POST-GRADUATE WING OF SBRR MAHAJANA FIRST GRADE COLLEGE

(Autonomous)

Accredited by NAAC with 'A' grade

Pooja Bhagavat Memorial Mahajana Education Centre

K.R.S. Road, Metagalli, Mysuru-570016.

Affiliated to University of Mysore.

DEPARTMENT OF STUDIES IN BIOCHEMISTRY

Program: Master of Science
Subject: Biochemistry
Program Code: PGMSBC

REGULATIONS 2023-2024

UPDATED REGULATIONS FOR CHOICE BASED CREDIT SYSTEM (CBCS) AND CONTINUOUS ASSESSMENT GRADING PATTERN (CAGP) FOR M.Sc., BIOCHEMISTRY PROGRAMME

PREAMBLE

The University Grants Commission (UGC) has stressed on speedy and substantive academic and administrative reforms in higher education for promotion of quality and excellence. The Action Plan proposed by UGC outlines the need to consider and adopt Semester System, Choice Based Credit System (CBCS), and Flexibility in Curriculum Development and Examination Reforms in terms of adopting Continuous Evaluation Pattern by reducing the weightage on the semester- end examination so that students enjoy a de-stressed learning environment. Further, UGCexpects that institutions of higher learning draw a roadmap in time bound manner to accomplishthe above.

ABOUT THE COURSE

The M.Sc., Biochemistry course of the University of Mysore is approved by the University Grants Commission. The syllabus is designed to provide a holistic insight into the subject by experts of the University and was adopted for teaching in the Centre. The Department is well furnished and provided with state-of-the-art laboratory facilities. The Department has highly qualified and experienced faculty for the students to learn and experiment, hands on, with techniques of great relevance to current day bio industries. Besides, the Centre also invites eminent Scholars, Scientists and Professors from UOM, CFTRI, DFRL and other institutions for special lecturesto enlighten students on most recent developments in the subject. The students are also encouraged to take part in scientific seminars, group discussions and quiz competitions apart from the other extracurricular activities. Our students have won prizes in intercollegiate essay, debate and music competitions.

OBJECTIVE

The Department makes it their mission to provide socially and industrially relevant post- graduate education and training. The Department also undertakes basic and applied research in the area of Biochemistry as related to the sustainability of the Earth Ecosystem.

The Department endeavors to build and enhance the capabilities of the future generation by providing quality education that provides a deep insight into the subject that can be exploited to build sustainable bio-enterprises. The Department also strives to produce technically highly qualified and skilled scientists to help the bio-industries.

1. TITLE AND COMMENCEMENT

These Regulations shall be as per the University of Mysore regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for M.Sc., Biochemistry program. These Regulations shall come into force from the

academic year 2019.

2. PROGRAM OFFERED

(1) **M.Sc.,** Biochemistry

3. ABOUT THE ASSESSMENT AND CREDITS:

Credit Distribution: The Choice Based Credit System (CBCS) comprises Hard Core, Soft Core subjects for Biochemistry Students and Open Elective for students other than Biochemistry.

Following shall be the minimum and maximum subjects per semester:

The credit pattern is Lecture (L); Tutorial (T); Practical (P); (L: T: P) Pattern.

Course is of 4 credits, and the different credit distribution patterns in L: T: P format is:

0 : 0,	2 : 1,	1 : 2,	0 : 3,	3 : 0,
1 : 1,	2 : 0,	0 : 2,	1 : 0,	0 : 1,
2 : 2,	4 : 0,	0 : 4,	1 : 3,	3 : 1,

The concerned BoS will choose the convenient credit pattern for every course based on the requirement.

One semester period is 16 weeks of teaching and learning.

Duration of semester is 20 weeks that includes semester end examinations. Credit Pattern:

Hard Core: 3 – 6 Credits **Soft Core:** 2 – 4 Credits **Open elective:** 4 Credits

Project Work: 6 Credits

Course Type	Credits
Hard Core	Minimum Credits - 42 and Maximum Credits - 52
Soft Core	Minimum Credits – 16
Open Elective	Minimum Credits - 4

- A Candidate can enroll for **maximum of 24 Credits per semester** inclusive of Open Elective earned from the other Departments.
- A Candidate has to earn a minimum of **76 Credits** for successful completion of Master degree.
- A minimum 76 Credits and additional 18 Credits (76 + 18 = 94 Credits) shall acquire add on Proficiency Diploma.

Continuous Assessment Pattern:

Continuous Assessment	Time Duration	Marks		Minimum 30% and an aggregate of 40% to declare pass
		Max	Min	
C1	1 week to 8 weeks	15	4.5	
C2	9 week to 16 weeks	15	4.5	
C3	Complete 16 weeks	70	21	

Finally, awarding the grades should be completed latest by 24th week of the semester.

4. ELIGIBILITY FOR ADMISSION

Students of Bachelors of Science degree from any UGC recognized Universities in life science subjects with Chemistry or Biochemistry as major subjects are eligible. Students from Foreign National degree will apply through equivalence committee. Minimum percentage of marks is as prescribed by the University of Mysore regulations for admission i e., **45% for general category and 5% relaxation for SC/ST students**.

5. SETTING QUESTIONS PAPERS AND EVALUATION OF ANSWERSCRIPTS

1. Questions papers in three sets shall be set by the internal examiner for a course. Whenever there are no sufficient internal examiners, the chairman of BOE shall get the questions papers set by external examiners.

The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

2. (i) There shall be single valuation for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited.

(ii) The examination for Practical work/ Field work/Project work will be conducted jointly by two internal examiners. However, the BOE on its discretion can also invite external examiners if required.

5.0 Scheme of Instructions

5.1 A Master's Degree program is of 4/6 semesters-two/three year's duration for regular candidates.A regular candidate can avail a maximum of 8/12 semesters – 4/6 years (in one stretch) to complete Masters' Degree (including blank semesters, if any). Whenever, a candidate opts for blank semester(s)/DROP in a course or in courses or is compelled to DROP a course or courses as per the provision of the regulation, he/she has to study the prevailing courses offered by the department as per the prevailing scheme, when he/she continues his/her study.

5.2 A candidate has to earn a minimum of 76 credits, for successful completion of Master's degree with a distribution of credits for different courses as given in the following table.

5.3

Course Type	Credits
Hard Core	A minimum of 42, but not exceeding 52
Soft Core	A minimum of 16
Open Elective	A minimum of 4

Every course including project work, practical work, field work, seminar, self- study elective should be entitled as hard core or soft core or open elective by the BoS concerned.

Note: Minimum credit requirement for the award of master's degree in specific programmes, refer Annexure III

5.4 A candidate can enroll for a maximum of 24 credits per semester with the approval of the concerned department.

5.5 Only such candidates who register for a minimum of 18 credits per semester in the first two semesters and complete successfully 76 credits in total of the 4 semesters shall be considered for declaration of ranks, medals and are eligible to apply for student fellowship, scholarship, free ships and hostel facilities.

5.6 In excess to the minimum of 76 credits for master degree in the concerned discipline / course of study, a candidate can opt to complete a minimum of 18 extra credits to acquire **add on proficiency diploma** in that particular discipline/course along with the masters' degree. In such of the cases wherein, a candidate opts to earn at least 4extra credits in different discipline / courses in addition to a minimum of 76 credits at master level as said above then an **add on proficiency certification** will be issued to the candidate by listing the courses studied and grades earned.

5.7 A candidate admitted to Master Program can exercise an option to exit with Bachelor Honors Degree / PG diploma after earning 40 credits successfully.

6.0. Continuous Assessment, Earning of Credits and Award of Grades

The evaluation of the candidate shall be based on continuous assessment. The Structure for evaluationis as follows:

Assessment and evaluation processes happen in a continuous mode. However, for reporting purposes, a semester is divided into 3 discrete components identified as C1, C2, and C3.

6.1 The performance of a candidate in a course (30:70 pattern) will be assessed for a maximum of 100 marks as explained below:

6.1.1 The first component (C1), of assessment is for 15 marks. This will be based on test/ assignment/seminar/quiz/group discussions, etc., during the first half of the semester; the first 50% of the syllabus will be completed. This shall be consolidated during the 8^{th} week of the semester. Beyond 8^{th} week, making changes in C1 is not permitted.

6.1.2 The second component (C2), of assessment is for 15 marks. This will be based on test/ assignment/seminar/quiz/group discussions etc. The continuous assessment and scores of second half of the semester will be consolidated during the 16^{th} week of the semester. During the second half of the semester the remaining units in the course will be completed.

6.1.2.1. The outline for continuous assessment activities for Component-I (C1) and Component-II (C2) will be proposed by the teacher(s) concerned before the

commencement of the semester and will be discussed and decided in the respective Departmental Council. The students should be informed about the modalities well in advance. The evaluated courses/assignments during component I (C1) and component II (C2) of assessment are immediately returned to the candidates after obtaining acknowledgement in the register maintained by the concern teacher for this purpose.

6.1.3 Setting question papers and evaluation of answer scripts:

I. Question papers in two sets shall be set by the internal examiner and one set by external examiner for a course. Whenever there are no sufficient internal examiners, The Chairman, BoEshall get the question papers set by external examiners.

Whenever there are no external examiners, The Chairman, BoE shall get the question papers set by internal examiner.

II. The Board of Examiners shall scrutinize and approve the question papers and scheme ofevaluation.

III. (i) There shall be single evaluation for all theory papers by internal examiner and 25% ofthe total scripts will be reviewed by an external examiner.

(ii) The average of first valuation and the review evaluation will be considered as the final marks ofthe candidate.

(iii) If there is difference of marks in maiden and reviewed evaluation is greater than 15 marks, then the script will go for third evaluation by the external examiner and marks awardedin the third evaluation will be final.

(iv) The examination for Practical work/ Field work/ Project work will be conducted jointly by oneinternal and one external examiner.

(v) If a course is fully of (L=0): T: (P=0) type, then the examination for C3Component will be asdecided by the BOS concerned.

IV. Challenge Evaluation

A student who desires to apply for challenge evaluation shall obtain a Xerox copy of the answer script by paying the prescribed fee within 10days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Controller of Examinations within

15 days after the announcement of the results. This challenge evaluation is only for C3 component.

The answer scripts, for which challenge evaluation is sought for, shall be sent to external examiner.

The marks awarded in the challenge evaluation will be final.

6.1.4 In case of a course with only practical component a practical examination will be conductedwith two examiners (one Internal and one external)

A candidate will be assessed on the basis of

a) Knowledge of relevant processes

b) Skills and operations involved
c) Results / products including calculation and reporting.

If external examiner does not turn up, then both the examiners will be internal examiners. The duration for semester-end practical examination shall be decided by the Departmental council.

6.1.5 If **X** is the marks scored by the candidate out of 70 in C3 in theory examination, if **Y** is the marks scored by the candidate out of 70/50/40 in C3 in Practical examination, and if **Z** is the marks scored by the candidate out of 70/50/40 in C3 for a course of (L=0): T:(P=0) type that is entirely tutorial based course, then the final marks (M) in C3 is decided as per the following table.

6.1.6 6.1.6

L.T.P distribution	Formula to compute Mark (M) in C3
L:T:P	[(L+T)*X]+[(T+P)*Y] L+2T+P
L:(T=0):P	(L*X)+(P*Y) L+P
L:T:(P=0)	X
L:(T=0):(P=0)	X
(L=0):T :P	Y
(L=0): (T=0):P	Y
(L=0): T:(P=0)	Z

Continuous Formative Evaluation/Internal Assessment (HC, SC & OE)

Credit Distribution: The Choice Based Credit System (CBCS) comprises HardCore, Soft Core subjects for Biochemistry Students and Open Elective for students other than Biochemistry.

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Credit Pattern: **Hard Core:** 3 – 6 Credits **Soft Core:** 2 – 4 Credits **Open elective:** 4 Credits

Project Work:

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- A Candidate has to earn a minimum of **76 Credits** for successfulcompletion of a Master's degree.
- A minimum 76 Credits and additional 18 Credits (76 + 18 = 94 Credits) shall acquire add on Proficiency Diploma.

Continuous Assessment Pattern:

The details of continuous assessment (30:70 patterns) are summarized in

The following table:

Component	Syllabus in a Course	Weightage	Period of Continuous Assessment	Marks
C1	First 50%	15%	First half of the semester To be consolidated by 8thweek	15
C2	Remaining 50%	15%	Second half of the semester. To be consolidated by 16thweek	15
C3	Semester-end examination (All units of the course)	70%	To be completed during 18th-20th Week.	70

Continuous Assessment	Time Duration	Marks		Minimum 30% and an aggregate of 40% to declare pass
		Max	Min	
C1	1 week to 8 weeks	15	4.5	
C2	9 week to 16 weeks	15	4.5	
C3	Complete 16 weeks	70	21	

Finally, awarding the grades should be completed latest by 24th week of thesemester.

Theory evaluation:

Component – I (C1): Periodic Progress, Progress Reports, test (15%) calculated for 15marks

Component – II (C2): Periodic Progress, seminar, test (15%) calculated for 15marks)

Component III: (C3): Final exam (end semester exam for 70marks) (70%)

Practical evaluation:

Component – I (C1): Periodic Progress, Laboratory record and Progress Reports (15%)

Component – II (C2): Results of Work, tour report, assignment, class tests,laboratory exercise and Draft Report (15%)

Component III: (C3): (70%) Practical exams to be conducted for 6 hours, students will prepare reagents and perform the experiments, report to the examiners. A viva voce will be conducted during practical examination for each student and marks are allotted accordingly from the experimental efficiency and viva.

In case a candidate secures less than 30% in C1 and C2 put together in a course, the candidate is said to have DROPPED that course, and such a candidate is not allowed to appear for C3 in that course.

Minor/ Major Project Evaluation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the guide. Components of evaluation are as follows:

Component – I (C1): Periodic Progress and Progress Reports (15%) Component – II (C2): Results of Work and Draft Report (15%) Component– III (C3): Final Viva-voce and evaluation (70%).

The report evaluation is for 40% and Viva-voce examination is for 30%.

