T)+2 P
ID7	Minor Disciplinary courses	MID-7: **Bioinformatics**	4	3(L)+2(P)
MID8		MID-8: **Research Methodology**	4	4
		Total Credits / Total Hours of Work	**20 Credits**	**25 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25

SEMESTER VIII

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD18 MJD19	Major Disciplinary courses (compulsory)	MJD19: **Genomics & Proteomics** MJD20: **Cell Culture Technology**	4 4	3(L)+1(T)+2(P) 3(L)+1(T)+2(P)
MJD 20	Research Project or Major Disciplinary Course (Choose one) **or**	MJD 24: R**esearch Project** (Alternatively) **or**	12 **or**	18 **or**
MJD 21	**3** Major Disciplinary Courses	MJD 21: **Introduction to Drug Discovery**	4	3(L)+1(T)
MJD 22		MJD 22: **Introduction to Stem Cell Technology**	4	3(L)+1(T)
MJD 23		MJD 23: **Cell Signaling**	4	3(L)+1 (T)
		Total Credits / Total Hours of Work	**20 Credits**	**24 Hours**

L denotes Lecture, T denotes Tutorial, and P denotes Practical hours and conducted in batches if student strength exceeds 25

B.Sc. (Honors) in Biochemistry: Students will be awarded B.Sc. (Honors) in Biochemistry after eight semesters and securing minimum **164 credits.**

B.Sc. (Honors with Research) in Biochemistry: Students will be awarded B.Sc. (Honors with Research) in Biochemistry after eight semesters and securing minimum **164 credits** with Research Project.

20.SYLLABUS

SEMESTER I

Year	I	Course Code: BC1MJ01	Credits	4
Sem.	I	Course Title: Biological Sciences	Hours	45 (T) 30 (P)
Course Prerequisites, if any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *This module serves as a bridge-course between the biology studied in school, and that relevant to the understanding of biochemistry to be studied in subsequent years*
- *This interdisciplinary paper is also aimed at providing wide horizontal knowledge so that the student can feel comfortable in taking any life science major in higher studies*
- *This paper offers a competitive advantage in exams like GATE and NET, as it provides an overview of all topics in life sciences*

UNIT I: INTRODUCTION TO PLANT AND ANIMAL SCIENCES (12 hrs)

What is life? Origin of life: Modern and cell theory. Abiogenesis experimental proof and evidences. Concepts of species and general classification of plants and animals. Overview of kingdom Animalia (Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and Vertebrates) and Plantae (Bryophytes, Pteridophytes, and Spermatophytes: Gymnosperms and Angiosperms). General characteristics of each group up to class level with an example.

UNIT II: STRUCTURE & FUNCTIONS OF PLANT & ANIMAL TISSUES (10 hrs)

Structure, distribution and functions of parenchyma, collenchyma, sclerenchyma, secretory ducts, laticiferous tubules, meristematic tissue, xylem and phloem. Structure, distribution and functions of epithelial tissue (squamous), connective tissue (fibrous). Cellular basis of connective tissue. Structure and functions of smooth, striated and cardiac muscle tissue, and nervous tissue (neuron).

UNIT III: NUTRITION AND TRANSPORT IN PLANTS (8 hrs)

Grouping of organisms based on energy and carbon sources. Photosynthetic pigments and photosynthesis (light and dark reactions). Plant–water relations: movement of water through a flowering plant, transpiration and stomatal mechanism. Ascent of water in xylem: cohesion, adhesion and root pressure. Mechanism of movement of organic solutes in phloem: Munch's mass flow hypothesis. Significance of nutrients in plants: macronutrients (nitrogen, phosphorus and potassium) and micronutrients (magnesium, manganese, iron, zinc and sulphur).

UNIT IV: NUTRITION, TRANSPORT IN ANIMALS (8 hrs)

Different types of heterotrophic nutrition: holozoic, saprotrophic, parasitic and symbiotic. Feeding mechanisms: filter feeders, detritus feeders, biting and chewing, fluid feeders (sucking and piercing). Types of heart: two-, three- and four-chambered. Types of circulation: open, closed, single and double circulation. General characteristics of blood vessels (arteries, veins, capillaries). Brief introduction to vascular system, lymphatic organs and lymph in humans. Composition of blood and clotting mechanism.

UNIT V: GROWTH IN PLANTS AND ANIMALS (7 hrs)

Definition and types of growth**,** measurement of growth and patterns of growth. Growth and development in flowering plants. Plant growth regulators: phytohormones biological functions (auxin, gibberellin, cytokinin, abscisic acid and ethylene. Photoperiodism. Growth patterns and evidence of growth in animals. Sexually and asexually produced offspring, Regeneration, metamorphosis and neoteny.

LAB IN BIOLOGICAL SCIENCE: (30Hrs)

1. Study of morphological characteristics of plants
2. Examination of cross sections of stem, root, leaf of dicots and monocots
3. Effect of CO_2 concentration on photosynthesis in *Hydrilla*
4. Observation of stomata in dicot leaf
5. Transpiration index: measurement of transpiration by cobalt chloride method in dry and moist conditions
6. Study of histological slides of various animal tissues: epithelial tissue (columnar and squamous epithelium), connective tissue (adipose and cartilage tissue), muscle (cardiac, skeletal and smooth muscle), and blood vessels (arteries and veins)

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Tortora GJ, Derrickson BH, *Principles of Anatomy & Physiology* (12th ed), John Wiley & sons, USA, 2008.

SUGGESTED READINGS:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.
2. Dickison WC, *Integrative Plant Anatomy* (1st ed.), Harcourt Academic Press, USA, 2000.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understand the basics and feel comfortable in any life science subject from phenetics and cladistics to zoology, botany, plant and animal physiology*
- *Comprehend the basic physiology that occurs in all the diverse living organisms*
- *Appreciate the biodiversity of the world, and learn to conserve it by minimizing human impact on environment*

Year	I	**Course Code: BC1MI01E1** **Course Title: Chemical Foundation of Biochemistry**	**Credits**	4
Sem.	I		**Hours**	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course is designed to refresh important concepts in chemistry, whose understanding is critical for proper and effective learning of biochemistry.*
- *It is also augmented with other basic concepts in electrochemistry and the principles of thermodynamics learnt in school*
- *To provide hands-on training in the basic techniques used in the chemistry laboratory*

UNIT I: ATOMIC STRUCTURE AND CHEMICAL BONDING (12 hrs)

Structure of an atom, Illustration of Pauli`s exclusion principle, Aufbau principle, and Hund`s rule, electron configuration, octet rule (in brief). Nature and types of chemical bond: ionic, covalent-polar/non-polar, Sigma, pi and co-ordinate bonds and non-covalent bonds, hydrophobic: van der Waals interactions, dipole–dipole/ion–dipole interactions, London forces, hydrogen bonding, Bond properties: bond angle, bond length, bond order, bond strength. Types of hybridization, Electron displacement effects, and steric effects, and their effect on the properties of compounds.

UNIT II: STEREOCHEMISTRY OF CARBON COMPOUNDS (8 hrs)

Concept of isomerism, Types of isomerism, Configurational and conformational isomerism (ethane and butane), Fischer, Newman and Sawhorse projections with suitable examples, Geometrical isomerism, Configuration of geometrical isomers, E and Z nomenclature (including oximes), Optical isomerism: optical activity, chiral carbon atom, enantiomers, diastereomers, R/S nomenclature (with one chiral carbon atom only)

UNIT III: GENERAL REACTION & MECHANISMS (CONCEPT ONLY) (7 hrs)

Ionic and radical reactions: heterolytic and homolytic bond cleavage. Aromatic compounds: electrophilic substitution in benzene, mechanisms of nitration, halogenation, alkylation and acylation. Heterocycles: structural aspects of five and six membered heterocycles containing hetero atoms (pyridine, pyrrole, furanose, pyranose, purines and pyrimidines).

UNIT IV: PRINCIPLES OF THERMODYNAMICS (9 hrs)

Definition of system and surroundings. Types of systems: isolated, closed and open. Extensive and intensive properties in thermodynamics. Concept of thermodynamic equilibrium, concept of temperature, heat and work, reversible work, irreversible work and maximum work. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb`s energy, free energy change.

UNIT V: PRINCIPLES OF ELECTROCHEMISTRY (9 hrs)

Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, electrodes, half-cell reaction, standard electrodes. Lewis concept, ions, redox reactions, redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin,

LAB IN FOUNDATION OF CHEMISTRY: (30 hrs)

1. Safety measures in the laboratories
2. Preparation of normal, molar and percent solutions
3. Estimation of hydrochloric acid using oxalic acid standard
4. Estimation of ferrous sulphate using Mohrs salt standard
5. Systematic analysis of functional groups: Detection of monofunctional organic compounds (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1o amines)

REFERENCE BOOKS:

1. Elil EL and Wilen SH, Stereochemistry of organic compounds, New York: John Wiley & Sons, 2008.
2. Wade LG and Simek JW, Organic chemistry (9 th ed.), Harlow: Pearson Education, 2017.
3. Atkins PW, de Paula J and Keeler J, Atkins' physical chemistry (11 th ed.), Oxford: Oxford University Press, 2018.

SUGGESTED READING:

1. Mann FG and Saunders BC, *Practical Organic Chemistry*, Pearson Education, 2009.
2. Furniss BS, Hannaford AJ, Smith PWG, Tatchell AR, *Practical Organic Chemistry, 5th Ed.*, Pearson, 2012.
3. Ahluwalia VK and Aggarwal R, *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press, 2000.
4. Vogel AI, *A Textbook of Quantitative Inorganic Analysis*, ELBS.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the role of thermodynamics and kinetics for any reaction and the concept of electrochemistry.*
- *Understand atomic structure, and the nature and types of chemical bonds, the types of isomers, and their importance in biology*
- *Have a basic comprehension of the structure and properties of aliphatic, aromatic and heterocyclic compounds*
- *Independently prepare standard solutions, and perform qualitative organic analysis in the lab*
- *Acquire practical hands-on expertise in acid–base and redox titrations, and also learn the preparation of inorganic salts.*

Year	I	Course Code: BC1SE01E1	Credits	3
Sem.	I	Course Title: Biochemistry Laboratory Skills I	Hours	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To impart basic knowledge of biochemistry, apparatus, units, equipment, and volumetric analysis in the Biochemistry labs.*

UNIT I: BASIC LABORATORY PRINCIPLES (12 hrs)

Organization of clinical laboratory and role of Medical Lab Technologist, Code of conduct of medical laboratory personnel, ethics, responsibility, safety measure and hazards in clinical biochemistry lab and first aid in laboratory accidents. Waste disposal in the labs.

UNIT II: PRINCIPLES AND CALIBRATION (12 hrs)

Laboratory instruments, Glassware's & plastic wares used in lab, Cleaning, care and maintenance of glasswares. calibration of volumetric apparatus. Principle, working, care & maintenance and calibration of Weighing balance, autoclave, Centrifuges, Incubator, Hot air oven, Colorimeter, Spectrophotometer, Water distillation plant, pH meter.

UNIT III: **PREPARATION OF SOLUTION AND REAGENTS (12 hrs)**

Preparation of Normal saline. Preparation of Normal solution, molar solutions, percent solution, buffer solution, dilutions, w/v, v/v, standard solution.

UNIT IV: COLLECTION, TRANSPORT AND DISPOSAL (12 hrs)

General approach to specimen collection, transport and disposal: Specimen collection and processing of blood, urine & CSF, separation of serum and plasma, Handling of specimens for testing, preservation of specimen, transport of specimen, effect of storage on sample. Anticoagulants- E.D.T.A, Dipotassium salts of EDTA Double oxalate, single oxalate, sodium citrate. Sodium Fluoride.

UNIT V: ANALYZERS IN CLINICAL LABORATORY (12 hrs)

Types of analyzers - Semi-auto analyzer - Batch analyzer - Random Access autoanalyzers. Steps in the automated systems - Responsibilities of a technician in the maintenance of the analyzers.

Clinical laboratory records. Quality control in clinical laboratories: - Quality control: Accuracy, Precision, and Reference values.

REFERENCE BOOKS:

1. Teitz, *Clinical Chemistry*, W.B. Saunders Company Harcourt (India) Private Limited New Delhi.
2. Singh & Sahni, *Introductory Practical Biochemistry*,2nd edition, Alpha science, 2008.
3. Godkar PB, Godkar DB, *Text book of Medical Laboratory Technology*. Bhalani Publishing House, 2014.

SUGGESTED READING:

1. Vasudevan DM, (2011), *Text book of Medical Biochemistry*, 6th edition Jaypee Publishers.
2. Baker EJ, Silverton RE, Butterworth-Heinemann. *Introduction to Medical Laboratory Technology*, Butterworth- Heinemann, 2014.
3. Chatterjea MN & Rana Shinde, (2012), *Text book of Medical Biochemistry*, 8th edition, Jayppe Publications.

Course outcome:

Upon successful completion of the course, students possess:

- *Basics of reagent preparation,*
- *Instrument handling*
- *Can perform common analytical techniques in biochemistry lab.*
- *Hands on experience in auto analyzers.*
- *Know about quality control, lab accredition and automation*

Year	I	Course Code: BC1SE01E2	Credits	3
Sem.	I	Course Title: Phytochemistry of Medicinal Plants	Hours	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

To learn about:

- *the role and scope of medicinal plants in traditional and modern systems of Medicine.*
- *the medicinally important plant parts and*
- *the organoleptic study of some important medicinal plants.*
- *the biological activities and pharmacological importance of medicinal plants*.

UNIT I: INTRODUCTION TO MEDICINALLY IMPORTANT PLANT PARTS (4 hrs)

Fruits, Leaves, Stem and its modifications (underground and aerial), Roots.

UNIT II: PLANT IDENTIFICATION (12 hrs)

Elementary knowledge of Binomial nomenclature – Outline of Bentham and Hooker classification – Herbarium techniques.

UNIT- III: INTRODUCTION TO HERBAL MEDICINE (16 hrs)

Herbal medicine - History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action- Traditional uses of Indian medicinal plants - *Eclipta alba, Gymnema sylvestre, Ocimum sanctum, Curcuma longa.*

Medicinal Plants – past and present status in world and India. Important medicinal plants of India with their systematics, geographical distribution and uses. *Acorus calamus, Adhatoda vasica, Abrus precatorius Aloe vera, Phyllanthus amarus, Stevia rebaudiana, Belladona and Cinchona*

UNIT IV: ORGANOLEPTIC STUDY (16 hrs)

Organoleptic study of the following medicinal plants: Fruit – Amla, Bulb – Garlic, Rhizome – Ginger, seed – castor, Bark – Cinchona, Leaves – Neem and Flower – Clove

UNIT-V: HEALTH BENEFITS OF PHYTOPHARMACEUTICALS (12 hrs)

Introduction of Phytopharmaceuticals. Health benefits of phytopharmaceuticals - anthocyanins, carotenoids, lycopene, isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.

REFERENCE BOOKS:

1. Godte VM, *Ayurvedic pharmacology and therapeutic uses of medicinal plants*. Bharathiya Vidya Bhavan, Mumbai. 2000.
2. Grewal RC, *Medicinal Plants*, Campus Books International, New Delhi. 2000.

SUGGESTED READINGS:

1. Kumar NC, *An Introduction to Medicinal Botany and Pharmacognosy* –Emkay
2. Acharya Vipul Rao, *Herbs that Heal*, Diamond Pocket Books, New Delhi.
3. Samant SS and Dhar U, *Medicinal Plants of Indian Himalaya*.

Course outcome:

After completion of the course, student will

- *understand the basic concepts of phytochemistry.*
- *have basic knowledge to medicinally important plant parts*
- *get familiarize with the bioactive components present in the medicinal plants.*
- *understand the importance and benefits of medicinal plants in health.*

SEMESTER II

Year	I	Course Code: BC2MJ02	Credits	4
Sem.	II	Course Title: Cell Biology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To study the structural and functional organization of the cell and its organelles*
- *To comprehend the phases of cell cycle and cell division*
- *To acquire knowledge about the components of microscope and the principles and applications of different microscopy techniques*

UNIT I: INTRODUCTION TO CELL BIOLOGY (8 hrs)

Historical aspects: cell theory, protoplasm theory and organizational theory. Broad classification of cell types: prokaryotic cell and eukaryotic cells, and their characteristics. Compartments and division of labour within organelles. Ultrastructure of virus, bacterial, plant and animal cells.

UNIT II: CELL WALL AND CELL MEMBRANE (10 hrs)

Structure and functions of the bacterial cell wall and the plant cell wall. Plasma membrane: membrane models and composition. Types of junctions: tight junction, gap junction and adherens junction. Transport mechanisms: simple diffusion, osmosis, facilitated diffusion, uniport, antiport, symport and bulk transport (ion channels, exocytosis, endocytosis, pinocytosis and phagocytosis). Cytoskeleton structure: microtubules and microfilaments. Basic aspects of intercellular communication: autocrine, paracrine, endocrine and neuronal signaling.

UNIT III: CELL ORGANELLES (12 hrs)

Structure and functions of: endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), Golgi apparatus, lysosomes, centrioles, basal bodies, vacuoles, ribosomes and microbodies (peroxisomes and glyoxisomes). Mitochondria: structure, function and organization of the respiratory chain. Chloroplasts: structure, function and photophosphorylation.

UNIT IV: THE NUCLEUS (7 hrs)

Structure of the nucleus and the nuclear pore complex. Internal organization of the nucleus, the nuclear matrix and the nucleolus. Supercoiling and organization of genomic DNA: chromosomes and higher order chromatin structure, functional domains within the nucleus. Cell cycle: cell division (mitosis and meiosis), and its regulation: checkpoints in the cell cycle.

