PONDICHERRY UNIVERSITY
SCHOOL OF LIFE SCIENCES
DEPARTMENT OF BIOCHEMISTRY & MOLECULAR BIOLOGY

CBCS REGULATIONS (2017-18 onwards)
& COURSES OF STUDIES FOR M.Sc. PROGRAMME
In Biochemistry & Molecular Biology

2019-20 onwards
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CHOICE BASED CREDIT SYSTEM

REGULATIONS

1. PREAMBLE

The Choice Based Credit System (CBCS) enables a student to obtain a degree by accumulating required number of credits prescribed for that degree. The number of credits earned by the student reflects the knowledge or skill acquired him / her. Each course is assigned with a fixed number of credits based on the contents to be learned. The student also has choice in selecting courses out of those offered by various departments. The grade points earned for each course reflects the student’s proficiency in that course.

The CBCS enables the students to earn credits across departments and provides flexibility in duration to complete a Programme of study. The CBCS facilitates transfer of credits earned in different Departments/Centers of other recognized / accredited universities or institutions of higher education in India and abroad. In this System student representatives take part in designing the curriculum for a Programme of Study and facilitate in running the academic Programmes.

2. SCOPE AND COVERAGE

1) The CBCS is applicable to all full-time Post Graduate and Five year integrated Post Graduate study approved by the Academic Council
2) It is also applicable to any other Programme of study approved by the Academic Council that has been prescribed to follow the CBCS pattern
3) The learning and evaluation is on Semester pattern
4) Eligibility, qualifications and admission procedure for each Programme of study is as approved by the Academic Council and specified in Information Brochure of the University.

3. CREDITS AND COURSES

3.1. Contact hours

1) One credit shall mean one period of teaching for theory or two periods for laboratory / practical course per week in a semester (of 16 weeks)
2) One teaching period shall be for 60 minutes duration including 10 minutes for discussion/movement;

3) One credit shall be assigned to one week of field training Programme where the students spend the entire duration in the field along with the faculty member(s);

4) Up to two credit shall be assigned to one month of Internship undergone in a Company/ Organization/Institutions approved by the Faculty Advisor / Head of the Department;

5) One Tutorial hour per week may be conducted in addition to regular contact hours for both Hard core and Soft core theory Courses.

3.2. Number of credits

1) The core credits for any M. A. / M. Sc./ MBA Programme (inclusive of Hard-core, Soft-core and Project work) shall be in the range specified in Table 1 given below.

2) A candidate who has successfully completed all the Hard Core courses and a Project work, if any, and accumulated not less than minimum number of Credits prescribed shall be eligible to receive the Degree.

3) The normal duration of any PG Programme is 4 semesters. However students have the flexibility to complete the PG Programme of Study within minimum of 3 semesters and maximum of 8 semesters. Integrated 5 year PG Programme students shall be permitted to graduate in 8 semesters and not more than 16 semesters.

4) The minimum credits required for the award of degree in various PG Programmes are given in the Table 1.
### Table I

<table>
<thead>
<tr>
<th>S.No</th>
<th>Program</th>
<th>Hard-core Courses credits</th>
<th>Soft-core Courses credits</th>
<th>Total (Minimum credits required for award of the degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M.A. / M.Sc. / All M.Tech. except M.Tech (ECE) / Any other 2 year P.G. Programme not mentioned below</td>
<td>48 to 60</td>
<td>12 to 24</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>M.Com.,</td>
<td>68 to 78</td>
<td>12 to 24</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>All MBA programmes</td>
<td>72 to 86</td>
<td>14-28</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>M.C.A.</td>
<td>72 to 90</td>
<td>18 to 36</td>
<td>108</td>
</tr>
<tr>
<td>5</td>
<td>5 year Integrated P.G.</td>
<td>148 to 162</td>
<td>30 to 44</td>
<td>192</td>
</tr>
<tr>
<td>5.1</td>
<td>Exit option for UG degree in 5 year Integrated P.G.</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>6</td>
<td>M.Tech (Electronics &amp; Communication Engineering)</td>
<td>59</td>
<td>15</td>
<td>74</td>
</tr>
</tbody>
</table>

### 3.3. Courses

1) The courses offered under a Programme of Study are designated as Hard Core and Soft Core.

2) A course designated as Hard Core for a particular Programme of Study must invariably be completed by the student to receive the degree in that Programme. The Hard Core Course cannot be substituted by any other course. Any other paper chosen by the candidate either within department or outside department will be treated as softcore course with respective credit assigned to the paper.

3) A student needs to earn certain number of minimum credits by successfully completing Soft core courses to receive the degree (Please see Table I).

4) The soft core courses are to be chosen from (a) a list of courses marked as Soft core courses for a particular Programme of Study and (b) any course offered by a Centre/Department/School under CBCS as Soft-core Course with the advice of his/her Faculty Advisor.

5) Dropping of soft-core courses shall be accepted within a period of three weeks only. Afterwards the student has no option to drop it. If, the Department is not offering that specific soft-core paper, the Programme Committee may take a decision on this issue.
6) The courses offered for Integrated 5 year PG and other PG programmes shall carry 2 or 3 or 4 credits. Normally no theory course shall have more than 4 credits.

7) Project Work of PG programmes may carry 4 or 5 credits. Up to 12 credits can be assigned if an entire semester is assigned for Project work. The Project includes submission of a written Project Report and a Viva-voce examination (one credit is assigned for the Viva-voce).

8) While choosing the soft core the student can keep in mind that the chosen paper is
   a. Supportive to the discipline of study.
   b. Providing an expanded scope
   c. Enabling an exposure to some other discipline/ domain
   d. Nurturing student’s proficiency/skill

4. REGISTRATION

1) Each student, on admission shall be assigned to a Faculty Advisor.

2) With the advice and consent of the Faculty Advisor the student shall register for a set of courses he/she plans to take up in each Semester.

3) The student has to seek the consent of each teacher offering the courses for registration.

4) No student shall be permitted to register for courses exceeding 30 credits per semester. However, registration for Repeat courses is allowed in excess of this limit.

5) A student, to retain his status, should register for at least a minimum of 12 credits in a semester.

6) Students shall have to register for the courses within first week of a semester.

7) The maximum number of students to be registered in each course shall depend upon the physical facilities available.

8) The information on list of all the courses offered in every department specifying the credits, the prerequisites, a brief description of syllabus or list of topics, the faculty who is offering the course and the time slot may be made available in the University website.

9) In any department, preference for registration shall be given to those students of that department for whom the course is a Hard core course.
10) The registration for the soft core course shall be on first come first served basis, provided the student fulfills prerequisites for that course, if any. The number of students to be registered shall be based on the classroom and laboratory capacity. Every effort shall be made by the Department/Centre to accommodate as many students as possible.
11) No soft core course shall be offered unless a minimum of 5 students are registered.

5. INTRODUCTION OF COURSES

5.1 Course Structure and Syllabus
1. The Course Structure shall prescribe the minimum eligibility, Semester wise list of courses, total credits for each Programme of Study, including, Theory, Practical, Field-work, Project work and Viva-voce examinations, etc.
2. Detailed syllabus for all courses offered by the Department shall be prepared in a specific number of units along with full details of Text Books, Reference Books, Web based resources, Reference of papers, e-Books, Published Reports, Monographs, etc. relevant to the course and made available to teachers and students. Each course shall have a title and course code. The course code shall consist of four alphabets representing the Department /Centre, and three numerals. The first numeral stands for level of the course, the second numeral stands for odd or even semester and third numeral is the serial number of the course.
3. The Course Structure and Syllabus of each PG programme shall be approved and recommended by the Programme Committee to Board of Studies (BOS) and School Board and then the Academic Council.
4. New hard-core or soft-core course proposed by a Faculty member is to be first considered and approved in the Programme Committee of the Department and BOS and then to be placed before the School Board and Academic Council for approval.
5. The syllabi of courses need to be revised to keep in tune with recent developments in knowledge and inventions. Minor revision of the already approved Syllabus of any course with proper justification shall be considered and recommended by the Programme Committee through the Chairperson of School Board to the Academic Council. However, the Chairperson of the Academic Council may approve the revisions to facilitate implementation of the revised syllabi in a timely manner.
5.2.1 Hard core course

1. A Hard core subject may be a Theory, Practical, Field based or Project Work based subject which is a compulsory component in the Course Structure. Based on the quantum of time required for teaching – learning the number of credits for each subject is to be decided within the prescribed limit (please see 3.3 (6 & 7)).

2. Registration for Hard Core courses is also open to students of other departments provided they meet the prerequisites.