6.2 In case a candidate secures less than 30% in C1 and C2 put together in a course, the candidate is said to have DROPPED that course, and such a candidate is not allowed to appear for C3 in that course.

In case a candidate's class attendance in a course is less than 75%, the candidate is said to have DROPPED that course, and such a candidate is not allowed to appear for C3 in that course.

Teachers offering the courses will place the above details in the Department Council meeting during the last week of the semester, before the commencement of C3, and subsequently a notification pertaining to the above will be brought out by the Chairman of the Department before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Director & the Controller of Examinations.

6.3 In case a candidate secures less than 30% in C3, he/she may choose DROP/MAKEUP option.

In case a candidate secures more than or equal to 30% in C3, but his/her grade (G) = 4, as per section 6.9 below, then he/she may be declared to have been conditionally successful in this course, provided such a benefit of conditional clearance based on G=4 shall not be availed for more than 8 credits for the entire program of Master's Degree of two years.

In case a candidate secures more than 30% in C3, he/she may choose DROP/MAKE-UP option.

The candidate has to exercise his/her option immediately within 10 days from the date of notification of results.

A MAKE UP examination for C3 shall be conducted in all the semesters. Candidates can register for the MAKE UP examination within 10 days from the date of notification of results. The MAKE UP examination will be conducted within one month of the notification of the results.

If a candidate is still unsuccessful, A MAKE UP Examination for odd semester courses will be conducted along with next regular odd semester examinations and for even semester courses along with next regular even semester examinations; however, not exceeding double the duration norm in one stretch from the date of joining the course.

6.4 A candidate has to re-register for the DROPPED course when the course is offered again by the department if it is a hard core course. The candidate may choose the same or an alternate core/elective in case the dropped course is soft core / elective course. A candidatewho is said to have DROPPED project work has to re-register for the same subsequently within the stipulated period.

6.5 <u>The details of any dropped course will not appear in the grade card.</u>

6.6 The tentative / provisional grade card will be issued by the Controller of Examinations at the end of every semester indicating the courses completed successfully. This statement will not contain the list of DROPPED courses.

6.7 Upon successful completion of Bachelors Honors/Master's Degree, a final grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Controller of Examinations.

6.8 The grade and the grade point earned by the candidate in the course will be as given below.

Marks(M)	Grade	Grade Point (GP = V x G)
30-39	4	V*4
40-49	5	V*5
50-59	6	V*6
60-64	6.5	V*6.5
65-69	7	V*7
70-74	7.5	V*7.5
75-79	8	V*8
80-84	8.5	V*8.5
85-89	9	V*9
90-94	9.5	V*9.5
95-100	10	V*10

Here, **P** is the Percentage of marks (P = [(C1+C2) + M] secured by a candidate in a course which is rounded to nearest integer. **V** is the credit value of course. **G** is the Grade and **GP** is the Grade Point.

6.9 A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a paper, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is soft core/open elective.

A DROPPED course is automatically considered as a course withdrawn.

6.10 Overall Cumulative Grade Point Average (CGPA) of a candidate after successfully completing the required number of credits (76) is given by:

CGPA = ΣGP / Total Number of Credits

7. Classification of Results

The Final Grade Point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Numerical Index	Qualitative Index

4<= CGPA <5	5	Second Class
5<= CGPA <6	6	
6<= CGPA <7	7	First Class
7<= CGPA <8	8	
8<= CGPA <9	9	Distinction
= CGPA <10		

Overall Percentage = 10* CGPA or is said to be 50% in case CGPA<5

Medium of Instruction

The medium of instruction shall be English. However, a candidate will be permitted to write the examinations either in English or Kannada. This rule is not applicable to languages.

8. Attendance and Conduct

Students SHALL NOT take up any employment/course, part time or full time during their study. Students found violating this rule shall be removed from the course. Minimum attendance of 75% of actual working hours in all the courses is required. A student who does not satisfy the requirements of attendance and conduct shall not be permitted to write examination.

In the case of a candidate who represents his institution/University/Karnataka State/Nation in Sports/NCC/NSS/Cultural or any official activities, shortage of attendance up to maximum of 15 days in a Semester per course may be condoned, based on the recommendation and prior permission of the Head of the Institution concerned.

The Head of the Department shall notify the list of all students who have less than 75% attendance in each course at the beginning of the 16th week of the semester. A copy of the same should be sent to the Controller of Examination of the college.

9. Transfer within University and from other Universities

a) Transfer to a different institution within the University is permitted only at the beginning of the academic year.

b) A Candidate seeking transfer to a different institution within University of Mysore should have completed all the courses/papers of the previous semesters.

c) A Candidate from any other university can join a program of this college only at the beginning of the academic year.

d) A Candidate from other university seeking admission by transfer to the college should have completed all the courses of the previous semesters.

10. Provision for Appeal

If a candidate is not satisfied with the evaluation of C1 and C2 components, he / she can approach the grievance cell with the written submission together with all facts, the assignments, and test papers etc., which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the college on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she found guilty. The decision taken by the grievance cell is final.

For every program there will be one grievance cell. The composition of the grievance cell is as follows.

1. The Controller of Examinations-ex-officio Chairman / Convener
2. One senior faculty member (other than those concerned with the evaluation of the course concerned) drawn from the department/discipline and/or from the sister departments/sister disciplines.
3. One senior faculty member / course expert drawn from outside the department.

11. Discipline

1) Every student is required to maintain discipline and decorum both inside and outside the campus in accordance with the instructions of the college and also as per the instructions issued by the University of Mysore/Government of Karnataka/UGC from time to time regarding Student Conduct Rules.
2) Any act of indiscipline of a student is first to be considered by the Disciplinary committee of the college for necessary action. If the issue demands more serious consideration, the act of indiscipline will be reported to the concerned authority who will initiate appropriate action.
3) Concerned authority may take necessary actions depending upon the prima facie evidence.

12. Any other issue not envisaged above, shall be resolved by the competent authority of the autonomous college, which shall be final and binding.

Any matter which is not covered under this regulation shall be resolved as per the University of Mysore Regulations in this regard.

DEPARTMENT OF STUDIES IN BIOCHEMISTRY

Motto: Our motto is to provide impetus for education, training, opportunities and work environments that are characterized by honesty, liability, impartiality, and a commitment to understand concepts of life at the Biochemical and Molecular level forall cadres of society.

Vision: Our vision is to obtain a well-defined elucidation of the molecular interactions that underlie both normal physiology and disease states of life forms which is the foundation of etiology, drug designing and personalized medicine. Additionally, our goal is to understand the molecular mechanisms of and to develop new tools, for biology such as biosensors, biomarkers, study models and therapeutic molecules that will enhance the quality of life through better medical care, disease prevention measures, nutrition, and environmentally sound processes.

Mission: Provision of academic environment for promoting the quality of learningand research in biochemistry. To be a diverse, inclusive community that serves students, our professionals and the public through innovative education, individualized advising, holistic mentoring and cutting-edge molecular life science research that creates knowledge and solves real-life problems.

Objectives

To enable students to become Teachers in academia.

To enable motivated researchers in research institutions or industries.

To enable entrepreneurial skills so as to serve the industries as well as initiate ownfirms.

PO: Program outcome:

1. To develop an ability to acquire in-depth theoretical and practical knowledge of Biochemistry
2. To demonstrate an understanding of structure and metabolism of biological macromolecules and tounderstand the regulation and disorders of metabolic pathways.
3. To gain proficiency in laboratory techniques in biochemistry and biological sciences like immunology, physiology, molecular biology, enzymology and biotechnology.
4. To develop an ability to understand the technical aspects of existing technologies and to provide cost efficient solutions that help in addressing the biological and medical challenges faced by mankind. Additionally, the practical skills are improved which help their research experience among academic or industrial R&D programs.
5. To understand the published literature by using online and offline methods; to be able to apply the scientific method to the processes of experimentation and hypothesis testing. To develop an ability to translate knowledge of Biochemistry to address environmental, intellectual, societal, and ethical issues through innovative thinking and research strategies.
6. To develop an ability to put forward the scientific perception to a person/ community belonging to non-science background. Also, inculcate skills for teaching in academic institutions forundergraduate and postgraduate students.
7. Develop confidence in taking competitive examination in the field of life sciences both in India andabroad so that they can pursue higher education.

Pedagogies employed

1. The regular class room sessions will include the use of black board/ whiteboard, power point presentations, video presentations.
2. Theclass room teaching will also use additional information andcommunications technology (ICT).
3. Group discussions about the class and student seminars.
4. Tutorials include interaction with individual student for the preparation ofseminars,practical problems.
5. Each student performs experiments as per the protocol in practical sessions.
6. Student seminar/ research paper presentation in each semester.
7. Project work on a small research problem.
8. Literature review in the form of Dissertation and presentation.
9. Invited talks from eminent scientists.
10. Laboratory / industrial visits to understand the real time processing/ functioning ofacompany.

M.Sc. DEGREE IN BIOCHEMISTRY

Eligibility:

1. Eligibility is as prescribed by the University of Mysore regulations for PG admission.
2. Students of Bachelors of Science (B.Sc.) degree from any UGC recognized Universities with Chemistry or Biochemistry as one of the majors/Optional
3. For general category- minimum 45% marks in Chemistry/ Biochemistry
4. For SC/ST category- 40% marks in Chemistry/ Biochemistry
5. Students with bachelor degree from Foreign Universities will apply through equivalence committee of University of Mysore.

The applicant has to take "Post Graduate Entrance Examination (PGEE)" for the current year conducted by the University of Mysore or as applicable and marks obtained shall be filled in the college application form.

Course Structure

CHOICE BASED CREDIT SYSTEM

Semesters	Hard Core (HC)		Soft Core (SC)		Open Elective (OE)		Total	
	Number of Courses	Credits	Number of Courses	Credits	Number of Courses	Credits	Number of Courses	Credits
I semester	6	19	01	03	-	-	7	22
II semester	4	11	02	06	01	04	7	21
III semester	4	12	02	08	-	-	6	20
IV semester	1	10	01	03	-	-	2	13
Total	15	52	06	20	01	04	22	76

Credits to be earned for Successful award of M.Sc. degree in Biochemistry

A Candidate has to earn a minimum of 76 Credits for successful completion of a Master degree. Additional 18 Credits (Total: 76 + 18 = 94 Credits) shall acquire add on Proficiency Diploma.

	Minimum Required	Obtained
Minimum Credits from Hard Core	42	52
Minimum Credits from Soft Core	16	20
Minimum Credits from Open Elective	04	04
Minimum Total Credits	76	76

I Semester

Sl. No.	Course	Course Type	Credit Pattern			Total Credits
			L	T	P	
1	Fundamentals of Biochemistry	FCHC	3	1	0	4
2	Techniques in Biology	FCHC	3	1	0	4
3	Molecular Cell Biology	FCHC	3	1	0	4
4	Bioorganic and Bioinorganic Chemistry	HC	3	0	0	3
5	Practical 1A Experiments in Biological techniques and Bioorganic chemistry & Tour Report (Laboratory Visit and Tour Report)	HC	0	0	2	2
6	Practical 1B Experiments in Cell Biology, Genetics and Bioinorganic chemistry & Seminar	HC	0	0	2	2
	Soft Core (Any One)					
7	Genetics	FCSC	3	0	0	3
	Membrane Biology	SC	3	0	0	3
TOTAL CREDITS: 22 5 Hard Core (HC): 19 Credits; 1 Soft Core (SC): 03 credits						

II Semester

Sl. No.	Course	Course Type	Credit Pattern			Total Credits
			L	T	P	
1	Molecular Biology	FCHC	3	1	0	4
2	Enzymology	HC	3	0	0	3
3	Practical 2A: (Experiments in Molecular Biology and Energy Metabolism; Laboratory visits and Tour report)	HC	0	0	2	2
4	Practical 2B: (Experiments in Enzymology and Research Paper presentation)	HC	0	0	2	2
	Soft Core (Any Two)					
5	Metabolism of Lipids	SC	3	0	0	3
6	Metabolism of Carbohydrates	SC	3	0	0	3
	Endocrinology	SC	3	0	0	3
	Dissertation – Review of Literature	SC	0	2	0	2
	Open Elective papers offered for students of other disciplines					
7	OE: Biology for Non-biologists	OE	2	2	0	4
	OE: Nutrition in Health and Disease	OE	2	2	0	4
	Students of M.Sc. Biochemistry can opt from OE courses offered by non-science Master programs (minimum requirement 4 credits)					
TOTAL CREDITS: 21 , 4 Hard Core (HC): 11 Credits; 2 Soft Core (SC): 06 credits; 1 Open elective (OE): 04 credits						

III Semester

Sl. No.	Course	Course Type	Credit Pattern			Total Credits
			L	T	P	
1	Immunology	FCHC	3	1	0	4
2	Metabolism of Amino Acids and Proteins	HC	3	1	0	4
3	Practical-3A: Experiments in Immunology and amino acid metabolism. Study tour and tour report.	HC	0	0	2	2
4	Practical 3B: Experiments in Metabolism and Review of Literature.	HC	0	0	2	2
	Soft Core (Any Two)					
5	Metabolism of Nucleic Acids	SC	3	1	0	4
6	Research Methodology, Biostatistics, and Bioinformatics	SC	3	1	0	4
	Human Physiology with clinical relevance	SC	3	1	0	4
	Internship	SC	0	0	2	2
TOTAL CREDITS: 20 4 Hard Core (HC): 12 Credits; 2 Soft Core (SC): 08 credits						

IV Semester

Sl. No.	Course	Course Type	Credit Pattern			Total Credits
			L	T	P	
1	Research Project Work, Report and Viva Voce	HC	0	0	10	10
	Soft Core (Any One)					
2	Clinical Biochemistry	SC	3	0	0	3
3	Biotechnology	SC	3	0	0	3
	Plant Biochemistry	SC	3	1	0	4
	Human Nutrition	SC	3	1	0	4
TOTAL CREDITS: 13 1 Hard Core (HC): 10 Credits; 1 Soft Core (SC): 03 credits						

LTP: Lecture, Tutorial, Practical FCHC: Foundation Course Hard Core; FCSC: Foundation Course Soft Core.