UNIT V: MICROSCOPY **(8 hrs)**

Principles and applications: refraction, magnification, resolution, resolution limit and Ernst Abbe's equation. Types of microscopy, with principles and application: light microscopy, dark field microscopy, phase contrast microscopy, differential interference contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy (transmission electron microscopy, scanning electron microscopy, scanning tunneling microscopy) and atomic force microscopy.

Lab in Cell Biology **(30 Hrs)**

1. Study of parts of compound microscope
2. Micrometry
3. Examination of prokaryotic and eukaryotic cell
4. Study of salivary gland chromosomes
5. Staining of nuclei in cheek epithelium
6. Examination of Barr body
7. Study of mitosis in onion root tip squash preparation

REFERANCE BOOKS:

1. Cooper GM, *The cell: a molecular approach* (8th ed.), London: Sinauer, 2018.
2. Alberts B, Johnson A, Lewis J, *et al*., *Molecular biology of the cell* (6th ed.), New York: Garland Science, Inc., 2014.

SUGGESTED READING

1. De Robertis EDP and De Robertis EMF, *Cell and molecular biology* (8th ed.), New York: Lippincott Wilkins & Williams, 2011.

Course outcomes:

Upon successful completion of this course, students are able to:

- *Understand the structure and functions of the basic components of prokaryotic and eukaryotic cells, and also gain insights about various types of membrane transport*
- *Comprehend the structure and functions of chromosomes and learn to independently prepare stained specimens and identify the phases of cell division*
- *Independently gain practical hands-on expertise in basic microscopy, simple staining and temporary mount preparation*

Year	I	Course Code: BC2MI02E1	Credits	4
Sem.	II	Course Title: Plant Biochemistry	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course provides insights to give a broad but concise overview of the various aspects of plant biochemistry in an efficient way.*
- *The course also motivates the students to carry out research in the development of new crops, enhancing the quality & quantity of crops, pest control methods.*

UNIT I: PLANT CELL (8 Hrs)

Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, transpiration, photoperiodism and biological clocks, plant movement.

UNIT II: MEHANISM OF PHOTOSYNTHESIS (8 Hrs)

Photosynthesis: Photosynthetic apparatus, pigments of photosynthesis, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction and its regulation, Structure, function and regulation of RUBISCO, Crassulacean acid metabolism in plants. Photorespiration: photorespiration pathway and significance, cyanide resistance, relationship between photosynthesis, photorespiration.

UNIT III: NITROGEN METABOLISM (10 hrs)

Role of nitrogen in plants, sources of nitrogen – molecular nitrogen, organic & inorganic nitrogen. Conversion of nitrate into ammonia, regulation of nitrate reductase. Biological nitrogen fixation - symbiotic and non-symbiotic nitrogen fixation. Mechanism of Symbiotic nitrogen fixation in legumes by Rhizobia. Regulation of nif and nod genes of nitrogen fixation. Factors controlling biological nitrogen fixation.

UNIT IV: SECONDARY PLANT METABOLITES (12 Hrs)

Nature, distribution, biosynthesis and function of plant metabolites, biosynthesis of nicotine. Biochemistry of plant toxins, phyto hemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins, role of secondary metabolites in chemical defense.

UNIT V: PLANT STRESS PHYSIOLOGY (12 Hrs)

Plant stress, plant responses to abiotic and biotic stresses, salinity, water, heat, chilling, anaerobiosis, heavy metals, radiations and their impact on plant growth and metabolism, mechanisms of resistance to biotic stress and abiotic stress, antioxidative defense mechanism.

UNIT V: PLANT DEFENSE **(10 Hrs)**

Genetic basis of plant-pathogen interactions, antio R-Avr gene interactions and isolation of R genes, hypersensitive response (HR), systemic acquired resistance (SAR) and induced systemic resistance (ISR).

REFERENCE BOOKS:

1. Peter J. Lea Richard. C. Lee good, *Plant Biochemistry and Molecular Biology,* 1999, 2nd edition. John Wiley & Sons, NY.
2. Bowsher C, Steer M, and Tobin A, *Plant Biochemistry*. Garland Science 2008. 446 pages
3. "Plant Defense: Warding off Attack by Pathogens, Herbivores and Parasitic Plants"Richard S. S. Jones, Wiley-Blackwell,2011

SUGGESTED READING*:*

1. Srivastava HS, *Plant Physiology and Biochemistry*, Rastogi publication, 2005.
2. Sinha RK, *Modern plant physiology,* Narosa publishing house, 2004.
3. "Plant Stress Physiology": Sergey Shabala: CABI: 2012

***Course outcomes*:**

Upon successful completion of the course the student will be able

- *To describe photosynthetic pigments, nitrogen metabolism & plant growth regulators.*
- *To get knowledge about the plant tissue culture and transgenic plants.*
- *To get exposure of wide application of transgenic plants and their future potential, which drive the students for future research.*

Year	I	**Course Code: BC2SE02E1** **Course Title: Biochemistry Laboratory Skills II**	**Credits**	3
Sem.	II		**Hours**	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To describe the organization of a clinical biochemistry lab.*
- *To enumerate on the various equipment in the clinical biochemistry laboratory.*
- *To perform independently estimation of triglycerides, estimation of liver function tests and other clinical biochemistry tests.*
- *To maintain independently the various equipment in the biochemistry laboratory.*

UNIT I: INTRODUCTION TO CLINICAL BIOCHEMISTRY (8 hrs)

Definition of biochemistry, use of biochemical tests-the application of biochemistry in hospital setting. Introduction and definition of photometry. Colorimetry - Lambert Beer's Law - Parts of photo colorimeter.

UNIT II: BIOCHEMICAL ESTIMATIONS IN BLOOD (12 hrs)

Determination of proteins in serum and plasma. Determination of glucose, glycated hemoglobin, triglycerides, cholesterol, lipoproteins.

UNIT III: EVALUATION OF ORGAN FUNCTION TESTS (16 hrs)

LFT, RFT, pancreatic, gastric function test, thyroid function tests (important test). Diagnostic enzymes of pancreas and heart.

UNIT IV: BODY FLUIDS (12 hrs)

Body Fluids: Characteristics of Cerebrospinal Fluid. - Synovial fluid – Pleural fluid - Pericardial fluids - Peritoneal fluids.

UNIT V: GENERAL EXAMINATION OF URINE (12 hrs)

Physical, chemical and microscopic examination of urine, Bence Jones Proteinuria and its clinical significance, qualitative test of urine for reducing sugars, protein, ketone bodies, bile Salt, bile pigments, urobilinogen, occult blood, uric acid, urea and Creatinine, quantitative estimation of 24 hrs urine for protein and their clinical significance.

REFERENCE BOOKS:

1. Mayne, *Clinical Chemistry in Diagnosis and Treatment*, ELBS. 6th ed. 1994.
2. Todd & Stanford, *Clinical Diagnosis and Management by Laboratory Methods*, 16th ed. 2016.

SUGGESTED READING:

1. Vasudevan DM, (2011), *Text book of Medical Biochemistry*, 6th edition Jaypee Publishers.
2. Chatterjee MN & Rana Shinde, (2012), *Text book of Medical Biochemistry*, 8th edition, Jayppe Publications
3. Teitz, *Clinical Chemistry*. W.B. Saunders Company Harcourt (India) Private Limited New Delhi
4. Harold Varley. *Practical clinical biochemistry*. CBS Publisher. 6th ed. 2002

Course outcome:

On Successful completion of the course, the students will be able to

- *Perform the biochemical analysis of clinical sample*
- *Perform independently estimation of triglycerides, estimation of liver function tests and other clinical biochemistry tests.*
- *Maintain independently the various equipment in the biochemistry laboratory*

Year	I	**Course Code: BC2SE02E2**	**Credits**	3
Sem.	II	**Course Title: Herbal Technology**	**Hours**	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To learn the general methods of phytochemical plant analysis*
- *To know the WHO and ICH guidelines for evaluation of herbal drugs*
- *To study the pharmacogenetic characters of medicinal plants*
- *To learn the analytical aspects of pharmacognosy*

UNIT-1: EXTRACTION AND PURIFICATION METHODS (12 hrs)

Extraction – purification of bio-active compounds from plants - cold & hot extract extraction. Soxhlet extraction - crude extracts purification by various solvents.

UNIT-II: CHROMATOGRAPHIC TECHNIQUES (12 hrs)

Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography, HPLC and UPLC.

UNIT-III: STRUCTURAL ANALYSIS TECHNIQUES (12 hrs)

Structural analysis of bioactive compounds - IR spectroscopy - Mass spectroscopy- GC–MS, LC–MS, NMR spectroscopy and their applications in natural products.

UNIT IV: INTRODUCTION TO HERBAL INDUSTRY (12 hrs)

General Introduction to Herbal Industry Herbal drugs industry: Present scope and future prospects. Schedule T – Good Manufacturing Practice of Indian systems of medicine Components of GMP (Schedule – T) and its objectives Infrastructural requirements, working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation and records.

WHO & ICH guidelines for the assessment of herbal drugs. Stability testing of herbal drugs (in brief).

UNIT-V: ANALYTICAL PHARMACOGNOSY (12 hrs)

Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs – Preliminary phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

REFERENCE BOOKS:

1. .Harbone JB, *Phytochemical Methods*: A guide to modern techniques of plant analysis, Springer (India) Private Limited, 3rd ed. New Delhi. 1998.
2. Silverstein RM, Wester FX, *Spectroscopic identification of organic compounds*, John Wiley. 1998.
3. Willard HH, Merrit LL, Dean JA, *Instrumental Methods of Analysis*, 1987.

SUGGESTED READING:

1. Gokhale, S.S., C.K.Kokate and A.P. Purohit (1994) Pharmacognosy. Nirali Prakashan. Pune.
2. Tyagi, Dinesh Kumar (2005) Pharma Forestry. Field Guide to Medicinal Plants. Atlantic Publishers and Distributors, New Delhi.
3. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons Publishers, New Delhi, India, 2002.

Course outcome:

After completion of the course, student will

- *Have knowledge related to the herbal technology.*
- *Know the various extraction and chromatographic methods commonly involved in phytochemistry.*
- *Aware of structural analysis techniques involved in identification of bioactive compounds from plant extracts.*
- *Helps the students to understand the organization and research of natural products in herbal drugs industries*

SEMESTER III

Year	II	Course Code: BC3MJ03	Credits	4
Sem.	III	Course Title: Biomolecules	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *This course is designed to serve as a bridge-course between the basics of chemistry and biology learnt in school, and those which will be taught in this degree program*
- *It emphasizes on the basic chemical foundations of life: water, carbohydrates, lipids, amino acids, proteins, and nucleic acids, and their unique structural, and physico-chemical properties*
- *It also aims to provide hands-on practical training for the qualitative analysis of different biomolecules*

UNIT I: FOUNDATIONS OF LIFE (8 hrs)

Introduction to cellular and chemical foundations of life. Elements found in living organisms. Biological significance of water, weak interactions in aqueous systems, ionization of water, pH, pK_a. Henderson–Hasselbalch equation, biological buffer systems: body fluids and their principal buffers.

UNIT II: CARBOHYDRATES (10 hrs)

Classification, chemical and physical properties. Monosaccharide: stereoisomers, enantiomers, epimers, mutarotation. Sugar derivatives: amino sugars, sugar alcohol, sugar acids, deoxy-sugar and glycosides. Disaccharides: sucrose, lactose and maltose. Polysaccharides: homo and hetero polysaccharides, mucopolysaccharides and glycoproteins.

UNIT III: LIPIDS (10 hrs)

Classification, chemical and physical properties. Fatty acids: saturated, unsaturated and essential fatty acids; rancidity, saponification number, iodine number, acid number and Reichert–Meissel number. Structure and biological functions of triacylglycerol, phospholipids, cholesterol and plant sterols.

UNIT IV: PROTEINS AND AMINO ACIDS (9 hrs)

Classification, chemical and physical properties of amino acids. Peptide bond: planarity and dihedral angles, Ramachandran plot. Structural hierarchy of proteins: primary, secondary, super- secondary, tertiary and quaternary structures. Classification of proteins, properties: isoelectric point, zwitterions, and precipitation reactions. Globular and fibrous proteins: structure and functions of hemoglobin, collagen, elastin, and keratin.

UNIT V: NUCLEIC ACIDS **(8 hrs)**

Chemistry of purine and pyrimidine, nucleosides and nucleotides. Types of DNA: structure and properties of A-, B- and Z-DNA. Denaturation, renaturation, T_m and hyperchromicity. Effect of acid and alkali on DNA and RNA. Types and functions of RNA: rRNA, mRNA, tRNA. Primary, secondary, and tertiary structures of tRNA.

LAB IN FUNDAMENTALS OF BIOCHEMISTRY **(30 Hrs)**

1. Safety measures in the laboratories
2. Determination of pK_a of acetic acid and glycine
3. Qualitative tests for carbohydrates:
    i. Monosaccharides: hexoses (glucose and fructose)
    ii. Disaccharides: reducing (maltose/lactose and non-reducing (sucrose)
    iii. Polysaccharides: starch
4. Qualitative tests for lipids and nucleic acids
5. Qualitative tests for amino acids & proteins

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.
3. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the chemical and molecular foundations of life and their roles in biological systems*
- *Comprehend the classification, structure, chemical properties and biological functions of carbohydrates, lipids, amino acids, proteins and nucleic acids*
- *Prepare biochemical solutions and analyze various biomolecules qualitatively in the laboratory.*

Year	II	Course Code: BC3MJ04	Credits	4
Sem.	III	Course Title: Plant & Animal Physiology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *This module is intended to provide basic knowledge in realms of life science and to draw the attention of students to different arenas of life sciences suitable for their higher studies.*
- *This paper can also be useful for competitive advantage in exams like GATE and NET, as it provides an overview of all topics in life science*

UNIT I: HOMEOSTASIS (8 hrs)

Homeostasis concept. Control systems in biology: types and components of control system (block diagram of input unit, processing unit and responding unit), threshold level and steady state level. Temperature regulation in ectothermic and endothermic animals. Osmoregulation and water conservation: nitrogen and urea excretion in ammonotelic, ureotelic and uricotelic animals, blood pH regulation.

UNIT II: REPRODUCTION IN PLANTS AND ANIMALS (10 hrs)

Reproduction types in plants. Types of asexual reproduction in plants: cutting, grafting and layering. Roles of plants part involved in asexual reproduction: bulb, corn, rhizomes, tuber and stolen. Artificial propagation of plants, and tissue culture. Sexual reproduction: pollination and fertilization. Reproduction in animals: outline of asexual reproduction in animals. Sexual reproduction in animals: Humans male and female reproductive system.

UNIT III: BASIC CONCEPTS OF DEVELOPMENTAL BIOLOGY (10 hrs)

History, basic concepts and landmark experiments in developmental biology. Outline of organizers, gametogenesis, fertilization, cleavage, blastulation, gastrulation. Types of morphogenetic movements: epiboly, emboly, involution, ingression, invagination, intercalation and convergent extension. Cell fate and commitment. Differentiation and pattern formation.

Fates of the ecto- (epidermis, neural crest and neural tube), endo- and mesoderm. Somitogenesis: paraxial, caudal, lateral and intermediate.

UNIT IV: CONTROL AND CO-ORDINATION IN PLANTS AND ANIMALS (7 hrs)

Plant movements: tropism, taxes, nastic and kinesis in brief. Types of stimuli and their applications. Types of plant movements with examples. Phloem calcium channels in plant co- ordination. Control and coordination in animals: stimuli, means of coordination: receptors and effectors. Parts of the nervous system: central, peripheral (sensory, motor and somatic) and autonomic. Reflex action and its importance.

UNIT V: EVOLUTION **(10 hrs)**

Theories of the origin of life. Evolution, and evidences for evolution: fossils, comparative anatomy, comparative embryology, biochemical and biogeographic evidence. Human evolution. Selection: definition, types (artificial and natural), and mechanisms. Concept of inbreeding and outbreeding: advantages and disadvantages. The peppered moth experiment (directional, stabilizing and disruptive selection). Definition of species, and types of speciation: inter- and intraspecific (allopatric and sympatric) speciation.

LAB IN PLANT AND ANIMAL PHYSIOLOGY **(30Hrs)**

1. Preservation of embryo
2. Transverse sectioning, staining and temporary mounting of root
3. Transverse sectioning, staining and temporary mounting of leaf
4. Transverse sectioning, staining and temporary mounting of stem
5. RBC fragility test
6. Extraction and isolation of chlorophyll
7. Assay of starch hydrolysis in germinating seeds

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Barresi MJF and Gilbert SF, *Developmental biology* (12th ed.), New York: Sinauer, 2019.
3. Taiz L, Zeiger E, Møller IM and Murphy A, *Plant physiology and development* (6th ed.), New York: Sinauer, 2015.
4. Lea PJ and Leegood RC, *Plant biochemistry and molecular biology* (2nd ed.), New York: John Wiley & Sons, 2001.
5. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

SUGGESTED READING:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understand the basics of most life science subjects from physiology to developmental and evolutionary biology*
- *Comprehend the basic physiology that occurs in all living organisms such as homeostasis, control and co-ordination*
- *Learn about the origin of life, and the narrow balance that exists within*

Year	II	Course Code: BC3MI03E1	Credits	4
Sem.	III	Course Title: Nutritional Biochemistry	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course is an introduction to the importance of nutrition in human health*
- *It includes the requirements and roles of macro- and micronutrients in the body, and the biochemical bases of deficiency diseases*
- *The course also provides practical, hands-on training in the biochemical methods and analyses used in nutritional research*

UNIT I: NUTRITION AND ENERGY METABOLISM (12 hrs)

Nutrition and the role of nutrition in maintaining health. Energy, unit of energy and measurements of energy. Energy requirement for different categories of people, body mass index (BMI) and basic metabolism. Basal metabolic rate (BMR): determination. factors affecting BMR, SDA, RQ.

