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

WITH EFFECT FROM 2024 TO 2026

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 experience a de-stressed learning environment. Further, UGC expects that institutions of higher learning draw a roadmap in a time bound manner to accomplish the above.

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 for all 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 learning and 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 own firms.

PO: Program outcomes:

1. 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 to understand the regulation and disorders of metabolic pathways.
3. The principles of bioenergetics and enzyme catalysis;
4. Understanding of metabolic pathways among prokaryotes and eukaryotes.
5. Gain proficiency in laboratory techniques in biochemistry and biological sciences like immunology, physiology, molecular biology, enzymology and biotechnology.
6. 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.
7. The practical skills are improved which help their research experience among academic or industrial R&D programs.
8. 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.
9. Develop an ability to translate knowledge of Biochemistry to address environmental, intellectual, societal, and ethical issues through innovative thinking and research strategies.
10. Develop an ability to put forward the scientific perception to a person/ community belonging to a non- science background.
11. To inculcate skills for teaching in academic institutions for undergraduate and postgraduate students.
12. Develop confidence in taking competitive examinations in the field of life sciences both in India and abroad so that they can pursue higher education.

Pedagogies employed

1. The regular classroom sessions will include the use of black board/ white board, slide presentations, video presentations.
2. The classroom teaching will also use additional information and communications technology (ICT).
3. Group discussions about the class and student seminars.
4. Tutorials include interaction with individual students for the preparation of seminars, 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. Value added courses include both theory and laboratory sessions for skill enhancement.
10. Invited talks from eminent scientists.
11. Laboratory / industrial visits to understand the real time processing/ functioning of a company.

1. TITLE AND COMMENCEMENT

These Regulations are for the OUTCOME BASED EDUCATION (OBE) and CONTINUOUS ASSESSMENT GRADING PATTERN (CAGP) 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 2024-25 to 2025-26.

2. PROGRAM - M.Sc.

3. SUBJECT: BIOCHEMISTRY

4. Number of semesters: 04

5. Duration: 2 years

One semester period is 16 weeks of teaching and learning.

Duration of semester is 20 weeks that includes semester end examinations.

6. ELIGIBILITY FOR ADMISSION

a) Eligibility is as prescribed by the University of Mysore regulations for PG admission.
b) Students of Bachelors of Science (B.Sc.) degree from any UGC recognized Universities with Chemistry or Biochemistry as one of the majors/Optional
c) For general category- minimum 45% marks in Chemistry/ Biochemistry
d) For SC/ST category- 40% marks in Chemistry/ Biochemistry
e) Students with bachelor degrees from Foreign Universities will apply through the equivalence committee of University of Mysore.
f) The applicant has to take "Post Graduate Entrance Examination (PGEE)" for the current year conducted by the University of Mysore or as applicable.

7. ABOUT THE CREDITS:

Credit Distribution: The OUTCOME BASED EDUCATION (OBE) [Choice Based Credit System-CBCS] comprises Foundation Course Hard Core (FCHC), Hard Core (HC), Soft Core (SC), value added course (SC), courses for Biochemistry Students and Open Elective (OE) for students other than Biochemistry.
Hard Core: 3 – 10 Credits (including Research Project-10 credits);
Soft Core: 2 – 6 credits (including Value Added Courses);
Open elective: 4 Credits

Credit Pattern: The credit pattern is Lecture (L); Tutorial (T); Practical (P); (L: T: P) Pattern. The tutorial can be off-classroom teaching/guidance for seminar, test, academic doubts.

For example, the credit pattern for a course of 03 credits, the L:T:P pattern can be any ONE of the following:

L	3	0	2	2	0	1
T	0	0	1	0	1	1
P	0	3	0	1	2	1

The concerned BoS will choose the convenient credit pattern for every course based on the requirement. If a course is full of (L=0): T: (P=0) type, then the examination for C3 Components will be decided by the BOS concerned.

- A Candidate has to earn a minimum of **76 Credits** for successful completion of the Master degree.
- A candidate shall **enroll for a minimum of 20 and a maximum of 30 credits per semester** inclusive of Open Elective earned from the other departments for first, second and third semesters, with the approval of the concerned department. For the fourth semester, a candidate shall enroll for a minimum of 10 credits and a maximum of 22 credits. Only such candidates who register for a minimum of 76 credits in total of the 4 semesters and complete successfully, shall be considered for declaration of ranks and medals.
- **A minimum 76 Credits and additional 18 Credits (76 + 18 = 94 Credits)** shall acquire add on Proficiency Diploma. The additional credits can be acquired by registering for extra soft core courses in each semester; and the extra courses studied and grades earned shall be appearing on the end semester marks card and final marks transcript.
- **The Proficiency Diploma shall be issued** to the candidate **as a separate certificate apart from the M.Sc. degree certificate or as per the regulations of University of Mysore.**

8. Scheme of Instructions

A Masters Degree program is of 4 semesters-two year's duration for regular candidates.A regular candidate can avail a maximum of 8 semesters – 4 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 perthe prevailing scheme, when he/she continues his/her study.

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

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 concerned Board of Studies.

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

1) 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.

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

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

Continuous Assessment Pattern:

Component	Time Duration	Syllabus Considered	Weightage	Marks		Aggregate Marks	
				Max	Min (30%)	Max	Min (40%)
C_1	1-8 wks	First 50%	15%	15	4.5	$[C_1 + C_2 + C_3]$	$[C_1 + C_2 + C_3]$
C_2	9-16 wks	Remaining 50%	15%	15	4.5		
C_3	Complete 16 weeks	Complete Syllabus (Semester End Examination)	70%	70	21	100	40
A minimum of 15% in each component individually (among C_1, C_2 & C_3) and a minimum of 40% aggregate (adding up C_1, C_2 & C_3) to declare PASS.							

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

4) 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 concerned teacher for this purpose.

5) 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) 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 the 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.

9. Medium of Instruction

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

10. Setting Questions Papers And Evaluation Of Answer Scripts

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

11. EVALUATION

11.1 Theory evaluation:

1) Component – I (C1): Periodic Progress, Progress Reports, test (15%) calculated for 15 marks Component – II (C2): Periodic Progress, seminar, test (15%) calculated for 15 marks)
2) Component III: (C3): Final exam (end semester exam for 70 marks) (70%). There shall be a single valuation of C3 for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited.
3) There shall be a single evaluation for all theory papers C3 by an internal examiner and 25% of the total scripts will be reviewed by an external examiner. The average of first valuation and the review evaluation will be considered as the final marks of the candidate.
4) 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.

11.2 Practical evaluation:

1. Component – I (C1): Periodic Progress, Laboratory record and Progress Reports (15%)
2. Component – II (C2): Results of Work, tour report, seminar, assignment, class tests,laboratory exercise and Draft Report (15%)
3. 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 foreach student and marks are allotted accordingly from the experimental efficiency and viva.
4. 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.
5. The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
6. A candidate will be assessed on the basis of
    i. Knowledge of relevant processes
    ii. Skills and operations involved
    iii. Results / products including calculation and reporting.
    iv. Inference / Conclusion of the results if applicable.
7. If the external examiner does not turn up then both the examiners will be internal examiners. The duration of semester-end practical examination shall be decided by the Departmental council.
8. 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 awarded in the third evaluation will be final.

11.3 Evaluation of Minor/ Major Project/ Dissertation/ Internship

1) The research project can be executed by the candidate at the department (if a faculty agrees to guide) or at an outside firm/ laboratory/institute approved by the department. If a candidate is executing the research project/ internship at an external facility he/she shall report the updates in a timely manner as and when required by the assigned internal faculty at the department, in which case such faculty becomes the co-guide. 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/ co-guide. The candidate shall follow the rules of the college as well as the external site during the project work. The candidate shall submit the project report in the format prescribed by the department.

2) Components of evaluation are as follows:
   i) Component – I (C1): Periodic Progress and Progress Reports (15%) by the internal faculty.
   ii) Component – II (C2): Results of Work, seminar and Draft Report (15%) by the internal faculty.
   iii) Component– III (C3): Practical/viva shall be conducted for 6 hours for each batch with a maximum of 12 students/ batch. Final Viva-voce and evaluation (70%). The report evaluation is for 40 marks and Viva-voce examination is for 30 marks. C3 evaluation shall be conducted by one internal and one external examiner.
3) 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.
4) The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
5) A candidate will be assessed on the basis of
   i. Knowledge of relevant processes
   ii. Skills and operations involved
   iii. Results / products including calculation and reporting.
   iv. Inference / Conclusion of the results if applicable.

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

7) If there is a 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 awarded in the third evaluation will be final.

11.4 Valuation of Value Added Courses

1) Component – I (C1): Periodic Progress and Progress Reports (15%) by the internal faculty.
2) Component – II (C2): Results of Work, seminar and Draft Report (15%) by the internal faculty.
3) Component– III (C3): Practical/viva shall be conducted for 6 hours for each batch with a maximum of 12 students/ batch. Final Viva-voce and evaluation (70%). The report evaluation is for 40 marks and Viva-voce examination is for 30 marks. C3 evaluation shall be conducted by one internal and one external examiner.

4) 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.
5) The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
6) A candidate will be assessed on the basis of
    i. Knowledge of relevant processes
    ii. Skills and operations involved
    iii. Results / products including calculation and reporting.
    iv. Inference / Conclusion of the results if applicable.
7) If the external examiner does not turn up then both the examiners will be internal examiners. The duration of semester-end practical examination shall be decided by the Departmental council.
8) If there is a 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 awarded in the third evaluation will be final.

12. 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 10 days after the announcement of the results (or as prescribed by the Controller of Examination-CoE). 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 (or as prescribed by the Controller of Examination-CoE). This challenge evaluation is only for C3 components. The answer scripts, for which challenge evaluation is sought for, shall be sent to an external examiner. The marks awarded in the challenge evaluation will be final.

12. Computing the FINAL MARKS

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.

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

14. DROPPED COURSES

- 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 such notification shall also be sent to the office of the Director & the Controller of Examinations.
- In case a candidate secures less than 30% in C3, he/she may choose the 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 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 chooseDROP/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 (or as per the instructions from the controller of examinations-CoE)
- 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.
- 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 a soft core / elective course. A candidate who is said to have DROPPED project work has to re-register for the same subsequently within the stipulated period. **The details of any dropped course will not appear in the grade card.**
- 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.
- 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.

15. 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 is 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 was drawn from outside the department.

16. GRADE POINTS

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

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

b) 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.

c) 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**

17. 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	
5<= CGPA <6	6	Second Class
6<= CGPA <7	7	
7<= CGPA <8	8	First Class
8<= CGPA <9	9	
= CGPA <10		Distinction

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

18. Attendance and Conduct

Students SHALL NOT take up any employment/course, part time or full time during their M.Sc. program. Students found violating this rule shall be removed from the course/ program. 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 examinations.

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.

19. 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 another university seeking admission by transfer to the college should have completed all the courses of the previous semesters.