M.Sc. Biochemistry I Semester	Fundamentals of Biochemistry Course Code: 23F101	FCHC – Foundation Course Hard Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Basics of Chemical Bonding and Carbohydrates Bonding: Covalent bond; coordinate bond; coordinate bond formation in transition metals. Bonding of iron in hemologlobin and cytochromes, cobalt in Vit B12, magnesium in chlorophyll. Special properties of water; Structure and bonding, non-covalent interactions, reactions of carbohydrates. Carbohydrates: Structure and classification of carbohydrates, monosaccharides (pentoses, hexoses), disaccharides (lactose, sucrose, maltose) and polysaccharides (starch, cellulose, glycogen and bacterial cell wall polysaccharides) explanations.	12h
2	Basics of Amino Acids and Proteins Aminoacids: Nomenclature, classification and buffering properties, zwitterionic structure, reactions of Amino acids. Proteins: Primary, secondary, tertiary and quaternary structures, protein sequencing. Factors responsible for protein folding: Anfinsen's experiment. Non-covalent interactions and S-S bridges in stabilizing the proteins, Denaturation and renaturation of proteins, molten globule, chaperones.	12h
3	Basics of Lipids & Enzymology Lipids: Classification & reaction of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Role in cell membrane. Enzymology: Classification, enzyme activity, Michaelis-Menten kinetics, LB plot, inhibition - competitive, uncompetitive, non-competitive, determination of Ki, active site, allosterism - ATCase, isoenzymes- LDH, catalytic strategies, co-enzymes and cofactors, multienzyme complexes-PDC.	12h
4	Basics of Nucleic Acids: DNA as genetic material ,Griffith ,Avery & Macleod experiments , isolation of DNA & RNA from biological sources, secondary structure of DNA, Watson and Crick model, Chargaff's rule; B and Z DNA. Features of mitochondrial, chloroplast DNA and plasmids. Secondary structure of tRNA and clover leaf model. Physiochemical properties of nucleic acids, melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on Cot curve.	12h
Learning Outcomes: After studying this paper the students will know – Knowledge of Chemistry of biomolecules. The fundamental principles in sequencing of DNA. Importance of biomolecules in the biological system.		

Structure and function of enzymes.
References: Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited. Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd. Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman. Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK. Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall. Nelson, D. L., Lehninger, A. L., and Cox, M. M. 2008. Lehninger principles of biochemistry. New York : Voet, D., and Voet, J. G. 2010. Biochemistry, (4th Ed.) New York: J. Wiley & Sons.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	2	2	2	3	3	3
CO2	2	1	2	1	2	2	2
CO3	2	2	2	2	1	1	2
CO4	1	2	1	2	2	2	1
Weighted average	2	1.75	1.75	1.75	2	2	2

M.Sc. Biochemistry I Semester	Techniques in Biology Course Code: 23F102	FCHC – Foundation Course Hard Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Biological samples: Types and preparation Study Models: In vivo and in vitro models; Microbial, Animal, Plants; choice of models; types of studies, Auxotrophs. Routes of exposure of test chemicals in animals. Culture: microbes, animal and plant cells in laboratory. Cell fractionation techniques: Tissue homogenization, Cell lysis techniques, extraction of cellular contents. Protein purification techniques: salting in, salting out, dialysis and ultrafiltration. Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium. Ultra centrifugation: Differential and density gradient centrifugation, centrifugal elutriation, isolation of cell organelles (e.g. Mitochondria) from biological tissue samples.	12h
2	Spectroscopic analysis Principles and applications of colorimeter, spectrophotometer, fluorimeter, multiwall plate reader. Beer-Lambert's Law and its limitations. Extinction coefficient, chromogenic and fluorescent probes, their applications. Principle of flame photometry, and X-ray crystallography, IR, ESR, NMR & Raman's spectroscopy.	12h
3	Chromatographic and electrophoretic techniques Chromatography: Principles, working and applications of paper chromatography (radial, ascending, descending and 2-D), Thin layer chromatography, Brief introduction, application of Adsorption, Ion exchange, Gel filtration, Affinity, Gas chromatography. Chromato focusing, HPLC, UPLC and FPLC. Protein electrophoresis: Polyacrylamide gel electrophoresis, SDS-PAGE, IEF & 2DEF.Visualizing proteins using CBB, silver stain;glycoproteinsand lipoproteins staining,Brief introduction to Zymogram and reverse zymogram; Nucleic acid electrophoresis: Agarose gel electrophoresis, Visualizing nucleic acids in using Ethidium bromide and UV. Fluorescence probes: SYBR green and Eeva green, Taq man, PFGE and capillary electrophoresis.	12h
4	Radiochemistry and Mass spectroscopy Isotopes: Heavy isotopes and radio isotopes, half-life, decay constant, detection and quantitation; Principle and working of GM counter and scintillation counter (solid/liquid). Mass spectroscopy Principle and construction of mass spectrometer. m/e, tof, MALDI and ESI. LC-MS, LC-MS-MS. Applications of radioactivity: Radio isotopes in biology 3H, 14C, 32P, 131I, 35S; Labeling of proteins and nucleic acids,	12h

	autoradiography, pulse chase method, carbon dating.	

Learning Outcomes: After studying this paper the students will know – Techniques in Biology. The fundamental principles in cell homogenization. Importance of bio analytical techniques. Significance of radiochemistry and mass spectroscopy.

References: Slater, A.., Scott, N., and Fowler, M. 2003. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, Oxford, New York, Wilson, K., and Walker, J. 2010. Principles and techniques of biochemistry and molecular biology. Cambridge University Press.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	2	2	2	3	3	3
CO2	2	1	2	1	2	2	2
CO3	2	2	2	2	1	1	2
CO4	1	2	1	2	2	2	1
Weighted average	2	1.75	1.75	1.75	2	2	2

M.Sc. Biochemistry I Semester	Molecular Cell Biology Course Code: 23F103	FCHC – Foundation Course Hard Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Organization of the cell Universal features of cells, Ultra-structure of prokaryotic and eukaryotic cells (Plants and animals), Structure of plant cell wall, Structure of cell membrane and models, functions of cell membrane, Intracellular organelles: Structure and functions of Ribosomes, Golgi apparatus; Mitochondria, Chloroplast, Lysosomes, Centrosome, Endoplasmic reticulum, Nucleus-Internal organization, Chromatin- structure and function, cellular cytoskeleton.	12h
2	Cellular processes Cell cycle and its regulation, Cell cycle check points, Molecular dynamics of cell division, interphase, Mitosis and meiosis, Cyclins and CDKs, Cell differentiation: Stem cells, Differentiation of stem cells into different cell types and organization into specialized tissues, apoptosis, necrosis & autophagy Molecular mechanisms of membrane transport active, passive and facilitated, Receptor mediated endocytosis.	12h
3	Cancer Biology Introduction,Historical account, classification, Characteristics of cancer cells, hallmark features of cancer cells, Carcinogenesis, Exogenous and endogenous carcinogens, cancer initiation, promotion and progression, Cancer cell cycle, Viruses and cancer, Oncogenes, Tumor suppressor genes with examples, cancer therapy presentand future, Role of p53 in cancer. Role of phytochemicals in cancer treatment, cancer stem cells.	12h
4	Basics of Signal Transduction Extra-cellular matrix components, Cell junctions, Cell adhesion molecules, Hormones and their receptors, Cell surface receptors as reception of extra-cellular signals, Types of cell signalling, Growth factors- EGFR, VEGF, PDGF and theirSignalling, signalling through G-protein coupled receptors; Second messengers in signal transduction pathways: cAMP and calcium ions (Ca2+), signalling through Receptor tyrosine kinases ,MAP kinase pathway,P13K -Akt pathway.	12h

Learning Outcomes: After studying this paper the students will know –
Structural and functional components of a cell.
Role of cell cycle and its regulation.
Phytochemicals in cancer treatment and stems cells.
Receptors of signaling pathways.

M.Sc. Biochemistry I Semester	Bioorganic and Bioinorganic Chemistry Course Code: 23F104	HC – Hard Core
Total Hours: 48	Credits: 03 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Bonding: Covalent bond; coordinate bond; coordinate bond formation in transition metals. Bonding of iron in hemologibin and cytochromes, cobalt in Vit B12, magnesium in chlorophyll.Special properties of water; Structure and bonding. Crystal field theory; Ligand field theory and Valence bond theory. Chelators; types of ligands and complexes.	12h
2	Electrolytes, Non-Electrolytes and Electrodes Osmotic pressure, vapor pressure, osmometer, Donnan membrane equilibrium. Hydrogen electrode, electrode potential, and redox potential.	12h
3	Stereochemistry: Importance of stereochemistry, position and order of groups around carbon. Geometric and optical isomerism; absolute and relative configuration.Symmetry view of chirality, relation between chirality and optical activity, representation of chiral structures by Fischer. Structure and stereochemistry of sugars and amino acids; anomer, epimer, diastereomer, sterioisomer, D and L, (+) and (-), R and S.	12h
4	Mechanism of organic reactions and Heterocyclic compounds: Intermediates and rearrangements in organic reaction. Reaction energetic.Classification of rearrangement reactions.Reaction rates, order and molecularity of reaction.Mechanisms and stereochemistry of substitution (electrophilic and nucleophilic - sN1 and sN2 reactions) addition, elimination and rearrangement reactions.Mechanisms of ester hydrolysis.Property of aromaticity and resonance. Heterocyclic Compounds: Chemistry of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole. Chemistry of porphyrins and heme and their biological importance.	12h

Learning Outcomes: After studying this paper the students will know –
The basics in chemical reactions.
Chemical bonding.
Stereochemistry of biomolecules.
Different types of heterocyclic compounds and their biological role.

References: Bahl A. (2010) Advanced organic chemistry (22nd Edition). S Chand & Company Limited. Mathews P. (2002) Advanced chemistry (5th Edition). Cambridge low price editions. Cambridge University Press UK. Morrison R. and Boyd R. (1992). Organic Chemistry (6th edition). Englewood Cliffs, NJ: Prentice Hall.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	1	2	1	2	3	2
CO2	2	2	1	2	3	1	3
CO3	1	3	3	2	1	2	1
CO4	2	2	2	3	2	2	2
Weighted average	1.75	2	2	2	2	2	2

M.Sc. Biochemistry I Semester	Practical 1A (Experiments in Biological Techniques, Bioorganic chemistry & Tour Report Laboratory Visit and Tour Report) Course Code: 23F105	HC – Hard Core
Total Hours: 64	Credits: 02 (LTP - 0:0:4)	Total Marks: 15+15+70 = 100

1. Determination of pKa of amino acids.
2. Estimation of λmax and molar extinction coefficient (Beer Lambert's Law).
3. Isolation of starch from potatoes and estimation of purity.
4. Isolation of glycogen from chicken liver and estimation of purity.
5. Estimation of reducing sugar by DNS method.
6. Centrifugation.
7. Purification of casein from cow's milk.
8. Estimation of proteins by Lowry's method.
9. Estimation of proteins by Biuret Method.
10. Estimation of saponification of lipids.
11. Estimation of iodine value of lipids.
12. Wavelength scans of proteins and nucleic acids using a spectrophotometer.
13. Circular paper chromatography for separation of amino acids.
14. Ascending paper chromatography for separation of amino acids.
15. Descending paper chromatography for separation of amino acids.
16. 2D paper chromatography for amino acids.
17. Thin layer chromatography of amino acids (1D and2D).
18. Column chromatography for the separation of plant pigments.
19. Gel filtration (Size exclusion chromatography).
20. Photometry
21. Estimation of Phosphate ions using Fiske-Subbarow method.
22. Estimation of calcium.
23. Estimation of Iron using Wong's method.
24. Synthesis and purification of aspirin.
25. Estimation of polyphenols from plant samples.
26. Estimation of anthocyanins from plant samples.

Laboratory Visits:

27. Demonstration of native Poly Acrylamide Gel Electrophoresis (PAGE).
28. Demonstration of Sodium Dodecyl Sulphate-Poly Acrylamide Gel Electrophoresis (SDS-PAGE) and estimation of molecular weight of proteins.
29. Demonstration of High Performance Liquid Chromatography.
30. Demonstration of Liquid Chromatography Mass Spectroscopy (LC-MS).