UNIT II: MACRONUTRIENTS (10 hrs)

Role of food and classification of foods. Macronutrients: functions, and dietary sources of carbohydrates, fats, proteins and dietary fibre. Caloric value and recommended daily allowances (RDA). Malnutrition: deficiencies and over-consumption.

UNIT III: MICRONUTRIENTS (12 hrs)

Vitamins, classification of vitamins, dietary sources, RDA and deficiency of vitamins A, D, E, K, C and B-complex. Hypervitaminosis, and the biochemical bases of deficiency symptoms. Minerals, classification of minerals. Distribution in the body, dietary sources, RDA, digestion, mechanism of absorption, utilization, transport, storage, excretion, balance, deficiency and toxicity of calcium, iron and phosphorus. Distribution in the body, dietary sources, physiological function, deficiency and toxicity of iodine, fluoride, magnesium, copper, zinc, selenium and manganese.

UNIT IV: DIFFERENT DIMENSIONS FOR FITNES (10 hrs)

Balanced diet, Different criteria for health and well-being: physical, intellectual, emotional, social, spiritual, environmental and occupational. Special nutritional concerns: pregnancy, lactation and aging. Special nutritional requirements of working women, female athletes and post-pregnancy weight management. Eating disorders: anorexia, bulimia, binge-eating and obesity.

UNIT V: PRESERVATION OF FOOD (8 hrs)

Preservation of nutrients, safe food handling and toxicity. Storage of food, food preservation, food additives and its principles.

UNIT VI: ADULTERATION (8 hrs)

Food adulteration: definition, detection and prevention. Adulterants in commonly consumed food items. Accidental contamination: botulism and staphylococcal intoxication. Importance of food labels in processed food: nutritional labelling and food standards.

REFERENCE BOOKS:

1. Mahan LK and Raymond J, *Krause's food and nutrition care process* (14th ed.), St. Louis: Elsevier, 2017.
2. Gibson R, *Principles of nutritional assessment*, London: Oxford University Press, 2005.
3. Coombs GF and McClung JP, The vitamins: fundamental aspects in nutrition and health (5th ed.), London: Academic Press, 2017.

SUGGESTED READING:

1. Brody T, *Nutritional biochemistry* (2nd ed.), San Diego: Academic Press, 1999.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of this course, students are able to:

- *Describe the biochemical roles of macro- and micronutrients in human health and diseases*
- *Calculate the recommended metabolic requirements in normal humans, athletes and pregnant women*
- *Capable of independently estimating the vitamin and nutrition content in various food stuff in a laboratory*

Year	II	Course Code: BC3SE03E1	Credits	3
Sem.	III	Course Title: Microbiological Laboratory Skills	Hours	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

To Acquire a basic

- *understanding of importance and applications of microbiology.*
- *knowledge of aseptic and staining techniques in the field of microbes.*
- *skills and techniques to avoid the contamination of cultures from undesirable microbes in the laboratory and to subculture.*

UNIT I: INTRODUCTION TO MICROBIOLOGY (12 hrs)

History and mile stones in microbiology. Contributions of Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Ivanowsky. Classification of microorganisms (in brief). Importance and applications of microbiology. Principles of microscopy

UNIT II: METHODS OF STERILIZATION (12 hrs)

Physical methods, Chemical methods and their application. Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Protection of microbial cultures: subculturing, overlaying cultures with mineral oils, lyophilization, and cultures, storage at low temperature.

UNIT III: STAINING TECHNIQUES (12 hrs)

Simple and Differential staining techniques. Gram positive cell wall, Gram negative cell wall, Cell wall of fungi and yeasts.

UNIT IV: MICROBIAL GROWTH - DIRECT METHODS (12 hrs)

Principles of growth, Kinetics of growth, Methods of measuring growth, Direct methods: viable plate counts, membrane filtration.

UNIT V: MICROBIAL GROWTH - INDIRECT METHODS (12 hrs)

Indirect methods: Metabolic activity –measurements of DNA, Protein, Microscopic counts, electronic counters, most probable number; Batch and continuous growth, Synchronous culture, Diauxic growth, Types of cultures-stock, batch, continuous and synchronous cultures.

EXCERCISES:

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria
3. Preparation of culture media for cultivation of fungi
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Light compound microscope and its handling
7. Microscopic observation of bacteria (Gram +ve bacilli and cocci, Gram -ve bacilli), Cyanobacteria, Algae and Fungi.
8. Simple staining
9. Gram's staining
10. Hanging-drop method.
11. Isolation of pure cultures of bacteria by streaking method.
12. Preservation of bacterial cultures by various techniques.

REFERENCE BOOKS:

1. Prescott LM, Harley JP and Klein DA *Microbiology* (7th edition) McGraw Hill, New York, 2006.
2. Pelczar MJ, Chan ECS and Kreig NR, *Microbiology*, 5th Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1993.
3. Dube RC and Maheswari DK, *General Microbiology*, S Chand, New Delhi, Edition, Himalaya Publishing House, Mumbai, 2000.
4. Power CB and Daginawala HF, *General Microbiology Vol I & II*, (1986).

SUGGESTED READING:

1. Reddy SM, and Reddy SR, *Microbiology*, Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad. (1998).
2. Jaya Babu, *Practical Manual on Microbial Metabolisms and General Microbiology*. Kalyani Publishers, New Delhi, (2006).
3. Gopal Reddy et al., Laboratory Experiments

Course outcome:

After successful completion of this course students are expected to:

- *Understand the basic microbial structure and also*
- *Understand the structural similarities and differences among various physiological groups of bacteria*
- *Learn basic concepts and their applications as technology*

Year	II	Course Code: BC3SE03E2	Credits	3
Sem.	III	Course Title: Basics of Medical coding	Hours	60 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 50	End Semester Marks: 50	Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To understand the basic physiological concepts of the human body*
- *To understand the diseases related in the biological systems*
- *To know the elements of medical words.*
- *To gain an understanding of standard medical abbreviations.*
- *To study the concept of medical billing related to coding*

UNIT I: INTRODUCTION TO HEALTH CARE (4 hrs)

Healthcare in India and US, Patient, Provider and Payers Relationship (in brief), Importance and significance of coding in today's world. Goals, scope and opportunities of medical coding.

UNIT II: ANATOMY AND PHYSIOLOGY (12 hrs)

Basic concepts of human anatomy and physiology: Skin; The musculoskeletal system; The nervous system; Special senses; pulmonology; The circulatory system; The lymphatic system; The digestive system; The urinary system; The endocrine system; The reproductive system.

UNIT III: INTRODUCTION TO MEDICAL TERMINOLOGY (8 hrs)

Definition and Origin of Medical Terms. Components of Medical Terms. Introduction to Medical Terminology: Word Parts; Medical Terminology: Dividing and Combining Terms; Medical Terminology: Abbreviations, Symbols and Special Terms.

(9 hrs)

UNIT IV: INTRODUCTION TO MEDICAL RECORDS AND DOCUMENTATION

Definition and history of medical records; purposes and uses of medical records; Process of identification of various types of health and medical records (in brief). Maintenance of medical records in both paper and electronic forms (in brief). Documentation process in the Health Information Management System (HIMS) as per organizational policies and procedures. Medical ethics in brief.

UNIT-V: INTRODUCTION TO CODING AND MEDICAL BILLING (12 hrs)

History of the International Classification of Diseases, ICD-9-CM coding system. Main terms and sub-terms to describe coding pathways (in brief).

Medical Billing- part of coding in billing. Brief account on CPT, diagnosis and modifiers, basic description of the codes. Specialty codes.

REFERENCE BOOKS:

1. Guyton, A.C. and Hall, J.E. (2010). Textbook of Medical Physiology, Twelfth Edition, Saunders Company Publishers, New York.
2. CMAI: Medical Records Science- Handbook of medical terminology.
3. Medical Coding: A Quick Study Laminated Reference Guide, Shelley Safian, 2017.
4. CPT Professional 2024.

SUGGESTED READING:

1. Evelyn: Anatomy, physiology and laboratory science.
2. Jehraned: Medical terminology made easy, 1968. Pears.
3. Buck's Step-by-Step Medical Coding.

Course outcome:

- *Gain the basic knowledge of Human anatomy and physiology.*
- *Attain knowledge of the various medical terms and diseases.*
- *Developing an ability to read and understand medical records and the medical literature.*
- *Establishing accuracy in the International Classification of Diseases.*
- *Study the interrelationship between medical coding and Billing.*

SEMESTER IV

Year	II	Course Code: BC4MJ05	Credits	4
Sem.	IV	Course Title: Enzymology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *The course is designed to provide an insight into the nomenclature and classification of enzymes, the mechanism and kinetics of an enzymatic reaction, and the types and kinetics of enzyme inhibition*
- *To practically determine the kinetics of enzymatic reactions and to study the effect of pH and temperature*

UNIT I: OVERVIEW AND CLASSIFICATION OF ENZYMES (9 hrs)

Historical perspective and definition of enzymes. Nomenclature of enzymes, enzyme classification and characteristics. Co-enzymes and cofactors. Isoenzymes, abzymes and ribozymes. Metalloenzymes and metal-activated enzymes. Units of enzyme activity. Proteolytic enzymes. Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthase.

UNIT II: ENZYME KINETICS (9 hrs)

Factors affecting enzyme activity: pH, temperature and substrate concentration. Derivation of Michaelis–Menten equation. Limitations and transformation of the MM equation: Lineweaver–Burk plot and Hanes–Woolf plot. K_m, V_{max} and K_{cat}. Turnover number, catalytic efficiency and enzyme specificity.

UNIT III: MECHANISM OF ENZYME CATALYSIS (9 hrs)

Enzyme active site and its general characteristics. Mechanism of enzyme action: lock-and-key model, induced- fit hypothesis. Mechanisms of enzyme catalysis: acid–base catalysis, covalent catalysis, substrate strain and entropy effect. Mechanisms of action of chymotrypsin, lysozyme and carboxypeptidase.

UNIT IV: ENZYME REGULATION (9 hrs)

Enzyme inhibition: reversible (competitive, uncompetitive and non-competitive) and irreversible. Enzyme regulation: covalent modification, allosteric, end-product, and feedback regulation.

UNIT V: APPLICATIONS OF ENZYMES (9 hrs)

Immobilization techniques: adsorption, covalent binding, cross linking, entrapment, encapsulation, Properties of immobilized enzymes to free enzymes. - Enzyme utilization in Industry: - Application in Food and Drink industries - Application in Artificial kidney machines - Application in other industries (pharmaceutical industry; washing powder manufacturing industries)

LAB IN ENZYMOLOGY & METABOLISM I (30 Hrs)

1. Isolation and quantification of starch from potatoes
2. Isolation and quantification of casein and lactalbumin from milk
3. Isolation and quantification of ovalbumin from egg
4. Extraction of urease from jack bean
5. Extraction of pectinase
6. Determination of acid number
7. Spectrophotometric estimation of protein by A_{280} method
8. Estimation of enzyme activity by end-point and continuous monitoring assay
9. Effect of pH and temperature on enzyme activity
10. Determination of enzyme activity in the presence of activators and inhibitors

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al.*, *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.
3. Palmer T and Bonner PL, *Enzymes* (2nd ed.), Cambridge: Woodhead Publishing, 2007.
4. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.
5. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.
2. Devlin TM, Textbook of biochemistry with clinical correlations (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of the course, students are able:

- *to understand the concepts of enzymes, and the mechanics and kinetics of enzymatic reactions*
- *to independently perform enzymology experiments and learn to calculate enzyme activity and kinetics.*

Year	II	Course Code: BC4MJ06	Credits	4
Sem.	IV	Course Title: Intermediary Metabolism I	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *To understand the various pathways of carbohydrates metabolism, their regulations and energetics*
- *The course provides a detailed overview of lipid and amino acid metabolism, and the disorders associated with them*
- *It provides an understanding of the integration of metabolism and the inter-conversion of metabolites*
- *To provide hands-on training in metabolism-based reactions, as well as in estimation of metabolites involved like glucose, and cholesterol.*

UNIT I: CARBOHYDRATE METABOLISM (12 hrs)

Introduction to metabolism. Types of metabolic pathways: anabolic, catabolic and amphibolic pathways**.** The glycolytic pathway, TCA cycle and their regulations. Mitochondrial transport systems: malate and glycerophosphate shuttles. Significance of substrate level phosphorylation. Gluconeogenesis, Glycogenesis, Glycogenolysis and their regulations. The Luebering–Rapoport pathway, Cori cycle, Glucose–alanine cycle and the utilization of lactose and fructose. HMP shunt and the Uronic acid pathways.

UNIT II: BIOENERGETICS (9 hrs)

Basic principles; enthalpy, entropy, spontaneous and non-spontaneous thermodynamic reaction, equilibrium constant and concept of free energy, standard reduction potential, High-energy compounds, energy charge, ATP as energy currency, ATP hydrolysis, coupled reaction, Group transfer energy, Inorganic phosphate as potential phosphoryl donor,

UNIT III: BIOLOGICAL OXIDATION (8 hrs)

The electron transport chain (ETC): components and reactions of the ETC. Mechanism of oxidative phosphorylation: ATP synthase complex and Mitchell's chemiosmotic theory. P/O ratio, uncouplers and inhibitors of the ETC.

UNIT IV: LIPID METABOLISM (12 hrs)

Fatty acid biosynthesis and its regulation. Biosynthesis of triacylglycerol and phospholipids. Metabolism of cholesterol: synthesis, transport, degradation and excretion. Fatty acid oxidation: β-oxidation, its energetics and regulation. Ketone bodies: formation, utilization and excretion. Transport of lipid: VLDL, LDL, HDL and chylomicrons.

UNIT V: AMINO ACID METABOLISM (12 hrs)

Amino acid pool, glycogenic and ketogenic amino acids. Transamination, deamination, decarboxylation and catabolism of amino acids. Biosynthesis and catabolism of tyrosine, methionine and lysine. Urea cycle and its regulation, interrelationship between urea cycle and the TCA cycle. Inborn errors of amino acid metabolism: alkaptonuria, phenylketonuria, cystinuria, BCAA, hyper homocysteinemia, Fanconi's syndrome and albinism.

UNIT VI: INTEGRATION OF METABOLISM (7 hrs)

Metabolic fluxes, energy demand and supply. Integration of Metabolic fluxes and energy requirement. Major organs involved in metabolic integration and metabolism during starvation: liver, adipose tissue, skeletal muscle and brain.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al*., *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.
3. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.
5. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of this course, students are able to

- *comprehend the basic types of metabolic pathways, and energetic of carbohydrates metabolism*
- *understand the important metabolic pathways of major classes of biomolecules, and their associated diseases*
- *appreciate the integrated nature of metabolism and metabolic fluxes. Independently they can perform enzyme assays.*

Year	II	**Course Code: BC4MJ07**	**Credits**	4
Sem.	IV	**Course Title: Analytical Biochemistry**	**Hours**	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *The main objective of the course is the study of preparative and analytical separation techniques, and analysis of different biomolecules in a living system*
- *It includes the study of the principle behind the operation of different tools and methods for identification, analysis and examination of the physico-chemical properties of different biomolecules*
- *It helps biochemistry students understand the vast array of technologies and instruments at their disposal, and their applications*

UNIT I: CENTRIFUGATION (9 hrs)

Principle of centrifugation and Svedberg unit, analytical and preparative. Centrifugation rotors: vertical, fixed angle, swinging bucket. Subcellular fractionation by differential centrifugation, density gradient (Rate zonal, isopycnic) and principle of analytical ultracentrifuge.

UNIT II: CHROMATOGRAPHY (9 hrs)

Partition and adsorption chromatography. Types of chromatography: Paper, TLC, ion exchange, gel filtration and affinity chromatography. Principles and instrumentation of gas–liquid chromatography (GLC) and high-performance liquid chromatography (HPLC).

UNIT III: ELECTROPHORESIS (9 hrs)

Principle and applications of agarose and native polyacrylamide gel electrophoresis. Denaturing SDS–PAGE: principle, reagents, instrumentation, protocol and applications.

UNIT IV: SPECTROSCOPIC TECHNIQUES (9 hrs)

Beer–Lambert's law, transmittance, absorbance, optical density and colorimetry. Types of spectroscopy, UV–Visible spectroscopy: principle, instrumentation and applications.

UNIT V: RADIOACTIVE TECHNIQUES (9 hrs)

Types of radiation, units of radioactivity and half-life. Measurement of radioactivity: GM and scintillation counters. Applications of radioactivity: autoradiography. Hazards of radioactivity and safety measures.

LAB IN ANALYYTICAL BIOCHEMISTRY **(30 Hrs)**

1. Calibration of pH meter
2. Verification of Beer's Law and estimation of sample concentration using spectrophotometer and colorimeter
3. Separation of plant pigments using paper, thin layer, and column chromatography
4. Native and SDS–PAGE
5. Subcellular fractionation by differential centrifugation

REFERENCE BOOKS:

1. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
2. Campbell I, *Biophysical techniques*, London: Oxford University Press, 2012.