20. 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.
4) Any other issue not envisaged above, shall be resolved by the competent authority of the autonomous college, which shall be final and binding.
5) Any matter which is not covered under this regulation shall be resolved as per the University of Mysore Regulations in this regard.

SBRR MAHAJANA FIRST GRADE COLLEGE
(Autonomous)
Accredited by NAAC with 'A' grade

DEPARTMENT OF STUDIES IN BIOCHEMISTRY
SCHOOL OF LIFE SCIENCES
POOJA BHAGAVAT MEMORIAL MAHAJANA EDUCATION CENTRE PG WING
K.R.S. Road, Metagalli, Mysuru-570016

Affiliated to the University of Mysore

CHOICE BASED CREDIT SYSTEM (CBCS)
OUTCOME BASED EDUCATION (OBE) AND
CONTINUOUS ASSESSMENT GRADING PATTERN (CAGP) FOR
M.Sc. BIOCHEMISTRY PROGRAMME

Syllabus for 1-4 semesters
2024-2026
M.Sc. Biochemistry

PG ✔

WITH EFFECT FROM 2024 TO 2026

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5) Gain proficiency in laboratory techniques in biochemistry and biological sciences like immunology, physiology, molecular biology, enzymology and biotechnology.
6) 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.
7) The practical skills are improved which help their research experience among academic or industrial R&D programs.
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12) Develop confidence in taking competitive examinations in the field of life sciences both in India and abroad so that they can pursue higher education.

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2) To enable motivated researchers in research institutions or industries.
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Course Structure: M.Sc. DEGREE IN BIOCHEMISTRY (August 2024)

Minimum Requirements

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

CHOICE BASED CREDIT SYSTEM (CBCS)

Outcome Based Education (OBE)

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

	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**

Semester I

Sl. No.	Title of the Paper	Course Type	Credit Pattern			Total Credits	Course Code
			L	T	P		
Hard Core (All Compulsory)							
1	Molecular Cell Biology	FCHC	3	1	0	4	24F101
2	Techniques in Biology	FCHC	3	1	0	4	24F102
3	Fundamentals of Biochemistry	FCHC	3	1	0	4	24F103
4	Bioorganic and Bioinorganic Chemistry	HC	3	0	0	3	24F104
5	**Practical 1A** Experiments in Biological techniques and Bioorganic chemistry	HC	0	0	2	2	24F105
6	**Practical 1B** Experiments in Cell Biology, Bioinorganic chemistry & Seminar	HC	0	0	2	2	24F106
Soft Core (Any One to be selected)							
7	Genetics	SC	3	0	0	3	24F107
8	Membrane Biology	SC	3	0	0	3	24F108
TOTAL MINIMUM CREDITS: 22 6 Hard Core (HC): 19 Credits 1 Soft Core (SC): 03 credits							
Extra credits available: 1 Soft Core (SC): 03 credits							

Semester II

Sl. No.	Title of the Paper	Course Type	Credit Pattern			Total Credits	Course Code
			L	T	P		
Hard Core (All Compulsory)							
1	Molecular Biology	FCHC	3	1	0	4	24F201
2	Enzymology	HC	3	0	0	3	24F202
3	**Practical 2A:** Experiments in Molecular Biology and Energy Metabolism	HC	0	0	2	2	24F203
4	**Practical 2B:** Experiments in Enzymology and Seminar	HC	0	0	2	2	24F204
Soft Core (Any Two to Five to be selected)							
5	Metabolism of Lipids	SC	3	0	0	3	24F205
6	Metabolism of Carbohydrates	SC	3	0	0	3	24F206
7	Endocrinology	SC	3	0	0	3	24F207
8	Research Methodology, IPR and Review of Literature	SC	1	0	2	3	24F208
9	Health Care Technology	SC	0	0	2	2	24F209
Open Elective papers offered for students of other disciplines							
10	**OE: Biology for Non-biologists**	OE	2	2	0	4	24F210
11	**OE: Nutrition in Health and Disease**	OE	2	2	0	4	24F211
TOTAL MINIMUM CREDITS: 25 4 Hard Core (HC): 11 Credits 4 Soft Core (SC): 3+3+2+2 = 10 credits 1 Open elective (OE): 04 credits							
Extra credits available: 1 Soft Core (SC): 03 credits							

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

Semester III

Sl. No.	Title of the Paper	Course Type	Credit Pattern			Total Credits	Course Code
			L	T	P		
Hard Core (All Compulsory)							
1	Immunology	FCHC	3	1	0	4	24F301
2	Metabolism of Amino Acids and Proteins	HC	3	1	0	4	24F302
3	Practical 3A- Immunology, Nitrogen Metabolism and Seminar	HC	0	0	2	2	24F303
4	Practical 3B: Basic Experiments in Bioinformatics and Biostatistics	HC	0	0	2	2	24F304
Soft Core (Any Two to Four to be selected)							
5	Metabolism of Nucleic Acids	SC	3	1	0	4	24F305
6	Biostatistics, and Bioinformatics	SC	3	1	0	4	24F306
7	Human Physiology with clinical relevance.	SC	3	1	0	4	24F307
8	Internship	SC	0	0	4	4	24F308
TOTAL MINIMUM CREDITS: 24 4 Hard Core (HC): 12 Credits 3 Soft Core (SC): 12 credits							
Extra credits available: 1 Soft Core (SC): 04 credits							

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

Semester IV

Sl. No.	Title of the Paper	Course Type	Credit Pattern			Total Credits	Course Code
			L	T	P		
Hard Core (All Compulsory)							
1	Research Project Work, Report and Viva Voce	HC	0	0	10	10	24F401
Soft Core (Any One to Four to be selected)							
2	Clinical Biochemistry	SC	3	1	0	4	24F402
3	Biotechnology and Genetic Engineering	SC	3	1	0	4	24F403
4	Plant Biochemistry	SC	3	1	0	4	24F404
5	Human Nutrition	SC	3	1	0	4	24F405
TOTAL MINIMUM CREDITS: 14 1 Hard Core (HC): 10 Credits 1 Soft Core (SC): 04 credits							
Extra credits available: 3 Soft Core (SC): 04+04+04 = 12 credits							

LTP: Lecture, Tutorial, Practical.

I semester

Name of the course:	**Molecular Cell Biology**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (FCHC- Foundation Course Hard Core)
Course Code:	24F101
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Course Outcomes: Students should study this paper to know

1. The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. Cell cycle and cellular processes.
3. Concept of cancer biology and signal transduction.
4. Phytochemicals in cancer treatment and stems cells.

Module- I: Organization of the cell 12 Hours

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.

Module – II: Cellular processes 12 Hours

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.

Module – III: Cancer Biology 12 Hours

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 present and future, Role of p53 in cancer. Role of phytochemicals in cancer treatment, cancer stem cells.

Module – IV Basics of Signal Transduction 12 Hours

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 signaling growth factors- EGFR, VEGF, PDGF and their Signalling, 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.

References:

1. 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.
2. Cooper, G. M., and Hausman, R. E. 2013. The Cell: a Molecular Approach (6th Ed.). Washington: ASM, Sunderland.
3. Hardin, J., Bertoni, G., Kleinsmith, L. J., and Becker, W. M. 2012. Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.
4. Kleinsmith, L.J., and Kish, V. M. 1995. Principles of Cell and Molecular Biology (2ndEd.) Harper Collins College Publishers, New York, USA.
5. Lodish H., and Berk A. 2016. Molecular Cell Biology (8th Ed.). New York. W H Freeman.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : MOLECULAR CELL BIOLOGY (FCHC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	2	2	2	3	2	3	3	3	3	3	3	3
CO2	2	2	2	3	2	3	2	3	3	3	3	3
CO3	2	2	2	3	2	3	2	3	3	3	3	3
CO4	2	2	2	3	2	3	2	3	3	3	3	3
Weighted Average	**2**	**2**	**2**	**3**	**2**	**3**	**2.25**	**3**	**3**	**3**	**3**	**3**

I semester

Name of the course:	**Techniques in Biology**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (FCHC- Foundation Course Hard Core)
Course Code:	24F102
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Course Outcomes: Students should study this paper to know

1. This paper is designed to give a brief introduction to most of the techniques usedin the field of biological analyses.
2. Nevertheless, the topics in this paper are to be taught compendiously.
3. The fundamental principles in cell homogenization.
4. Importance of bioanalytical techniques.

Module I: Biological samples: Types and preparation 12hours

Study Models: In vivo and in vitro models; Microbial, Animal, Plants; choice of models;types ofstudies, auxotrophs. Routes of exposure of test chemicals in animals. Culture: microbes, animaland plant cells in laboratory.

Cell fractionation techniques: Tissue homogenization, Cell lysis techniques, extraction of cellcellularcontents. 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.

Module II: Spectroscopic analysis 12Hours

Principles and applications of colorimeter, spectrophotometer, fluorimeter, multiwell 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.

Module III: Chromatographic and electrophoretic techniques: 12Hours

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. Chromatofocusing, HPLC, UPLC and FPLC.

Protein electrophoresis: Polyacrylamide gel electrophoresis, SDS-PAGE, IEF & 2DEF.Visualizing proteins using CBB, silver stain, glycoproteins and 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.

Module IV: Radiochemistry and Mass spectroscopy 12Hours

Isotopes: Heavy isotopes and radio isotopes, half-life, decay constant, detection and quantification 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, autoradiography, pulse chase method, carbon dating.

References:

1. Bryce, C. and Balasubramanian, D.2004. Concepts in Biotechnology: Universities Press.
2. Crueger, W. and Crueger, A. 2017. Biotechnology:a textbook of microbiology. Medtech.
3. Marshall, A. G.1978. Biophysical chemistry: principles, techniques, and applications: Wiley New York.
4. Micklos, D. A., andFreyer, G. A. 1990. DNA science; a first course in recombinant DNA technology: Cold Spring Harbor Laboratory Press.
5. Purohit, S., and Mathur, S.1999. Drugs in Biotechnology fundamentals and applications. Purohit SS.,Ed.,Maximum Publishers, India.
6. Slater,A.., Scott, N., and Fowler, M. 2003. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, Oxford, New York,

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : TECHNIQUES IN BIOLOGY (FCHC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

I semester

Name of the course:	**Fundamentals of Biochemistry**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (FCHC- Foundation Course Hard Core)
Course Code:	24F103
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Module 1 12 hours

Basics of Chemical Bonding and Carbohydrates:

Bonding: Covalent bond; coordinate bond; coordinate bond formation in transition metals. Bonding of iron in hemoglobin and cytochromes, cobalt in Vit B12, magnesium in chlorophyll. Special properties of water; Structure and bonding, non- covalent interactions.

Carbohydrates: properties and reactions of carbohydrates, structure and classification of carbohydrates, monosaccharides (pentoses, hexoses), disaccharides (lactose, sucrose, maltose) and polysaccharides (starch, cellulose, glycogen and bacterial cell wall polysaccharides).

Module 2 12 hours

Basics of Amino Acids and Proteins: Amino acids-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.

Module 3 12 hours

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.

Module 4 12 hours

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.