31. Demonstration of X-Ray Diffraction crystallography (XRD).
32. Demonstration of Nuclear Magnetic Resonance (NMR).
33. Demonstration of Infra-Red Spectroscopy (IR).
34. Demonstration of Atomic Absorption Spectroscopy (AAS).
35. Distillation of water for biochemical assays.
36. Preparation buffers and solutions & Measurement of pH.
37. Microscopic examination of prokaryotic and eukaryotic cells using staining techniques.
38. Cell Counting using hemocytometer.
39. Micrometry.
40. Assessment of cell viability and cytotoxicity.
41. Preparation of liquid and solid media for growth of microorganisms
42. Isolation and maintenance of microorganisms (from soil and water) by plating, streaking and serial dilution methods, slants and stab cultures.
43. Culturing the anaerobic bacteria by candle jar method.
44. Gram staining
45. Ultra-violet killing curve and determination of mutant types in Saccharomyces cerevisiae.
46. Isolation of cell organelles.: Isolation of mitochondria from the animal sources and MTT reduction assay.
47. Estimation of mitochondrial enzymes: Succinate Dehydrogenase (ETC complex II)
48. Study of mitosis in onion root tips.
49. Study of meiosis in onion flower buds.
50. Study of special chromosomes- B chromosomes, and sex chromosomes.
51. Determination of chiasma frequency in onion.
52. Assessment of polytene chromosomes.
53. Study of chromosomes by air-dry technique
54. Study of Mutations in Drosophila
55. Study of Autosomal and sex-linked gene inheritance in Drosophila
56. To solve genetic problems on linkage, ordered and unordered tetrads

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	3	3	1	2	2	2
CO2	2	2	2	2	1	1	1
CO3	1	1	2	3	2	3	2
CO4	3	2	2	2	2	2	3
Weighted average	2.25	2	2.25	2	1.75	2	2

M.Sc. Biochemistry I Semester	Practical 1B (Experiments in Cell Biology, Genetics and Bioinorganic Chemistry & Seminar) Course Code: 23F106	HC – Hard Core
Total Hours: 64	Credits: 02 (LTP - 0:0:4)	Total Marks: 15+15+70 = 100

1. Distillation of water for biochemical assays.
2. Preparation buffers and solutions & Measurement of pH.
3. Microscopic examination of prokaryotic and eukaryotic cells using staining techniques.
4. Cell Counting using hemocytometer.
5. Micrometry.
6. Assessment of cell viability and cytotoxicity.
7. Preparation of liquid and solid media for growth of microorganisms
8. Isolation and maintenance of microorganisms (from soil and water) by plating, streaking and serial dilution methods, slants and stab cultures.
9. Culturing the anaerobic bacteria by candle jar method.
10. Gram staining
11. Ultra-violet killing curve and determination of mutant types in *Saccharomyces cerevisiae.*
12. Isolation of cell organelles.: Isolation of mitochondria from the animal sources and MTT reduction assay.
13. Estimation of mitochondrial enzymes: Succinate Dehydrogenase (ETC complex II)
14. Study of mitosis in onion root tips.
15. Study of meiosis in onion flower buds.
16. Study of special chromosomes- B chromosomes, and sex chromosomes.
17. Determination of chiasma frequency in onion.
18. Assessment of polytene chromosomes.
19. Study of chromosomes by air-dry technique
20. Study of Mutations in *Drosophila*
21. Study of Autosomal and sex-linked gene inheritance in *Drosophila*
22. To solve genetic problems on linkage, ordered and unordered tetrads

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	3	3	1	2	2	2
CO2	2	2	2	2	1	1	1
CO3	1	1	2	3	2	3	2
CO4	3	2	2	2	2	2	3
Weighted average	2.25	2	2.25	2	1.75	2	2

M.Sc. Biochemistry I Semester	Genetics Course Code: 23F107	FCSC – Foundation Course Soft Core
Total Hours: 48	Credits: 03 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	History and developments of genetics: Principle of Genetic Transmission: Mendel's' Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rites). Extensions of Mendelian Principles:co-dominance, incomplete dominance, gene interactions, multiple alleles, lethal alleles, pleiotropy, penetrance and expressivity, polygenic inheritance, linkage and crossing over, sex linked inheritance, sex limited and influenced traits, genome imprinting, extra nuclear inheritance.	12h
2	Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination and Mapping. Bacterial Genetics: Bacterial Transformation- Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation- properties of the F plasmid, F+ x F- mating, F' x F- conjugation, Hfr conjugation. Fungal Genetics: Neurospora- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in Neurospora. Algal Genetics: Chlamydomonas - unordered tetrad analysis - Recombination and Mapping.Floral meristems and floral development in Arabidopsis, ABC model.	12h
3	Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms and Drosophila. Site directed mutagenesis and its applications. Recombination: Homologous and non-homologous recombination, Holliday model, site-specific recombination. DNA Repair: Mechanism of genetic repair- direct repair, photoreactivation, excision repair, mismatch repair, post-replicative recombination repair, Repair of double- strand breaks, SOS repair.	12h
4	Sex Determination-Sex chromosomes, Chromosomal and genetic basis of sex determination. Sex determination in C.elegans,Drosophila, human and Plant(Melandrium). Dosage compensation-Genic balance, Gene dose, Molecular basis of dosage compensation in Drosophila and man. Transposable elements- discovery in maize and bacteria, transposal elements in bacteria and bacteriophage, types and functions; Transposable elements in eukaryotes- Plants, Drosophila and Humans, mechanisms of transpositions.	12h

Learning Outcomes: After studying this paper the students will know –
Model organisms available to study genetics.

Mutation and mutagenesis. Types of DNA recombination and DNA repair. Detailed account on transposable elements and transpositions.
References: Buchanan, B.B., Gruissem, W., and Jones, R.L. 2010. Biochemistry and Molecular Biology of Plants. Ed. ASPP Press.USA. Griffith, A. J. F., Gelbart, W.M., Muller, J. H., and Lewintin, R. C. 1999. Modern Genetic Analysis. W.H. Freeman and Co. New York. Hartl, D. 1991. Basic Genetics (2nd Ed.). Jones and Barlett Publisher Inc. Boston. Randhawa, S. S. 2017. Textbook of Genetics (Ist Ed.). S Vikas and Company, Jalandhar. Tamarin, R. H. 2009. Principles of Genetics (7th Ed.) Tata-McGraw Hill, New Delhi. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine M., and Losick, R. 2004. Molecular Biology of the Gene (5th Ed.). Pearson Education Pt. Ltd., New Delhi, India.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	3	2	2	3	3	2
CO2	2	1	3	3	1	2	1
CO3	1	2	2	2	2	1	3
CO4	2	2	3	2	2	2	1
Weighted average	1.75	2	2.5	2.25	2	2	1.75

M.Sc. Biochemistry I Semester	Membrane Biology Course Code: 23F108	SC – Soft Core
Total Hours: 48	Credits: 03 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Learning Objectives: Students should study this paper to know –
To study biological membrane structure and function.
To study physiological process of biological membranes

Module	Course contents	
1	Physico-chemical properties of membranes: Compositions and supra molecular organization. Membrane lipid phases; bilayer phase, non-bilayer phase, phase transition and membrane potential. Models of membrane: Evolution in concept of membrane models, Gorter and Grendel's experiment. Bilayer structure; Danielle - Davson model of membrane, Singer and Nicholson's model and Newer models. Membrane asymmetry; Membrane lipids, proteins and carbohydrates and their lateral diffusion. Biogenesis of lipids and proteins, polarized cells, membrane domains; caveolae, rafts and protein turnover. Intracellular targeting of proteins. Biogenesis of sub cellular organelles.	12h
2	Methods of study of membrane structure: Lipid transfer proteins, phospholipases, chemical methods, amino-phospholipid translocation, TNBS reagent, freeze fracture and freeze etching. Lipid vesicles; liposome preparations and application, function of sterols in membranes. FRET, FRAP, single particle tracking, EM of membranes, calorimetry, confocal microscopy of membrane dynamics. Cell fusion, shedding of membrane.	12h
3	Membrane transport: Laws of diffusion across membranes; simple diffusion, facilitated diffusion and active transport. Glucose transporters, Ca2+ ATPase, Na+-K+ ATPase (Structure and mechanism of action). Endocytosis, receptor mediated endocytosis, exocytosis, ion channels; gated and non-gated, aquaporin channel. Bacterial phosphor transfer system.	12h
4	Nerve transmission: Structure and types of Neuron. Acetylcholine receptor and neurotransmitters, mechanisms of nerve conduction, resting and action potential, ion channels, ionophores, patch clamp technique. Presynaptic and postsynaptic membranes. Nicotinic and muscarinic neurons. GABA, NMDA, structure and function. Muscle contraction: Mechanisms, role of calcium, calmodulin, and phospholamban.	12h

Learning Outcomes: Understand properties of biological membrane, and different models of membranes explaining the biological function.
Understand membrane asymmetry and other properties using various methods.
Understand the complex mechanism involved in transportation of biomolecules across membranes. Nerve transmission.

References:Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. 2008. Molecular Biology of the Cell. (5th Ed.) New York: Garland Science.
Cooper, G. M., and Hausman, R. E. 2013. The Cell: a Molecular Approach (6th Ed.). Washington: ASM, Sunderland. Lodish H., and Berk A. 2016. Molecular Cell Biology (8th Ed.). New York. W H Freeman.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	3	2	1	2	1	2
CO2	2	1	2	2	1	3	2
CO3	1	2	1	1	2	2	1
CO4	2	2	3	2	1	1	-
Weighted average	2	2	2	1.5	1.5	1.75	1.25

II Semester

M.Sc. Biochemistry II Semester	Molecular Biology Course Code: 23F201	FCHC – Foundation Course Hard Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Learning Objectives: Students should study this paper to know –

a. To understand biological activities and metabolism at DNA and protein level

Module	Course contents	
1	Genome organization: Prokaryotic and eukaryotic genome organization, central dogma, structural organization of chromosome, structure and functions of DNA & RNA, Biochemical evidences for DNA as genetic material. DNA: Chemistry of DNA, Forces stabilizing DNA structure, Physical Properties of Ds DNA (UV absorption spectra Denaturation and renaturation), chemical that react with DNA, Interaction with small ions, DNA binding motifs: Zinc finger, leucine zipper, helix-turn- helix others motifs, DNA binding and kinks.	08h
2	DNA topology: Supercoiled form of DNA, Biology of supercoiled DNA, DNA topoisomerases, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication. DNA Replication: Characteristics and functions of bacterial DNA polymerases I, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Eukaryotic DNA polymerases and mechanism of replication. Replication of viral DNA, DNA replication in telomeric regions, Telomerases, mechanisms of action of topoisomerase I and II ,Models of DNA replication, Inhibitors of replication.	12h
3	Transcription: Characteristics and function of bacterial RNA polymerases Eukaryotic RNA polymerases, mechanism of transcription and regulation. transcription factors, Stringent response. Post transcriptional modifications of mRNA mechanism of splicing, Processing of tRNA and rRNA. Inhibitors of transcription. Mechanism of action of ribozymes , Translation: Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing, Control of translation in eukaryotes (Antisense RNA, Heme and interferon).	14h

4	Regulation of Gene expression in prokaryotes and eukaryotes: Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination ,global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms. Protein localization & Gene Silencing: Export of secretory proteins-signal hypothesis, transport and targeting of proteins to mitochondria, chloroplast, peroxisomes, Gene Silencing: Definition, types, RNAi pathway, shRNA & CRISPR- CAS.Non coding RNA: coding andnon-coding RNA, types of ncRNA : Short ncRNA (mi RNA, Sn RNA, Pi RNA, t-RNA & it's fragments, SnoRNA) long ncRNA ,functional significance of ncRNA	14h
Learning Outcomes: After studying this paper the students will know – The idea about the principles behind molecular biology. Understand the molecular tools and its application in basic research applied research in various fields of life sciences. Regulation of gene expression		
References: Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D.1994. Molecular Biology of the Cell. Garland Science, New York. Cooper, G.M. 1997.The Cell: A molecular approach, ASM Press, USA. Elliott, W. H., and Elliott, D. C. 2006. Biochemistry and Molecular Biology (3rd Indian Ed.). Oxford University Press, Oxford.		

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	3	3	3	1	3	3
CO2	3	1	2	1	2	2	2
CO3	2	2	1	2	3	1	1
CO4	1	1	3	3	2	2	-
Weighted average	2	1.75	2.25	2.25	2	2	1.5

M.Sc. Biochemistry II Semester	Enzymology Course Code: 23F202	HC – Hard Core
Total Hours: 48	Credits: 03 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	General aspects: Nature of enzymes, localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes, fold purity. Nomenclature and IUB classification of enzymes. Enzyme specificity, specific activity, assay methods; coupled enzyme assays, continuous, end point and kinetic assay. Units of enzyme activity, IU and Katal.	12h
2	Enzyme kinetics: Michaelis-Menten equation for uni substrate reactions, initial velocity approach, steady state approach. Vmax, Km and their significance. Linear transformation of Michaelis-Menten equation; Lineweaver-Burk plot, Eadie-Hofstee, Wolf and Cornish-Bowden.Scatchard plot. Rate of a reaction, order and molecularity. I order reaction kinetics. Rectangular hyperbola, Michaelis-Menten equation as rectangular hyperbola, linear transformation, calculation of slope, intercept. Reversible and irreversible inhibition; competitive, noncompetitive, uncompetitive product inhibition and suicide inhibition. Determination of Ki and Kd. Bisubstrate reaction: Cleland's notation with examples of ordered, ping-pong, and random reactions. General rate equation.	12h
3	Cooperativity; Isozymes and Multifunctional enzymes Binding of ligands to macromolecules; Scatchard plot, positive and negative cooperativity. Oxygen binding to hemoglobin .Hill equation, homotropic and heterotropic effectors, aspartyl trans carbamylase as an allosteric enzyme. Metabolic regulation of enzyme activity: Feedback regulation, fine control of enzyme activity. Isoenzymes; LDH, multifunctional enzymes (DNA polymerase) and multi enzyme complex (PDC).	12h
4	Mechanisms of enzyme catalysis: Active site structure; methods of determining active site structure. Isolation of ES complex, affinity labeling, chemical modification studies, site directed mutagenesis. Nature of enzyme catalysis: Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophilic catalysis, intramolecular catalysis, entropy effects. Effect of temperature and pH on enzyme catalysed reaction. Fast reactions - Stopped flow, temperature jump method with examples of enzymes. Mechanisms of action of specific enzyme: Chymotrypsin; zymogen activation, acid- base catalysis, charge relay network. Lysozyme, alcohol dehydrogenase, ribonuclease, carboxypeptidase A, RNA as an enzyme, abzymes, coenzymic action of NAD+, FAD, TPP, PLP, Biotin, CoA, folic acid and lipoic acid.	12h

Learning Outcomes: After studying this paper the students will know – a. Chemistry of enzyme catalysis. b. Enzyme kinetics c. Regulation of enzyme activity d. Enzyme inhibition

References: Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited. Boyer R.F. (2006). Biochemistry Laboratory: Modern Theory and Techniques.
Creighton T.E. and Chasman D.I. (1997). Protein structure: a practical approach: IRL press Oxford. Palmer T, Bonner P.L. (2007). Enzymes: biochemistry, biotechnology, clinical chemistry: Elsevier.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	2	2	1	1	2	2
CO2	2	1	2	2	2	3	3
CO3	1	3	1	2	1	1	1
CO4	2	2	3	3	3	2	2
Weighted average	2	2	2	2	1.75	2	2

M.Sc. Biochemistry II Semester	Practical 2A (Experiments in Molecular Biology and Energy Metabolism; Laboratory visits and Tour report) Course Code: 23F203	HC – Hard Core
Total Hours: 64	Credits: 02(LTP - 0:0:4)	Total Marks: 15+15+70 = 100

Course objectives:

- To gain proficiency in laboratory techniques in molecular biology and energy metabolism.
- To learn the experiments to articulate the metabolic pathways.
- To test the markers for health and disease.
- To obtain real time knowledge from the industries and institutes of national and international repute.

