M.Sc., BIOCHEMISTRY

CHOICE BASED CREDIT SYSTEM

Curriculum and Syllabus

Regular (2022-2023)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

DEPARTMENT OF BIOCHEMISTRY
FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

KARPAGAM ACADEMY OF HIGHER EDUCATION
(*Deemed to be University)*
(Established Under Section 3 of UGC Act 1956)
Accredited with A^+ Grade by NAAC in the second cycle
Pollachi Main road, Eachanari (Post), Coimbatore – 641 021, Tamil Nadu, India
Phone: 0422 – 298001 – 15; Fax No: 0422 – 2980022 – 23
Email: info@karpagam.com; Web: www.kahedu.edu.in

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
(Established under Section 3 of UGC Act, 1956)
Coimbatore - 641 021, INDIA

FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

POST-GRADUATE PROGRAMMES

(M.Sc., M.Com.)

REGULAR MODE
CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS - 2022

The following Regulations are effective from the academic year 2022-2023 and are applicable to the candidates admitted in Post Graduate (PG) Degree programmes in the Faculty of Arts, Science, Commerce and Management, Karpagam Academy of Higher Education (KAHE).

1 PROGRAMMES OFFERED,
MODE OF STUDY AND ADMISSION REQUIREMENTS

1.1 P.G. PROGRAMMES OFFERED

The various P.G. Programmes offered by the KAHE are listed in the table below.

S. No.	Programme Offered
1	M.Sc. Biochemistry
2	M.Sc. Microbiology
3	M.Sc. Biotechnology
4	M.Sc. Physics
5	M.Sc. Chemistry
6	M.Sc. Mathematics
7	M.Sc. Computer Science
8	M.Sc. Applied Astrology
9	M.Com.
10	MA English

1.2 MODE OF STUDY

Full-Time

All programmes are offered under Full-Time Regular mode. Candidates admitted under 'Full-Time' should be present in the KAHE during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

1.3 ADMSSION REQUIREMENTS (ELIGIBILITY)

Candidates for admission to the first semester Master's Degree Programme shall be required to have passed an appropriate Degree Examination of this Karpagam Academy of Higher Education or any other University accepted by the KAHE as equivalent thereto. Admission shall be offered only to the candidates who possess the qualification prescribed against each course as given in the table below.

QUALIFICATIONS FOR ADMISSION

S. No.	Name of the Programme Offered	Eligibility
1	M.Sc. Biochemistry	B.Sc. Degree with Biology / Biochemistry / Chemistry / Biotechnology / B.F.Sc. / Polymer Chemistry / Microbiology/ Zoology / Botany / Plant Science / Plant Biotechnology / Animal Science / Animal Biotechnology / B.Pharm / Industrial Chemistry / Applied Microbiology / Medical Microbiology / Human Genetics / Medical Genetics / Molecular Biology / Genetics Technology / Environmental Science / Environment Biotechnology / Genetics Engineering / Bioinformatics / Plant Biology & Biotechnology / Animal Cell & Biotechnology / Agriculture / Medical Lab Technology / Nutrition & Dietetics
2	M.Sc. Microbiology	B.Sc. Microbiology / Applied Microbiology / Industrial Microbiology / Medical Microbiology / Botany / Zoology / Biology / Biotechnology / Molecular Biology / Genetic Engineering / Biochemistry / Agriculture / Forestry / Medical Lab Technology / Life Sciences
3	M.Sc. Biotechnology	B.Sc. Degree with Biology / Biochemistry / B.Sc Biology with Chemistry Ancillary / B.F.Sc. / Microbiology / Zoology / Botany / Plant Science /Plant Biotechnology / Animal Science /Animal Biotechnology / B.Pharm / Applied Microbiology / Medical Microbiology / Human Genetics / Medical Genetics / Molecular Biology / Genetics / Environmental Science / Environment Biotechnology / Genetics Engineering / Bioinformatics / Plant Biology

		& Biotechnology / Animal Cell & Biotechnology / Agriculture / B.Tech (Biotech)
4	M.Sc. Physics	B.Sc. Physics, B.Sc. Physics (CA) / B.Sc. Applied science
5	M.Sc. Chemistry	B. Sc. Chemistry, Industrial Chemistry, Polymer Chemistry
6	M.Sc. Mathematics	B.Sc. Mathematics / B.Sc. Mathematics with Computer Applications
7	M.Sc. Computer Science	B.Sc. Computer Science / Computer Technology / Information Technology / Electronics / Software Systems / BCA/ B.Sc. Applied Sciences
8	M.Com	B.Com./BCom.(CA)/B.Com(PA)/B.Com(Finance&Insurance)/ B.Com.(e-Commerce)/ B.Com.(IT) /B.B.M. /B.B.M.(CA) /B.B.A./B.B.A (CA) / B.Com (CS), B.A. Co-Operation / Bachelor's Degree in Bank Management/ B.A. Economics / B. Com Financial Analytics/ B. Com International Accounting and Finance
9	MA English	BA (English)/Any UG degree with first class in Part II - English

2 DURATION OF THE PROGRAMMES

2.1 The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Sc., M.Com., MA	4	8

2.2 Each semester normally consists of 90 working days or 450 Instructional hours for full-time mode of study. Examination shall be conducted at the end of every semester for the respective courses.

3. CHOICE BASED CREDIT SYSTEM

3.1 All programmes are offered under Choice Based Credit System with a total credit range from 87 to 93 for the PG programmes.

3.2 Credits

Credits means the weightage given to each course of study by the experts of the Board of Studies concerned.

4. STRUCTURE OF THE PROGRAMME

Every Programme will have a curriculum and syllabus consisting of core courses, elective courses, open elective and project work.

a. Core course

Core course consists of theory and practical and the examinations shall be conducted at the end of each semester.

b. Elective course

Elective courses are to be chosen with the approval of the Head of Department concerned from the list of elective courses mentioned in the curriculum.

c. Project Work

The candidates shall undertake the project work in the Fourth Semester either in the Department concerned or in Industries, Institute or any other Organizations and the project report has to be submitted at the end of the fourth semester.

In case the candidate undertakes the project work outside the Department, the teacher concerned within the Department shall be the Main guide and the teacher/scientist under whom the work is carried out will be the Co-guide. The candidate shall bring the attendance certificate from the place of project work carried out.

d. Value Added Courses

Courses of varying durations but not less than 30 hours which are optional and offered outside the curriculum that add value and help the students in for getting placement. Students of all programmes are eligible to enroll for the Value Added Courses. The student shall choose one Value Added Course per semester from the list of Value Added Courses available in KAHE. The examinations shall be conducted at the end of the Value Added Course at the Department level and the student has to secure a minimum of 50% of marks to get a pass. The certificate for the Value Added Course for the passed out students shall be

issued duly signed by the HOD and Dean of the Faculty concerned.

e. Internship

The student shall undergo 15 days internship in the end of II semester. Internship report will be evaluated and awarded in the III semester. Students have to earn 2 credits for the Internship.100 marks is awarded for Internship through Continuous Internal Assessment.

f. Open Elective

He / She may select one of the open elective courses from the list given below offered by the other department in the third semester. Students have to earn 2 credits for this course. (The student cannot select a course offered by the parent department).

S.No.	Name of the Department	Course Code	Name of the Course
1	M.A English	22MAPOE301	English for Competitive Examinations
2	M.Com	22CMPOE301	Personal Finance and Planning
3	MBA	**22MBAPOE301**	Organizational behavior
4	MCA	22CAPOE301	Robotics
5	M.Sc Computer Science	22CSPOE301	Cyber forensics
6	M.Sc Mathematics	22MMPOE301	Coding theory
7	M.Sc Physics	22PHPOE301	Non-destructive techniques – an industrial approach
8	M.Sc Chemistry	22CHPOE301	Applying Chemistry to Society
9	M.Sc Microbiology	22MBPOE301	Fermentation technology
10	M.Sc Biochemistry	22BCPOE301	Nutrition and Dietetics
11	M.Sc Biotechnology	22BTPOE301	Plant Tissue culture and its applications

Online Course

Student shall study at least one online course from SWAYAM / NPTEL / MOOC in any one of the first three semesters for which examination shall be conducted at the end of the course by the respective external agencies if any. The student can register to the courses which are approved by the Department. The student shall produce a Pass Certificate from the respective agencies before the end of the third semester. The credit(s) earned by the students will be considered as additional credit(s) over and above the credits minimum required to earn a particular Degree.

5. MEDIUM OF INSTRUCTION

The medium of instruction for all courses, examinations, seminar presentations and project/thesis/dissertation reports should be in English.

6. MAXIMUM MARKS

The maximum marks assigned to different courses shall be as follows:

(i) Each of the theory and practical courses shall carry maximum of 100 marks. Out of which 40 marks are for Continuous Internal Assessment (CIA) and 60 marks for End Semester Examinations (ESE).

(ii) Maximum marks for Project work

S. No	Programme	Maximum marks	CIA	ESE
1	M.Sc., M.Com., MA	200	80	120

7. REQUIREMENTS TO APPEAR FOR THE END SEMESTER EXAMINATION

a. Ideally every student is expected to attend all classes and secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classes and the conduct of the candidate is satisfactory during the course.

b. A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) or due to participation in University / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Extension activities or similar programmes with prior permission from the Registrar shall be given exemption from prescribed minimum attendance requirements and shall be permitted to appear for the examination on the recommendation of the Head of Department concerned and Dean to condone the shortage of attendance. The Head of Department has to verify and certify the genuineness of the case before recommending to the Dean. However, the candidate has to pay the prescribed condonation fee to the KAHE.

c. However, a candidate who has secured attendance less than 64% in the current semester due to any reason shall not be permitted to appear for the current semester examinations. But he/she will be permitted to appear for his/her supplementary examinations, if any and he/she has to re do the same semester with the approval of the "Students' Affairs Committee" and Registrar.

8. a. FACULTY MENTOR

To help students in planning their courses of study and for general advice on the academic programme, the HoD shall allot a certain number of students to a faculty who will function as mentor throughout their period of study. Faculty mentors shall advise the students and monitor their behavior and academic performance. Problems if any shall be counseled by them periodically. The Faculty mentor is also responsible to inform the parents of their wards progress. Faculty mentor shall display the cumulative attendance particulars of his / her ward students' periodically (once in 2 weeks) on the Notice Board to enable the students to know their attendance status and satisfy the **clause 7** of this regulation.

b. **ONLINE COURSE COORDINATOR**

To help students in planning their online courses and for general advice on online courses, the HOD shall nominate a coordinator for the online courses. The Online course coordinator shall identify the courses which the students can select for their programme from the available online courses offered by the different agencies periodically and inform the same to the students. Further, the coordinators shall advice the students regarding the online courses and monitor their course.

9. CLASS COMMITTEE

Every class shall have a Class Committee consisting of teachers of the class concerned, student representatives (Minimum two boys and 2 girls of various capabilities and Maximum of 6 students) and the concerned HoD / senior faculty as a Chairperson. The objective of the class committee Meeting is all about the teaching – learning process. Class Committee shall be convened at least once in a month. The functions of the Class Committee shall include

- Analyzing and Solving problems experienced by students in the class room and in the laboratories.
- Analyzing the performance of the students of the class after each test and finding the ways and means to improve the performance.
- The Class Committee of a particular class of any department is normally constituted by the HoD / Chairperson of the Class Committee. However, if the students of different departments are mixed in a class, the class committee shall be constituted by the respective faculty Dean.
- The Class Committee shall be constituted during the first week of each semester.
- The HoD / Chairperson of the class committee are authorized to convene the meeting of the class committee.
- The respective faculty Dean has the right to participate in any class committee meeting.
- The Chairperson is required to prepare the minutes of every meeting, and submit the same to Dean within two days after having convened the meeting. Serious issues if any shall be brought to the notice of the Registrar by the HoD / Chairperson immediately.

10. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Dean depending upon whether all the teachers handling the common course belong to a single department or to various other departments. The 'Course Committee' shall meet in order to arrive at a common scheme of evaluation for the tests to ensure a uniform evaluation of the tests. If feasible, the course committee shall prepare a common question paper for the Internal Assessment test(s).

11. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

11.1 Every Faculty is required to maintain an **Attendance and Assessment Record (Log book)** which consists of attendance of students marked for each lecture / practical / project work class, the test marks and the record of class work (topic covered), separately for each course. This should be submitted to the HoD once in a fortnight for checking the syllabus coverage and records of test marks and attendance. The HoD shall sign with date after due verification. The same shall be submitted to Dean once in a month. After the completion of the semester the HoD should keep this record in safe custody for five years. Because records of attendance and assessment shall be submitted for Inspection as and when required by the KAHE / any other approved body.

11.2 **Continuous Internal Assessment (CIA)**: The performance of students in each course will be continuously assessed by the respective faculty as per the guidelines given below:

Theory Courses

S. No.	Category	Maximum Marks
1	Attendance	5
2	Test – I (first 2 ½ units)	10
3	Test – II (last 2 ½ units)	10
4	Journal Paper Analysis & Presentation*	15
Continuous Internal Assessment : Total		40

*****Evaluated by two faculty members of the department concerned. Distribution up of marks for one Journal paper analysis: Subject matter 5 marks, Communication/PPT Presentation 4 marks, Visual aid 2 marks and Question and Discussion 4 marks

Practical Courses

S. No.	Category	Maximum Marks
1	Attendance	5
2	Observation work	5
3	Record work	5
4	Model practical examination	15
5	*Viva – voce* [Comprehensive]*	10
Continuous Internal Assessment: Total		**40**

* *Viva - voce* conducted during model practical examination.

Every practical Exercise / Experiment shall be evaluated based on the conduct of Exercise/ Experiment and records maintained.

11.3 **Pattern of Test Question Paper**

11.4

Instruction	**Remarks**
Maximum Marks	50 marks
Duration	2 Hours
Part – A	Objective type (20x1=20)
Part - B	Short Answer Type (3 x 2 = 6)
Part - C	3 Eight marks questions 'either – or' choice (3 x 8 = 24 Marks)

Attendance

Marks Distribution for Attendance

S. No.	**Attendance (%)**	**Maximum Marks**
1	91 and above	5.0
2	81 - 90	4.0
3	76 - 80	3.0
4	Less than 75	0

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12. ESE EXAMINATIONS

12.1 End Semester Examination (ESE): ESE will be held at the end of each semester for each course. The question paper is for a maximum of 60 marks.

Pattern of ESE Question Paper

Instruction	**Remarks**
Maximum Marks	60 marks for ESE
Duration	3 hours (½ Hr for Part – A Online & 2 ½ Hours for Part – B and C)
Part – A	20 Questions of 1 mark each (20 x 1 = 20 Marks) Question No. 1 to 20 Online Multiple Choice Questions
Part- B	5 Questions of six marks each (5 x 6 = 30 Marks.) Question No. 21 to 25 will be 'either-or' type, covering all five units of the syllabus; i.e., Question No. 21: Unit - I, either 21 (a) or 21 (b), Question No. 22: Unit - II, either 22 (a) or 22 (b), Question No. 23: Unit - III,

	either 23 (a) or 23 (b), Question No. 24: Unit - IV, either 24 (a) or 24 (b), Question No. 25: Unit - V, either 25 (a) or 25 (b)
Part - C	Question No.26. One Ten marks Question (1 x 10 = 10 Marks)

12.2 **Practical:** There shall be combined valuation. The pattern of distribution of marks shall be as given below.

Experiments	: 40 Marks
Record	: 10 Marks
Viva-voce	: 10 Marks
Total	**: 60 Marks**

Record Notebooks for Practical Examination

Candidate taking the Practical Examination should submit Bonafide Record Notebook prescribed for the Practical Examination, failing which the candidate will not be permitted to take the Practical Examination.

In case of failures in Practical Examination, the marks awarded for the Record at the time of first appearance of the Practical Examination shall remain the same at the subsequent appearance also by the candidate.

12.3. **Evaluation of Project Work**

12.3.1 The project shall carry a maximum marks as per clause 6 (ii). ESE will be a combined evaluation of Internal and External Examiners.

12.3.2 The project report is prepared according to the approved guidelines and duly signed by the supervisor(s) shall be submitted to HoD.

Guidelines to prepare the project report

a. Cover page
b. Bonafide certificate
c. Declaration
d. Acknowledgement
e. Table of contents
f. Chapters
   Introduction
   Aim and Objectives
   Materials and Methods (Methodology)
   Results (Analysis of Data) and Discussion (Interpretation)
   Summary
   References

12.3.3 The evaluation of the project will be based on the project report submitted and *Viva-Voce* Examination by a team consisting of the supervisor, who will be the Internal Examiner and an External Examiner who shall be appointed by the COE. In case the supervisor is not available, the HoD shall act as an Internal Examiner.

12.3.4 If a candidate fails to submit the project report on or before the specified date given by Examination Section, the candidate is deemed to have failed in the project work and shall re-enroll for the same in a subsequent semester.

If a candidate fails in the *viva-voce* examinations he/she has to resubmit the project report within 30 days from the date of declaration of the results. For this purpose the same Internal and External examiner shall evaluate the resubmitted report.

12.3.5 Copy of the approved project report after the successful completion of *viva voce* examinations shall be kept in the KAHE library.

13. PASSING REQUIREMENTS

13.1 Passing minimum: There is a passing minimum 20 marks out of 40 marks for CIA and the passing minimum is 30 marks out of 60 marks in ESE. The overall passing in each course is 50 out of 100 marks (Sum of the marks in CIA and ESE examination).