3. A Course may be treated as a Hard core or Soft Core Course for students of other department as per the requirement of Programme of Study.

5.2.2 Soft core course

1. A Soft core course may be a Theory, Practical, Field based or Project Work, which is optional for the students to register.

2. Students can exercise their choice among a set of Soft core courses from the list of Soft core courses specified for each Programme of study.

3. Students have a choice to register for Soft Core Courses offered by any Department under the advice of the Faculty Advisor.

4. Students may be advised to choose Soft Core
   (a) Supportive to the discipline of study
   (b) Providing an expanded scope
   (c) Enabling an exposure to some other discipline/domain
   (d) Nurturing student’s proficiency/skill

5. Students can be allowed to register to audit a course for knowledge enhancement if they wish to learn. Auditing refers to having the required attendance but an exemption from internal assessment and end semester examinations. Such Courses can be marked as AUD in grade card to indicate that student has audited.

6. Based on students’ requirements a department could request or float a foundation course which could be a non-credit course. For example if a PG programme of a department requires a basic course in a language, such a course could be offered by the department or the department can request the relevant language department to offer the course. The performance of students in non-credit Foundation Course shall be graded as Satisfactory or Unsatisfactory instead of the letter grade and this will not be counted for the computation of SGPA/CGPA. (page 5 of UGC guidelines)
5.3 Teachers work load
1. Every faculty member shall be assigned workload as per the UGC norms.
2. In addition to regular handling of classes, teachers are required to participate in preparation of detailed Syllabus, designing Teaching plan, Evaluation of answer papers of examination, preparation of grades, etc.
3. Teachers shall undertake to associate with organizing practical Lab sessions, Field visits, Industrial Tours and guide Project Work.
4. Faculty Members of the Department shall actively involve in all the academic activities of the department such as organizing National Events, Seminars, Guest Lectures, etc.

6. EVALUATION

6.1 Breakup of Internal/ End Semester Exams:
1. All theory courses in a PG programme shall carry an Internal Assessment component of 40 marks and End Semester component of 60 marks.
2. In case of practical courses involving Laboratory/Field/Project work, appropriate distribution of marks for Practical Record/ Project Report, Practical end-Semester exam, Viva etc. may be decided by the respective Programme Committee.

6.2. Break up of Internal Assessment Marks
Each teacher shall organize a continuous assessment of each of the courses assigned to him/her. The internal assessment marks shall be given as per the following breakup:

- Internal Assessment Tests / Term Papers / Quizzes
  (Minimum two) = 30 marks
- Seminars/ Assignments/ Case Demos/ Presentations/
  Write ups/ Viva, etc. = 10 marks
- Internal Total = 40 marks

6.3. Internal Assessments
A schedule of Internal Assessment tests may be prepared at the beginning of each semester. Internal Assessment marks shall be displayed a week before the conduct of end
semester examination and all corrected answer papers shall be given back to students with comments, if any. It is mandatory for all students to participate in all the Internal Assessment tests and in various course-work related activities for award of the above marks.

6.4. End-semester examinations and Evaluation

1. End Semester examination shall be conducted for all courses offered in the department. The duration of the end semester examination shall be 3 hours.

2. A schedule of End Semester examinations will be prepared and displayed by the department at least one month ahead of the conduct of the examination.

3. No student who has less than 70% attendance in any course shall be permitted to attend the end-semester examination and he/she shall be given grade of FA – failure due to lack of attendance. He/she shall be required to repeat that course. The HOD shall ensure that the candidate is informed about lack of attendance before the commencement of examination and confirm that such candidates are not permitted to write the exam.

4. End-semester Examination shall be conducted by the Department by assigning the responsibility of question paper setting, invigilation and valuation of answer papers to the course teachers. Wherever project/viva-voce evaluation is involved, a nomination may be obtained from the Dean concerned. The Dean may nominate a faculty from the sister departments / any other department in the University. Each teacher shall prepare the question paper, which should cover all the units of syllabus.

5. The Dean of the concerned school in consultation with HOD shall at Random scrutinize the question paper of the End Semester Examinations to ensure consistency and quality in the Academic Standards of the Questions and coverage of the syllabus.

6.5. Consolidation of Marks

Programme Committee consisting of VC’s nominee and other members shall take up the consolidation of Internal Assessment marks and End-Semester marks and prepare a consolidated Marks Statement.

In order to declare the pass, a Student should get

a) A minimum of 40% marks in end-semester exam, and

b) A minimum of 50% marks in aggregate when Internal Assessment and End-Semester marks are added.
6.6. Supplementary Exam

a) A failed student who meets the attendance requirement and has a minimum of 40% in internal assessment mark may be permitted to register for the next end-semester examination in the following semester itself or in any semester of his/her choice.

b) Students who have failed due to insufficient attendance and / or less than 40 % Internal Assessment marks should repeat the course as and when it is offered.

7. PROGRAMME COMMITTEE

Every academic department of the University shall have a Programme Committee for implementing and monitoring the CBCS. The Programme Committee shall consist of a nominee of the Vice Chancellor who will be from a related disciple/department, all teachers offering the Hard and Soft core-courses for the Programmes of study and one student representative per class. The Head of the Department shall be the ex-officio Chair person.

7.1. Activities of the Programme Committee

Duties and Responsibilities

1. It shall be the duty and responsibility of Programme Committee to implement the CBCS guidelines in all Programmes of Study prescribed in a Department. It reviews and monitors the implementation of BOS approved Course structure, Coverage of syllabus, Time Table, Distribution of workload of faculty, Conduct of classes, Internal Assessments and End-semester examinations.

2. Programme Committee shall review and recommend infrastructure requirements for smooth conduct of teaching-learning activities and to carryout research in every Department.

3. Programme Committee provides an opportunity for individual teachers to initiate steps to float new courses, new methods of teaching, ICT implementation, etc.
4. Programme Committee may give recommendations on the Non-plan Budget requirements for each Programme of Study under different heads like, a) Teaching aids, b) Invited Lecture, c) Field studies, d) Software subscriptions and renewals, e) Study Tour/ Industrial Visits, etc.

7.2. Frequency of Meetings

The Committee shall meet at least thrice in every semester. At first, in the beginning of the semester to chalk out Time Table, list of courses to offer, etc. Second time, at middle of the Semester to review the progress of academic activities. Last meeting of the Programme Committee shall finalize and recommend the grades for all the courses offered by the department in that semester. In this meeting student members shall not take part.

8. SCHOOL BOARD

1. The Dean, who is Chairperson of the respective School Board is the overall in-charge of implementing CBCS in all Programmes of study offered in different departments of the School.
2. Dean, being the Chairman of the School Board shall suggest certain uniform academic practices across all the departments in each School.
3. Dean also gives his approval for Grades and Results.
4. Dean of the respective School shall periodically review the Academic activities of Departments, resolve any issues in conduct of academic Programmes under CBCS regulations.

9. GRADING AND GRADE CARD

The Programme Committee shall prepare two copies of the results, one with marks to be sent to the University Office and another for the Department. Grades shall be awarded as indicated below (Section 9.1) in a meeting of the Programme Committee to be held at the earliest, not later than 15 days after the last day of semester examinations.
The department shall display the provisional grades approved by Programme Committee within a week after the meeting. If a student wishes to look at the evaluated answer script, he/she can approach the concerned teacher within a week of declaration of the provisional results. Students can approach the Grievance Committee for issues relating to award of Marks/Grade. The Grievance Committee shall consist of the Dean, the HOD and an external subject expert and the decision by the Grievance committee after examining the paper shall be the final. Thereafter the results shall be communicated to the Dean for approval.

9.1. Letter Grades

Performances of students in each paper are expressed in terms of marks as well as in Letter Grades. In case of fractions the marks shall be rounded off to nearest integer. The class interval for the purpose of awarding the grades can be arrived at by dividing the difference between the highest mark secured and the minimum pass mark by 6 as there are six passing grades. The formula is given below:

\[ K = \frac{(X-50)}{6} \]

Where, \( K \) = class interval, \( X \) = the highest mark in the subject.

The grades may be awarded as given in the following Table II.