SUGGESTED READING:

1. Upadhyay A, Upadhyay K and Nath N, *Biophysical techniques: principles and techniques* (4th ed.), Mumbai: Himalaya Publishing House, 2016.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the criteria of choosing appropriate strategies and instrumentation for analysis of different biological sample types*
- *Know the applicability, advantages, limitations and sources of error of current analytical instruments through an understanding of the working principles of these instruments and the underlying biochemical basis*
- *Enable independent conduct of biochemical analyses and instrument evaluations in the laboratory and to link the practical applications to the learned theory.*

Year	II	Course Code: BC4MI04E1	Credits	4
Sem.	IV	Course Title: Biostatistics & Scientific writing	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *The course is designed to help understand the statistical tools commonly used in biological research*
- *It helps to know the concept of hypothesis testing and the importance of statistical significance in interpreting research data*
- *To learn how to use software applications such as MS Office Excel to perform all statistical operations*

UNIT I: DIAGRAMMATIC REPRESENTATION OF DATA (9 hrs)

Collection of data and types of data. Data collection: types and methods. Tabulation and representation of data: histogram, frequency, line plots (polygon and ogive) and pie chart. Importance of correct choice of data representation for scientific interpretation

UNIT II: CENTRAL TENDENCY, DISPERSION AND CORRELATION (12 hrs)

Calculating the mean, median, and mode for grouped and ungrouped data. Merits and demerits of mean, mode and median. Measurements of dispersion: range, standard deviation and coefficient of variation. Correlation: types and methods for calculating correlation, and Karl Pearson's correlation coefficient.

UNIT III: TEST OF SIGNIFICANCE (12 hrs)

The null hypothesis, statistical significance and confidence interval. Methods of measuring statistical significance: Student's *t*-test, F-test, Chi-squared test and one-way ANOVA.

UNIT IV: LITERATURE REVIEW IN SCIENCE (12 hrs)

Introduction to literature review. Methods for literature search: use of library, books and journals, and the Internet (PubMed, Medline, Scopus and Elsevier) Search of patents and grant proposals. Purpose of literature review: selection of research problem and formulation of hypothesis.

UNIT V: BASICS OF SCIENTIFIC LITERTATURE (9 hrs)

Types of scientific literature: research articles, review articles, books, conference proceedings, grant proposal, project reports, theses and dissertations.

UNIT VI: COMPONENTS OF A SCIENTIFIC ARTICLE (8 hrs)

Title, authors, affiliations, abstract, references, acknowledgements, tables, illustrations and footnotes, and rules and guidelines for writing each component. Methods to avoid plagiarism.

REFERENCE BOOKS:

1. Daniel WW and Cross CL, *Biostatistics: a foundation for analysis in the health sciences* (11th ed.), Hoboken: Wiley, 2019.
2. Zar JH, *Biostatistical analysis* (5th ed.), Upper Saddle River: Prentice-Hall, 2010.

SUGGESTED READING:

1. Lewis AE, *Biostatistics demystified*, New York: McGraw-Hill, 2013.
2. Sokal RR and Rohlf FJ, *Biometry* (4th ed.), New York: W.H. Freeman, 2012.

Course outcome:

Upon successful completion of this course, students are able to:

- *Recognize the importance of choosing proper diagrammatic representation for scientific data, and interpret whether results obtained are statistically significant*
- *Use the computer to present, analyse and interpret scientific data*
- *Access the Internet to retrieve information from biological databases.*

SEMESTER V

Year	III	Course Code: BC5MJ08	Credits	4
Sem.	V	Course Title: Intermediary Metabolism II	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course Objectives:

- *The course provides a detailed overview of nucleic acid, heme, vitamin and mineral metabolism, and the disorders associated with them*

UNIT I: NUCLEIC ACID METABOLISM I (12 hrs)

Nucleosides and nucleotides. Biosynthesis of purine and pyrimidine nucleotides: sources of nitrogen and carbon atoms of purine and pyrimidine ring. *De novo* and salvage pathways significance and regulation.

UNIT II: NUCLEIC ACID METABOLISM II (7 hrs)

Degradation of purines and pyrimidines. Abnormalities in nucleic acid metabolism: orotic aciduria and gout.

UNIT III: HEME METABOLISM (8 hrs)

Structure and functions of hemoglobin: chemistry of porphyrins, biosynthesis and degradation of heme. Bile pigment formation, conjugated and unconjugated bilirubin. Abnormalities in heme metabolism: metabolic consequences in sickle cell anemia, thalassemia, porphyria and jaundice (hemolytic, hepatic and obstructive).

UNIT IV: BIOCHEMICAL ACTION OF VITAMINS IN THE METABOLISM(9 hrs)

Structure and active forms of water soluble and fat-soluble vitamins, biochemical action of co-enzymes in the metabolism. deficiency diseases and symptoms, hypervitaminosis

UNIT V: MINERAL METABOLISM (9 hrs)

Introduction about the mineral metabolism, function, classification, Role of minerals in life process.

LAB IN INTERMEDIARY METABOLISM II (30Hrs)

1. Estimation of vitamins in serum
2. Estimation of minerals in food stuff
3. Determination of nutritive value of foods
4. Case studies on nutritional disorders

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al*., *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.
3. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.
5. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of this course, students are able to

- *comprehend the basic types of metabolic pathways,*
- *understand the important metabolic pathways of major classes of biomolecules, and their associated diseases*

Year	III	Course Code: BC5MJ09	Credits	4
Sem.	V	Course Title: Human Physiology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *This course provides an overview on physiology, an insight into the processes responsible for sustaining life*
- *It serves as a bridge between medicine and chemistry by explaining the chemistry behind physiological processes like digestion, muscle contraction, nerve conduction, heart pumping, etc.*
- *The course also describes the alterations in normal physiology, which occur during disease, thus, providing a molecular perspective of several disease states*

UNIT I: THE DIGESTIVE SYSTEM (8 hrs)

The anatomy of the human alimentary canal. Accessory glands of the digestive system. The biochemistry of digestion of carbohydrates, protein and fats in various regions of the alimentary canal in humans. Absorption, and fates of ingested carbohydrates, protein and dietary lipids. Storage and detoxification.

UNIT II: THE CARDIOVASCULAR AND CIRCULATORY SYSTEM (10 hrs)

Structure and functions of heart, conductive system of heart, origin and conduction of the heartbeat. Cardiac cycle, and electrocardiogram (ECG). Structure of the endothelium. Anatomy of the human vascular and lymphatic systems. Composition of blood and its functions. Common diseases of the blood, blood vessels and heart.

UNIT III: THE RESPIRATORY AND MUSCULAR SYSTEMS (10 hrs)

Structure and functions of lung. Mechanism of pulmonary ventilation: exchange of gases between lung and blood, and transport of gases between blood and tissues. Disorders associated with the lungs: occupational and habitual diseases. Ultra-structure and chemical composition of skeletal muscle, sliding filament theory, physico-chemical changes during muscle contraction and muscular dystrophy.

UNIT IV: THE NERVOUS SYSTEM (9 hrs)

Concept of nerve and nerve cells. Transmission of nerve impulse. Action potential, neurotransmitters. Synaptic conduction: neuromuscular synapse, adrenergic and cholinergic neurotransmission. The anatomy of the human brain. Functions of different parts of the human brain. The blood–brain barrier. Structure and functions of the spinal cord. Parts of the nervous system: central, peripheral and autonomic. Reflex action: importance of reflexes, sympathetic and parasympathetic nervous systems. CSF and its composition. Neurodegenerative diseases.

UNIT V: THE EXCRETORY SYSTEM (8hrs)

Structure and functions of kidney and nephron. Composition and formation of urine. Principle of ultrafiltration. Fluid and electrolyte balance, acid–base dynamics. Role of the lungs in excretion. Metabolic and respiratory acidosis and alkalosis.

LAB IN HUMAN PHYSIOLOGY (30 Hrs)

1. Determination of blood pressure
2. Determination of hemoglobin
3. RBC count
4. WBC count
5. Determination of PCV and ESR
6. Measurement of PT and PTT
7. Determination of Ankle Brachial Index

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2015.
2. Waugh A and Grant A, *Ross and Wilson anatomy and physiology in health and illness* (13th ed.), New York: Churchill Livingstone, 2018.
3. Bell GH, Emslie-Smith D and Paterson CR, *Textbook of physiology and biochemistry* (9th ed.), London: Churchill Livingstone, 1976.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the chemical reactions involved in digestion, absorption and assimilation, as well as the electrochemical and ionic changes that power the heart, neurons and muscle functions*
- *Comprehend the applications of gas laws and buffer systems in the transport of gases by the circulatory system, and the alterations in disease states*
- *Independently perform complete blood count, and be competent in hematology.*

Year	III	Course Code: BC5MJ10	Credits	4
Sem.	V	Course Title: Microbiology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *Microbes are omnipresent, including as symbionts and commensals. This course provides a brief but thorough overview of the types of microbes, their distribution, diseases and control, as well as their beneficial applications*
- *It provides hands-on training in the basic skills necessary for sterile practices and the handling and manipulation of cultures in the microbiology laboratory*

UNIT I: INTRODUCTION AND BACTERIAL CLASSIFICATION (10 hrs)

Definition, scope and history of microbiology. Germ theory of disease. Differences between prokaryotic and eukaryotic microorganisms. Classification of Bacteria: based on Gram's staining, temperature and oxygen requirement. Types of bacteria: chlamydia, rickettsia, mycoplasma, actinomycetes, cyanobacteria and eubacteria. Brief overview of Archea.

UNIT II: VIRUSES, FUNGI, ALGAE AND PROTOZOANS (10 hrs)

Classification and types of viruses: Baltimore classification. General characteristics of major groups of fungi: Oomycota, Zygomycota, Ascomycota and Basidiomycota. Classification of protozoa: Mastigophora, Sarcodina, Sporozoa and Ciliophora. General characteristics of major groups of algae: Chlorophyta, Phaeophyta, Rhodophyta, Pyrrophyta, Chrysophyta and Euglenophyta.

UNIT III: MICROBIAL GROWTH (7 hrs)

Microbial growth, growth rate, doubling time and exponential growth phases. Factors affecting microbial growth: nutrient factors (C, H, N, O, P, S and trace elements) and non-nutrients factors (temperature, hydrostatic pressure, pH, osmotic strength). Types of nutrient media and special nutrient media. Differential media, and examples to distinguish different groups of bacteria using differential media.

UNIT IV: FOOD AND INDUSTRIAL MICROBIOLOGY (10 hrs)

Quality control of drinking water: total coliform count. Microorganisms in milk and milk products, and the preservation of milk. Role of microbes in industrial production of fermented foods: alcoholic beverages, dairy products, coffee and chocolate. Preservation of wine. Single-cell proteins, microbial biofuel and biofertilizers.

UNIT V: MICROBIAL DISEASES AND ANTIMICROBIAL AGENTS (8 hrs)

Diseases caused by bacteria, viruses, protozoa and fungi: airborne diseases, water-borne diseases and milk-borne diseases. Prion diseases. Principles and methods of sterilization and disinfection. History, and brief overview of antibiotics, their mechanisms of action, and antibiotic resistance.

LAB IN MICROBIOLOGY **(30 Hrs)**

1. Sterilization techniques
2. Identification of bacterial cells and the determination of antibacterial activity
3. Pure culture techniques: streak plate, pour plate, spread plate and serial dilution
4. Methylene blue reductase test (MBRT)
5. Simple staining & Gram staining
6. Microbial growth curve

REFERENCE BOOKS:

1. Willey JM, Sherwood LM and Woolverton CJ, *Prescott, Harley, and Klein's Microbiology* (7th ed.), Boston: McGraw Hill, 2007.Leboffe MJ and Pierce BE, *A photographic atlas for the microbiology laboratory* (4th ed.), Englewood: Morton Publishing, 2011.
2. Ananathanarayanan and Panikar, *Text book of microbiology* (10^{th} ed.), New Delhi: The Orient Blackswan, 2017.
3. Sherman N and Cappuccino JG (2004) *Microbiology A Laboratory Manual*, Benjamin-Cummings Publishing Company, San Francisco, 2004.

***Course outcome**:*

Upon successful completion of the course, students possess:

- *Foundational horizontal knowledge in microbiology*
- *Awareness of communicable diseases, their mode of transmission, preventive and control measures, for public health awareness*
- *The skill of handling microbial cultures, sterile practices and basic microbial techniques, which will be useful in handling diseased samples in the biochemistry laboratory*

Year	III	Course Code: BC5MI05	Credits	4
Sem.	V	Course Title: Pharmaceutical Biochemistry	Hours	45 (T) & Field Visit
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *To identify specific molecular targets within the body that drugs interact with. This involves studying the receptors, enzymes, and other biomolecules that drugs bind to or modulate.*
- *To understand the detailed mechanisms through which drugs exert their effects.*
- *Understanding how drugs are metabolized and distributed in the body is essential for optimizing dosage regimens and ensuring therapeutic efficacy and Drug-Drug Interactions.*

UNIT I: IMPORTANCE OF BIOCHEMISTRY AND PHARMACY (10 hrs)

Metabolites and anti-metabolites; Drugs -Classification of drugs, Placebo effect, routes of drug administration, absorption and distribution of drugs, factors influencing drug absorption.

UNIT II: DRUGS (8 hrs)

Prodrug concept, Drug receptor- localization, Receptor interaction, involvement of binding forces in drug receptor interaction, drug action not mediated by receptors; Drug metabolism, role of cytochrome P 450. agonist & antagonist. Examples

UNIT III: ADVERSE EFFECTS OF DRUGS (8 hrs)

Definition for IC 50 and LD50 of a drug - Drug tolerance and intolerance, Idio syneracy Adverse responses and side effects of drugs, Types: Allergy, drug intolerance, drug addiction, drug abuses, abusive drug types and their biological effects.

UNIT IV: PLANTS AND BIOACTIVE COMPOUNDS (7 hrs)

Plants and bioactive compounds used in traditional medicine: Ayurveda, Siddha and Unani - tulsi, turmeric, neem, ashwagandha, amla, coriander, ginger, Aloe barbadensis. Nila vembu kashayam preparation. Natural products: Alkaloids - nicotine, Terpenoids - menthol, Flavonoids –anthoxynene; Aloevera - Sources, preparation and uses; Jetropa - Sources, preparation and uses.

UNIT V: CANCER CHEMOTHERAPY (12 hrs)

Normal vs Cancer cell. Characteristics of cancer cells, Benign and malignant tumors, Sign and symptoms of cancers, Physical, chemical and biological carcinogenic agents, Types of chemotherapeutic agents for cancer, Classification of chemotherapeutic agents, Mechanisms of action of different drug classes, Cell cycle and phase specific and nonspecific drugs for cancer.

UNIT VI: FIELD VISIT

REFERENCE BOOKS:

1. Satoskar RS, Bhandhakar SD, *Pharmacology and pharmacotheraphy*, Elsevier, 2017.
2. Bertram. G. Katzung, *Basic and clinical Pharmacology*, Tata Mc Qrahill publishers, 2015**.**
3. Barar FSK, *Textbook of Pharmacology*, S Chand & Co Ltd, Edition-1st 2013.

SUGGESTED READING:

1. David G. smith, Oxford textbook of clinical pharmacology and drug therapy, Oxford press, 2008, 3rd edition.
2. Ajay Kumar Meena, Parveen Bansal, Sanjiv Kumar Plants-herbal wealth as a potential source of ayurvedic drugs, Asian Journal of Traditional Medicines, 2009

Course outcomes:

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

- *Students should be able to describe the detailed biochemical and molecular mechanisms through which drugs exert their therapeutic effects or produce adverse reactions.*
- *Students should have a solid understanding of pharmacokinetic concepts, including drug absorption, distribution, metabolism, and excretion.*
- *Students should be able to assess the potential toxicological risks associated with drug therapy*
- *Students should be equipped to contribute to the early stages of drug development by providing insights into target identification, mechanism elucidation, and optimization strategies.*

SEMESTER VI

Year	III	Course Code: BC6MJ12	Credits	4
Sem.	VI	Course Title: Molecular Biology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *The course describes the central role of the information molecule – the DNA, in controlling all physiological and cellular processes*
- *It describes the flow of information from nucleic acids to proteins, and the significance of the central dogma*
- *It explains the molecular mechanisms and regulation of DNA replication, repair, transcription, post-transcriptional processing and protein synthesis*

UNIT I: INTRODUCTION AND HISTORY OF MOLECULAR BIOLOGY (9 hrs)

Discovery of DNA as genetic material: experiments of Griffith, Avery, McLeod and McCarty, Hershey and Chase experiment, Lederberg and Tatum's conjugation experiment and Friedrich Miescher's experiment. Types of DNA and RNA. Chromosomal organization in prokaryotes and eukaryotes. Chemical nature of the gene. Gene and gene concept: cistron, muton, replicon and recon. Central dogma of molecular biology.

UNIT II: DNA REPLICATION (9 hrs)

Messelson–Stahl experiment of semiconservative DNA replication. DNA replication in prokaryotes: enzymes and proteins involved in replication. DNA mutation and repair: types of mutation (mismatch, base-excision, nucleotide excision and direct repair). Replication of plasmids and mitochondrial DNA.

UNIT III: TRANSCRIPTION (9 hrs)

Transcription in prokaryotes: types of RNA polymerases. DNA elements in transcription: promoters, enhancers, silencers, transcription factors and inhibitors of transcription. Structure of mRNA in prokaryotes and eukaryotes. Post-transcriptional processing in eukaryotes: splicing, capping and polyadenylation. Codon, characteristics of genetic code and wobble hypothesis. Reverse transcription, transposons and retrotransposons.

UNIT IV: TRANSLATION (9 hrs)

Mechanism of translation in prokaryotes: amino acid activation, initiation, elongation, and termination. Posttranslational modification in eukaryotes. Inhibition of protein synthesis by antibiotics.

UNIT V: REGULATION OF GENE EXPRESSION (9 hrs)

Positive and negative control: *lac* and *trp* operon. Gene regulation in eukaryotes, Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix turn helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs. Regulation of Gene Expression in Development- Development in Drosophila. Maternal genes –bicoid and nanos and hunchback. Gap genes, pair rule genes segmentation genes, homeotic genes Gene silencing – of chromatin in regulating gene expression and gene silencing-RNAi, MicroRNAs riboswitches-regulation of gene expression in bacteriophage-gene dosage- gene amplification.