13.2 If a candidate fails to secure a pass in a particular course (either CIA or ESE or Both) as per clause 13.1, it is mandatory that the candidate has to register and reappear for the examination in that course during the subsequent semester when examination is conducted for the same till he/she secures a pass both in CIA and ESE (vide Clause 2.1).

13.3 Candidate failed in CIA will be permitted to improve CIA marks in the subsequent semesters by writing tests and by re-submitting assignments.

13.4 CIA marks (if it is pass) obtained by the candidate in the first appearance shall be retained by the Office of the Controller of Examinations and considered valid for all subsequent attempts till the candidate secures a pass in ESE.

13.5 A candidate who is absent in ESE in a Course / Practical / Project work after having enrolled for the same shall be considered to have **failed** in that examination.

14. IMPROVEMENT OF MARKS IN THE COURSE ALREADY PASSED

Candidates desirous to improve the marks secured in a passed course in their first attempt shall reappear once (**only in ESE**) in the subsequent semester. **The improved marks shall be considered for classification but not for ranking.** If there is no improvement there shall be no change in the marks awarded earlier.

15. AWARD OF LETTER GRADES

All assessments of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain number of points, will be awarded as per the range of total marks (out of 100) obtained by the candidate in each course as detailed below:

Letter grade	Marks Range	Grade Point	Description
O	91 - 100	10	OUTSTANDING
A+	81- 90	9	EXCELLENT
A	71-80	8	VERY GOOD

B+	66- 70	7	GOOD
B	61 – 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
D	50 - 54	4	PASS
RA	<50	-	REAPPEARANCE
AAA	-	-	ABSENT

16. GRADE SHEET

After the declaration of the results, Grade Sheets will be issued to each student which will contain the following details:

i. The list of courses enrolled during the semester and the corresponding grade scored.

ii. The Grade Point Average (**GPA**) for the semester and

iii. The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.

GPA of a Semester and CGPA of a programme will be calculated as follows.

$$\textbf{GPA of a Semester} = \frac{\text{Sum of the product of the GP by the corresponding credits of the courses offered in that Semester}}{\text{Sum of the credits of the courses of that Semester}}$$

i.e. **GPA** of a Semester = $\dfrac{\sum_i CiGPi}{\sum_i Ci}$

Sum of the product of the GPs by the corresponding credits of the courses offered for the entire programme

CGPA of the entire programme = ----------

Sum of the credits of the courses of the entire programme

i.e. **CGPA** of the entire programme = $\dfrac{\sum_n \sum_i CniGPni}{\sum_n \sum_i Cni}$

where,

Ci is the credit fixed for the course 'i' in any semester
GPi is the grade point obtained for the course 'i' in any semester
'n' refers to the Semester in which such courses are credited

Note: RA grade will be excluded for calculating **GPA** and **CGPA**.

17. REVALUATION

Candidate can apply for revaluation and retotalling of his / her semester examination answer script (**theory courses only**), within 2 weeks from the date of declaration of results, on payment of a prescribed fee. For the same, the prescribed application has to be sent to the Controller of Examinations through the HoD. **A candidate can apply for revaluation of answer scripts not exceeding 5 courses at a time.** The Controller of Examinations will arrange for the revaluation and results will be intimated to the candidate through the HODs concerned**.** Revaluation is not permitted for supplementary theory courses.

18. TRANSPARENCY AND GRIEVANCE COMMITTEE

Revaluation and Re-totaling is allowed on representation (clause 17). Student may get the Xerox copy of the answer script on payment of prescribed fee, if he / she wish. The student may represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HoD, the Dean of another Faculty nominated by the KAHE), the HoD of Department concerned, the faculty of the course and Dean from other discipline nominated by the KAHE and the CoE. If the Committee feels that the grievance is genuine, the script may be sent for external valuation; the marks awarded by the External examiner will be final. The student has to pay the prescribed fee for the same.

19. ELIGIBILITY FOR THE AWARD OF THE DEGREE

A student shall be declared to be eligible for the conferment of the Degree if he / she has

- Successfully completed all the components in clause 3 and gained the required number of total credits as specified in the curriculum corresponding to his / her Programme within the stipulated period.
- Not any disciplinary action pending against him / her.
- The award of the degree must be approved by the Board of Management.

20. CLASSIFICATION OF THE DEGREE AWARDED

20.1 Candidate who qualifies for the award of the Degree (vide clause 13) having passed the examination in all the courses in his / her first appearance, within the specified minimum number of semesters and securing a **CGPA not less than 8.0** shall be declared to have passed the examination in **First Class with Distinction.**

20.2 Candidate who qualifies for the award of the Degree (vide clause 13) having passed the examination in all the courses within the specified maximum number of semesters (vide clause 2.1), securing a **CGPA not less than 6.5** shall be declared to have passed the examination in **First Class**.

20.3 All other candidates (not covered in clauses 20.1 and 20.2) who qualify for the award of the degree (vide Clause 19) shall be declared to have passed the examination in **Second Class**.

21. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION

21.1 A candidate due to valid reason on prior application may be granted permission to withdraw from appearing for the examination of any one course or consecutive examinations of more than one course in a semester examination.

21.2 Such withdrawal shall be permitted only once during the entire period of study of the degree programme.

21.3 Withdrawal of application is valid only if it is made within 10 days prior to the commencement of the examination in that course or courses and recommended by the HoD / Dean concerned and approved by the Registrar.

21.3.1 Notwithstanding the requirement of mandatory TEN days notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

21.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during IV semester.

21.5 Withdrawal from the End semester examination is **NOT** applicable to arrears courses of previous semesters.

21.6 The candidate shall reappear for the withdrawn courses during the examination conducted in the subsequent semester.

22. PROVISION FOR AUTHORISED BREAK OF STUDY

22.1 **Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme.** However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the semester for valid reasons, and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he / she applies to the Registrar, but not later than the last date for registering for the end semester examination of the semester in question, through the HoD stating the reasons therefore and the probable date of rejoining the programme.

22.2 The candidate thus permitted to rejoin the Programme after the break shall be governed by the Curriculum and Regulations in force at the time of rejoining. Such candidates may have to do additional courses as per the Regulations in force at that period of time.

22.3 The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification. (Vide

Clause 20). However, additional break of study granted will be counted for the purpose of classification.

22.4 The total period for completion of the Programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in clause 2.1 irrespective of the period of break of study (vide clause 22.3) in order that he/she may be eligible for the award of the degree.

22.5 If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Break of Study' or 'Withdrawal' (Clause 21 and 22) is not applicable for this case.

23. RANKING

A candidate who qualifies for the PG Degree programme passing all the Examinations in the first attempt, within the minimum period prescribed for the programme of study from Semester I through Semester IV to the programme shall be eligible for ranking. Such ranking will be confined to 10% of the total number of candidates qualified in that particular programme of Study subject to a maximum of 10 ranks.

The improved marks will not be taken into consideration for ranking.

24. SUPPLEMENTARY EXAMINATION

Supplementary Examination will be conducted only for the final semester students within ten days from the date of publication of results for students who have failed in one theory course only. Such students shall apply with prescribed fee to the Controller of Examinations within the stipulated time.

25. DISCIPLINE

25.1. If a student indulges in malpractice in any of the Internal / External Examinations he / she shall be liable for punitive action as prescribed by the KAHE from time to time.

25.2. Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the KAHE. The erring students will be referred to the disciplinary committee constituted by the KAHE, to enquire into acts of indiscipline and recommend the disciplinary action to be taken.

26. REVISION OF REGULATION AND CURRICULUM

Karpagam Academy of Higher Education may from time to time revise, amend or change the Regulations, Scheme of Examinations and syllabi if found necessary.

M.Sc., BIOCHEMISTRY

PREAMBLE

- Biochemistry is the study of chemistry and relating to biological organisms.
- Biochemistry is viewed as a hybrid branch of organic chemistry which specializes in the chemical processes and chemical transformations that take place inside of living organisms.
- Biochemistry incorporates everything in size between a molecule and a cell and all the interactions between them.
- Biochemistry essentially remains the study of the structure and function of cellular components (such as enzymes and cellular organelles) and the processes carried out both on and by organic macromolecules - especially proteins, but also carbohydrates, lipids, nucleic acids and other biomolecules.
- All life forms alive today are generally believed to have descended from a single proto-biotic ancestor, which could explain why all known living things naturally have similar biochemistries.
- Biochemistry is most simply put the chemistry of life.

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DEPARTMENT OF BIOCHEMISTRY
FACULTY OF ARTS, SCIENCE AND HUMANITIES
PG PROGRAM (CBCS)- M.Sc., Biochemistry
(2022–2023 and onwards)

Course code	Name of the course	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks			Category	Page No
		PEOs	POs	L	T	P		CIA	ESE	Total		
								40	60	100		
SEMESTER - I												
22BCP101	Chemistry of Biopolymers	I	a	4	0	0	4	40	60	100	C	7
22BCP102	Enzymes and Microbial Technology	II	d	4	0	0	4	40	60	100	C	9
22BCP103	Bioinstrumentation and Good Laboratory Practices	II	d, e	4	0	0	4	40	60	100	C	11
22BCP104	Cellular Biochemistry	III	a	3	1	0	4	40	60	100	C	13
22BCP105A	Advanced Plant Biochemistry	III	a	4	0	0	4	40	60	100	E	16
22BCP105B	Ecology and Evolutionary biology	I	c, f								E	18
22BCP105C	Signal Transduction and Regulation	I	d								E	20
22BCP111	Practical – I Quantitative Estimation and Séparation Techniques	II	a	-	0	4	2	40	60	100	C	22
22BCP112	Practical – II Plant Biochemistry and Microbiology	I, III	a, e	-	0	4	2	40	60	100	C	24
	Journal paper analysis and Presentation	I- III	a, e	2	0	0	-	-	-	-		
Semester Total				**21**	**1**	**8**	**24**	**280**	**420**	**700**		
SEMESTER – II												
22BCP201	Intermediary metabolism	II	a	4	0	0	4	40	60	100	C	26
22BCP202	Molecular Biology	II	a, b	4	0	0	4	40	60	100	C	28
22BCP203	Developmental Genetics	II	a, b	3	1	0	4	40	60	100	C	30
22BCP204	Bioinformatics	III	d	4	0	0	4	40	60	100	C	32
22BCP205A	Recombinant DNA Technology	I	d	4	0	0	4	40	60	100	E	36
22BCP205B	Advanced Animal Tissue Culture	III	d, e								E	40

22BCP205C	Forensic Toxicology and Phramacology	III	d								E	44
22BCP211	Practical – III Molecular Biology and Animal Biotechnology	II	d, g	0	0	4	2	40	60	100	C	46
22BCP212	Practical – IV Biological Databases and Analysis	III	d, g	0	0	4	2	40	60	100	C	49
Journal paper analysis and Presentation		I-III	a, e	2	0	0	-	-	-	-		
Semester Total				**21**	**1**	**8**	**24**	**280**	**420**	**700**		
SEMESTER – III												
22BCP301	Immunobiology	I	a	4	0	0	4	40	60	100	C	51
22BCP302	Clinical Biochemistry	I, III	a, d	4	0	0	4	40	60	100	C	53
22BCP303	Endocrinology	II	a, d	4	0	0	4	40	60	100	C	55
22BCP304	Drug Biochemistry and Clinical Toxicology	III	a, d	4	0	0	4	40	60	100	C	57
22BCP305A	Biostatistics and Research Methodology	III	e, g	3	0	0	3	40	60	100	E	59
22BCP305B	Clinical Research	III	d, e								E	61
22BCP305C	Molecular Virology	I	d								E	63
22BCP311	Practical – V Clinical Enzymes And Animal Handling	I, II	d, e	-	0	4	2	40	60	100	C	65
22BCP312	Practical – VI Biostatistics in Clinical Case Studies	I	d, e	-	0	4	2	40	60	100	C	66
Journal paper analysis and Presentation		I-III	d, e	1	0	-	-	-	-	-		
22OEP30X	Nutrition and dietetics			3	0	0	2	40	60	100	OE	83
22BCP391	Internship Programme			-	-	-	2	100	-	100	C	85
Semester Total				**23**	**0**	**7**	**27**	**420**	**480**	**900**		

Category *C – Core Paper, E- Elective Paper OE – Open Elective

Course code	**Name of the course**	**Hrs/Week**	**Marks**			**Exam**	**Credit**
			CIA	**ESE**	**Total**	**Hrs**	**(s)**
SEMESTER IV							
22BCP491	Project and Viva Voce	-	80	120	200	-	86
	Semester total	-	80	120	200	-	15
		90	1060	1440	2500		90

Blue – Employability

Green – Entrepreneurship

Red – Skill Development

Elective courses *

Core Elective – 1 (22BCP105)*		**Core Elective – 2 (22BCP205)***		**Core Elective – 3(22BCP305)***	
Course code	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**
22BCP105-A	Advanced Plant Biochemistry	22BCP205-A	Recombinant DNA Technology	22BCP305-A	Biostatistics and Research Methodology
22BCP105-B	Ecology and Evolutionary biology	22BCP205-B	Advanced Animal Tissue Culture	22BCP305-B	Clinical Research
22BCP105-C	Signal Transduction and Regulation	22BCP205-C	Forensic Toxicology and Pharmacology	22BCP305-C	Molecular virology
				Open Elective – 1 (22BCPOE301)	
				22BCPOE301	**HEALTH AND NUTRITION**

***** The candidate has to select any one elective course from three options in each semester

VALUE ADDED COURSES

1. Scientific Writing
2. Clinical Laboratory Techniques
3. Animal Handling Procedures
4. Nutrition and dietetics

PROGRAMME OUTCOME(POs)

PG biochemistry graduate will be able to achieve

a. **Critical Thinking and Effective Communication:** The teaching is intended to kindle the critical thinking of the student to address problems (Problem based learning) and equip them to list out their understanding (Activity based learning). The syllabus also includes journal paper presentation and analysis on specific topics of all subjects which will be evaluated by faculty handling the subject.

b. **Future Career:** To prepare students for future careers in the various fields of biochemistry such as academic and research institution.

c. **Societal Contribution and Social Interaction:** The Biochemistry Programme will benefit the society on the whole by adding to the highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe. Inside the classrooms group discussion is encouraged on topics during the last five minutes of class to improve the understanding and to share the knowledge and view point. Outside the classroom, various outreach programme are conducted on various health initiatives.

d. **Identification and Differential Diagnosis:** To acquire **b**iochemist position in leading hospitals and scientist position in industries.

e. **Ethics:** Students learn about the significance of having right moral features to develop good interpersonal skills.

f. **Environment and Sustainability:** Understand the role of citizen to maintain sustainable environment and encourage Eco-friendly initiatives.

g. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of health and disease.

PROGRAMME SPECIFIC OUTCOME (PSOs)

h. To prepare students for future careers in various fields of biochemistry by enhancing analytical and critical-thinking skills in which a core understanding of the chemistry of biological processes is important for the understanding of human health and disease.

i. To equip highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe.

j. The skills acquired in the programme will help the students in acquiring scientific, academic and industrial positions such as Analyst, Research Scientist at Pharma (R&D)

k. Industries, Academician, Project Associates (JRF, SRF), Doctoral Research positions abroad at India and abroad. Clinical biochemist at renowned hospitals, medical coding, Scientific writers.

PROGRAMME EDUCATIONAL OBJECTIVE (PEOs)

I. The course aims to impart advanced and in depth understanding on all the human physiological and pathological state. To understand the molecular process and their perturbation during disease.

II. The programme covers various aspects of Biomolecule estimation and regulation to ascertain health and disease state. metabolic pathways alterations along with their regulation at the replication, transcriptional, translational, and post-translational levels including by studying DNA, RNA and protein molecules, immunology, endocrinology, advancements in rDNA technologies to circumvent genetic disorders.

III. Further to enrich research understanding various genomic, proteomic and bioinformatics tools are added. Animal cell culture, IPR, Biostatistics, research methodology, clinical research and Plant tissue culture are offered as elective papers to get specialized in a specific area. The final semester is devoted exclusively to enrich the students to address specific research objective.

Mapping of PEOs and POs

POs	a	B	c	D	e	f	g	i	j	k
PEO I	X		X			X				
PEO II	X		X	X	X	X		X	X	X
PEO III	X	X	X	X	X		X		X	X

Semester I

22BCP101 CHEMISTRY OF BIOPOLYMERS 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- To understand the biological significance of biopolymers of carbohydrates in living systems
- To understand the structure of biopolymers of amino acids and their biological significance in living systems
- To know the structure, properties and biological significance of lipid biopolymer in biological systems
- To understand the lipid peroxidation and importance of antioxidants in the treatment and prevention of degenerative diseases
- To understand the structure and functional role of nucleic acid in living systems
- To understand the interaction of proteins and with nucleic acid and their relevance.

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Recognize the structure and organization of storage and structural polysaccharides in living system
2. Understand the structure and importance of proteins and amino acids in biological system.
3. Recall the role of lipids in biomembrane including signal transduction
4. Understand the relevance of antioxidants
5. Differentiate the structure, types, properties and functions of DNA and RNA
6. Recognize the nucleic acid interaction with proteins and downstream events

UNIT I: Carbohydrates

Brief review of carbohydrates, classification. Monosaccharides, Disaccharides and Polysaccharides – Properties and Biological Significance. Occurrence, structure and biological functions of cellulose, chitin, inulin, agar, starch and glycogen. Fructans, arabinans and galactans. Occurrence, structure, and biological functions of bacterial cell wall polysaccharides and blood group antigens. Structure and significance of glycoconjucates-Glycosaminoglycans – structure and biological role of hyaluronic acid, chondroitin sulfate and heparin, sialic acid; keratan sulfate, glycoproteins and glycolipids. Conformation of sugars

UNIT II: Proteins

Review of structure and classification of aminoacids. Classification of proteins Orders of protein structure. Primary structure – determination of amino acid sequence of proteins. The peptide bond – The Ramachandran plot. Secondary structures – α-helix, β-sheet and β-turns. Fibrous proteins- Collagen triple helix-Structure and assembly. Globular proteins-forces involved, folding process and folding patterns. Tertiary structure –Myoglobin organisation.