<table>
<thead>
<tr>
<th>Range of Marks in %</th>
<th>Letter Grade</th>
<th>Points for Calculate of CGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>X to (X-K)+1</td>
<td>O</td>
<td>10</td>
</tr>
<tr>
<td>(X-K) to (X-2K)+1</td>
<td>A+</td>
<td>9</td>
</tr>
<tr>
<td>(X-2K) to (X-3K)+1</td>
<td>A</td>
<td>8</td>
</tr>
<tr>
<td>(X-3K) to (X-4K)+1</td>
<td>B+</td>
<td>7</td>
</tr>
<tr>
<td>(X-4K) to (X-5K)+1</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>(X-5K) to 50</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Below 50</td>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

Failure due to lack of attendance | FA | 0

K should not be rounded off to less than two decimal places. The numbers given in Range of Marks column, (X-K), (X-2K), (X-3K), etc., can be rounded off to the nearest whole number.

In courses where the number of students who have secured 50 marks and above is less than 10 then grading may be given based on the Table III.
Table III

<table>
<thead>
<tr>
<th>Range of Marks in %</th>
<th>Letter Grade</th>
<th>Points for Calculate of CGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>81-100</td>
<td>O</td>
<td>10</td>
</tr>
<tr>
<td>71-80</td>
<td>A+</td>
<td>9</td>
</tr>
<tr>
<td>66-70</td>
<td>A</td>
<td>8</td>
</tr>
<tr>
<td>61-65</td>
<td>B+</td>
<td>7</td>
</tr>
<tr>
<td>56-60</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>50-55</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Below 50</td>
<td>F</td>
<td>0</td>
</tr>
<tr>
<td>Failure due to lack of attendance</td>
<td>FA</td>
<td>0</td>
</tr>
</tbody>
</table>

The GPA and CGPA will be calculated as weighted average of points secured by the student in all the papers registered by him/her. The weights are the number of credits for each paper. For example, a student getting A+ grade in 4 credit course, A grade in 2 credit course, O grade in a 3 credit course and F grade in a 3 credit course will have a GPA as \((9\times4 + 8\times2 +10\times3 + 0\times3)/(4+2+3+3)=(36+16+30+0)/12=82/12 = 6.83\) out of 10.0; GPA = 6.83. The CGPA shall also be calculated in similar lines taking all subjects taken by the students in all semesters.

Students with a CGPA of 9.0 and above and did not fail in any of the courses taken by him/her shall be awarded Distinction.

A CGPA of 6.0 and above shall be placed in First class.

Student who has secured less than 50% marks in any paper gets F Grade and he is treated as failed in that paper.

Model Grade Sheet

<table>
<thead>
<tr>
<th>Example 1 - Average performance</th>
<th>Example 2 - Good performance</th>
<th>Example 3 - Skipping of grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marks Grade</td>
<td>Marks Grade</td>
<td>Marks Grade</td>
</tr>
<tr>
<td>78 O</td>
<td>76 O</td>
<td>83 O</td>
</tr>
<tr>
<td>72 A+</td>
<td>80 A+</td>
<td>80 O</td>
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<tr>
<td>70 A+</td>
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<tr>
<td>64</td>
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9.2. Grade Card

1. The University Office shall issue a Grade card for the students, containing the marks and grades obtained by the student in the previous semester and Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA).

2. The grade card shall list:
   a. The title of the courses taken by the student.
   b. The credits associated with the course.
   c. The marks and grade secured by the student.
   d. The total credits earned by the student in that semester
   e. The GPA of the student.
   f. The total credits earned by the students till that semester.
   g. The CPGA of the student.

10. EXIT OPTION IN 5 YEAR INTEGRATED PROGRAMME

(1) The Exit Option shall be allowed at the end of 3rd year of all 5 year Integrated Programmes with the exception of M.P.Ed Programme and subject to fulfilling mandatory conditions.

(2) It is mandatory to complete the courses such as English, MIL Communication, Environmental Sciences and Public Administration.
(3) The Concerned Co-ordinators have to frame the course structure and to arrange classes for the compulsory papers which are to be offered to fulfil the mandated requirements for consideration to issue Bachelor Degree.

(4) The minimum number of credits to be completed for a 3 year UG degree is 120, including mandatory courses.

(5) The students should be successful in all the courses (both hard and soft core).

(6) The students are permitted to exercise Exit Option any time after 3 years. However, the students should have completed minimum required credit for a UG Programme by that time.

(7) The respective Board of Studies will suggest the nomenclature of appropriate UG degree to the students who are exercising Exit Option.

(8) Integrated/Dual Degree (name of the first degree - name of the final degree) will be awarded to all students on successful completion of 5 year Integrated Programme.

11. POWER TO MODIFY AND REMOVE DIFFICULTIES

1. Notwithstanding anything contained in the foregoing, the Chairman, Academic Council shall have the power to issue directions or orders to remove any difficulty.

2. Nothing in the foregoing limits the power the A.C. to amend, modify or repeal any or all of the above.
PONDICHERRY UNIVERSITY
SCHOOL OF LIFE SCIENCES
DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY
MASTER OF SCIENCE
IN
BIOCHEMISTRY AND MOLECULAR BIOLOGY

PROGRAMME OBJECTIVES

The M.Sc. programme in Biochemistry and Molecular Biology will:
(1) provide training and understanding of basic concepts as well as cutting edge advancement in the field of Biochemistry and Molecular Biology,
(2) impart practical skills through laboratory courses and understanding of modern scientific techniques,
(3) enhance analytical, statistical and validation skills through hands on training,
(4) expose students to various aspects of research through dissertation, and
(5) introduce applications of Biochemistry and Molecular Biology in order to prepare highly trained and skilled workforce for teaching, research and entrepreneurship.

PROGRAMME OUTCOMES

By the end of the programme students will:
(1) have an in-depth understanding of the basic and recent developments in the field of Biochemistry and Molecular Biology,
(2) acquire skills of critical, analytical and problem solving in order to enable them to be successful in various national and international examinations,
(3) possess skills for independent thinking and in writing scientific proposal and presentations, and
(4) capable of becoming successful academicians/researchers and/or entrepreneurs.
PONDICHERRY UNIVERSITY

SCHOOL OF LIFE SCIENCES

DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY

SYLLABUS FOR M.Sc. BIOCHEMISTRY AND MOLECULAR BIOLOGY

2019-20 onwards

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THIRD SEMESTER

FOURTH SEMESTER

SOFT CORE / ONLINE COURSES*

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*Online Courses recognized by UGC can be opted for with the approval of the Department.

Total credit requirements 72
BCMB 430 - ANALYTICAL BIOCHEMISTRY AND BIOPHYSICS

3 Credits

COURSE OBJECTIVES: To understand the principles of physical sciences that form the basis of the techniques and instrumentation used in biological science

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Electrochemical techniques & Photometry

UNIT- II – Microscopy

UNIT- III – Centrifugation
Basic principles of Centrifugation – instrumentation, centrifugation units - Types of centrifuges – rotors, accessories - centrifugation methods - sedimentation velocity - sedimentation equilibrium – colloids - cell fractionation methods.

UNIT- IV – Chromatography
Types of chromatography - column, thin layer, paper, adsorption, partition, gas liquid ion exchange, affinity, High Performance Liquid Chromatography -principles of each type- instrumentation and accessories- detection methods & systems – qualitative and quantitative aspects – applications;

UNIT- V –Electrophoresis

Text Books

Suggested Reading

COURSE OUTCOME: Students will know the physical basis of appropriate strategies and instrumentation for analysis of different biological sample types.
COURSE OBJECTIVES: To provide basic understanding of physical & chemical properties of macromolecules and principles of bioenergetics

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I– Biomolecules concepts and Bioenergetics 8h

UNIT- II – Carbohydrates 8h

UNIT- III – Proteins and Amino acids 9h

UNIT- IV– Lipids 8h

UNIT- V– Nucleic acids 7h
Nucleic acids types (A, B and Z forms) – Chemistry and structural organization – supercoiling – triple helix of DNA. Denaturation and renaturation of DNA – hyper and hypochromicity – Tm. Structure and functions of t-RNA – hnRNA – and non-coding regulatory RNAs (siRNA– miRNA, etc.).

Text Books

Suggested Reading

COURSE OUTCOME
The course will ensure basic understanding of physical, chemical and functional properties of macromolecules and principles of bioenergetics.
BCMB 432 - CELL BIOLOGY

3 Credits

COURSE OBJECTIVES: To understand structural and functional aspects of cells and basic mechanisms underlying cell signaling and cell division.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT-I - Cellular evolution
Assembly of macromolecules and origin of life, endosymbiotic theory, RNA world hypothesis - structural organization of prokaryotic and eukaryotic cells - different cell types in tissues.

UNIT-II – Bio-membranes and cell signaling

UNIT-III - Mitochondria
Molecular organization and function - components of respiratory chain- chemiosmotic theory- ATP formation- uncouplers of oxidative phosphorylation- mitochondrial DNA and semiautonomy; autophagy and necrosis. Ribosomes- biogenesis, structural organization and functions.

