MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

College with Potential for Excellence

NAAC Accredited and Reaccredited 'A+ Grade' Institution

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Integrated M.Sc. Programme in Basic Sciences – BIOLOGY

SYLLABUS

PROGRAMME STRUCTURE AND CREDITS

(2020 Admission onwards)

INTEGRATED PG PROGRAMS: UNDER MAHATMA GANDHI UNIVERSITY REGULATIONS 2020-2021

1. SHORT TITLE

These Regulations shall be called Mahatma Gandhi University Regulations (2020) governing Integrated Post Graduate Programmes under Credit Semester System (MGU).

These Regulations shall come into force from the Academic Year 2020-2021 onwards

2. SCOPE

The regulation provided herein shall apply to all Integrated Post-Graduate Programmes in the affiliated colleges with effect from academic year 2020-2021 admissions.

3. DEFINITIONS

'Academic Committee' means the Committee constituted by the Vice Chancellor under this regulation to monitor the running of the Integrated Post- Graduate Programmes under the Credit Semester System (MGU IPG CSS2020)

'Academic Week' is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration each day. A sequence of minimum 18 such academic weeks constitute a semester.

'Audit Course' is a course for which no credits are awarded.

'CE' means Continuous Evaluation (Internal Evaluation)

'College Co-ordinator' means a teacher from the college nomiated by the College Council to look into the matters relating to MGU IPG for Programmes conducted in the College.

'Comprehensive viva-voce' means the oral examinations conducted by the examiners appointed for the purpose and shall cover all courses of study undergone by a student of the Programme.

'Common Course' is a core course which is included in more than one programme with the same course code.

'Complementary Course' is a course which is generally related to the core course.

'Core Course' means a course which cannot be substituted by any other course.

'Course' means a segment of subject matter to be covered in a semester. Each Course is

to be designed variously under Lectures / Tutorials / Laboratory or Fieldwork / Seminar / Project / Practical Training / Assignments / Viva – voce etc., to meet the effective teaching and learning needs.

'Course Code' means a unique alpha numeric code assigned to each course of a program.

'Course Credit' One credit of the course is defined as a minimum of one hour lecture / minimum 2 hours lab / field work per week for 18 weeks in a semester. The course will be considered as completed only by conducting the final examination.

'Course Teacher' means the teacher of the institution in charge of the course offered in the Programme.

'Credit' of a course is a numerical value which depicts the measure of the weekly unit of work assigned for that course in a semester.

'Credit Point (CP)' of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course **CP = GP x Cr**

'Cumulative Credit Point Average (CCPA)' is the value obtained by dividing the sum of credit points of all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places. CCPA determines the overall performance of a student at the end of a programme.

[CCPA = Total CP obtained / Total Credits of the Programme]

'Department' means any teaching Department in the affiliated college / Institution offering a programme of study approved as per the relevant provisions of the Act / Statutes of the University.

'Department Council' means the body of all teachers of a Department in a college.

'Dissertation' means a long document on a particular subject in connection with the project / research / field work, etc.

'Duration of Programme' means the period of time required for the conduct of the programme. The duration of Integrated Post Graduate Programme shall be 10 semesters spread over 5 academic years.

'Elective Course' means a course, which can be substituted, by an equivalent course from the same subject.

'Elective Group' means a group consisting of elective courses for the programme.

'ESE' means End Semester Evaluation [External Evaluation]

'Evaluation' is the process by which the knowledge acquired by the student is quantified as per the criteria detailed in these regulations.

'External Examiner' is the teacher appointed from other colleges for the valuation of courses of study undergone by the students in a college. The external examiner shall be appointed by the University.

'Faculty Advisor' is a teacher nominated by the Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department of the affiliated College / Institution.

'Grade Point *GP+' – Each letter grade is assigned a 'Grade Point' *GP+ which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

'Grade Point Average *GPA+' is an index of the performance of a student in a semester. It is obtained by dividing the sum of the weighted grade points obtained in the semester by the sum of the weights of the course (GPA=ΣWGP/ΣW).

'Improvement Course' is a course registered by a student for improving his/her performance in that particular course, along with the subsequent batch. No improvement will be allowed for VI and X Semesters.

'Internal Examiner' is a teacher nominated by the department concerned to conduct Internal Evaluation.

'Letter Grade' or 'Grade' for a course is a letter symbol [A+, A, B+, B, C, D] which indicates the broad level of performance of a student for a course.

'Parent Department' means the department which offers a particular Integrated Post Graduate programme.

3.33. **'Plagiarism'** is the unreferenced use of other authors' material in dissertations and assignments and is a serious academic offence.

'Programme' means the entire course of study and examinations. 3.37 **'Project'** is a core course in a programme. It means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department / any appropriate research center in order to submit a dissertation on the project work as specified. It allows students to work more autonomously to construct their own learning and culminates in realistic, student-generated products or findings.

'Repeat Course' is a course that is repeated by a student for having failed in that course in an earlier registration.

'Semester' means a term consisting of minimum 90 working days, inclusive of examinations, distributed over a minimum of 18 weeks of 5 working days each.

'Seminar' means a lecture given by a student on a selected topic and is expected to train the student in self-study, collection of relevant matter from various resources, editing, document writing and presentation.

'Semester Credit Point Average' *SCPA+ is the value obtained by dividing the sum of credit points [CP] obtained by a student in the various courses taken in a semester by the total number of credits for the course in that semester. The SCPA shall be rounded off to two decimal places. SCPA determines the overall performance of a student at the end of a semester

[SCPA = Total CP obtained obtained in the semester / Total Credits for the Semester].

'Tutorial' Tutorial means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

'University' means Mahatma Gandhi University Kottayam, Kerala.

'Weight' is a numeric measure assigned to the assessment units of various components of a course of study.

'Weighted Grade Point' *WGP+ is the grade point multiplied by weight. **[WGP=GPxW]**

'Weighted Grade Point Average *WGPA+' is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points by the sum of the weights. WGPA shall be obtained for CE (Continuous Evaluation) and ESE (End Semester Evaluation) separately and then the combined WGPA shall be obtained for each course.

Words and Expressions used and not defined in this regulation but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statutes.

4. ACADEMIC COMMITTEE

There shall be an Academic Committee constituted by the Vice Chancellor to manage and monitor the working of MGU IPG CSS2021.

The Committee consists of:

a) The Vice-Chancellor
b) The Pro-Vice-Chancellor
c) The Registrar
d) The Controller of Examinations
e) Two Teachers nominated from among the Syndicate Members

There shall be a sub-committee nominated by the Vice Chancellor to look after the day- today affairs of the Mahatma Gandhi University Regulations for the Integrated Post Graduate Programmes.

5. PROGRAMME STRUCTURE

Students shall be admitted to Integrated Post Graduate Programme under the various faculties. Medium of instruction shall be **English**, except for programmes under Faculty of Language and Literature. The programme shall include four types of courses - Core Courses, Complementary Courses, Elective Courses, and Common Courses. There shall be a project / dissertation and comprehensive viva voce in the VI and X Semester as part of core courses for all programmes. The programme shall also include Assignments / Seminars / Practicals / Internships.

Core Courses

Core courses are included in all semesters (except semester X) of the programme as theory, practical, projects and comprehensive viva courses. Semester X is exclusively for doing Major Project. External examination for Comprehensive Viva shall also be conducted in semester X.

Complementary Courses

There shall be one or two complementary/Vocational courses in the programme. The number of such courses, their credits and teaching hours shall in a par with the corresponding UG programme stream (model I/II/III). Such courses **shall not** have more credits and teaching hours than the corresponding UG Programme. If the UG programme has no such complementary courses, then the corresponding credits may be given to the core courses.

Elective Courses and Bunches

The student/college shall select **three** (unless otherwise specified) elective courses for each programme as per the interest of the student, availability of faculty and academic infrastructure of the institution. There shall be three (unless otherwise specified) elective bunches **A, B** and **C** each of

which consists of a **minimum** of two elective courses. All the elective courses have equal credits of 4 (unless otherwise specified). The student/college shall select **one** elective course each from bunch A, B and C as the elective courses for semesters **6, 8 and 9** respectively. The hours/week of courses in different bunches may vary. However, the hours/week of all courses in a particular bunch **should be the same**.

In the case of subjects which have their conventional UG programmes in Model II/III structure only (Eg.: Computer Science), the pattern of electives mentioned in 5.3.1 may change. For such integrated programmes, the number of electives, and thus the number of elective bunches, may vary. The details of the elective course distribution shall be given in the concerned curriculum.

The elective courses selected by the College shall be intimated to the Controller of Examinations within two weeks of commencement of the semester in which the elective courses are offered. The elective course selected by the college, on behalf of the students admitted in a particular academic year shall not be changed.

Project Work

Project work shall be completed in accordance with the guidelines given in the curriculum.

There shall be **two Projects** (one **Minor** project and one **Major** project), unless otherwise specified, in a programme. Evaluation of the Minor Project will be done in the **sixth** semester and that of Major Project will be done in the **tenth** Semester. **Minor Project** work shall be carried out under the supervision of a teacher of the department concerned.

The final semester (semester X) is dedicated for **Major Project**. Major project can be based on a three to four month Internship/industrial training/laboratory engagements at reputed institutions or research organisations etc.

The college shall provide a list of institutions to the students. The students may choose their project place from the list as per their aptitude/interest. However, if a student wants to do his/her project in an institution which is not enlisted, the college may include that institution also in the list.

The college should ensure the quality of the institutions by considering the following points. Availability of experts as guides/supervisors, well-equipped laboratories/industries/firms, other technical supports, possibility of higher studies/employment and any other relevant factors.

After completing the initial formalities, the student needs to join the organisation within one week of the commencement of last semester. He/she may be given a relieving letter to produce before the new organisation and shall send a copy of the joining letter to the parent institution.

The student is required to re-join the parent institution before two weeks of the ending of Xth semester. At the time of re-joining, the student needs to submit the following items to the Head of the parent institution/Head of the Department.

a) Relieving letter from the Head of the Organisation/Department where the student did his/her internship.
b) Internal evaluation form duly signed by the Head of the organisation and Supervisor/Guide where he/she has undergone internship.
c) A brief report of his/her work duly signed by the supervisor/guide (one or two pages).
d) Dissertation/Thesis duly signed by the Head of the organisation/department and Supervisor/Guide where he/she has undergone internship.

The parent institution holds the right to bring the student back at any stage of the internship. Details regarding the structure and conduct of Major Projects of an Integrated Programme shall be explained in the corresponding curriculum.

There shall be an internal assessment and external assessment for both the Project Works. The Project Works shall be evaluated based on the presentation of the project work done by the student, the dissertation submitted and the viva-voce of the project.

The external evaluation of the Project Works shall be conducted by one External examiner from a different college and an internal examiner from the college concerned.

Assignments: Every student shall submit **at least** one assignment as an internal component for each course.

Seminar Lecture: Every College Going student shall deliver one seminar lecture as an internal component for every course. The seminar lecture is expected to train the student in selfstudy, collection of materials relevant to the subject of study from various resources, editing, document writing, and presentation.

Test Papers (Internal): Every student shall undergo **at least** one class test as an internal component for each course.

No courses (Except Major Project) shall have **more than 5** credits unless otherwise specified.

Comprehensive Viva-voce

Comprehensive viva-voce shall cover questions from all core and elective courses of the programme. There shall be an internal and an external assessment for the comprehensive viva- voce.

Total Credits Required

a	Programme Duration	10 semesters
b	Total credits required for successful completion of the programme	200
c	Total Credits required from semester 1 to 6	120
d	Total Credits required from semester 7 to 10	80
e	Credits required from Common Course 1 (Semester 1 & 4 only)	8
f	Credits required from Common Course 2 (Semester 2 only)	4
g	Credits required from Core (including Electives & Minor Project) and Complementary / Vocational Courses – from Semester 1 to 6	108

Credits Distribution

Sl No.	Courses	Semester	Total Credits
1	Core (excluding Project)+ Complementary/ Vocational Courses	1 to 6	**102**
2	Core (excluding Project & Viva)	7 to 9	**52**

3	Elective	6, 8 & 9 (Unless otherwise specified)	**12** (4 each) (Unless otherwise specified)
4	Complementary 1	1 & 2	Same as UG credits
	Complementary 1 (for Science Subjects)	1 to 4	Same as UG credits
5	Complementary 2	3 & 4	Same as UG credits
	Complementary 2/ Vocational Course (for Science Subjects)	1 to 4	Same as UG credits
6	Common Course 1	1 & 4	**8**
7	Common Course 2	2	**4**
8	Minor Project	6	**2**
9	Major Project	10	**16**
10	Comprehensive Viva	10	**4**
	Total		**200**

5.11 Audit Course: Audit courses are courses with no credits, but have teaching hours. Different programmes may consist of different audit courses according to the nature of the subjects. Such courses shall be internally evaluated and the result will be either a 'Pass' or a 'Fail'. There is no supplementary evaluation process for audit courses. The result shall be mentioned in the grade card.

6. ATTENDANCE

The minimum requirement of aggregate attendance during a semester for appearing at the end semester-examination shall be **75%**. Condonation of shortage of attendance to a maximum of 15 days in a semester, subject to a maximum of two times during the whole period of the programme may be granted by the University.

If a student represents his / her institution, University, State or Nation in Sports, NCC, or Cultural or any other officially sponsored activities such as College Union, University Union, etc, he / she shall be eligible to claim the attendance for the actual number of days participated, subject to the attendance certificate from concerned authorities and based on the specific recommendations of the Head of the Department or teacher concerned.

Those who could not register for the examination of the particular semester due to shortage of attendance may repeat the semester along with junior batches, without considering sanctioned strength, subject to the existing University Rules and Clause 7.2 of this regulation.

7. REGISTRATION / DURATION

A student shall be permitted to register for the programme at the time of the admission. A student who has registered for the programme shall complete the Programme within a period of Seven years from the date of commencement of the programme.

8. ADMISSION

The admission to all regular IPG programmes shall be through Centralized Allotment Process (CAP) of the Mahatma Gandhi University, unless otherwise specified.

The eligibility criteria for admission to IPG Programmes shall be published by the University along with the notification for admission.

There shall be provision for inter-collegiate transfer, from second semester onwards to the corresponding semester of the same IPG programme, if seats are available, within a period of four weeks from the date of commencement of the semester.

There shall be provision of Credit Transfer, subject to the conditions stipulated by the Board of Studies / Expert Committee concerned.

9. ADMISSION REQUIREMENTS

Students admitted to these Programmes are governed by the eligibility requirements specified by Mahatma Gandhi University Regulations in force.

10. PROMOTION

A student who registers for a particular semester examination shall be promoted to the next semester. However, a student who registers for the IX Semester should have completed all the courses successfully up to VI Semester.

A student having 75% attendance for the semester and fails to register for end of semester examination of that particular semester shall be allowed to register notionally and is promoted to the next semester, provided application for notional registration shall be submitted before the University within 15 days from the commencement of the next semester.

11. EXAMINATIONS

There shall be University examinations at the end of every semester.

Practical examinations shall be conducted by the University at the end of even semesters as prescribed in the syllabus of the particular programme. The number of examiners for the practical examinations shall be prescribed by the Board of Practical Examinations of the Programme. The odd semester's practical examination shall be conducted internally or externally as prescribed by the university.

End-Semester Examinations: The examinations shall normally be conducted at the end of each semester using Question Bank developed by MG University.

1.4 There shall be one end-semester examination of 3-hours duration for each lecture/ practical course.

11.5 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage.

12. EVALUATION AND GRADING

Evaluation: The evaluation scheme for each course shall contain two parts:

(a) End Semester Evaluation [**ESE**] [External Evaluation] and (b) Continuous Evaluation [**CE**][Internal Evaluation]. 25% weightage shall be given to the internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both End Semester Evaluation [ESE] and Continuous Evaluation [CE] shall be carried out using Direct Grading system.

Direct Grading: The direct grading for CE [Internal] and ESE [External Evaluation] shall be based on 6 letter grades **[A+, A, B, C, D and E]** with numerical values of **5, 4, 3, 2, 1 and 0** respectively.

Grade Point Average [GPA]: Internal and External components are separately graded and the combined grade point with weightage 1 for internal and 3 for external shall be applied to calculate the Grade Point Average [GPA] for each course. Letter grade shall be assigned to each course based on the categorization provided in 12.17

Internal Evaluation for Programme: The Internal Evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars, seminar lectures, lab skills, records, viva-voce, etc.

Components for Internal [CE] and External Evaluation [ESE]: Grades shall be given to the evaluation of theory / practical / project / comprehensive viva voce and all internal evaluations are based on the Direct Grading System. Proper guidelines shall be prepared by the Board of Studies / Expert Committee for evaluating the assignment, seminar, practical, project and comprehensive viva-voce within the framework of the regulation.

12. 6 There shall be no separate minimum grade point for internal evaluation.

The models of the components and its weightages for Continuous Evaluation [CE] and End Semester Evaluation [ESE] are shown below:

a) For Theory (CE) [Internal]

No.	Components	Weightage
I	Assignment	2
II	Seminar	4
III	Test Paper 1	2

IV	Test Paper 2	2
	Total	**10**

b) For Theory (ESE) (External)

Evaluation is based on the pattern of question specified in 12.15 **c) For Practical (CE) (Internal)**

No.	Components	Weightage
I	Lab Test	2
II	Lab involvement & Record	2
III	Viva	1
	Total	**5**

(The components and its weightage of the Practical (Internal) can be modified by the concerned BOS without changing the total weightage 5)

d) For Practical (ESE) (External)

No.	Components	Weightage
I	Principle/Procedure/ flowchart/Programme etc.	6
II	Observation/ Calculation/ Graph/ Programme debugging & execution etc.	6
III	Result/ analysis/ error calculation etc.	3
	Total	**15**

(The components and its weightage of the Practical (External) can be modified by the concerned BOS without changing the total weightage 15) **e) For Project – Minor (CE) (Internal)**

No.	Components	Weightage
I	Project Involvement & Data collection.	2
II	Project Analysis & Presentation	2

III	Project Viva	1
	Total	**5**

(The components and its weightage of the Project – Minor (Internal) can be modified by the concerned BOS without changing the total weightage 5.)

f) For Project – Minor (ESE) (External)

No.	Components	Weightage
I	Relevance of the topic & Analysis	6
II	Project content, Presentation & Report.	6
III	Project Viva	3
	Total	**15**

(The components and its weightage of the Project - Minor (External) can be modified by the concerned BOS without changing the total weightage 15)

g) For Project – Major (CE) (Internal)

This has to be obtained from the institution where the student is doing the major project.