Quarternary structure of proteins- Structure of haemoglobin. Models for haemoglobinallostery. Quintinary structure-basics only. Methemoglobin. Structural and functional role of proteins.

UNIT III: Lipids

Introduction, classification, structure, properties and functions of simple lipid, compound lipids-phospholipids, glycolipids, storage lipids and choesterol. Eicosanoids-prostaglandins, thromboxanes and leukotrienes. Properties of lipids-Micelles, bilayers and liposomes. Steroids – Plant and Animal Steroids; Significance of lipid anchored protein-prenylated, fatty acylated and GPI anchored proteins. Transport of lipids.Lipoproteins – classification, composition and biological functions. Lipids as signals, cofactors and pigments (Brief account). Lipid peroxidation and antioxidants.

UNIT IV: Nucleic acids

DNA double helical structure – Watson and Crick model. A, B and Z forms of DNA. Tertiary and quadraplex structures of DNA. DNA supercoiling and linking number. Properties of DNA – DNA bending, buoyant density, viscosity, denaturation and renaturation – The cot curve – Chemical synthesis of DNA.

Major classes of RNA – mRNA, rRNA, tRNA, small nuclear RNAs – structure and biological functions. miRNA, siRNA, cr RNA and lnc RNA. Secondary and tertiary structure of tRNA and rRNA.

UNIT V: Nucleic acid interaction with proteins

DNA binding motifs in proteins – the basic helix loop helix (bHLH) motif, zinc finger, the leucine zipper, helix-loop helix and homeo domain. RNA binding motifs in proteins. Molecular aspects of protein-nucleic acid binding – direct interactions. Techniques characterizing nucleic acid-protein complex – Genomic organization of of Histones and DNA chromatin immunoprecipitation assay, DNase I foot printing. Gene editing techniques: TALENS. ZFN and CRISPR/CAS9

SUGGESTED READING

1. Murray, R.K., Bender, D.A., Botham, K.M., and Kennelly, P.J. (2018). Harper's illustrated Biochemistry, 31st Edition. McGraw-Hill Medical. London.
2. Nelson, D., and Cox, M. W.H. (2021). Lehninger Principles of Biochemistry (8th Ed.) New York, Freeman and Company.
3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: Life at the molecular level. Hoboken, NJ: Wiley.
4. Zubay, G., (2009). Biochemistry, Wm.C Brown Publishers, Saunders and Company,Philadelphia.

22BCP102 ENZYMES AND MICROBIAL TECHNOLOGY 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- To understand the structure of enzymes and their classifications.
- To analyse the active site of enzymes by various experimental approaches.
- To learn the kinetics of enzyme catalysed reactions.
- To learn the importance of enzyme immobilization and its wide applications in medicine and industries.
- To study various fermentor designs, culture systems and the application of fermentation process in industry.
- To learn the fermented products preparation, downstream processing and its industrial applications.

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the mechanism of action of enzymes and their classifications.
2. Recall the kinetics of enzyme catalyzed reactions
3. Understand the enzyme immobilization concept and apply the knowledge to produce more products out of it.
4. Gain knowledge in designing fermentor based on Industrial needs
5. Have clear understanding of microbes derived a products and the role of enzymes in downstream process.
6. Clear in concept of various culture techniques and apply the suitable one for a particular application.

UNIT I: Enzymes

Enzymes Nomenclature and classification of Enzymes with examples; Structure and functions of coenzymes and cofactors. Activesite, the investigation of active site structure – The identification of binding sites, catalytic sites-trapping the E-S complex. Use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo oxidation and chemical modification of amino acid side chains. Affinity labeling studies and super reactive amino acid chains. The 3-D structural features of active sites as revealed by X-ray chrystallographic and chemical studies, site directed mutagenesis. catalytic triad. Lock and key model, Induced fit model. Factors affecting enzyme activity. Isolation, purification and characterization of enzymes.Mechanism of enzyme action –Acid base and covalent catalysis metal activated and metalloenzymes. Ribozymes.

UNIT II: Enzyme Kinetics

Derivation of MM equation, LB plot, Eadie Hofstee plot and Hanes plot. Bisubstrate reactions-types of bi-bi reactions, differentiating bi substrate mechanisms-diagnostic plots, isotope exchange. Enzyme inhibition-Types and differentiation of competitive,

uncompetitive and non-competitive inhibition, Allosteric inhibition, feed-back inhibition and regulation. Reversible covalent modification (glycogen phosphorylase); proteolytic cleavage (Zymogen); multi enzyme complex as regulatory enzymes (PDH); isoenzymes (LDH). Mechanism based inhibitors-antibiotics as inhibitors. Mechanism of action of enzymes - chymotrypsin and lysozyme. Enzyme based diagnostic techniques. Overview of various methods to assay enzymes. Utility of enzyme kinetics for the determination of therapeutic doses.

UNIT III: Immobilization of enzymes

Methods of immobilization - adsorption, covalent binding, entrapment, membrane confinement. Effect of immobilization on enzyme. Use of enzymes in clinical diagnosis and industries.Enzyme engineering – for therapeutic and diagnosis purpose. Artificial enzymes and synzymes, Abzymes, ribozymes, enzymes in organic solvents.

Biosensors –working Principle, Technique and Applications. Various components of biosensors, biocatalysis based biosensors.

UNIT IV: Microbial Growth

Balanced and Unbalanced microbial growth; Measurement of growth; Principles of microbial growth and culture systems- culture, fed culture, semi-continuous culture and continuous culture. Isolation and screening of industrially important microbes. Important strains for better yield. Design of a fermenter. Types of bioreactor-Continuous stirred tank, Bubble column, Airlift, Fluidized bed, Packed bed and Photobioreactor.

Solid substrate fermentation and Media fermentation. Examples of bioprocess for the production of biomass. Microbial metabolic products-primary and secondary metabolites.Water testing: Microbial growth analysis in water. Basic assays.

UNIT V: Production of fermented products and downstream processing

Production of alcohol and alcoholic beverages. Microbial production of Organic acids: Source, recovery and uses of Citric acid, Lactic acid, and Acetic acid. Production of antibiotics: Penicillin and Tetracyclin. Bioinsecticides: Production of Bacterial and fungal polysaccharides, commercial production of Xanthan gum and pullulan. Production of edible mushroom and Single cell protein from azola.

Biofertilizers *Phosphobcterium* and *Rhizobium sp*., Biopesticides, leaching of ores by microbes, microbial treatment of wastewater – aerobic and anaerobic methods.

SUGGESTED READINGS

1. Jain, J.L, (2016). Fundamentals of Biochemistry, S. Chand & Co Ltd, New Delhi.
2. SathyaNarayana U, (2013). Biotechnology, Books and Allied Publishers, Kolkata.
3. Trevor and Palmer, (2007). Enzymes, East West Press Pvt Ltd, New Delhi.
4. Glazer, A.N., Nikaido, H. (2007). Fundamentals of Applied Microbiology. W H. Freeman Company, New York.
5. Ritika Joshi, Vinay Sharma Arindam Kuila (2018). Fermentation Technology: Current Status and Future Prospects .https://onlinelibrary.wiley.com/doi/book/10.1002/9781119460381

Semester I

22BCP103 BIOINSTRUMENTATION AND GOOD LABORATORY PRACTICES **4H-4C**

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- To learn centrifugation techniques and their applications in biological system.
- To understand the principle of colorimetry and advanced spectrophotometric techniques
- To learn the basics, advanced techniques and applications of chromatography
- To learn the importance of calibration of analytical instruments.
- To learn the principle and applications of electrophoresis and radioisotopic techniques in biological sample analysis
- In good laboratory practices procedures.

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Apply the centrifugation techniques in biological system
2. Use colorimetry and spectrophotometry for sample analysis
3. Use chromatographic techniques for sample analysis
4. Understand the basics to calibrate analytical instruments
5. Detect radioisotopes and analyze samples using electrophoretic techniques
6. Understand the necessary to follow good laboratory practice procedures (GLP)

UNIT I: Centrifugation

Principles, Types of centrifuges and applications of analytical and preparative centrifuges, density gradient and ultra centrifugation. Relative molecular mass determination and sedimentation coefficient. Sub cellular fractionation of cellular components using osmotic gradients, Applications. Separation of cells on the basis of density.

Colorimetry: Beer's law and Lambert's law. Principle of photoelectric colorimeter. **Spectroscopy:** Properties of electromagnetic radiations, Instrumentation and applications of UV Visible and mass spectroscopy, FTIR, NIR, reverse spectroscopy. Spectrofluorimetery, atomic spectroscopy, NMR spectroscopy, Mass spectroscopy (GC – MSMS), LC-MSMS, MALDI-TOF, ICPMS and its applications. Advantatages and disadvantages and advancements of spectroscopic methods. Electron spin resonance, Surface plasma resonance

UNIT II: Chromatography

Principles, Types – paper chromatography, thin layer chromatography and HPTLC, Separation of phytoconstituents using TLC. Column chromatography - Ion exchange chromatography, affinity chromatography, gel filtration chromatography, Principle and application of gas chromatography, Sephadex columns. Low pressure liquid chromatography (LPLC) and High Performance Liquid Chromatography (HPLC)- Normal and Reverse Phase Gas -liquid chromatography; Application and calibrations of analytical instruments (HPLC, GC and ICPMS) GC – MS library.

UNIT III: Electrophoresis

Principle, instrumentation and applications of agarose gel electrophoresis, sodium dodecyl sulphate – polyacrylamide gel electrophoresis (SDS-PAGE), native PAGE, isoelectric focusing, immunoelectrophoresis, lateral flow assay, 2D gel electrophoresis - Image analysis, Digital imaging, Spot detection and quantification, Gel matching. Data Analysis – Database for 2D gel. Pulse field gel electrophoresis, capillary electrophoresis, gel documentation – Applications.Blotting- dot and western blotting techniques. X-ray film based detection and chemidocumentation.

UNIT IV: Radioisotopic techniques

Introduction, nature of radio activity, types and rate of radioactive decay, units of radio activity, detection and measurement of radioactivity-Geiger-Muller counter, solid and liquid scintillation counter. Autoradiography, X-ray diffraction and circular dichorism. Non-radioactive, fluorescent methods. Applications of radioisotopes in biological sample analysis. Alternative to EtBr for DNA staining and visvalization.

Flowcytometry: Principles, Instrumentation and applications**.**

Microscopic Imaging techniques: Atomic Force Microscopy, Confocal microscopy, SEM and TEM.

Invited talk from international experts on advancement in techniques

UNIT V: GCLP guidelines and principles

Laboratory safety procedure - Safety precautions, General Safety-biological safety and fire safety, personal protective equipment-glass ware, equipment safety, hand washing procedure. Precaution to be undertaken to prevent accident and contamination. Good manufacturing practice. Quality concepts-Records and Documents, retention samples, Scope and organization and personnel, test systems, test and reference items, standard operating procedures, performance of the study, reporting of study result, storage and retention of records and materials data generation and storage. Quality management system audits, guidelines and regulations. NABL and NABH accreditation-Benefits and scope, Good Manufacturing Practices. GLP Guidelines: ICMR, WHO, OECD, CDSCO, European Union. Institutional biosafety guidelines.

SUGGESTED READING

1. Wilson, K., and Walker, J. (2016). Principles and Techniques of Biochemistry and Molecular Biology
2. Richard, A.G., Richard, G., (2009). New Drug Approval Process Drugs and the Pharmaceutical Sciences), 5theditionCRC Press, U.S.A.
3. Upadhyay Nath (2009). Biophysical Chemistry Principles and techniques. Revised edition
4. Weinberg, S. (2007). Good Laboratory Practice Regulations, ^{4th} edition, CRC Press, U.S.A.
5. Bio instrumentation techniques – Swayam Nptel - https://nptel.ac.in/courses/102103083
6. Biomedical instrumentation http://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/

22BCP104 **CELLULAR BIOCHEMISTRY** **4H-4C**

Instruction hours/week: L: 3 T: 1 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students

- To recall the knowledge in organization and dynamics of mitochondria.
- To understand the molecules within the cell and interaction between cells that allows construction of multicellular organisms.
- To understand cytoskeleton network and extracellular matrix.
- To learn cell signaling mechanisms and pathways
- To understand cell cycle, cell division and cell death process.
- To recognize cancer and mutational changes at gene level.

Course Outcomes (CO's)

Upon successful completion of this course students will be able to:

1. Recognize the organization and dynamics of mitochondria.
2. Recognize cell cell interaction and their mechanism.
3. Comprehend the organization of cytoskeleton structure and functions of micro, macro and intermediary filaments.
4. Recognize the cell signaling mechanisms and pathways.
5. Enumerate the phases of cell cycle, events in cell division and mechanism of cell death
6. Relate properties of cancerous cells to mutational changes in gene function.

UNIT I: Membrane

Cellular organization:

Membrane models, chemical composition of membrane, movement of small and large molecules across the cell membrane, osmosis, diffusion, endocytosis, phagocytosis, Membrane lipids- fluidity, asymmetry, phase transition, Liposomes: Artificial liposomes and its application.

Sub-cellular organelles: Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, plastids, peroxisomes. Organization of prokaryotic, eukaryotic and bacterial cells. Bacterial cell wall, capsule and flagella

UNIT II: Membrane transport

Membrane proteins – Types, Orientation, Mobility – Experiments, flippases, proteins of RBC membrane, RBC ghosts, Bacteriorhodopsin, Porins – aquaporin.

solubilisation of proteins, lipid anchored proteins, carbohydrates – cell surface carbohydrates – Lectins and selectins.

Passive diffusion, facilitated diffusion in erythrocytes, Carriers and ion channels, Ion concentration gradients.

Transport process driven by ATP- Ion pumps: Calcium ATP ase; Na^+ K^+ ATPase; Mechanism, Gastric H^+ K^+ ATPase, ABC superfamily – ATPases that transport peptides and drugs (MDR proteins). ABC transport protein for drug transport, functioning and regulation.

Co-transport by Symporters and antiporters, Group translocation. Osmosis,receptor mediated endocytosis and its significance. **Extracellular matrix and cell adhesion molecules:** Function and composition of extracellular matrix molecules, types of cell adhesion molecules, integrin, cadherin and immunoglobin superfamily proteins.

Protein targeting: Signal sequence**.** Protein synthesis on free and bound ribosomes, modification and quality control of protein in ER, secretion and transport of protein to various cell compartments, post translational modification.

UNIT III: Mitochondria

Mitochondria – Reduction potential,Free energy and entropy**,** electron transport chain – Complexes, Q-cycle, Cyt C oxidase complex, Translocation of protons and the establishment of a proton motive force, machinery for ATP formation and chemi-osmotic mechanism, ATP synthase – Experiments, inhibitors and uncouplers of oxidative phosphorylation.

Microfilaments – Actin – Stuctures, Assembly, Myosin. Microtubules – Organisation and dynamics, kinesin and dynein. Cilia and flagella – Structure and functions, intermediary filaments.

Mitochondrial transport system: ATP/ADP exchange, malate-glycero phosphate shuttle.

UNIT IV: Cell – Matrix interaction

Cell – Cell interaction: Extra cellular matrix; collagen, hyaluronan and proteoglycans, laminin, integrins, Fibrillin, elastin and fibronectins.

Cell – Cell adhesion: Specialised junctions – Desmosomes, Gap junctions, Tight junctions. Adhesion molecules – Cadherins (E and N), Connexins.

UNIT V: Cell cycle and cancer

Cell cycle and its control, Cell cycle control in mammalian cells, checkpoints in cell cycle regulation. Cyclin D, E, Cdk4, Cdk6

Cancer: Properties of tumour cells and genetic basis and onset of cancer.

Tumour viruses – DNA&RNA Viruses as transforming agents – mechanism. Example: HTLV, HPV, HHV

Tumour suppressor genes and functions of their products. Carcinogenic and anticarcinogenic effect of chemicals and radiation. Mechanisms of cell death- Different modalities of cell death – necrosis autophagy, cornification and necroptosis. Apoptosis (Programmed cell death) – pathways, regulators and effectors on apoptosis and necrosis. Ferroptosis. Cancer therapies-CART

SUGGESTED READING

1. Alberts, B.,, Johnson, A., Lewis, J., and Raff, M. (2007). Molecular Biology of the Cell, 5th edition. Garland Publishing Co.New York.