UNIT-IV - Endomembrane system
Structure and function of endoplasmic reticulum and Golgi complex- post translational modifications, protein sorting, targeting and secretion; importance of proteasomes. Microbodies-peroxisomes, glyoxysomes, lysosomes, and their functions; Nucleus - internal organization-nuclear pore complex and transport- nucleosomes and chromatin organization.

UNIT-V – Cell division
Stages of mitosis and meiosis- cohesins and condensins in chromosomes segregation, structure and functions of kinetochore, centrosomes and its functions, regulation of cell cycle- cyclin, CDKs, check points in cell cycle.

Text Books:

Suggested Reading:

COURSE OUTCOME: Students will understand the fundamentals of cell biology and cell signaling.
BCMB 433 - ENZYMEOLOGY

3 Credits

COURSE OBJECTIVES: To understand the principles of physical sciences in the techniques and instrumentation used in biological science

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Introduction to Enzymes 10h

UNIT- II – Bisubstrate reactions and enzyme inhibition 7h

UNIT- III – Enzyme Catalysis 10h

UNIT- IV – Regulation of enzyme activity 7h

UNIT- V – Applications of Enzymology 6h
Enzyme purification – methods and strategies. Test for catalytic activity – active site titrations – Overview of enzyme engineering - Immobilized enzymes- methods and applications in industry-medicine - enzyme electrodes in biosensors.

Text Books

Suggested Reading

COURSE OUTCOME: Basic understanding of enzyme kinetics, inhibition, mechanisms of action, enzyme regulation and applications.
BCMB 434 – MOLECULAR BIOLOGY

3 Credits

COURSE OBJECTIVES: To demonstrate knowledge and understanding of the molecular machinery of living cells. This course will introduce the principles that govern the synthesis of macromolecules: DNA, RNA and protein and chromatin organization.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Introduction
Discovery of DNA - The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast- Gene transfer in microorganisms- conjugation- transformation, transduction – protoplasmic fusion.

UNIT- II – Organization of genome
Components of eukaryotic chromatin - chromatin and chromosome structure- DNA-supercoiling - linking number- Cot curve, C- value paradox - satellite DNA - possible functions - repetitive sequences – transposons.

UNIT- III – DNA replication
Prokaryotic and eukaryotic DNA replication – mechanism of replication, enzymes and necessary proteins in DNA replication, telomeres, telomerase and end replication, role of telomerase in aging and cancer. DNA Mutation and Repair - mutation subtypes, mismatch, base-excision, nucleotide-excision and direct repair. DNA recombination - homologous, non - homologous and site-specific. DNA transposition.

UNIT- IV – Transcription
Prokaryotic and eukaryotic transcription - RNA polymerases - general and specific transcription factors- regulatory elements. Mechanism of transcription regulation and transcription termination. Post-transcriptional modification - 5’ cap formation- 3’end processing and polyadenylation- splicing-editing- nuclear export of mRNA- mRNA stability. Inhibitors of transcription

UNIT- V – Translation

Text Books

Suggested Reading

COURSE OUTCOME: Students will be able to understand the central dogma of molecular biology and fundamentals of biogenesis of macromolecules.
BMB 480 - ANALYTICAL BIOCHEMISTRY LAB

1 Credit

1. **Buffers:** Basic principles, Concept of pH, buffering capacity and pKa, Preparation of different biological buffers in the laboratory, Calculations based on Henderson- Hassel Balch equation Use of pH meters. Handling of buffers and storage concerns.

2. **UV- Visible Spectroscopy:** Basic Principles, Concept of extinction coefficient, absorption spectra of nucleic acids, amino acids and proteins.

3. Separation of biomolecules by precipitation techniques

4. Separation of biomolecules by extraction techniques - Partition chromatography, adsorption chromatography

5. Biomolecule separation by ion exchange chromatography

6. Separation of Biomolecules by Size exclusion chromatography

7. Determination isoelectric point of proteins

8. Electrophoretic separation of proteins

9. Subcellular fractionation by centrifugation

**Reference:**
BCMB 481- BIOMOLECULES LAB

1 Credit

2. Comparative of protein quantification methods – Biuret & Lowry – sensitivity, specificity and interference
5. Estimation of cholesterol.
7. Estimation of free proline.
8. Isolation and estimation of casein in milk.
9. Isolation of cholesterol and lecithin from egg.

Reference:

BCMB 482 - CELL BIOLOGY LAB

1 Credit

1. Observation of eukaryotic cells with the help of light microscope.
2. Permanent slide preparation and preparation of slide for dicot leaf section.
5. Isolation of mitochondria and assay for function.
6. Isolation of peroxisomes and assay for function.
7. Determination of osmotic fragility of cell (goat erythrocyte).
9. Karyotyping
10. Mammalian Cell culture (demonstration and report only)

Reference:
1. Estimation of enzyme activity (serum alkaline phosphatase) by endpoint assay.
2. Estimation of enzyme activity (serum alkaline phosphatase/lactate dehydrogenase/horse radish peroxidase) by continuous monitoring assay.
4. Effect of pH on enzyme (horse gram urease/ alkaline phosphatase) activity.
5. Effect of Temperature on enzyme (horse gram urease/alkaline phosphatase) activity.
6. Effect of substrate concentration on enzyme (serum alkaline phosphatase/urease) activity.
7. Determination of $K_m$ & $V_{max}$ of an enzyme (horse gram urease/alkaline phosphatase).
8. Partial purification of enzyme and determination of specific activity.
10. Enzyme inhibition studies and determination of Ki (cadmium chloride on alkaline phosphatase).

**Reference:**

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1. Extraction of genomic DNA
2. Extraction of plasmid DNA
3. Spectrophotometric analysis of purity of isolated DNA
4. Agarose gel electrophoresis of genomic and plasmid DNA
5. Restriction digestion of chromosomal DNA
6. Restriction digestion of plasmid DNA
7. Isolation of DNA fragment from agarose gel
8. Isolation of RNA

**Reference:**
COURSE OBJECTIVES: The objective of the course is to learn basic statistics and scientific communication.

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT- I – Central Tendency and Dispersion of Data 12h
Introduction- definition of statistics-population and universe- the sample and population- statistical inference- parameter and statistics
Handling of bulky data- construction a histogram- interpretation of histogram- the normal distribution- the mean-mode-and standard deviation- uncertainties in estimating a mean.

UNIT- II – Chi Square and Poisson’s Distribution 6h
Proportion data- Examples of Proportion data- MPM- sterility testing of medicines- animal toxicity-infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data-Chi-square test- goodness of fit to normal distribution.
Count data- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.). Statistical treatment to count data- Poisson’s distribution- standard error- confidence limits of counts.

UNIT- III - Test of significance 6h
Analysis of variance- Introduction –procedure-F and t test.

UNIT- IV – Correlation and Regression 8h
Correlation regression and line fitting through graph points- standard curves- correlation- linear regression (fitting the best straight line through series of points)- standards curves and interpolations of unknown y-values thereon.

UNIT- V – Scientific Writing & Communication 8h
Methodology for writing science report and oral presentation- compilation of experimental record-program of writing- use of vocabulary- use of good english-art of illustration- report writing- editing and correcting- technique of oral presentation.

Text Book:

Suggested Reading:

COURSE OUTCOME: At the end of the course the students will be able to apply appropriate statistical test for their analysis and will be able to effectively communicate scientifically.
**BCMB 436 - GENOMICS**

**COURSE OBJECTIVES:** To get an overview of genomics, its functional aspects and understanding of genome analysis.

**Pre-requisite** – Master’s level course in Molecular Biology.

**UNIT- I - Overview of Genomics**
Introduction to Genomics, number of genes and complexity of genomes, Structural genomics, Comparative genomics, Organelle genome: nuclear genome, mitochondria and chloroplast, Concepts of Metagenomics, Conservation and diversity of genomes.

**UNIT- II – The Genome project**
History, organization and goals of human genome project, Strategies for sequencing genomes, Genetic and physical map, DNA segment nomenclature, Organization of human genome: Mitochondrial genome, Gene density, CpG islands, RNA-encoding genes, functionally identical/similar genes, Diversity in size and organization of genes, Annotation. Human genome diversity, Human Microbiome Project, 16S rRNA analysis.

**UNIT- III – Functional genomics**

**UNIT- IV – Molecular markers in genome analysis**
Tools for genome analysis- RFLP, RAPD, AFLP, SSLPs, STR, EST and SNPs, Disease monitoring, Linkage and Pedigree, disease prognosis, genetic counseling.