No.	Components	Weightage
I	Project Involvement	1
II	Data collection	1
III	Project Analysis	1
IV	Result	1
V	Project Viva	1
	Total	**5**

(The components and its weightage of the Project – Major (Internal) can be modified by the concerned BOS without changing the total weightage 5.)

h) For Project – Major (ESE) (External)

No.	Components	Weightage
I	Relevance of the topic & Data Collection.	3
II	Project Analysis	3
III	Project content & Result	3

IV	Presentation & Dissertation	3
V	Project Viva	3
	Total	**15**

(The components and its weightage of the Project – Major (External) can be modified by the concerned BOS without changing the total weightage 15)

i) Comprehensive viva-voce (CE) (Internal)

No.	Components	Weightage
I	Communication/ Presentation	1
II	Topics from all semesters	2
III	Topic of Interest	2
	Total	**5**

(The components and the weightage of the components of the Comprehensive Viva (Internal) can be modified by the concerned BOS without changing the total weightage 5)

j) Comprehensive viva-voce (ESE) (External)

No.	Components	Weightage
I	Communication/ Presentation	3
II	Topics from all semesters	6
III	Topic of Interest	6
	Total	**15**

(Weightage of the components of the Comprehensive viva-voce (external) **shall not** be modified)

All grade point averages shall be rounded to two decimal points.

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board

at least one week before the commencement of external examination.

There shall **not** be any chance for improvement for internal grade. However, the students can redo the same.

The **course teacher** and the **faculty advisor** shall maintain the academic record of each student registered for the course which shall be forwarded to the University through the Principal and a copy should be kept in the college for verification for at least two years after the student completes the programme.

External Evaluation. The external examination in theory courses is to be conducted by the University at the end of the every semester. The answers may be written in **English** or in **Malayalam** except those for the Faculty of Languages. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably through Centralized Valuation.

12.13. Photocopies of the answer scripts of the external examination shall be made available to the students on request as per the rules prevailing in the University.

The question paper should be strictly on the basis of model question paper set and directions prescribed by the BOS / Expert Committee.

Pattern of Questions for Theory examination

Questions shall be set to assess knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage shall be given to each module based on content/teaching hours allotted to each module.

The question setter shall ensure that questions covering all skills are set.

A question paper shall be a judicious mix of short answer type, short essay type/problem solving type and long essay type questions.

The question shall be prepared in such a way that the answers can be awarded A+. A. B, C. D, E grades.

Total Weight is **30**. Different types of questions shall be given different weights to quantify their range as follows:

Sl. No.	Type of Questions	Weightage	No. of questions to be answered
1	Short Answer type questions.	1	8 out of 10
2	Short Essay/Problem solving type questions	2	6 out of 8
3	Long Essay type questions	5	2 out of 4

Pattern of question for Practical Examination

The pattern of questions for external evaluation of practical shall be prescribed by the **concerned Board of Studies**.

Direct Grading System

Direct Grading System based on a **6-point** scale is used to evaluate the Internal and External examinations taken by the students for various courses of study.

Grade	Grade Point	Range
A+	5	4.50 to 5.00

A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

Performance Grading

Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a **7-point** scale as detailed below.

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very Good
3.00 to 3.49	B	Good (Average)
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal (Pass)
Up to 1.99	D	Deficient (Fail)

No Separate minimum is required for internal evaluation for a pass, but a **minimum** C grade is required for a pass in an external evaluation. However, a **minimum** C grade is required for pass in a course.

A Student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

Improvement of Course- The candidates who wish to improve the grade/grade point of the external examination of course/courses he/she has passed can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch.

One Time Betterment Programme- A candidate will be permitted to improve the **CGPA** of the programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The **CGPA** for the betterment appearance will be computed based on the **SGPA** secured in the original or betterment appearance of each semester whichever is higher. If a candidate opts for the betterment of **CGPA** of a programme, he/she has to appear for the external examination of the entire semester(s) excluding practicals/project/comprehensive viva-voce. One time betterment programme is restricted to students who have passed in all courses of the programme at the regular (First) appearance.

Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) Calculations.

The **SGPA** is the ratio of sum of the credit points of all courses taken by a student in the semester to the total credit for that semester. After the successful completion of a semester, **Semester Grade Point Average (SGPA)** of a student in that semester is calculated using the formula given below.

$$\textbf{Semester Grade Point Average = SGPA (Sj)} = \frac{\sum (Ci \times Gi)}{\sum Ci}$$

$$\textbf{ie, SGPA} = \frac{\text{Total Grade Points awarded in a semester}}{\text{Total Credits of the semester}}$$

where **'Sj'** is the **jth** semester, **Gi** is the grade point scored by the student in the **ith** course **Ci** is the credit of the **ith** course.

Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula:-

$$\textbf{Cumulative Grade Point Average = CGPA} = \frac{\sum (Ci \times Si)}{\sum Ci}$$

$$\textbf{ie, CGPA} = \frac{\text{Total Grade Points awarded in all semesters}}{\text{Total Credits of the programme}}$$

where **'Ci'** is the credits for the **ith** semester, **Si** is the **SGPA** for the **ith** semester. The SGPA and CGPA shall be rounded off to 2 decimal points.

For the successful completion of a semester, a student shall pass all courses and score a minimum **SGPA** of 2.00. However, a student is permitted to move to the next semester irrespective of her/his **SGPA**.

13. GRADE CARD

The university under its seal shall issue to the students, a consolidated grade card on completion of the programme, which shall contain the following information.

a. Name of the University
b. Name of College
c. Title of the Integrated PG Programme

d. Name of the Semesters

e. Name and Register Number of the student

f. Code, Title, Credits and Max GPA (Internal, External & Total) of each course (Theory & Practical), Projects, viva etc. in each semester.

g. Internal, external and total grade, Grade Point (G), Letter Grade and Credit Point (P) in each course opted in the semester.

h. The total credits and total credit points in each semester.

i. Semester Grade Point Average (SGPA) and corresponding Grade in each semester

j. Cumulative Grade Point Average (CGPA), Grade for the entire programme.

k. A one line statement as '**This First Degree Programme is recognised as equivalent to <name of the conventional degree & Subject> Degree Programme of Mahatma Gandhi University, Kottayam, Kerala'** (for First degree Grade Card) **OR**,

A one line statement as '**This Integrated Degree Programme is separately recognised as equivalent to the corresponding conventional <name of the conventional degree & Subject> degree and <name of the conventional PG degree & Subject> Degree Programme of Mahatma Gandhi University, Kottayam, Kerala'** (for Final Degree Grade Card).

For a student who got **lateral entry** in the 7th semester and completed the programme successfully: A one line statement as '**This Final Degree Programme is recognised as equivalent to <name of the conventional PG degree & Subject> Degree Programme of Mahatma Gandhi University, Kottayam, Kerala'** (for Final degree Grade Card only).

l. Separate Grade card will be issued at the request of candidates and based on University Guidelines issued from time to time.

m. Details of description of evaluation process-Grade and Grade Point as well as indicators, calculation methodology of SGPA and CGPA as well as conversion scale shall be shown on the reverse side of the grade card.

14. INTERIM EXIT OR LATERAL ENTRY FACILITY

The Integrated Programme consists of an Under Graduate (UG) programme (up to semester VI) as the first degree and a Post Graduate (PG) programme (from semester VII to semester X) as the final degree. Thus, all the Programmes would carry the nomenclature of "**Integrated <name of the first degree> - <name of the final degree>**". Therefore, the Integrated Programme intends to offer two separate degrees with an option for Interim Exit or Lateral Entry. The student shall avail the interim exit facility only after the completion of semester VI. If the student completes up to semester VI **successfully**, he/she shall be awarded a 'First Degree Programme in <Subject> (Degree)' Degree *Ex: First Degree Programme in Physics (B.Sc)], which is recognized as equivalent to the corresponding conventional degree (First Degree). The total credits required for such a degree is 120 (see
5.10.1).

On successful completion of the whole Programme, the student shall be awarded an 'Integrated <name of the first degree> - <name of the final degree> (Specialisation, if required)' degree [Ex. Integrated BA-MA English, Integrated B.Sc-M.Sc Physics (Electronics)]. Here the first degree (semester I to VI) and final degree (semester VII to X) are individually and separately recognized as equivalent to corresponding conventional degrees.

Eligible students may avail 'Lateral entry' facility for admission to VIIth semester of the programme, provided sufficient seats are available. Applicants who have a **UG degree** or **equivalent** in the concerned subject, with a required credit of 120, can apply for lateral entry. The eligibility and other criteria are the same as that for the corresponding PG admission. The lateral admission is **strictly** based on merit and university norms which exist at the time of admission. The details of selection process shall be announced by the university at the time of lateral entry.

15. AWARD OF DEGREE (Graduate/ Post Graduate)

The successful completion of all the courses with 'C' grade within the stipulated period shall be the minimum requirement for the award of the degree.

16. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Vice-Chancellor to monitor the internal evaluations conducted by institutions.

17. POSITION CERTIFICATE

The University shall publish the list of top 10 candidates for each programme after the publication of the programme results. Position certificates shall be issued to candidates who secure positions from 1st to 3rd in the list. Position certificate shall be issued to candidates on their request.

Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank/position. Rank certificate and position certificate shall be signed by the Controller of Examinations.

18. GRIEVANCE REDRESSAL COMMITTEE

Department Level: The College shall form a Grievance Redressal Committee in each Department comprising of the course teacher and one senior teacher as members and the Head of the Department as Chairperson. The Committee shall address all grievances relating to the internal assessment grades of the students.

College Level: There shall be a College level Grievance Redressal Committee comprising of faculty advisor, college coordinator, one senior teacher and one staff council member, and the Principal as Chairperson.

University Level: The University shall form a Grievance Redressal Committee as per the existing norms.

19. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Vice-Chancellor shall, for a period of three year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

20. REPEAL

The Regulations now in force in so far as they are applicable to programmes offered by the University and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Credit Semester System in their application to any course offered in a College, the latter shall prevail.

21. CREDITS ALOTTED FOR PROGRAMMES AND COURSES

Total credit for each programme shall be 200
Semester-wise total credit can vary from 16-25

21.3. The Minimum credit of a course (excluding Major Project) is 1 and maximum credit is 5, unless otherwise specified.

22. COMMON COURSE

If a course is included as a common course in more than one programme, its credits shall be same for all programmes

23. COURSE CODES

The course codes assigned for all courses (core course, elective courses, common courses etc.) shall be unique.

24. **Models** of distribution of courses, course codes, type of the course, credits, teaching hours for a programme are given in the following tables.

EXAMPLE 1

PROGRAMME STRUCTURE (WITHOUT PRACTICAL)

SEMESTER	Sl. No.	CODE	TITLE	HOURS/ WEEK	CREDITS	TOTAL HOURS
	1	Code1	ENGLISH 1	5	4	90
	2	Code2	CORE1	4	3	72
	3	Code3	CORE2	4	3	72

I	4	Code4	CORE3	4	3	72
	5	Code5	CORE4	4	3	72
	6	Code6	COMPLEMENTARY 1 - PAPER I	4	4	72
			TOTAL	**25**	**20**	**450**
II	1	Code7	SECOND LANGUAGE	5	4	90
	2	Code8	CORE5	4	3	72
	3	Code9	CORE6	4	3	72
	4	Code10	CORE7	4	3	72
	5	Code11	CORE8	4	3	72
	6	Code12	COMPLEMENTARY 1 - PAPER II	4	4	72
			TOTAL	**25**	**20**	**450**
III	1	Code13	CORE9	4	3	72
	2	Code14	CORE10	4	3	72
	3	Code15	CORE11	4	3	72
	4	Code16	CORE12	4	3	72
	5	Code17	CORE13	4	3	72
	6	Code18	COMPLEMENTARY 2 - PAPER 1	5	4	90
			TOTAL	**25**	**19**	**450**
IV	1	Code19	ENGLISH 2	5	4	90
	2	Code20	CORE14	4	4	72
	3	Code21	CORE15	4	3	72
	4	Code22	CORE16	4	3	72
	5	Code23	CORE17	3	3	54
	6	Code24	COMPLEMENTARY 2 - PAPER 2	5	4	90
			TOTAL	**25**	**21**	**450**
V	1	Code25	CORE18 - Environmental Studies & Human Rights	5	4	90
	2	Code26	CORE19	4	3	72
	3	Code27	CORE20	4	3	72
	4	Code28	CORE21	4	3	72
	5	Code29	CORE22	4	3	72
	6	Code30	CORE23	4	3	72

			TOTAL	**25**	**19**	**450**
VI	1	Code31	CORE24	4	3	72
	2	Code32	CORE25	4	3	72
	3	Code33	CORE26	4	3	72
	4	Code34	CORE27	4	3	72
	5	Code35	CORE28	4	3	72
	6	Code36	ELECTIVE I (Bunch A)	5	4	90
	7	Code37	PROJECT - MINOR		2	0
			TOTAL	**25**	**21**	**450**
VII	1	Code38	CORE29	5	4	90
	2	Code39	CORE30	5	4	90
	3	Code40	CORE31	5	4	90
	4	Code41	CORE32	5	4	90
	5	Code42	CORE33	5	4	90
			TOTAL	**25**	**20**	**450**
VIII	1	Code43	CORE34	5	4	90
	2	Code44	CORE35	5	4	90
	3	Code45	CORE36	5	4	90
	4	Code46	CORE37	5	4	90
	5	Code47	ELECTIVE II (Bunch B)	5	4	90
			TOTAL	**25**	**20**	**450**
IX	1	Code48	CORE38	5	4	90
	2	Code49	CORE39	5	4	90
	3	Code50	CORE40	5	4	90
	4	Code51	CORE41	5	4	90
	5	Code52	ELECTIVE III (Bunch C)	5	4	90
			TOTAL	**25**	**20**	**450**
X	3	Code53	PROJECT - MAJOR		16	
	4	Code54	COMPREHENSIVE VIVA		4	
			TOTAL		**20**	

EXAMPLE 2

PROGRAMME STRUCTURE (WITH PRACTICAL)

SEMESTER	Sl. No.	CODE	TITLE	HOURS/ WEEK	CREDITS	TOTAL HOURS
I	1	Code1	ENGLISH 1	5	4	90
	2	Code2	CORE1	4	3	72

	3	Code3	CORE2	4	3	72
	4	Code4	CORE3	2	2	36
	5	Code5	COMPLEMENTARY 1 - PAPER I	4	3	72
	6	Code6	COMPLEMENTARY 2 - PAPER I	2	2	36
	7	Code7	CORE PRACTICAL-1	2	2	36
	8	Code15	COMPLEMENTARY 2- PRACTICAL-1	2		36
			TOTAL	**25**	**19**	**450**
II	1	Code8	SECOND LANGUAGE	5	4	90
	2	Code9	CORE4	4	3	72
	3	Code10	CORE5	4	3	72
	4	Code11	CORE6	2	2	36
	5	Code12	COMPLEMENTARY 1 - PAPER II	4	3	72
	6	Code13	COMPLEMENTARY 2 - PAPER II	2	2	36
	7	Code14	CORE PRACTICAL 2	2	2	36
	8	Code15	COMPLEMENTARY 2- PRACTICAL-1	2	2	36
			TOTAL	**25**	**21**	**450**
III	1	Code16	CORE7	4	3	72
	2	Code17	CORE8	4	3	72
	3	Code18	CORE9	3	2	54
	4	Code19	COMPLEMENTARY 1 - PAPER 3	5	4	90
	5	Code20	COMPLEMENTARY 2 - PAPER 3	3	3	54
	6	Code21	CORE PRACTICAL 3	2	2	36
	7	Code22	CORE PRACTICAL 4	2	2	36
	8	Code30	COMPLEMENTARY 2- PRACTICAL-2	2		36
			TOTAL	**25**	**19**	**450**
IV	1	Code23	ENGLISH 2	5	4	90
	2	Code24	CORE10	3	2	54
	3	Code25	CORE11	3	2	54
	4	Code26	COMPLEMENTARY 1 - PAPER 4	5	4	90
	5	Code27	COMPLEMENTARY 2 - PAPER 4	3	3	54

	6	Code28	CORE PRACTICAL 5	2	2	36
	7	Code29	CORE PRACTICAL 6	2	2	36
	8	Code30	COMPLEMENTARY 2-PRACTICAL-2	2	2	36
			TOTAL	**25**	**21**	**450**
V	1	Code31	CORE12 - Environmental Studies & Human Rights	5	4	90
	2	Code32	CORE13	4	3	72
	3	Code33	CORE14	4	3	72
	4	Code34	CORE15	4	3	72
	5	Code35	CORE16	4	3	72
	6	Code36	CORE PRACTICAL 7	2	2	36
	7	Code37	CORE PRACTICAL 8	2	2	36
			TOTAL	**25**	**20**	**450**
VI	1	Code38	CORE17	4	3	72
	2	Code39	CORE18	4	3	72
	3	Code40	CORE19	4	2	72
	4	Code41	CORE20	4	2	72
	5	Code42	ELECTIVE I (Bunch A)	5	4	90
	6	Code43	CORE PRACTICAL 9	2	2	36
	7	Code44	CORE PRACTICAL 10	2	2	36
	8	Code45	PROJECT - MINOR		2	0
			TOTAL	**25**	**20**	**450**
VII	1	Code46	CORE21	4	4	72
	2	Code47	CORE22	4	3	72
	3	Code48	CORE23	3	3	54
	4	Code49	CORE24	3	3	54
	5	Code50	CORE25	3	3	54
	6	Code51	CORE PRACTICAL 11	4	2	72
	7	Code52	CORE PRACTICAL 12	4	2	72
			TOTAL	**25**	**20**	**450**
VIII	1	Code53	CORE26	4	4	72
	2	Code54	CORE27	4	3	72
	3	Code55	CORE28	3	3	54
	4	Code56	CORE29	2	2	36
	5	Code57	ELECTIVE II (Bunch B)	4	4	72
	6	Code58	CORE PRACTICAL 13	4	2	72
	7	Code59	CORE PRACTICAL 14	4	2	72
			TOTAL	**25**	**20**	**450**
IX	1	Code60	CORE30	4	4	72
	2	Code61	CORE31	3	3	54

	3	Code62	CORE32	3	3	54
	4	Code63	CORE33	2	2	36
	5	Code64	ELECTIVE III (Bunch C)	5	4	90
	6	Code65	CORE PRACTICAL 15	4	2	72
	7	Code66	CORE PRACTICAL 16	4	2	72
TOTAL				**25**	**20**	**450**
X	3	Code67	PROJECT - MAJOR		16	
	4	Code68	COMPREHENSIVE VIVA		4	
TOTAL					**20**	

* Complementary1 is a course without Practicals.
Complementary2 is a course with Practicals.