2. Cooper, G.M., and Hausman, R.E., (2013). Cell-A Molecular Approach, 6thEdition. Sinauer Associates. USA.
3. Garrette& Grisham, (2004). Principles of biochemistry, 4th edition. Saunders college publisher, Philadelphia,United States.
4. Gerald, K., 2013. Cell and Molecular Biology, 7th edition. John Wiley and Sons, Inc, Hoboken, United States.
5. Lodish, H., Berk, A., Kaiser, C.A.,and Krieger, M.,(2012). Molecular Cell Biology, 7th edition. W.H. Freeman & Company, London.
6. Nelson, D.L., and Cox, M.M., (2012). Lehninger's Principles of Biochemistry, 6th edition. W.H.Freeman and company, New York.
7. Paul, A., (2015). Text Book of Cell and Molecular Biology,1st edition. Books and Allied (P) Ltd, Kolkata.
8. Swyam – NPTEL. Cell Biology: Cellular organization, division and processes https://onlinecourses.nptel.ac.in/noc21_cy15/preview

Semester I

22BCP105A ADVANCED PLANT BIOCHEMISTRY 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students

- To recollect the knowledge in plant cell organelles and their functions
- To understand the functions and regulations of major biosynthetic pathways of plants
- To learn and understand the role of plant growth substances in various stages of plant growth
- Obtaining knowledge on tissue culture techniques
- To learn metabolic engineering to increase the production of plant secondary metabolites
- To become familiar with the transformation process and its applications

Course Outcomes (CO's)

Upon successful completion of this course, students will be able to:

1. Understand the plant cell organelles and their functions
2. Recognize the source of food for other organisms and their synthesis in plants
3. Recall the role of plant growth substances in various stages of plant growth
4. Follow the fundamentals of with tissue culture techniques
5. Understand the role of secondary metabolites production and their importance
6. Equip with gene transfer techniques

UNIT I: Plant photosynthesis

Overview of photosynthesis: photosynthetic pigments, photosynthetic apparatus, reaction center, photosystems I and II, mechanism of photosynthesis-cyclic and noncyclic photophosphorylation; evidences in support of light and dark reactions.

Solute transport and photo assimilate translocation – Uptake, transport and translocation of water, ions, solutes and macromolecules from soil.

UNIT II: Assimilatory mechanisms in plants

Photorespiration and water consumption, CO_2 assimilation by C3 and C4 plants, function and regulation of RUBISCO, CAM pathway. Nitrogen assimilation; reduction of nitrate, nitrogen fixation in symbiotic and non-symbiotic plants, nitrogen cycle, NIF genes and its regulation. Sulphate metabolism in leaf; sulfite reduction and sulphur cycle, glutathione synthesis. Carbon and phosphorus cycles.

UNIT III: Lipid metabolism in plants

Biosynthesis of fatty acids in plastids, synthesis of waxes, triacylglycerols and glycolipids. Synthesis of chlorophyll. Carotenoid formation. Synthesis of nitrogenous compounds: caffiene synthesis, ureide synthesis in nodulated legumes. Secondary oxidative mechanisms: β- oxidation, ω- oxidation, glyoxylate pathway.

UNIT IV: Plant growth substances and plant defense response

Chemistry, biosynthesis, mode of action and physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene.Factors influencing endogenous growth- Biotic and Abiotic factors.Phytochromes: molecule, biological display, functions as light sensor. Crytochromes and phototropins, stomatal movement, photoperiodism and biological clock. Senescence: biochemical changes, regulation.

Plant defense response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance.

UNIT V: Plant secondary metabolites

Synthesis of secondary metabolites- shikimate pathway. Alkaloids, flavonoids, terpenoids, phenols and glycosteroids-Occurrence, distribution & functions, Production of secondary metabolites in plants, stages of secondary metabolite production. Biochemistry of plant toxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins, role of secondary metabolites in chemical defence. Importance of secondary metabolites: Uses of secondary metabolites to man: as drugs, precursors of drugs in pharmaceutical industry, as natural pesticides/insecticides; other uses of secondary metabolites.

Plant Tissue Culture- Totipotency, meristematic and nodal cultures-Callus induction. Somatic embryogenesis, Cell suspension culture. Metabolic engineering for increased production of secondary metabolites.

SUGGESTED READING

1. Caroline Bowsher, Alyson Tobin (2021). Plant Biochemistry 2nd edition
2. Buchannan, B., (2015). Biochemistry and Molecular Biology of Plants, IK. International, New York.
3. Goodwin,T.W., and Mercer, E.I., Introduction to Plant Biochemistry, 1st edition, Robert Maxwell. M.C Publisher, New York.
4. Heldt, H.W.,Piechulla,B., Heldt, F.,(2011). Plant Biochemistry, Fourth Edition, Academic Press Publication, London, UK.
5. Verma,S.K., and Verma, M., (2010). A Text Book of Plant Physiology, Biochemistry and Biotechnology. 7thedition. S.Chand and Co, New Delhi.
6. Wink,M.,(2010). Functions and Biotechnology of Plant Secondary Metabolites, Second edition, Blackwell Publishing Ltd, London.
7. Bahadur B., Rajam M V., Sahijram L (2015). Plant Biology and Biotechnology: Volume II: Plant Genomics and Biotechnology

Semester I

22BCP105B ECOLOGY AND EVOLUTIONARY BIOLOGY 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students

- To gain an appreciation for the diversity of life
- To understand how organisms interact with each other and their environment
- To gain a basic understanding of how populations function,
- To learn how communities are structured
- To understand behavioral ecology
- To be aware of the central role that evolution plays in biology

Course Outcomes (CO's)

After completion of this course the students will be able to

1. Appreciate the biodiversity
2. Interact with each other and their environment
3. Understand of species interaction
4. Built a structured community
5. Acquire Expertise in behavioral ecology
6. Recognize the central role of ecosystem and evolution in biology

UNIT I: Ecology

Population ecology; metapopulation dynamics; growth rates; density independent growth; density dependent growth; niche concept; Species interactions: Plant-animal interactions; mutualism, commensalism, competition and predation; trophic interactions; functional ecology; ecophysiology; behavioural ecology.

UNIT II: Community Ecology

Community assembly, organization and evolution; biodiversity: species richness, evenness and diversity indices; endemism; species-area relationships; Ecosystem structure, function and services; nutrient cycles; biomes; habitat ecology; primary and secondary productivity; invasive species; global and climate change; applied ecology.

UNIT III: Basics of Evolution

Origin, evolution and diversification of life; natural selection; levels of selection. Types of selection (stabilizing, directional etc.); sexual selection; genetic drift; gene flow; adaptation; convergence; species concepts; Life history strategies; adaptive radiation; biogeography and evolutionary ecology.

UNIT IV: Origin of genetic variation

Mendelian genetics; polygenic traits, linkage and recombination; epistasis, gene-environment interaction; heritability; population genetics; Molecular evolution; molecular clocks; systems of classification: cladistics and phenetics; molecular systematics; gene expression and evolution.

UNIT V: Behavioral Ecology

Classical ethology; neuroethology; evolutionary ethology; chemical, acoustic and visual signaling; Mating systems; sexual dimorphism; mate choice; parenting behavior Competition; aggression; foraging behavior; predator–prey interactions; Sociobiology: kin selection, altruism, costs and benefits of group-living.

SUGGESTED READING

1. Bergstrom, Carl, T. and Lee Alan Dugatkin., (2016). Evolution. W.W. Norton & Company. ISBN 978-0-393-93793-0.
2. Hall, B.J, (2011) Evolution, Jones and Bartlett Publishers, 1st Edition, USA.
3. McMillan, Victoria E. (2012). Writing Papers in the Biological Sciences, 5th Edition. Bedford/St. Martin's Press, Boston. ISBN- 0-312-64971-1.
4. Lappenga E., (2014). Ecology and Evolutionary Biology Ecology and Evolutionary Biology
5. Christopher Barry Cox & Peter D. Moore & Richard J. Ladle (2017). Biogeography: an ecological and evolutionary approach

Semester I

22BCP105C SIGNAL TRANSDUCTION AND REGULATION 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

The students should be able to:

- To make the regulation of transcription and translation
- Understand the basic mechanism of signal transduction
- Understand the cell cycle regulation
- Understand cell cycle check point
- Signal transduction mechanism in various disease conditions.
- Understand Nuclear Receptor Signaling

Course Outcomes (CO's)

After completion of this course, students will be able to

1. Understand the underlying mechanism behind the signal transduction
2. Apply their knowledge in studying the gene regulation in the maintenance of health
3. Students will understand the receptors and signaling pathways
4. Application of their knowledge in studying the gene regulation during disease
5. Extend their research through drug development.
6. Find potential job opportunity in Pharma and Research institutions

Unit – I: Different modes of Signal Transduction

Signal transduction: definition, signals, autocrine, joxtracrine, paracrine, endocrine, and autocrine signaling. Sensory Transduction : Nerve impulse propagation – Nerve cells, synapses, reflex arc structure, Resting membrane potential, action potential, voltage gated ion-channels, impulse transmission, neurotransmitters, neurotransmitter receptors. Rod and cone cells in the retina, biochemical changes in the visual cycle, photochemical reaction and regulation of rhodopsin. Odor receptors. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction. Cholinergic and adrenergic transmission.

Unit – II: Membrane Receptor Signaling

Receptors and signaling pathways: cell signaling, cell surface receptors. G Protein coupled receptors- structure, mechanism of signal transmission, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Signal transmission via transmembrane receptors with tyrosine specific protein kinase activity. Role of phosphotyrosine in SH2 domain binding. Signal transmission via Ras proteins Intracellular signal transduction: The protein cascade of the MAP kinase pathway.

Membrane receptors with associated tyrosine kinase activity, Other receptor classes: TGFβ – TGRBR1, TGRBR II receptors, smad proteins, receptor regulation by intra membrane

proteolysis; signal transduction via the two component pathway. Cytokine receptors-structure and activation of cytokine receptors, Jak-Stat pathway.

Unit – III: Nuclear Receptor Signaling

Signaling by nuclear receptors : ligands, structure and functions of nuclear receptors, nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Androgen, estrogen, venoestrogen and thyroid signaling.

Unit – IV: Cell Cycle Regulation by different Signaling

Regulation of the cell cycle: Overview of the cell cycle, cell cycle control mechanisms, Cyclin-dependent protein kinases (CDKs), regulation of cell cycle by proteolysis, G1/S Phase transition, G2/M Phase transition, cell cycle control of DNA replication, DNA damage check points. Cancer, types of cancer, factors causing cancer- physical, chemical and biological agents. Malfunctioning of signalling pathways and tumerogenesis. Oncogenes, proto-oncogenes and tumor suppressor genes.Tumor suppressor protein p53 and its role in tumor suppression.Tumor suppressor Wnt/β-Catenin signaling.

Signal transduction in health and disease: Cancer, Neurodegeneration, and Obesity and Inflammation

Unit – V: Signaling and Transcription Control

Regulation in eukaryotes- gene families, regulatory strategies in eukaryotes, gene alteration, regulation of synthesis of primary transcripts, hormonal control, transcription factors - Activators and suppressors. transcription factors: targets of signaling pathways, Regulation at the level of translation in prokaryotes and eukaryotes. HAT, HDAC

SUGGESTED READING

1. Molecular biology- David Freifelder, Narosa Publishing House Pvt. Limited, 2005
2. Molecular Biology of the Cell, 4th edition, Bruce Alberts. New York: Garland Science; 2002. ISBN-10: 0-8153-3218-1ISBN-10: 0-8153-4072-9.
3. Molecular Cell Biology, 4th edition, Harvey Lodish.New York: W. H. Freeman; 2004. ISBN-10: 0-7167-3136-3
4. Signal Transduction 3rd Edition, Ijsbrand M. Kramer, Academic Press, 2015 ISBN: 978-0-12-394803-8
5. Swayam Course Principles of Signals and Systems https://onlinecourses.nptel.ac.in/noc20_ee15/preview

Semester I

22BCP111 **PRACTICAL –I** **4H-2C**

QUANTITATIVE ESTIMATION AND SEPARATION TECHNIQUES

Instruction hours/week: L: 0 T: 0 P: 4 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

- To provide hands on experience on preparation of buffers and determination of pH of solutions
- To estimate the macromolecules quantitatively thro colorimetric procedures
- To perform fluorometric experiments and titrimetry
- To separate the macromolecules using TLC and column chromatography
- To perform the secondary metabolite quantification using HPLC
- Gain hands on training in protein extraction and purification techniques

Course Outcomes (CO's)

After completion of this course the students will be able to:

1. Prepare buffers and reagents based on the needs of experiments
2. Estimate macromolecules quantitatively thro colorimetric procedures
3. Estimate vitamins and calcium using fluorimetry and titrimetry
4. Quantify secondary metabolites using HPLC
5. Separate the macromolecules using TLC and column chromatography
6. Extract and purify protein from various sources

Experiments

Colorimetry

1. Isolation and estimation of starch from potato (Anthrone method)
2. Isolation and estimation of glycogen from liver (Anthrone method)
3. Estimation of Total carotenoids (Spectroscopic method)
4. Estimation of fructose in fruits (Resorcinol method)
5. Estimation of ascorbic acid (DNPH method)
6. Estimation of Vitamin E (Dipyrridyl method)
7. Estimation of methionine (Sodium nitroprusside method)
8. Determination of saponification and iodine number of fat or oil

Fluorimetry

9. Estimation of thiamine from cereals or fruits
10. Estimation of riboflavin

Titrimetry

11. Estimation of lactose in milk
12. Estimation of calcium in milk

Separation techniques

13. Separation of plant pigments by TLC.
14. Separation of plant pigments by column chromatography.
15. Determination of HbA1c by HPLC (Demo).
16. Determination of heavy metal contents in water sample by AAS (Demo).
17. Separation of ions by flame photometer (Demo).
18. Separation of fatty acids by Gas Chromatography.

Cell biology:

19. Preparation of standard buffer and determination of pH of buffers.
20. Subcellular fractionation by differential centrifugation and purity assessment with marker enzymes (Group Experiment).
21. Salting out of proteins using ammonium sulphate precipitation

EQUIPMENTS REQUIRED

1. Spectrophotometer
2. Fluorimeter
3. Column chromatography
4. Microscope
5. Flame photometer
6. Gas chromatography
7. HPLC
8. AAS

SUGGESTED READING

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
2. Lodish, H., Berk, A., Kaiser, C.A., and Krieger, M., (2012). Molecular Cell Biology, 7th edition. W.H. Freeman & Company, London. IBSN: 10: 1- 4641-0981-8
3. Sadasivam, S.,andManickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.
4. Singh, S.P., (2009). Practical Manual of Biochemistry, CBS Publishers, New Delhi.

Karp, G., (2010) Cell and Molecular biology: Concepts and Experiments. 6 th Edition. John Wiley & sons. Inc.

M.Sc., Biochemistry

Semester I

22BCP112 **PRACTICAL –II** **4H-2C**

PLANT BIOCHEMISTRY AND MICROBIOLOGY

Instruction hours/week: L: 0 T: 0 P: 4 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students

- To screen phytochemicals and estimate the amount of secondary metabolites
- To handle microbiological techniques
- To identify microbes in soil and water samples
- To isolate, characterize and purify microbial enzymes
- To perform antibacterial activity of active compounds
- To gain hands on experience in plant tissue culture

Course Outcomes (CO's)

After completion of this course the student will perform

1. Phytochemical screening and secondary metabolite estimation
2. Microbiological techniques
3. Microbial identification in soil and water samples
4. Isolation, characterization and purification of microbial enzymes.
5. Antibacterial activity of active compounds
6. Callus induction and regeneration of plantlets

Experiments

Plant Biochemistry

1. Phytochemical screening of any one selected medicinal plant-Extraction and analysis, lyophilisation
2. Estimation of Tannins
3. Estimation of Flavonoids
4. Estimation of Chlorophyll
5. Estimation of Phenols
6. Spectrophotometric estimation of Indole acetic acid in plant tissues

Microbiology

7. Isolation of pure culture – serial dilution, pour plate, spread plate, streak plate methods.
8. Colony morphology – colony counting. Gram staining, Acid fast staining, capsule staining.
9. Staining techniques- simple, differential, endospore (Schaeffer Fulton method), and fungal staining (Lactophenol Cotton Blue Staining).
10. Antibiotic resistance / sensitivity test (Kirby-Bauer Disk diffusion method)
11. Estimation of bacteria- growth curve of bacteria and generation time.

12. Identification of microorganisms – biochemical tests (IMVIC test) (Group Experiment)
13. Microbiology of potable water
14. Isolation, characterization and purification of ANY one of the following microbial enzymes
    a) Amylase
    b) Protease
15. Assay of Antibacterial of ANY ONE selected medicinal plant by Disc or Well diffusion and broth dilution method.
16. Assay of antifungal activity of ANY ONE selected medicinal plant by Disc or Well diffusion. TLC-Bioautography.

Plant Tissue Culture (Group Experiment)

17. Induction of meristem culture.
18. Callus induction.
19. Regeneration of shoot and root from callus culture.
20. Micropropagation of any one medicinal plant.

EQUIPMENT REQUIRED

1. Spectrophotometer
2. Microscope
3. Laminar air flow
4. Incubator
5. Biosafety cabinet

SUGGESTED READING

1. Jayaraman, J., (2011). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
2. Mohanty S., Verma A (2016). Practical Clinical Biochemistry. Jaypee Brothers Medical Publishers.
3. Sadasivam, S., and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.
4. Talib,V.H., (2015). A Handbook of Medical Laboratory Technology, CBS publishers,2nd edition. NewDelhi.
5. Varley, H., (2003). Practical Clinical Biochemistry, CBS Publishers, New Delhi.
6. Persing D H., Tenover F C., Hayden R T., Ieven G., Miller M B., Nolte F (2016) Third edition. Molecular Microbiology: Diagnostic Principles and Practice

Semester II

22BCP201 INTERMEDIARY METABOLISM 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

- To shed knowledge on generation and transformation of energy in metabolic pathways.
- To know the metabolic pathway of carbohydrate and their regulation with associated disorders.
- To learn fatty acid synthesis and degradation and their regulation
- To study the regulation of amino acid metabolismand its regulations with Metabolic disorders.
- To understand the inter relationship of carbohydrate, lipid, protein and nucleic acid metabolism and understand the importance of TCA cycle.
- To aware about the homeostatis of glucosemetabolites by intrinsic and extrinsic control mechanism.