Course Outcomes:

- Proficiency in laboratory techniques in molecular biology and energy metabolism.
- Proficiency in the experiments to articulate the metabolic pathways.
- Efficacy in testing the markers for health and disease.
- Proficiency in real time functioning of the industries and institutes of national and international repute.

1. Isolation of Genomic DNA from yeast cells and determination of purity.
2. Estimation of DNA by diphenyl amine method.
3. Isolation of RNA from yeast or plant cells.
4. Estimation of RNA by orcinol method.
5. Restriction digestion of DNA and agarose gel electrophoresis.
6. Determination of RNAse activity
7. Restriction digestion of plasmid and analysis
8. Polymerase Chain Reaction.
9. Estimation of Blood glucose: fasting, post prandial, random
10. Isolation of phospholipids and neutral lipids from hen yolk.
11. Estimation of phospholipids and neutral lipids using thin layer chromatography.
12. Estimation of neutral lipids (cholesterol) using Zak's method.
13. Estimation of triglycerides.
14. Estimation of HDL, LDL.
15. Assessment of membrane stability of RBCs.

16. Estimation of a keto acid.
17. Activity of lipases.
18. Estimation of acid value of lipids.
19. Estimation of peroxide value of lipids.
20. Study tour to Molecular Biology based industries and institutes.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	1	2	1
CO2	3	1	3	2	2	2	2
CO3	1	3	1	1	2	1	3
CO4	2	2	1	3	1	3	2
Weighted average	2	2	1.75	2	1.5	2	2

M.Sc. Biochemistry II Semester	Practical 2B (Experiments in Enzymology and Research Paper Presentation) Course Code: 23F204	HC – Hard Core
Total Hours: 64	Credits: 02(LTP - 0:0:4)	Total Marks: 15+15+70 = 100

Course objectives:

- To gain proficiency in enzymology techniques.
- To study a recent research article in the field of Biochemistry and related streams, and present as a platform presentation.

Course Outcomes:

1. Proficiency in in enzymology techniques.
2. Proficiency in understanding a research article in the field of Biochemistry and related streams,
3. Efficiency in presenting a platform presentation.
4. Efficacy in isolating and purifying an enzyme and assess the parameters.

1. Estimation of activity of Salivary amylase.
2. Estimation of Specific activity of Salivary amylase.
3. Estimation of optimum pH for the activity of Salivary amylase.
4. Estimation of optimum buffer conjugates for activity of Salivary amylase.
5. Estimation of optimum buffer concentration for activity of Salivary amylase.
6. Estimation of temperature optimum for Salivary amylase.
7. Time kinetics of Salivary amylase.
8. Estimation of energy of activation of Salivary amylase.
9. Effect of enzyme concentration on activity of Salivary amylase.
10. Estimation of Km and Vmax of Salivary amylase.
11. Plotting Lineweaver-Burk plot for Salivary amylase.
12. Assessment of effects of selected metal ions and drugs on the activity of Salivary amylase.
13. Purification of Alkaline phosphatase from bovine milk by differential centrifugation.
14. Estimation of activity of Alkaline phosphatase.
15. Estimation of Specific activity of Alkaline phosphatase and fold purity.
16. Calculation of fold purity of Alkaline phosphatase.
17. Purification of Invertase from plant latex.
18. Estimation of activity of Invertase.
19. Estimation of Specific activity of Invertase.
20. Calculation of fold purity of Invertase.
21. Purification of Esterase from peas by using ammonium sulphate precipitation.
22. Estimation of activity of Esterase.
23. Estimation of Specific activity of Esterase and fold purity.
24. Calculation of fold purity of Esterase.
25. Purification of Proteases from plant latex.
26. Estimation of activity of Protease.

27. Estimation of Specific activity of Protease.
28. Calculation of fold purity of Protease.
29. Estimation of catalase activity and specific activity.
30. Assessment of clinically relevant enzymes: SGOT, SGPT, Creatine Kinase, Lactate
31. Dehydrogenase.
32. Research paper presentation.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	1	2	1
CO2	3	1	3	2	2	2	2
CO3	1	3	1	1	2	1	3
CO4	2	2	1	3	1	3	2
Weighted average	2	2	1.75	2	1.5	2	2

M.Sc. Biochemistry II Semester	Metabolism of Lipids Course Code: 23F205	SC – Soft Core
Total Hours: 48	Credits: 03(LTP - 3:0:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Phospholipids, TG and Fatty acid degradation: Degradation of triacylglycerols, phospholipids and sphingolipids and regulations; lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. β-oxidation Knoop's experiment, saturated and unsaturated fatty acids. Regulatory aspects. Oxidation α , β and ᵞ oxidation. Energetics and biosynthesis of fatty acids; fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals, conversion of linoleate to arachiodnante. Regulatory aspects.	12h
2	Cholesterol synthesis, degradation, and regulations: Metabolism of circulating lipids; chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Mechanism of foam cell formation. Obesity, and mechanisms, exercise and regulation of energy metabolism.	12h
3	Phospholipid biosynthesis and regulations: Denovo pathway and inter conversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Biosynthesis of prostaglandins, thromboxanes, leukotrienes, and lipoxins. Role of Hormones in the regulation of lipid metabolism: HPA axis. Adrenal gland and pancreatic hormones.	12h
4	Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thrombaxanes, DAG, ceramide and PAF. Role of anti-inflammatory drugs and eicosanoids. Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation.	12h
Learning Outcomes: After studying this paper the students will know – Chemistry of lipid metabolism. Importance of lipid metabolism. Role of hormones in the regulation of lipid metabolism. Lipid mediators and inflammation.		
References: Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited. Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons. Nelson D.L., Lehninger A.L. and Cox M.M. (2008).		

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	1	2	1
CO2	3	1	3	2	2	2	2
CO3	1	3	1	1	2	1	3
CO4	2	2	1	3	1	3	2
Weighted average	2	2	1.75	2	1.5	2	2

M.Sc. Biochemistry II Semester	Metabolism of Carbohydrates Course Code: 23F206	SC – SOFT Core
Total Hours: 48	Credits: 04 (LTP - 3:0:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Introduction: Catabolism, anabolism, and amphibolic pathways. Energy Utilization: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. High energy compounds: Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound.	12h
2	Catabolism and Anabolism of Carbohydrates Cellular ingestion of glucose, glycolysis, energetics regulation. Pathways of utilization of pyruvate-lactate, ethanol, gluconeogenesis, regulation, Cori cycle, glucose paradox, citric acid cycle and its regulation, energetics, anaplerosis, glyoxylate cycle. HMP shunt pathway, inter conversion of hexoses. Utilization of non-glucose sugars. Biosynthesis of sucrose, lactose, starch and glycogen.	12h
3	Mitochondrial electron transport: Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on red-ox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis. Substrate level phosphorylation, futile cycles and their application.	12h
4	Hormonal regulation of glucose metabolism: Effect of hormones on carbohydrate metabolism; insulin, glucagon, catecholamines, growth hormones, corticosteroids and thyroid hormones in different tissues. Secretion of Insulin and glucagon in response to various stimuli (Fasting, food, intestinal hormones etc.,) Role of Hormones in the regulation of carbohydrate metabolism: HPA axis. Adrenal gland and pancreatic hormones Disorders of carbohydrate metabolism: diabetes mellitus, classification and clinical diagnosis.	12h

Learning Outcomes: After studying this paper the students will know –
Chemistry of carbohydrate metabolism.
The fundamental thermodynamic principles in metabolism.
Importance of carbohydrate metabolism.
Role of hormones in the regulation of carbohydrate metabolism.

References: Berg J.M., Tymoczko J.L. and Stryer L. (2002) Biochemistry (5th Edition). International edition: WH Freeman & Company Limited Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). J. Wiley & Sons. Nelson D.L., Lehninger A.L. and Cox M.M. (2008) Principles of Biochemistry (12th Edition). Macmillan. Voet D. and Voet J.G. (2010) Text book of Biochemistry (4thEdition). New York: J. Wiley & Sons.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	1	2	2	2	2	1	1
CO2	2	1	1	1	1	2	2
CO3	3	2	2	2	2	2	3
CO4	2	2	1	3	3	3	2
Weighted average	2	1.75	1.5	2	2	2	2

M.Sc. Biochemistry II Semester	Endocrinology Course Code: 23F207	SC –Soft Core
Total Hours: 48	Credits: 03(LTP - 3:0:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Cell: Structure of a cell, mitosis, meiosis, cell cycle and its regulation, different phases of cell cycle. Apoptosis, cyclins and CDKs. Cell-cell and cell-ECM interaction and ECM structure and function. Endocrine System: Endocrine organs in man. Location and inter relationship of endocrine glands in man; classification and chemistry of hormones, hormones of hypothalamus, pituitary, thyroid, parathyroid, pancreas, liver, adrenals, gonads and intestine.	08h
2	Functions and abnormalities: Hypo and hyper production of hormones secreted by; pituitary, thyroid, pancreas, adrenals and gonads. Structure and control of hypothalamus function: Hormones produced; GRH, somatostatin, TRH, CRH, GnRH. Pituitary gland: Structure, hormones of anterior, posterior and median lobes. Pro- opiomelanocortin. Testes and ovaries: Structure, hormones produced by testes and ovaries, menstrual cycle. Regulation of hormone production and release: hypothalamus-pituitary-target organ axis and regulation by feedback mechanism.	14h
3	Mechanism of hormone action: Peptide hormones: General mechanisms of cell signaling by hydrophilic factors, transmembrane receptors, transmembrane receptors, G protein coupled receptors, receptor tyrosine kinase, eicosanoid receptors. Second messengers: 1P3, DAG, cAMP, protein kinases. Nitric oxide signaling; generation and action. Growth factors: Structure, mechanism of action and receptors of EGF, PDGF, NGF and IGF. insulin receptor.	12h
4	Mechanism of action of steroid hormones: Conversion of cholesterol to steroid hormone.Steroid receptors, isolation and characterization of steroid receptors. Receptor down regulation, desensitization and up regulation. Pineal gland, melotonin and circadian rhythm. Chemistry and action of prostaglandins, prostacyclins and thromoxanes. Newly discovered hormones Insect hormones: Structure and function of moulting hormone, ecdysone, juvenile hormones, Pheromones. Application of insect hormones.	14h

Learning Outcomes: After studying this paper the students will know – Understand the detailed structure of a cell Involvement of various organelles in the synthesis of protein, amino acid and steroid hormones.
Understand the various endocrine organs in relation to the regulation of various metabolic processes.
Understand the hypo and hyperactivities of all the endocrine organs and their manifestation in various disorders.

References: Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. 2008. Molecular Biology of the Cell. (5th Ed.) New York: Garland Science.
Cooper, G. M., and Hausman, R. E. 2013. The Cell: a Molecular Approach (6th Ed.). Washington: ASM, Sunderland. Lodish H., and Berk A. 2016. Molecular Cell Biology (8th Ed.). New York. W H Freeman.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	3	3	3	1	3	3
CO2	3	1	2	1	2	2	2
CO3	2	2	1	2	3	1	1
CO4	1	1	3	3	2	2	-
Weighted average	2	1.75	2.25	2.25	2	2	1.5

M.Sc. Biochemistry II Semester	Biology for non-biologists Course Code: 23F209	Open Elective
Total Hours: 48	Credits: 04 (LTP - 2:2:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Introduction: History of Biology; Origin of Life-theories, The Scientific Study of Life; The Chemical Basis of Life ; The Molecules of Cells A Tour of the Cell ; The Working Cell Classification of Phyla, (microbes, plants and animals.) Photosynthesis: Using Light to Make Food; How Cells Harvest Chemical Energy	12h
2	The Cellular Basis of Reproduction and Inheritance Patterns of Inheritance	6h
3	Human Physiology: Basic structure and functioning, disorders of Nervous, renal, hepatic, muscle, blood, bone tissues. Reproduction, Hormones. Animal cell culture for research and therapy. Plant physiology: Meristems, primary and secondary growth, types of tissues, reproduction, flowers, fruits, seeds, germination. Plant hormones, Plant tissue culture for crop improvement.	18 h
4	Molecular Biology of the Gene. Importance of gene expression. DNA Technology and Genomics and Proteomics Human diseases: Communicable, non-communicable. Familial and Sporadic disorders.	12

Learning outcomes
Student would be able to work independently to use scientific methods during biology related investigations.
Use critical thinking and scientific problem-solving to make informed decisions in a real-world context.
Understand cellular processes in a living being.
Human diseases.