EXAMPLE 3

PROGRAMME STRUCTURE (Computer Science)

SEMESTER	Sl. No.	COURSE CODE	COURSE TITLE	HOURS/ WEEK	CREDITS	TOTAL HOURS
I	1	Code1	ENGLISH 1	5	4	90
	2	Code2	Core 1	4	3	72
	3	Code3	Core 2	3	3	54
	4	Code4	Core 3	3	3	54
	5	Code5	Complementary 1 Paper 1	4	4	72
	6	Code6	Core Practical 1	6	4	108
TOTAL				**25**	**21**	**450**
II	1	Code7	SECOND LANGUAGE	5	4	90
	2	Code8	Core 4	3	3	54
	3	Code9	Core 5	3	3	54
	4	Code10	Core 6	4	4	72
	5	Code11	Complemetary 1 Paper 2	4	4	72
	6	Code12	CorePractical 2	6	4	108
TOTAL				**25**	**22**	**450**
III	1	Code13	Core 7	4	4	72
	2	Code14	Core 8	3	3	54
	3	Code15	Core 9	4	3	72
	4	Code16	Core 10	4	4	72
	5	Code17	Complementary 2 Paper 1	4	4	72
	6	Code18	Core Practical 3	6	2	108

			TOTAL	**25**	**20**	**450**
IV	1	Code19	ENGLISH II	5	4	90
	2	Code20	Complementary 2 Paper 2	4	3	72
	3	Code21	Core 11	4	4	72
	4	Code22	Core 12	4	3	72
	5	Code23	Core 13	4	3	72
	6	Code24	Complemetary 2 Practical 2	2	2	36
	7	Code25	Core Practical 4	2	1	36
			TOTAL	**25**	**20**	**450**
V	1	Code26	Core 14	3	4	54
	2	Code27	Core 15	4	3	72
	3	Code28	Core 16	4	3	72
	4	Code29	Core 17	3	4	54
	5	Code30	Project Minor - Phase I	3	0	54
	6	Code31	Core Practical 5	8	3	144
			TOTAL	**25**	**17**	**450**
VI	1	Code32	Core 18	3	3	54
	2	Code33	Core 19	4	4	72
	3	Code34	Core 20	4	4	72
	4	Code35	Elective 1 (Bunch A)	3	3	54
	5	Code36	Project Minor Phase II	7	4	126
	6	Code37	Core Practical 6	4	2	72
			TOTAL	**25**	**20**	**450**
VII	1	Code38	Core 21	4	4	72
	2	Code39	Core 22	4	4	72
	3	Code40	Core 23	4	4	72
	4	Code41	Core 24	4	3	72
	5	Code42	Core practical 7	5	3	90
	6	Code43	Core practical 8	4	2	72
			TOTAL	**25**	**20**	**450**
VIII	1	Code44	Elective 2 (Bunch B)	4	4	72
	2	Code45	Core 25	4	4	72
	3	Code46	Core 26	4	4	72
	4	Code47	Elective 3 (Bunch C)	4	4	72
	5	Code48	Core practical 9	5	2	90
	6	Code49	Core practical 10	4	2	72
			TOTAL	**25**	**20**	**450**

IX	1	Code50	Elective 4 (Bunch D)	4	4	72
	2	Code51	Core 27	4	3	72
	3	Code52	Core 28	4	4	72
	4	Code53	Elective 5 (Bunch E)	4	4	72
	5	Code54	Core practical 11	4	2	72
	6	Code55	Case Study and Minor Project	5	3	90
TOTAL				**25**	**20**	**450**
	1	Code56	Major Project		16	
	2	Code57	Comprehensive Viva		4	
TOTAL				**25**	**20**	**450**

APPENDIX

A. Evaluation first stage – Both Internal and External (to be done by the teacher)

Grade	Grade Point	Range
A+	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

The final Grade range for Courses, SGPA and CGPA

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very Good
3.00 to 3.49	B	Good (Average)
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal (Pass)
Up to 1.99	D	Deficient (Fail)

A. Theory – External - ESE

Maximum weight for external evaluation is 30. Therefore Maximum Weighted Grade Point (WGP) is 150.

Type of question	Qn. Nos.	Grade Awarded	Grade Point	Weight	Weighted Grade Point (WGP)
Short Answer	1	A+	5	1	5
	2	-	-	-	-
	3	A	4	1	4
	4	C	2	1	2
	5	A	4	1	4
	6	A	4	1	4
	7	B	3	1	3
	8	A	4	1	4
	9	B	3	1	3
	10	-	-	-	-
Short Essay	11	B	3	2	6
	12	A+	5	2	10
	13	A	4	2	8
	14	A+	5	2	10
	15	-	-	-	-
	16	-	-	-	-
	17	A	4	2	8
	18	B	3	2	6
Long Essay	19	A+	5	5	25
	20	-	-	-	-
	21	-	-	-	-
	22	B	3	5	15
			TOTAL	**30**	**117**
Calculation: Overall Grade of the Theory paper = Sum of weighted Grade Points / Total Weight = 117/30 = 3.90; Grade B+					

B. Theory – Internal (CE)

Maximum weight for Internal evaluation is 10. Therefore Maximum Weighted Grade Point (WGP) is 50.

Components	Weight (W)	Grade Awarded	Grade Point (GP)	WGP = W*GP	Overall Grade of the Course
Assignment	2	A	4	8	WGP/Total Weight = 48/10 = 4.80 = **A+**
Seminar	4	A+	5	20	
Test Paper 1	2	A+	5	10	
Test Paper 2	2	A+	5	10	
Total	**10**			**48**	**A+**

C. Practical – External (ESE)

Maximum weight for External evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75.

Components	Weight (W)	Grade Awarded	Grade Point (GP)	WGP = W*GP	Overall Grade of the Course
Principle/Procedure/ Programme etc.	6	A	4	24	WGP/Total Weight = 69/15 = 4.60 = **A+**
Observation/ Graph/ Programme debugging & execution etc.	6	A+	5	30	
Result/ analysis/ error calculation etc.	3	A+	5	15	
Total	**15**			**69**	**A+**

D. Practical – Internal (CE)

Maximum weight for Internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	Weight (W)	Grade Awarded	Grade Point (GP)	WGP = W*GP	Overall Grade of the Course
Lab Test	2	A	4	8	WGP/Total Weight = 20/5 = 4.00 = **A**
Lab involvement & Record	2	A+	5	10	
Viva	1	C	2	2	
Total	**5**			**20**	**A**

E. Project – Major (External)

Maximum weight for External evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75.

Components	Weight (W)	Grade Awarded	Grade Point (GP)	WGP = W*GP	Overall Grade of the Course
Relevance of the topic & Data Collection.	3	C	2	6	WGP/Total Weight = 51/15 = 3.40 = **B**
Project Analysis	3	A+	5	15	
Project content & Result	3	B	3	9	

Presentation & Dissertation	3	A	4	12	
Project Viva	3	B	3	9	
Total	**15**			**51**	**B**

F. Project – Major (Internal)

Maximum weight for Internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	**Weight (W)**	**Grade Awarded**	**Grade Point (GP)**	**WGP = W*GP**	**Overall Grade of the Course**
Project Involvement	1	C	2	2	WGP/Total Weight = 18/5 = 3.60 = **B+**
Data collection	1	A+	5	5	
Project Analysis	1	B	3	3	
Result	1	A	4	4	
Project Viva	1	A	4	4	
Total	**5**			**18**	**B+**

G. Project – Minor (External)

Maximum weight for External evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75.

Components	**Weight (W)**	**Grade Awarded**	**Grade Point (GP)**	**WGP = W*GP**	**Overall Grade of the Course**
Relevance of the topic & Analysis	6	C	2	12	WGP/Total Weight = 51/15 = 3.40 = **B**
Project content, Presentation & Report.	6	A+	5	30	
Project Viva	3	B	3	9	
Total	**15**			**51**	**B**

H. Project – Minor (Internal)

Maximum weight for Internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	**Weight (W)**	**Grade Awarded**	**Grade Point (GP)**	**WGP = W*GP**	**Overall Grade of the Course**
Project Involvement & Data collection.	2	C	2	4	WGP/Total Weight = 17/5 = 3.40 = **B**
Project Analysis & Presentation	2	A+	5	10	
Project Viva	1	B	3	3	

Total	**5**			**17**	**B**

I. Comprehensive Viva (External)

Maximum weight for External evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75.

Components	**Weight (W)**	**Grade Awarded**	**Grade Point (GP)**	**WGP = W*GP**	**Overall Grade of the Course**
Communication/ Presentation	3	C	2	6	WGP/Total Weight = 54/15 = 3.60 = **B+**
Topics from all semesters	6	A+	5	30	
Topic of Interest	6	B	3	18	
Total	**15**			**54**	**B+**

J. Comprehensive Viva (Internal)

Maximum weight for Internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	**Weight (W)**	**Grade Awarded**	**Grade Point (GP)**	**WGP = W*GP**	**Overall Grade of the Course**
Communication/ Presentation	1	C	2	2	WGP/Total Weight = 18/5 = 3.60 = **B+**
Topics from all semesters	2	A+	5	10	
Topic of Interest	2	B	3	6	
Total	**5**			**18**	**B+**

B. Evaluation second stage (To be done by the University)

Consolidation of the Grade (GPA) of a Course PC-1

The End Semester Evaluation (ESE) (External Evaluation) grade awarded for the course PC-1 is A (Grade point awarded is 4.20) and its continuous Evaluation (CE) (Internal Evaluation) grade is A (Grade point awarded is 4.40). The consolidated grade for the course PC-1 is calculated as follows.

Evaluation	Weight (W)	Grade awarded	Grade Points awarded (G)	Weighted Grade Point (W*G)
External	3	A	4.20	12.60
Internal	1	A	4.40	4.40
Total	4			17
Grade of a course	**GPA** of the Course = Total weighted grade points/ Total Weight = 17/4 = 4.25; **Grade 'A'**			

C. Evaluation Third Stage (To be done by the University)

Semester Grade Point Average (SGPA)

Course Code	Title of the Course	Credits (C)	Grade awarded	Grade Points awarded (G)	Grade Points (GP=C*G)
01	PC1	5	A	4.25	21.25
02	PC2	5	A	4.00	20.00
03	PC3	5	B+	3.80	19.00
04	PC4	2	A	4.40	8.80
05	PC5	3	A	4.00	12.00
Total		20			81.05
SGPA	Total Grade points/ Total Credits = 81.05/20 = 4.05; **Grade 'A'**				

D. Evaluation- Fourth Stage (To be done by the University)

Cumulative Grade Point Average (CGPA)

If a candidate is awarded **three** A+ grades, **two** A grades, **one** B+ grade, **two** B grades, **one** C+ grade and **one** C grade as the **SGPA** of various semesters of the programme as given below, then the CGPA is calculated as follows.

Semester	Credit of the Semester (C)	Grade Awarded	Grade Point Average (SGPA)	Credit Points (C*SGPA)
I	19	A+	4.50	85.50
II	21	A+	4.60	96.60
III	19	B	3.00	57
IV	21	A+	4.50	94.5
V	20	A	4.00	80
VI	20	A	4.10	82

VII	20	C	2.20	44
VIII	20	B+	3.60	72
IX	20	B	3.40	68
X	20	C+	2.80	56
TOTAL	**200**			**735.6**
CGPA	**Total Grade points awarded / Total Credit of all semesters = 735.6/200 = 3.68, which is in the range 3.50 to 3.99 in 7-point scale. Therefore, the overall grade awarded in the Program is 'B+'.**			

Conversion of CGPA into percentage of marks

Percentage of marks = (CGPA x 20)%

Eg. CGPA of 3.68 = (3.68x20) % = 73.60 %

The curriculum and the "Mahatma Gandhi University Regulations Governing Post Graduate Integrated Programmes Under Credit Semester System 2020" have since been uploaded in the website- www.mgu.ac.in.

Additional Reference for clauses 5.1, 5.2, 5.3.1 & 5.3.4 – U.O.No: 1743/ACAIV/2022/MGU, dtd: 19.02.2022

MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS) Members of Board of Studies Subject: BASIC SCIENCE- BOLOGY(Integrated PG)	
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EXPERTS from outside the Parent University	
Dr. Tapas Manna	Professor Department of Biology Indian Institute of Science Education and Research (ISER) Thiruvananthapuram
Dr. Jos T. Puthur	Professor Department of Botany University of Calicut Calicut University P.O.-673635 Tel: Mobile: +91-9447507845, E Mail:jtputhur@yahoo.com
Dr. Sreejith. P.	Assistant Professor Department of Zoology University of Kerala Kariavattom Campus, Thiruvananthapuram-Kerala p.sreejith@gmail.com 09496793794
Dr. T. P. Sajeevan	Professor Department of Marine Biology, Microbiology and Biochemistry, Cochin University of Science and Technology, Lakeside Campus, Kochi-16 Mob: 9946099408 sajeev@cusat.ac.in
MEMBER TEACHERS	
Dr. Aji C. Panicker	Associate Professor Department of Zoology Mar Athanasius College

INTEGRATED PROGRAMME OUTCOMES

PO No.	Upon completion of postgraduate programme, the students will be able to:
PO-1	Create, apply and disseminate knowledge leading to innovation
PO-2	Think critically, explore possibilities and exploit opportunities positively
PO-3	Work in teams, facilitating effective interaction in work places.
PO-4	Lead a sustainable life
PO-5	Embrace lifelong learning

PROGRAMME SPECIFIC OUTCOMES

PSO No.	**Intended Programme Specific Outcomes (PSO)** ***Upon completion of BSc. Zoology Degree Programmes, the graduates will be able to:***	**GPO** No.
PSO-1	Develop a broad foundational knowledge of the faunal and floral diversity especially local fauna and flora, pattern of evolution, morphologicalfeatures, adaptation and classification	**GPO.3** **GPO.4**
PSO-2	Show proficiency in performing various basic and advanced laboratory techniques employed in Biology in academia and industries.	**GPO.3** **GPO.4** **GPO.5**
PSO-3	Understand the basic concepts in cell biology, environmental biology, biochemistry, developmental biology, genetics, evolution, microbiology, immunology, research methodology, statistics and physiology	**GPO.1**
PSO-4	Understand the application of biological sciences in aquaculture, apiculture, vermiculture and quail farming agricultural pest management there by getting employed or impart skill for a source of additional income and self-employment	**GPO.6**
PSO-5	Generate innovative ideas for performing experiments in the areas of biochemistry, physiology, genetics, microbiology, developmental biology, bioinformatics, taxonomy, economic zoology and ecology	**GPO.6**

PSO-6	Explain the recent developments in genetic engineering, biotechnology, immunology, microbiology, general informatics and bioinformatics for research activities in the department research center or in collaboration with other research institutes	**GPO.2**
PSO-7	Use concepts, tools and techniques related to chemistry, physics, mathematics and computer to acquire knowledge and its application in biology. To improve communication in skill in English and regional language for scientific communication in Global and regional perspersitive. Understand basic human rights.	**GPO.1** **GPO.5** **GPO.6**

SEMESTER I

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20EN1CC01	Basic English Grammar and Communication	Theory	5	4
IP20ML1CC01	Saahithya Padanam	Theory	5	4
IP20HN1CC01	Prose and One Act Plays			
IP20BS1CR01	Systematics and Diversity of Lower Life Forms and Non Vascular Plants	Theory	2	2
IP20BS1CR02	Systematics and Diversity of Invertebrates	Theory	2	2
IP20MT1CM01	Fundamentals in Mathematics	Theory	3	3
IP20CH1CM01	Bio-Physical Chemistry	Theory	2	2
IP20BS2CRP1	Systematics and Diversity of Lower Life Forms and Non Vascular Plants	Practical	2	0
IP20BS2CRP2	Systematics and Diversity of Invertebrates	Practical	2	0
IP20CH2CMP1	Bio-Physical Chemistry	Practical	2	0
Total			25	17

SEMESTER II

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS2CR01	Systematics and Diversity of Vascular Plants	Theory	2	2
IP20BS2CRP1	Systematics and Diversity of Vascular Plants (P)	Practical	2	2
IP20BS2CR02	Systematics and Diversity of Vertebrates	Theory	2	2
IP20BS2CRP2	Systematics and Diversity of Vertebrates (P)	Practical	2	2
IP20MT2CM01	Mathematical biology	Theory	5	4
IP20CS2CM01	Basics in Computing	Theory	2	2
IP20PH2CMP1	Basics in computing(p)	Practical	2	1
IP20PH2CM01	Introductory physics	Theory	2	2
IP20PH2CMP1	Introductory physics(p)	Practical	2	2
IP20CH2CM01	Organic chemistry	Theory	2	2
IP20CH2CMP1	Organic chemistry(p)	Practical	2	2
Total			25	23

SEMESTER III

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS3CR01	Plant Anatomy and Physiology	Theory	3	3
IP20BS3CR02	Animal Anatomy and Physiology	Theory	3	3
IP20BS3CR03	Science Education	Theory	5	4
IP20CS3CM01	Computer Science	Theory	3	3
IP20CH3CM01	Inorganic Chemistry	Theory	3	3
IP20BS4CRP1	Plant Anatomy and Physiology (P)	Practical	2	0
IP20BS4CRP2	Animal Anatomy and Physiology	Practical	2	0
IP20CS3CMP1	Computer Science (P)	Practical	2	1
IP20CH4CMP1	Inorganic Chemistry(P)	Practical	2	0
Total			25	17

SEMESTER IV

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20EN4CC01	Listening, Speaking, Reading, Writing and Understanding Literature	Theory	5	4
IP20BS4CR01	Bioinstrumentation	Theory	3	3
IP20BS4CR02	Cell biology	Theory	3	3
IP20PH4CM01	Biophysics	Theory	3	3
IP20CH4CM02	Bio-organic and Green Chemistry	Theory	3	3
IP20BS4CRP1	Bioinstrumentation(p)	Practical	2	1
IP20BS4CRP2	Cell biology(p)	Practical	2	2
IP20PH4CMP1	Biophysics(p)	Practical	2	2
IP20CH4CMP1	Bio-organic and green chemistry(p)	Practical	2	2
Total			25	23

SEMESTER V

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS5CR01	Genetics	Theory	3	3
IP20BS5CR02	Evolutionary Biology And Ethology	Theory	3	3
IP20BS5CR03	Biostatistics	Theory	3	3
IP20BS5CR04	Environmental Biology And Human Rights	Theory	3	3
IP20BS5CR05	Soft Skill Development	Theory	4	3
P20BS6CRP2	Evolutionary Biology And Ethology (P)	Practical	2	0
P20BS6CRP3	Environmental Biology And Human Rights(P)	Practical	2	0
P20BS6CRP3	Biostatistics (P)	Practical	2	0
P20BS6CRP4	Genetics (P)	Practical	2	0
	Mini Project		1	0
Total			25	15

SEMESTER VI

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS6CR01	Plant Reproduction and Breeding	Theory	3	3
IP20BS6CR02	Animal Reproduction and Breeding	Theory	3	3
IP20B6CR03	Molecular Biology	Theory	3	3
IP20BS6CR04	Research methodology	Theory	2	1
IP20BS6CR05	Occupational Biology	Theory	3	3
IP20BS6CRP1	Plant Reproduction and Breeding (P)	Practical	2	2
IP20BS6CRP2	Animal Reproduction and Breeding (P)	Practical	2	2
IP20BS6CRP3	Molecular Biology (P)	Practical	2	2
IP20BS6CRP4	Occupational Biology(P)	Practical	2	2
	Mini Project		3	4
Total			25	25

SEMESTER VII

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS7CR01	Pathology	Theory	5	4
IP20BS7CR02	Biomedical Sciences	Theory	5	4
IP20BS7CR03	Microbiology and Immunology	Theory	5	4
IP20BS7CR04	Systems Biology	Theory	4	3
IP20BS7CRP1	Pathology (P)	Practical	2	2
IP20BS7CRP2	Microbiology and Immunology (P)	Practical	2	2
IP20BS7CRP3	Biomedical Sciences and Systems Biology (P)	Practical	2	1
Total			25	20

SEMESTER VIII

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS8CR01	Genomics and Proteomics	Theory	5	4
IP20BS8CR02	Animal Molecular Physiology	Theory	5	4
IP20BS8CR03	Plant Molecular Physiology	Theory	5	4
IP20BS8CR04	Genetic Engineering	Theory	4	3
IP20BS8CRP1	Genomics and Proteomics (P)	Practical	2	2
IP20BS8CRP2	Animal Molecular Physiology and Plant Molecular Physiology (P)	Practical	2	2
IP20BS8CRP3	Genetic Engineering (P)	Practical	2	1
Total			25	20

SEMESTER IX

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS9CR01	Plant and Animal Biotechnology	Theory	5	4
IP20BS9CR02	Elective - Green Biotechnology	Theory	5	4
IP20BS9CR03	Elective - Bioprocess Technology	Theory	5	4
IP20BS9CC04	Elective - Biosafety, Bioethics and IPR	Theory	4	3
IP20BS9CRP1	Plant and Animal Biotechnology (P)	Practical	2	2
IP20BS9CRP2	Green Biotechnology (P)	Practical	2	1
IP20BS9CRP3	Bioprocess Technology and Biosafety, Bioethics and IPR (P)	Practical	2	2
Total			25	20

SEMESTER X

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS10D	PROJECT-MAJOR	Theory		16
IP20BS10V	COMPREHENSIVE VIVA	Theory		4
Total				20

SEMESTER I

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20EN1CC01	Basic English Grammar and Communication	Theory	5	4
IP20ML1CC01	Saahithya Padanam	Theory	5	4
IP20HN1CC01	Prose and One Act Plays			
IP20BS1CR01	Systematics and Diversity of Lower Life Forms and Non Vascular Plants	Theory	2	2
IP20BS1CR02	Systematics and Diversity of Invertebrates	Theory	2	2
IP20MT1CM01	Fundamentals in Mathematics	Theory	3	3
IP20CH1CM01	Bio-Physical Chemistry	Theory	2	2
IP20BS2CRP1	Systematics and Diversity of Lower Life Forms and Non Vascular Plants	Practical	2	0
IP20BS2CRP2	Systematics and Diversity of Invertebrates	Practical	2	0
IP20CH2CMP1	Bio-Physical Chemistry	Practical	2	0
Total			25	17

IP20BS1CR01- SYSTEMATICS AND DIVERSITY OF LOWER LIFE FORMS AND NON VASCULAR PLANTS

36 hrs **2 credits**

Module 1 6 hrs

Viruses: General characters and replication of viruses, TMV (RNA Virus) and T4 Phage (DNA Virus) Lytic and Lysogenic cycle. Economic importance of Viruses – a brief account Viriods and Prions – General structure.