Course Outcomes (CO's)

1. Gain knowledge on glucose anabolic and catabolic pathways that ultimately control the glucose homeostatis.
2. know the metabolic pathway of amino acid and their regulation with associated disorders.
3. learn fatty acid synthesis and degradation and their regulation
4. Able to explain the role of lipids, their metabolism and their stringent control by hormones and other factors.
5. Understand the anabolic and catabolic processes associated with amino acids and nucleic acids and their regulation.
6. Able to understand the energy homeostatis during starvation and energy excess

UNIT I: Introduction to enzyme based regulation of metabolic pathways

Controlling amount of enzymes: Enzyme induction and repression. Controlling activity of enzyme: Allosteric interaction; covalent modification; Reversible and irreversible; feed back inhibition; feed forward stimulation. Role of compartmentation.Elucidation of Metabolic pathways- Single-and Multi-step pathways. Experimental approaches to study the metabolism- using metabolic inhibitors, Radioisotopes and autoradiography.

UNIT II: Carbohydrate Metabolism

An overview of Glycolysis and Gluconeogenesis. Role of PDH and its regulation. Regulation of Glycolysis and Gluconeogenesis-Reciprocal control of Glycolysis and Gluconeogenesis, TCA cycle- steps, regulation at branch points; Glycogen Metabolism: Overview of glycogenesis and glycogenolysis. Reciprocal control of glycogenesis and glycogenolysis. Alternative pathways of metabolism-HMP shunt, Entner- doudoroff pathway, glucoronate and Glyoxalate pathway, cori cycle. Hormonal regulation of fuel metabolism; Metabolic disorders-Diabetes mellitus and insipidus.

UNIT III: Lipid metabolism

An overview of fatty acid synthesis and degradation, Regulation of fatty acid synthesis-control of acetyl CoA carboxylase and fatty acid synthetase complex; Reciprocal control of fatty acid synthesis and degradation. Biosynthesis of triacyl glycerol, phosphatidyl choline, phosphotidyl ethanolamine and sphingomyelin and their regulation.Synthesis and degradation of cholesterol and its regulation.Metabolism of prostaglandins-COX and LOX pathways.Metabolic fate of VLDL, LDL and HDL, Apolipoproteins A2, B. Ketogenesis and its control. Obesity and regulation of body mass. Metabolic disorders- Atherosclerosis, Hyper and hypo lipoproteinemia.

UNIT IV: Amino acid metabolism

Regulation of synthesis of pyruvate, serine, glutamate, aspartate, aromatic and histidine family of aminoacids (Flow chart only). Key role of glutamate dehydrogenase and glutamine synthetase in nitrogen metabolism and their allosteric regulations. General breakdown of amino acid - Oxidative deamination, Non oxidative deamination, decarboxylation and transamination. Fate of amino group- Ammonia formation and disposal- urea cycle and its regulation. Fate of carbon skeleton. Biosynthesis of heme (porphyrin) and its regulations. Molecules derived from aminoacids. Inborn errors of amino acid metabolism.

UNIT V: Nucleic acid metabolism

De novo synthesis of purine and its regulation – Role of PRPP amino transferase. *De novo* synthesis of pyrimidine and its regulation – Role of aspartate carbomyltransferase. Regulation of deoxyribonucleotides by activators and inhibitors. Intergration of metabolism. Analysis of metabolism during several phase of starvation. Tissue specific metabolism-Metabolic profile of major organs- Brain, Muscle, Liver and Adipose tissue. Metabolic disorders- Gout –HGPRT regulation. SCID – Adenosine deaminase. Metabolomics - Introduction to metabolomics - biological aspects and applications.

SUGGESTED READING

1. Nelson, D., and Cox, M. W.H. (2021). Lehninger Principles of Biochemistry (8th Ed.) New York, Freeman and Company.
2. Stryer, L., Berg, J., Tymoczko, J., and Gatto, G. (2019). Biochemistry (9th Ed.), United Kingdom, Palgrave Macmillan.
3. Rodwell, V. W., Benter, D., Botham, K. M., and Kennelly, P. J., (2018). Harper's Illustrated Biochemistry (31st Ed.), United States, McGraw-Hill Education / Medical.
4. Abali, E. E., Cline, S. D., Franklin, D. S., and Vuselli, S. M. (2021). Lippincott Illustrated reviews: Biochemistry (8th Ed.), United States, Lippincott Williams and Wilkins.
5. https://nios.ac.in/media/documents/dmlt/Biochemistry/Lesson-03.pdf
6. https://www4.unifr.ch/biochem/assets/files/schneiter/cours/Voet_Pratt/Voet_chap_20_new.pdf

22BCP202 **MOLECULAR BIOLOGY** **4H-4C**

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

The course aims to provide students with a basic understanding of

- To acquire the knowledge on Organization of DNA in a genome and transposons
- To know the mechanism behind replication and repair.
- To enable the knowledge on transcription and translation.
- To understand the mechanism of Regulation of gene expression in prokaryotes
- To study the structure and remodeling of chromatin
- To learn the mechanism of Eukaryotic gene regulation

Course Outcomes (CO's)

At the end of the course, student will be able to

1. Acquire the knowledge on molecular structure of genes.
2. Understand the structure of nucleic acids and the DNA replication process
3. Learn about the process of transcription
4. Understand the mechanism of translation
5. Learn about gene regulation in prokaryotes
6. Learn about gene regulation in eukaryotes

UNIT I: Molecular structure of genes

DNA as genetic material, experimental proofs. Molecular definition of gene, chromosomal organization of genes and non-coding DNA, protein coding genes, tandomly repeated genes, single sequence DNA. Comparison between Prokaryotes and Eukaryotes. Structural organization of eukaryotic chromosomes- histone proteins –H1, H2A, H2B, H4. chromatin, functional elements. DNA Supercoiling.Topoisomerase. Inhibitors of topoisomerase Mobile DNA elements- bacterial IS elements, transposons, viral transposons and non- viral transposons- Mechanisms. Mutation- types. DNA as genetic material, experimental proofs.

UNIT II: DNA replication and repair

General features of chromosomal replication. Enzymology of DNA replication, DNA replication machinery.Replication in prokaryotes and eukaryotes- Initiation, elongation and termination.Relationship between replication and cell division.DNA damage-types. Repair mechanism of DNA damage- Replication errors and mismatch repair system, repair of DNA damage – homology and non homologous repair. direct repair, base excision repair, nucleotide excision repair and recombination repair. Translation, DNA synthesis.

UNIT III: Transcription

Prokaryotic gene transcription- Initiation, elongation and termination. Eukaryotic gene transcription- transcription unit, RNA polymerases- types, Transcription and processing of mRNA, tRNA and rRNA. Regulatory sequences in protein coding genes-TATA box, initiators, CpG Island, promoter-proximal element, activators and repressors of transcription, Multiple transcription control elements. Regulation of transcription factor

activity by lipophilic hormones. Inhibitors for transcription process as drugs for microbial disease.

UNIT IV: Transcription Regulation and Translation

Post Transcriptional modification of RNA. RNA splicing mechanism all types. Alternative splicing. RNA editing.

Translation- Deciphering genetic code, features. Wobble hypothesis. Ribosomes as protein synthetic machinery. Initiation, elongation and termination of prokaryotic and eukaryotic translation. Fidelity of Post translational modifications-all types.

UNIT V: Prokaryotic gene regulation

Operon model, Lac, trp ara and Gal operons. Regulatory proteins-DNA binding domain, protein- protein interaction domain. Recombination- holiday model, Rec BCD enzymes, Rec A protein, Messelson Radding model, site- specific recombination. Antisense RNA technology.

Eukaryotic gene regulation: Transcriptionally active chromatin, chromatin remodeling, DNA binding transactivators and coactivators. Regulation of gene expression by intracellular and intercellular signal, RNAi, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors. Epigenetic modifications.

SUGGESTED READING

1. Iwasa, J. and Marshall, W. (2020). Karp's Cell and Molecular Biology (9th Ed.), New York, Wiley.
2. Nelson, D., and Cox, M. W.H. (2021). Lehninger Principles of Biochemistry (8th Ed.) New York, Freeman and Company.
3. Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T. (2018). Lewin's Genes XII (12th Ed.). United States, Jones & Bartlett Learning.
4. http://www.csun.edu/~cmalone/pdf360/Ch11-1%20replication.pdf.
5. https://www.youtube.com/watch?v=6gUY5NoX1Lk

Semester II

22BCP203 **DEVELOPMENTAL GENETICS** **4H-4C**

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

- To interpret the Mendelian Principle and experiments
- To infer the environmental effects and human intelligence
- To acquire the knowledge on diagnosis of infectious disease and molecular probes used in diagnosis.
- To study gametogenesis and fertilization
- To have knowledge on chemical changes in cell division and cleavage
- To understanding and discuss ramifications of inherence, gene structure and function, gene mutation, and research related to genetics and its applications.

Course Outcomes (CO's)

At the end of the course students will able to

1. Comprehend the chemical basis of heredity
2. Comprehend the genetic methodology
3. Perform the quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
4. Comprehensive detailed understanding of cellular mechanisms of developmental stages.
5. Grasp the basic of inherence, gene structure and function, gene mutation, and research related to genetics and its applications.
6. knowledge on chemical changes in cell division and cleavage

UNIT-I: Mendelian Principle and experiments

Mendelian inheritance-principles; Mendel‟s experiments-monohybrid, dihybrid trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; lethal genes. Environmental influence of gene expression: penetrance and expressivity; temperature, light, phenocopies. Environmental effects and twin studies; human intelligence. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; Extra chromosomal inheritance.

UNIT-II: Prenatal Screening

Amniocentesis; Prenatal diagnosis of genetic diseases, XX and XY karyotyping, DNA/RNA probes. DNA probes in the diagnosis of infectious diseases; Mycobacterial, plasmodial, HIV and HPV infections during development. Molecular probes in diagnosis of genetic diseases: PGT Down syndrome, Cystic fibrosis, Sickle cell anemia, Alkaptonuria, Phenylketonuria, Kleinfelter syndrome and Cancer (breast cancer, Leukaemia, Burkets lymphoma).

UNIT-III: Developmental Stage I, II and III

Gametogenesis – Origin of germ cells – Significance of different stages of gametogenesis Oogenesis –Types of eggs–growth, development and maturation of oocyte, Egg envelopes, Polarity and symmetry, Sperm Structure, Types of sperm, spermatogenesis. Fertilization – Approach of spermatozoon–Reaction of egg, essence of activation–Changes in egg cytoplasm during fertilization. Cell division in cleavage – Chemical changes–Patterns of embryonic cleavage. Gastrulation – Primary organ, Rudimental organs, Organizer– Morphogenetic movements- invagination, extension, ingression movements and locomotion. Organogenesis: Induction and differentiation. Development of Immune system, Genetic basis of differentiation. Invited lecture from embryologist

UNIT-IV: Regeneration & Aging

Genetics of Metamorphosis, Regeneration & Aging – Metamorphosis in Insects, Metamorphosis in Amphibia, Morphallactic Regeneration in Hydra, Epimorphic regeneration of Salamander limbs, Compensatory regeneration in the Mammalian Liver, Causes of Aging, Genetically regulated pathway of Aging. Telomere length modification.

UNIT-V: Medical implications of Developmental Biology

Global patterning, holoprosencephaly, Spondlocostal dysostosis (somitogenesis), imprinting, Hirschsprung disease, Arabidopis, Demethylation, Ubipuitination, Fins, Tasition to limbs, Hox Genes and molecular controls, controlling the segmentation clock, Stem cells, Alzheimer's, Genetic errors of Human development, inborn errors of nuclear RNA processing & translation, identifying the genes for Human developmental anomalies, Teratogenesis – environmental assaults on Human development. Activation of oncogenes and oncogenesis.

SUGGESTED READING

1. Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T. (2018). Lewin's Genes XII (12th Ed.). United States, Jones & Bartlett Learning.
2. Gilbert, S. F. (2019). Developmental Biology (12th Ed.). United States, Sinauer Associates Inc.
3. Gupta, P.K., (2019). Genetics (5th Ed. Revised). India, Rastogi Publications.
4. https://www.youtube.com/watch?v=BKxpNsZvA1k&list=PLyqSpQzTE6M-rfUc9aLLKpklbfOUOktuP&index=24
5. https://www.youtube.com/watch?v=jY0ZUN30-4s&list=PLyqSpQzTE6M-rfUc9aLLKpklbfOUOktuP&index=25

Semester II

22BCP204 **BIOINFORMATICS** **4H-4C**

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To make students understand the essential features of the interdisciplinary field of science for better understanding the biological data.
- To retrieve the sequence analysis of Nucleic acid and protein
- To create students opportunity to interact with algorithms, tools and data in current scenario.
- To make the students look at a biological problem from a computational point of view.
- To find out the methods for analyzing the expression, structure and function of proteins,
- To understand the relationships between species.

Course Outcomes (CO's)

At the end of the course, the students will

1. Acquire the knowledge on biological data, submission and retrieval from databases.
2. Be able to make experiment pair wise and multiple sequence alignment
3. Analyze the secondary and tertiary structures of protein sequences.
4. Understand the data structure (databases) used in bioinformatics and interpret the information (especially: find genes; determine their functions),
5. Understand and be aware of current research and problems relating to this area.
6. Acquire Knowledge on applications of bioinformatics

UNIT I: Concepts of Bioinformatics

Definition, concepts of Bioinformatics: Objectives, Genome sequencing projects, Human Genome Project.

Introduction to Biological databases: Types of databases, sequence databases-nucleic acid sequence databases, GenBank, protein sequence database, Swiss-Prot, PIR, motif database-PROSITE, structural databases, and organism specific databases- GMOD- Searching and retrieval of data-Entrez and SRS. Microbial Genome Database (MBGD), Organism specific Database OMIM/OMIA, Genome Browser: NCBI Map viewer, UCSC Browser. SNP

UNIT II: Sequence Analysis

Introduction to sequence Alignment: Pairwise and multiple sequence alignment, substitution matrices. Dynamic programming algorithms-Needleman and Wunsch and Smith-Waterman, Similarity searching programs, BLAST, FASTA, EXPASY, Multiple sequence alignment – CLUSTALW, CLASTAL – Omega, MEGA 7.0. Introduction and application of phylogenetic trees, basic terminologies, Phylogenetic analysis-PHYLIP theory of phylogeny,

UNIT III: Gene Identification and Protein prediction strategies

Protein three dimensional structure prediction-Comparative modeling, threading, Concepts of Molecular modeling, Model refinement, Ramachandran plot, evaluation of the model, protein folding and visualization of molecules – Visualization tools-RasMol, SPDB viewer. Protein Data Bank, Molecular modeling database (MMDB). Gene structure in prokaryotes and eukaryotes. Gene prediction tool (GeneMark, GenScan), Pattern Recognition, Global gene expression studies-DNA Micro array. Comprehensive analysis and prediction of regulatory regions using biophysical and computational tools. MOSCOT

UNIT IV: Advances in Genomics and Proteomics

Genomics: Genome sequencing strategies, comparative genomics-whole genome alignments, mega Blast, MUM mer, Applications of comparative genomics. Functional Genomics: Sequence comparison, structure analysis and comparison, Machine learning, SVM, Artifical Neural Networks.

Proteomics: Proteome analysis: 2D gel electrophoresis, Analysis of tertiary structure of protein using computational and biophysical tools: Mass Spectroscopy, XRD, MALDI-TOF, Protein-Protein Interactions. Proteomics in drug Discovery. sequencing, Genome database-SWISS-2D PAGE database, Probabilistic models: Markov chain-random walk-Hidden markov models. Advances in the development of oral peptide delivery.

UNIT V: Applications of Bioinformatics

Applications of Bioinformatics-Molecular medicine, biotechnology, forensic analysis, agricultural, Computer Aided Drug Designing-structure and ligand based drug designing, ADME profiles, QSAR. Docking- principles and Methods. Autodocking, GEMDOCK, GOLD, Molegro Virtual Docker. Designing of primers, screening of lead molecules, advantages and limitations of computational screening techniques. Clinical data management and pharmacovigilance – General definition and applications of data science tools in clinical data management: SAS, Phyton, Pig data, HIVE and R studio.

SUGGESTED READING

1. Rigden, D. J. (2017). From Protein Structure to Function with Bioinformatics (2nd Ed.), United States, Springer.
2. Singh, V. and Kumar, A. (2021). Advances in Bioinformatics (1st Ed.), India, Springer Nature.
3. Singh, D. B. and Pathak, R. K (2021). Bioinformatics: Methods and Applications (1st Ed.), India, Elsevier.
4. Tiwary, B. K. (2021). Bioinformatics and Computational Biology: A Primer for Biologists (1st Ed.), India, Springer Nature.
5. https://www.youtube.com/watch?v=UZBnu8GxYqs

22BCP205A RECOMBINANT DNA TECHNOLOGY 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To make the student to understand the concept of gene manipulation and gene transfer technologies.
- To understand the concept of recombinant DNA technology or genetic engineering
- To interpret the characterization of recombinant protein
- To infer the knowledge on cDNA
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineeringtechniques.

Course Outcomes (CO's)

1. An understanding on application of genetic engineering techniques in basic and applied experimental biology
2. The concept of recombinant DNA technology or genetic engineering
3. Study the gene cloning vectors and their expression
4. Explore the knowledge on genomic library
5. Proficiency in designing and conducting experiments involving genetic manipulation.
6. Describe DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications.