References:
Renato A Dela Pena Jr. General Biology. 2016. JFS Publishing
Holley D. General Biology I: Molecules, Cells and Genes. 2017. Dog Ear Publishing
Dela Pena Jr et al., General Biology. JFS Publishing Services 2016

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	1	2	2	1	1	2
Weighted average	2	1.5	2	1.75	1.5	1.5	2

M.Sc. Biochemistry II Semester	Nutrition in Health and Disease Course Code: 23F210	Open Elective
Total Hours: 48	Credits: 04 (LTP - 2:2:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Food Physiology: Concept of balanced diet and energy content of foods; Basal and resting metabolism- influencing factors, Absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins. Common metabolic disorders: Diabetes mellitus, disorders of HDL-cholesterol, LDL cholesterol, triglycerides, phenylketonuria, albinism. Antioxidants: Free radicals: definition, formation in biological Systems. Natural anti- oxidants, defense against free radicals. Role of free radicals and antioxidants in health and disease. Nutrition and lifestyle choices impact the life cycle before and during pregnancy, during lactation and infancy, during childhood and adolescence, and through adulthood and aging. The function of the RDA, DRI, and Tolerable Upper Intake Level.	14h
2	Vitamins: Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water soluble vitamins; Hypervitaminosis symptoms of fat- soluble vitamins. Minerals: Dietary sources and deficiency disorders of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Malnutrition and blood disorders: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor, Nutritional anemia - vitamin B12, folate and iron deficiency anemia; hemoglobinopathies and thalassemias.	12h
3	Selection of foods, preliminary preparation of food, principles of cooking, methods of cooking - Boiling, Steaming, Pressure cooking, Microwave oven, Frying (shallow, deep fat), Smoking point of oil, Combination method, methods of cooking: advantages and disadvantages. Effect of cooking on nutritive value, methods of enhancing nutritive value	8h
4	Obesity: Definition, classification and biochemical basis; Genetic and environmental factors leading to obesity; Obesity related diseases and management of obesity. Cardiovascular disease: Diseases of Liver, Gall bladder & Pancreas-Hepatitis, (A, B, and C), alcoholic liver disease, Gall stones, pancreatitis, Prevention and dietary management. Clinical significance of aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, amylase, lipase and trypsin.Diagnosis of jaundice and clinical importance of bilirubin.	14h
5	Questionnaire based Survey by students. Setting up Diagnostic test camps. Arranging for nutrition counseling. Seminars by students.	

Upon completion of this course, student will be able to: Describe how to properly design individualized eating plans by utilizing diet planning principles, The Food Guide Pyramid, Exchange System other food guide plans that incorporate personal food preferences. Students will learn about food and its relationship to health, development, and disease/ disorders.
References: Bansal. Nutrition in disease. 2012. Pustak Mahal Chakraborthy and Chakraborthy. Textbook of Nutrition in Health and Disease. 2019. Springer Nisha. Diet Planning for Diseases. 2006. Kalpaz Publications. Esperanza J. Carcache de Blanco, Jay Mirtallo , " Nutrition: An Approach to Good Health and Disease Management ", Bentham Science Publishers (2016). https://doi.org/10.2174/97816810810831160101 Esperanza J. Carcache de Blanco and Jay Mirtallo. Influence of Socio-economic Status and Culture in Diet and Nutrition. 2020. Bentham. Teresa Aldamiz- Echevarria Lois Maria, Recarte Garcia-Andrade Carlos and Millan Nunez-Cortes Jesus, Cardiovascular Risk Factors and Dietary Patterns, Current Nutrition & Food Science 2011; 7(2) . https://dx.doi.org/10.2174/157340111795713852 Berglund, Nutrition and Heart Disease: Causation and Prevention: 1st edition, edited by Ronald R Watson and Victor R Preedy, 2004, 354 pages, CRC Press, Boca Raton, FL, The American Journal of Clinical Nutrition, Volume 80, Issue 6, 2004 Martínez-González MA, Kim H, Prakash V, et al Personalised, population and planetary nutrition for precision health BMJ Nutrition, Prevention & Health 2021;4:doi: 10.1136/bmjnph-2021-000235 Lundstorm. Nutrition and Disease. Prevention and Therapy. Cambridge Scholars Publishing. 2020. Coulston et al., Nutrition in the Prevention and Treatment of Disease. 2017. Academic Press.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	1	2	2	1	1	2
Weighted average	2	1.5	2	1.75	1.5	1.5	2

III Semester

M.Sc. Biochemistry III Semester	Immunology Course Code: 23F301	FCHC – Foundation Course Hard Core
Total Hours: 48	Credits: 04(LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Over view and Types of immunity: Innate immunity: anatomic barriers, physiologic barriers, phagocytic barriers, microbial antagonism, acute phase reactants, anti-microbial peptides, interferons, inflammation, Pattern Recognition Receptors (PRRs), Pathogen Associated Molecular Patterns (PAMPs) and Damage Associated Molecular Patterns (PAMPs). Complement system: components, pathways of activation and biological consequences. Acquired immunity: Active (Naturally acquired and artificially acquired), Passive (Naturally acquired and artificially acquired), Adoptive immunity, Humoral and Cell mediated immune response Tissues of immune system: Structural organization and functions of Lymphatic system, Primary lymphoid organs (Bone marrow, Thymus) Secondary lymphoid organs and tissues (Spleen, Lymph node, Tonsils, Adenoids, Peyer's patches, Lamina propria, Mucosa-associated lymphoid tissue, Gut-associated lymphoid tissue). Cells of the immune system: Hematopoiesis, Biology, Development and Functions of PMNLs, NK cells, Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells	14h
2	Antigens, and Antibodies: Antigens, Immunogens and Haptens, Factors influencing immunogenicity, adjuvants, epitopes, Structure and functions of immunoglobulins, Synthesis of immunoglobulins, Genetic basis of immunoglobulin diversity. MHC molecules: Types, structure, diversity and functions Antigen recognition: Thymus dependent and independent Antigens, Clonal selection and immunological memory of B and T cells, Antigen processing and presentation (Endogenous pathway, Exogenous pathway, Cross presentation), Superantigens. Monoclonal Antibodies: Hybridoma technology and production of mAbs, types, and applications. Advantages and disadvantages of mAbs in therapy.	12h

3	Immune System in Health and Disease: Immunological Tolerance and Autoimmunity, Autoimmune Diseases (Organ specific autoimmune diseases-Graves' disease, Myasthenia Gravis, Systemic autoimmune diseases-Multiple Sclerosis, Rheumatoid Arthritis, Systemic Lupus Erythematosus), Immunosuppression, Hypersensitivity (Type I, II, III & IV). Vaccines and Vaccination: Principles of vaccination, Immune response to vaccines (Primary and Secondary response), Whole-Organism vaccines, Purified macromolecules as vaccines, Recombinant vaccines, DNA vaccines, Multivalent subunit vaccines and Edible vaccines, Vaccine safety, Reverse vaccinology. Overview of COVID-19 vaccines. Primary & Secondary Immuno-Deficiency Disorders: Primary: Wiscott-Aldrich syndrome, Severe combined immunodeficiency disease (SCID), DiGeorge syndrome, Ataxia-telangectasia, Leucocyte adhesion defects, Chronic granulomatous disease, X- linked agammaglobulinemia, Complement deficiencies. Gammopathies (Multiple	12h
	myeloma). Secondary: AIDS, Malnutrition, Drug regimen, Diabetes, Chronic infection	
4	Clinical Immunology: Transplantation of tissues and organs: Nomenclature of transplantations, Transplantation reactions, HvG and GvH. Exception from rejections, Major and minor blood groups, Blood transfusion, tissue typing, Kidney and bone marrow transplantations. Immunosuppressive drugs. Tumor immunology: Neoplasms, tumor-associated antigens, immune response to tumor antigens, immunologic factors favoring tumor growth, immune surveillance,Tumor necrosis factor α and β.Metastatic processes, Immunodiagnosis, Antitumour drugs, Immunotherapy. Immunological Techniques:. In vitro antigen-antibody reactions, serotyping, agglutination, complement fixation, immunoprecipitation, Immunodiffusion, ELISA, RIA, IHC, Immunoelectrophoresis.	10h

Learning Outcomes: After studying this paper the students will know – Organs, tissues, cells and molecules of the immune system Antibodies and infectious disorders
The immunological methods used to detect the disease How the knowledge of immunology can be transferred into clinical decision-making through case studies presented in class.

References: Abbas A.K., Lichtman A.H. and Pillai S. (2014). Cellular and Molecular Immunology (10th Edition). Online Access: Elsevier Health Sciences. Abbas, AK., Andrew,H., Lichtman, H., Pillai, S. 2012.Basic Immunology: Functions and Disorders of the Immune System, ; Saunders Abul, K.A., Andrew, H. L. and Shiv, P. 2019. Basic Immunology: Functions and Disorders of the Immune System. Elsevier India. Ajoy, P. 2015. Textbook of Immunology: including Immunotechnology & Immunotherapy. Books & Allied Press. Ashim, K. C. 2006. Immunology and Immunotechnology (1st ed.). Oxford University Press. Berg J.M., Tymoczko J.L. and Stryer L. (2002). Biochemistry (5th Edition). International edition: WH Freeman & Company Limited Brostoff, J., Seaddin, J. K., Male, D. and Roitt, I. M. 2002. Clinical Immunology. London: Gower Medical Pub.
Chapel,H., Haeney,M., Misbah,S., Snowden, N. 2014. Essentials of Clinical Immunology; Wiley-Blackwell Coico, R. and Sunshine, G. 2015. Immunology – A Short Course (7th ed.). Wiley. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. (2011) Roitt's essential immunology: John Wiley & Sons. Hawley,L., Clarke, B., Ziegler, RJ. 2013.

Microbiology and Immunology; LWW Madhavee Latha, P. 2012. A Textbook of Immunology. S. Chand Press. Murphy, K., Travers, P., Walport, M. and Janeway, C. 2012. Janeway's Immunobiology. Taylor & Francis. Nelson D.L., Lehninger A.L. and Cox M.M. (2008). Principles of Biochemistry (12th Edition). Macmillan. Owen J.A., Punt J., Stranford S.A. and Jones P.P. (2013) Kuby immunology: WH Freeman New York.
Parham, P. 2005. The Immune System. New York: Garland Science. Paul, W. E. 2012. Fundamental Immunology. Raven Press. Peter,DJ., Seamus, MJ., Dennis, BR. 2011. Roitt's Essential Immunology; Wiley & Sons, Incorporated, John Pinchuk, G. 2001. Schaum's Outline of Immunology; McGraw-Hill Ramesh, S. R. 2016. Immunology. Mc Graw Hill Education India Pvt. Ltd.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	3	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	1	2	2	1	1	-
Weighted average	2	1.5	2	1.75	1.75	1.5	1.5

M.Sc. Biochemistry III Semester	Metabolism of Amino acids and Proteins Course Code: 23F302	HC – Hard Core
Total Hours: 48	Credits: 03 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Proteins: General mechanisms of degradation in cells; ubiquitin-proteosome pathway, lysosomal pathway. Degradation and biosynthesis of glycoproteins and proteoglycans. Degradation and Biosynthesis of heme and porphryns.	12h
2	Non ribosomal peptide synthesis and Biosynthesis of physiologically active amines: glutathione, gramicidine. Biosynthesis of physiologically active amines; serotonin, histamine, dopamine, norepinephrine and epinephrine.	12h
3	Degradation and biosynthesis of individual amino acids: Aliphatic, aromatic, and branched chain amino acids. Role of cofactors; PLP and THF in amino acid metabolism. Deamination, transamination, decarboxylation desulphuration process. Differences in the pathways in microorganisms, plants and animals. Regulation of amino acid biosynthesis;transglutaminase cycle, urea cycle.	12h
4	Intermediatory metabolism and In born errors of metabolism: Ketogenic and glucogenic amino acids. In born errors of amino acid degradation; PhenylKetonuria, alkaptonuria, maple syrup urine. Role of Hormones in the regulation of protein and amino acid metabolism: HPA axis. Adrenal gland and pancreatic hormones	12h

Learning Outcomes: After studying this paper the students will know –
Chemistry of protein and amino acid metabolism. .
Importance of protein and amino acid metabolism.
Role of hormones in the regulation of protein
Regulation of and disorders of amino acid metabolism.

References:

Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited.
Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons.
Nelson D.L., Lehninger A.L. and Cox M.M. (2008). Principles of biochemistry: Macmillan.
Voet D. and Voet J.G. (2010). Biochemistry (4th Edition). New York: J. Wiley & Sons.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	1	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	3	2	1	1	1	3
Weighted average	2	2	2	1.25	1.5	1.5	2.25

M.Sc. Biochemistry III Semester	Practical 3A Experiments in Immunology and amino acid metabolism; Study Tour and tour report.) Course Code: 23F303	HC – Hard Core
Total Hours: 64	Credits: 02(LTP - 0:0:4)	Total Marks: 15+15+70 = 100

Course objectives:

- To gain proficiency in laboratory techniques in immunology and amino acid metabolism.
- To visit the industries and national laboratories involved in immunological research andmetabolic studies and present a report on the same.

Course Outcomes:

- Proficiency in laboratory techniques in immunology
- Techniques in amino acid metabolism.
- Identification of antibody purity.
- Proficiency in preparing a tour report document after visiting immunology or biology based industries and research institutes.

1. Estimation of proteins using Bradford's method.
2. Estimation of proteins using Bicinchoninic acid method.
3. Estimation of A/G ratio in blood.
4. Estimation of aminoacids using ninhydrin method.
5. Purification of IgG.
6. Slide agglutination test/ Blood grouping.
7. Immunoprecipitation test: Ochterlony double diffusion assay.
8. Estimation of nitric oxide.
9. Estimation of Urea by DAMO method and Clinical significance.
10. Estimation of uric acid and Clinical significance.
11. Estimation of Creatinine and Clinical significance.
12. Study tour and report.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	1	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	3	2	1	1	1	3
Weighted average	2	2	2	1.25	1.5	1.5	2.25

M.Sc. Biochemistry III Semester	Practical 3B Experiments in Metabolism; Review of Literature Course Code: 23F304	**DoS in Biochemistry** HC – Hard Core
Total Hours: 64	Credits: 02(LTP - 0:0:4)	Total Marks: 15+15+70 = 100

Course objectives:

- To gain proficiency in metabolism related experiments.
- To articulate between different metabolic pathways.
- To understand the energetics of photosynthesis.
- To study the literature available about a specific scientific problem and prepare a standard document ofReview of Literature, and present as a platform presentation.

Course Outcomes:

- Proficiency in metabolism related experiments.
- Proficiency to articulate between different metabolic pathways.
- Proficiency to understand the energetics of photosynthesis.
- Proficiency in studying the literature available about a specific scientific problem and prepare a standard document of Review of Literature, and present as a platform presentation.