LAB IN MOLECULAR BIOLOGY (30 Hrs)

1. Hydrolysis of DNA and separation of nucleotide bases by paper chromatography
2. Ultraviolet absorption spectrum of DNA and estimation of concentration by A_{260} method
3. Colorimetric estimation by DNA by diphenylamine (DPA) method
4. Isolation of microbial DNA
5. Isolation of plant and animal DNA
6. Agarose gel electrophoresis
7. Estimation of RNA by Orcinol method

REFERENCE BOOKS:

1. Watson JD, Baker TA, Stephen PB, *et al.*, *Molecular biology of the gene* (7th ed.), San Francisco: Pearson Education, 2017.
2. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
3. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

SUGGESTED READING:

1. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the central dogma of molecular biology: replication, transcription, translation, together with their regulation*
- *Appreciate the importance of biochemical reactions that result in molecular processes, which ultimately help a cell assemble another cell*
- *Independently perform molecular biology based experiments such as isolation and analysis of DNA, RNA and proteins*

Year	III	Course Code: BC6MJ13	Credits	4
Sem.	VI	Course Title: Immunology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To compare and contrast the innate and the adaptive immune systems, as well as humoral and cell- mediated immune responses*
- *To distinguish various cell types, antibody isotypes, and cytokines involved in immune responses and associated functions*
- *To understand the significance of the Major Histocompatibility Complexes in immune surveillance and transplantation*

UNIT I: OVERVIEW AND HISTORICAL PERSPECTIVE (8 hrs)

Immunity and types of immunity: innate and adaptive, active and passive, natural and acquired immunity. Overview of immune system, cells of the immune system and their functions. Organs of the immune systems and their functions: primary and secondary lymphoid organs

UNIT II: ANTIGEN AND ANTIBODY (10 hrs)

Nature and types of antigens, specificity, epitope, haptens, adjuvants. Immunogenicity and factors affecting immunogenicity. Immunoglobulins: structure, classes and functions. Antigen– antibody reactions: agglutination, precipitation, flocculation, complement fixation, neutralization.

UNIT III: HUMORAL AND CELL-MEDIATED IMMUNITY (9 hrs)

Functions of T_H, T_C, T_S and B lymphocytes. Primary and secondary immune responses and the role of memory cells. Polyclonal and monoclonal antibody generation and their applications.

UNIT IV: IMMUNODIAGNOSTIC TECHNIQUES (10 hrs)

Single immunodiffusion: one dimension and radial, double immunodiffusion: one dimension and radial. Immunoelectrophoresis, immunofluorescence, rocket electrophoresis, haemagglutination assay, CFT, ELISA, RIA.

UNIT V: HYPERSENSITIVITY REACTIONS (8 hrs)

Types of hypersensitive reactions: type I, II, III and IV. Fundamentals of autoimmune disorders, immunodeficiency diseases, brief account on immune suppression. Transplantation immunology: graft acceptance and rejection (in brief).

LAB IN BASIC IMMUNOLGY **(30 Hrs)**

1. Blood grouping
2. Identification of immune cells in blood smears
3. Single and double immunodiffusion
4. Radial immunoassay
5. Dot ELISA
6. Widal's test
7. Complement Fixation Test

REFERENCE BOOKS:

1. Punt J, Stranford S, Jones P and Owen J, *Kuby immunology* (8th ed.), New York: W.H. Freeman, 2018.
2. Murphy K, Mowat A, Weaver CT, *Janeway's Immunobiology* (8th ed), Garland Science, London & New York, 2012.
3. Gordon JR, *A practical guide to cellular and molecular research methods in immunology* (4th ed.), Saskatoon: University of Saskatchewan, 2002.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

SUGGESTED READING:

1. Delves PJ, Martin, SJ, Burton RD and Roitt IM, *Roitt's essential immunology* (13th ed.), London: Wiley-Blackwell, 2017.

Course outcome:

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

- *Understand the components of different cells and organs involved in humoral and cell-mediated immunity*
- *Comprehend the role of over-activation of immune system in hypersensitivity and its consequences*
- *Gain knowledge about autoimmunity, graft rejection and therapeutic modalities for immunosuppression during transplantation*

Year	III	Course Code: BC6MJ14	Credits	4
Sem.	VI	Course Title: Clinical Biochemistry	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *This course translates the knowledge learned in multiple courses such as intermediary metabolism and physiology into the diagnosis of human health and disease.*
- *It serves as a rational guide on how to employ biochemical investigations systematically in clinical diagnosis and prognosis.*
- *It also provides practical, hands-on training in the estimation of clinically relevant biomolecules in body fluids*

UNIT I: APPROACHES TO CLINICAL BIOCHEMISTRY (7 hrs)

Concepts of accuracy, precision, sensitivity and reproducibility. Quality control and determination of normal range. Collection and processing of blood and urine samples, anticoagulants, preservatives for blood and urine, and transport of biological samples.

UNIT II: DISORDERS OF CARBOHYDRATE METABOLISM (8 hrs)

Introduction: normal fasting and post-prandial blood glucose level, mechanism of blood glucose homeostasis: hypo- and hyperglycemia, renal threshold value. Diabetes mellitus: types, diagnosis, clinical features, metabolic defects and complications. GTT, galactosemia, fructosuria and glycogen storage diseases.

UNIT III: DISORDERS OF PROTEIN METABOLISM (10 hrs)

Introduction: clinical significance and variation of plasma and serum proteins. Clinical features of phenylketonuria, alkaptonuria, albinism and tyrosinosis. Disorders of the urea cycle. Clinical significance of non-protein nitrogen: BUN and creatinine (normal and abnormal levels). Clinical importance of clearance determination. Abnormal constituents of urine and their significances.

UNIT IV: DISORDERS OF LIPID AND NUCLEIC ACID METABOLISM (8 hrs)

Introduction, hypertriglyceridemia, hypo- and hyperlipoproteinemia. Atherosclerosis: clinical features and complications. Lipid storage diseases and fatty liver. Gout: types, aetiology and clinical features. Brief overview of lysosomal storage diseases.

UNIT V: LIVER AND GASTRIC FUNCTION TESTS (12 hrs)

Functions of the liver and classification of LFTs. Abnormalities in bile pigment metabolism: differential diagnosis of jaundice (hemolytic, hepatic and obstructive). Changes in plasma proteins, clotting factors and prothrombin time. Serum enzymes in liver diseases: ALP, SGOT, SGPT and γ-GTP. Bile pigment levels in urine and faeces. Gastric function tests: collection and examination of gastric contents after stimulation. Errors in collection of samples. Fractional test meal analysis and its interpretation, and tubeless gastric analysis.

LAB IN CLINICAL BIOCHEMISTRY (30 Hrs)

1. Blood glucose and urea analysis
2. Serum creatinine estimation
3. Serum uric acid estimation
4. Serum cholesterol estimation
5. Serum bilirubin estimation
6. Estimation of total protein and determination of A/G ratio
7. Urine analysis

REFERENCE BOOKS:

1. Murphy MJ, Srivastava R and Deans K, *Clinical biochemistry: an illustrated color text* (6th ed.), Edinburgh: Elsevier, 2019.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.
3. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

SUGGESTED READING:

1. Chatterjea MN, Rana Shinde, *Textbook of Medical Biochemistry*, JPB; eigth edition (1 January 2012).
2. Vasudevan DM, Sreekumari S, Kannan Vaidyanathan, *Textbook Of Biochemistry For Medical Students*, Jaypee Brothers Medical Publishers; Ninth edition, 2019.

Course outcome:

Upon successful completion of the course, students are able to:

- *Acquire knowledge on diagnosis, prognosis and treatment of disorders of carbohydrate, protein, lipid and nucleic acid metabolism.*
- *Comprehend renal, liver and gastric function tests, and how they are employed in systematic diagnosis of diseases*
- *Acquire hands-on clinical laboratory training in estimating glucose, cholesterol, urea, creatinine and total protein from blood and urine.*

Year	III	Course Code: BC6MJ15	Credits	4
Sem.	VI	Course Title: Genetics	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *The course addresses the question of the mechanism of inheritance of traits from one generation to the next*
- *It begins with the Mendelian concepts and the emergence of the science of genetics, and comprehensively covers current topics including population genetics*
- *It also demonstrates how the principles of genetics can be used as a powerful experimental tool to unravel the molecular function of genes, and study human diseases*

UNIT I: INTRODUCTION AND MENDELIAN GENETICS (8 hrs)

A brief overview of the modern history of genetics: Mendelian theory and the chromosomal theory. Mendel's experiments, laws of segregation, dominance and independent assortment, and back cross

UNIT II: EXTENSIONS TO MENDELIAN GENETICS (12 hrs)

Genetic interactions: allelic and non-allelic. Allelic variation and gene function: dominance relationships, multiple alleles, lethal alleles and null alleles. Muller's classification of mutant alleles (brief definitions). Penetrance and expressivity. Human pedigree analysis: pedigree conventions and applications of pedigree analysis.

UNIT III: LINKAGE AND CROSSING OVER (10 hrs)

Different theories of linkage: Boveri–Sutton, Bateson and Punnet, and Morgan's theory. Types of linkages: complete and incomplete. Coupling and repulsion, factors affecting linkage, and significance of linkage. Crossing over: mitotic and meiotic, types of crossing over, and significance of crossing over. Complementation and tetrad analysis. Gene mapping in *Drosophila*.

UNIT IV: INHERTANCE AND NON-DISJUNCTION (10 hrs)

Types of inheritance: extrachromosomal, autosomal and sex-linked inheritance (X-linked and Y- linked). Sex-linked lethal, sex-limited and sex-influenced traits. Non disjunction: primary and secondary. Conditions associated with chromosomal non-disjunction: Down syndrome, Turner's syndrome and Klinefelter's syndrome.

UNIT V: CYTOGENETICS (10 hrs)

Normal human karyotype, banding techniques. Sex chromosomes: X-linkage determination patterns. Dosage compensation in *Drosophila*. Changes in chromosome number and structure: aneuploidy, euploidy, and polyploidy. Types of mutations: point mutations (transversion, transition, insertion, deletion, missense, nonsense and frame shift), chromosomal aberrations and significance of mutations.

UNIT VI: POPULATION GENETICS (10 hrs)

Mendelian population: gene pool, allele frequency, genotype frequency, Hardy–Weinberg equation. Factors influencing gene frequency or deviations from Hardy–Weinberg equilibrium: selection (directional and artificial selection), mutation, genetic load, genetic drift, meiotic drive and migration.

REFERENCE BOOKS:

1. Griffiths AJF, Doebley J, Peichel C and Wassarman D, *Introduction to genetic analysis* (12th ed.), New York: W.H. Freeman & Co., 2020.
2. Pierce BA, *Genetics: a conceptual approach* (7th ed.), New York: W.H. Freeman & Co., 2020.

SUGGESTED READING:

1. Snustad DP and Simmons MJ, Principles of genetics (7th ed.), Singapore: John Wiley & Sons, 2015.

Course outcome*:*

Upon successful completion of the course, students are able to:

- *Understanding and solve problems based on Mendelian and Morgan's genetics*
- *Demonstrate working knowledge in pedigree analysis*
- *Comprehend genetic map construction, cytogenetics and the mechanisms of various genetic diseases*

Year	III	Course Code: BC8MI06E1	Credits	4
Sem.	VI	Course Title: Biochemical Toxicology	Hours	45 (T)/ Case studies
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course Objectives:

- *To acquire knowledge, understand and develop an understanding of the kinds of toxicant interactions, their impact on human health.*
- *To study the fundamental concepts, methods, approaches of Biochemical and environmental toxicology.*
- *Understanding the toxicological effects of biochemical and environmental toxicants on humans*

UNIT I: INTRODUCTION (9 Hrs)

Definition and scope of toxicology and Biochemical toxicology, Sources and classes of toxicants; air, water and soil pollutants, food additives and contaminants, Toxic effects of Persistent organic pollutants (POPs), dioxins, drugs and Pesticides and their biochemical mode.

UNIT II: TOXICOKINETIC (9 Hrs)

Absorption, distribution, excretion, and biotransformation of toxicants, Metabolism of toxicants; xenobiotic metabolism and biological consequences of Phase I and Phase II reactions, role of cytochrome P450 in Phase I monooxygenations and types of Phase II metabolic conjugations.

UNIT III: FACTORS AFFECTING METABOLISM OF TOXICANTS (9 Hrs)

Chemical, physiological and environmental, Different routes of elimination of toxication; exhalation (lung), renal and hepatic routes. Hepatic and renal toxicology; basic principles and specific examples.

UNIT-IV: FOOD TOXICOLOGY (9 Hrs)

Role of diet in cardio-vascular disease and cancer. Toxicology of food additives. Metal toxicity: Toxicology of arsenic, mercury, lead and calcium. Environmental factors affecting metal toxicity – effect of light, temperature and pH.

UNIT V: GENETIC POISONS (9 Hrs)

DNA damage agents, chemical carcinogenesis and trace element toxicity and their toxic mechanism, Bone marrow toxicity: benzene as a case study, Neurotoxicology, Metal toxicology: mercury, cadmium, Nanoparticle toxicology.

REFERENCE BOOKS:

1. Robert CS, *Molecular and Biochemical Toxicology*, Ernest Hodgson, (2018), Wiley publications.
2. Dong MH, *An Introduction to Environmental Toxicology*, (2018) 4th ed., Create space Independent Publishing platform, ISBN: 1979904510.
3. Timbrell JA, *Principles of Biochemical Toxicology*. (4th Edition) CRC Press.
4. Robert CS, *Introduction to Biochemical Toxicology*. Ernest Hodgson, (3rd Edition) Wiley inter-science.

SUGGESTED READING:

1. Landis WG, Sofield RM and Yu MH, *Introduction to Environmental Toxicology*: Molecular Substructures to Ecological Landscapes (2017) 5th ed., CRC Press, ISBN:978- 1498750424.
2. Bhunia AK, *Foodborne Microbial Pathogens*: Mechanisms and Pathogenesis (2018) 2nd ed., Springer Nature, ISBN: 978-1493973477.
3. Yu MH, Tsunoda H and Tsunoda M, *Environmental Toxicology*: Biological and Health Effects of Pollutants (2011) 3rd ed., CRC Press, ISBN: 978-1439840382.
4. Taylor RJ and Francis, *Environmental Toxicology Current Developments* (2014) 1st ed., ISBN: 0203-30551-5.

Course outcome:

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

- *Understand different types of toxins their biological process and effects on various organs/ systems of the human body*
- *Aware of dose absorption, excretion of the toxic components*
- *Understand impact of toxin on renal, liver, neural systems*
- *Identify underlying susceptibility factors which contribute to the ability of chemicals to elicit bio effects which contribute to human disease.*

SEMESTER VII

Year	IV	Course Code: BC7MJ16	Credits	4
Sem.	VII	Course Title: Endocrinology	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *The course provides an overview of the process of cell–cell communication through hormones*
- *It will help understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body, and the hormonal imbalances that result in human diseases*
- *It is also intended to prepare a student for postgraduate studies in any course related to molecular medicine*

UNIT I: INTRODUCTION TO ENDOCRINOLOGY (12 hrs)

Historical perspective, comparative endocrinology and its roles in homeostasis. Definition of hormones. Major endocrine glands: Anatomy, structure and functions. Concept of secondary messenger system- Sutherland experiment. Chemical nature and types of hormones. Hormones regulations and feedback mechanisms.

UNIT II: BRAIN AND PITUITARY GLAND HORMONES (12 hrs)

Hormones of the hypothalamus: Structure and functions. Control of hypothalamic–hypophyseal hormone secretion. Pituitary gland: anatomy, hormones, their biological roles and associated disorders.

UNIT III: THE THYROID AND PARATHYROID GLANDS HORMONES (10 hrs)

Structure and functions of the thyroid gland. Thyroid hormones: biosynthesis and biological functions. Diseases associated with the thyroid gland: hypo- and hyperthyroidism. Structure and functions of the parathyroid gland. Parathyroid hormone: biological functions. Hypo- and hyperparathyroidism. Regulation of calcium and phosphorus metabolism by calcitriol.

UNIT IV: THE PANCREAS (8 hrs)

Endocrine regions of the pancreas. Synthesis, regulation, secretion, biological actions and disorders associated with the pancreatic hormones: glucagon, insulin and somatostatin.

UNIT V: ADRENAL GLAND HORMONES (8 hrs)

Hormones of the adrenal gland: adrenal cortex (glucocorticoids and mineralocorticoids) and adrenal medulla (epinephrine and norepinephrine).

UNIT VI: THE REPRODUCTIVE AND ADIPOSE HORMONES (10 hrs)

Structure and cell types of the testis. Spermatogenesis, steroidogenensis and endocrine control of testicular function. Biological actions of androgens and associated disorders. Structure and cell types of the ovaries. The ovarian cycle, ovarian steroid hormones, their physiological roles and associated disorders. Hormones of the adipose tissue, their biological functions, and roles in diseases.