Learning Outcomes: After studying this paper the students will know –

a. Knowledge of Chemistry of biomolecules.
b. The fundamental principles in sequencing of DNA.
c. Importance of biomolecules in the biological system.

d. Structure and function of enzymes.

References:

1. Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
2. Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.
3. Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
4. Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
5. Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
6. 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.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : FUNDAMENTALS OF BIOCHEMISTRY (FCHC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

I semester

Name of the course:	**Bioorganic and Bioinorganic Chemistry**
Credits:	03 (LTP - 3:0:0)
Course Type:	Hard Core (HC)
Course Code:	24F104
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a. The basics in chemical reactions.
b. Chemical bonding.
c. Stereochemistry of biomolecules.

Different types of heterocyclic compounds and their biological role.

Module 1 6 hours

Electrolytes, Non-Electrolytes and Electrodes

Osmotic pressure, vapor pressure, osmometer, Donnan membrane equilibrium. Hydrogen electrode, electrode potential, and redox potential.

Module 2 12 hours

Stereochemistry:

Importance of stereochemistry, position and order of groups around carbon. Geometric and optical isomerism; absolute and relative configuration.Symmetry viewof 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

Module 3 18 hours

Mechanism of organic reactions and Heterocyclic compounds:

Intermediates and rearrangements in organic reaction. Reactionenergetic.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.

Module 4 6 hours

Heterocyclic Compounds: Chemistry of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole. Chemistry of porphyrins and heme and their biological importance.

References

a) Bahl A. (2017) Advanced organic chemistry (22nd Edition). S Chand & Company Limited.

b) Organic Chemistry (12th edition) By T.W. Graham Solomons, Craig B. Fryhle and Scott A. Snyder

c) Tamagawa, H., & Ikeda, K. (2017). Generation of membrane potential beyond the conceptual range of Donnan theory and Goldman-Hodgkin-Katz equation. *Journal of biological physics*, *43*(3), 319–340

d) Sjöström, A., Rysz, S., Sjöström, H., & Höybye, C. (2021). Electrolyte and acid-base imbalance in severe COVID-19. *Endocrine connections*, *10*(7), 805–814.

e) Dembinski, R., & Soloshonok, V. (2023). Featured Reviews in Organic Chemistry. *Molecules (Basel, Switzerland)*, *28*(16), 5975.

f) Morrison R. and Boyd R. (1992). Organic Chemistry (6th edition). Englewood Cliffs, NJ: Prentice Hall.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : BIOORGANIC AND BIOINORGANIC CHEMISTRY (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

I semester

Name of the course:	**Practical 1A-Experiments in Biological Techniques, Bioorganic chemistry**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F105
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

a) Basic techniques in biochemistry
b) Bioorganic chemistry
c) Photometry
d) Electrophoresis

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. Estimation of reducing sugar by DNS method.
5. Purification of casein from cow's milk.
6. Estimation of proteins by Lowry's method.
7. Estimation of proteins by Biuret Method.
8. Estimation of saponification of lipids.
9. Estimation of iodine value of lipids.
10. Circular paper chromatography for separation of amino acids.
11. Ascending paper chromatography for separation of amino acids.
12. Descending paper chromatography for separation of amino acids.
13. 2D paper chromatography for amino acids.
14. Thin layer chromatography of amino acids (1D and2D).
15. Column chromatography for the separation of plant pigments.
16. Gel filtration (Size exclusion chromatography).
17. Estimation of Iron using Wong's method.
18. Synthesis and purification of aspirin.
19. Estimation of polyphenols from plant samples.
20. Demonstration of Sodium Dodecyl Sulphate-Poly Acrylamide Gel Electrophoresis (SDS-PAGE) and estimation of molecular weight of proteins.

References:

a) Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
b) Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.
c) Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
d) Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
e) Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
f) NIN manual, Hyderabad, India

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
COURSE NAME : PRACTICAL 1A- EXPERIMENTS IN BIOLOGICAL TECHNIQUES, BIOORGANIC CHEMISTRY (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

I semester

Name of the course:	**Practical 1B-Experiments in Cell Biology, Bioinorganic chemistry and seminar**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F106
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

a) Basic techniques in cell biology
b) Bioinorganic chemistry
c) Cell division studies and Cell viability assays.
d) Presentation skills

1. Preparation buffers and solutions & Measurement of pH.
2. Microscopic examination of prokaryotic and eukaryotic cells using staining techniques.
3. Assessment of cell viability and cytotoxicity.
4. Study of mitosis in onion root tips.
5. Study of meiosis in onion flower buds.
6. Determination of chiasma frequency in onion.
7. Estimation of Phosphate ions using Fiske-Subbarow method.
8. Estimation of calcium.
9. Estimation of Iron using Wong's method.
10. Seminar

References:

a) Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
b) Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.
c) Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
d) Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
e) Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
f) NIN manual, Hyderabad, India

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
COURSE NAME : PRACTICAL 1B- EXPERIMENTS IN CELL BIOLOGY, BIOINORGANIC CHEMISTRY AND SEMINAR (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

I semester

Name of the course:	**Genetics**
Credits:	03 (LTP - 3:0:0)
Course Type:	Soft Core (SC)
Course Code:	24F107
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a) Model organisms available to study genetics.
b) Mutation and mutagenesis.
c) Types of DNA recombination and DNA repair.
d) Detailed account on transposable elements and transpositions.

Module 1 - 12 hours

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.

Module 2 - 12 hours

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.

Module 3 – 12 hours

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.

Module 4 – 12 hours

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.

References

a) Buchanan, B.B., Gruissem, W., and Jones, R.L. 2010. Biochemistry and Molecular Biology of Plants. Ed. ASPP Press.USA.

b) 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.

c) Hartl, D. 1991. Basic Genetics (2nd Ed.). Jones and Barlett Publisher Inc. Boston.

d) Randhawa, S. S. 2017. Textbook of Genetics (Ist Ed.). S Vikas and Company, Jalandhar.

e) Tamarin, R. H. 2009. Principles of Genetics (7th Ed.) Tata-McGraw Hill, New Delhi.

f) 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.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : GENETICS (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

I semester

Name of the course:	**Membrane Biology**
Credits:	03 (LTP - 3:0:0)
Course Type:	Soft Core (SC)
Course Code:	24F108
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a. properties of biological membrane, and different models of membranes the biological function.

b. Understand membrane asymmetry and other properties using various methods.

c. Understand the complex mechanism involved in transportation of biomolecules acrossmembranes.

d. Laws of diffusion

Module 1 - 12 hours

Physico-chemical properties of membranes: Compositions 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.

Module 2 - 12 hours

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.

Module 3 – 12 hours

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 sterolsin membranes. FRET, FRAP, single particle tracking, EM of membranes, calorimetry, confocal microscopy of membrane dynamics. Cell fusion, shedding of membrane.

Module 4 – 12 hours

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 phosphotransferase system.

References

a) Molecular Biology of the Cell; 6 th Edn. Bruce Alberts, Alexander Johnson, Julian

Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science (2014).
b) Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
c) Bajar, B. T., Wang, E. S., Zhang, S., Lin, M. Z., & Chu, J. (2016). A Guide to Fluorescent Protein FRET Pairs. Sensors (Basel, Switzerland), 16(9), 1488
d) Berrocal, M., & Mata, A. M. (2023). The Plasma Membrane Ca2+-ATPase, a Molecular Target for Tau-induced Cytosolic Calcium Dysregulation. Neuroscience, 518, 112–118.
e) Allen, N. J., & Eroglu, C. (2017). Cell Biology of Astrocyte-Synapse Interactions. Neuron, 96(3), 697–708.
f) Forrest L. R. (2015). Structural Symmetry in Membrane Proteins. Annual review of biophysics, 44, 311–337.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
Course Name : MEMBRANE BIOLOGY (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**Molecular Biology**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (FCHC-Foundation Course Hard Core)
Course Code:	24F201
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. To understand biological activities and metabolism at DNA and protein level
2. The course gives an in-depth insight into the molecular aspects of life - the central dogma.
3. It explains molecular aspects of genes and its regulation- genome- gene expressions heredity- recombination- protein synthesis- molecular basis of diseases- mutations genetic analysis etc.
4. Understand the molecular tools and its application in basic research and applied research in various fields of life sciences.

Module 1: 12 Hours

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.

Module 2 12 Hours

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 :

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.

Module 3: 12 Hours

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).

Module 4: 12 Hours

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 and non 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.

References:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.1994. Molecular Biology of the Cell. Garland Science, New York.
2. Cooper, G.M. 1997.The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J. Lodish, H. and Baltimore, D. 1990. Molecular Cell Biology. Scientific American Books Inc. NY.
4. Elliott, W. H., and Elliott, D. C. 2006. Biochemistry and Molecular Biology (3rd Indian Ed.). Oxford University Press, Oxford.
5. Garrett, R.H. and Gresham, C.M.1995. Molecular aspects of Cell Biology, International edition, Saunders College Publishing.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
Course Name : MOLECULAR BIOLOGY (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**Enzymology**
Credits:	03 (LTP - 3:0:0)
Course Type:	Hard Core (HC)
Course Code:	24F202
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

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

Module 1: 12 Hours

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. Monosubstrate and Bisubstrate reaction: Cleland's notation with examples of ordered, ping-pong, and random reactions. General rate equation. Coenzymic action of NAD+, FAD, TPP, PLP, Biotin, CoA, folic acid and lipoic acid.

Module 2 12 Hours

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.

Module 3: 12 Hours

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. Reversible and irreversible inhibition; competitive, non competitive, uncompetitive product inhibition and suicide inhibition. Determination of Ki and Kd. Metabolic regulation of enzyme activity: Feedback regulation, fine control of enzyme activity (PDC). Isoenzymes; LDH, multifunctional enzymes (DNA polymerase) and multi enzyme complex (PDC). Abzymes, ribozymes, zymogen.

Module 4: 12 Hours

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,

roximity 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 Chymotrypsin; acid- base catalysis, charge relay network.

References:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry: Trevor Palmer, Horwood, (2001).
2. Enzyme Kinetics: Principles and Methods: Hans Bisswanger, Wiley–VCH (2002).
3. Fundamentals of Enzyme Kinetics: 4 th edn. Athel Cornish-Bowden, Wiley-Blackwell (2012)
4. Klein, R., Nagy, O., Tóthová, C., & Chovanová, F. (2020). Clinical and Diagnostic Significance of Lactate Dehydrogenase and Its Isoenzymes in Animals. Veterinary medicine international, 2020, 5346483
5. Fried, S. D., & Boxer, S. G. (2017). Electric Fields and Enzyme Catalysis. Annual review of biochemistry, 86, 387–415
6. McDonald, A. G., & Tipton, K. F. (2022). Parameter Reliability and Understanding Enzyme Function. Molecules (Basel, Switzerland), 27(1), 263.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
Course Name : ENZYMOLOGY (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**Practical 2A - Experiments in Molecular Biology and Energy Metabolism**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F203
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a) Proficiency in laboratory techniques in molecular biology and energy metabolism.
b) Proficiency in the experiments to articulate the metabolic pathways.
c) Efficacy in testing the markers for health and disease.
d) Proficiency in real time functioning of the industries and institutes of national andinternational repute.