Module 2 8 hrs

Bacteria: General characters, Morphology and Cell structure, Reproduction and Genetic recombination (Conjugation, transformation and transduction) in Bacteria. Economic importance of Bacteria - a brief account.

Cyanobacteria: General characters, Morphological and Structural diversity and Reproduction. Cyanophages – a brief account. Economic importance of Cyanobacteria.

Mycoplasma: General characters, Morphological and Structural diversity and Reproduction. Economic importance Mycoplasma– a brief account.

Module 3 8 hrs

Fungi and Lichens: General characters and outline on the classification of fungi by Ainsworth. General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Zygomycotina – Rhizopus; Ascomycetes – Xylaria; Basidiomycetes – Agaricus. Economic importance of Fungi: as food, industry, decomposition of organic matter. Fungal toxins and human health. Mycorrhiza – Ecto and endo mycorrhiza. Lichens: Classification based on thallus morphology. Economic importance of lichen: food, industry, medicine.

Module 4 10 hrs

Algae: General characters of algae and their classification up to classes (F E Fritsch); range of thallus variation in Algae. Reproduction and life history of the following groups with reference to the types mentioned: Cyanophyceae - Nostoc; Chlorophyceae - Oedogonium (Volvox, Spirogyra, Cladophora - vegetative features only); Phaeophyceae – Sargassum; Rhodophyceae – Polysiphonia. Economic importance of Algae: food, industry, medicine, biofertilizers; algal bloom.

Module 5 4 hrs

Bryophytes: General characters and Classification (Proskauer,1957). Morphological and Structural diversity, Reproduction in Riccia and Funaria, Economic importance of Bryophytes

Recommended readings:

1. Alexopoulus C.J. & Mims C.W. 1990. Introductory mycology, 5th edn Wiley Eastern Limited, New Delhi.

2. Fritsch, F.E. 1961. Structure and reproduction in algae, Vol. I, II. Cambridge University Press, London.
3. Bhatia, K.N. 1984. A treatise on Algae. S. Chand and Company, New Delhi.
4. Bold, H.C. and Wyhne, M.J. 1978. Introduction to Algae: Structure and reproduction. Prentice Hall, Engle Wood Cliffs, New Jersey.
5. Chopra, R.N & Kumar, P.K. 1988. Biology of Bryophytes. New Age International Publisher, New Delhi.
6. Contract, F. H., Kimball, P.C. and Jay, L. 1998. Virology. Prentice Hall, Englewood Cliff, New Jersey.
7. Fritsch, F.E. 1961. Structure and Reproduction in Algae. Vol. I and II. Cambridge University Press. Cambridge, U.K.
8. Kumar, H.D. 1990. Introductory Phycology. Affiliated East West Pvt. Ltd. Bangalore.
9. Pandey, B.P. 1994. Fungi. S. Chand and Company Ltd, New Delhi.
10. Parihar N.S. 1970. An Introduction to Embryophyta, Vol. I Bryophyta.
11. Pandey B.P (2007), College Botany Vol. I, S. Chand and Company
12. Pandey B. P(2007), College Botany Vol II, S. Chand and Company

Systematics and Diversity Of Lower Life Forms and Non-Vascular Plants -Practical

-36 hrs

1. Bacterial staining.
2. Study of morphology and Micro-preparation of the following; Rhizopus, Xylaria, Agaricus.
3. Study of morphology and Micro-preparation of the following; Oscillatoria, Nostoc, Oedogonium, Volvox, Cladophora, Sargassum. and Polysiphonia.
4. Study of Morphology, Anatomy of Vegetative and Reproductive structures of Riccia, Funaria.
5. Field visits to study and to collect non-vascular plants.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Appraise the world of microorganisms and its course of evolution and diversity.	K2	**5,6**	N/R/G
2	Compare different microbes, fungi and lichens.	K3	**5,6**	N/R/G

3	Analyze the economic and ecologic significance of algae, fungi, lichens and bryophytes.	K4	**5**	N/R/G
4	Develop basic botanical skills like microscopy and specimen preparation.	K2	**2**	N/R

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS1CR02- SYSTEMATICS AND DIVERSITY OF INVERTEBRATES

2 credits **36 hrs**

Module 1 5hrs

Systematics of Animals: Meaning, Nomenclature, Principles of Classification, Classification of Animal Kingdom. Criteria for classification of animals in the animal kingdom

Module 2 7hrs

Classification, general characters and diversity of Phylum Protozoa, Porifera, Coelenterata, Ctenophora, Platyhelminthes and Aschelminthes. Life cycle of *Plasmodium, Trypanosoma, Obelia, Fasciola hepatica, Taenia solium, Ascaris lumbricoides*.

Module 3 7hrs

General characteristics and classification of minor phyla

General characteristics, classification and diversity of Phylum Annelida, Life cycle of leech

Module 4 10 hrs

Phylum Arthropoda Salient features, Classification upto classes
Type: Prawn –*Fenneropenaeus (Penaeus)*

Module 5 7hrs

General characteristics, classification and diversity of Phylum Mollusca and Echinodermata.

Phylum Hemichordata Eg. Balanoglossus

Recommended readings:

1. Barnes, R.D. (1987). Invertebrate Zoology, W.B. Saunders, New York.
2. Barrington, E.J.W.(1967). Invertebrate Structure and function. ELBS and Nelson,London.
3. Dhami, P.S. and Dhami, J.K. (1979). Invertebrate Zoology. S. Chand and Co. New Delhi.
4. Ekamberanatha Ayyar M. (1990) A Manual of Zoology, Volume I. Invertebrate Part I and part II. S. Viswanathan Printers & Publishers. Pvt. Ltd.
5. Groove, A.J. and Newell, G.E. (1974). Animal Biology – Indian Reprint, University Book Stall, New Delhi.
6. Hyman, L.H. (1942) The Invertebrate volumes. McGraw-Hill.
7. James R.D. (1987). Invertebrate Zoology, W.B. Saunders, New York.
8. Jordan E.L and Verma P.S (2007). Invertebrate Zoology. S.Chand and Co.New Delhi.
9. Joy P.J., George Abraham K., Aloysius M. Sebastian and Susan Panicker (Eds) (1998). Animal Diversity, Zoological Society of Kerala, Kottayam
10. Kapoor, V.C. (1994). Theory and Practice of Animal Taxonomy, Oxford and IBH Publishing Co., New Delhi.
11. Kotpal.R. L., 1988-92 (All series). Protozoa, Porifera, Coelentereta, Helminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Rastogi Publishers, Meerut.

12. Kotpal R.L. Agarwal S.K. and R.P. Khetharpal (2002). Modern Text Book of Zoology. Rastogi Publications, Meerat – 250 002.
13. Marshall, A.J. and Williams, W.D. (1972). Text Book of Zoology Vol. Invertebrates (ELBS and Macmillan, London).
14. Mayr, E. (1980). Principles of Systematic Zoology (Tata McGraw Hill Publishing Co., New Delhi)
15. Parker and Hanswell, 2004, Text Book of Zoology,Vol I (Invertebrate), 7th Edition, A.Z.T,B.S. Publishers and Distributors, New Delhi – 110 051
16. Pechenik J A (2005) Biology of Invertebrates, (Tata McGraw Hill Publishing Co., NewDelhi.)
17. Prema A.K., Joseph M.L. and Terrence Rebello V. (Eds) (2011). Invertebrate Diversity of Kerala. Zoological Society of Kerala, Kottayam.
18. Thomas A P (Editor) 2010 The Invertebrates, Green leaf publications Kottayam

Systematics and Diversity Of Invertebrates- Practical -36 hrs

Identification and Classification of Representatives of Phylum Protozoa – Paramecium, Vorticella, Plasmodium, Euglena, Trypanosoma, Noctiluca, Entamoeba (Amoeba).

Porifera - Leucosolenia, Gemmule, Euspongia (Bath sponge), Euplectella (Venus flower basket), Hyalonema (glass rope sponge).

Coelentarata – Obelia, Aurelia, Sea anemone, Physalia, Porpita, Corals – Fungia, Astrea, Gorgonia, Meandrina (Brain coral), Tubifora (Slag horn coral), Pennantula (Sea pen).

Platyhelminthes-Liver fluke, tape worm, planaria. Aschelminthes- Ascaris, Ancylostoma (Hook worm), Schistosoma (Blood worm) Filarial worm.

Identification and Classification of major representatives of Annelida - Earth worm, Nereis, Aphrodite, leech, Sabella, Tubifex, Arenicola.

Arthropoda- Lepas, Balanus, Centipede, Millipede, Scorpion, Peripatus, Limulus, Prawn, Crab, Lobster, Grass hopper, mouth parts of insects : butterfly, mosquito, honeybee, housefly and cockroach. Mollusca - Sepia, Octopus, chiton, Patella, Dentalium, fresh water mussel, Pila globosa (snail), Nautilus, Murex, Xanchus, Cyprea. Echinodermata - Sea urchin, Starfish, Sea cucumber, Brittle star, Sea lilly.

Demonstration of Dissections – a. Reproductive, Digestive and Nervous system of male and female Cockroach, Silk moth. b. Earth worm – Nervous system and appendages of prawn

Field visits to Museums, Butterfly park and natural habitats of invertebrates

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Knowledge level	PSO No.	Relevance to Local/ National/ Regional/ Global developmental needs
1	Discuss the importance of systematics and taxonomy of animals	K4	1	N/R/G
2	Classify non chordates as per their distinguishing features	K3	1	N/R/G
3	Identify various invertebrates based on systematics	K2	1, 2	N/R/G
4	Describe and classify various phylum belonging to invertebrates	K2	1, 2	N/R/G
5	Generate an understanding about minor phyla	K2	1, 2	N/R/G

*PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CH1CM01- BIO-PHYSICAL CHEMISTRY

Credits 2 **Total : 36 hours**

Module 1: Atomic structure 4 hours

Planck's quantum theory of radiation, dual nature of matter and radiation - de Broglie equation, Photoelectric effect, Heisenberg's uncertainty principle. Schrodinger wave equation, significance of wave function. Atomic orbitals - shapes of orbitals, Quantum numbers, Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity.

Module 2 : Chemical bonding 8 hours

Electrovalency and ionic bond formation, factors favouring the formation of ionic compounds, lattice energy, covalent bond- sigma and pi bonds, Valence bond theory, Hybridization and geometry of covalent molecules - VSEPR theory - Molecular Orbital theory (Elementary idea), LCAO- Electronic configuration of nitrogen, oxygen - calculation of bond order, polarization of covalent bond - polarizing power, polarisability of ions and Fajan's rule, dipole moment, co-ordinate covalent compounds and their characteristics, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intramolecular hydrogen bond - van der Waals forces, importance in biomolecules. Hydrophobic forces.

Module 3: Thermodynamics 9 hours

System and surroundings – isolated, closed and open systems - - Intensive and extensive variables. Thermodynamic processes - reversible and irreversible, isothermal and adiabatic processes - state and path functions - First law of thermodynamics – mathematical statement. Thermochemistry : Enthalpy change of a reaction at constant volume and at constant pressure, enthalpy of formation, combustion, neutralization, solution and hydration, temperature dependence of heat of reaction -Kirchoff's equation, Hess's law and its applications

Statement of second law based on entropy, physical significance of entropy- entropy change in phase transitions, entropy of mixing - entropy criterion for spontaneous and equilibrium processes - Gibbs free energy (G) and Helmholtz free energy (A) - significance of free energy-conditions for equilibrium and spontaneity- effect of temperature on spontaneity of reaction. Third law of thermodynamics.

Thermodynamics of irreversible processes with simple examples, entropy production, phenomenological relations and phenomenological coefficients.

Bioenergetics : Thermodynamics of living cells - Exergonic and endergonic reactions, coupled reactions, ATP and its role in bioenergetics, thermodynamic aspects of metabolism and respiration, glycolysis, energy production by aerobic processes.

Module 4: Acids, Bases and Buffers 6 hours

Modern concepts of acids and bases. Ionisation of acids. Dissociation of water. Ionic product of water. Hydrogen ion concentration.-pH. Determination of pH. Dissociation of weak acids (pKa). Effects of salts on dissociation of acids. Interaction of acids with bases. Dipolar ions - isoelectric pH of amino acids and proteins. Buffers, buffer equation, buffer capacity. Problems on preparation of buffer solutions. Buffers of blood plasma, red blood cells and tissue fluids.

Use of buffers. Determination of pH- colorimetric method, based on use of indicators, limitations. Use of buffer solution ons and indicators.

Module 5 : Liquid State Chemistry 3 hours

Liquids- Intermolecular forces, Viscosity of liquids: Determination of viscosity of liquids using Oswald's viscometer.

Surface tension: Definition, determination of surface tension of liquids using Stalagmometer. Effect of surfactants, capillary action.

Module 6 : Solutions and Colligative Properties 6 hours

Types of solutions - homogeneous and heterogeneous- concentration of a solution - methods for expressing concentration - concept of activity and activity coefficients- Binary liquid solutions- Raoult's law- ideal and non- ideal solutions. Factors influencing solubility, solubility curves, Henry's Law - applications.

colligative properties - relative lowering of vapour pressure, elevation of boiling point, depression in freezing point and their applications in the determination of molecular weight. Osmotic pressure and its measurement by the Berkley-Hartley method. Laws of osmotic pressure. Hypo, hyper and isotonic solutions. Effect of osmotic pressure on living cells. Donnan membrane equilibrium. Abnormal molecular weights. van't Hoff factor. Degree of association and dissociation.

Recommended readings:

1. Manas Chanda, Atomic Structure and Molecular Spectroscopy, P. L. Soni Inorganic Chemistry
2. B. R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. CO., 2008 (Chapter 19)
3. C. N. R. Rao, University General Chemistry, Macmillan (Chapter 3)
4. B R Puri, L R Sharma and K C Kalia, Principles of Inorganic chemistry, Milestone Publishers New Delhi 2013
5. Gurudeep Raj, 'Advanced Physical Chemistry' Goel Publishing House
6. P W Atkins, 'Physical Chemistry', ELBS, 10th edition, 2014.
7. R. J. Siby and R. A. Alberty, Physical Chemistry, John Wiley & Sons.
8. K. L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd, 3rd Edition, 2012.
9. R.P. Rastogi, R.R. Misra, An introduction to Chemical Thermodynamics, Vikas Publishing house, 1996.
10. J. Rajaram, J.C. Kuriakose, Thermodynamics, Pearson Education, 2013.
11. D.A. McQuarrie, J.D. Simon, Physical Chemistry: A Molecular Approach, University Science Books, 1997.
12. C. Kalidas, M.V. Sangaranarayanan, Non-equilibrium Thermodynamics Macmillan India, 2002.
13. R.K. Murray, D.K. Granner, P. A. Mayes, V.W. Rodwell, Harper's Biochemistry, Tata McGraw Hill, 2015.
14. Tinoco, K. Sauer, J.C. Wang, J.D. Puglisi, Physical Chemistry: Principles and
15. Applications in Biological Science, Prentice Hall, 2002
16. Irving M. Klotz, Robert M. Rosenberg, Chemical Thermodynamics, John Wiley & Sons, INC Publication, 2008.
17. Casey, E.J. 1969. Biophysics, concept and mechanism, Affiliated East West press.

18. Bose, S. 1982. Elementary Biophysics. Jyothi Books, New Delhi.
19. Ackerman, E. 1967. Biophysical Science. Prentice Hall, N.Y.
20. Narayanan, P. 2000. Essentials of Biophysics. New Age International Publication. New Delhi.
21. Van Holde, 1998. Principals of physical biochemistry. Prentice Hall, N.Y.
22. J.D. Lee, 2009. Concise Inoganic chemistry. 4th edition. Wiley India publication.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Explain the features and limitations of various models of atomic structure	K2	**7**	N/R/G
2	To explain the formation of different types of bonds	K2	**3, 7**	N/ G
3	To understand the molecular orbital theory of diatomic molecules	K3	**3, 7**	N/G
4	To apply the principles of quantum mechanics to describe atomic structure.	K3	**7**	N/ G
5	Apply thermodynamic principles to irreversible processes and bioenergetics	K3	**7**	N/G
6	Apply the intermolecular forces in liquids to determine the surface tension and viscosity of liquids	K3	**7**	N/ G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20MT1CM01- FUNDAMENTALS IN MATHEMATICS

54 hrs **3 credits**

Module 1 20 Hrs

Elementary algebra, monomial, binomial, polynomial (linear quadratic cubic), simple factorization of quadratic and cubic polynomials, Quadratic equations (Solutions of quadratic equations with real roots only)

Text 2. Relevant sections.