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2016.
2. Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, *Harper's illustrated biochemistry* (31st ed.), Blacklick: McGraw-Hill Education, 2018.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

Couse outcome:

Upon successful completion of the course, students are able to:

- *Understand the different cognate and non-cognate modes of communication between cells in a multi-cellular organism*
- *Comprehend the roles of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function*
- *Describe the molecular, biochemical and physiological roles of all hormone, as well as the integrative regulations of their secretions in health and disease*

Year	IV	Course Code: BC7MJ17	Credits	4
Sem.	VII	Course Title: Genetic Engineering	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *The course outlines how molecular manipulation of DNA provides complete control of the Central Dogma of molecular biology, and the principles of the techniques used in gene identification, isolation and analysis*
- *It also lists applications of genetic engineering, such as the production of recombinant therapeutic proteins, vaccines, molecular farming and organ farming*
- *It provides hands-on, practical training in isolation and manipulation of DNA, which form the basis of molecular cloning*

UNIT I: INTRODUCTION TO GENETIC ENGINEERING (9 hrs)

Basic steps of gene cloning, Enzymes used in genetic engineering, Restriction enzymes - types, target sites, nomenclature, DNA polymerase, ribonuclease, ligases, alkaline phosphatases, reverse transcriptase.

UNIT II: CLONING VECTORS (9 hrs)

Plasmid vectors, bacteriophage, phagemid, cosmids, yeast vectors and plant vectors; Gene transfer techniques - microinjection, electroporation and gene gun bombardment.

UNIT III: GENOMIC AND DNA LIBRARIES (9 hrs)

Selection and screening of recombinants; Isolation and purification of cellular and plasmid DNA, methods for labeling nucleic acids and probes, somatic cell hybrids, in situ hybridization. Amplification of DNA by PCR: Technique and applications, analysis of DNA, RNA and proteins by blotting techniques.

UNIT IV: PLANT GENETIC ENGINEERING (9 hrs)

Transgenic plants - Agrobacterium mediated gene transfer and protoplast fusion - somaclonal variation - Applications of transgenic plants.

UNIT V: ANIMAL GENETIC ENGINEERING (9 hrs)

Transgenic animals: Production of recombinant insulin, and vaccines. RAPD, RFLP and its applications, DNA fingerprinting, foot printing, gene therapy.

LAB IN GENETIC ENGINEERING **(30 Hrs)**

1. Isolation of plasmid DNA from bacterial culture
2. Restriction digestion analysis of DNA
3. Ligation of DNA fragments and bacterial transformation
4. Immobilization of cells
5. Recovery of DNA by low temperature-melting agarose gel method
6. Polymerase chain reaction (Only demonstration)

REFERENCE BOOKS:

1. Primrose SB and Twyman RM, *Principles of gene manipulation and genomics* (7th ed.), Malden: Wiley Blackwell, 2014.
2. Brown TA, *Gene cloning and DNA analysis: an introduction* (7th ed.), Hoboken: Wiley- Blackwell, 2016.
3. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

SUGGESTED READING:

1. Nicholl DST, *An Introduction to Genetic Engineering*, Cambridge University Press, United Kingdom, 2010.
2. Glick BR, Pasternak JJ, Patten CL, *Molecular Biotechnology*: Principles and Applications of recombinant DNA, ASM Press, Washington DC, 2012.
3. Sambrook J and Russell DW, *Molecular Cloning*: A Laboratory Manual –a set of 3 volumes, CSHL Press, New York, 2012.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understanding the isolation of DNA using restriction enzymes, and its incorporation into suitable cloning and expression vectors*
- *Comprehend the methods and techniques used in the construction and analysis of genomic and cDNA libraries, and their applications*
- *Gain expertise in practical hands-on isolation of genomic DNA from mammalian tissue including its estimation, manipulation as required in gene cloning.*

Year	IV	Course Code: BC7MJ18	Credits	4
Sem.	VII	Course Title: Cellular basis of diseases	Hours	45 (T) 30 (P)/Case studies
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *Investigate the molecular and cellular factors contributing to the development of various diseases.*
- *Explore the basics of the immune system and its responses to pathogens, including autoimmune diseases*
- *Examine the molecular basis of cardiovascular diseases, atherosclerosis*

(9 hrs)

UNIT I: INFLAMMATION AND REPAIR/WOUND HEALING AND CANCER BIOLOGY

Chronic inflammation, acute inflammation-Vascular changes-cellular events - chemical mechanism of inflammation- effects of inflammation-wound healing-mechanism, autoimmune disorder. Cancer Biology: Hallmarks of cancer. Oncogenes and tumor suppressor genes, Tumor microenvironment

UNIT II: HEMODYNAMIC DISORDERS, THROMBOSIS & SHOCK (9 hrs)

Edema-hyperemia and congestion hemorrhage-hemostasis and thrombosis - Mechanism, fate of thrombus-embolism-pulmonary, systemic, amniotic fluid, fat infarction-septic shock. Atherosclerosis

UNIT III: RED & WHITE CELL DISEASES (9 hrs)

Normal development of blood cells-anemias-hemolytic- sickle cell-thalassemias, chronic disease -aplastic-marrow failure-polycythemia-bleeding disorders leukopenia-reactive proliferation of white cells - plasma cell dyscrasias.

UNIT IV: NEURONAL DISEASE AND METABOLIC DISEASES (12 hrs)

Molecular basis of neurodegeneration. Alzheimer's, Parkinson's, and other neurodegenerative diseases. Metabolic Diseases: Diabetes and insulin signaling - Obesity-related diseases.

UNIT V: HEPATIC DISORDERS (12 hrs)

Hepatic injury-Hepatitis a through E-Alcohol liver disease-Drug and toxin induced liver disease- cirrhosis- pregnancy associated-transplantation associated adenomas and primary carcinoma.

REFERENCE BOOKS:

1. Cotran, Kumar, Robbins. *Pathological Basis of Disease*. 8th ed. Prism, India. 2009.
2. William B. Coleman, Gregory J. Tsongalis, Molecular Pathology: The Molecular Basis of Human Disease). Elsevier Publication.

SUGGESTED READING:

1. Goodman & Gilman. Pharmacological Basis of therapeutics. 11thed, McGraw Hill 2006.
2. Zilva& Pannell. Clinical Biochemistry in Diagnosis & Treatment, Lloyd Luke Publications USA.

Course outcomes*:*

- *Students should be able to articulate a comprehensive understanding of the molecular mechanisms underlying various diseases*
- *Students should be able to articulate a comprehensive understanding of the molecular mechanisms underlying various diseases*
- *Students should be capable of critically analyzing experimental data related to molecular and cellular aspects of diseases. This includes the ability to interpret research findings*

Year	IV	Course Code: BC7MI07E1	Credits	4
Sem.	VII	Course Title: Bioinformatics	Hours	75 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *The course aims to provide students with an introduction to the basic practical techniques in bioinformatics*
- *It emphasizes on the application of bioinformatics and biological databases to solving real-world research problems including computer-aided drug design*
- *It aims to make students familiar with the use of a wide variety of internet applications, biological databases and publicly available biological software for solving fundamental biological problems*

UNIT I: INTRODUCTION TO BIOINFORMATICS (6 hrs)

Introduction, scope and branches of bioinformatics. Applications of bioinformatics. biological data types. Human Genome project, and its findings.

UNIT II: BIOLOGICAL DATABASES (12 hrs)

Biological search engine: Entrez, SRS concept and applications. Literature database: Pubmed, Biological database and its types: primary, secondary and composite databases. Nucleotide sequence databases: GenBank, EMBL and DDBJ. Protein sequence databases: UniProt, SwissProt, TrEMBL and PIR. Structural databases: PDB, CATH and SCOP PubChem, ChemBank, CCSD (in brief).

UNIT III: SEQUENCE ALIGNMENT (9 hrs)

Sequence alignment: Pairwise sequence alignment: - Global and Local alignment, Multiple Sequence alignment (MSA):- Progressive and Iterative Methods, Bioinformatics tools – BLAST, FASTA and CLUSTAL W.

UNIT IV: MOLECULAR PHYLOGENETIC ANALYSIS (9 hrs)

Phylogenetic tree and its components; dendrograms and cladogram. Construction of phylogenetic tree- Methods for construction of phylogenetic trees: maximum parsimony, maximum likelihood and distance methods (in brief). Phylogenetic analysis using PHYLIP.

UNIT V: PROTEIN STRUCTURE ANALYSIS AND THE OMICS ERA (9 hrs)

Protein structure analysis: visualization with RasMol, Swiss PDB viewer. Protein structure prediction: Steps involved in homology modelling with SWISS-MODEL. Brief list of the different types of omics databases, and their applications.

UNIT VI: LAB AIDED CLASS FOR 2-5 UNITS (30 hrs)

REFERENCE BOOKS:

1. Parry-Smith DJ, Phukan S and Attwood TK, *Introduction to bioinformatics* San Francisco: Pearson, 2007.
2. Baxevanis AD and Ouellette BF, *Bioinformatics: a practical guide to the analysis of genes and proteins* (3rd ed.), Hoboken: John Wiley & Sons, Inc., 2005.

SUGGESTED READING:

1. Instant Notes-Bioinformatics- Westhead *et al*., Viva Books (P), Ltd
2. Introduction to Bioinformatics- Attwood T K and Parry-Smith, D. J. Pearson Education.
3. Introduction to Bioinformatics- Lesk, A.M. Oxford University Press

Course outcome:

Upon successful completion of the course, students would possess knowledge about the following:

- *Scope of bioinformatics and applications of biological databases*
- *Mechanisms of molecular sequence analysis and phylogenetic analysis*

Types and methods of computer-aided drug design

Year	IV	Course Code: BC7MI08E1	Credits	4
Sem.	VII	Course Title: Research Methodology	Hours	60 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course Objectives:

- *This paper highlights the various postulates of research problems, research design, writing a thesis and modern statistical methods.*
- *This helps to carry out research problem individually in a perfect scientific method, Raise awareness about ethical issues and considerations in research.*
- *Familiarize and equip students with the fundamental principles and concepts of research methodology, including the scientific method, hypothesis formulation, and the importance of systematic investigation.*

UNIT I: MEANING OF RESEARCH - FUNCTION OF RESEARCH (10 Hrs)

Meaning of research - Function of research – Characteristics of research – Steps involved in research – Research in pure and applied sciences - Inter disciplinary research. Factors which hinder research –

UNIT II: SIGNIFICANCE OF RESEARCH (10 Hrs)

Research and scientific methods – Research process– Criteria of good research – Problems encountered by researchers – Literature review.

UNIT III: IDENTIFICATION OF RESEARCH PROBLEM (10 Hrs)

Selecting the research problem – Necessity of defining the problem – Goals and criteria for identifying problems for research. Perception of research problem – Techniques involved in defining the problem –Source of problems – Personal consideration.

UNIT IV: RESEARCH DESIGN (10 Hrs)

Formulation of research design – Need for research design – Features of a good design – Important concepts related to research design. Different research designs – Basic principles of experimental designs – Computer and internet in designs.

UNIT V: INTERPRETATION AND REPORT WRITING (10 Hrs)

Meaning and technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a research report. Types of report – Mechanics of writing a research report – Precautions for writing a research report – Conclusion.

UNIT VI: STATISTICAL TECHNIQUES AND TOOLS (10 Hrs)

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test, T Test including testing hypothesis of association. Interpretation of data and paper writing – Layout of a research paper, Journals in Biochemistry, Impact factor of journals, When and where to publish? Ethical issues related to publishing, plagiarism & its softwares. Introduction to applications of reference management software like Zotero/Mendeley, software for paper formatting like LaTeX/MS Office

REFERENCE BOOKS:

1. John W. Creswell and J. David Creswell, "*Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*", SAGE Publications, 2017 (4th edition).
2. Ranjit Kumar, *"Research Methodology: A Step-by-Step Guide for Beginners*", SAGE Publications 2019 (5th edition).
3. John W. Creswell and Cheryl N. Poth, "Qualitative Inquiry and Research Design: Choosing Among Five Approaches", SAGE Publications, 2017 (4th edition).

SUGGESTED READING:

1. Mukul Gupta and Deepa Gupta, *Research Methodology*, PHI Learning Private Ltd., New Delhi, 2011.
2. Gupta SC and Kapoor VK, *Fundamentals of Mathematical statistics*, Sultan Chand & Sons, New Delhi,1999.
3. Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams, *"The Craft of Research"*, University of Chicago Press, 2008 (3rd edition).

Course outcome:

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

- *Students will develop the ability to choose appropriate research designs*
- *Students will demonstrate the ability to create reliable and valid measurement instruments for data collection.*
- *Students will develop the ability to choose and apply appropriate statistical or analytical tools*
- *Students will understand and adhere to ethical principles in research, demonstrating awareness of the rights and well-being of research participants and capable of identifying and addressing ethical issues in research.*

SEMESTER VIII

Year	IV	Course Code: BC7MJ19	Credits	4
Sem.	VIII	Course Title: Genomics & Proteomics	Hours	45 (T) 30 (P)/(Case Studies)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To introduce and teach basic concepts and advanced techniques employed in genomics and proteomics.*
- *To introduce genomic and proteomics techniques employed in understanding cellular function and also in Industrial application for producing therapeutic molecules.*

UNIT I: CONCEPT OF GENOMICS (9 Hrs)

Mutagenesis, Regulated vectors for controlled expression of multiple genes to study gene function in different hosts. Recombinant DNA strategies to study protein interactions. (Yeast 2-hybrid system, Phage display, Protein fragment complementation). Determining the Function of Individua l genes (Gene deletion, over-expression and complementation, Genome-wide insertional mutagenesis).

UNIT II: FUNDAMENTALS OF WHOLE-GENOME SEQUENCING (9 Hrs)

Sequencing of Phage, Viral and Bacterial Genomes, Human Genome sequencing, and comparative genomics. High throughput genome-wide cloning and protein expression strategies and applications. Antibody gene cloning and engineering, humanization and Human antibodies.

UNIT III: INTRODUCTION TO PROTEOME (9 Hrs)

Proteomics technology, types and kinds of proteomics investigation, importance of proteomics. Principles and applications of the separation technology (Electrophoresis, Centrifugation, Chromatography) in proteomics. Mass spectrometry (Ionizers, analyzers and detectors) technology and its application in proteomics. General workflow for the 2-D Gel Electrophoreses, sample preparation, evolution of 2D PAGE, experimental details for the 2-D gel and high throughput 2-D PAGE. Application of two-dimension gel electrophoreses in proteomics and biomarker discovery. Importance of 2-D fluorescence difference gel electrophoresis for comparative proteomics.

(9 Hrs)

UNIT IV: PROTEOMIC PROFILING FOR HOST-PATHOGEN INTERACTION

Sample treatment for labeling, 2D LC-MS/MS analysis, database search and relative quantification, analysis and interpretation, quantitative proteomics. Protein-Protein Interaction (PPI) and its application in proteomics. Methods to study PPI. Application of proteomics for drug discovery. Biomarkers and drug targets identification.

UNIT V: VALIDATION OF DRUG TARGETS AND ASSESSMENT OF ITS TOXICOLOGY (9 Hrs)

Case Studies:

(i) Strategies for large-scale expression of recombinant proteins in heterogonous hosts. Purification and downstream processing to produce Therapeutic grade recombinant proteins and regulatory aspects.

(ii) Microarray techniques for DNA, Proteins and Antibodies. Global expression profiling

(iii) Cellular Engineering.

REFERENCE BOOKS:

1. Glick BR, Pasternak JJ and Patten CL, *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (2010) 4th ed., ASM Press (Washington DC).
2. Erica G and Peter DA, *Protein-Protein Interactions: A Molecular Cloning Manual* (2005) Cold Spring Harbor Laboratory Press,
3. Green MR and Sambrook J, *Molecular cloning*, A Laboratory Manual Vol. I-III. (Fourth edition), (2012) Cold Spring Harbor Laboratory Press.
4. Ausubel FM, et al., Current Protocols in Molecular Biology, (2015) John Wiley and Sons, Inc.

SUGGESTED READING:

1. James D. Watson, Richard M. Myers, Amy A. Caudy and Jan Witkowski, *Recombinant DNA, Genes and Genomes – A Short Course* (3rd edition), (2007). Cold Spring Harbor Laboratory Press.
2. Primrose SB and Twyman RM, Principles of Genome Analysis and Genomics. (7th edition), (2006) Blackwell Publishing.

Course outcomes:

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

- *Understand basic concepts of high throughput genomics and proteomics techniques*
- *Understand the genomic manipulation techniques and designing recombinant molecules*
- *Understand different platforms employed in next generation genome sequencing and acquire the ability to perform nucleic acid and peptide sequencing*
- *Understand the strategies employed for studying protein-protein interactions, protein expression including antibody gene cloning and protein engineering*

Year	IV	Course Code: BC8MJ20	Credits	4
Sem.	VIII	Course Title: Cell Culture Technology	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *Objective of this course is to familiarize the student with concepts of cell and tissue culture technology in both animals and plants.*
- *The course objective of Cell Culture Technology typically focuses on providing students with a comprehensive understanding of the principles, techniques, and applications of cell culture in both academic and industrial settings.*

UNIT I: ANIMAL CELL CULTURE (10 Hrs)

History, biology of cultured cells, culture media-composition, preparation and development, cell isolation, establishment and evaluation of cell culture, sterilization techniques for ATC lab. Animal cell lines: Establishment, properties and use of cell lines, cultures of tumor cells; Cryopreservation of animal cells. Culture and scale up: Monolayer culture-surface requirements, gas phase requirements, capillary culture units, suspension culture scale up. Somatic cell fusion: Methods of somatic cell fusion, selection, properties of cell hybrids and their applications.

UNIT II: ANIMAL CLONING AND EMBRYO TRANSFER (8 Hrs)

Superovulation, in vitro fertilization, embryo transfer technology in animals; Concepts and techniques of cloning. Applications: Industrial applications of animal cell culture; Stem cell culture and its applications.

UNIT III: PLANT TISSUE CULTURE (9 Hrs)

History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation. Callus and cell culture: Isolation of cells, growth of single isolated cells. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis.