1. Isolation of Genomic DNA from biological samples and agarose gel electrophoresis.
2. Estimation of DNA by diphenyl amine method.
3. Estimation of RNA by orcinol method.
4. Restriction digestion of DNA and agarose gel electrophoresis.
5. Polymerase Chain Reaction.
6. Estimation of Blood glucose: fasting, post prandial, random
7. Isolation of phospholipids and neutral lipids from hen yolk.
8. Estimation of phospholipids and neutral lipids using thin layer chromatography.
9. Estimation of neutral lipids (cholesterol) using Zak's method.
10. Estimation of triglycerides.
11. Estimation of HDL, LDL.
12. Assessment of membrane stability of RBCs.
13. Estimation of a keto acid.
14. Estimation of acid value of lipids.
15. Estimation of peroxide value of lipids.

References:

a) Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
b) Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.
c) Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
d) Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
e) Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
f) NIN manual, Hyderabad, India

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
COURSE NAME : PRACTICAL 2A- EXPERIMENTS IN MOLECULAR BIOLOGY AND ENERGY METABOLISM (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**Practical 2B-Experiments in Enzymology and Seminar**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F204
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a) Proficiency in in enzymology techniques.

b) Proficiency in understanding a research article in the field of Biochemistry and related streams,

c) Efficacy in isolating and purifying an enzyme and assessing the parameters.

d) Seminar presentation

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, estimation of specific activity and fold purity of Alkaline phosphatase.
14. Purification, estimation of specific activity and fold purity of Invertase from plant latex.
15. Purification, estimation of specific activity and fold purity of Esterase from peas.
16. Purification, estimation of specific activity and fold purity of Proteases from plant latex.
17. Seminar

References:

g) Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.

h) Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.

i) Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.

j) Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.

k) Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.

l) NIN manual, Hyderabad, India

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER I												
COURSE NAME : PRACTICAL 2B-EXPERIMENTS IN ENZYMOLOGY AND SEMINAR (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**Metabolism of Lipids**
Credits:	03 (LTP - 3:0:0)
Course Type:	Soft Core (SC)
Course Code:	24F205
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Chemistry of lipid metabolism.
2. Importance of lipid metabolism.
3. Role of hormones in the regulation of lipid metabolism.
4. Lipid mediators and inflammation.

Module 1: 12 Hours

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 w 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.

Module 2 12 Hours

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.

Module 3: 12 Hours

Phospholipid biosynthesis and regulations: Denovo pathway and interconversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides.

Module 4: 12 Hours

Lipid mediators: Biosynthesis of eicosanoids (prostaglandins, thromboxanes, leukotrienes, leukotrienes, prostacyclins and lipoxins). Importance of PAF. Role of anti-inflammatory drugs. Role of Hormones in the regulation of lipid metabolism: HPA axis. Adrenal gland and pancreatic hormones. Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation.

References:

a) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).

b) Biochemistry VII Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer,

W H Freeman and Co. (2010).

c) Kong, P., Cui, Z. Y., Huang, X. F., Zhang, D. D., Guo, R. J., & Han, M. (2022). Inflammation and atherosclerosis: signaling pathways and therapeutic intervention. *Signal transduction and targeted therapy*, *7*(1), 131.

d) Hoogeveen, R. C., & Ballantyne, C. M. (2021). Residual Cardiovascular Risk at Low LDL: Remnants, Lipoprotein(a), and Inflammation. *Clinical chemistry*, *67*(1), 143–153.

e) Wang, B., Tang, X., Yao, L., Wang, Y., Chen, Z., Li, M., Wu, N., Wu, D., Dai, X., Jiang, H., & Ai, D. (2022). Disruption of USP9X in macrophages promotes foam cell formation and atherosclerosis. *The Journal of clinical investigation*, *132*(10), e154217

f) Apovian C. M. (2016). Obesity: definition, comorbidities, causes, and burden. *The American journal of managed care*, *22*(7 Suppl), s176–s18

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : METABOLISM OF LIPIDS (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

II Semester

Name of the course:	**Metabolism of Carbohydrates**
Credits:	03 (LTP - 3:0:0)
Course Type:	Soft Core (SC)
Course Code:	24F206
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Chemistry of enzyme catalysis.
2. Enzyme kinetics.
3. Regulation of enzyme activity
4. Enzyme inhibition

Module 1: 12 Hours

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.

Module 2 12 Hours

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.

Module 3: 12 Hours

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.

Module 4: 12 Hours

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.

References:

a) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012)

b) Biochemistry VII Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2010)

c) . Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons Inc.(2010).

d) Harreiter, J., & Roden, M. (2023). Diabetes mellitus – Definition, Klassifikation, Diagnose, Screening und Prävention (Update 2023) [Diabetes mellitus: definition, classification, diagnosis, screening and prevention (Update 2023)]. *Wiener klinische Wochenschrift*, *135*(Suppl 1), 7–17

e) Guo, R., Gu, J., Zong, S., Wu, M., & Yang, M. (2018). Structure and mechanism of mitochondrial electron transport chain. *Biomedical journal*, *41*(1), 9–20

f) Adeva-Andany, M. M., Pérez-Felpete, N., Fernández-Fernández, C., Donapetry-García, C., & Pazos-García, C. (2016). Liver glucose metabolism in humans. *Bioscience reports*, *36*(6), e00416.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : METABOLISM OF CARBOHYDRATES (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**ENDOCRINOLOGY**
Credits:	03 (LTP - 3:0:0)
Course Type:	Soft Core (SC)
Course Code:	24F207
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a. Understand the detailed structure of a cell

b. Involvement of various organelles in the synthesisof protein, amino acid and steroid hormones.

c. Understand the various endocrine organs in relation to the regulation of various metabolic processes.

d. Understand the hypo and hyperactivities of all the endocrine organs and their manifestation in various disorders

Module 1: 12 Hours

Endocrine System: Endocrine organs in man. Location and inter relationship of endocrine glands in man; classification and chemistry of hormones, HPA axis, hormones of hypothalamus, pituitary, thyroid, parathyroid, pancreas, liver, adrenals, gonads and intestine..

Module 2 12 Hours

Hypo and Hyper secretion of hormones and symptoms

Pituitary, thyroid, parathyroid, pancreas, liver, adrenals, gonads and intestine.

Pineal gland, melatonin and circadian rhythm..

Module 3: 12 Hours

Mechanism of hormone action: Peptide hormones: General mechanisms of cell signalling 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.

Module 4: 12 Hours

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.

References:

a) 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.

b) Cooper, G. M., and Hausman, R. E. 2013. The Cell: a Molecular Approach (6th Ed.). Washington: ASM,Sunderland.

c) Clegg, A., & Hassan-Smith, Z. (2018). Frailty and the endocrine system. *The lancet. Diabetes & endocrinology*, *6*(9), 743–752.

d) Kobayashi, E., Flückiger, L., Fujioka-Kobayashi, M., Sawada, K., Sculean, A., Schaller, B., & Miron, R. J. (2016). Comparative release of growth factors from PRP, PRF, and advanced-PRF. *Clinical oral investigations*, *20*(9), 2353–2360.

e) Belles X. (2023). Investigating the origin of insect metamorphosis. *eLife*, *12*, e94410.

f) Naamneh Elzenaty, R., du Toit, T., & Flück, C. E. (2022). Basics of androgen synthesis and action. *Best practice & research. Clinical endocrinology & metabolism*, *36*(4), 101665.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : ENDOCRINOLOGY (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

II semester

Name of the course:	**Research Methodology, IPR and Review of Literature**
Credits:	02 (LTP - 0:0:2)
Course Type:	Soft Core (SC)
Course Code:	24F208
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Basics and ethics in research. Various streams of ethical responsibilities of researchers' at societal, environmental, legal and emotional ethics.
2. Importance of plagiarism.National and international guidelines about Intellectual property rights.Basics and ethics in research.
3. The types and significance of scientific reports.
4. Writing and analysis of research articles.

Theory: Research Methodology: 16 hours

Definition –Characteristics, types of research in biology. 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 – copyright – 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 (Case studies of IPR/copyright infringement in science and related industry)

Practical: 32 hours (64 hours of practical session)

Review of literature of a selected topic, dissertation (report preparation), citation, alignment, structure of the report, seminar of the report (or viva).

References

a) Leeflang M. M. G. (2023). Responsible research: using the right methodology. *Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases*, *29*(4), 422–423.

b) Research methods in biological science. Dr.S.Palanichamy, & M. Shanmugavelu

c) Pinzi, L., & Rastelli, G. (2019). Molecular Docking: Shifting Paradigms in Drug Discovery. *International journal of molecular sciences*, *20*(18), 4331.

d) Research Methodology in the Medical and Biological Sciences, Petter Laake, Haakon Breien Benestad ,Bjorn R. Olsen (Eds) AcADEMIC Press, (2007).

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : RESEARCH METHODOLOGY, IPR AND REVIEW OF LITERATURE (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	3	1	1	1	3	3	3	3	3	3	3	3

II semester

Name of the course:	**Health Care Technology**
Credits:	02 (LTP - 0:0:2)
Course Type:	Soft Core (SC)
Course Code:	24F209
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Knowledge about Demonstrate knowledge of the health care delivery system and the medical documentation.
2. Knowledge about phlebotomy and serological analyses
3. Knowledge about Blood bank and Histology
4. Knowledge about Biosafety and Waste Management

Syllabus

1. Phlebotomy and blood bank technology

Healthcare issues, Human Anatomy & physiology,Phlebotomy, anticoagulants, serum, plasma, and formed elements, Phlebotomy Equipments & Tools, Phlebotomy Procedures; Venipuncture, skin puncture.

2. Hematology & Clinical Pathology; Blood Bank technology: Collection, Processing and storage of blood; Coagulation studies & Blood Bank procedures; Biosafety and waste management. Systematic bacteriology, Mycology & Virology

3. Medical Lab technology and Histology

Instruments used at a medical facility; Diagnostic markers in the blood and serum. Blood cell count, markers of metabolic disorders and infectious diseases.

4. Biosafety and waste management.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : HEALTH CARE TECHNOLOGY (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

II Semester

Name of the course:	**BIOLOGY FOR NON-BIOLOGISTS**
Credits:	04 (LTP - 2:2:0)
Course Type:	Open Elective (OE)
Course Code:	24F210
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

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

Module 1: 12 Hours

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

Module 2 12 Hours

The Cellular Basis of Reproduction and Inheritance. Mitosis and Meiosis. Sexual and asexual reproduction. Patterns of Inheritance

Module 3: 12 Hours

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.

Module 4: 12 Hours

Molecular Biology of the Gene. Importance of gene expression. DNA Technology and Genomics and Proteomics. Human diseases: Communicable, non-communicable. Familial and Sporadic disorders.