Module 2 14 Hrs

Permutations and combinations- simple applications, Trigonometry- Introduction, values of trigonometric ratios of 0^o, 30^o, 45^o, 60^o, 90^o, Heights and distances, Exponential and logarithmic functions.

Text 2. Relevant sections.

Module 3: MATRICES 20 Hrs

Definition and examples of Symmetric, Skew- symmetric, Conjugate, Hermitian, Skew-Hermitian matrices. Rank of Matrix. Determination of rank by row canonical form and normal form, Linear equations, Solution of non- homogeneous equations using Augmented matrix and by Cramer's Rule, Homogeneous equations.

Text 1. Relevant sections of Chapter 2, 5, 10 (Proofs of all theorems in module 4 and excluded).

Recommended readings:

1. Frank Ayres Jr: Matrices, Schaum's Outline Series, TMH Edition.
2. M. Tyra & K. Kundan- Concepts of Arithmetic, BSc Publishing company Pvt.Ltd, C-37, Ganesh Nagar, Pandav Nagar Complex, Delhi-110092
3. Shanti Narayanan & P. K Mittal, A Text Book of Matrices, S. Chand

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Classify polynomials and solve quadratic equations	K2	**7**	N/R/G
2	Use computational and algebraic skills to calculate rank, eigen value and eigen vectors of a metrix	K3, K5	**7**	N/R/G
3	Solve linear equations using metrices	K3, K5	**7**	N/R/G

4	Evaluate hights and distance using trigonometric ratios	K5	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20EN1CC01- BASIC ENGLISH GRAMMAR AND COMMUNICATION

72 hrs **4 credits**

Module 1 – Basics 14 hrs

The Sentence and Parts of Speech – Nouns/Subjects – Nouns/Objects – Verb and its functions – Verb and its basic varieties – Adjectives and Adjectival Phrases – Adverbs and Adverbial Phrases – Conjunctions – Prepositions – Assessment and Production of Effective Sentences – Clauses – How the Clauses Are Conjoined – Understanding the Verb – Understanding the Auxiliary Verbs: Primary and Modal – The Articles – Phrasal Verbs.

Module 2 – Start Action 15 hrs

Word Class Coversions – Affixation: Prefixes and Suffixes – Tense Table: Comprehension and Production – Presentness and Present Tenses – The Presentness of a Past Action – Futurity in English – Voices: Active and Passive – Voices: Production and Conversion – Tenses and Voices: Usage and Formalities – Common Tense Errors – To Err Is Human – Subject Verb Concord

Module 3 – Words and Meanings 14 hrs

Singleness of Meaning – Shades of Meaning – Vocabulary Enrichment via root words – Words in Sentences – Words in Paragraphs – Punctuations and its use – Reading Comprehension Exercises – Cloze Passages.

Module 4 14 hrs

Interrogatives and Negatives - Negatives- How to Frame Questions -What‘s What? The Question Tag Conversational English - Polite Expressions - Some Time Expressions - In Conversation - Is John There Please?

Module 5 15 hrs

Miscellaneous and General Topics - On Geese and Mongooses - Pluralisation - On Gender and Sexisms Reading – Kinds of Reading – Recreational Reading – Study-type Reading Survey Reading – The Process of Reading – Readability – The Importance of Reading – Previewing - Skimming

Core Texts

1. Fine-tune Your English by Dr Mathew Joseph. Orient Blackswan and Mahatma Gandhi University.
2. Objective General English by R.S. Aggarwal. S.Chand. 2019.
3. Spoken English & Grammar: A Self Learning Book Made Simple For All. NEO.
4. Essential English Grammar with Answers by Raymond Murphy. CUP. 2000
5. Scholars Insights Comprehension and Cloze Grade 5. Sheth Publishing House.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Apply theoretical notions of English language in speaking and writing	K3	**7**	N/R/G
2	Effectively use English for formal communication	K5	**7**	N/R/G
3	Have a good command over the language	K3	**7**	N/R/G
4	Explore the varied dimensions of spoken and written communication	K2	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20HN1CC01- गद्य और एकांकी (Prose & One-Act Plays)

गद्य/Prose

1. कहाँ चोर का बेटा – उषा बाला

2. जब मैं फेल हुआ – ए. पी. जे. अब्दुलकलाम

3. जब इन्तिज़ार हुसैन अपनी जन्मभूमि आए – अज़गर वजाहत

एकांकी/One-Act Plays

1. दीपदान – रामकुमार वर्मा

2. जान से प्यारे – ममता कालिया

3. बहु की विदा – विनोद रस्तोगी

(Module-wise Distribution)

Module I	**Module II**	**Module III**
कफन चोर का बेटा	जब मैं फेल हुआ	जब इन्तिज़ार हुसैन अपनी जन्मभूमि आए
दीपदान	जान से प्यारे	बहु की विदा

Text book – साहित्य दर्पण

IP20ML1CC01- സാഹിത്യപഠനം

Credit 2

മൊഡ്യൂൾ 1: കവിതാസാഹിത്യം

വിശദപഠനത്തിന്

1. അധ്യാത്മരാമായണം കിളിപ്പാട്ട്(ലക്ഷ്മണോപദേശം)
2. വീണപൂവ്(കുമാരനാശാൻ)
3. കുറ്റിപ്പുറം പാലം(ഇടശ്ശേരി)
4. കൊച്ചിയിലെ വൃക്ഷങ്ങൾ(കെ.ജി.ശങ്കരപ്പിള്ള)
5. മുറ്റമടിക്കുമ്പോൾ(അനിത തമ്പി)

മൊഡ്യൂൾ 2: നോവൽ, ചെറുകഥ

വിശദപഠനത്തിന്.

1. മഞ്ഞ്(എം.ടി.വാസുദേവൻ നായർ)
2. ആടുജീവിതം(ബെന്യാമിൻ)
3. ഭൂമിയുടെ അവകാശികൾ(വൈക്കം മുഹമ്മദ് ബഷീർ)

4ഭ്രാന്ത് (സി.അയ്യപ്പൻ)

5. അഗ്നി (സിതാര എസ്)
6. ഓർമ്മച്ചിപ്പ് (കെ.വി.പ്രവീൺ)
7. ശരീരദൂരം (കെ.പി.രാമനുണ്ണി)

മൊഡ്യൂൾ 3: നിരൂപണം

വിശദപഠനത്തിന്.

1. കാളിദാസനും കാലത്തിന്റെ ദാസൻ (ജോസഫുണ്ടശ്ശേരി)
2. നമ്മുടെ അടുക്കളകൾ തിരിച്ചുപിടിക്കുക (സാറാജോസഫ്)
3. ഭാഷ,നവോത്ഥാനം,ജനാധിപത്യം (പി. പവിത്രൻ)

റഫറൻസ്

1. കവിതാസാഹിത്യചരിത്രം(എം. ലീലാവതി)
2. ആധുനിക മലയാളകവിത(എൻ. അജയകുമാർ)
3. മലയാളകവിതാപഠനങ്ങൾ (സച്ചിദാനന്ദൻ)
4. നോവൽസാഹിത്യചരിത്രം(കെ.എം.തരകൻ)
5. ആധുനികതയുടെ മധ്യാഹ്നം(ആർ.നരേന്ദ്രപ്രസാദ്)

6. ചെറുകഥ ഇന്നലെ ഇന്ന്(എം. അച്യുതൻ)

7. ചെറുകഥാപ്രസ്ഥാനം(എം.പി.പോൾ)

8. ചെറുകഥ- വാക്കുംവഴിയും(കെ.എസ്.ശിവകുമാർ)

9. മലയാളസാഹിത്യവിമർശം(സുകുമാർ അഴിക്കോട്)

10. മാതൃഭാഷയ്ക്കുവേണ്ടിയുള്ള സമരം(പി.പവിത്രൻ)

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	പ്രമുഖരായ എഴുത്തുകാരുടെ കൃതികൾ പരിചയപ്പെടുക	K1, K2	7	**R**
2	സമാനസ്വഭാവമുള്ള മറ്റ് എഴുത്തുകാരുടെ കൃതികൾ കണ്ടെത്തുക	K1, K2	**7**	**R**
3	ഒരു സാഹിത്യ ജനുസ്സിൽപ്പെട്ട വ്യത്യസ്തകൃതികളിലെ സാമ്യവ്യത്യാസങ്ങൾ വിലയിരുത്തുക	K5	**7**	**R**
4	സാഹിത്യകൃതികളുടെ ആഖ്യാനപരമായ സവിശേഷതകൾ മനസ്സിലാക്കുക	K2	**7**	**R**
5	സാഹിത്യകൃതികളുടെ പ്രമേയപരമായ സവിശേഷതകൾ വിലയിരുത്തുക	K2	**7**	**R**

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

SEMESTER II

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS2CR01	Systematics and Diversity of Vascular Plants	Theory	2	2
IP20BS2CRP1	Systematics and Diversity of Vascular Plants (P)	Practical	2	2
IP20BS2CR02	Systematics and Diversity of Vertebrates	Theory	2	2
IP20BS2CRP2	Systematics and Diversity of Vertebrates (P)	Practical	2	2
IP20MT2CM01	Mathematical biology	Theory	5	4
IP20CS2CM01	Basics in Computing	Theory	2	2
IP20PH2CMP1	Basics in computing(p)	Practical	2	1
IP20PH2CM01	Introductory physics	Theory	2	2
IP20PH2CMP1	Introductory physics(p)	Practical	2	2
IP20CH2CM01	Organic chemistry	Theory	2	2
IP20CH2CMP1	Organic chemistry(p)	Practical	2	2
Total			25	23

IP20BS2CR01- SYSTEMATICS AND DIVERSITY OF VASCULAR PLANTS

36 hrs **2 credits**

Module 1 7 Hours

Pteridophytes: General characters and classification (Reimers 1954). Morphology, anatomy and reproduction in Selaginella, Equisetum and Pteris. A brief account on stelar evolution, heterospory and seed habit.

Module 2 9 Hours

Gymnosperms: General characters and classification (Pilger and Melchior (1954) Morphology, Anatomy and Reproduction in Cycas and Pinus. A brief account of economic importance, origin and evolution of Gymnosperms.

Paleobotany: Geological timescale, Fossils and fossilisation (Brief account)

Module 3 20 Hours

Angiosperms: Systematics of Angiosperms: Introduction and a brief account of the history of taxonomy. Botanical Nomenclature: Principles of Nomenclature, a brief account of ICBN. Herbarium – Preparation, maintenance and Importance of herbaria; Important herbaria of the world. Classification of flowering plants: Classifications of Bentham and Hooker.

Morphology of Angiosperms: Leaves, Flowers, Inflorescence and fruits (Brief account)

Salient features and economic importance of the following families: Annonaceae, Malvaceae, Rutaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Rubiaceae, Asteraceae (Compositae), Lamiaceae (Labiatae), Euphorbiaceae, Arecaceae (Palmae), Poaceae (Gramineae).

Recommended Reading

1. Bower F.O. 1884. On the comparative morphology of the vascular cryptogams and gymnosperm. Phil. Trans. Roy. Society. London.
2. Eames A.J. 1936. Morphology of vascular plants (lower groups). Mc. Graw Hill Publications, NewYork
3. Parihar. N.S. 1977. The morphology of Pteridophytes, Central book Dept, Allahabad, India.
4. Andrew. H.N. 1961. Studies in Paleobotany. John Wiley, New York.
5. Bhatnagar and Moitra. A. 1996. Gymnosperms. Poplei. New Age International Ltd. New Delhi. fossilization, fossilization,
6. Chamberlain. C.J. 1986. Gymnosperms, structure and evolution. CBS Publications, New Delhi.
7. Chopra. G.L and Verma. V. 1988. Gymnosperm. Pradeep Publications, Jalandar, India
8. Cronquist. A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
9. Davis. P.H. and Heywood. V.H. 1973. Principles of Angiosperm taxonomy, Robert and E. Kriegen Publications, New York.

10. Heywood. V.H and Moore. D.M. 1984. Current concept in plant taxonomy, Academic Press, London.
11. Sambamurthy. A.V.S.S. 2005. Taxonomy of Angiosperm. IK International Publishers, New Delhi. 5. Lawrence. G.H.M. 1951. Taxonomy of vascular plants, Mac Milan, New York.

Systematics and Diversity Of Vascular Plants -Practicals-36 Hours

1.Pteridophytes: Study of morphology, anatomy of vegetative and reproductive structures of Selaginella, Equisetum, Pteris.
2.Gymnosperms: Study of morphology, anatomy of vegetative and reproductive structures of Cycas, Pinus.
3. Angiosperms: Herbarium preparation, Description of a taxon using technical terms.
4. Identify typical local plants belonging to the families prescribed in the syllabus by analysing vegetative and floral characters.
5. Study of local flora and field visits to Botanical gardens.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Appraise the world of vascular plants and its course of lifecycle, classification and diversity.	K2	**1**	N/R/G
2	Compare the general characters of Pteridophytes and Gymnosperms.	K3	**1**	N/R/G
3	Identification of local types of vascular plants with morphological characteristics.	K2	**1**	N/R/G
4	Analyze the economic importance and ecological significance of vascular plants.	K4	**1**	N/R/G
5	Develop basic ideas about plant taxonomy.	K2	**1**	N/R/G
6	Explain the types of fossils and process of fossilization.	K2	**1**	N/R/G
7	Develop basic taxonomic skills for plant identification and classification.	K2	**1**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS2CR02- SYSTEMATICS AND DIVERSITY OF VERTEBRATES

36 hrs **2 credits**

Module 1 10 Hrs

Introduction, General Characters and outline classification of Vertebrates
Sub phylum: Vertebrata General characters and Classification
Division 1– Agnatha
Class I Ostracodermi Eg: *Cephalaspis*
Class II Cyclostomata Eg: *Petromyzon*
Division 2 – Gnathostomata
Super class Pisces General Characters and Classification
Class: Chondrichthyes - General Characters
Sub class – ElasmobranchI Eg: *Narcine*
Sub class - Holocephali Eg: *Chimaera*
Class: Osteichthyes - General Characters
Sub class – Choanichthyes
Order 1 Crossopterigii(Coelocanths) Eg: *Latimeria*(Evolutionary Significance)
Order 2 Dipnoi Eg: *Lepidosire*n - Distribution, affinities and systematic position of lung fishes.
Sub class: - Actinopterygii
Super order 1. ChondrosteI Eg: *Acipencer*
Super order 2. Holostei Eg: *Amia*
Super order 3. Teleostei Eg: Sardine
General topics
1. Accessory respiratory organs in fishes.
2. Parental care in fishes.
3. Scales in fishes.
4. Migration in fishes

Module 2 16 Hrs
Super class: Tetrapoda General characters, Classification up to Orders
Class Amphibia - Type Frog (*Euphlyctis hexadactylus*)
Order I Anura Eg*: Hyla*
Order II Urodela Eg: *Amblystoma* (mention axolotl larva and Paedomorphosis /neotony)
Order III Apoda Eg: *Ichthyophis.*
Class Reptilia
Sub class I: Anapsida
Order Chelonia Eg: *Chelone*
Sub class II: Parapsida Eg: *Ichthyosaurus*
Sub class III: Diapsida
Order I Rhynchocephalia Eg: *Sphenodon*
Order II Squamata Eg: *Chamaleon*
Order III. Crocodilia Eg..*Crocodylus*
Sub class IV: Synapsida Eg: *Cynognathus*
General topic
Identification of poisonous and non-poisonous snakes

Module 3 3 Hrs

Class Aves
Sub class I: Archeornithes Eg: *Archaeopteryx* (Affinities)
Sub class II: Neornithes
Super order I: Palaeognathe Eg: *Struthio*
Super order II: Neognathe Eg: Brahminy kite
General topics
1. Migrations in birds
2. Flight adaptations in birds

Module 4 7 Hrs
Class Mammalia
Brief mention of general characters and classification up to order with example. (Mention any five salient features of each order, detailed accounts of examples are not necessary)
Sub class I: Prototheria Eg: Echidna, *Ornithorhychus*
Sub class II: Metatheria Eg: *Macropus*
Sub class III: Eutheria
Order 1 Insectivora Eg: *Talpa*
Order 2 Dermoptera Eg: *Galeopithecus*
Order 3 Chiroptera Eg: *Pteropus*
Order 4 Primates Eg: *Loris*
Order 5 Carnivora Eg: *Panthera*
Order 6 Edentata Eg: *Armadillo*
Order 7 Pholidota Eg: *Manis*
Order 8 Proboscidea Eg: *Elephas*
Order 9 Hydracoidea Eg: *Procavia*
Order 10 Sirenia Eg: *Dugong*
Order 11 Perissodactyla Eg:*Rhinoceros*
Order 12 Artiodactyla Eg: *Camelus*-mention ruminant stomach
Order 13 Lagomorpha Eg: *Oryctolagus*
Order 14 Rodentia Eg: *Hystrix* (Porcupine)
Order 15 Tubulidentata Eg: *Orycteropus*
Order 16 Cetacea Eg: *Delphinus*
General topics
1. Dentition in Mammals
2. Aquatic Mammals and their adaptations.

Recommended readings:

1. Ekambaranatha Iyer (2000), A Manual of Zoology Vol. II .S. Viswanathan and Co.
2. Jhingran (1977), Fish and Fisheries of India, Hindustan Publishing Co.
3. Jordan E L and P.S. Verma, (2002), Chordate Zoology, S. Chand and Co. New Delhi
4. Joy P.J., George Abraham K.,Aloysius M. Sebastian (1998). Animal Diversity. Zoological Society of Kerala, Kottayam
5. Kotpal R.L. (2000), Modern Text Book of Zoology, Vertebrates, Rastogi Publications, Meerut.– 250 002.
6. Nigam, H. C. (1983). Zoology of Chordates, Vishal Publications, Jalandhar - 144008
7. Nigam, H.C. and Sobti (2000), Functional Organization of Chordates, Shoban Lal Nagin Chand and Co., New Delhi.

8. Parker and Hanswell, (2004), Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S. Publishers and Distributors, New Delhi – 110 051
9. Pough H. (2009) Vertebrate life, VIII Edition, Pearson International
10. Prema A.K., Terrence V.R. and Mini K.D.(Eds.) (2011). Chordate Diversity of Kerala, Zoological Society of Kerala, Kottayam
11. Thomas A. P. (Editor) (2010) Chordata .Green leaf publications Kottayam
12. Young J.Z.(2004), The life of Vertebrates, Oxford University Press (Third Ed.) India Ed.

Systematics and Diversity of Vertebrates- Practicals- 36 Hrs - Credit 1

1. Scientific Drawing

Make scientific drawing of 5 locally available vertebrate specimens belonging to different classes

2. Dissections

Frog: Photographs/diagrams/one dissected & preserved specimen each/models may be used for study.