UNIT IV: PLANT ORGANOTYPIC CULTURE (9 Hrs)

Meristem culture, embryo culture and embryo rescue, another culture, virus free plant production and haploid plant production, production of synthetic seed, micropropagation. Protoplast culture and fusion: Isolation of protoplasts, culture and regeneration; fusion of protoplasts, selection of fusion products of protoplasts; Cybrids. Somaclonal variation, plant transformation-Agrobacterium mediated and particle gun mediated, secondary plant metabolites and application of plant biotechnology in crop improvement.

UNIT V: APPLICATIONS & ASSAYS (9 Hrs)

Cell-Based Assays- Proliferation assays, Apoptosis assays Reporter gene assays. Clinical Applications- Stem cell culture and regenerative medicine. Cell therapy and personalized medicine. Current Trends and Emerging Technologies- 3D cell culture, Organoids and microfluidics, Ethical and Regulatory Considerations- Ethical guidelines in cell culture research, Regulatory requirements for cell-based products

LAB IN CELL CULTURE TECHNOLOGY (30 hrs)
DEMONSTRATION ONLY

REFERENCE BOOKS:

1. Freshney RI, *Culture of animal cells:* A manual of Basic Technique, 5th edition (2005), Willey Liss Publisher.
2. Minuth WW, Strehl R, Schumacher K, *Tissue Engineering*: Essential for Daily Laboratory Works, Willey Publisher (2005).
3. Chawla HS, *Plant Biotechnology*, Oxford and IBH, 2009.
4. Chrispeels MJ. and Sadava DE, *Plants, Genes and Crop Biotechnology*, 2nd Edition, American Society of Plant Biologists, Jones and Bartlett Publishers, USA (2003).

SUGGESTED READINGS:

1. Singh BD, *Plant Biotechnology*. Kalyani publisher, 2003.
2. Arie Altman, Marcel Dekker, *Agricultural Biotechnology*, Inc. (2001).
3. Buchanan BB, Gruissem W, and Jones RL *Biochemistry and Molecular Biology of Plants*, (2000).

Course outcome:

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

- *Understand the basics of plant and animal cell culture*
- *Get an in-depth knowledge about growing the animal cells in vitro to get cell mass, tissues, and their applicability examples*
- *learn the mass propagate the plants in vitro and how to raise virus free, pest resistance, new variety of plants etc.*
- *Understand application of cell culture in industries and research labs*

Year	IV	Course Code: BC8MJ21	Credits	4
Sem.	VIII	Course Title: Introduction to Drug discovery	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course Objectives:

- *To develop a foundational understanding of the concept of drug targets and the process of target validation.*
- *Explore how specific biological molecules or processes are identified as potential targets for therapeutic intervention*
- *Familiarize students with fundamental principles of medicinal chemistry, preclinical Development*

UNIT I: FUNDAMENTALS OF DRUG DISCOVERY (12 Hrs)

Overview of Drug Discovery Process and development process. Importance and challenges in the field. Historical Perspective and Milestones in Drug Discovery Key Players in Drug Discovery: Pharma Industry, Academia, and Government Agencies, Drug Targets and Therapeutic Areas.

UNIT II: DRUG TARGET IDENTIFICATION AND VALIDATION (12 Hrs)

Understanding Molecular Targets: Identification of potential drug targets, such as specific proteins, enzymes, or receptors. Validation of the biological relevance of these targets in the context of a particular disease. Hit discovery and lead optimization: Screening methods to identify initial compounds High-throughput Screening (HTS) Techniques.

UNIT III: DRUG DESIGN AND OPTIMIZATION (12 Hrs)

Validation Criteria for Drug Targets. Importance of Biomarkers in Target Validation. Computational methods and structure-activity relationship (SAR) studies for designing new drug candidates. Rational Drug Design vs. High-throughput Screening. structure-Activity Relationship (SAR) Studies, Computer-Aided Drug Design (CADD) and Molecular Modelling, Medicinal Chemistry Approaches to Optimization.

UNIT IV: PRECLINICAL DEVELOPMENT AND PHARMACOKINETICS (12 Hrs)

In vitro studies assessing the drug's activity, selectivity, and mechanism of action. In vitro and In vivo Testing: In vivo studies using animal models to evaluate pharmacokinetics, toxicity, and efficacy. Animal Models in Drug Development, Pharmacokinetics and Pharmacodynamics, Toxicology Studies and Safety Assessment.

UNIT V: CLINICAL TRIALS AND REGULATORY PROCESSES (12 Hrs)

Phases I-IV clinical trials involving human subjects to assess safety, tolerability, and efficacy. Formulation and Drug Delivery: Development of suitable formulations for drug administration. Novel drug delivery systems to enhance bioavailability or control release. Ethical Considerations in Human Trials, Regulatory Agencies and Compliance. Factors influencing drug pricing. Post-Marketing Surveillance and Pharmacovigilance-Monitoring of drug safety and effectiveness after it has been approved and is on the market. Identification and management of adverse effects.

REFERENCE BOOKS:

1. Young D and Marron TK, "*Principles of Drug Discovery*", Publisher: John Wiley & Sons (2005).
2. Williams AM, "*Introduction to Medicinal Chemistry*: How Drugs Act and Why", Publisher: Wiley-Blackwell (2014).
3. Walter Sneader *"Drug Discovery: A History*", Publisher: John Wiley & Sons (2005).
4. Peter GMW and Thomas WG, *"The Drug Development Process*: Increasing Efficiency and Cost Effectiveness", Publisher: Wiley (2008).

SUGGESTED READING:

1. Thomas NT and Malcolm Rowland, *"Introduction to Pharmacokinetics and Pharmacodynamics*: The Quantitative Basis of Drug Therapy", Publisher: Lippincott Williams & Wilkins (2015).
2. Duolao Wang, Ameet Bakhai, and Shein-Chung Chow, *"Clinical Trials:* A Practical Guide to Design, Analysis, and Reporting", Publisher: Remedica (2006).
3. Milo Gibaldi and Donald Perrier, "Biopharmaceutics and Clinical Pharmacokinetics", Publisher: Lea & Febiger (1982).

Course outcome:

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

- *Students will be able to articulate a comprehensive understanding of the drug discovery process.*
- *Students will acquire the ability to apply medicinal chemistry principles and demonstrate knowledge of how chemical modifications can impact the efficacy and safety profiles of drugs.*
- *Students will be able to analyze preclinical data and assess the safety, ethical considerations surrounding drug discovery research throughout the drug development process.*

Year	IV	Course Code: BC8MJ22	Credits	4
Sem.	VIII	Course Title: Introduction to Stem Cell Technology	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *The course will focus on the biology and mechanism involving stem cells, their applications in replacing, regenerating and engineering human cells for translational regenerative medicine and ethical issues associated with the same.*
- *The objective of this paper is to familiarize the students with stem cell technology and*
- *The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.*

UNIT I: INTRODUCTION TO STEM CELLS (10 Hrs)

Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

UNIT II: TYPES OF STEM CELLS (12 Hrs)

Stem Cell biology and therapy, types embryonic stem cell, Pluripotent, Multipotent and Totipotent Stem cells; Primordial germ cells, adult stem cell, Stem Cell Biology and Therapy, Embryonic Stem Cells, culture and the potential benefits of stem cell technology

UNIT III: THERAPEUTIC APPLICATIONS OF STEM CELLS (12 Hrs)

Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and future prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors

UNIT IV: ETHICAL ISSUES (12 Hrs)

Ethical issues associated with stem cell-based regenerative medicine field**:** Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.

UNIT- V: TISSUE AND ORGAN DEVELOPMENT (14 Hrs)

Differentiation in early development, Potency, Commitment, specification, induction, competence determination and differentiation, morphogenetic gradients, cell fate. Cellular differentiation of the nervous system.

REFERENCE BOOKS:

1. Lanza, R. and Atala, A. (2013) Essentials of Stem Cell Biology, Academic Press, California.
2. Huang, N.F., L'Heureux, N., Song, L. (2018) Engineering Stem Cells for Tissue Regeneration. World Scientific Publishing Company
3. Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. Wiley, 1998

SUGGESTED READING:

1. Scott, C.T. (2006) Stem Cell Now, Pearson Education, New Jersey.
2. Marshak, D.R., Gardner, R.L., Gottlieb, D. Lanza, R., Atala, A (ED.) (2001) Stem Cell Biology.Cold Spring Harbor Press, New York.
3. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003

Course outcome:

- *The course will provide the basic understanding of stem cell biology and their applications in translational therapeutics*
- *The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society.*
- *The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.*

Year	IV	Course Code: BC8MJ23	Credits	4
Sem.	VIII	Course Title: Cell Signaling	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course Objectives:

- *Develop a thorough understanding of the fundamental principles of cell signaling.*
- *Understand downstream events in signaling cascades, such as the role of second messengers and the mechanisms of signal amplification and termination*
- *Gain expertise in the study of intracellular signaling pathways*
- *Apply the knowledge of cell signaling principles to understand diseases associated with aberrations in signaling pathways*

UNIT I: INTRODUCTION TO CELL SIGNALING (10 Hrs)

Overview of cellular communication, Types of signaling: autocrine, paracrine, endocrine, Local and long-distance communication. Components of signaling pathways: ligands, receptors, effectors, Historical milestones in cell signaling research

UNIT II: RECEPTOR-LIGAND INTERACTIONS (12 Hrs)

Receptor classification: cell surface receptors, intracellular receptors, Ligand binding and conformational changes, Downstream events triggered by receptor activation, Signal amplification and termination, Mechanisms for terminating signals. Signal Termination-Role of phosphatases and desensitization.

UNIT III INTRACELLULAR SIGNALING PATHWAYS (12 Hrs)

Second messengers: cAMP, cGMP, calcium ions, Protein kinases and phosphorylation cascades: Examples of key signaling pathways: MAPK, JAK-STAT, NF-κB. G-protein coupled receptors (GPCRs), Enzyme-linked receptors and receptor tyrosine kinases (RTKs)

UNIT IV REGULATION OF CELL SIGNALING (14 Hrs)

Negative feedback loops in signaling pathways, Examples of negative feedback in different signaling pathways. Crosstalk between signaling pathways, Cell communication in development and tissue homeostasis- Signaling in embryonic development.

Role of signaling in tissue regeneration and repair. Role of signaling in immune responses- Inflammatory signaling pathways. Immunomodulation and therapeutic implications

UNIT V: DISEASES AND ABERRATIONS IN CELL SIGNALING (12 Hrs)

Genetic mutations and signaling pathway dysregulation- Diseases associated with genetic alterations in signaling pathways, Cancer and abnormal cell signaling- Hallmarks of cancer and their connection to signaling pathways.

Oncogenes and tumor suppressor genes. Signaling in neurodegenerative diseases- Therapeutic targeting of signaling pathways- Overview of drug development targeting signaling pathways.

REFERENCE BOOKS:

1. "Cell Signaling" Wendell Lim, Bruce Mayer, Tony Pawson (2014), Garland Science Publications, 3rd edition
2. "Molecular Biology of the Cell", Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2014), Garland Science Publications, 6th edition
3. "Signal Transduction", Bastien D. Gomperts, Ijsbrand M. Kramer, Peter E.R. Tatham (2009), Academic Press Publications, 3 rd edition
4. "Cell Signaling in Health and Disease" Martin Beckerman, (2018), CRC Press, 1st edition

SUGGESTED READING:

1. "Principles of Cell Signaling" Authors: C. David Sherris, Robert E. Sherris, (2010), Garland Science Publication, 1st edition
2. "Cell Signaling: Principles and Mechanisms" Tony Pawson, Anthony J. Hunter (1998), Oxford University Press, 1st edition
3. "Cell Signaling and Growth Factors in Development: From Molecules to Organogenesis" Daniel R. Marshak, Michael T. Coughlin, Jeffrey L. Smith, (2006), Cold Spring Harbor Laboratory Press, 1st edition

Course outcomes:

Students will be able to

- *articulate the fundamental principles of cell signaling, including the classification of signaling molecules, receptors, and effectors.*
- *demonstrate an understanding of signal amplification and termination*
- *develop expertise in studying intracellular signaling pathways, including the role of protein kinases, phosphorylation cascades, and second messengers*
- *apply their knowledge of cell signaling concepts to understand the molecular basis of diseases associated with aberrant signaling pathways*

MINOR COURSES OFFERED TO OTHER DEPARTMENT OF LIFESCIENCES

Year	I	Course Code: BC1MI01E2	Credits	4
Sem.	I	Course Title: Fundamental of Biochemistry	Hours	45 (T) 30 (P)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

This course is designed to:

- *serve as a bridge-course between the basics of chemistry and biology learnt in school, and those which will be taught in this degree program*
- *learn about the structural and functional role of vital biomolecules like carbohydrates, proteins, fats, and nucleic acids in biological systems*
- *appreciate the role of biochemical processes in living organisms.*

UNIT-I: CHEMISTRY OF CARBOHYDRATES (9 hrs)

Definition and classification of carbohydrates, linear and ring forms (Haworth formula) for monosaccharides (ribose, glucose, fructose, mannose, galactose)–disaccharides and glycosidic bond (maltose, lactose, sucrose). Physical properties – mutarotation Chemical properties – oxidation, reduction, osazone formation. Polysaccharides (homo and hetero): starch, glycogen and cellulose – occurrence, structure and functions.

UNIT-II: CHEMISTRY OF AMINOACIDS AND PROTEINS (9 hrs)

Standard and non-standard amino acids and their properties, amphoteric nature, isoelectric point, isoelectric pH and Zwitter ion. Proteins: classification – shape and size, solubility, physical properties and functional properties. Primary, secondary, tertiary and quaternary structure of protein.

UNIT-III: CHEMISTRY OF LIPIDS (9 hrs)

Definition, classification and functions. Occurrence, chemistry and biological functions – simple lipids, phospholipids steroids (e.g. cholesterol). Saturated and unsaturated fatty acids physical property–emulsification. Chemical properties – saponification, rancidity, definition of acid number, saponification number, iodine number and Reichert-Meissl number.

UNIT-IV: CHEMISTRY OF NUCLEIC ACIDS (9 hrs)

Definition, sugar pucker – nucleoside, nucleotide and polynucleotide. Double helical model of DNA – super coil forms and linking numbers of DNA. Structure of RNA's– occurrence, chemistry and biological functions. Differences between DNA and RNA, properties– quantification of nucleic acids – thermal denaturation – cot curve and cot value, T_m, hypo and hyperchromicity.

UNIT -V: METABOLIC PATHWAYS **(9 hrs)**

Glycolysis, TCA cycle and its energetics, electron transport chain and oxidative phosphorylation: Gluconeogenesis, Deamination, transamination reaction, Urea cycle β – oxidation of fatty acids.

EXERCISES: **(30 hrs)**

Preparation of Molar, Normal solutions and buffers – Determination of pH using pH meter - Qualitative analysis of carbohydrates, protein and fats-Estimation of glucose by Benedict's test, Estimation of ascorbic acid, Preparation of starch from potatoes, Determination of activity of human salivary α amylase.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.
3. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the chemical and molecular foundations of life and their roles in biological systems*
- *Comprehend the classification, structure, chemical properties and biological functions of carbohydrates, lipids, amino acids, proteins and nucleic acids*
- *Prepare biochemical solutions and analyze various biomolecules qualitatively in the laboratory.*

Year	I	Course Code: BC2MI02E2	Credits	4
Sem.	II	Course Title: Basic Concept in Nutrition	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course is an introduction to the importance of nutrition in human health*
- *It includes the requirement and roles of macro- and micronutrients in the body*
- *The course also provides the biochemical bases of deficiency diseases*

UNIT I: INTRODUCTIONS TO NUTRITION (12 hrs)

Basic concepts of nutrition and health; Role of food in the maintenance of good health; Definition of Health, Nutrition and Malnutrition.

UNIT II: NUTRITIONAL REQUIREMENT (12 hrs)

Minimum Nutritional Requirement and RDA - Formulation of RDA and Dietary Guidelines. Energy in Human Nutrition: Idea of energy and its unit, Energy balance, Assessment of energy requirements - Deficiency and Excess, Determination of energy in food, BMR and its regulation, SDA.

UNIT III: CONCEPTS OF CALORIE (12 hrs)

Nutrients in food and food supplying them; Carbohydrates, Protein,Fat, Vitamins and Minerals - Source, functions and requirements and deficiency.

UNIT IV: BASIC FOOD GROUPS AND STUDY OF DIFFERENT FOODS (12 hrs)

Food pyramids - Nutritional allowances -Nutrition during preschool, school, adolescence, adulthood and old age.

UNIT V: ENERGY REQUIREMENTS (12 hrs)

Energy requirement during rest, different physical activities. Dietrelated health disorders - Alcohol, drugs, food poisoning, allergy, anorexia, bulimia, etc.

REFERENCE BOOKS:

1. Dietetics by B Srilakshmi, 2014, 7th Edition, Publisher: New Age International Private Limited.
2. Principles of Nutrition & Dietetics, Swaminathan M, ISBN-13: 5551234022792, 2001, the Bangalore Printing
3. ASSOCHAM Study on Preventive Healthcare. 2009

Course outcomes:

- *Upon successful completion of this course, students are able to Describe the biochemical roles of macro- and micronutrients in human health and disease and calculate the recommended metabolic requirements in normal humans, athletes and pregnant women*

Ear	II	Course Code: BC3MI03E2	Credits	4
Sem.	III	Course Title: Lifestyle Disorders &Management	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course is designed to promotes and protects health and well-being*
- *This emphasis on the practices such as eating nutrient rich foods, prevention & management.*
- *It also aims to impart knowledge on many chronic noncommunicable diseases, such as heart disease, diabetes and cancer.*

UNIT I: LIFESTYLE & ATHEROSCLEROSIS (12 hrs)

Life style, food habits, healthy habits, exercise and unhealthy habits (brief description only). Characteristics, causes (confirmed & indirect risk factors – brief description only), ischemia, myocardial infarction -definition, Diagnosis (electrocardiography, Exercise ECG – Stress test, Echocardiography, Coronary angiography, Intravascular ultrasound, Magnetic resonance imaging – brief description only), Prevention (lifestyle, diet, drugs), management (drugs, angioplasty, stent, bypass surgery- brief description only).