**UNIT- V – Pharmacogenomics**
Pharmacogenetics, cancer genomics, immunogenomics, somatic cell Genomics, biochemical genomics, single cell analysis, Genetics of globin triplet repeat Disorders, polygenic inheritance, Effects of drugs in individual and susceptibility, Personalized medicine, Synthetic Genomes. Ethics and issues of synthetic.

**Text Books**

**Suggested reading**

**COURSE OUTCOME:** The course will impart understanding of comparative genomics, construction of protein interaction maps and outline the various experimental methods used to identify transcribed parts of a genome.
COURSE OBJECTIVES: To provide an overview of cellular metabolism, organization of metabolic networks and regulatory mechanisms.

Pre-requisite – Master’s level course in Biomolecules and Enzymology.

UNIT- I - General Introduction

UNIT- II - Metabolism of Lipids

UNIT- III - Metabolism of Amino acids
Overview of biosynthesis of non-essential amino acids from amphibolic intermediates – α-ketoglutarate, oxaloacetate, 3-phosphoglycerate. Glucose - alanine cycle, Urea cycle reactions.

UNIT-IV - Metabolism of Porphyrins
Biosynthesis and catabolism of Porphyrins – heme, bile pigments. Metabolism of Purines and Pyrimidines: biosynthesis and catabolism of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis.

UNIT- V - Dietary Minerals
Biological roles of magnesium, sodium, potassium and phosphate trace elements. Metabolism of iron: absorption, storage, transport and excretion, iron deficiency and overload. Genetic errors of metabolism: representative examples– galactosemia, phenylketonuria, alkaptonuria, albinism.

Text Books

Suggested Reading

COURSE OUTCOME: Understanding of different regulatory mechanisms in metabolic pathways, the key regulatory points in metabolic pathways and molecular mechanisms underlying major inherited diseases of metabolism.
BMB 438 - MOLECULAR ENDOCRINOLOGY

3 Credits

COURSE OBJECTIVES:
To provide basic understanding of organization, physiology and regulation of endocrine glands along with biological functions and control mechanisms.

Pre-requisite – Bachelor’s level course in Life Sciences.

UNIT- I – Introduction to Endocrinology 8h
Definition and scope of Endocrinology – historical and anatomical aspects of mammalian endocrine system. Definition of a hormone – chemical nature of mammalian hormones – types of hormone receptors. Secondary messenger systems – General mechanism of signaling by G protein coupled receptors, receptor tyrosine kinase and ion channels. General mechanism of peptide and non-peptide hormone action. Axis and feed-back regulation of endocrine system.

UNIT - II – Brain and gut hormones 8h

UNIT- III – Thyroid and Parathyroid gland hormones 8h

UNIT - IV– Adrenal gland and Adipose tissue hormones 8h

UNIT- V– Reproductive Endocrinology 8h

Text Books:
**Suggested Reading:**

**COURSE OUTCOME**
*Development of understanding of organization and functions of endocrine glands, feedback regulations, mechanisms of actions of hormones and clinical importance.*
BCMB 439 – MOLECULAR GENETICS

3 Credits

COURSE OBJECTIVES: The course will focus on the fundamental concepts in genetics and techniques used to predict genetic outcomes.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Introduction to Genetics
Molecular Evolution: History of Genetics and Evolutionary biology, Neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; origin of new genes and proteins; Gene duplication and divergence.
Mendelian and non-Mendelian principles: Laws of Inheritance, autosomal inheritance, Chi square analysis, Phenocopy, Inheritance of mitochondrial and chloroplast genes, X- linked Inheritance, Maternal Effect - Sex influenced and sex determined traits.

UNIT- II – Genome Mapping
Mapping in Bacteria, bacteriophages and yeast: - Mapping genes by interrupted mating, deletion mapping
Chromosomal Mapping in Eukaryotes: Linkage maps, - Physical Mapping- restriction mapping, mapping with molecular markers, somatic cell hybrids. Linkage mapping in haploid organisms - tetrad analysis, development of mapping population in plants.

UNIT- III – Developmental Genetics
Genetics of drosophila embryo development, axes and pattern formation in drosophila, Homeotic induction, Floral development in plants, Sex determination, Dosage compensation and X-inactivation in human female, Genomic imprinting.
Epigenetic regulation and inheritance – Chromatin modification, Euchromatin, Heterochromatin-DNA methylation, histone acetylation, histone methylation, non-coding RNAs in chromosomal remodeling and gene activity.

UNIT- IV – Human Genetics
Population Genetics: Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Human Impact in Genetic Variation, Co-evolution.

UNIT- V – Mutations and Genetics of Cancer
Genetics of Cancer: Defects in DNA repair, oncogenes and proto-oncogenes, viral oncogenes, tumor suppressor genes, genes in cell cycle checkpoint regulation and cancer.

Text Books

**Suggested Reading**

**COURSE OUTCOME:** Basic understanding of Mendelian /transmission genetics and mechanisms of non-Mendelian inheritance of traits, population and quantitative genetics and basic understanding of the genetic basis of development and cancer.
BCMB 485 - GENERAL MICROBIOLOGY LAB

1 Credit

1. Introduction to sterilization techniques- sterilization of glass wares, autoclaving.
2. Preparation of liquid and solid media
3. Isolation of Bacteria and fungi from soil samples – serial dilution technique
4. Measurement of bacterial population
5. Pure culture techniques: spread plate, streak plate technique and pour plate
6. Determination of Bacterial growth curve
7. Identification of bacteria by morphological and Biochemical characteristics
8. Smear preparation and staining of bacteria: simple staining, Grams staining and spore staining
9. In vitro antibiotic sensitivity tests for selected bacterial cultures
10. Methods for preserving microbial cultures: slant, glycerol stock and lyophilization

Reference:

BCMB 486 - METABOLISM AND REGULATION LAB

1 Credit

1. Estimation of urea
2. Estimation of uric acid
3. Estimation of creatinine
4. Determination of bilirubin
5. Estimation of pyruvate
6. Precipitation of calcium and estimation of calcium
7. Assay of acid phosphatase enzyme activity
8. Determination of catalase activity from liver/serum
9. Assay of alcohol dehydrogenase/ glutamate dehydrogenase enzyme activity in liver/ serum
10. Determination of alanine transaminase enzyme activity

Reference:


BCMB 536 - GENETIC ENGINEERING

3 Credits

COURSE OBJECTIVES: To provide understanding of genetic manipulation and gene transfer in addition to providing insights into its success in living systems.

Pre-requisite: Master’s level course in Molecular Biology.

UNIT- I - Introduction to Genetic Engineering 10h
Enzymes used in rDNA technology (Restriction enzymes, nuclease, RNA polymerases, DNA polymerases, PNK, alkaline phosphatases, DNA ligases). Cloning Vectors for E. coli: Plasmids, Bacteriophage λ, Filamentous phage, Cosmids, Phagemids and other advanced vectors: BAC, YAC, P1-derived Artificial Chromosome, Shuttle vectors, Expression vectors.

UNIT- II – Gene Transfer Techniques 8h

UNIT- III - Gene Cloning Strategies 7h

UNIT- IV – Gene Manipulation Techniques 8h

UNIT- V – Expression of Engineered Proteins 7h

Text Books

Suggested Reading
**COURSE OUTCOME:** Understanding of basic cloning, gene transfer techniques and methods of identifying the successful clones and expression of the desired protein, concepts of knock-in, knock-out and gene therapy.
BCMB 537 - IMMUNOLOGY

Course Objectives: To understand the basic concepts in Immunology and techniques used in Immunology research

Pre-requisite: Master’s level course in Cell Biology and Molecular Biology.