1. Frog Viscera
2. Frog Digestive System
3. Frog Arterial System
4. Frog 9th& 1st Spinal nerve
5. Frog Sciatic Plexus
6. Frog Brain

3. Mounting of placoid scales; study of cycloid and ctenoid scales

4. Osteology

Frog vertebrae - typical, atlas, 8th and 9th

Rabbit – Atlas, Axis and typical vertebra

Pectoral and pelvic girdles of Frog and Rabbit

Bird - Keel and Synsacrum

Turtle/Tortoise - plastron and carapace

5. Study of sections.

Amphioxus T. S. through pharynx/T.S. through intestine

6. Identification:-

General identification-

Identify, classify and describe the following animals by their generic names and 30 % of them by their scientific names.

Protochordata-1, Pisces-5, Amphibia-5, Reptilia- 5, Aves-2, Mammalia-2.

Taxonomic identification with key:-

i) Identification of fishes up to the level of order.

ii) Identification of snakes up to family.

7. Visit to Biological National Parks, Zoo, Sanctuaries and report

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Knowledge levl	PSO No.	
1	Understand the Diversity of vertebrates their morphology and anatomy	K2	1	N/R/G
2	Remember the common features vertebrates and make a comparative study with Chordata in this ground	K1, K4	1	N/R/G
3	Apply it in the transformation level and make a set up approach to evolution	K3	1	N/R/G
4	Describe different classes of vertebrates, level of organization and evolutionary relationship between different subphyla and classes	K3	1	N/R/G
5	Predict the classification category of given vertebrates based on morphological features	K6	1	N/R/G

*PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CH2CM01- ORGANIC CHEMISTRY

2 Credits **36 hrs**

Module 1: Classification and nomenclature of organic compounds 5 hrs

Classification of organic compounds-Rules of IUPAC system of nomenclature of common organic compounds – alkanes, alkenes, alkynes, alkadienes (conjugated and isolated dienes), cycloalkanes, alkyl halides, alcohols and phenols, aldehydes, ketones, carboxylic acids and its derivatives, amines and nitro compounds (both aliphatic and aromatic) and spiro compounds.

Purification of organic compounds-chemical methods of purification.

Module 2: Basic concepts of reaction mechanism 12 Hrs

Line diagram drawing. Factors affecting reaction mechanism. Polarity of bonds.

Electronic displacements: Inductive effect, electromeric effect, mesomeric effect, resonance and hyperconjugation. steric effects- H bonding: Inter and intramolecular hydrogen bonding.

Cleavage of bonds: Homolysis and heterolysis with suitable examples. curly arrow rules, formal charges.

Types of reagents: Nucleophiles and electrophiles.

Reactive intermediates: Carbocations, carbanions, free radicals and carbenes – Structure, formation and stability.

Types of organic reactions: Addition, elimination, substitution and rearrangement reactions (definition and one example each).

Nuleophilic substitution reactions- Aliphatic nucleophilic substitutions: - SN^i, SE^1, SE^2- SN_1, SN_2 - mechanism. Factors. affecting the rate of substitution reactions: Effect of substrate, solvent, nucleophile and leaving groups. Stereochemistry-Walden inversion.

Elimination Reactions: - E1 and E2 elimination, mechanism-Hoffmann and Saytzeff rules. Elimination versus substitution. Elimination at bridge head carbon-Bredt's rule-Chugav reaction-elimination vs substitution.

Addition reactions :- Addition of halogens and hydrogen halides. Mechanisms of addition of Br_2 and hydrogen halides to double bonds - Markownikoff's rule, peroxide effect. Test for unsaturation Bromine water, Baeyer's reagent.

Module 3: Aromaticity 5 Hrs

Resonance: - Concept of resonance, resonance energy. Structure & stability of alkenes, butadienes and Benzene-heat of hydrogenation and heat of combustion-orbital picture of benzene.

Aromaticity:- Concept of aromaticity- Hückel's rule - Application to benzenoid (benzene and naphthalene) and non-benzenoid (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation) ,Effect of aromaticity on the stability and reactivity of aromatic systems.

Benzene - Aromatic electrophilic substitution reactions – General mechanism of electrophilic substitution-halogenation, nitration, sulphonation, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution – ortho-para and meta directing groups-Ring activating and deactivating groups with examples.

Module 4: Heterocyclic compounds 5 Hrs

Aromaticity of heterocyclic compounds. Classification and nomenclature of heterocyclic compounds (containing only one hetero atom).

General methods of synthesis and reactions of : Furan, Pyrrole Thiophene and Pyridine. Comparative study of basicity of pyrrole, pyridine and piperidine with amines. Synthesis and reactions of quinoline, isoquinoline and indole with special reference to Skraup, Bischler and Napieralskii and Fisher indole synthesis.

Module 5: Stereochemistry 9 Hrs

Stereoisomerism - definition - classification.Introduction to molecular symmetry and chirality: examples from common objects to molecules. Axis, plane, center, alternating axis of symmetry.

Stereoisomerism – definition, classification.

Optical isomerism: Optical activity, specific rotation, concept of chirality (upto two carbon atoms).

Configuration. Enantiomerism, diastereomerism and meso compounds-optical isomers in glyceraldehyde, lactic acid and tartaric acid. Racemic mixture and methods of resolution. Asymmetric synthesis. Threo and erythro; *d* and *l* designations; Cahn-Ingold-Prelog rules: R/ S notation (for upto 2 chiral carbon atoms). Stereochemistry of sulphur and nitrogen compounds-stereospecific, stereoselective and assymmetric synthesis.

Geometrical isomerism: cis–trans, syn-anti and E/Z nomenclature (for upto two C=C systems), cyclic compounds aldoximes and ketoximes. Methods of distinguishing geometrical isomers. Interconversion of cis-trans isomers.

Conformational analysis: Conformational descriptors - factors affecting conformational stability of molecules. Conformational analysis with respect to ethane and n-butane.

Recommended readings:

1. R. T. Morrison and R.N Boyd, ‘Organic Chemistry’, 6th Edition - Prentice Hall of India. (Chapters-4,13)
2. J. March, ‘Advanced Organic Chemistry’, IV Edn, John Wiley & Sons, NY
3. P. S. Kalsi’ ‘Organic Reactions and their Mechanisms’’ New Age International Publishers. (Chapters-4,5,11,12,16)
4. S. H. Pine ‘Organic Chemistry’ - - McGraw Hill
5. J. March, ‘Advanced Organic Chemistry’, IV Edn, John Wiley & Sons, NY
6. Paula Y. Bruice, ‘Organic Chemistry’ - 3rd Edn. Pearson Education.
7. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press
8. I. L. Finar, ‘Organic Chemistry ’- Vol.- 6 th Edition I, Pearson Education (Chapters-3,4,17)
9. M. K. Jain and S.C. Sharma ‘Modern Organic Chemistry’, 3rd Edition, Vishal Publishing Company Co. (Chapters-6,7)
10. K. S. Tewari and N. K. Vishnoi ‘Organic Chemistry’, 3rd Edition, Vikas Publishing House.
11. (Chapter-6)

12. Peter Sykes, A Guide book to Mechanism in Organic Chemistry: 6 th Edition, Pearson Education. (chapters 1,4,5,6,7,8,9,10)
13. P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers. (Chapters- 4, 5,11,12,16)

Organic Chemistry- Practicals

Separation Techniques and Qualitative Organic Analysis (36 Hrs)

I-Separation Techniques

1. Separation of mixture of liquid compounds by distillation
2. Solvent extraction – aniline from water - methyl benzoate from water - using ether- Record the yield recovery- (Any two experiments shall be done).
3. Separation of a mixture of organic compounds (any five mixtures) by thin layer chromatography (TLC).

II- Qualitative Organic Analysis

1. Systematic analysis of the following organic compounds and characterization with its physical constant.

   aldehyde, ketone, carboxylic acid, dicarboxylic acid, unsaturated acid, primary amines, amide, diamide, polynuclear hydrocarbons, reducing sugars, phenol. **(Minimum ten compounds to be analysed)**

Recommended readings:

1. Mann, F. G.; Saunders, B. C. (2009),Practical Organic Chemistry, Pearson Education.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.
3. Ahluwalia, V.K.; Aggarwal, R.(2004),Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press.
4. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Familiarize the classification and nomenclature of organic compounds	K2	**3, 7**	N/R/G

2	Discuss the basic concepts, mechanism and factors which affect the reaction rate of different organic reactions	K5	**3, 7**	N/R/G
3	Understand the basic concepts of stereochemistry and conformational analysis of organic molecules	K3	**3, 7**	N/R/G
4	Interpret the concept of resonance and aromaticity	K5	**3, 7**	N/R/G
5	Explain the reaction mechanism of aromatic electrophilic and nucleophilic substitution reactions	K2	**3, 7**	N/R/G
6	Study the fundamentals of heterocyclic compounds	K2	**3, 7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20MT2CM01- MATHEMATICAL BIOLOGY

4 credits **90 hrs**

Module 1: DIFFERENTIAL CALCULUS 25Hrs

Differential calculus- Differentiation: Standard results(derivatives), Product rule, Quotient rule, Derivative of trigonometric functions, chain rule, higher order derivatives.
Functions of several variables (Definitions only), Partial derivatives, The chain rule.
Text 1. Chapter 3. Relevant sections (all proofs are excluded)
Chapter 14 (Sections 14.1(Definitions only), 14.3 and 14.4)

Module 2: INTEGRATION 20 Hrs

Definite integral, Fundamental theorem of calculus, Indefinite integrals and substitution rule, substitution and area between curves.
Text 1. Chapter 5 (Sections 5.3, 5.4, 5.5 and 5.6)

Module 3: Fibonacci Numbers in nature 20 Hrs

The rabbit problem, Fibonacci numbers and types, Lucas numbers and types, Fibonacci in nature: Fibonacci and earth, Fibonacci and flowers, Fibonacci and the sunflower, Fibonacci and bees, Fibonacci and subsets, Fibonacci and sewage treatment.
Text 2. Chapter 2 & 3 relevant sections.

Module 4: Golden Ratio 25 Hrs

The Euclidian algorithm and Lucas Formula, the golden ratio, mean proportional, a geometric interpretation, rule and compass construction, Euler construction.
Text 2. Relevant sections.

References:

1. George B. Thomas, Jr: Thomas' Calculus Eleventh Edition, Pearson, 2008.
2. Thomas Koshy: Fibonacci and Lucas numbers with applications, John Wiley & Sons, Inc (2001)
3. Joseph Edward: Differential Calculus for beginners. Nabu Press (2011)
4. S Narayana, T. K Manikavachagam Pillai: Calculus Volume I, S Viswanathan Printers and publications Pvt. Ltd

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Describe the concept of partial differentiation and learn to find partial derivatives	K1	7	N/R/G
2	Evaluate definite integrals and use it to find area between curves	K5	7	N/R/G

3	Interpret the numerous properties of Fibonacci numers and golden ratio	K4	6, 7	N/R/G
4	Illustrate how mathematics manifests in nature through Fibonacci numbers and golden ratios	K2	3, 6, 7	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CS2CM01-BASICS IN COMPUTING

2 credits **36 hrs**

Module 1: Basic Computer Organization and Design 8hrs

Operational concepts, Instruction codes, Computer Registers, Computer Instructions, Timing & Control, Instruction Cycles, Memory locations and addresses, Memory Reference Instruction, Input - Output & Interrupts, Bus organization, Complete Computer Description & Design of Basic Computer

Module 2: Processor and Control Module 6hrs

Hardwired vs. Micro programmed Control Module, General Register Organization, Stack Organization, Addressing modes, Instruction Classification, Program control.

Module 3: Memory Organization 8hrs

Main Memory, Memory Hierarchy, Processor vs. Memory Speed, High-Speed Memories, Cache Memory, Associative Memory, Interleave, Virtual Memory, Memory Management, Auxiliary memory, Memory mapping Techniques.

Module 3: I/O Systems 6hrs

Peripheral Devices, I/O Interface, Data Transfer Schemes, Program Control, Interrupt, DMA Transfer, I/O Processor.

Module 5: Parallel Architectures 8hrs

Introduction to parallel processing, Pipeline computers, Multi processing systems, Instruction-level- parallelism, Parallel processing challenges, Flynn‘s classification , Hardware multithreading, Multicore processors, Pipelining and Vector processing, Array Processors.

Recommended readings:

1.M.Morris Mano, Computer Systems Architecture, Third Edition, Pearson Education
2.Carl Hamacher, Computer Organization, Fifth Edition, Tata McGraw Hill.
3.John P Hayes , Computer Architecture & Organization, Mc Graw Hill.
4.David A. Patterson and John L. Hennessey, Computer Organization and Design, Fifth edition, Morgan Kauffman / Elsevier, 2014.
5.John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, 4th Edition.
6.William Stallings, Computer Organization and Architecture , Seventh Edition, Pearson Education
7.Kai Hwang and F A Briggs, Computer Architecture and parallel processing, McGraw Hill

Basics In Computing -Practical-(36 hrs)

Internet Technologies Lab

Basic browsing, surfing, Computer components identification, input output devices, Biology related models and simulations. Biology sites, uploading and downloading, important biological data bases

Given the problem statement, students are required to formulate problem, develop code, execute and test it. Students should be given programming assignments on following

User Interface Design: HTML Editors, Image maps in a website, CSS and DHTML, XML and XHTML document construction, Display Alert, Confirm and Prompt Dialog Boxes, Web applications using Java Script, Java Beans API.Interaction with Database: SQL, MySQL, JDBC

Server side scripting using AJAX and JQUERY and for creating dynamic webpages using HTML5.

Internet Telephony: VoIP, Streaming media, Codec and Plugins, Search Engine and Web Crawler

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Introduce principles of computer organization and the basic architectural concepts.	K2	**7**	N/R/G
2	Understand the architecture and functionality of central processing and simple register transfer to specify various computer operations.	K5	7	N/R/G
3	Understanding the heirarchial memory system, cache memories and virtual memory	K5	6, 7	N/R/G
4	Exemplify in a better way the I/O and memory organization.	K3	3, 6, 7	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

IP20PH2CM01- INTRODUCTORY PHYSICS

2 credits **36 hrs**

Module 1 : Development of Physics 12 hours

An overview on ancient perspectives on the universe- Galileo and his emphasis on experiments and observations, Kepler's Laws, Newton and the deterministic universe, Maxwell and the unification of electricity, magnetism and optics, Fundamental particles and the unification of all forces of nature

Planck's hypothesis, Quantum Mechanics, Einstein and his theories of relativity, Contributions by the Great Indian Scientists- S.N. Bose, M. N. Saha, C.V. Raman, quantum theory of Raman effect, Chandrasekhar limit (details and derivations not required)

Module 2: Units and Measurements of Physical quantities 12 hours

Fundamental and derived quantities. Units and dimensions, dimensional analysis, order of magnitude, significant figures, errors.

Length measurement- rulers-standard metre- Vernier callipers-micrometers- screw gauges-travelling microscope- laser range finder- sonar- RADAR, GPS. Angle measurement-spectrometer- scale and telescope- measurement of stellar parallaxes.

Module 3: Elasticity 12 hours

Basic ideas on elasticity – Young's modulus, bulk modulus, rigidity modulus, Poisson's ratio, relations connecting various elastic constants. Work done per Module volume in a strain. Bending of beams, bending moment, flexural rigidity. Young's modulus – uniform and non-uniform bending, cantilever. I –section girders. Determination of rigidity modulus using Static and Dynamic methods.

Recommended readings:

1. University Physics, Roger A Freedman, Hugh D Young 14 th Edition.
2. Principles of Physics: Jearl Walker, David Halliday and Robert Resnick
3. Feynman lectures of Physics
4. Mechanics by D.S. Mathur – Chapter 12, 13.
5. Concepts of Modern Physics: Arther Beisser
6. Modern Physics: Kenneth Krane

IBP 206- General Physics Lab 36 hrs

1. Symmetric Compound Pendulum- Determination of acceleration due to gravity (g), radius of gyration (K) and moment of Inertia
2. Asymmetric Compound Pendulum- Determination of acceleration due to gravity (g), radius of gyration (K) and moment of Inertia
3. Kater's pendulum- Determination of acceleration due to gravity (g).
4. Torsion Pendulum- Determination of rigidity modulus (n) and moment of Inertia (I).
5. Torsion Pendulum (Method of equal masses) - Determination of rigidity modulus (n) and moment of Inertia (I).
6. Measurement of density of solid- Sensibility method to find mass using beam balance and screw guage/vernier callipers for dimension measurements

7. Uniform bending – Pin and Microscope- Determination of Young's modulus
8. Non-Uniform bending – Pin and Microscope- Determination of Young's modulus
9. Uniform bending – Optic Lever- Determination of Young's modulus
10. Non Uniform bending – Optic Lever - Determination of Young's modulus

Recommended readings:

1. Properties of Matter- D S Mathur
2. Practical Physics- P R Sasikumar Eastern Eco. Ed.
3. Advance level Practical Physics IV Ed., Nelkon and J M Ogborn
4. Advance course in Practical Physics, D Chathopathyaya
5. Practical Physics, C L Arora
6. Electronics Lab Manuel, K A Navas
7. Digital Fundamentals, Thomas L Floyed
8. A course of experiments with He- Ne Laser, R S Sirohi
9. Laboratory manual for introductory Electronic experiments, L K Maheswari& Nm S Anand
10. Optics, N Subramanyan, Brijilal 7 Avadhanalu.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Acquire knowledge on historical development of physics and its possibilities. Hence understand the values of lifelong learning	K2	**7**	N/R/G
2	Develop a scientific temper and understand units, common laboratory instruments and evaluate errors in measurements and scientific methods.	K5	**7**	N/R/G
3	Revise the basics of properties of matter and elasticity and apply the theory to practical uses	K3	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

COMBINATIONS OF PRACTICAL EXAMINATIONS OF MSc INTEGRATED PROGRAMME IN BASIC SCIENCES- BIOLOGY

SEMESTER II

COURSE CODE	TITLE
IP20BS2CRP1	Systematics and Diversity of Lower Life Forms and Non Vascular Plants and Systematics and Diversity of Vascular Plants
IP20BS2CRP2	Systematics and Diversity of Invertebrates and Systematics and Diversity of Vertebrates
IP20CS2CMP1	Basics in Computing
IP20PH2CMP1	Introductory Physics
IP20CH2CMP1	Bio-Physical Chemistry and Organic Chemistry

SEMESTER III

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS3CR01	Plant Anatomy and Physiology	Theory	3	3
IP20BS3CR02	Animal Anatomy and Physiology	Theory	3	3
IP20BS3CR03	Science Education	Theory	5	4
IP20CS3CM01	Computer Science	Theory	3	3
IP20CH3CM01	Inorganic Chemistry	Theory	3	3
IP20BS4CRP1	Plant Anatomy and Physiology (P)	Practical	2	0
IP20BS4CRP2	Animal Anatomy and Physiology	Practical	2	0
IP20CS3CMP1	Computer Science (P)	Practical	2	1
IP20CH4CMP1	Inorganic Chemistry(P)	Practical	2	0
Total			25	17

IP20BS3CR01- PLANT ANATOMY AND PHYSIOLOGY

54 hrs **3 credits**

Plant anatomy

Module 1 9 Hours

Organization of primary plant body, Permanent tissues – Simple and complex tissues. Types of vascular bundles. Primary structure of stem, root and leaf (Dicot and monocot) – Brief account.