References:

a) Renato A Dela Pena Jr. General Biology. 2016. JFS Publishing

b) Holley D. General Biology I: Molecules, Cells and Genes. 2017. Dog Ear Publishing

c) Ward J. E. (2020). Communicable disease outbreaks: Contact tracing. *Australian journal of general practice*, *49*, 10.31128/AJGP-COVID-26.

d) Signor, S. A., & Nuzhdin, S. V. (2018). The Evolution of Gene Expression in cis and trans. *Trends in genetics : TIG*, *34*(7), 532–544.

e) Peixoto, P., Cartron, P. F., Serandour, A. A., & Hervouet, E. (2020). From 1957 to Nowadays: A Brief History of Epigenetics. *International journal of molecular sciences*, *21*(20), 7571

f) Levit, G. S., & Hossfeld, U. (2019). Ernst Haeckel in the history of biology. *Current biology : CB*, *29*(24), R1276–R1284.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : BIOLOGY FOR NON-BIOLOGISTS (OE)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

II Semester

Name of the course:	**NUTRITION IN HEALTH AND DISEASE**
Credits:	04 (LTP - 2:2:0)
Course Type:	Open Elective (OE)
Course Code:	24F211
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1.Describe how to properly design individualized eating plans by utilizing diet planning principles,

2. The Food Guide Pyramid, Exchange System
3. other food guide plans that incorporate personal food preferences.
4. Students will learn about food and its relationship to health, development, and disease/ disorders.

Module 1: 12 Hours

Composition of food, carbohydrates, proteins, lipids, minerals, water, fiber and vitamins

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. *Food Physiology***:** Concept of balanced diet and energy content of foods; Basal and resting metabolism- influencing factors,

Module 2 12 Hours

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.

Module 3: 12 Hours

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

Module 4: 12 Hours

Obesity: Definition, classification and biochemical basis; Genetic and environmental factors leading to obesity; Obesity related diseases and Diabetes 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 diagnosis.

References:

1. Bansal. Nutrition in disease. 2012. Pustak Mahal
2. Chakraborthy and Chakraborthy. Textbook of Nutrition in Health and Disease. 2019. Springer
3. Nisha. Diet Planning for Diseases. 2006. Kalpaz Publications.
4. Esperanza J. Carcache de Blanco, Jay Mirtallo , " Nutrition: An Approach to Good Health andDisease Management ", Bentham Science Publishers (2016)
5. Rahesh, J., Chu, V., & Peiris, A. N. (2019). Hypervitaminosis D without toxicity. *Proceedings (Baylor University. Medical Center)*, *33*(1), 42–43
6. Apovian C. M. (2016). Obesity: definition, comorbidities, causes, and burden. *The American journal of managed care*, *22*(7 Suppl), s176–s18

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER II												
COURSE NAME : NUTRITION IN HEALTH AND DISEASE (OE)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

III Semester

Name of the course:	**IMMUNOLOGY**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (FCHC-Foundation Course Hard Core)
Course Code:	24F301
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Role of immune system in maintaining health
2. Cellular and molecular basis of immune responses
3. How immune responses are triggered and regulated
4. How the knowledge of immunology can be transferred into clinical decision-making through case studies presented in class.

Module 1: 12 Hours

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.

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 & Passive (Naturally acquired and artificially acquired), Adoptive immunity, Humoral and Cell mediated immune response.

Module 2 12 Hours

Antigens, and Antibodies: Antigens, Immunogens and Haptens, Factors influencing immunogenicity, adjuvants, epitopes, Structure and functions 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

Monoclonal Antibodies: Hybridoma technology and production of mAbs, types, and applications, Advantages and disadvantages of mAbs in therapy.

Module 3: 12 Hours

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 myeloma). Secondary: AIDS.

Module 4: 12 Hours

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 favoringtumor 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.

References:

1. Abbas A.K., LichtmanA.H. and Pillai S.(2014).Cellular and Molecular Immunology(10th Edition). Online Access: Elsevier Health Sciences.

2. Abbas, AK., Andrew,H., Lichtman, H., Pillai, S. 2012.Basic Immunology: Functions andDisorders of the Immune System, ; Saunders

3. Abul, K.A., Andrew, H. L. and Shiv, P. 2019. Basic Immunology: Functions and Disordersof the Immune System. Elsevier India.

4. Ajoy P. 2015. Text book of Immunology: including Immunotechnology & Immunotherapy.Books & Allied Press.

5. Ashim, K. C. 2006. Immunology and Immunotechnology (1sted.). Oxford University Press.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : IMMUNOLOGY (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

III Semester

Name of the course:	**METABOLISM OF AMINO ACIDS AND PROTEINS**
Credits:	04 (LTP - 3:1:0)
Course Type:	Hard Core (HC)
Course Code:	24F302
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Role of immune system in maintaining health
2. Cellular and molecular basis of immune responses
3. How immune responses are triggered and regulated
4. How the knowledge of immunology can be transferred into clinical decision-making through case studies presented in class.

Module 1: 12 Hours

Proteins: General mechanisms of degradation in cells; ubiquitin-proteasome pathway, lysosomal pathway. Degradation and biosynthesis of glycoproteins and proteoglycans. Degradation and Biosynthesis of heme and porphryns..

Module 2 12 Hours

Non ribosomal peptide synthesis and Biosynthesis of physiologically active amines: glutathione, gramicidine. Biosynthesis of physiologically active amines; serotonin, histamine, dopamine, norepinephrine and epinephrine.

Module 3: 12 Hours

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.

Module 4: 12 Hours

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

References:

1. Berg J.M., Tymoczko J.L. and Stryer L. (2006). Biochemistry: international edition: WH Freeman & Company Limited.
2. Devlin T.M. (2020). Textbook of biochemistry: with clinical correlations (8th Edition). New York: J. Wiley & Sons.
3. . Harper;s Illustrated Biochemistry, 31st Edn.Victor W Rodwell et al., (2018).
4. Liu, W. J., Ye, L., Huang, W. F., Guo, L. J., Xu, Z. G., Wu, H. L., Yang, C., &

Liu, H. F. (2016). p62 links the autophagy pathway and the ubiqutin-proteasome system upon ubiquitinated protein degradation. Cellular & molecular biology letters, 21, 29.

5. van Spronsen, F. J., Blau, N., Harding, C., Burlina, A., Longo, N., & Bosch, A. M. (2021). Phenylketonuria. Nature reviews. Disease primers, 7(1), 36.

6. Strauss, K. A., Puffenberger, E. G., & Carson, V. J. (2006). Maple Syrup Urine Disease. In M. P. Adam (Eds.) et. al., GeneReviews®. University of Washington, Seattle.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : METABOLISM OF AMINO ACIDS AND PROTEINS (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

III Semester

Name of the course:	**PRACTICAL 3A- EXPERIMENTS IN IMMUNOLOGY, NITROGEN METABOLISM AND SEMINAR**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F203
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Proficiency in laboratory techniques in immunology and metabolism.
2. Identification of antibody purity.
3. Proficiency to articulate between different metabolic pathways
4. Proficiency to understand the energetics of photosynthesis.

Experiments

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. Slide agglutination test/ Blood grouping.
6. Immunoprecipitation test: Ouchterlony double diffusion assay.
7. Estimation of nitric oxide.
8. Estimation of Urea by DAMO method and Clinical significance.
9. Estimation of uric acid.
10. Estimation of purines.
11. Photo-oxidation of methylene blue.
12. Photosynthetic reduction of 2,6 dichlorophenolindophenol.
13. Identification and assessment of leguminous root nodules for Rhizobium.
14. Oxygen generation during photosynthesis.
15. Estimation of glutathione.
16. Seminar

References:

1. Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
2. Berg, J. M., Tymoczko, J. L., and Stryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Ltd.
3. Berg, J. M., Tymoczko, J. L, and Stryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
4. Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
5. Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
6. NIN manual, Hyderabad, India

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : PRACTICAL 3A- EXPERIMENTS IN IMMUNOLOGY, NITROGEN METABOLISM AND SEMINAR (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

III Semester

Name of the course:	**PRACTICAL 3B- EXPERIMENTS IN BIOINFORMATICS AND BIOSTATISTICS**
Credits:	02 (LTP - 0:0:2)
Course Type:	Hard Core (HC)
Course Code:	24F204
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Basic statistical methods to solve problems.
2. 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.
3. Fundamentals of protein and DNA databases
4. Molecular Docking for medical and industrial applications

Experiments

1. Databases of Bioinformatics: Nucleotides, Proteins, Pathway, Genome databases.
2. Querying softwares: ENTREZ, SRS
3. Retrieving DNA & protein sequences from databases.
4. Retrieving protein information from UNIPROT/ identifying key proteins modified in genetic diseases such as thalassemia.
5. Comparison/ sequence similarity search using BLAST and FASTA for nucleotide and protein sequences.
6. Perform global and Local alignment, pair wise alignment (EMBOSS)
7. Multiple sequence alignment and phylogenetic analysis.
8. Protein structure analysis- prediction of cleavage sites and post-translational modifications and functional domains by Prosite/ Proscan (secondary structure)
9. Protein tertiary structure analysis, Ramachandran plot, prediction of secondary and tertiary structure by homology modelling
10. RASMOL, visualization
11. Gene prediction – coding regions (Eukaryotes and Prokaryotes)
12. Designing PCR primers
13. Drug design and Personalized medicine:
14. Drug target identification
15. ADMET
16. Lipinski's rule of 5
17. Automated Docking through PyRx
18. Gene ontology, functional enrichment
19. Protein-protein interaction analysis.
20. Calculation of Mean, average, standard deviation, and standard error.
21. Effect of sample size on standard deviation and standard error.
22. Student t test and Analysis of variance (ANOVA), degrees of freedom
23. Post hoc tests-Dunette and Tukey
24. Analysis of correlation, regression.
25. Representation of data in column, line graph, pie charts
26. Use of softwares for statistical analyses and graphical representation.

References:

1. Understanding Bioinformatics, M. Zvelebil, J.O. Baum (2008) Taylor and Francis, USA
2. Beall J, Elm J, Chamberlain J, Rosenthal E, Kapur J, Durkalski-Mauldin V. An Expected Score Approach to Ordinal Outcomes in a Bayesian, Response Adaptive, Randomized Trial. Stat Biopharm Res. 2023;15(4):820-825. doi:10.1080/19466315.2023.216934
3. Mao L. Power and Sample Size Calculations for the Restricted Mean Time Analysis of Prioritized Composite Endpoints. Stat Biopharm Res. 2023;15(3):540-548. doi:10.1080/19466315.2022.2110936
4. Lu Y, Zhao Q, Zou J, et al. A Composite Endpoint for Treatment Benefit According to Patient Preference. Stat Biopharm Res. 2022;14(4):408-422. doi:10.1080/19466315.2022.2085783

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : PRACTICAL 3B- EXPERIMENTS IN BIOINFORMATICS AND BIOSTATISTICS (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	3	1	1	1	3	3	3	3	3	3	3	3

III Semester

Name of the course:	**METABOLISM OF NUCLEIC ACIDS**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F305
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

a. Chemistry of nucleic acid metabolism. .
b. Importance of nucleic acid metabolism.
c. Mechanism of photosynthesis
d. nitrogen metabolism.