UNIT II: HYPERTENSION (12 hrs)

Characteristics, Causes, Diagnosis, Prevention and Management (brief description only), Stroke, Characteristics (ischemic and hemorrhagic), Causes, Diagnosis (neurological examination, scanning - brief description only), Management – (drugs, Mechanical thrombectomy, Angioplasty and stenting – brief description only).

UNIT III: DIABETES MELLITUS (12hrs)

Classification – type 1, type 2, gestational (brief description only), Type 2 diabetes: Glucose level, GTT, Glycated haemoglobin (mention only) Characteristics (polyuria, polydypsia, polyphagia), Causes, Diagnosis, Management (diet, exercise, drugs). Obesity classification according to BMI (brief description), symptoms, causes, diagnosis, treatment and management.

UNIT V: CANCER (12 hrs)

Introduction, Types-(benign, malignant), Metastasis (definition), Causes, Diagnosis (screening. blood tests, X-rays, CT scans & endoscopy - brief description only), Prevention-(Dietary, Medication, Vaccination, Screening-Outline only) Management- (Surgery, Chemotherapy, Radiation, Palliative care).

UNIT VI: NEPHRITIS **(12 hrs)**

Functions of kidney (brief outline), Nephritis (mention subtypes), Causes, Symptoms, Diagnosis (Kidney function test) Treatment, management (dialysis- peritoneal and hemodialysis). Liver disease Function of liver (brief outline), Liver disease symptoms, causes, diagnosis (Liver function test), treatment and management.

REFERENCE BOOKS:

1. Dietetics by B Srilakshmi, 2014, 7th Edition, Publisher: New Age International Private Limited.
2. Preventing non communicable diseases in the workplace through diet and physical activity: WHO/World Economic Forum report of a joint event. 2008.
3. ASSOCHAM Study on Preventive Healthcare. 2009.
4. The effect of diet on risk of cancer by Key TJ, Allen NE, Spencer EA. Lancet. 2002; 360: 86 – 8.
5. Metabolic Syndrome and Related Disorders by Anoop Misra, Lokesh Khurana. doi:10.1089/met.2009.0024.

SUGGESTED READING:

1. Guide to Prevention of Lifestyle Diseases by M. Kumar and R. Kumar, 2003, DEER & DEEP publications, New Delhi
2. Principles of Nutrition & Dietetics by Swaminathan M, ISBN-13: 5551234022792, 2001.

Course Outcomes:

Upon successful completion of this course, students are able to:

- *Describe dimensions of health and concepts of wellness.*
- *Identify the major physical and psychological health concerns of our nation.*
- *Describe how personal decisions and behaviors affect health and impact the most common lifestyle diseases.*
- *Identify basic principles of nutrition and ways to obtain/maintain a healthy body composition.*
- *Describe and discuss the health- related components of physical fitness and techniques for developing a personal exercise program.*

Year	II	Course Code: BC4MI04E2	Credits	4
Sem.	IV	Course Title: Microbiome	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs. Duration of ESA (Practical): 03 hrs.		

Course objectives:

- *To introduce basic concepts, terminology, techniques, and significance of microbiome.*
- *To recognize how microbiome has greatly impact on the health.*

UNIT I: INTRODUCTION TO MICROBIOME (12 hrs)

Evolution of microbial life on Earth. Normal human microbiota and their role in health-gut microflora, skin microflora, microflora of reproductive and excretory system. Symbiotic and parasitic association.

UNIT II: CULTURING OF MICROBES FROM MICROBIOMES (12 **hrs)**

Culturing of organisms of interest from the microbiome: bacterial, fungal, and yeast.

UNIT III: STUDY OF THE MICROBIOME GENOME AND APPLICATIONS(12 hrs)

Approaches and methods for study the human microbiome: Emerging culture and sequence-based technologies for human microbiome analysis (in brief); Fecal microbiota transplantation (FMT), Human Microbiome and its pharmaceutical and biotechnology applications in brief.

UNIT IV: MICROBIOMES AND HUMAN HEALTH (12 hrs)

Pre- and post-natal Microbiome, metabolic health-role of gut microbiomes in human obesity, human type 2 diabetes. Influence of microbiome in aging (in brief).

Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and symbiotic. Functional foods-health claims and benefits, Development of functional foods.

UNIT V: MICROBIOMES AND DISEASES (12 hrs)

Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials (in brief).

REFERENCE BOOKS:

1. Edward Ishiguro, Natasha Haskey and Kristina Campbell, *Gut Microbiota*. 1st edition, (2018), 2008pp.
2. Beloborodova NV, *Human Microbiome*. Intech Open, (2021), 166pp.
3. Nwadiuto (Diuto) Esiobu, Olawole O. Obembe, et al., *Microbiomes and Emerging Applications* (Multidisciplinary Applications and Advances in Biotechnology), 1st edition, CRC Press, (2022).

SUGGESTED READING:

1. Angela E Douglas, (2018), *Fundamentals of Microbiome Science*: How Microbes Shape Animal Biology. Princeton University Press. 248pp.
2. Emeran Mayer, (2018), *The Mind-Gut Connection*: How the Hidden Conversation within our bodies impacts our mood, our choices, and our overall Health. Harper Wave, 336pp.
3. Robert G. Beiko, Will Hsiao, John Parkinson, (2019), *Microbiome Analysis*: Methods and Protocols: 1849 (Methods in Molecular Biology), 1st ed. 2018 edition

Course Outcome:

- *A detailed knowledge and understanding of Microbiome field*
- *Designing the research plans or experimental setup to address the specific issues on Microbiome.*
- *Enable students to work efficiently in their future to pursue career opportunities.*
- *Compare and contrast the micro biome of different human body sites.*
- *The scope of microbiome in sustainable healthcare promotion.*

MINOR COURSES OFFERED TO STUDENTS OF NON-LIFE SCIENCES

Year	I	Course Code: BC1MI01E3	Credits	4
Sem.	I	Course Title: Biodiversity	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *Explore the importance of biodiversity in maintaining ecological balance and the well-being of ecosystems.*
- *Evaluate the role of protected areas, habitat restoration, and sustainable resource management in biodiversity conservation.*
- *Analyze the ethical and socio-economic implications of biodiversity loss and explore ways to mitigate negative human impacts*

UNIT I: INTRODUCTION TO BIODIVERSITY (12 hrs)

Understanding Biodiversity, Definition and scope of biodiversity, Types of biodiversity: genetic, species, and ecosystem diversity, Biodiversity hotspots and global distribution, Tools and technologies for biodiversity assessment

UNIT II: ECOSYSTEM AND EVOLUTIONARY PROCESSES (12 hrs)

Evolution and Biodiversity, Darwinian evolution and natural selection, Speciation and the origin of biodiversity, Adaptive radiation and convergent evolution, The role of biodiversity in providing essential services, Ecosystem services and their impact on human well-being, basic Policy and legal frameworks for biodiversity conservation

UNIT III: THREATS TO BIODIVERSITY (12 hrs)

Biodiversity Conservation Challenges, Anthropogenic threats: habitat loss, pollution, climate change, Invasive species and overexploitation, Natural threats: diseases and natural disasters and managing small populations, Biodiversity and Human Interactions, Ethics of biodiversity conservation

UNIT IV: ECOSYSTEM BIODIVERSITY (12 hrs)

Ecosystem Structure and Function, Ecosystem components and interactions, Biotic and abiotic factors influencing biodiversity, Ecological niches and biodiversity patterns, Biodiversity's role in ecosystem stability and resilience.

UNIT 5: CONSERVATION AND CHALLENGES (12 hrs)

International efforts in biodiversity conservation, Challenges and opportunities for global biodiversity conservation, emerging issues in biodiversity research and conservation, Integrating biodiversity into sustainable development goals.

REFERENCE BOOKS:

1. "Biodiversity: An Introduction" by Kevin J. Gaston and John I. Spicer, Wiley Publication, 3rd Edition, (2018)
2. "Biodiversity" by E.O. Wilson and F.M. Peter, National Academies Press,1st Edition, (1988)
3. "Biodiversity Conservation: A Multidisciplinary Approach" by Navjot S. Sodhi and Paul R. Ehrlich, Cambridge University Press, 1st Edition (2010)
4. "Biodiversity and Conservation" by Richard B. Primack, W. H. Freeman Publications, on: 4th Edition (2019)

SUGGESTED READING:

1. "Conservation Biology: Foundations, Concepts, Applications" by Fred Van Dyke, Springer, 2nd Edition (2008)
2. "Biodiversity: A Beginner's Guide" by John Spicer, Oneworld Publications,1st Edition ,(2010)
3. "Principles of Conservation Biology" by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll, Sinauer Associates Publications, 3rd Edition (2006)

Course outcomes:

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

- *Students will be able to identify and classify various forms of biodiversity and demonstrate the ability to use taxonomic tools.*
- *Discuss how biodiversity contributes to ecosystem resilience, human well-being, and the overall health of the planet.*
- *Evaluate different conservation strategies and assess their effectiveness in preserving biodiversity.*
- *Propose and discuss potential solutions and sustainable practices to mitigate negative impacts on biodiversity*

Year	I	Course Code: BC2MI02E3	Credits	4
Sem.	II	Course Title: Concepts of Diet Therapy	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

1. *Identify the components of a balanced diet and analyze their contributions to overall well-being.*
2. *Apply knowledge of nutrition to assess and address common health conditions through diet therapy*
3. *Understand the relationship between diet and specific diseases, such as cardiovascular diseases, diabetes, and dietary intolerances, and design appropriate dietary interventions and basics about food adulterants*

UNIT I: INTRODUCTION TO NUTRITION AND DIET THERAPY (12 hrs)

Overview of nutrition: macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals). Introduction to diet therapy: understanding the role of diet in preventing and managing various health conditions. Basic dietary guidelines and recommendations for different populations. Energy requirement for different categories of people, body mass index (BMI). Definition of Basal metabolic rate (BMR): determination and SDA, RQ.

UNIT II: NUTRITION AND COMMON HEALTH CONDITIONS (12 hrs)

Diet therapy for weight management: understanding energy balance, healthy weight loss, and weight gain strategies. Nutrition for cardiovascular health: role of diet in preventing heart diseases and managing conditions like hypertension. Dietary considerations for diabetes: managing blood glucose levels through diet. Addressing common nutritional challenges in non-communicable diseases.

UNIT III: SPECIAL DIETS AND DIETARY RESTRICTIONS (12 hrs)

Vegetarian and vegan diets: meeting nutritional needs without animal products. Gluten-free and lactose-free diets: understanding food intolerances and allergies. Balanced diet, Different criteria for health and well-being: physical, intellectual, emotional, social, spiritual, environmental and occupational.

UNIT IV: DIFFERENT DIMENSIONS FOR FITNESS (12 hrs)

Special nutritional concerns: pregnancy, lactation and aging. Special nutritional requirements of working women, female athletes and post-pregnancy weight management. Eating disorders: anorexia, bulimia, binge-eating and obesity.

UNIT V: PRESERVATION OF FOOD AND ADULTERATION (12 hrs)

Preservation of nutrients, safe food handling and toxicity. Storage of food, food Preservation and Importance of food labels in processed food , food additives and its principles. Food adulteration: definition, detection and prevention. Adulterants in commonly consumed food items.

REFERENCE BOOKS:

1. Mahan LK and Raymond J, Krause's food and nutrition care process (14th ed.), St. Louis: Elsevier, 2017.
2. Gibson R, Principles of nutritional assessment, London: Oxford University Press, 2005.
3. Coombs GF and McClung JP, The vitamins: fundamental aspects in nutrition and health (5th ed.), London: Academic Press, 2017.

SUGGESTED READING:

1. Brody T, Nutritional biochemistry (2nd ed.), San Diego: Academic Press, 1999.
2. Devlin TM, Textbook of biochemistry with clinical correlations (7th ed.), NewYork: John Wiley & Sons, 2010.

Course outcomes:

Upon successful completion of this course, students are able to:

1. *Understand the role of diet therapy in preventing and managing common health conditions, such as obesity, diabetes, and cardiovascular diseases*
2. *Apply knowledge of nutrition principles to create therapeutic diets that support the treatment and management of specific diseases.*
3. *Capable of independently estimating the vitamin and nutrition content in various food stuff in a laboratory*

Ear	II	Course Code: BC3MI03E3	Credits	4
Sem.	III	Course Title: Lifestyle Diseases	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *This course is designed to promotes and protects health and well-being*
- *This emphasis on the practices such as eating nutrient rich foods that are moderate in calories and fat, exercising on most days, avoiding tobacco, drug and alcohol abuse and proper stress management.*
- *It also aims to impart knowledge on many chronic noncommunicable diseases, such as heart disease, diabetes and cancer.*

UNIT I: INTRODUCTION (12 hrs)

Definition of health, lifestyle disorders, types and contributory factors of lifestyle disorders, impact of lifestyle factors on physical & mental health of the people.

UNIT II: LIFESTYLE DISORDERS (12 hrs)

Eating, physical, mental and occupational lifestyle disorders; Causes - food, physical & mental habits and its consequences, Symptoms and Prevention of lifestyle disorders in children, adult and old age diseases.

UNIT III: LIFESTYLE DISORDERS IN INDIA (12 hrs)

Cardiovascular disease – hypertension, heart attack and stroke; Asthma, chronic liver disease, chronic obstructive pulmonary diseases (COPD), nephritis diabetes and osteoporosis; Cancer, Alzheimer's disease and Obesity.

UNIT IV: GROWTH MONITORING AND PROMOTION (12 hrs)

Growth & factors affecting growth and development; Importance of Nutrition for ensuring adequate development, management of diet related to lifestyle disorders.

UNIT V: STRATEGIES AND APPROACHES IN LIFESTYLE DISORDERS (12 hrs)

Prevention of disease by means of dietand lifestyle changes; Lifestyle choices and personal wellness.

REFERENCE BOOKS:

1. Dietetics by B Srilakshmi, 2014, 7th Edition, Publisher: New Age International Private Limited.
2. Preventing non communicable diseases in the workplace through diet and physical activity: WHO/World Economic Forum report of a joint event. 2008.
3. ASSOCHAM Study on Preventive Healthcare. 2009.
4. The effect of diet on risk of cancer by Key TJ, Allen NE, Spencer EA. Lancet. 2002; 360:86 – 8.
5. Metabolic Syndrome and Related Disorders by Anoop Misra, Lokesh Khurana. doi:10.1089/met.2009.0024.

SUGGESTED READING:

1. Guide to Prevention of Lifestyle Diseases by M. Kumar and R. Kumar, 2003, DEER & DEEP publications, New Delhi
2. Principles of Nutrition & Dietetics by Swaminathan M, ISBN-13: 5551234022792, 2001.

Course Outcomes:

Upon successful completion of this course, students are able to:

- *understand the importance of "Nutrition, Exercise, Sleep" will positively influence the students' ability*
- *get awareness on noncommunicable diseases related to common risk factors*

Year	II	Course Code: BC3MI04E3	Credits	4
Sem.	III	Course Title: Ecology & Environment	Hours	45 (L) 15 (T)
Course Prerequisites, if Any	NA			
Internal Assessment Marks: 25	End Semester Marks: 75	Duration of ESA (Theory): 03 hrs.		

Course objectives:

- *To understand the complex interactions of humans and ecological systems in the natural world.*
- *To learn the basic statistical analysis or systems modeling methodology in environmental analysis.*

UNIT I: INTRODUCTION TO ECOLOGY (12 hrs)

Definition and scope of ecology, Levels of ecological organization, Ecological principles and their applications

UNIT II: ECOSYSTEMS (12 hrs)

Ecosystem structure and function, Biogeochemical cycles, Biotic and abiotic components of ecosystems, Human impact on ecosystems

UNIT III: BIODIVERSITY (12 hrs)

Definition and levels of biodiversity, Importance of biodiversity, Threats to biodiversity, Conservation strategies and practices

UNIT IV: ENVIRONMENTAL ISSUES (12 hrs)

Global environmental challenges, Climate change and its impacts , Pollution (air, water, soil), Waste management

UNIT V: SUSTAINABLE PRACTICES AND SOLUTIONS (12 hrs)

Sustainable development principles, Renewable energy sources, Conservation and sustainable resource management, green practices in daily life

REFERENCE BOOKS:

1. Ignaci Muthu S, '*Ecology and Environment'* Eastern Book Corporation, 2007.
2. Krebs, Charles J. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th edition, 2001.
3. Mitsch, J.W. and Jorgensen, S.E., *Ecological Engineering, An Introduction to Ecotechnology*, John Wiley & Sons, New York, 1989.

SUGGESTED READING:

1. OdumE P, *Fundamentals of Ecology*, Sauders publication; Indian edition, Nataraj Publications Dehradun, 1998.
2. Verma PS. and Agarwal VK, *Concept of ecology (Environmental Biology)*, S. Chand & Co. Ltd., New Delhi 2004.

Course outcomes*:*

- *Students will be able to interpret, synthesize, and apply a wide range of scientific literature in the ecological and environmental sciences, particularly dealing with both climate change and global change.*
- *They will be able to interpret environmental, resource management, and sustainability conflicts from multiple perspectives.*
- *They will be able to effectively analyze and integrate the social and natural sciences to understand diverse environmental and sustainability challenges ranging from local issues to global environments.*