UNIT I: Introduction to gene manipulation

Basic techniques- Isolation and purification of nucleic acids, Hybridization of nucleic acids-probes and types. Hybridization techniques-Southern, Northern, Western blotting. DNA and RNA markers.

Enzymology of Genetic manipulation, Genome Editing. Gene editing techniques: TALENS. ZFN and CRISPR/CAS9

UNIT II: Gene cloning vectors

Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes- BAC, YAC, HAC. Restriction mapping of DNA fragments, Map construction, Cloning in *E. coli*- Vector engineering and codon optimization. Gene expression in *E.coli*. Expression vector- PET vector. Genomic library. Cloning methods: Blunt end, cohesive end. Transfection: calcium chloride, lipofectamide

UNIT III: Isolation and characterization of gene transcripts

Introduction, Converting mRNA transcripts into cDNA, Screening representative cDNA libraries, Functional sequencing of cDNA expression libraries. Expressed cDNAs compared

with computer databases.Characterization of recombinant proteins- Processing, purification and refolding and stabilization-Insulin, hGH, tpA. Scale up technologies – Laboratory scale to industrial scale process. RNAseq

UNIT IV: Mutagenesis

Mutagenesis, Knock-in, Knock-out, conditional knock-outs, Chromatin – immune precipitation assay. Site directed mutagenesis. Regulation of gene expression, cDNA arrays, gene silencing by RNAi, dominant negative approach, in vivo and in vitro protein protein interactions, bacterial and yeast one, two and three hybrids, phage display, GST pull down, co-immunoprecipitation, Far Western blot, FRET, Biacore; DNA, RNA – protein interactions, Applications of genetic engineering

Gene therapy- Different strategies for gene therapy, therapeutics based on targeted exhibition of gene expression and mutation correction *in vivo*, Gene therapy for inherited diseases, ADA, FH, Cystic fibrosis.

UNIT V: Transgenics

Gene transfer techniques- Microinjection, biolistic methods, vector based transfer.

Transgenic plants: *Agrobacterium tumifaciens* plasmids. Methods of engineering herbicide resistance plants, Stress resistance plants and modification of plant nutritional content (amino acids, β- carotene). Plants as bioreactors: edible vaccines.
Transgenic animals: Method of Engineering transgenic mice, transgenic cattle-applications. Biosafety- regularities and concerns. Societal impact of genetically modified food.

SUGGESTED READING

1. Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction (8th Ed.), United States, Wiley-Blackwell.
2. Klug, W., Cummings, M., Spencer, C., Palladino, M. and Killian, D (2019). Concepts of Genetics (12th Ed.), New York, Pearson.
3. Gupta, P.K., (2019). Genetics (5th Ed. Revised). India, Rastogi Publications.
4. https://www.youtube.com/watch?v=3oGrVSTJa8I&list=PLwdnzlV3ogoWcRPq0WkGTsi4Wzu8onVfH&index=38
5. https://www.youtube.com/watch?v=AG5gNPZWbGc&list=PLwdnzlV3ogoWcRPq0WkGTsi4Wzu8onVfH&index=39

Semester II

22BCP205B ADVANCED ANIMAL TISSUE CULTURE 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To impart the knowledge on basic tissue culture techniques and limitations in products
- To study about tissue culture laboratory and safety – biohazards
- To extrapolate the different types of culture media
- To understand the various types of cultures
- To learn synchronization of cell cultures and cell division
- To know the importance of stem cell research and its applications

Course Outcomes (CO's)

1. Learn to demonstrate foundational knowledge of cell culture techniques and competence in laboratory techniques.
2. Set up a tissue culture lab to carry out research based on cell lines.
3. Extrapolate the different types of culture media
4. Understand the various types of cultures
5. Learn synchronization of cell cultures and cell division
6. Know the importance of stem cell research and its applications.

UNIT I: Introduction to cell culture

Introduction, importance, history of cell culture development, different tissue culture techniques including primary cell clone and continuous cell lines, suspension culture, organ culture, advantages and limitations medical/pharmaceutical products of animal cell culture-genetic engineering of animal cells and their applications. CART therapy Risks in a tissue culture laboratory and safety - biohazards.

UNIT II: Different types of cell culture media

Different types of cell culture media-Basal and advanced, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application. Facilities for animal cell culture-infrastructure, Clean room, equipment, culture vessels. Biology and characterization of cultured cells- STR Profiling cell adhesion, proliferation, differentiation, morphology of cells and identification.

UNIT III: Types of cell culture techniques

Primary cell culture techniques - mechanical disaggregation, enzymatic disaggregation-collagenase I, II, IV, Trypsin digestion, separation of viable and non-viable cells. Mass culture of cells - manipulation of cell line selection –Transformation of plasmid-types of cell lines -maintenance of cell lines - immobilization of cells and its application - synchronization of cell cultures and cell division - production of secondary metabolites -

biotransformation - Induction of cell line mutants and mutations - cryopreservation – germplasm conservation and establishment of gene banks.

UNIT IV: Animal cell culture scale up

Animal cell culture scale up: Scale up in suspension - Stirrer culture, impellor, continuous flow culture, air-lift fermentor culture; Scale up in monolayer - Roller bottle culture, multi-surface culture, multiarray disks, spirals and tubes - monitoring of cell growth. Organ culture –Mini gut development in vitro-organ on a chip-whole embryo culture - specialized culture techniques - measurement of cell death-AO/EtBr staining

UNIT V: Tissue engineering

Tissue engineering: Design and engineering of tissues - tissue modeling. Embryonic stem cell engineering - ES cell culture to produce differential cells - Human embryonic stem cell research. Transgenic animals-transgenic animals and xenotransplantation.

SUGGESTED READING

1. Kasper, C., Charwat, V., and Lavrentieva, A. (2018). Cell Culture Technology (1st Ed.), Germany, Springer Nature.
2. Capes-Davis, A and Freshney, R. I. (2021). Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th Ed.), United States, Wiley-Blackwell.
3. https://iopscience.iop.org/chapter/978-0-7503-1347-6/bk978-0-7503-1347-6ch1.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/
5. http://www.uop.edu.pk/ocontents/Lec%20no%201(2).pdf
6. https://www.youtube.com/watch?v=g5B_bDN_w2g

Semester II

22BCP205C FORENSIC TOXICOLOGY AND PHARMACOLOGY 4H-4C

Instruction hours/week: L: 4 T: 0 P: 0 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

The main objective of this course is to equip students

- To provide a comprehensive theoretical knowledge on genomics and proteomics including fundamentals
- To make the student understand the concept and Significance Poisons
- To get knowledge about current techniques and applications.
- To get knowledge about extraction techniques
- To update and strengthen basic concepts in proteomics and genomics to address the modern biological issues.
- Isolation and General characterization of alkaloids.

Course Outcomes (CO's)

After completion of this course the student will have

1. The students will to identify and describe the different components in prokaryotic and eukaryotic genomes and proteomes.
2. Adequate skill to identify molecular mechanisms responsible for diseases.
3. To use the different methodologies, techniques and tools commonly used in genome sequencing, assembly and annotation.
4. Idea on different methodologies, techniques and tools commonly used in proteomics.
5. Understanding and strengthen basic concepts in proteomics and genomics to address the modern biological issues.
6. Understanding about current techniques and applications.

UNIT-I Forensic Toxicology:

Introduction, concept and Significance Poisons: Definition, Classification of poisons, Types of poisoning sign and symptoms of poisoning, mode of action, factors modifying the action of poisons, Toxicological exhibits in fatal and survival cases, their preservation. Strategies in slow poisoning. Prepation of toxicity report analysis. Treatment in cases of poisoning, Analysis report.

UNIT-II Extraction, Isolation and Clean-up procedures:

Non-volatile organic poison, Stas-otto, Dovbriey Nickolls (Ammonium sulphate) method, acid digest and Valov (Tungstate) methods, Solid phase micro extraction techniques, Solvent extraction methods Volatile Poisons: Industrial solvent acid and basic Distillation Toxic Cations: Dry Ashing and Wet digestion process Toxic Anions: Dialysis method total alcoholic extract

UNIT-III General Study and Analysis:
Barbiturates, methaqualone, Hydromorphine, Methadone, Meprobamate, Mescaline, Amphetamines, LDS, Heroin, Cannabinoids, Phinothiazines Insecticides: Types, General methods for their analysis Alkaloids: Definition, classification, Isolation and General characterization.

UNIT-IV Forensic Examination of Metallic Poisons:
Arsenic, Mercury, Lead, Bismuth, Copper, Aluminium, Iron, Barium, Zinc Analysis of Ethyl Alcohol in blood and urine, illicit liquor, Methanol, Acetone, Chloroform, Phenol Snake venoms and Poisons, Irrespirable gases. RFLP analysis for crime detection. Ames – test - Mutation analysis.

UNIT-V Forensic Pharmacological studies:
Absorption, Distribution, Metabolism, Pathways of drug metabolism General studies and Analysis of some vegetable poisons, Opium, Abrus, Cynanogenetic glycosides, Dhatura, Marking nuts, Nux-vomica, Oleander and Aconite. Sodium micro glutamate.

SUGGESTED READING

1. Houck, M. M. (2018). Forensic Toxicology (1st Ed.), United States, Academic Press.

2.Lappas, N. and Lappas, C. (2021). Forensic Toxicology: Principles and Concepts (2nd Ed.), United States, Academic Press.

3. Singh, S. P (2021). Forensic Toxicology (1st Ed.), India, Selective and Scientific Books (SSB).

4.https://journalofhospitalpharmacy.in/johp/admin/freePDF/c4pik8lgixdbknaci830.pdf

5.https://japi.org/article/files/understanding_forensic_pharmacology_what_indian_physicians_need_to_know.pdf

22BCP211 **PRACTICAL –III** **4H-2C**

MOLECULAR BIOLOGY AND ANIMAL BIOTECHNOLOGY

Instruction hours/week: L: 0 T: 0 P: 4 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To understand the Molecular structure, functions of cells, molecules such as DNA, RNA, proteins.
- To understand the principles of animal cell culture and its application.
- To learn the knowledge on quantity of DNA by Diphenylamine method
- To infer the Estimation of RNA by Orcinol method
- To know the Preparation of competent *E coli*- transformation
- To explore the knowledge on Ligation of DNA

Course Outcomes (CO's)

By the end of the course, students should be able

1. To demonstrate knowledge and understanding of the molecular machinery of living cells, cell and tissue culture to manipulate.
2. To explore the genomes of animals for ways to improve the livestock for food production and biomedical purpose as well as and to analyse, interpret, and participate in reporting to their peers on the results of their laboratory experiments.
3. To identify of DNA by Agarose gel electrophoresis
4. To estimate of RNA by Orcinol method
5. To prepare of competent *E coli*- transformation
6. To understand and perform ligation of DNA

MOLECULAR BIOLOGY

1. Isolation of DNA and RNA from liver. Manual, Column and magnetic beads based extractions
2. Estimation of DNA and RNA - UV method
3. Estimation of DNA by Diphenylamine method
4. Estimation of RNA by Orcinol method
5. Estimation of Protein by Lowry's method
6.Culturing and Isolation of Plasmid DNA
7. Agarose gel electrophoresis of DNA, Gel documentation
8. Restriction digestion analysis of DNA (Demonstration)
9. Preparation of competent *E coli*- transformation (demonstration)
10. Determination of Molecular weight of polypeptides by SDS PAGE (group)
11. Polymerase Chain Reaction for amplification of DNA – real time-PCR: HIV DNA, HCV RNA (Lab visit and demo)
12. Ligation of DNA
13. Southern Blot Analysis (Demonstration)
14.Western Blotting (Demonstration)

ANIMAL TISSUE CULTURE (Demonstration)

15. Preparation and Sterilization of media
16. Cell lines and maintenance-Trypsinisation, Passaging, Staging
17. Cell counting and cell staining
18. Cell viability determination – Trypan blue exclusion, fluorescence microscopy

EQUIPMENT USED:

1. Cooling centrifuge
2. Spectrophotometer
3. Electrophoresis unit
4. Gel Documentation unit/Chemidoc

SUGGESTED READING

1. Kasper, C., Charwat, V., and Lavrentieva, A. (2018). Cell Culture Technology (1st Ed.), Germany, Springer Nature.
2. Capes-Davis, A and Freshney, R. I. (2021). Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th Ed.), United States, Wiley-Blackwell.
3. Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T. (2018). Lewin's Genes XII (12th Ed.). United States, Jones & Bartlett Learning.
4. Iwasa, J. and Marshall, W. (2020). Karp's Cell and Molecular Biology (9th Ed.), New York, Wiley.
5. Nelson, D., and Cox, M. W.H. (2021). Lehninger Principles of Biochemistry (8th Ed.) New York, Freeman and Company.

Semester II

22BCP212 **PRACTICAL –IV** **4H-2C**

BIOLOGICAL DATABASES AND ANALYSIS

Instruction hours/week: L: 0 T: 0 P: 4 **Marks**: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To provide hands on experience on various biological databases
- To learn the retrieval of data from the biological databases
- To make them learn about pair wise and multiple sequence analysis.
- To learn and apply the statistical approaches
- To study the models for phylogenetic analysis and tree reconstruction.
- To learn them protein prediction methods and its validation.

Course Outcomes (CO's)

The students shall be able to understand

1. The use of various biological databases
2. The importance functions in the biological system.
3. The use computational approaches for pair wise, multiple and phylogenetic analysis.
4. Aware to predict the physio-chemical properties, protein structure and validation using computer based labs.
5. Solve the biological problems using various computational tools and techniques.
6. Visualization of Protein structure by RASMOL.

Experiments

1. Biological Databanks Sequence databases, Structure Databases, Specialized databases
2. Data base file formats.
3. Data retrieval tools and methods (PUBMED, ENTREZ, SRS)
4. Sequence Similarity searching (NCBI- BLAST, FASTA)
5. Protein sequence analysis (ExPASY proteomics tools)
6. Multiple sequence alignment (Clustal-W)
7. Gene structure and function prediction (Using ORF Finder, Genscan, GeneMark)
8. Molecular Phylogeny (PHYLIP)
9. Sequence Analysis using EMBOSS
10. Protein structure visualization – RASMOL (Menu function and Command line entries), Deep View.
11. Homology modeling using Swiss Model
12. Active site & Pocket prediction
13. Molecular Docking using PATCH DOCK
14. Retrive Drug molecule using PubChem

15. SAS programming in CDM.
16. Data visualization tools in CDM (Phyton)

INSTRUMENTS REQUIRED

1. SEESAR Software

2. Online free software

3. Bioedit, Molecular Evolutionary Genetics Analysis (MEGA) software

SUGGESTED READING

1.Singh, V. and Kumar, A. (2021). Advances in Bioinformatics (1st Ed.), India, Springer Nature.

2. Singh, D. B. and Pathak, R. K (2021). Bioinformatics: Methods and Applications (1st Ed.), India, Elsevier.

3. Tiwary, B. K. (2021). Bioinformatics and Computational Biology: A Primer for Biologists (1st Ed.), India, Springer Nature.

4. https://www.youtube.com/watch?v=UZBnu8GxYqs

5.https://www.youtube.com/watch?v=rDhElW5ox6w

6.https://www.youtube.com/watch?v=q4yHvpfsRpM

Semester III

22BCP301 IMMUNOBIOLOGY 4H-4C

Instruction hours/week:L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

Equip the students with

- Specialized immune cells and their function
- Mechanisms of humoral immunity
- Mechanisms of cell mediated immunity
- Hyperactivation of immune cell and associated pathogenesis
- Basis behind immunodeficiency diseases
- Utility of immune based principles in diagnostic field

Course Outcomes (CO's)

After successful completion, the students will understand:

1. The structure and functions of specialized immune cells
2. Basis of humoral immunity
3. Basis of cell mediated immunity
4. Hypersensitivity reactions (I-V)
5. Hereditary and acquired immunodeficiency diseases
6. Utility of immune based principles in diagnostic field

UNIT I: Cells and Organs of the Immune System

Overview of immune stem cells - Lymphoid cells, mononuclear, granulocytes, mast cells and dendritic cells. Lymphoid classes B, T and NK – B & T Cell maturation, activation and differentiation; Lymphocyte surface markers, CD nomenclature. Primary and secondary lymphoid organs, Cross talk and inter dependency between humoral and cell mediated immunity. Innate immune responses: Anatomical, biological barrier immunity. Cell-mediated and humoral response, soluble molecules and membrane associated receptors (PRR), pattern recognition-connections between innate and adaptive immunity cell adhesion molecules, complements (classical and alternate pathways), MALT- chemokines, leukocyte extravasation, localized and systemic response.

UNIT II: Antigen - Antibody, Processing and Presentation

Epitope, B cell and T cell epitope, haptens, viral and bacterial antigens; factors influencing adjuvant technology. Immunoglobulins-domains, B cell receptors, antigenic determinants on immunoglobulins, Immunoglobulin super family. Immunoglobulin genes: multigene family; Immunoglobulin rearrangement- antibody diversity - Burnet's clonal selection theory. Cell-mediated immunity – MHC: organization, MHC molecules and genes, MHC class-I/II and non-MHC antigen presentations.