1. Estimation of uric acid.
2. Estimation of purines.
3. Photo-oxidation of methylene blue.
4. Photosynthetic reduction of 2,6 di chloro phenol indophenol.
5. Identification and assessment of leguminous root nodules for Rhizobium.
6. Oxygen generation during photosynthesis.
7. Estimation of glutathione.
8. Estimation of bilirubin.
9. Review of Literature.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	3	3	3	1	3	3
CO2	3	1	2	1	2	2	2
CO3	2	2	1	2	3	1	1
CO4	1	1	3	3	2	2	-
Weighted average	2	1.75	2.25	2.25	2	2	1.5

M.Sc. Biochemistry III Semester	Metabolism of Nucleic Acids Course Code: 23F305	SC –Soft Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Learning Objectives: Students should study this paper to know –
a. The basics of nucleic acid metabolism. b. To understand the nitrogen metabolism.

	Course contents	
1	Purines and pyrimidines: Pathways of biosynthesis and degradation of nucleic acids, purines and pyrimidines, uric acid formation. Salvage pathways, de novo biosynthetic pathways and regulations.	12h
2	Gout and Lysch-Nyhan syndrome. Conversion of nucleotides to deoxynuclotides. Mchanisms of action of methotrexate, 5-fluorouridine, azathymidine. Biosynthesis of cofactors: NAD+, FAD and coenzyme A, polyamine biosynthesis and their metabolic role.	12h
3	Photosynthesis: Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and phosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle. C3, C4 and CAM cycle. Photorespiration, bacterial photosynthesis. Regulation of photosynthesis. RUBISCO.	12h
4	Nitrogen metabolism: Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and non-symbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion.	12h

Learning Outcomes: After studying this paper the students will know – Chemistry of nucleic acid metabolism. . Importance of nucleic acid metabolism. Mechanism of photosynthesis nitrogen metabolism.

References:Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited. Chatterjee C.C. (2017) Human physiology: Medical Allied Agency:CBS Publishers and Distributors Pvt. LTD. Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons. Nelson D.L., Lehninger A.L. and Cox M.M. (2008). Principles of biochemistry: Macmillan. Voet D. and Voet J.G. (2010). Biochemistry (4th Edition). New York: J. Wiley & Sons.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	3	3	3	1	3	3
CO2	3	1	2	1	2	2	2
CO3	2	2	1	2	3	1	1
CO4	1	1	3	3	2	2	-
Weighted average	2	1.75	2.25	2.25	2	2	1.5

M.Sc. Biochemistry III Semester	Research Methodology, Biostatistics and Bioinformatics Course Code: 23F306	SC – Soft Core
Total Hours: 48	Credits: 04 (LTP - 3:0:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
1	Research Methodology: Definition –Characteristics, types. Identification of the problem, assessing the status of the problem, formulating the objectives, preparing the design (experimental or otherwise), actual investigation. Review of literature, Hypothesis, Data– Categorical, nominal & Ordinal. Methods of Collecting Data: Observation, field investigations, direct studies, questionnaires: Sources, methods-questionnaires, records, archives. Validation and standardization of the methods, modification and experimental design. Types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports - Illustrations and tables. Bibliography: Citations and references; Plagiarism – Citation and Acknowledgement (citation softwares) Ethical Issues – Ethical Committees, Types of experiments that require ethical clearance –GMO, animal ethics and human ethical guidelines, socio-environmental responsibilities. Commercialization – copy right – royalty – Intellectual Property rights (IPR) and patent law; Indian and International scenario, WIPO, – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability. Helsinki declaration.	12h
2	Introduction to Biostatistics: Introduction: Population, sample, sampling techniques, random sample. Mean, median, mode, range, variance, coefficient of variation, frequency, standard deviation, standard error. Statistical tests: Probability: Rules of probability, binomial distribution, normal distribution, area under the curve, Z value, choosing sample size, hypothesis testing, Student's t test. One way ANOVA, correlation and regression. Goodness of fit, test of independence. Non parametric statistics, sign test, rank sum test, rank correlation. Statistics softwares. Representation of statistical data line graph, histogram, bar diagram, pie chart, scatter diagram. Collection of data: Relevance of sample size.	18h
3	Bioinformatics: Biological databases: Introduction, classification of biological databases, retrieval of biological database systems. Molecular Modeling Database at NCBI, PDB, Molecular visualization software (RASMOL). Phylogenetics Clustal. Prediction of genes (Gene finder, ORF finder). Sequence comparison and database search: Introduction, different types of alignment. Iterative refinement methods, pattern matching in DNA and protein sequences, PAM matrices, BLAST, FAST and FASTA. nucleotide sequence analysis, single nucleotide polymorphism, primer designing. Emboss, prosite, prodom, protein expression profiling. Prediction of Secondary structure of proteins, softwares for secondary structure prediction, protein famil ies and classification, (trans membrane regions). CATH and SCOP. Introduction to drug designing: In silico analysis, physico-chemical property prediction, aqueous solubility, Lipinski's rule of five.	12h

4	Docking methods: Three dimensional descriptions of binding site environment and energy calculation, automatic docking method. Three dimensional database search approaches, protein-protein interactions, design of ligands, drug-receptor interactions, automated structure construction methods	6h
Learning Outcomes: After studying this paper the students will know. Basics and ethics in research. Various streams of ethical responsibilities of a researchers at societal, environmental, legal and emotional ethics. Importance of plagiarism.National and international guidelines about Intellectual property rights.Basics and ethics in research.Writing and analysis of research articles. Knowledge of basic statistical methods to solve problems. The importance of statistics in research and prepares them for a career in research. Understanding about the sequence analysis tools and also about the drug discovery.		
References: Bulakh P.M., Patki P.S. and Chodhary A.S. (2010). Research Methodology. Expert Trading Corporation Dahisar West, Mumbai. Garg B.L., Karadia R., Agarwal F. and Agarwal U.K. (2002). An introduction to Research Methodology. RBSA Publishers. Gupta S.P. (2008). Statistical Methods. (37th Edition). Sultan Chand and Sons. New Delhi. Kothari C.R.(2008). Research Methodology: Methods and Techniques. (2nd Edition). New Age International Publishers, New Delhi. Leon A. and Leon M. (2012). Internet for everyone (15th Edition). Vikas Publishing House. Sinha S.C. and Dhiman A.K. (2002). Research Methodology. Ess Ess Publications. Wadehra B.L. (2000).Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing. Amdekar, S.J. 2014. Statistical Methods for Agricultural and Biological Sciences. Narosa Publishing House. Baxevamis, A.D. and Ouellette, F. B. E. 2004. Bioinformatic: A practical guide to the analysis of genes and proteins. John Wiley & Sons. Chen, D. G., and Zhao, Y. 2018. New Frontiers of Biostatistics and Bioinformatics. Springer.		

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	3	1	1	1	1	2	1
CO2	2	1	3	2	1	1	2
CO3	1	3	2	3	3	1	3
CO4	1	1	2	1	2	1	3
Weighted average	1.75	1.5	2	1.75	1.75	1.25	2.25

M.Sc. Biochemistry III Semester	Human Physiology with clinical relevance Course Code: 23F307	SC –Soft Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Learning Objectives: Students should study this paper to know –
a. To study different systems operating in living organisms.

Module	Course contents	
1	Blood: Composition, cells, plasma proteins and lipoproteins, preparation of plasma, serum, and different blood cells. Erythrocytes; shape and function. WBC; types, differential count and functions. Platelets and their function. Half-life of blood cells. Buffer systems, hemostasis, blood clotting, different pathways of blood clotting, mechanisms of initiation of clotting pathways, various enzyme complexes digestion of clot, anticoagulants, blood volume, blood pressure and its regulations. Plasma lipoproteins and their functions, HDL, LDL, VLDL, chylomicrons.	12h
2	Respiratory System: Lungs, structure and functions, gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation and acid-base balance. Nervous system: Structure of a neuron, nerve transmission, mechanism of neurotransmission, action potential, synapse, different types of neurotransmitters, stimulatory and inhibitory, central and peripheral nervous system, neuro-muscular junction. Parts of brain, brain-gut interaction, ion channels, types of ion-channels, secretion of neurotransmitters, CSF; composition and function.	12h
3	Excretory System: Ultra structure of the nephron, glomerular filtration, filtration rate, mechanism of formation of urine, acid-base balance. Consequences of imbalance in acid-base balance, formation of kidney stones. Kidney function tests Hepatobiliary System: Anatomy of the liver, blood supply, cells; hepatocytes, endothelial cells and Kupffer cells, secretory and excretory functions and formation of bile. Role of liver in detoxification.	12h
4	Digestive System: GI tract, digestion and absorption of carbohydrates, proteins and lipids. Mechanism of HCI production in the stomach. Gastrointestinal hormones and role of pancreas in digestion. Muscle physiology: Types of muscle, structure of skeletal muscle and smooth muscle, muscle proteins; actin, myosin, tropomyosine, troponins. Mechanisms of skeletal and smooth muscle contraction, sliding filament model.	12h

Learning Outcomes: After studying this paper the students will know – Biological processes involving membranes. Importance of membranes in the biological system Nutritional significance Disorders related to nutrition and digestion.

References: Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited. Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons. Guyton and Hall. Human Physiology.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	1	2	2	1	1	2
Weighted average	2	1.5	2	1.75	1.5	1.5	2

IVSemester

M.Sc. Biochemistry IV Semester	Project Work, Report and Viva Voce Course Code: 23F401	HC –Hard Core
Total Hours: 320	Credits: 10 (LTP - 0:2:20)	Total Marks: 15+15+70 = 100

Objective:

To enhance the laboratory skills of the student.

To make the students efficient in identifying a research problem and plan a research work.

Project work:

Each student has to work on a unique and independent mini research project for 3-4 months and submit a dissertation with the research findings.

The quality of work and efficiency of the defense will be evaluated by two examiners during end semester exams.

Outcome:

Enhanced laboratory skills.

Efficiency in identifying a research problem and plan a research work. Appropriate review of literature and selection of proper laboratory methods. Application and importance of statistics.

Make the appropriate conclusions of the research data.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	2	2	1
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	2	1	2	2	1	1	2
Weighted average	2	1.5	2	1.75	1.5	1.5	2

M.Sc. Biochemistry IV Semester	Clinical Biochemistry Course Code: 23F402	SC – Soft Core
Total Hours: 48	Credits: 03(LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Learning Objectives: Students should study this paper to know – The basics of clinical biochemistry. Clinical Diagnosis of different diseases. Different types of clinical diagnosis.

Module	Course contents	
1	Basic concepts: Health and disease. Normal and pathological changes, affecting cells in the body. Cell death and the physiological causes; physical, chemical, biological agents and nutritional deficiency. Blood: Composition, cells, functions of plasma proteins and lipo-proteins in diseases. Disorders of hemoglobin; thalassemia, sickle cell anemia. Anemias; microcytic, normocytic and macrocytic. Diagnostic enzymology: Clinically important enzymes; alkaline phosphatase, AST, ALT and isoenzymes of creatine kinase and LDH	12h
2	Endocrine system: Endocrine system: Overview of the physiology of endocrine system. Laboratory diagnosis to assess the function of pituitary, thyroid, adrenals and gonads. Disroders; graves disease, Hashimoto disease, Addission's disease, hypo and hyper secretion of hormones. Acromegaly, gigantism.	12h
3	Hepatobiliary, Kidney, and GI System: Hepatobiliary system: Overview of hepatobiliary system. Biochemical indices of hepatobiliary diseases. Diagnosis of liver function tests. Bile pigments - formation of bilirubin, urobilinogen, bile acids. Jaundice; prephapatic, hepatic and post hepatic. Diseases of the liver - Hepatitis cholestasis, cirshosis, fatty liver and gallstones. Overview of renal system. Assessment of renal function; creatine clearance, renal calculi, uremia, laboratory investigation of kidney disorders. Gastrointestinal disorders: Fractional gastric analysis, hypo and hyper acidity, gastric ulcers, malabsorption syndrome, steatorrhea and diarrhoea.	12h
4	Cardiac, Skeletal Muscles and Nervous System: Overview of heart and skeletal muscles, CNS. Major Cardio vascular system, atherosclerosis, risk factors and pathogenesis. Diagnosis and prognosis. Assessment of CSF.	12h

Learning Outcomes:A) Application of Biochemistry in the clinical diagnosis. B) Importance of biochemical parameters in the clinical diagnosis. C) Hepatobiliary disorders D) GI tract disorders and diagnosis.

References:Berg J.M., J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited. Chatterjee C.C. (2017). Human physiology: Medical Allied Agency:CBS Publishers and Distributors Pvt. LTD. Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons. Guyton A.C. and Hall J.E. (2006). Text book of Medical Physiology. Elsevier India Pvt. Ltd

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	2	2	2	2	2	2	2
CO2	3	1	3	2	1	1	2
CO3	1	2	1	1	2	2	3
CO4	1	1	3	2	3	1	2
Weighted average	1.75	1.5	2.25	1.75	2	1.5	2.25

M.Sc. Biochemistry IV Semester	Biotechnology Course Code:23F403	SC – Soft Core
Total Hours: 48	Credits: 03 (LTP - 3:0:0)	Total Marks: 15+15+70 = 100

Course Objectives To study the basics of microorganisms and its use in fermentation.
To study the various factors governing the growth of microorganisms at laboratory scale and at industrial fermentation scale To study the methodology used in animal and plant cell culture.