Cell wall: Structure and development of the cell wall (light microscopic and ultramicroscopic structure), composition of the cell wall, Cell wall development.

Meristems: Definition, classification of meristem. Apical meristems of Shoot and Root apex, relevant theories pertaining to structure and organization of root apex and shoot apex: Apical Cell Theory, Tunica Corpus Theory, Histogen Theory.

Module 2 5 Hours

Development of the secondary vascular system of the stem and root. Role of the vascular cambium. Normal secondary growth in dicot stem and root. Periderm: structure and development - phellum, phellogen, phelloderm, bark, and lenticels.

Anomalous secondary growth: Bignonia, Dracaena

Module 3 4 Hours

Nodal anatomy - A general account. Secretary tissues in plants: Internal secretory structures and External secretory structures.

Ecological adaptations: Xerophytes, Mesophytes, Hydrophytes, Epiphytes, Parasites and Mangroves.

Plant Physiology

Module 4 8 Hours

Water relation of a plant cell: Diffusion, Osmosis, Imbibition. Water potential - concepts and components (pressure potential, gravity potential, osmotic potential and matric potential). Absorption of water - active and passive, pathway of water movement - apoplastic and symplastic pathway. Ascent of sap - cohesion-tension theory. Transpiration - types, mechanism, theories (Starch-sugar, Proton-K+ ion exchange), significance; Guttation.

Mineral nutrition: Role of major and minor elements in plant nutrition, deficiency symptoms of essential nutrients; mineral uptake - passive (ion exchange) and active (carrier concept)

Module 5 12 Hours

Photosynthesis: General concepts and historical background, photosynthetic apparatus and Pigments. Mechanism of absorption of light, Absorption spectrum and Action spectrum. Emersson's enhancement effect, two pigment system-PS-I and PS–II. Non cyclic and cyclic electron transport system. Photophosphorylation, carbon assimilation-the Calvin cycle, C4 cycle and the CAM pathway. Photorespiration and its significance.

Translocation of solutes: pathway of phloem transport, source-sink concept, mechanism - mass flow hypothesis.

Module 6 8 Hours

Respiration: Types of respiration, mechanism of respiration, Glycolysis, Kreb's Cycle, Electron transport system - components. Oxidative phosphorylation, ATPase, Chemiosmotic hypothesis. Energetics of biological oxidation, respiratory inhibitors.

Module 7 5 Hours

Growth and development of plants: Plant growth hormones, Physiological effects of Auxins, Cytokinins, Gibberellins, Abscisic acid and ethylene. Plant movements – Tropic and Nasitic movements (Brief account). Physiology of flowering - Phytochrome, Photoperiodism and Vernalization.

Module 8 3 Hours

Nitrogen metabolism: Introduction, Biological nitrogen fixation – symbiotic and non symbiotic. Nodule formation in legumes, Leghaemoglobin.

Recommended readings:

1. Katherine Easn, 1996. Anatomy of seed plants, First Wiley prints, New Delhi.
2. Cutter, D.G. 1971. Plant anatomy- Part-1. Cell and Tissues. Edward Arnold, London.
3. Cutter, D.G. 1971. Plant Anatomy, Part II, Cell and tissues, Edward Arnold, London.
4. Chand, S. 2005. Plant Anatomy, S, Chand and Company Ltd., New Delhi.
5. Metcalf C.R and L. Chalk, 1950, Anatomy of Dicotyledons. Leaves, Stems and wood in relation to taxonomy with Notes on Economic users II Vols. Clerodendron press, Oxford.
6. Pandey, Plant Anatomy, Chand and Company ltd, New Delhi.
7. Cutler Botha and Stevenson (2007) Plant anatomy an applied approach. Black well publishing, UK.
8. Fahn A.1990, Plant anatomy, 4th edition, Pergamon press, Oxford.
9. Conn, E.E., Stumpf, Bruenning, G. and Doi, R.H. 1987. Outlines of Biochemistry, John Wiley and Sons, New York.
10. Wilkins, M.B. (eds). 1989. Advanced physiology, Pitman publishing Ltd, London.
11. Salisbury and Ross, 2005. Plant physiology, CBS publication, New Delhi.
12. Trivedi and Verma, 2007. A text book of physiology, biochemistry and biotechnology, S. Chand and Co., New Delhi.
13. Tiaz and Zeiger, 2010. Plant Physiology, 6th edition, Lincoln Taiz & Eduardo Zeiger. Sinauer Associates, Oxford University Press.
14. W.G Hopkins and W.P.A Huner Introduction to plant physiology 4th edition, 2011.

Plant Anatomy and Physiology- Practicals--36 Hours

1. Study of primary structure of Stem, Root and Leaf – Dicots and Monocots.
2. Study of normal secondary growth of dicot stem and root
3. Anomalous secondary growth of stem - Bignonia and Draceana.

4. Study of Ecological adaptations – Xerophyte, Hydrophyte, Epiphyte

Plant Physiology Experiments (Any four compulsory)

1. Determination of osmotic pressure of plant cell sap by plasmolytic/weighing method.
2. Compare the stomatal indices of hydrophytes, xerophytes and mesophytes (any two).
3. Separation of plant pigments by TLC/Paper chromatography.
4. Measurement of photosynthesis by Wilmott‟s bubbler/any suitable method.
5. Estimation of plant pigments by colorimeter.
6. Papaya petiole osmoscope.
7. Relation between transpiration and absorption.
8. Measurement of transpiration rate using Ganong‟s potometer/Farmer‟s potometer.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Explain the structure and function of cells and tissues.	K2	**3, 5**	N/R/G
2	Compare the anatomical features of stem, root and leaves.	K5	**3, 5**	N/R/G
3	Analyze the structural adaptations in plants that are growing in different environments.	K5	**3, 5**	N/R/G
4	Apply the techniques used to preserve and study plant materials.	K3	**3, 5**	N/R/G
5	Explain the various physiological phenomenon in plants and appraise the role of enzymes in plant life.	K2	**3, 5**	N/R/G
6	Identify the basic concepts and techniques in plant physiology.	K2	**3, 5**	N/R/G
7	Assess the significance of biomolecules associated with plant life.	K3	**3, 5**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS3CR02- ANIMAL ANATOMY AND PHYSIOLOGY

54 hrs **3 credits**

Module 1 5hrs

Integument and derivatives of mammals: Structure and functions of skin (Mammals), scales, claws, nails, hairs. feathers and horns.

Module 2 8hrs

Comparative account of heart (Fish, Frog, Reptile, Bird and Mammals), eyes –compound and camera eye, gills (fish) and lungs (Mammals), skull (rabbit), limbs - fore limbs & hind limbs (mammals).

Module 3 5hrs

Histophysiology: Liver, Kidney, Spleen, Testis, Ovary, Pituitary, Pancreas.

Module 4 7hrs

Respiration and Circulation: Types of respiration, Respiratory pigments, transport of O2 and CO2, Open and closed circulation, Blood composition and function.

Module 5 7 hrs

Excitability - Nature of the Nerve Impulse. Origin and propagation of action potential. Propagation of action potential across cell membrane and synaptic junction

Module 6 7 hrs

Excretory patterns in vertebrates: ammonotelism, ureotelism and uricotelism, Role of kidney in osmoregulation, Counter current mechanism

Module 7 8hrs

Contractility: Cytoplasmic Streaming, Ameboid Movement, Ciliary, Flagellar and Muscular movements. Contraction of smooth, cardiac, skeletal muscle fibers. The sliding Filament Mechanism of Muscular Contraction. Mechanism of Contraction – Excitation and Relaxation of Muscle Cell.

Module 8 7hrs

Feeding and digestion: Feeding patterns in vertebrates. Chemical and mechanical digestion, Stimulation of gastro-intestinal secretions, Digestion of carbohydrates, lipids and proteins. Nutritive types, vitamins, minerals, energy requirements, nutrition requirements of different ages. Nutritional disorders.

Recommended readings :

1. Parker, J&W. Haswell, 1995. Textbook of Zoology – Vertebrates. The Macmillan Press Ltd., U.K.
2. Stephen A. Miller & John P. Harley 2001, Zoology. The Animal Kingdom. Wm. C Publishers.
3. Berme, R.N. and Levy MN Principles of Physiology, Mosby Year Book. Inc.1996.

4. Eckert and Randall. Animal Physiology – Mechanisms and adaptations. CBS Publishers, 2000.
5. Schmidt-Nielsen. Animal Physiology. Cambridge Univ. Press, 2000.
6. D. Jenson. The Principles of Physiology. Appleton-Century-Crofts, 1996.
7. Prosser CL. Comparative Animal Physiology. WB Saunders and Company, 1973.

Animal Anatomy and Physiology - Practicals- 36 Hrs

ANATOMY

1.Identification and functions of scales (fishes), claws, nails, hairs, horns, feathers, Hoofs and nests.
2.Field visits to Research institutes, national parks and natural vegetations.
3.Vertebrae – Procoelous (Frog), Amphicoelous (Bird), Amphiplateous (Rabbit).
4.Skulls in vertebrates : Frog, Bird, Mammal, rabbit, dog, man, turtle.
5.Histology sections of Testis, Ovary, Liver, Pancreas, Kidney, Spleen, intestine.
6.Microtomy – Organ fixing, Block making, Sectioning and staining of any one organ (rat)

PHYSIOLOGY

1.Determination of oxygen consumption and metabolic rate in fish.
2.Rate of protein digestion by trypsin.
3.Acetylcholine activity in tissues
4.Determination of ATPase activity in tissues

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge level**	**PSO No.**	
1	Knowledge about functioning of various internal organs	K2	2, 3, 5	N/R/G
2	Compare histological structures of various organs with their function	K1, K4	2, 3, 5	N/R/G
3	Knowledge about basics of different organ system in animal body and its comparative studies	K3	2, 3, 5	N/R/G

*PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CH3CM01- INORGANIC CHEMISTRY

3 credits **54 hrs**

Module 1: Bioinorganic Chemistry 18 hours

Metal ions in biological system -Trace and bulk metal ions.

General aspects of dioxygen transport- Hemoglobin and Myoglobin, Co operative effect, Bohr effect

Metallo enzymes- Nitrogenase, carbonic anhydrase, cytochromes. vitamin B12

Role of alkali and alkaline earth metals- Sodium-potassium pump, Chlorophyll and photosynthesis, clotting of blood, muscle contraction.

Metals in medicine- Anticancer drugs: Cis-platin, oxaliplatin, carboplatin- Structure and mechanism of action.

Toxicity of metal ions (Pb, Hg, Cr, Cd and As). Chelation therapy

Module 2: Nuclear chemistry 9 hours

Nuclear forces, Radioactivity: Characteristics of radioactive decay, Decay kinetics, types of decay, α, β, γ- emissions, artificial radioactivity. Nuclear fission and fusion

Applications of radioactivity: 14C dating -Tracer techniques- applications. Autoradiography. Applications of radioactivity principles in medicine- radio diagnosis and therapy, radioimmunoassay - Radioactivity applications in agriculture, Applications in chemical analysis- neutron activation analysis, radiometric titrations, isotopic dilution analysis, neutron absorptiometry

Nuclear waste Management

Module 3: Fundamental concepts of Analytical Chemistry 9 hours

Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and ppb. Primary standard-secondary standard, quantitative dilution – problems.

Quantitative analysis: Volumetric titrations- Acid base titrations, redox titrations. Indicators- acid base indicators and redox indicators. Introduction to gravimetric analysis.

Introduction of micro scale experiments and their advantages.

Evaluation of analytical data: Significant figures, Precision and accuracy, Errors- determinate and indeterminate errors, error distribution curve, Statistical treatment of analytical data- Mean and standard deviation. Tests of significance- T test, F test.

Module 4: Analytical Techniques 9 hrs

Chromatography : Column Chromatography - Principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications.

Thin Layer Chromatography - Principle, Rf- Values, significance of Rf values.

Paper Chromatography - Principle, Solvents used, Development of Chromatogram

Ion - Exchange Chromatography – Principle - Experimental techniques.

Gas Liquid Chromatography - Principle - Experimental techniques - Instrumentation and applications.

High Performance Liquid Chromatography- Principle - Experimental techniques - Instrumentation and applications

Module 5: Chemistry of Non-aqueous Solvents 5 hours

Non-aqueous Solvents: Classification – General properties – Self ionization and leveling effect. Reactions in non-aqueous solvents with reference to liquid NH3, H2SO4, liquid HF, liquid SO2. ionic liquid: molten salts solvent systems, ionic liquid at ambient temperature; supercritical fluids: properties of supercritical fluids and their uses as solvents, liquid CO2

Module 6: Chemical Toxicology 4 hours

Hazardous chemicals and their management; biomagnification, POPs, pesticides, carcinogenic, teratogenic and mutagenic substances; Threshold limit value (TLV), Material Safety Data Sheet (MSDS). Safety precautions during handling, transport and use.

Recommended readings:

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
4. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 33rd Edition, Milestone Publishers and Distributors, New Delhi, 2016-17.
5. Satya Prakash et.al, *Advanced Inorganic Chemistry, Volume 1 &2*, S. Chand and Sons, New Delhi, 19th edition.
6. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2010.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Understand the role of metal ions in biological processes	K2	**3,7**	N/R/G
2	Understand the fundamental concepts of analytical chemistry.	K5	**7**	N/R/G

3	Appreciate the central role of chemistry in our society and use this as a basis for ethical behaviour in issues facing chemists including an understanding of safe handling of chemicals	K5	**7**	N/R/G
4	To evaluate errors in chemical analysis.	K3	**7**	N/R/G
5	Appreciate the advantages of micro scale experiments in chemistry.	K2	**7**	N/R/G
6	Familiarize with various chromatographic techniques	K2	**7**	N/R/G
7	Acquire a comprehensive knowledge and understanding about the concepts of nuclear chemistry , nuclear reactions and nuclear reactors	K2	**7**	N/R/G
8	Recognise the applications of radioisotopes in theoretical, analytical and industrial fields.	K2	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CS3CM01- COMPUTER SCIENCE

3 credits **54 hrs**

Module 1 8hrs

History and Evolution of OS, Basic OS functions, Resource Abstraction, Types of Operating Systems– Multiprogramming, Batch, Time Sharing Systems; Operating Systems for Personal Computers, Workstations and Hand-held Devices, Real time Systems, Operating System Services.

Module 2 Process 14 hrs

Basic Concepts, Processor and User Modes, Kernels, System Calls and System Programs, System View of the Process and Resources, Process Abstraction, Process Hierarchy, Threads, Threading Issues, Thread Libraries; Process Scheduling, Non-Pre-emptive and Pre-emptive Scheduling Algorithms.

Module 3 Process Management and Synchronization 12 hrs

Concurrent and Dependent Processes, The Critical Section problem, Semaphores, Methods for Inter- process Communication, Classical Problems of Synchronization, Monitors. Deadlocks: Deadlock Characterization, Methods of handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Module 4 Memory Management 12hrs

Physical and Virtual Address Space, Memory Allocation Strategies– Fixed and Variable Partitions , Swapping, Contiguous memory allocation, Paging, Segmentation. Virtual Memory Management- Demand paging, Page Replacement.

Module 5 Storage and I/O Management 8hrs

File Concepts, Access Methods, Directory structure, File System Structure, File Allocation Methods, Free Space Management, Disk Scheduling.

Recommended readings:

1. A Silberschatz, P.B. Galvin, G. Gagne, Operating Systems Concepts, 8th Edition, John Wiley Publications.
2. William Stallings , Operating Systems, Prentice Hall of India, Pearson
3. William Stallings, Operating Systems: Internals and Design Principles, 7th Ed., Prentice-Hall, 2011.
4. A.S. Tanenbaum, Modern Operating Systems, Pearson Education .
5. M. Milenkovic, Operating Systems- Concepts and design, Tata McGraw Hill
6. Chris Bates, Web Programming Building Internet Applications, Wiley publications.
7. Larry Ullman, PHP and MySQL For Dynamic Web Sites, 4th Edition,Pearson,.
8. Steven M.Schafar, HTML, CSS, Javascript, Perl, Python & PHP, Wiley Publication.
9. ElizebethNaramrore, Jaison Garner, Beginning PHP5, Apache and MySQL.

10. H M Deitel, P J Deitel&A B Goldberg, Internet and Worldwide Web Programming: How to Program, 3/e, Pearson Education

Computer Science- Practical - 36 hrs

WEB PROGRAMMING LAB

Given the problem statement, students are required to formulate problem, develop code, execute and test it. Students should be given programming assignments on following :

Configuring and Installation-Apache and PHP, MySQL, Develop HTMLform with PHP, PHP pages using PHP tags, setting and using Session and Cookie, using File and Directories.

Creating and managing Databases using MySQL, Input, Output and Edit Databases, Manipulating and Creating Images with PHP, Validation

Develop Applications/Projects using PHP5 (LAMP, WAMP may also be used).

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Understands the different services provided by operating system at different levels	K2	**7**	N/R/G
2	Discuss various scheduling algorithm and synchronization techniques to avoid deadlock	K5	**7**	N/R/G
3	Understand different memory management techniques and comprehend how an operating system virtualizes CPU and memory	K5	**7**	N/R/G
4	Explain how a simple file system organizes data in the hard disk	K2	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS3CR03-SCIENCE EDUCATION

4 credits **90 hrs**

Module 1 The History of Science- Philosophy 12 hrs

Ancient Philosophy, Argumentation analysis, Types-Rhetorical and Dialogue, Positivism, Relativism, Realism, Ancient civilisation in India, China, Babylon, Egypt, Greece, Rome, Aristotelian views, Archimedes, The Copernican revolution, Contributions of Galileo, Louis Pasteur, Newton, Einstein, Linus Pauling.

Module 2 The History of Science- Development 12 hrs

Development of science, New physics, Newtonian physics, Revolution in Biology, Chemistry, Mathematics, Computer Science, Need of Environmental Education, Science in twenty first century.

Module 3 Teaching critical thinking 14 hrs

Improving reasoning, Critical thinking, Affective strategies, Cognitive strategies, Media role, Science and knowledge, Types of knowledge: practical, theoretical, and scientific knowledge. What is science, features of science, Scientific Methods (observation, prediction, experiment, hypothesis, consistency, theory) Scientific theory, Scientific Law, Scientific Revolution, Scientific naming, Deductive and inductive models, Simulation and virtual testing, scientific temper, empiricism, vocabulary of science. Beliefs, Justification, Maths in Science

Module 4 Experimentation in Science 18hrs

Design of experiments-observation, data collection, nature and types of data (typical examples), treatment of data, data interpretation, significance of statistical tools in data interpretation. Experimentation: Selection of controls, Observational requirements, Instrumental requirements. Types of experiments: Experiment to test a hypothesis, to measure a variable or to gather data by preliminary and explorative experiments.

Observations: Direct and indirect observations, Controlled and uncontrolled observations, Human and machine observations.