UNIT III: Adverse Immunology

Coombs & Gell classification, Definition causes and types of hypersensitivity. allergen mediated (Type I), antibody mediated cytotoxic (Type II), immune- complex mediated (type III) and cell-mediated (Type IV) hypersensitivity, Principles of autoimmunity and autoimmune diseases, Signature of T cell education. Significance of T cell education. MHC

and immune responsiveness, transplantation and rejection, tumor immunology, primary and secondary immunodeficiency disorders.

UNIT IV: Immunity to infection

Definition and types of immunity, Vaccines: active and passive immunization, types of vaccines with examples: Plasmid vaccines, recombinant vaccines and vector vaccines. Immune responses against bacterial, viral, fungal and parasitic agents. Evasion of infectious agents from immune system, Monoclonal antibodies - Production of monoclonal and polyclonal antibodies – Genetically engineered antibodies. Covid vaccine- concept of booster dose. Stability of vaccine.

UNIT V: Applied immunology

Antigen-antibody interactions - precipitation reaction, agglutination tests – haemagglutination inhibition test; complement fixation test, direct and indirect immunofluorescence, autonuclear antibodies, immune-precipitation, RIA, ELISA, CMIA, ECLIA, Immuno-blotting, effector cell assay, heme adsorption, hemolytic plaque and ELISPOT assays. Experimental Animal models. Antibody based FAIS staining

SUGGESTED READING

1. Abul K Abbas., Andrew H Lichtman., Shiv Pillai (2012). Cellular and Molecular Immunology, W.B. Elsevier/Saunders, Philadelphia, United States.
2. Kenneth Murphy and Casey Weaver (2017). Janeway Immunobiology, 9th edition, Garlamd Science, Taylor & Francis Group, LLC.
3. Kuby, J., (2015). Immunology, W.H. Freeman and Company, New York. 7th Edition.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2016). Roitt's Essential Immunology, Wiley-Blackwell.
5. Soboloff J., KappesDJ., (2018) editors. Signaling Mechanisms Regulating T Cell Diversity and Function. Boca Raton (FL): CRC Press/Taylor & Francis
6. Tizard, I.R., (2009). Immunology- An Introduction,. Saunders College Publishers, Sydney, 8th Edition.
7. Zubay, G., (2009). Immunology, W.B. Saunders and company, Philadelphia, United States.

Semester III

22BCP302 CLINICAL BIOCHEMISTRY 4H-4C

Instruction hours/week: L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

Equip the students with:

- Biological fluid collection and analysis
- Blood cell counting
- Assessment of inflammatory markers
- Estimation of clinically relevant enzymes
- Diagnosis of cancer
- Assessment of endocrine pathophysiology

Course Outcomes (CO's)

After completion of the Course students will gain

1. Integrated on Biochemistry, Anatomy and Physiology, in order to understand the pathophysiology of disease processes and their correlation in the study of body functions.
2. Expertise on how to assess blood test results and their involvement in the assessment of different pathologies.
3. Knowledge to describe and identify the main characteristics of diagnosis, screening, and prognosis of disease.
4. Knowledge on the processes of scientific research to use in emergency services in clinical biochemistry.

UNIT I: Clinical Samples and Phlebotomy

Automation in clinical biochemistry laboratory and factors in quality control. Procedures for collection of clinical specimen**:** Blood collection, collection order, processing and transfusion process. Normal blood profile, Blood grouping. Role of anticoagulant in blood sample collection. Cerebrospinal fluid: Composition, clinical investigation of CSF in meningitis. Amniotic fluid: Origin, composition and analysis of amniotic fluid, amniocentesis. Collection of urine: Suprapubic urine, midstream urine and terminal urine, Urine preservatives. Qualitative analysis of urine. Test for urine compounds. Clinical significance of urinary components. Stool - chemical examination and clinical significance. Pre-analytical errors, data handling and confidentiality of patients.

UNIT II: Serology and Hematology

Blood clotting mechanisms. - hemorrhagic disorders. Coagulation test, prothrombin test. Haemoglobin Normal and abnormal Hb, separation of haemoglobin, Thalassemia, Hemoglobinopathies. Disorder of erythrocyte metabolic pathways, erythrocyte enzyme disorders. Porphyrins and disorder: porphyrias. End reaction- End up reaction-(Glucose, urea, magnesium, total cholesterol).C- reactive protein test, immunological test for pregnancy, rheumatoid arthritis (RA), ESR. Immunoturbometric (ASO, RA, CRP). Electrophoresis-Serum protein and hemoglobin). Agglutination test-ABO grouping, Rh

grouping, PT, activated partial thromboplastin time. Infectious diseases-test priniciples and applications. Test for kidney function – uria, uric acid, creatinine. Glomerular filtration test

UNIT III: Metabolic Disorders

Disorders of carbohydrate metabolism: Diabetes - type I, II and gestational Diabetes, metabolic abnormalities, diagnosis and management, acute and long term complications. Glycogen storage disease, galactosemia.

Disorders of Lipid Metabolism: Lipoproteins, apolipoproteins, cholesterol, triglycerides and phospholipids in health and disease - hyperlipoprotenemia, A beta lipoprotenemia Lipid storage diseases - Taysach's disease and Niemann picks diseases, fatty liver. Atherosclerosis Myocardial infarctions risk factors, biochemical findings and management.

Abnormalities in Nitrogen Metabolism: Factors affecting nitrogen balance. Uremia, hyperuricemia, Oroticaciduria, Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch Nyhan syndrome, Sickle cell anemia, histidinemia

Diagnostic enzymes: Liver function test, clinical significance of liver marker enzymes (AST, ALT, ALP and GGT). Jaundice types and diagnosis. Pancreatic function test. Gastro intestinal function test. Renal function test. AIDS- Clinical diagnosis. Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemachromatosis, thalassemias, sickle cell diseases). HIV counseling.

UNIT IV: Oncology

Oncogenes and cell cycle, Initiation, sustenance and progression of cancer causing factors. Viruses, mutagen and environmental factors. Viral: Oncognic viruses, Etiology - Free radical induced cancer. Free radical scavengers. Antioxidants in disease prevention. Benign and malignant types- Different stages of cancer progression-Cancer Markers. Therapy-Chemotherapy, 4 R's of radiotherapy, Diagnosis and prognosis of various cancers.

UNIT V: Pathophysiology

Pathophysiology of hypothalamus and pituitary (dwarfism, Klinefelter syndrome, adenoma, galactorrhea, amenorrhea).Pathophysiology of thyroid cretinism, myxodema, hashimoto's (autoimmune thyroid disorder), hypo- and hyperparathyroidism, bone (osteopenia and osteoporosis), adrenal (Cushing syndrome and Addison's disease) Pancreas (IDDM and NIDDM) and gonads (cystic ovaries, endometriosis, hypogonadism, cryptorchidis and testicular carcinoma), liver (steatorrhoea, NAFLD, cirrhosis, fibrosis, HCC and Caput medusa).

SUGGESTED READING

1. Burtis, C.A., Ashwood, E.R., and Teitz, W. H., (1999). Textbook of Clinical Biochemistry, W.B. Saunders Company, London.
2. C.M. Porth, Essentials of Pathophysiology, 5th edition, (ISBN-13:978-1975107192)
3. Chatterjea, M.N., (2012). Text book of medical biochemistry, 8th edition, JB publisher.

4. Rodwell, V. W., Kennelly, P. J., Bender, D., Botham, K. M., & Weil, P. A. Harper's illustrated Biochemistry, 31st Edition. Blacklick: McGraw-Hill Education McGraw-Hill Companies. New York.
5. Smith, E., Handler, P., and White, A., (2004). Principles of Biochemistry, Mcgraw Hill International Book Company, London.
6. Varley,H., (2003). Practical Clinical Biochemistry, volume 1 and 2, CBS Publishers, New Delhi.
7. Ralston, S. H., Penman, I. D., Strachan, M. W. J., & Hobson, R. (2018). Davidson's principles and practice of medicine (23rd edition.). Elsevier Health Sciences.
8. C.M. Porth, Essentials of Pathophysiology, 5th edition, (ISBN-13:978-1975107192)
9. Murray, R.K., Bender, D. A., Botham, K.M., and Kennelly, P. J., (2012). Harper's illustrated Biochemistry, 29th Edition. McGraw-Hill Medical. London.
10. Smith, E., Handler, P., and White, A., (2004). Principles of Biochemistry, Mcgraw Hill International Book Company, London.
11. Varley,H., (2003). Practical Clinical Biochemistry, volume 1 and 2, CBS Publishers, New Delhi.

22BCP303 **ENDOCRINOLOGY** **4H-4C**

Instruction hours/week: L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

Equip the students with:

- Hypothalamo - Hypophyseal axis
- Classification of hormones
- Mechansim of action of peptide and steroid hormones
- Endocrine pathologies
- Endocrinology of pregnancy
- Investigative techniques in endocrinology

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Course Outcomes (CO's)

After successful completion, the students will understand the fundamentals related to

1. Hypothalamo - Hypophyseal axis
2. Different models of classification of hormones
3. Functioning of peptide and steroid hormones
4. The molecular and cellular basis of endocrine pathologies
5. Role of hormones in different stages of gestation
6. The techniques involved in the assessment of endocrine functions

Unit I: General Introduction

A brief history of endocrinology, Hypothalamo-hypophyseal axis, Chemical signaling – intracrine, autocrine, justacrine, endocrine, paracrine, intracrine and neuroendocrine mechanisms.Chemical classification of hormones, transport of hormones in the circulation and their half-lives.Hormone receptors – extracellular, transmembrane and intracellular. Receptor – hormone binding, Scatchard analysis, recycling Releasing/release-inhibiting hormones (TRH, GnRH, CRH, GHRH, somatostatin, dopamine).

Unit II: Protein/Peptide hormones

Protein/Peptide hormones, Steroid and Thyroid hormones, GH, prolactin, ACTH, insulin, glucagon, PTH and calcitonin, procalcitonin – diagnositic significance and glycoprotein hormones (TSH, FSH, LH and hCG) – Source, structure, synthesis, secretion, receptors, regulation, transport and metabolism. EGF1, TGFB, VEGF. Transmemberane recetors.

Unit III: Hormones and gonads

Physiological action of hormones in the regulation of spermatogenesis, sperm maturation, oogenesis and menstrual/estrus cycles. Gonadal and adrenal steroidogenesis. Cell-cell communication – Two cell concept. Hormonal control of implantation and formation of the fetus and placenta - as a feto maternal unit, mechanisms for single births and multiple births; milestones of fetal development, gestation and parturition. Physiology of lactation; hormonal effects on maternal-infant bonding; Menopause and pre menopausal symptoms. – puberty-menopause; hormonal contraception. Semen analysis.

Unit IV: Hormone action

Protein and steroid hormone receptors and their signaling cascades; non-genomic actions; Ras-Raf-MAPK signaling- PI3K signaling. Genomic actions of hormones- thyroid hormone nuclear receptor superfamily. Renin-angiotensin system, atrial natriuretic hormones. Vasopressin and water retention. Regulation of blood pressure.

Unit V: Investigative techniques in endocrinology and endocrine disorders

Hormone assays, RIA, IRMA, ELISA, Radio receptor assay, extraction, purification, and quantification of hormone receptors (cell surface, cytosolic and nuclear receptors). Radiolabeling techniques – Radioiodination of peptides, autoradiography. Properties of different types of radioisotopes commonly used in biology, radioactivity, detection and units of radioactivity, safely guidelines and disposal procedures. **Diseases of endocrine organs:** Diabetes, osteoporosis**,** Adrenal insufficiency, Cushing's disease, Gigantism (acromegaly), Hypothyroidism/Hyperthyroidism, Hypopituitarism, Multiple endocrine neoplasia I and II (MEN I and MEN II), Polycystic ovary syndrome (PCOS), Precocious puberty.

SUGGESTED READING

1. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th edition). W.H. Freeman.
2. David Norris., James Carr., (2020). Vertebrate Endocrinology, 6th Edition. Elsevier, ISBN 9780128200940
3. Widmaier, E.P., Raff, H. and Strang, K.T. (2019) Vander's Human Physiology, 15th edition. McGraw Hill, ISBN: 978-1259903885.
4. Robert Hardin Williams., Shlomo Melmed., P Reed Larsen., Henry M Kronenberg., and Kenneth S Polonsky., (2016). Williams Textbook of Endocrinology, 13th edition. Philadelphia : Elsevier, ISBN: 9780323297387.
5. Hadley, M.C., and Levine, J.E., (2007). Endocrinology 6th ed. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

Semester III

22BCP304 DRUG BIOCHEMISTRY AND CLINICAL TOXICOLOGY 4H-4C

Instruction hours /week:L:4 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

To enlighten the students with details of the

- This paper gives insight knowledge about the emerging themes of drug biochemistry.
- Provides an in-depth analysis of specific drug classes, its metabolism and therapeutic approaches.
- Drug tolerance and dependence
- Genetically engineered drugs
- Mechanism of action of drugs
- Undesired effects of drugs

Course Outcomes (CO's)

After completion of the Course students will gain

1. Ensure the widespread visibility and high impact of Drugs, thereby promoting on emerging research, pointing the way for the establishment of new medicines – from the identification of targets, through to the synthesis and evaluation of putative therapeutic entities.
2. Able to understand the adverse effect of drugs in various organs.
3. The principles and procedure for genetically engineered drugs
4. How the drugs elicit the desired effect
5. Undesired effects of drugs
6. Drug dependence

UNIT I: Basic concepts of Drugs

Drugs – Definition and classification. routes of administration, Structural features and pharmacological activity, prodrug concept, Adsorption – factors modifying drug absorption. Distribution, metabolism - phase I, II reactions, action of cytochrome P450 and excretion of drugs.

Drug receptors – Localization, types and subtypes, models and theories. G-protein coupled receptor - activators/blockers and ion-channel linked receptors. Examples of drug-receptor interactions. Agonists and antagonists. Bioavailability of drug

UNIT II: Drug assays and engineered drugs

Drug tolerance and drug dependence. Narcotic drugs. Principles of basic pharmacokinetics. Adversse response to drugs, drug intolerance, pharmacogenetics, drug allergy, tachyphylaxis, drug abuse, vaccination against infection, factors modifying drug action and effect. Assay of drug potency: chemical, bioassay and immunoassay.

Engineered Drug

Genetically engineered protein and peptide agents as drugs, Hurdles in the development of of oral peptides. Novel drug delivery systems, anti-AIDS drug development, oncogenes as

targets for drugs, multidrug resistance phenotypes, production of secondary metabolites by plant tissue culture. Genome based medicine. Regulatory requirements of drug discovery FDA, IUDA and Indian regulations.

UNIT III: Mechanism of action of drugs used in therapy

Mechanism of action of drugs used in therapy of Respiratory system – cough, bronchial asthma, pulmonary tuberculosis. Antimicrobial drugs – sulphonamides, trimethoprim, penicillins, aminoglycosides and bacterial resistance, Cancer chemotherapy – plant based, synthetic drugs. Radiotherapy.Thyroid and antithyroid drugs, insulin and oral antidiabetic drugs, antifertility and ovulation inducing drugs. Pharmacotherapy of gout and rheumatoid arthritis, Immuno therapy – Immunosuppressants and immunostimulants, Enzymes in therapy.

UNIT IV: Neurotransmitter Drugs

Brain – Neurotransmitters, encephalins and endorphins; general function of autonomic and somatic nervous system; cholinergic transmission and receptors; adrenergic transmission and receptors; muscarinic receptors. Non-steroidal and anti-inflammatory drugs; adrenergic blocking drugs; cholinergic blocking drugs; muscatrinic blocking drugs; parkinson's disease; Alzhiemier's disease. Neurodegenerative disorders – Amylotropic, lateral sclerosis, senile dementia, schizophrenia, Huntington's disease.

UNIT V: Clinical Toxicology

Toxicology: Principles of toxicology and treatment of poisoning. Heavy metals and antagonists. Nonmetallic environmental toxicant s. Methods involved in the development of new drugs. Preclinical toxicological studies. Irwin profile test, Pre –clinical pharmacokinetic and dynamic studies. Lipinski's rule for drug like molecule, High Throughput screening (*in vitro* and *in vivo*) for pre-clinical pharmacokinetic and pharmacodynamics studies.

SUGGESTED READING

1. Barar, F.S.K. (2013) Text Book of Pharmacology, 1st edition, S.Chand and Company Pvt. Ltd.
2. Rang, H.P., Dale, M.M., Ritter, J., Flower, R.J. and G Henderson (2012) Pharmacology, 7th edition, Churchill Living Stone Elsevier.
3. Satoskar, R.S., Nirmala Rege. and Bhandarkar, S.D. (2015) Pharmacology and Pharmacotherapeutics, 24th edition, Churchill Living Stone Elsevier.
4. Shargel,L. et al., 2012. Applied Biopharmaceutics and Pharmacokinetics, 6th Edition, McGraw-Hill Medical.
5. Tripathi, K.D. (2018) Essentials of Medical Pharmacology, 8th edition, Jaypee brothers medical publishers, New Delhi.

Semester III

22BCP305A BIOSTATISTICS AND RESEARCH METHODOLOGY 3H-3C

Instruction hours/week: L:3 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

Equip the students with:

1. Definition and representation styles of data
2. Analysis of data using correlation to understand the interdependence
3. Analysis of data using regression to understand the interdependence
4. To learn various measures of central values and standard deviation.
5. To understand the relationship between two variables.
6. To test the significance of a particular data by various parameters.

Course Outcomes (CO's)

After successful completion, the students will be able to

1. Use appropriate representation styles to present the data
2. Perform correlation analysis
3. Perform regression analysis
4. Calculate mean, median, mode and standard deviation.
5. Calculate the relationship between two variables.
6. Test the significance of a particular data by various parameters.