Module 1: 12 Hours

Purines and pyrimidines:

Pathways of biosynthesis and degradation of nucleic acids, purines and pyrimidines, uric acid formation. Salvage pathways, de novo biosynthetic pathways andregulations.

Module 2 12 Hours

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 biosynthesisand their metabolic role

Module 3: 12 Hours

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.

Module 4: 12 Hours

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.

References:

a) Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
b) Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 7 th Edn. Macmillan Publications (2017).
c) Clebak, K. T., Morrison, A., & Croad, J. R. (2020). Gout: Rapid Evidence Review. *American family physician*, *102*(9), 533–538.

d) Bell, S., Kolobova, I., Crapper, L., & Ernst, C. (2016). Lesch-Nyhan Syndrome: Models, Theories, and Therapies. *Molecular syndromology*, *7*(6), 302–311.

e) Bedoui, Y., Guillot, X., Sélambarom, J., Guiraud, P., Giry, C., Jaffar-Bandjee, M. C., Ralandison, S., & Gasque, P. (2019). Methotrexate an Old Drug with New Tricks. *International journal of molecular sciences*, *20*(20), 5023

f) Prywes, N., Phillips, N. R., Tuck, O. T., Valentin-Alvarado, L. E., & Savage, D. F. (2023). Rubisco Function, Evolution, and Engineering. *Annual review of biochemistry*, *92*, 385–410.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : METABOLISM OF NUCLEIC ACIDS (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

III Semester

Name of the course:	**BIOSTATISTICS AND BIOINFORMATICS**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F306
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Basic statistical methods to solve problems.
2. 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.
3. Fundamentals of protein and DNA databases
4. Molecular Docking for medical and industrial applications

Module 1 18 hours

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.

Module 2 12 hours

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.

Module 3 12 hours

Emboss, prosite, ProDom, protein expression profiling. Prediction of Secondary structure of proteins, softwares for secondary structure prediction, protein families and classification, (transmembrane regions). CATH and SCOP. Introduction to drug designing: In silico analysis, physico-chemical property prediction, aqueous solubility, Lipinski's rule of five.

Module 4 6 hours

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

References

a) Understanding Bioinformatics, M. Zvelebil, J.O. Baum (2008) Taylor and Francis, USA

b) Beall J, Elm J, Chamberlain J, Rosenthal E, Kapur J, Durkalski-Mauldin V. An Expected Score Approach to Ordinal Outcomes in a Bayesian, Response Adaptive, Randomized Trial. Stat Biopharm Res. 2023;15(4):820-825.

c) Mao L. Power and Sample Size Calculations for the Restricted Mean Time Analysis of Prioritized Composite Endpoints. Stat Biopharm Res. 2023;15(3):540-548.

d) Lu Y, Zhao Q, Zou J, et al. A Composite Endpoint for Treatment Benefit According to Patient Preference. Stat Biopharm Res. 2022;14(4):408-422.

e) Olarte Parra C, Daniel RM, Bartlett JW. Hypothetical Estimands in Clinical Trials: A Unification of Causal Inference and Missing Data Methods. Stat Biopharm Res. 2022;15(2):421-432. Published 2022 Jul 6.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : BIOSTATISTICS AND BIOINFORMATICS (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

III Semester

Name of the course:	**HUMAN PHYSIOLOGY WITH CLINICAL RELEVANCE**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F307
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

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
d. Disorders related to nutrition and digestion.

Module 1 18 hours

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. Anemias, disorders of albumin, haemoglobin-thalassemias, clotting and lipoproteins. Hypertension. Serological markers for diagnosis.

Module 2 12 hours

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. Neurodegenerative disorders: motor and memory disorders, stress, symptoms, mechanism, therapy.

Module 3 12 hours

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. RAS system. Kidney function tests. Chronic kidney disorder.

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. Hepatitis, fatty liver disease.

Module 4 6 hours

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. Indigestion, Irritable bowel syndrome,

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.

References

a) Hawk's Physiological Chemistry, ed. Oser, 14th Edn. (1976), Tata-McGraw Hill.
b) . Principles of Human Physiology; 4th Edn. Cindy L. Stanfield Pearson, (2010).
c) Molecular Biology of the Cell, Bruce Alberts, Alexander D Johnson, Julian Levis, David Morgan, Martin Raff, Garland Science (2014).
d) Bushart, D. D., & Shakkottai, V. G. (2019). Ion channel dysfunction in cerebellar ataxia. *Neuroscience letters*, *688*, 41–48.
e) Squire J. (2019). Special Issue: The Actin-Myosin Interaction in Muscle: Background and Overview. *International journal of molecular sciences*, *20*(22), 5715.
f) Weibel E. R. (2017). Lung morphometry: the link between structure and function. *Cell and tissue research*, *367*(3), 413–426.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : HUMAN PHYSIOLOGY WITH CLINICAL RELEVANCE (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

III semester

Name of the course:	**INTERNSHIP**
Credits:	04 (LTP - 0:0:4)
Course Type:	Soft Core (SC)
Course Code:	24F308
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Evaluate career goals and aspirations
2. Enhance resume and job prospects
3. Develop problem solving and critical thinking skills
4. Gain insight into company culture and operations.

Internship:

Each student shall enroll for an internship at an R & D laboratory and learn industrial skills in life sciences over a period of 1 month (non-class hours) and submit a report on the principles and applications of the scientific protocols. The student shall be evaluated for C1 and C2 by the internal faculty while for C3 the student shall be evaluated for their "Knowledge on the scientific protocols presented in the report" by two examiners (internal and external) during the end semester examination.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER III												
COURSE NAME : INTERNSHIP (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

IV Semester

Name of the course:	**RESEARCH PROJECT WORK, REPORT AND VIVA VOCE**
Credits:	10 (LTP - 0:0:10)
Course Type:	Hard Core (HC)
Course Code:	24F401
Total Hours	64 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Learning Outcomes: After studying this paper the students will know –

1. Enhanced laboratory skills.
2. Efficiency in identifying a research problem and plan a research work.
3. Appropriate review of literature and selection of proper laboratory methods. Application and importance of statistics.
4. Make the appropriate conclusions of the research data.

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 shall identify an individual/unique research problem and conduct independent mini research project for 3-4 months (non-class hours) and submit a dissertation with the research findings and conclusion. The student shall be evaluated for C1 and C2 by the internal faculty while for C3 the student shall be evaluated by two examiners (internal and external) for the students' "Knowledge on the scientific problem, protocols and inference of results presented in the report". The quality of work and efficiency of the defense will be evaluated by two examiners (internal and external) during the end semester examination.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER IV												
COURSE NAME : RESEARCH PROJECT WORK, REPORT AND VIVA VOCE (HC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	1	1	1	3	3	3	3	3	3	3	3
CO2	3	1	1	1	3	3	3	3	3	3	3	3
CO3	3	1	1	1	3	3	3	3	3	3	3	3
CO4	3	1	1	1	3	3	3	3	3	3	3	3
Weighted Average	**3**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

IV Semester

Name of the course:	**Clinical Biochemistry**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F402
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

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.

Module 1 12 hours

Basic concepts: Health and disease. Normal and pathological changes, affecting cells in the body. Celldeath 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

Module 2 12 hours

Endocrine system:Endocrine system: Overview of the physiology of endocrine system. Laboratorydiagnosis 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.

Module 3 12 hours

Hepatobiliary, Kidney, and GI System: Hepatobiliary system: Overview of hepatobiliary system. Biochemical indices ofhepatobiliary 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.

Module 4 12 hours

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. Assessmentof CSF.

References

1. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(1976), Tata-McGrawHill.
2. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).
3. Chatterjee C.C. (2017). Human physiology: Medical Allied Agency:CBS Publishers and Distributors Pvt. LTD.

4. Jin, B., Wang, S., & Fan, Z. (2022). Pathogenesis Markers of Hashimoto's Disease-A Mini Review. Frontiers in bioscience (Landmark edition), 27(10), 29.
5. Brătucu, M. N., Prunoiu, V. M., Strâmbu, V., Brătucu, E., Răvaş, M. M., Simion, L., & Petre, R. (2021). Unusual Complicated Gastric Ulcers. Medicina (Kaunas, Lithuania), 57(12), 1345.
6. Origa R. (2017). β-Thalassemia. Genetics in medicine : official journal of the American College of Medical Genetics, 19(6), 609–619.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER IV												
COURSE NAME : CLINICAL BIOCHEMISTRY (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

IV Semester

Name of the course:	**BIOTECHNOLOGY AND GENETIC ENGINEERING**
Credits:	04 (LTP – 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F403
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

1. Culture and maintenance of bacteria, plant and animal cells.
2. Using the cultured cells for medical and industrial applications.
3. Editing a gene for various applications.
4. Identifying a gene of medical and industrial importance.

Biotechnology:

Microbial culture-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. Industrial upscaling. Methods of Control of Microorganisms - Bacteriostatic and bactericidal agents. methods of cultivations and preservation of microbes. Mechanisms of disinfection and sterilization-Physical and chemical methods.

Cell culture techniques: Introduction to plant and animal tissue/cell culture.Laboratory design, aseptic conditions, equipment and materials for cell culture.

Plant cell culture: Micro propagation, callus culture, haploid production, somatic embryogenesis, somatic hybridization, cybridization and somaclonal variation. Their significance. 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.

Cell lines: Characteristics and routine maintenance, cell separation techniques. Measurement of viability and cytotoxicity. Scaling-up of animal cell culture;bioreactors and their types used in animal cell culture, amplified cultures, continuous cultures and their applications. Hybridoma technology, Cell immobilization techniques. Characterization of the cultured cells, measuring parameters of growth. Cell synchronization, Somatic cell fusion, cell cloning and cryopreservation. Applications of animal cell culture: Organ and histotypic cultures; three dimensional culture, tissue engineering-skin.

Genetic Engineering:

Extraction and purification of nucleic acids (DNA and RNA) from biological sources. Restriction-modification systems, restriction enzymes; type I, II and III, specificity, sticky ends and blunt ends, isoschizomers. **Gene cloning;** genomic cloning, shotgun cloning, cDNA cloning. **Vectors:** Plasmids, phage, cosmids and phagemid. Yeast cloning vectors, plant vectors, bacterial artificial chromosome, Yeast artificial chromosome, SV40, shuttle vectors, construction of expression vectors. **Ligation**: Blunt end and sticky end ligation, use of linkers and adopters, homopolymer tailing, colony hybridization, plaque hybridization.

Transformation: Micro injection, electroporation, lipofection, calcium phosphate method, protoplast fusion/somatic cell hybridization and biolistic methods.

Transgenic plants and animals, gene knockout.

Techniques: DNA sequencing, chromosome walking, PCR; nested PCR, applications of PCR in cloning, agriculture and medicine. RT-PCR technique and applications. Real time PCR for quantification. **Identifying the right clones:** Direct screening; insertional inactivation of marker gene, visual screening, plaque phenotype. Indirect screening; immunological techniques, hybrid arrest translation, hybrid select translation. Screening using probes; construction of gene probes, hybridization and labeling.