UNIT- I -Historic perspectives and introduction to immunology - 8h
History and scope of immunology; Types of Immunity-Innate/basic immunity, Acquired immunity-natural, artificial, active and passive immunity; nature of antigens, immunogenicity, antigenicity, epitopes; PAMPS, DAMPs; PRRs-Toll like receptors, acute phase proteins; functions of cells of myeloid and lymphoid lineage- granulocytes, dendritic cells, macrophages, T and B lymphocytes; Inflammatory response; Pathways of complement activation and its regulation

UNIT- II -Functions of Lymphoid organs- 6h
Primary and Secondary lymphoid organs; development of T and B lymphocytes in Thymus and Bone marrow-positive and negative selection; MHC restriction- types and significance of MHC molecules; antigen processing and presentation to T cells- endogenous and exogenous pathways; Formation of effector T and B lymphocytes in the secondary lymphoid organs; Lymphocyte recirculation

UNIT- III – Humoral Immunity and Immunological Techniques- 8h
Immunoglobulins-structure, types and biological functions; Primary and Secondary immune response; Molecular basis of antibody diversity-multiple germ-line gene segments, somatic gene recombination, N and P nucleotide addition and somatic hypermutation; Mechanism of antigen-antibody interaction; principle and applications of precipitation, agglutination reactions, ELISA, RIA, Western Blotting, and immunofluorescence techniques; Hybridoma technique- principle and methodology for production of monoclonal antibodies; Biomedical applications of murine and humanized monoclonal antibodies

UNIT- IV – Cell Mediated Immunity- 8h
Functions of T cell subsets-Th1, Th2, Treg, CTLs, and NK cells; Mechanism of activation of T cells; Tolerance mechanisms-central and peripheral tolerance-clonal deletion, clonal anergy; Role of cytokines in immune regulation; T cell-B cell interaction-immunoglobulin class switching; Mechanism of target cell killing by CTLs and NK cells-death signaling-induction of apoptosis-intrinsic and extrinsic pathways

UNIT- IV – Immunopathology- 10h
Types and causes of hypersensitivity reactions, autoimmune diseases and immune deficiency diseases; Transplantation immunity-types of grafts and the mechanism of graft rejection; Applications of physical, chemical and biological immunosuppressive agents. Vaccines: conventional vaccines-attenuated, killed and subunit vaccines; Modern vaccines- recombinant vaccines, DNA vaccines and Edible vaccines

Text Books:

Suggested Reading:
**COURSE OUTCOME:** Students will learn the basics of immune-surveillance mechanisms by both humoral and cell mediated immunity at molecular and cellular level. Students will also acquire knowledge on immunological techniques, immuno prophylaxis and immunotherapy.
BCMB 538 - PROTEOMICS

COURSE OBJECTIVES: The course focuses on the detailed study of proteins which represent the major proportion of functional molecules of the cell. The course will familiarize students on the application of technologies for the analysis and quantification of proteins.

Pre-requisite: Master’s Level Course in Genetic Engineering.

UNIT- I – Introduction to Proteomics
8h
Human genome - Genomes to Proteomes - HUPO –Human Proteome Project, Branches of proteomics - Protein extraction Methods: Subcellular fractionation, Density gradients, Ultrafiltration, - Protein fractionation - Affinity purification –Removal of interfering compounds, salts, DNA, lipids, Protein solubilization methods, chaotropes, detergents, etc - Sample handling and storage - Stable Isotope Labeling with Amino acids in Culture (SILAC)

UNIT- II – Structural Proteomics
6h
Protein structure-function relationship – Disulfide bonds, Post translational modifications, Glycosylation, Phosphorylation, other modifications, Applications - methods for detection of protein-protein interactions - Yeast 1 and 2 hybrid systems – Phage display – Surface Plasmon Resonance (SPR) - Fluorescence Resonance Energy Transfer (FRET).

UNIT- III – Proteomic Techniques for Analysis
10h

UNIT- IV – Protein expression
8h
Expression Systems –, E. coli, Yeast, Pitchia pastoris, Bacculovirus - introduction, detection and purification of expressed transgenes - antibody capture – antibody generation and Engineering – Protein/peptide chemical synthesis -- Protein-polynucleotide interactions Reconstitution of proteins in lipid vesicles, - Liposomes-Peptide and protein drugs.

UNIT- V – Proteomic approach for Clinical studies
8h
Protein Biomarker Discovery and Validation - low abundance and hydrophobic proteins. High through put techniques to identify protein molecules in sample Body fluid profiles, blood disease profiles, diabetes profiles stroke and myocardial infarction, Alzheimer, Proteomics in Biotechnology.

Text Books

Suggested Reading

COURSE OUTCOME: The course will impart the knowledge of Structural Proteomics, advances in high throughput technologies, protein engineering approaches for protein structure-function research.
BCMB 560 - GENETIC ENGINEERING LAB

1 Credit

1. Culture of *E. coli* cells & plasmid isolation
2. Preparation of competent cells
3. Calcium chloride mediated transformation
4. Ligation of DNA
5. Polymerase chain reaction
6. Restriction fragment length polymorphism
7. Random amplified polymorphic DNA
8. Sub-cloning of GFP protein

**Reference:**

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BCMB 561 - IMMUNOLOGY LAB

1 Credit

1. Agglutination reactions- Active agglutination- Widal Test, Blood group analysis
2. Passive agglutination reactions -Latex agglutination Test
3. Precipitation reactions on gel-double immuno diffusion
4. Single radial immunodiffusion (SRID)
5. Immunelectrophoresis (IEP)
6. ELISA technique
7. SDS-PAGE analysis
8. Immunoblotting technique

**Reference:**
BCMB 441 - GENERAL MICROBIOLOGY  

Course Objectives: To develop a lucid understanding of the microbial diversity, structural features of prokaryotes, culture conditions for bacteria and major microbial diseases.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Introduction to Microbiology  

6h

UNIT- II - Microbial diversity:  

8h
Carl Woese’s three domain system of classification. Major groups of bacteria- Archaeabacteria, Eubacteria; identification of bacteria based on phenetic, physiologic/metabolic characteristics and molecular phylogeny. General characteristics of major groups of Fungi, viruses and protozoa.

UNIT- III – Structural features of prokaryotic cells  

8h
Structure of Gram positive and Gram negative bacterial cell walls, periplasm, flagella, pili, capsule, cell membrane, nucleoid, plasmids, inclusion bodies and endospores; Life cycle of DNA and RNA viruses, bacteriophages - Lysogeny and Lytic cycle; Importance of virus like agents.

UNIT- IV – Culture techniques  

8h
Sterilization methods-physical and chemical methods-disinfectants, antiseptic agents; Culture media - composition and uses of solid, liquid, simple, complex, differential and selective media; continuous and synchronous culture; bacterial growth kinetics; Effect of pH, temperature and radiation on growth.

UNIT- V – Microbial diseases and antimicrobial agents  

10h
Respiratory diseases-diphtheria, tuberculosis, pneumonia and Influenza; Skin diseases-measles, chickenpox, human papilloma virus, and dermatophyte (tinea) infections; Diseases affecting GIT- Oral thrush, typhoid, cholera, pathogenic E. coli infections, amoebiasis, and hepatitis; Genitourinary infections –syphilis, candidiasis, HIV; Protozoan and helminthic diseases- malaria, trypanosomiasis and leishmaniasis, filariasis; Mode of action of antimicrobial agents - antibacterial, antiviral, antifungal, antihelminthic and antiprotozoan drugs; Mechanism of development of antibiotic resistance in microbes.

Text Books:

Suggested Reading:

COURSE OUTCOME: The course will impart knowledge on microbial diversity, structural features of different prokaryotes, growth characteristics of bacteria, major microbial diseases and their control.
BCMB 442 – HUMAN PHYSIOLOGY

3 Credits

COURSE OBJECTIVES: This course aims to introduce the students to the Physiological concepts of homeostasis and control mechanisms and to study the functions of body systems- with emphasis on clinical relevance.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I – Introduction and the Digestive System
Internal environment and homeostasis- coordinated body functions. Digestion- digestive processes at various regions of digestive system, regulation of -gastric secretion and motility- intestinal secretion and motility - role of gastrointestinal hormones.

UNIT- II – Cardiophysiology
Functional anatomy of heart - genesis and spread of cardiac impulses - cardiac cycle- heart sound- cardiac output- cardiovascular regulatory mechanisms - basic E.C.G. (Lead-II).

UNIT- III – Respiratory physiology

UNIT- IV – Renal physiology

UNIT- V – Nerve and Muscle Physiology
Nerve physiology - structure of neuron and synapses – excitability - action potential - conduction of nerve impulse-synaptic transmission - neurotransmitter systems.
Muscle physiology- skeletal and smooth muscle - electrical properties and ionic properties - types of muscle contraction.