Module	Course contents	
1	Historical Aspects - Discovery of microorganisms. Theory of spontaneous generation. Era of Louis Pasteur. Microbes and fermentation. Microbes and diseases Koch's Postulates. General characteristics: morphology, nomenclature and classification of bacteria, yeast, molds, fungi actinomycetes, rickettsia. Techniques - Isolation and culture of microorganisms - aerobic and anaerobic culture methods, culture media. Isolation of pure colony, characterization. Staining - Gram stain acid fast, endospore, flagella.	12h
2	Microbial Nutrition - Factors influencing growth, growth curve of bacteria. Measurement of growth, continuous culture, synchronous culture chemostat. Auxotrophs, autotrophs, heterotrophs, microorganisms. Growth curve and Diauxic growth curve. Methods of Control of Microorganisms - Bacteriostatic and bacteriocidal agents. methods of cultivations and preservation of microbes. Mechanisms of disinfection and sterilization. Physical and chemical methods.	12h
3	Cell culture techniques: Introduction to plant and animal tissue/cell culture. Laboratory design, aseptic conditions, equipments and materials for cell culture. Different constituents of culture medium, types of media and their applications. Plant cell culture: Micro propagation, callus culture, haploid production, somatic embryogenesis, somatic hybridization, cybridization and somaclonal variation. Production of disease free plants. Animal cell culture: Culture techniques, media, preparation of primary culture; disaggregation of tissue and primary cultures, chick embryo, HUVEC, characterization of cultures, ploidy, cell doubling time.	12h
4	Cell lines: Characteristics and routine maintenance, cell separation techniques. Measurement of viability and cytotoxicity. Scaling-up of animal cell culture; bioreactors used in animal cell culture, amplified cultures, continuous cultures and their applications. Industrial applications: Fermentor; stirred fermentor, micro carrier, encapsulation, hollow fiber chambers, packed glass bead reactors. Cell immobilization techniques. Haracterization of the cultured cells, measuring parameters of growth Cell synchronization, Somatic cell fusion, cell loning and cryopreservation. Applications of animal cell culture: Organ and histotypic cultures; three dimensional culture, tissue engineering;	12h

Course Outcomes Understand the principle and methodology employed in the growth of microorganisms Understand the various parameters affecting the growth of industrially important microorganisms. Understand the importance of plant and animal cell culture to produced therapeutically important secondary metabolites Understand the applications of industrial fermenters.

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	1	2	2	2	2	2	1
CO2	3	2	3	1	3	1	2
CO3	2	2	3	1	2	1	2
CO4	2	1	2	2	1	1	2
Weighted average	2	1.75	2.5	1.5	2	1.25	1.75

M.Sc. Biochemistry IV Semester	Plant Biochemistry Course Code:23F404	SC – Soft Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
	Learning Objectives: Students should study this paper to know – a. To study different systems operating in plants.	
1	Photosynthesis: Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and photophosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle. C3, C4 and CAM cycle. Photorespiration, bacterial photosynthesis. Regulation of photosynthesis. RUBISCO. Nitrogen metabolism: Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and nonsymbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion.	12h
2	Plant hormones: Biosynthesis, storage, breakdown and transport. Physiological effects and mechanisms of action of auxines, gibberlines, cytokinins, ethylene, abscisic acid. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, photoperiodism and biological clocks. Seed dormancy, inception of germination. Germination and growth regulators, juvenility, vernalization.	12h
3	Solute transport and photo assimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil through xylem and phloem. Transpiration, mechanisms of loading and unloading of photoassimilates. Phytochemicals: Extraction, fractionation and characterization. Secondary metabolites - Terpenes, phenols, flavonoids and nitrogenous compounds and their roles in plant physiology and as alternative medicine.	12h
4	Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress. Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in plants, cell-cell fusion in both normal and abnormal cells and defense system in plants.	12h
	Learning Outcomes: After studying this paper the students will know – a. Biological processes involving membranes. b. Importance of membranes in the biological system c. Nutritional significance for plants d. Stress physiology in plants, Transportation of ions and molecules	

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	1	2	2	2	2	2	1
CO2	3	2	3	1	3	1	2
CO3	2	2	3	1	2	1	2
CO4	2	1	2	2	1	1	2
Weighted average	2	1.75	2.5	1.5	2	1.25	1.75

M.Sc. Biochemistry IV Semester	Human Nutrition Course Code:23F405	SC – Soft Core
Total Hours: 48	Credits: 04 (LTP - 3:1:0)	Total Marks: 15+15+70 = 100

Module	Course contents	
	Learning Objectives: Students should study this paper to know – a. To study nutritional composition of foods. b. Nutrition-related disorders c. Dietetics	
1	Nutrition: Concepts of macro and micro nutrients, essential nutrients and their classification. Food groups, proximate analysis of foods, chemical and biological analysis for nutrients. Food as source of energy, methods of determining energy value of foods, calorimetry, physiological fuel value, daily requirement of energy, high and low calorie diets. Basal metabolic rate (BMR), factors affecting BMR, specific dynamic action of foods.	12h
2	Carbohydrates: Dietary sources, dietary fiber, essentiality of carbohydrates.Proteins: Essential amino acids, evaluation of nutritive value of dietary proteins, PER, BV, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition; Kwashiorkar and Marasmus.	12h
3	Fats: Sources, invisible fat, essential fatty acids, PUFA. Vitamins: Fat soluble and water soluble vitamins, provitamines, antivitamins, dietary sources, daily requirements, structure and function. Deficiency symptoms of B and C vitamins and fat soluble vitamins, hypervitaminosis, vitamin - like compounds.	12h
4	Minerals: Macro and micro nutrients, sources, requirements, functions and deficiency symptoms. Water metabolism; distribution in body, water balances and factors affecting water balance. Diet: Recommended daily allowances, special nutrition for infants, children, during pregnancy, lactation and old age. Nutrition for diabetes and cardiovascular disease patients. Wellness diets, fitness diets, obesity and BMI,	12h
	Learning Outcomes: After studying this paper the students will know – a. Biological processes involving digestion, absorption of foods. b. Importance of nutritional composisiton c. Nutritional significance for infants, nursing mothers, pregnant, children and adults	

CO/PO							
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO1	1	2	2	2	2	2	1
CO2	3	2	3	1	3	1	2
CO3	2	2	3	1	2	1	2
Weighted average	2	2	2.65	1.3	1.3	1.3	1.3

Continuous Formative Evaluation/Internal Assessment (HC, SC & OE)

Credit Distribution: The Choice Based Credit System (CBCS) comprises Hard Core, Soft Core subjects for Biochemistry Students and Open Elective for students other than Biochemistry.

Following shall be the minimum and maximum subjects per semester:

The credit pattern is Lecture (L); Tutorial (T); Practical (P); (L: T: P) Pattern.

Course is of 4 credits, and the different credit distribution patterns in L: T: P format is:

4 : 0 : 0,	1 : 2 : 1,	1 : 1 : 2,	1 : 0 : 3,	1 : 3 : 0,
2 : 1 : 1,	2 : 2 : 0,	2 : 0 : 2,	3 : 1 : 0,	3 : 0 : 1,
0 : 2 : 2,	0 : 4 : 0,	0 : 0 : 4,	0 : 1 : 3,	0 : 3 : 1,

The concerned BoS will choose the convenient credit pattern for every course based onthe requirement.

One semester period is 16 weeks of teaching and learning.

Duration of semester is 20 weeks that includes semester end examinations. Credit Pattern:

Hard Core: 3 – 6 Credits **Soft Core:** 2 – 4 Credits **Open elective:** 4 Credits

Project Work: 6 Credits

Course Type	Credits
Hard Core	Minimum Credits - 42 and Maximum Credits - 52
Soft Core	Minimum Credits – 16
Open Elective	Minimum Credits - 4

- A Candidate can enroll for **maximum of 24 Credits per semester** inclusive of Open Elective earned from the other Departments.
- A Candidate has to earn a minimum of **76 Credits** for successful completion of a Master's degree.
- A minimum 76 Credits and additional 18 Credits (76 + 18 = 94 Credits) shall acquire add on Proficiency Diploma.

Continuous Assessment Pattern:

The details of continuous assessment (30:70 patterns) are summarized in the following table:

Component	Syllabus in a Course	Weightage	Period of Continuous Assessment	Marks
C1	First 50%	15%	First half of the semester To be consolidated by 8th week	15
C2	Remaining 50%	15%	Second half of the semester. To be consolidated by 16th week	15
C3	Semester-end examination (All units of the course)	70%	To be completed during 18th-20th Week.	70

Continuous Assessment	Time Duration	Marks		Minimum 30% and an aggregate of 40% to declare pass
		Max	Min	
C1	1 week to 8 weeks	15	4.5	
C2	9 week to 16 weeks	15	4.5	
C3	Complete 16 weeks	70	21	

Theory evaluation:

Component – I (C1): Periodic Progress, Progress Reports, test (15%) calculated for 15marks

Component – II (C2): Periodic Progress, seminar, test (15%) calculated for 15marks)

Component III: (C3): Final exam (end semester exam for 70marks) (70%)

Practical evaluation:

Component – I (C1): Periodic Progress, Laboratory record and Progress Reports (15%)

Component – II (C2): Results of Work, tour report, assignment, class tests, laboratory exercise and Draft Report (15%)

Component III: (C3): (70%) Practical exams to be conducted for 6 hours, students will prepare reagents and perform the experiments, report to the examiners. A viva voce will be conducted during practical examination for each student and marks are allotted accordingly from the experimental efficiency and viva.

In case a candidate secures less than 30% in C1 and C2 put together in a course, the candidate is said to have DROPPED that course, and such a candidate is not allowed to appear for C3 in that course.

Minor/ Major Project Evaluation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the guide. Components of evaluation are as follows:

Component – I (C1): Periodic Progress and Progress Reports (15%)

Component – II (C2): Results of Work and Draft Report (15%)

Component– III (C3): Final Viva-voce and evaluation (70%).

The report evaluation is for 40% and Viva-voce examination is for 30%.

In case a candidate secures less than 30% in C1 and C2 put together in a course, the candidate is said to have DROPPED that course, and such a candidate is not allowed to appear for C3 in that course.

DEPARTMENT OF STUDIES IN BIOCHEMISTRY								
Program: Master of Science **Subject: Biochemistry** **Program Code: PGMSBC**								
	Title of Course	L:T: P	Credit	C1	C2	C3	Total	Subject Code
1	Fundamentals of Biochemistry	3:1:0	4	15	15	70	100	23F101
2	Techniques in Biology	3:1:0	4	15	15	70	100	23F102
3	Molecular Cell Biology	3:1:0	4	15	15	70	100	23F103
4	Bioorganic and Bioinorganic Chemistry	3:0:0	3	15	15	70	100	23F104
5	Practical 1A : Experiments inBiological techniques and Bioorganic chemistry & TourReport (Laboratory Visit and Tour Report)	0:0:2	2	15	15	70	100	23F105
6	Practical 1B : Experiments inCell Biology, Genetics and Bioinorganic chemistry & Seminar	0:0:2	2	15	15	70	100	23F106
7	Genetics	3:0:0	3	15	15	70	100	23F107
8	Membrane Biology	3:0:0	3	15	15	70	100	23F108
9	Molecular Biology	3:1:0	4	15	15	70	100	23F201
10	Enzymology	3:0:0	3	15	15	70	100	23F202
11	Practical 2A: Experiments in Molecular Biology and EnergyMetabolism; Laboratory visits and Tour report	0:0:2	2	15	15	70	100	23F203
12	Practical 2B: Experiments in Enzymology and Research Paper presentation	0:0:2	2	15	15	70	100	23F204
13	Metabolism of Lipids	3:0:0	3	15	15	70	100	23F205
14	Metabolism of Carbohydrates	3:0:0	3	15	15	70	100	23F206
15	Endocrinology	3:0:0	3	15	15	70	100	23F207
16	Dissertation – Review of Literature	0:2:0	2	15	15	70	100	23F208
17	OE: Biology for Non-biologists	2:2:0	4	15	15	70	100	23F209
18	OE: Nutrition in Health and Disease	2:2:0	4	15	15	70	100	23F210
19	Immunology	3:1:0	4	15	15	70	100	23F301
20	Metabolism of Amino Acids and Proteins	3:1:0	4	15	15	70	100	23F302
21	Practical-3A: Experiments inImmunology and amino acid metabolism. Study tour andtour report.	0:0:2	2	15	15	70	100	23F303
22	Practical 3B: Experiments in Metabolism and Review of Literature.	0:0:2	2	15	15	70	100	23F304
23	Metabolism of Nucleic Acids	3:1:0	4	15	15	70	100	23F305
24	Research Methodology,Biostatistics, and Bioinformatics	3:1:0	4	15	15	70	100	23F306
25	Human Physiology withclinical relevance	3:1:0	4	15	15	70	100	23F307
26	Internship	0:0:2	2	15	15	70	100	23F308
27	Research Project Work, Report and Viva Voce	0.0.10	10	15	15	70	100	23F401
28	Clinical Biochemistry	3:0:0	3	15	15	70	100	23F402
29	Biotechnology	3:0:0	3	15	15	70	100	23F403
30	Plant Biochemistry	3:1:0	4	15	15	70	100	23F404
31	Human Nutrition	3:1:0	4	15	15	70	100	23F405

Scheme of Question Paper for (50 marks)
To be calculated for 15 marks for C1 and C2

TIME: 2 HOURS
MAX.MARKS:50

I. Answer any FIVE of the following: [5X2=10]
1 to 6

II. Answer any FOUR of the following: [4X5=20]
1 to 5

III. Answer any TWO of the following: [2X10=20]
1 to 3

The C1 and C2 can be reduced to 25 marks over 1 hour.
Should be calculated for 15 marks (proportionately).
Marks from Seminar or assignment or Class Exercise also can be included.

Scheme of Question Paper for End Semester Examination (70 marks) C3

TIME: 3 HOURS **MAX.MARKS: 70**

I. Answer any ten of the following: [10X2=20]
1 to 12

II. Answer any four of the following: [4X5=20]
13 To 18

III. Answer any three of the following: [3X10=30]
19 to 23
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Question Paper Pattern for Practical – C1 and C2

Time: 2 Hours **Max Marks: 50**

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1. Conducting an Experiment/Micro-preparation /Plant identification	20m
2. Critical comments /Identification/ Procedure Writing	10 m
3. Viva-voce examination	10m
4. Class Records/Submissions.	10m

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The C1 and C2 can be reduced to 25 marks over 1 hour.
Should be calculated for 15 marks (proportionately).
Marks from Seminar or assignment or Class Exercise also can be included.

Question Paper Pattern for Practical – End Semester Examination C3

Time: 6 Hours **Max Marks: 70**

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1. Conducting Experiment/Micro-preparation /Plant identification	20m
2. Minor experiment/ Demonstrations	15m
3. Critical comments /Identification/ Procedure Writing	10m
4. Viva-voce examination	20m
5. Class Records/Submissions.	5m

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