UNIT I: Introduction to Biostatistics

Definition and scope of Biostatistics- Statistical survey-organizing, planning and executing the survey; Sources of data-primary and secondary data, Collection of data-Methods of data collection; Classification and tabulation of data - representation.

Measures of central tendency – Arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of dispersion-Range, quartile deviation, mean deviation and standard deviation, Coefficient of variation.

UNIT II: Correlation and Regression

Correlation: Meaning and definition - Scatter diagram –Karl Pearson's correlation coefficient. Rank correlation.

Regression: Regression in two variables – Regression coefficient problems – uses of regression in the plotting of standard curve for enzyme analysis and for Ic50

UNIT III: Probability

Probability- Definition, concepts, theorems (proofs of the theorems not necessary) and calculations of probability-simple problems, conditional probability, theoretical distributions-Binomial, Poisson and Normal distribution – simple problems

UNIT IV: Sampling distribution and test of significance

Sampling distribution and test of significance – concepts of sampling- Null and alternate hypothesis testing of hypothesis, errors in hypothesis testing, standard errors and sampling distribution– Student's t test, F-test, Chi-square test - goodness of fit. Analysis of variance – one way and two-way classification. CRD, RBD Designs. Posthoc test – SNK test. Various statistical packages used for data analysis: Excel, SPSS, R Programming, Python and Statistics. Null hypothesis, alternative hypothesis, paired and unpaired t-test, t-test correlation and Medlab statistical software.

UNIT V: Introduction to Research

Research:Scope and significance – Types of Research – Research Process – Characteristics of good research – Problems in Research – Identifying research problems. Research Designs – Features of good designs.

Sources of information: Journals, eJournals, books, biological abstracts, preparation of index cards, review writing, article writing – structure of an article, selection of journals for publication – Impact factor – citation index and H index – g, h, i index. Proposal writing for funding.IPR and patenting- design and patent process. Concepts and types. Outliers and specifications.DAIR and IAIR committee

SUGGESTED READING

1. Gupta,S.P., (2014). Statistical Methods, 43rd edition, Sultan Chand & Co, New Delhi.
2. Kothari, C.R., (2009). Research Methodology – Methods and Techniques, 3rd edition, New Age International Pvt. Ltd, New Delhi.
3. Sandhu, T., (1990). Research Techniques in Biological Sciences, Anmol Publishers, New Delhi.
4. SundarRao, P.S.S., and Richard, J., (2012). Introduction to Biostatistics and Research Methods, 5th edition, PHI Publication, New Delhi.

SemesterIII

22BCP305B **CLINICAL RESEARCH** **3H-3C**

Instruction hours/week:L:3 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- Students understand the concept of drug discovery, clinical research and IPR.
- Pre-clinical studies
- Components of clinical research (Phases)
- Understand about Indian GCP guidelines
- Understand about Ethical Guidelines for Biomedical Research on Human Subjects Schedule.
- Get knowledge about Finding and Evaluation databases of Scientific Literature

Course Outcomes (CO's)

1. This paper deals with the basic concept of drug discovery, clinical trial and IPR.
2. Using small experimental animals
3. Phase 2 and Phase 3 trials
4. Understand about Indian GCP guidelines
5. Understand about Ethical Guidelines for Biomedical Research on Human Subjects Schedule.
6. Get knowledge about Finding and Evaluation databases of Scientific Literature

UNIT I: Preclinical research: Definition of research and types of research. Preclinical studies - Preclinical technology, Chemistry manufacturing and controls / Pharmaceutics Pharmacology/Toxicology. Various regulatory requirements inclinical trials. ICMR guideline set. Documents in clinical study. Indian GCP guidelines, CDCSO guidelines, ICMR Guidelines-Ethical Guidelines for Biomedical Research on Human Subjects Schedule. Preclinical trial – Phases and significance.

UNIT II: Clinical Research

Definition of clinical research and development, History of randomized trial Literature - Finding and Evaluation databases of Scientific Literature; Critiquing of Research Projects, Time management and resource implications. Proband evaluation, document submission and precision. Clinical trial – Phases and significance.

UNIT III: Epidemiology Research

Experimental Procedure, Classification of epidemiological study designs. Controlled Experiments, Sampling Techniques, Questioner Design, Validity and reliability of observations, Primary variables, Acquisition and using secondary data, Randomization and Blinding: Theory and practice.

UNIT IV: Drug discovery and Development

Introduction to Pharmaceutical Industry, New drug discovery-Steps involved in drug discovery process. Target Identification- Target Prioritization/ validation, Lead identification, Lead optimization.

Stem Cell Research

Ethical issues associated with stem cell research. Implication of human embryonic stem cell research, societal implications: religious vs. scientific views. Ethical guidelines for stem cell research (National (ICMR-DBT) & International).

UNIT V: Virology

SARS viruses: History, types of SARS CoV, types of antibodies- IgG, IgM – subtypes of IgG (S1/S2). ICMR guidelines to detect the reactivity – Total antibodies. Spike proteins

SUGGESTED READING

1. Duolao, W., Bakhai.A., (2005). Clinical Trials: A Practical Guide to Design, Analysis and Reporting, Remedica, London.
2. Harburn, K., (1990). Quality Control of Packing Materials in Pharmaceutical Industry, CRC Press, U.S.A.
3. Prichard,E.,(1995). Quality in the Analytical Chemistry Laboratory, 1st edition, Wiley, U.S.A.
4. Richard, A.G., Richard,G., (2009). New Drug Approval Process Drugs and the Pharmaceutical Sciences), 5thedition CRC Press, U.S.A.
5. Weinberg, S., and Sandy, W., (2009). Guidebook for Drug Regulatory Submissions, 1st edition, Wiley-Blackwell, U.S.A.
6. Weinberg, S., (1995). Good Laboratory Practice Regulations, 3rd edition, CRC Press, U.S.A.

Semester III

22BCP305C **Molecular Virology** **3H-3C**

Instruction hours/week: L:3 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

UNIT I : Origin and evolution of viral respiratory diseases

History, clinical features, epidemiology of influenza, RSV and other respiratory diseases Biology of respiratory viruses: Biology and pathogenesis of SARS, human rhino virus and Corona virus. Diagnostics: RT-PCR, rapid antigen tests. Differential diagnosis of different respiratory diseases.: Virus taxonomy, introduction to replication strategies. Virus structure and morphology. Principles of bio-safety, contaminant facilities, maintenance and handling of laboratory animals and requirements of virological laboratory. IBSC

UNIT II : Vector Virus Relationship

Virus dissemination &mechanism of virus transmission in vectors, natural cycle, maintenance of viruses in nature, basis of vector competence, mechanical transmission, virus dissemination, susceptibility- intrinsic and extrinsic factors. Xenodiagnosis- methods and applications.

UNIT III Virus Replication

RNA Viruses: General strategies, replication of plus stranded RNA virus (polio), negative strand RNA viruses (VSV and Influenza) Other RNA Viruses. Replication of double stranded RNA virus (Rota), ambisense RNA (LCM) and retroviruses (HIV and HTLV). DNA viruses Replication of double stranded DNA viruses (SV40, Pox), ssDNA Virus (AAV). Prion proteins.

UNIT IV Viral Cancers and Antivirals

Role of papilloma, E5, E6 and E7 proteins, HIV, HBV, Epstein Barr virus, HTLV and herpes in pathogenesis of cancers, diagnosis, prevention. Interferons, designing and screening of antivirals, mechanism of action, antiviral libraries, antiretrovirals- mechanism of action and drug resistance. Modern approaches of virus control: Anti-sense RNA, siRNA, ribozymes. Assignments, group discussions and presentations.

UNIT V Viral Vaccines

Vaccines against different viral respiratory diseases. Conventional vaccines- killed and attenuated, modern vaccines recombinant proteins, subunits, DNA vaccines, peptides, immune modulators (cytokines), vaccine delivery and adjuvants, large scale manufacturing-QA/QC issues

SUGGESTED READING

1. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Theodora Hatziioannou, Anna Marie Skalka (2020). Principles of Virology, Multi-Volume, 5th Edition. ASM Press. ISBN: 978-1-683-67358-3

2. John Oxford, Paul Kellam, Leslie Collier (2016) Human Virology 5th edition. OUP oxford publishers. 978-0198714682

3. K. Smith, DA Ritchie (2020). Introduction to virology. Springer publishers. ISBN: 9789402419993

Semester III

22BCP311 **PRACTICAL–V** **4H-2C**

CLINICAL ENZYMES AND ANIMAL HANDLING

Instruction hours/week: L:0 T:0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

The main objective of this practical is

- To understand the principles and diagnostic importance of various clinically important enzymes
- To determine the activity of various clinically important enzymes
- To learn the immunological experiments and understand the antigen – antibody reactions.
- To analyse a case for various diseases like diabetes, cardiac diseases and cancer.
- Handling experimental animals
- Various routes of injections

Course Outcomes (CO's)

After learning this practicals the students could be able

1. To analyse the biological samples and can be able to interpret the results
2. By doing a case study they will be getting a clear picture of various diseases and their etiology.
3. Assess liver function through the estimation of bilirubin
4. Determine A/G ratio and interpret its relevance
5. Handle the small experimental animals
6. Understand the differences and significance of routes of injections

ENZYMOLOGY

1. Determination of the activity of the following serum enzymes:
   a. LDH
   b. Acid phosphatase
   c. Alkaline phosphatase
   d. Aspartate amino transferase
   e. Alanine amino transferase
   f. 5' nucleotidase
   g. Sodium potassium ATPase
   h. Ceruloplasmin

IMMUNOLOGY(DEMONSTRATION)

2. Raising of antibodies- single soluble and particulate antigen
3. Immunodiffusion- single radial and double diffusion.
4. Immunoelectrophoresis.
5. Rocket immunoelectrophoresis
6. ELISA - Antibody titration
7. Bacterial Agglutination: WIDAL-tube agglutination method

Case study-Report

8. Serum enzymes in liver disease
9. Serum enzymes in cardiac disease
10. Serum enzymes in cancer disease
11. Installation, operation and performance qualities of any instrument
12. Interpretation of a total cell count report

EXPERIMENTAL ANIMAL STUDIES (Group experiment)

13. Handling of small animals
14. Routes of drug administration
15. Induction of liver toxicity
16. Assay of lipid peroxidation in rat liver.
17. Federation of European Laboratory Animal Science Associations, CPCSEA, IAEC

INSTRUMENTS REQUIRED

1. UV Visible Spectrophotometer
2. Electrophoresis unit
3. ELISA Reader

SUGGESTED READING

1. David Wild, (2013). Immunoassay Hand Book, 4th edition, Elsevier.
2. Rodney Boyer, (2012). Biochemistry laboratory: Modern theory and techniques, 2nd edition, Pearson Education, Inc.
3. Jayaraman, J., (2011). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
4. Sadasivam,S., and Manickam, A.,(2009). Biochemical Methods, New Age International Publishers, New Delhi.
5. Singh, S.P., (2017). Practical Manual of Biochemistry, 8th edition, CBS Publishers, New Delhi.
6. Talib, V. H., (2019). Handbook of Medical Laboratory Technology, 2nd edition, CBS Publishers, New Delhi.

Semester III

22BCP312 **PRACTICAL – VI** **4H-2C**

BIOSTATISTICS IN CLINICAL CASE STUDIES

Instruction hours/week: L:0 T:0 P:4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

To make the students

- To know the statistical methods commonly used in the clinical laboratory.
- To know how can contribute the clinical laboratory to assess the health status of individuals.
- To understand the pathophysiology and molecular basis of the most prevalent diseases.
- To know the clinical data interpretation
- Understand what is correlation and regression
- To know the T test and F test

Course Outcomes (CO's)

Upon successful completion of this course, students will be able to:

1. Explain the physiopathological bases and the biochemical markers of the most prevalent diseases in our population.
2. Identify the principal analytical procedures used to measure biochemical magnitudes.
3. Interpret and integrate the analytical data from the principal biochemical and molecular genetics tests for the screening, diagnosis, prognosis and epidemiological monitoring of pathologies.
4. Understand the commonly used methods in the clinical laboratory.
5. To know how to use SPSS software in clinical data interpretation.
6. Compare and analysize data after correlation and regression

Clinical analysis

Collection of sample data on fasting glucose, glucose tolearance test, lipid profile , renal and thyroid profiles and subject the samples to following analysis

1. T-test (Paired and Unpaired)
2. F-test
3. Chi-square test
4. Karl pearlson rank correlation analysis
5. One way ANOVA
6. Two way ANOVA
7. Regression Analysis using SPSS software or Excel
8. Z score

INSTRUMENTS/TOOLS REQUIRED

1. SPSS

2. EXCEL

SUGGESTED READING

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, 3rd edition, New Age International Publishers, New Delhi.
2. Sadasivam, S., (2018). Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi.
3. Singh, S.P., (2017). Practical Manual of Biochemistry, 8th edition, CBS Publishers, New Delhi.
4. Talib, V. H., (2019). A Handbook of Medical Laboratory Technology, 2nd edition, CBS Publishers, New Delhi.

Semester III

22BCPOE301 NUTRITION AND DIETETICS 3H-2C

Instruction hours/week: L:3 T:0 P:0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

To Equip the students with

- Fundamentals of food, nutrients and their relationship to health
- Rrespect to deriving maximum benefit from available food resources
- Understanding of the consequences of vitamin and mineral deficiency/excess of vitamin
- Respect to the nutrition in adult age
- Nutrition deficiency diseases and their consequences
- Food adulteration and prevention of food adulteration

Course Outcomes (CO's)

After successful completion, the students will understand:

1. The fundamentals of nutrition and their relationship to health
2. To derive maximum benefits from available food resources
3. The consequences of vitamin and mineral deficiency/excess of vitamin
4. The nutrition in adult age
5. Nutrition deficiency diseases and their consequences
6. The sources of food adulteration and measures to prevent it

UNIT 1

Basic concepts in food and nutrition-Understanding relationship between food, nutrition and health, Functions of food-Physiological, psychological and social. Dietary guidelines for Indians and food pyramid

UNIT II

Nutrients - Functions, dietary sources and clinical manifestations of deficiency/ excess of the following nutrients: Carbohydrates, lipids and proteins, Fat soluble vitamins-A, D, E and K, Water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C, Minerals – calcium, iron and iodine

UNIT III

Nutrition during the adult years

Physiological changes, RDA, nutritional guidelines, nutritional concerns and healthy food choices -Adult, Pregnant woman, Lactating mother, Elderly.

Nutrition during childhood -Growth and development, nutritional guidelines, nutritional concerns and healthy food choices -Infants, Preschool children, School children, Adolescents.

Nutritional needs of nursing mothers and infants, determinants of birth weight and consequences of low birth weight, Breastfeeding biology, Breastfeeding support and Counselling, Infant and young child feeding and care - Current feeding practices and nutritional concerns, guidelines for infant and young child feeding, Breast feeding, weaning

and complementary feeding. Assessment and management of moderate and severe malnutrition among children, Micronutrient malnutrition among preschool children. Child health and morbidity, neonatal, infant and child mortality

UNIT IV

Introduction to Nutritional deficiency diseases -Causes, symptoms, treatment, prevention of the following: Protein Energy Malnutrition (PEM), Vitamin A Deficiency (VAD), Iron Deficiency Anaemia (IDA), Iodine Deficiency Disorders (IDD), Zinc Deficiency, Flurosis Nutritional needs during pregnancy, common disorders of pregnancy (Anaemia, HIV infection, Pregnancy induced hypertension), relationship between maternal diet and birth. Maternal health and nutritional status, maternal mortality and issues relating to maternal health.

UNIT V

Dietetics : Diet for diabetes mellitus-Nutrition recommendations for patient with diabetes, Meal planning, Exchange list of different food groups, Diabetic diets based on exchange list, Diabetic diets menu wise. Diet for Cardiovascular Diseases -Dietary management and general guidelines for coronary heart disease, Dietary recommendations of WHO. Diet for Acute cardiac diseases. Influence of diet on carcinogenesis, Dietary risk factors and cancers at various sites in the human body, diet therapy, eating well during cancer treatment, managing eating problems during treatment. Hormonal imbalance-Poly cystic ovarian syndrome, hypogonadism, cushing syndrome and thyroiditis. Causes of hormonal imbalance. Treatment- Dietary and stress management.

SUGGESTED READING

1. Garrow,J.S., and James, W.P.T.,(2000). Human Nutrition & Dietetics, Longman Group, UK.
2. Gordon M, Wardlaw and Paul M. 2012. Perspectives in Nutrition: U.S.A. McGraw Hill Publishers. 9rd Edition. New Delhi
3. Sharma, R (2004). Diet Management,3rdEdition,Reed Elsevier India Private Limited, Chennai.
4. Srilakshmi.B. 2014 Nutrition Science: New Age International (P) Ltd. Publishers.4th Edition. New Delhi.
5. Srilakshmi.B. 2015 Food Science:. New Age International (P) Ltd. Publishers. 6nd Edition., New Delhi
6. Swaminathan.M. 2008. Essential of Food and Nutrition Vol II The Bangalore Printing and Publishing Co. Ltd., Bangalore.

Semester III

22BCP391 **INTERNSHIP PROGRAMME** **2C**

Hours/ week: L:0 T:0 P:0 **Marks:** Internal: **100** External:- Total: **100**

Semester IV

22BCP491	**PROJECT AND *VIVA VOCE***	**30H-15C**

Hours/ week: L:5 T:0 P:25 **Marks:** Internal: **80** External:**120** Total: **200**