Text Books

Suggested Reading

COURSE OUTCOME
The course will impart understanding of the structure function association of the physiological systems.
BCMB 443 - PLANT BIOCHEMISTRY AND BIOTECHNOLOGY

3 Credits

COURSE OBJECTIVES: To learn basic metabolic processes plants in addition to theoretical knowledge of various applications like tissue culture, transgenic crops and micro propagation.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I - Introduction to Plant cells


UNIT- II- Nitrogen metabolism & Plant hormones


UNIT- III - Plant Stress physiology & Secondary metabolites


UNIT- IV- Introduction to plant tissue culture


UNIT- V- Application of Plant Biotechnology


Text Book:

Suggested Reading:

COURSE OUTCOME: Basic knowledge of plant physiology and various metabolic processes and applications for crop improvement and micro propagation.
**BCMB 541 - CANCER BIOLOGY**

**3 Credits**

**COURSE OBJECTIVES:**
*To understand cancer and the complex mechanisms that underlie its development and progression and thus to identify ways to treat the disease.*

**Pre-requisite:** Master’s level course in Cell Biology and Molecular Biology.

**UNIT-I- Introduction to Cancer**
7 h

**UNIT-II- Cancer cell biology and biochemistry**
8 h

**UNIT-III- Carcinogenesis & Free radicals**
8 h

**UNIT-IV - Cancer cell regulation**
9 h
Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRCA1 and BRCA2. Telomeres and Immortality; cell- cell interactions, cell adhesion-invasion and metastasis - VEGF signaling, angiogenesis. Hypoxia; Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing; Apoptosis in cancer-cell death by apoptosis–role of caspases; Death signaling pathways-mitochondrial and death receptor pathways. Autophagy in cancer.

**UNIT-V - Diagnosis and Cancer treatment**
8 h

**Text Book:**

**Recommended Reading:**

**COURSE OUTCOME:**
On completion of this course, a student will get the basic biochemistry, development of cancer and regulation at cellular level. Strategies of anti-cancer drug therapy have also been introduced.
BCMB 542 - CLINICAL BIOCHEMISTRY  
3 Credits

**COURSE OBJECTIVES:** The course focuses on understanding the methodology and interpretation of biochemical tests performed on body fluids and tissues to support diagnosis, treatment and monitoring disease.

**Pre-requisite:** Master Level Course in Metabolism.

**UNIT- I - Clinical biochemistry and quality assurance**  
Clinical biochemistry: concept, definition and scope; Biological samples: types, collection, processing, stability and storage; Phlebotomy tubes; Chemical composition of biological fluids: blood, urine and cerebrospinal fluid; Reference range; Quality assurance; Accuracy, precision and reliability; other factors in quality control Factors. Values in health and diseases.

**UNIT- II – Kidney and Liver function test**  
Kidney function test: Assessment of renal function, creatinine clearance, renal calculi, uremia, Laboratory investigation of kidney disorders: acute and chronic renal failure.
Liver function tests: Clinical features and diagnosis of liver function tests. Bile pigments formation of bilirubin, urobilinogen, bile acids. Jaundice; pre-hepatic, hepatic and post hepatic, plasma changes, clinically important enzymes; alkaline phosphatase, AST, ALT and isoenzymes of creatinine kinase and LDH, prothrombin time.

**UNIT- III – Disorders of carbohydrate and lipid metabolism**  
Diabetes mellitus, insulin receptors and c- peptide assay, proinsulin and insulin antibodies. Hemoglobin Alc; fructosamines, insulin tolerance test. Glycogen storage diseases, galactosemia, fructosuria, pentosuria. Obesity, Hypercholesterolemia, Metabolic syndrome.

**UNIT- IV – Prenatal Diagnosis**  

**UNIT- V – Molecular diagnosis of genetic defects**  
DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR); amplification of mRNA. Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemachromatosis, thalassemias, sickle cell diseases), Clinical diagnosis of AIDS.

**Text Books**

**Suggested Reading**

**COURSE OUTCOME:** The course will enable the students to clinically assess the laboratory indicators of diseases and the biochemical and molecular tools needed to accomplish preventive, diagnostic, and therapeutic intervention on hereditary and acquired disorders.
Course Objectives: The course will focus on the biology and mechanism involving stem cells, their applications in replacing, regenerating and engineering human cells for translational regenerative medicine and ethical issues associated with the same.

Pre-requisite: Master’s level course in Cell Biology.

UNIT-I – Introduction to Stem Cells
Definition and Criteria for Stem Cells; Pluripotent, Multipotent and Totipotent Stem cells; Primordial germ cells, Embryonic stem cells; Amniotic fluid derived stem cells; Cord blood stem cells.

UNIT-II – Stem Cell Biology and Mechanisms
Molecular Basis of Pluripotency, Mechanisms of Self Renewal, Role of LIF/JAK/STAT, Nodal/Activin/TFGβ, FGF/MAP kinase pathways, Chromatin signature of pluripotent cells, Cell cycle regulators in Stem cells; Stem cell niches, Change of phenotype and differentiation, Senescence of Dividing somatic cells, aging and stem cell renewal, Quiescent Stem Cells.

UNIT-III – Tissue and Organ Development
Differentiation in early development, Potency, Commitment, Polarity and the specification of asymmetric divisions, induction, competence determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Epigenetic silencing and lineage commitment; Cellular differentiation of the nervous system, Progenitors in adult brain, Epithelial stem cells; Adult progenitor cells, Mesenchymal stem cells, Plasticity; De-differentiation, Cancer stem cells.

UNIT-IV – Stem Cell Technology
Characteristics and characterization of Human Pluripotent Cells; Fluorescence and Magnetic bead assisted cell sorting, Derivation, characterization and maintenance of Murine and Human Embryonic Stem Cells, Differentiation of embryonic stem cells; Derivation of induced pluripotent stem cells; Derivation and differentiation of Human Embryonic Germ Cells; Genomic Reprogramming, Fate Mapping of Stem Cells.

UNIT-V – Stem Cells in Regenerative Therapeutics
Neural stem cells in Neurodegenerative diseases; Hematopoietic stem cell transplantation; Epithelial stem cells and burns; Stem cells and heart disease; Pancreatic stem cells and diabetes; Liver stem cells and cell therapy for liver disease; Embryonic stem cells in tissue engineering, Examples of stem cells in Clinical Trials and translational therapeutics, stem cell banking, Ethical concerns in stem cell research.

Text Books:

Suggested Reading:

Course Outcome: The course will provide the basic understanding of stem cell biology and their applications in translational therapeutics.
OBJECTIVES: This is a job oriented course which will introduce the basic principles of modern drug design, discovery and regulations of drug development. The course will impart knowledge on clinical trials management, regulatory affairs and patent rights.

Pre-requisite: Master’s Level Course in Genetic Engineering.

UNIT- I 8h
General Introduction to public health, drug design and drug discovery, Sources of drugs – Plants, Microbial and Animal origin, Recombinant therapeutic proteins – Use of transgenic models for therapeutic purpose, Drug delivery systems, Pre-clinical drug development strategies.

UNIT- II 6h
Clinical Trials – Fundamentals of clinical operations, Study design and methodology in clinical trials, Inclusion and Exclusion criteria, Informed Consent process, Clinical Trials Phase- I, II, III, IV; Monitoring treatment outcome and Termination of a trial, Clinical data management, Quality control; Ethical, Legal and Regulatory aspects of clinical trials.

UNIT- III 6h

UNIT- IV 9h
Regulatory Affairs - Regulatory aspects for drug product design, Drug and Cosmetics Act, Schedule-Y, Regulatory bodies in India and regulations in developed countries, Medical device registration; Preparation, review and submission of drug master files to regulatory bodies, Final approval procedures. Patent and Intellectual property rights – Importance and overview of IPR, The Indian Patents Act, Type of patents, Provisional applications and Patent infringement.

UNIT- V 7h
Guidelines: Guides to Good Manufacturing Practice (GMP), Good Laboratory Practice (GLP), Good Clinical Practice (GCP), Central Drugs Standard Control Organization (CDSCO) guidelines, International Council for Harmonization of Technical Requirement for Pharmaceuticals for Human Use (ICH) guidelines – Quality, Safety, Efficacy and Multidisciplinary guidelines; WHO and FDA guidelines; NABL and NABH.

Text books:

Suggested Reading:
from ADME to Toxicity Optimization, Elsevier Inc, Academic Press, California.


**COURSE OUTCOME**

*The students will get orientation towards the protocols followed in pharmaceutical industry.*
**BCMB 545 - DEVELOPMENTAL BIOLOGY AND AGEING**  
3 Credits

**COURSE OBJECTIVES:** The course offers a detailed understanding of the intricacies of developmental biology and how each step of development, patterning and ageing process takes place and how it is regulated at the molecular and cellular level.

**Course Pre-requisite:** Master Level Course in Cell Biology and Molecular Biology.

**UNIT - I – Introduction to Developmental Biology**  
6h
History and basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation. Morphogenetic gradients, cell fate and cell lineages, stem cells, genomic equivalence and the cytoplasmic determinants, imprinting, mutants and transgenics in analysis of development.