Mapping in Prokaryotes and Viruses: Bacterial transformation and transduction, conjugation; F+ plasmids, Hfr cells, time of entry mapping. Arrangement of genes in phage chromosome, plaque formation and lytic cycle. Lysogeny and λ-phage.

Applications: Gene therapy, applications in agriculture medicine, industry. GM foods, negative impact of genetic engineering.

References

1. Singh, R. 2003.Introduction to Biotechnology: Principles of biotechnology (2 nd Ed.). Global Vision Publishing House.
2. Thangadurai, D., Tanasupawat, S., Kanekar, P. P . 2019 Biotechnology of Microorganisms, Diversity, Improvement, and Application of Microbes for Food Processing, Healthcare, Environmental Safety, and Agriculture (1st Ed.).Apple Academic Press.
3. Dellagostin, O. A., Borsuk, S., Oliveira, T. L., & Seixas, F. K. (2022). Auxotrophic Mycobacterium bovis BCG: Updates and Perspectives. Vaccines, 10(5), 80
4. Georgiev, V., Slavov, A., Vasileva, I., & Pavlov, A. (2018). Plant cell culture as emerging technology for production of active cosmetic ingredients. Engineering in life sciences, 18(11), 779–798
5. Dufau, J., Shen, J. X., Couchet, M., De Castro Barbosa, T., Mejhert, N., Massier, L., Griseti, E., Mouisel, E., Amri, E. Z., Lauschke, V. M., Rydén, M., & Langin, D. (2021). In vitro and ex vivo models of adipocytes. American journal of physiology. Cell physiology, 320(5), C822–C84
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7. Origa R. (2017). β-Thalassemia. Genetics in medicine : official journal of the American College of Medical Genetics, 19(6), 609–619.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER IV												
COURSE NAME : BIOTECHNOLOGY AND GENETIC ENGINEERING (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

IV Semester

Name of the course:	**PLANT BIOCHEMISTRY**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F404
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

Learning Outcomes: After studying this paper the students will know –

[1] Biological processes involving membranes.
[2] Importance of membranes in the biological system
[3] Nutritional significance for plants and Stress physiology in plants
[4] Transportation of ions and molecules

Module 1 12 hours

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.

Module 2 12 hours

Plant hormones: Biosynthesis, storage, breakdown and transport. Physiological effects and mechanisms of action of auxins, 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.

Module 3 12 hours

Solute transport and photoassimilate 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.

Module 4 12 hours

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.

References

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b) Goodwin TW,Mercer EI(1983) Introduction to plant biochemistry

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e) Hasanuzzaman, M., & Fujita, M. (2022). Plant Oxidative Stress: Biology, Physiology and Mitigation. *Plants (Basel, Switzerland)*, *11*(9), 1185.

f) Huang, X. Q., & Dudareva, N. (2023). Plant specialized metabolism. *Current biology : CB*, *33*(11), R473–R47

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER IV												
COURSE NAME : PLANT BIOCHEMISTRY (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	3	2	2	2	2	2	2	3	3	3	3	3

IV Semester

Name of the course:	**HUMAN NUTRITION**
Credits:	04 (LTP - 3:1:0)
Course Type:	SOFT Core (SC)
Course Code:	24F405
Total Hours	48 hours
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Theory

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,
d. Nutritional significance for children and adults

Module 1 12 hours

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.

Module 2 12 hours

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..

Module 3 12 hours

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.

Module 4 12 hours

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,

References

a) Introduction to Human Nutrition, 2nd Edn., Gibney M, Lanham S, Cassidy A and Vorster H. The Nutrition Society, London, UK, (2012).

b) Nutrition and Metabolism, 2nd Edn., Lanham S, Mac Donald I and Roche H. The Nutrition Society, London, UK, (2012)

c) Alazzam, A. M., Alrubaye, M. W., Goldsmith, J. A., & Gorgey, A. S. (2023). Trends in measuring BMR and RMR after spinal cord injury: a comprehensive review. *The British journal of nutrition*, *130*(10), 1720–1731.

d) Noor, S., Piscopo, S., & Gasmi, A. (2021). Nutrients Interaction with the Immune System. *Archives of Razi Institute*, *76*(6), 1579–1588.

e) Rahesh, J., Chu, V., & Peiris, A. N. (2019). Hypervitaminosis D without toxicity. *Proceedings (Baylor University. Medical Center)*, *33*(1), 42–43

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ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

SEMESTER IV												
COURSE NAME : HUMAN NUTRITION (SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	3	2	2	2	2	2	2	3	3	3	3	3
CO2	3	2	2	2	2	2	2	3	3	3	3	3
CO3	3	2	2	2	2	2	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	3	3
Weighted Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

VALUE ADDED COURSES

COURSE TYPE:

VALUE ADDED COURSE

– OR –

SOFT-CORE-SC (ELECTIVE)

ELIGIBILITY:

A candidate of M.Sc. Life Sciences or Chemistry (currently pursuing or already completed) in any semester can enroll/ register for the value added courses.

For the students currently pursuing M.Sc. Life Sciences in the same college, the grade from the value added course shall be added to the score card / marks sheet as either "Value added course" or "Soft Core". For evaluation purposes, this course shall be considered as a practical course.

THE REGULATIONS OF M.Sc. Biochemistry will be applicable to the evaluation of the value added courses as well. The Following Value Added Courses are offered among all the semesters

Semester in which the course is being offered: I/ II/ III/ IV semester

I/ II/ III/ IV semester

Name of the course:	**Protein and Enzyme Technology**
Credits:	06 (LTP – 2:0:4)
Course Type:	VALUE ADDED COURSE – OR – SOFT-CORE-SC (ELECTIVE)
Course Code:	24F001
Total Hours	32 hours theory + 64 hours of Practical (128 hours of actual practical sessions)
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Course Outcomes: Students should study this paper to know

1. Protein isolation techniques.
2. Qualitative and quantitative estimation of proteins.
3. Identification of nature of proteins
4. Know the pharmaceutical applications of proteins..

Theory: Protein purification techniques, hofmeister series, precipitation, centrifugation, dialysis, reverse dialysis. Introduction to chromatographic techniques: Theoretical basis of chromatographic separations. Column, thin layer, Paper, Normal phase and reverse phase chromatography, Ion-exchange, Affinity and Gas Chromatography, High performance liquid chromatography (HPLC). Electrophoretic techniques: Theory and application of polyacrylamide and agarose gel electrophoresis, electrophoresis of protein and nucleic acids, Capillary electrophoresis

Aim and scope of enzyme technology; strategies of isolation and purification of enzymes from different sources; identification of binding and catalytic sites; use of enzymes in free solution and associated problems; stabilization of soluble enzymes; enzyme reactions; applications of enzymes in food industry, pharmaceutical, medical and analytical purposes; Objectives of enzyme immobilization, methods of enzyme immobilization-adsorption, entrapment, direct covalent linkage, cross-linking; immobilized enzyme reactors - batch, continuous and membrane reactors; Applications of immobilized enzymes for industrial-scale conversions, manufacture of commercial products, enzyme electrocatalysis - immobilization of enzymes onto electrodes, measurement of enzyme activity, regeneration of cofactors; basic principles of biosensors and use of enzymes in biosensors

Practical

1. Isolation of protein from biological sources;
2. Estimation of proteins, using spectrophotometric and colorimetric methods.
3. Isolation of protein using ammonium sulphate precipitation; Dialysis
4. Gel filtration chromatography; ion exchange and affinity chromatography.
5. Polyacryamide gel electrophoresis: SDS PAGE, native PAGE, CBB, PAS and silver staining.
6. Isolation of enzymes from biological sources. hydroxyapatite chromatography, cibacron blue affinity chromatography Fold purity.
7. End point assay, continuous assay, coupled assay.
8. MM plot and LB plots, Ki,
9. Zymogram and reverse zymograms. Enzyme immobilization technique

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

COURSE NAME : PROTEIN AND ENZYME TECHNOLOGY (VAC/ SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	2	2	2	3	2	3	3	3	3	3	3	3
CO2	2	2	2	3	2	3	2	3	3	3	3	3
CO3	2	2	2	3	2	3	2	3	3	3	3	3
CO4	2	2	2	3	2	3	2	3	3	3	3	3
Weighted Average	2	2	2	3	2	3	2.25	3	3	3	3	3

I/ II/ III/ IV semester

Name of the course:	**HIGH PERFORMANCE LIQUID CHROMATOGRAPHY**
Credits:	04 (LTP – 1:0:3)
Course Type:	VALUE ADDED COURSE – OR – SOFT-CORE-SC (ELECTIVE)
Course Code:	24F002
Total Hours	16 hours theory + 32 hours of Practical (64 hours of actual practical sessions)
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Course Outcomes: Students should study this paper to know

a) Chromatographic techniques.
b) To develop a protocol to assess an analyte using HPLC.
c) To assess the raw data from the chromatographic protocols.
d) Trouble shoot the shortcomings in HPLC.

1. Basics of chromatography, principle, types; column chromatography.
2. Liquid-Liquid chromatography, principle, apparatus, applications, working.
3. Types -normal phase and reversed phase.
4. Mobile phase and stationary phase.
5. Polarity of the solvents. Types of columns. Solvent selection.
6. Detectors: UV-Visible (diode array), fluorescent, electrochemical, RI
7. Flow rate, Retention factor, retention time
8. Standards-internal and external, spiking.
9. Standardization of a protocol.
10. Analysis of a compound.
11. Retrieving data from the software and identification of peaks.
12. Data analysis. Peak characteristics.
13. Trouble-shooting.
14. Data representation.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

COURSE NAME : HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (VAC/ SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	2	2	2	3	2	3	3	3	3	3	3	3
CO2	2	2	2	3	2	3	2	3	3	3	3	3
CO3	2	2	2	3	2	3	2	3	3	3	3	3
CO4	2	2	2	3	2	3	2	3	3	3	3	3
Weighted Average	2	2	2	3	2	3	2.25	3	3	3	3	3

I/ II/ III/ IV semester

Name of the course:	**DROSOPHILA AS A MODEL FOR BIOLOGICAL RESEARCH**
Credits	**04 (LTP – 1:0:3)**
Course Type:	VALUE ADDED COURSE – OR – SOFT-CORE-SC (ELECTIVE)
Course Code:	24F003
Total Hours	32 hours theory + 64 hours of Practical (128 hours of actual practical sessions)
Evaluation C_1+C_2+C_3	15+15+70
C_3 Exam type	Practical

Course Outcomes: Students should study this paper to know

a) Culture and maintenance of *Drosophila melanogaster.*
b) Identification of mutants.
c) Dissection of ganglia/ neurons from *Drosophila* larvae/ flies.
d) Behaviour assays and histology.

1. *Drosophila* morphology and anatomy; Chromosomes.
2. Transgenics
3. Mutants of *Drosophila,* their use in research.
4. Culture and maintenance- Collection of eggs, larvae and flies.
5. Experiments with larvae and flies.
6. Behavioral markers for stress, memory, motor function
7. Dissection of neurons from larvae and flies.
8. Modeling human disorders in *Drosophila* using chemical agents.
9. Exposure of larvae or flies to test compounds.
10. Analysis of various biomarkers in neurons, whole body homogenates.
11. Protein profile by electrophoresis and immunoblots.
12. Biochemical and immunochemical markers of oxidative stress, mitochondrial function, inflammation, neuronal manifestations.
13. Histology: H&E staining analysis.
14. Immunohistochemistry for specific markers and analysis.

ARTICULATION MATRIX MAPPING OF COURSE OUTCOME (COs)WITH PROGRAMME OUTCOME (PO I – PO XII)

COURSE NAME : DROSOPHILA AS A MODEL FOR BIOLOGICAL RESEARCH (VAC/ SC)												
PO / CO	PO-1	PO-II	PO-III	PO-IV	PO-V	PO-VI	PO-VII	PO-VIII	PO-IX	PO-X	PO-XI	PO-XII
CO1	2	2	2	3	2	3	3	3	3	3	3	3
CO2	2	2	2	3	2	3	2	3	3	3	3	3
CO3	2	2	2	3	2	3	2	3	3	3	3	3
CO4	2	2	2	3	2	3	2	3	3	3	3	3
Weighted Average	2	2	2	3	2	3	2.25	3	3	3	3	3

LIST OF COURSES
M.Sc. BIOCHEMISTRY

Title of Course	*Paper type*	*L:T:P*	*Credits*	*C1*	*C2*	*C3*	*Total*	*End Semester Exam TYPE*	*Course Code*
Molecular Cell Biology	HC (FCHC)	3:1:0	4	15	15	70	100	THEORY	24F101
Techniques in Biology	HC (FCHC)	3:1:0	4	15	15	70	100	THEORY	24F102
Fundamentals of Biochemistry	HC (FCHC)	3:1:0	4	15	15	70	100	THEORY	24F103
Bioorganic and Bioinorganic Chemistry	HC	3:0:0	3	15	15	70	100	THEORY	24F104
Practical 1A: Experiments in Biological techniques and Bioorganic chemistry	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F105
Practical 1B : Experiments in Cell Biology, Bioinorganic chemistry & Seminar	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F106
Genetics	SC	3:0:0	3	15	15	70	100	THEORY	24F107
Membrane Biology	SC	3:0:0	3	15	15	70	100	THEORY	24F108
Molecular Biology	HC (FCHC)	3:1:0	4	15	15	70	100	THEORY	24F201
Enzymology	HC	3:0:0	3	15	15	70	100	THEORY	24F202
Practical 2A: Experiments in Molecular Biology and Energy Metabolism and seminar.	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F203
Practical 2B: Experiments in Enzymology.	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F204
Metabolism of Lipids	SC	3:0:0	3	15	15	70	100	THEORY	24F205
Metabolism of Carbohydrates	SC	3:0:0	3	15	15	70	100	THEORY	24F206

Endocrinology	SC	3:0:0	3	15	15	70	100	THEORY	24F207
Research Methodology, IPR and Review of Literature	SC	1:0:2	3	15	15	70	100	PRACTICAL	24F208
Health Care Technology	SC	0:0:2	2	15	15	70	100	PRACTICAL	24F209
OE: Biology for Non-biologists	SC	2:2:0	4	15	15	70	100	THEORY	24F210
OE: Nutrition in Health and Disease	SC	2:2:0	4	15	15	70	100	THEORY	24F211
Immunology	HC (FCHC)	3:1:0	4	15	15	70	100	THEORY	24F301
Metabolism of Amino Acids and Proteins	HC	3:1:0	4	15	15	70	100	THEORY	24F302
Practical-3A: Experiments in Immunology and Nitrogen metabolism and seminar	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F303
Practical 3B: Experiments in Bioinformatics and Biostatistics	HC	0:0:2	2	15	15	70	100	PRACTICAL	24F304
Metabolism of Nucleic Acids	SC	3:1:0	4	15	15	70	100	THEORY	24F305
Biostatistics, and Bioinformatics	SC	3:1:0	4	15	15	70	100	THEORY	24F306
Human Physiology with clinical relevance.	SC	3:1:0	4	15	15	70	100	THEORY	24F307
Internship	SC	0:0:4	4	15	15	70	100	PRACTICAL	24F308
Research Project Work, Report and Viva Voce	HC	0.0.10	10	15	15	70	100	PRACTICAL	24F401
Clinical Biochemistry	SC	3:1:0	4	15	15	70	100	THEORY	24F402
Biotechnology and Genetic Engineering	SC	3:1:0	4	15	15	70	100	THEORY	24F403
Plant Biochemistry	SC	3:1:0	4	15	15	70	100	THEORY	24F404
Human Nutrition	SC	3:1:0	4	15	15	70	100	THEORY	24F405

Value added courses (offered in I/ II/ III/ IV semester)

Title of Course	*Paper type*	*L:T:P*	*Credits*	*C1*	*C2*	*C3*	*Total*	*End Semester Exam TYPE*	**Course Code**
Protein and Enzyme Technology	VAC/ SC	2:0:4	6	15	15	70	100	PRACTICAL	24F001
High Performance Liquid Chromatography	VAC/ SC	1:0:3	4	15	15	70	100	PRACTICAL	24F002
Drosophila as a model for biological research	VAC/ SC	1:0:3	4	15	15	70	100	PRACTICAL	24F003

SCHEME OF EVALUATION

Continuous Assessment, Earning of Credits and Award of Grades

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.

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

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

Continuous Assessment Pattern:

Component	Time Duration	Syllabus Considered	Weightage	Marks		Aggregate Marks	
				Max	Min (30%)	Max	Min (40%)
C_1	1-8 wks	First 50%	15%	15	4.5	$[C_1 + C_2 + C_3]$ 100	$[C_1 + C_2 + C_3]$ 40
C_2	9-16 wks	Remaining 50%	15%	15	4.5		
C_3	Complete 16 weeks	Complete Syllabus (Semester End Examination)	70%	70	21		
A minimum of 15% in each component individually (among C_1, C_2 & C_3) and a minimum of 40% aggregate (adding up C_1, C_2 & C_3) to declare PASS.							

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

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 concerned teacher for this purpose.

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 8th week of the semester. Beyond 8th week, making changes in C1 is not permitted.

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 the second half of the semester will be consolidated during the 16th week of the semester. During the second half of the semester the remaining units in the course will be completed.

Medium of Instruction

The medium of instruction shall be English however use of Kannada in the classes is allowed. Accordingly, a candidate will be permitted to write the examinations either in

English or Kannada. This rule is not applicable to languages.

SETTING QUESTIONS PAPERS AND EVALUATION OF ANSWER SCRIPTS

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.

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

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

EVALUATION

Theory evaluation:

a) Component – I (C1): Periodic Progress, Progress Reports, test (15%) calculated for 15 marks Component – II (C2): Periodic Progress, seminar, test (15%) calculated for 15 marks)
b) Component III: (C3): Final exam (end semester exam for 70 marks) (70%). There shall be a single valuation of C3 for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited.
c) There shall be a single evaluation for all theory papers C3 by an internal examiner and 25% of the total scripts will be reviewed by an external examiner. The average of first valuation and the review evaluation will be considered as the final marks of the candidate.
d) 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.

Practical evaluation:

a) Component – I (C1): Periodic Progress, Laboratory record and Progress Reports (15%)
b) Component – II (C2): Results of Work, tour report, seminar, assignment, class tests,laboratory exercise and Draft Report (15%)
c) 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 foreach student and marks are allotted accordingly from the experimental efficiency and viva.
d) 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.
e) The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
f) A candidate will be assessed on the basis of
g) Knowledge of relevant processes
h) Skills and operations involved
i) Results / products including calculation and reporting.

j) Inference / Conclusion of the results if applicable.
k) If the external examiner does not turn up then both the examiners will be internal examiners. The duration of semester-end practical examination shall be decided by the Departmental council.
l) 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 awarded in the third evaluation will be final.

Evaluation of Minor/ Major Project/ Dissertation/ Internship

1) The research project can be executed by the candidate at the department (if a faculty agrees to guide) or at an outside firm/ laboratory/institute approved by the department. If a candidate is executing the research project/ internship at an external facility he/she shall report the updates in a timely manner as and when required by the assigned internal faculty at the department, in which case such faculty becomes the co-guide. 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/ co-guide. The candidate shall follow the rules of the college as well as the external site during the project work. The candidate shall submit the project report in the format prescribed by the department.

2) Components of evaluation are as follows:
    - Component – I (C1): Periodic Progress and Progress Reports (15%) by the internal faculty.
    - Component – II (C2): Results of Work, seminar and Draft Report (15%) by the internal faculty.
    - Component– III (C3): Practical/viva shall be conducted for 6 hours for each batch with a maximum of 12 students/ batch. Final Viva-voce and evaluation (70%). The report evaluation is for 40 marks and Viva-voce examination is for 30 marks. C3 evaluation shall be conducted by one internal and one external examiner.
3) 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.
4) The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
5) A candidate will be assessed on the basis of
    - Knowledge of relevant processes
    - Skills and operations involved
    - Results / products including calculation and reporting.
    - Inference / Conclusion of the results if applicable.
6) If the external examiner does not turn up then both the examiners will be internal examiners. The duration of semester-end practical examination shall be decided by the Departmental council.
7) If there is a 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 awarded in the third evaluation will be final.

Valuation of Value Added Courses

1) Component – I (C1): Periodic Progress and Progress Reports (15%) by the internal faculty.
2) Component – II (C2): Results of Work, seminar and Draft Report (15%) by the internal faculty.
3) Component– III (C3): Practical/viva shall be conducted for 6 hours for each batch with a maximum of 12 students/ batch. Final Viva-voce and evaluation (70%). The report evaluation is for 40 marks and Viva-voce examination is for 30 marks. C3 evaluation shall be conducted by one internal and one external examiner.
4) 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.
5) The C3 examination for Practical work/ Field work/ Project work/ internship/ dissertation/ Value added course will be conducted jointly by one internal and one external examiner.
6) A candidate will be assessed on the basis of
    (1) Knowledge of relevant processes
    (2) Skills and operations involved
    (3) Results / products including calculation and reporting.
    (4) Inference / Conclusion of the results if applicable.

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

8) If there is a 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 awarded in the third evaluation will be final.

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 10 days after the announcement of the results (or as prescribed by the Controller of Examination-CoE). 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 (or as prescribed by the Controller of Examination-CoE). This challenge evaluation is only for C3 components. The answer scripts, for which challenge evaluation is sought for, shall be sent to an external examiner. The marks awarded in the challenge evaluation will be final.

QUESTION PAPER PATTERN-THEORY

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-PRACTICAL

Question Paper Pattern for Practical – C1 and C2

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

1.	Conducting an Experiment/Micro-preparation /Plant identification	10m
2.	Assay Calculations and report	10m
3.	Critical comments /Identification/ Procedure Writing	10m
4.	Viva-voce examination	10m
5.	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**

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

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