**UNIT - II – Early embryonic development**  
9h

**UNIT - III – Cell-cell communication and signaling in development**  
6h
Concepts of induction and competence, epithelial-mesenchymal interactions, role of FGF-RTK pathway, JAK-STAT, Hedgehog family, Wnt family, TGF-β superfamily, Notch pathway and developmental signals from extracellular matrix. Juxtacrine signaling and cell patterning.

**UNIT - IV – Model organisms, organogenesis and Sex determination**  
9h

**UNIT - V – Postembryonic development and ageing**  
10h

**Text Books:**

**Suggested reading:**

**COURSE OUTCOME:** The course will enable to gain a clear understanding of the stages of development, patterning and ageing process in various model organisms.
BCMB 546 – NEUROBIOLOGY

3 Credits

COURSE OBJECTIVES: The course focuses on the basic concepts Neurobiology and observing the interdisciplinary nature of the Neurosciences will encourage participation from students majoring in Physics, Chemistry, Psychology and Computer Science alongside the students of the School of Life Sciences.

Pre-requisite: Bachelor’s level course in Basic Biology.

UNIT- I – Gross Neuroanatomy and Cellular Components of Nervous System 10h

UNIT- II – Developmental Neurobiology 7h
Induction and patterning of body axis and neural development –Homeotic induction, morphogenic gradients, role of sonic hedgehog, TGF β and Wnt signaling, generation and survival of neurons and glia – Role of Notch Signaling and JAK STAT pathway - Activity dependent maturation of synapses – plasticity of mature synapses and circuits. Regeneration and Repair: Regenerative repair in the CNS and PNS, Stem cells in regenerative therapy.

UNIT- III – Neurotransmitters 10h

UNIT- IV – Brain and Behavior: 7h
Approaches and methods in study of behavior; Proximate and ultimate causation; Development of behavior; Social communication; Habitat selection, Social dominance, Mating systems, Parental investment and Reproductive success; Aggressive behavior, Migration, orientation and navigation, Photo-periodism, Circadian Rhythm– Sleep and arousal. Neural basis of Complex Behaviors: Learning, memory, Emotions, Stress and Adaptation, Altruism and evolution.

UNIT- V – Neurodegenerative and Neurochemical Disorders 6h

Text Books

Suggested Reading

COURSE OUTCOME: The course will provide the basic understanding of anatomical organization of the central and peripheral nervous system and its development, how communication in neural circuits leads to sensory perceptions, movement, behavior, learning and memory. Mechanisms of neurodegenerative processes and cellular processes of regeneration and basic neuropharmacology.
BCMB 547 - INDUSTRIAL CONVERGENCE IN LIFE SCIENCES
2 Credits

COURSE OBJECTIVES:
Skill development geared towards trained manpower for employment & entrepreneurship
Understand the present trends in life science industry
Familiarization to role of microbiome & awareness
Responsibility towards environment & climate change
Initiate curiosity in entrepreneurship.

Course Pre-requisite: Master’s Level Course in Genetic Engineering.

UNIT – I 6h
Introduction to biofoundries & biofactories – Introduction to synthetic biology. Production of artemisinin as case study. Building the new bio-economy. Introduction to Biofoundries & circuits. Role of automation and robotics in biofactories; use of plants for engineering biologics & small molecules. Biosurfactants as an example of microbial cell factory based production.

UNIT- II 5 h
Contemporary techniques in industry – Gene shuffling for large scale pathway assembly and engineering; Choices for microbial hosts for industrial applications – bacteria, yeast, insect. Gene editing methods – CRISPR/ Cas; Gene sequencing – Pyro sequencing, Nanopore sequencing.

UNIT- III 5 h
Microbiome Communities – Definition & role of microbiome on human health and wellbeing; Role of 16s rRNA based identification – metagenomics approaches for microbiome analysis; Human Microbiome project; Anti-microbial resistance and superbugs – methods to counter; specific case studies on its influence (positive & negative) on plants (soil microbiome), animals (poultry – minimize use of antibiotics) and aquaculture (viruses). Rapid responses to counter bio-terrorism.

UNIT – IV: 5h
Conservation Biology & Climate Change - Impact of climate change, Community response and Government policies, Ecological footprint, Clean Development Mechanism (CDM); Earth summit, Kyoto protocol, Framework convention on Climate change (UNFCCC); Genetic methods for conservation biology; Assessment of carbon and water footprint on processes. Biodiversity act & agencies regulating it (National & State biodiversity authorities). Potential biological methods to counter plastic & e-wastes.

UNIT – V 5h
Introduction to Entrepreneurship in life sciences – Need for entrepreneurship in life-sciences, Types of life-science companies in India (biopharma, bioagri, bioinformatics, bio services, biocatalysts, bioindustrial) and their growth; New startups & bio-medical device companies; Types of bio-incubators (Bioparks, Bioclusters, BioNests); Bio industry associations – BIO, ABLE,
AIBA: Funding avenues in India for entrepreneurship development – Government initiates (DBT - BIRAC), philanthropic (Gates, Wellcome, DNDi) & private funding; Types of companies and steps in company formation; Steps in compiling business plan. Introduction to regulatory agencies – DGCI, CIB, NBA, GEAC, FSSAI, CDSCO, ISO.

Text Books:

Suggested Reading:
1. Gene editing
   ii. https://www.addgene.org/crispr/guide/
7. CII report on biotech startups in India, 2017.
COURSE OBJECTIVES: The aim of this course is to provide basic knowledge about applications of nanoscience in the field of Biotechnology and Medicine.

Pre-requisite: Bachelor’s level course in Life Sciences.

UNIT- I – Introduction
Overview of Nanomaterials and nanoparticles in biological applications; Biomimetic nanostructures; Overview of DNA and protein based nanostructures; Inorganic nanoparticles; Applications of nanotechnology in bioseparations, enzymatic reactions and tissue/cell culture.

UNIT- II- Biological synthesis and characterization of nanomaterials
Biosynthesis- microbial, plant mediated synthesis. biofunctionalization of nanosurfaces with peptides and proteins. Bacteriorhodopsin: structure and its potential applications in nanobiotechnology; S-layers: structure and its applications; Cell-nanomaterial interactions; Monitoring nano-bio interactions: Cell targeting and cell penetrating peptides Atomic Force Microscopy.

UNIT -III -Implications of Nanobiotechnology
Nanotoxicity: Absorption and distribution of Nanoparticles in vivo; Toxicological effects of nanoparticles in various target organs in vivo.

UNIT- IV -Nanostructures for Analytics
Nanoparticles for electrobiochemical assays; Quantum dots in biology; Nanoparticle based biosensors; Protein nanoarrays; DNA nanoarrays; Lab-on-a-chip; Microfluidics: Definition and history, Advantages of microfluidic devices and their potential for nanobiotechnology.

UNIT- V -Nanoparticles for Diagnostic and Therapeutics
Introduction to drug delivery; Drug delivery systems based on nanotechnology; PLGA, lipid based nanoparticles, nanocrystals; Nanocarriers for applications in medicine; siRNA delivery using nanoparticles; Targeted drug delivery using nanocarriers; Nanoparticle contrast agents for magnetic resonance imaging; Nanodiamonds for bioimaging and therapeutic applications; Nanotherapeutics.

Text Books:

Suggested Reading:

COURSE OUTCOME: The course will enable to account for interaction of biomolecules with surfaces of different chemical and physical species, account for production and the applications of various types of nanostructured materials.
COURSE OBJECTIVES:

To enable the students to identify a research problem, perform review of literature, plan a study to address the same and frame a research proposal and defend the same.

Course Pre-requisite: Master Level Course on Biostatistics and Scientific Writing.

Course Plan –

This course will have the following components –

1. Identifying a Research Problem.
3. Planning a study to address the research question.

COURSE OUTCOME:

The students will learn to -

• Identify research gaps through study of scientific literature and device ways to address the same.
• Review Literature in their respective field of Research.
• Gain the experience of presenting a research proposal before an evaluating committee.
BCMB 581 - DISSERTATION

4 Credits

COURSE OBJECTIVES:
To enable the students to have hands-on research experience and write a comprehensive report, present, and defend the same.

Course Pre-requisite: BCMB 548: Pre-Project and Presentation

Course Plan -

This course will have the following components –

1. Executing the proposed Research Plan.
2. Designing and planning experiments.
3. Performing experiments or in silico studies based on the criteria.

COURSE OUTCOME:
The students will learn to execute a research proposal, prepare a project report and present, and defend the same.