Module 5 Scientific ethics 16 hrs

Factors affecting scientific interaction, Positivist perspective, Social perspective, Ethical dilemmas, Proximate vs ultimate causation, Pseudoscience, Ethics in science, Verifiability and reproducibility, Patent, Plagiarism, IPR, Cyber laws, Internet security

Module 6 Current Trends in Science 18 hrs

Latest developments in various branches of science and technology, Nobel Prizes, How science is changing the world, Science in future, Challenges and prospects

Recommended readings:

1. Science in history, 1-4 Volumes ,J D Bernal, MIT Press,Cambridge,1971.
2. The Story of Civilization,, Will Durant, Simon and Schuster Publishers,, United States, 1975

3. The Scientific Outlook, Bertrand Russell, Routledge Classics
4. Science and Society, John Scales Avery, World scientific
5. The New Physics, C.V. Raman, Literary Licensing LLC, Wisconsin
6. Evolution of the Philosophy of Science-Literary Perspectives, K. Sujatha, and S. Kurien, AneBooks Pvt. Ltd, 2011.
7. One, two, three…infinity ,George Gammow, Dover Publications, INC, NewYork,1974

COMBINATIONS OF PRACTICAL EXAMINATIONS OF MSc INTEGRATED PROGRAMME IN BASIC SCIENCES- BIOLOGY

SEMESTER III

COURSE CODE	TITLE
IP20CS3CMP1	Computer Science

SEMESTER IV

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20EN4CC01	Listening, Speaking, Reading, Writing and Understanding Literature	Theory	5	4
IP20BS4CR01	Bioinstrumentation	Theory	3	3
IP20BS4CR02	Cell biology	Theory	3	3
IP20PH4CM01	Biophysics	Theory	3	3
IP20CH4CM02	Bio-organic and Green Chemistry	Theory	3	3
IP20BS4CRP1	Bioinstrumentation(p)	Practical	2	1
IP20BS4CRP2	Cell biology(p)	Practical	2	2
IP20PH4CMP1	Biophysics(p)	Practical	2	2
IP20CH4CMP1	Bio-organic and green chemistry(p)	Practical	2	2
Total			25	23

IP20BS4CR02- CELL BIOLOGY

3 credits **54 hrs**

Module 1 10 hrs

Methods to study cells, sub-cellular structures and cell membranes: Homogenisation and centrifugation, Light microscopy, tissue fixation and sectioning, Rotary and ultra-microtomes, selective staining of cellular components,

Module 2 8 hrs

Structure and function of endo membrane system - Endoplasmic reticulum, Golgi complex, mitochondria, chloroplast, lysosomes and peroxisomes. Vesicular traffic -exo and endocytosis

Module 3 12 hrs

Nucleus: nuclear envelope, organization and functions of nucleolus. Structure and function of chromatin, organization of nucleosomes, euchromatin, heterochromatin. Mechanism of chromosome condensation. Specialized chromosomes (B-chromosomes, polytene chromosomes, lamp brush chromosome). Cytoplasts and karyoplasts.

Module 4 12 hrs

Cell cycle and cell division: Mitosis and Meiosis, present concept of chromosomal movement, importance of M phase, cytoskeleton, mechanism of cell division. Amitosis, Endomitosis, c-Mitosis and their significance; Regulation of cell division through cyclins.

Module 5 12 hrs

Cell Signaling and Apoptosis: General principles of cell signaling (autocrine, paracrine, synaptic, endocrine), classes of cell-surface receptor proteins(ion-channel linked, G protein-linked, enzyme-linked), signaling via GPCRs & enzyme-linked cell-surface receptors, Programmed cell death by intracellular proteolytic cascade, regulation of apoptosis by Bcl-2 family of proteins

Recommended readings :

1. Cell and Molecular Biology. De Roberts and De Roberts., Saunders College, USA 6th edition.
2. Molecular Cell Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore & Darnell. Freeman Press, 6th edition.
3. Cell Biology. Karp G., McGraw Hill book comp. New York. 2010 6th edition.
4. The Cell : A molecular approach. Cooper, G.M. ASM Press, USA 2009, 5th edition.
5. Chromatin structure and function. Wolfe, A., Academic press, New York 1995.
6. Cell Biology. Pollard. J.P. and Earnshow, W.C. Saunders, 2002.
7. The Cell –A molecular approach. Cooper, G.M. Princeton Publishers, NY, 2000.
8. Molecular Cell Biology. Lodin, H., Berk, A., Zipursky, S.L., Matsudain, P., Baltimore, D. and Darneil, T. Will Freeman company, NY, 6th edition.
9. Molecular biology of the cell. Albert, B., Johnson, A., Raff, M., Robert, K., Walter, P. Garland Sciences, NY, 5th edition.

Cell Biology – Practicals- 36 hrs

1. Isolation and separation of sub cellular organelles.
2. Vital staining of mitochondria
3. Squash and smear preparation of mitotic and meiotic chromosomes –
Allium cepa, Poecilocerus picta.
4. Determination of chromosome number from mitotic and meiotic preparations.
5. Preparation of Polytene chromosome- D.melanogaster /Chironomous
5. Cytological technique, preparation of semi-permanent and permanent slides.
6. Identification of B-chromosomes, sex chromosomes and chromosomal abnormalities.
7. Counting of cells using haemocytometer

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Understand the basic unit of life as whole	K2	**3**	N/R/G
2	Describe the fundamentals of cell signaling	K5	**3**	N/R/G
3	Describe how cells grow, divide and die, and how these important processes are regulated.	K5	**3**	N/R/G
4	Differentiate healthy and dying cells based on morphology, biochemical and molecular basis	K5	**3**	N/R/G3
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

IP20PH4CM01-BIOPHYSICS

3 credits **54 hrs**

Module 1 10 hrs

Foundations of Biophysics-Matter and energy – Photo electric effect, quantum theory of light, de Broglie wave equation, wave function, atomic models, Bohr's atomic energy levels.

Biomolecular interactions-Water-properties and interactions of water, association of macromolecules, supramolecular interactions, protein-protein interactions, protein nucleic acid interactions, lipid/membrane-protein interactions

Module 2 10 hrs

Thermodynamics: Laws of Thermodynamics, Gibbs free energy, Entropy and enthalpy and its relationship, Relation between standard free energy change and equilibrium constant, Redox reactions and a brief account on photo and chemo- bioenergetics.

Protein Structure analysis : Alpha helix and Beta sheet structure of proteins (fibroin structure), conformation of protein – Ramachadran plot, Tertiary conformation

Module 3 14 hrs

Protein thermodynamics: Free energy and entropic forces, solvent interactions and solvent entropy, polypeptide chains in water, the folding process, folding pathways, simulations and predictions, experimental studies on folding, Excitement and relaxation of protein structure, equilibrium fluctuations, kinetics of proteins, proteins as complex systems.

Module 4 10 hrs

Spectroscopy : Instrumentation and application of UV - visible spectrophotometer, fluorescence spectroscopy, NMR, Mass spectroscopy, IR, Raman. X-ray diffraction in determining molecular structure of proteins.

Module 5 10 hrs

Biological effects of light: Importance of Light, Radiant energy, Light interaction with biological materials, Effect on growth patterns in plants-Phytochrome system, Photochemical mechanism, Phototrophism, Photoperiodism, Solarization, Photodynamic action, UV light on living system, Photoreactivation, Lethal effects on animals and plants.

Recommended readings:

1. Casey, E.J. 1969. Biophysics, Concept and Machanics. Affiliated East West Press.
2. Dr. R. N. Roy, 2007.A Text book of Biophysics. New Central Book Agency (P) Ltd.
3. Ackerman, E. 1967. Biophysical Sciences. Prentice Hall, NY.
4. Narayan, P. 2000. Essentials of biophysics. New Age Int. Pub. New Delhi.
5. Cantor R. and Schimmel P.R, W.H. Freeman. Biophysical chemistry
6. David Freifelder, W H Freeman and company. Physical Biochemistry
7. A.L. Stanford, Academic Press. Foundations of Biophysics

Biophysics -Practicals (36 Hrs)

1.Absorption spectra of amino acids, proteins and nucleic acids by Spectrophotometer.

2.Verification of Beer-Lambert law.

3.Analysis of IR spectra of a diatomic molecule / simple biomolecules.
4.Denaturation and Renaturation of Protein by spectroscopic method.
5.Experiment with GM counter.
6.Experiment to demonstrate photo-electric effect

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Explain the working principle of spectroscopy, CD, NMR, Xray crystallography etc	K2	**2, 3, 7**	N/R/G
2	Explain the forces present in nature and their role in biomolecular interactions	K5	**2, 3, 7**	N/R/G
3	Discuss the protein folding and its analysis	K5	**2, 3, 7**	N/R/G
4	Detailed study on effect of light in biological systems	K2	**2, 3, 7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20CH4CM02- BIO ORGANIC AND GREEN CHEMISTRY

3credits **54 hrs**

Module 1 Terpenoids, Steroids, Vitamins, Enzymes & Lipids 12 Hrs

Terpenoids – Occurrence, Uses, Classification. Isoprene and special isoprene rule. Structure and uses of citral and geraniol. Natural rubber - structure, latexprocessing methods, vulcanisation, rubber compounding, mastication and uses.

Steroids – Introduction. Diels' hydrocarbon. Structure and functions ofcholesterol. Elementary idea of HDL and LDL.

Vitamins – Classification. Structure, biological functions and deficiency diseases of vitamins A, B_1, B_2, B_3, B_5, B_6, C and D.

Enzymes-Introduction, classification and characteristics of enzymes. Salient features of activesite of enzymes. Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action.

Lipids- Introduction to lipids. Classification. Oils and fats: Biological functions. Extraction and refining. Common fatty acids present in oils and fats. Omega fatty acids. Trans fats and their effect. Hydrogenation,Rancidity. Acid value, Saponification value, Iodine value and RM value.

Module 2 Amino Acids, Peptides, Proteins & Nucleic acid 18 Hrs

Classification of amino acids. Synthesis and reactions of α-amino acids. Zwitterion structure and Isoelectric point. Polypeptides. Synthesis of simple peptides (upto tripeptides)- Solution phase peptidesynthesis by N-protecting (benzyloxycarbonyl and *t*-butyloxycarbonyl) & C- activating groups. DCC method. Merrifield's solid phase peptide synthesis.

Classification of proteins. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of N-.terminal amino acid (by FDNB and Edman method) and C–terminal amino acid (by hydrazinolysis and with carboxypeptidase enzyme). Helical and sheet structures (elementary idea) Denaturation of proteins.- Green Fluorescent Proteins (elementary idea).

Nucleic acid:- Components of Nucleic acids: Bases -Adenine, guanine, cytosine, thymine and uracil (structure only), other components of nucleic acids. Nucleosides and nucleotides, Structure of polynucleotides; Structure of DNA (Watson - Crick Model. Biological functions of DNA and RNA - Conceptof hereditary- Genetic code, Replication and protein biosynthesis. Transcription and Translation

Module 3 Carbohydrates 9 Hrs

Classification of carbohydrates. Reducing and non-reducing sugars. General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotationand anomers. Determination of configuration of Glucose. Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Chain lengthening and chain shortening of aldoses - Kiliani-Fischer synthesis and Ruff degradation. Interconversion of aldoses and ketoses. Structure of the disaccharides sucrose, maltose and cellobiose. Uses of sucrose. Structure of the polysaccharides- starch and cellulose. Industrial applications of cellulose.

Module 4 Applied Organic chemistry 12 Hrs)

Medicinal chemistry:- Introduction, Elementary idea of the structure and mode of action of the following drugs:-Sulpha drugs-Sulphanilamide, Antibiotics-Penicillin, Chloramphenicol, Antimalarial-Chloroquine, Analgesic -Paracetamol and Analgin. Drugs

in cancer therapy- Chlorambucil.

Synthetic Dyes:- Theory of colour and constitution. Classification - according to structure and method of application. Preparation and uses of Azo dye-methyl orange, Triphenyl methanedye -Malachite green, Phthalein dye -Phenolphthalein and Fluorescein, Vat dye-indigo Anthraquinone dye -alizarin.

Food additives: Artificial sweeteners- Saccharine, cyclamate- aspartame-Food flavours-esters- aldehydes and heterocyclic compounds-Food colours-Restricted use, spurious colours- Emulsifying agents – preservatives-leavening agents-baking powder-yeast-Taste enhancers- MSG-vinegar.

Soaps and Detergents:- Composition of soaps- detergent action of soap, TFM-Synthetic detergents – LAS and ABS detergent -comparison between soaps and detergents-Environmental aspects.

Module 5 Introduction to Green Chemistry 3 Hrs

Definition of green chemistry and how it is different from conventionalchemistry and environmental chemistry.Importance of green chemistry in- daily life, Industries and solving humanhealth problems (Two examples each).

The twelve principles of the Green Chemistry with their explanations

Recommended readings:

1. Lancaster, M.(2016),Green Chemistry An Introductory Text.2nd Edition, RSC Publishing.
2. Ryan, M.A.; Tinnesand, M. (2002), Introduction to Green Chemistry (Ed), American Chemical Society, Washington DC.
3. Sharma, R.K.; Bandichhor, R. (2018),Hazardous Reagent Substitution, Royal Society of Chemistry.
4. V. K. Ahluwalia, Green Chemistry, Ane Books India.
5. L. Finar, Organic Chemistry - Volume I & II - Pearson Education (Chapters 18)
6. M. K. Jain and S. C. Sharma ‘Modern Organic Chemistry’, 3rd Edition, Visal Publishing Company Co. (Chapter-35)
7. K. S. Tewari and N. K. Vishnoi, ‘Organic Chemistry’, 3rd Edition, Vikas Publishing House (Chapter-33)
8. R. T. Morrison and R.N. Boyd, ‘Organic Chemistry’, 6th Edition - Prentice Hall ofIndia. (Chapter-36)
9. Bhat S.V., Nagasampagi, B.A. & Sivakumar M. Chemistry of Natural Products, Narosa, 2005.

Bio- Organic And Green Chemistry-Practical - Credits – 2
(36 + 36 hrs)

VOLUMETRIC ANALYSIS
Basic Laboratory Skills-
Safe laboratory practices – Lab safety signs. Personal Protective Equipment (PPE) Demonstration & concept of good lab practices including chemical/glassware handling and waste management.

Microscale Analysis for estimation by volumetric analysis.

Acidimetry and alkalimetry (Double burette method)
Strong acid – Weak base
Strong base – Weak acid
Estimation of Na_2CO_3 and $NaHCO_3$ in a mixture
Estimation of NaOH and Na_2CO_3 in a mixture

Complexometry (Double burette method)
Estimation of Zn using EDTA
Estimation of Mg using EDTA
Determination of hardness of water

Permanganometry
Estimation of Ferrous iron
Estimation of Oxalic acid

Dichrometry
Estimation of Ferrous iron using internal indicator
Estimation of Ferrous iron using external indicator

Recommended readings:

1. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8thedn, Brooks/Cole Nelson (Chapters 13,14)
2. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons EducationLtd.(Chapter 10)
3. D. Christian, Analytical Chemistry, JohnWiley and Sons(Chapter12)
4. R. D. Day, A. L. Underwood, Quantitative analysis,6th Edn.,Prentice Hallof India Pvt.Ltd

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Recognize the role of organic chemistry in food and soap industry	K2	**3, 7**	N/R/G

2	Discuss the structure and mode of action of sulpha drugs, antibiotics, analgesic and drugs in cancer therapy	K5	**3, 7**	N/R/G
3	Understand the theory of colours, structure, method of preparation and uses of important azo dye, triphenyl methane dye, phthalein dye, vat dye and anthraquinone dye	K5	**3, 7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20EN4CC01 - LISTENING, SPEAKING, READING, WRITING AND UNDERSTANDING LITERATURE

4 credits **90 hrs**

Module 1 Listening 18hrs

Active listening – Barriers to listening – Listening and Note taking– Listening to announcements – Listening to news on the radio and television – Listening Comprehension Practice.

Module 2 Speaking 18hrs

Vowels - Consonants - Syllables - Word and Sentence stress – Weak forms and strong forms – Pauses and sense groups – Falling and rising tones – Fluency and pace of delivery – Small talk in formal occasions – Participating in conversations – Making a short formal speech – Describing people, place, events and things –. Common errors in communication.

Module 3 Reading 18hrs

Reading: theory and Practice – Scanning – Surveying a textbook using an index – reading with a purpose – making predictions – Understanding text structure – Locating main points – Making inferences – Reading graphics – Reading Critically – Reading for research. Reading Comprehension Practice.

Module 4 Writing 18hrs

Applying for jobs – Preparing Resumes – Writing Cover letters – Preparing for interviews – Taking Interviews – Post-Interview follow-up – Promotion interviews – Group discussion skills and telephone skills.

Module 5 Understanding Literature 18hrs

Writing book reviews and movie reviews – Interactive Tasks: Classroom exercises that allow students to listen and speak to one another using English and to share ideas – Blog Writing: A regular record of our thoughts, opinions and experiences put on the Internet.

Core Texts

1. V.Sasikumar, P Kiranmai Dutt and Geetha Rajeevan, . Communication Skills in English. Cambridge University Press and Mahatma Gandhi University
2. Towards Academic English: Developing Effective Writing Skills. New Delhi: Cambridge UP, 2007.
3. Oxford Guide to Effective Writing and Speaking. OUP, 2007.

Recommended Reading

1. M. A. K Halliday – A Course in Spoken English
2. George A. Miller – Language and Communication
3. Samson et al. English for Life - 4. New Delhi: Cambridge UP.
4. Vasudev, Murthy. Effective Proposal Writing. New Delhi: Response, 2006.
5. Towards Academic English: Developing Effective Writing Skills. New Delhi: Cambridge UP, 2007.
6. Oxford Guide to Effective Writing and Speaking. OUP, 2007.
7. Bhatnagar, R. P. English for Competitive Examinations. New Delhi: Macmillan, 2009.
8. English for Careers. Pearson.

9. English for Career Development. Orient Longman, 2006.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Understand the nature and function of language	K2	**7**	N/R/G
2	Acquire knowledge about the basic concepts of linguistics	K5	**7**	N/R/G
3	Acquire the use of phonemic symbols in the pronunciation and the usage of effective communication skills	K5	**7**	N/R/G
4	Erich listening, reading, speaking and writing skills	K2	**7**	N/R/G
5	Develop an aesthetic ability to enjoy and relish literature	K5	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS4CR01 - BIO INSTRUMENTATION

3 credits **54 hrs**

Module 1 15hrs

Microscopy and Microscopic techniques: Mechanism, application of light, inverted phase contrast, electron microscope (SEM & TEM), confocal microscope, scanning tunneling microscope,. Micrometry and flow cytometry. Fluorescence microscopy, Phase-contrast microscopy, Confocal scanning microscopy, SEM & TEM, Cryo-electron microscopy

Module 2 15hrs

pH meter and its applications, Cell disruption techniques – Physical and chemical methods, PCR, RT-PCR, nano-drop, DNA analyzer,

Centrifugation – basic principles of sedimentation, types of centrifuges and rotors, ultracentrifugation, differential centrifugation, density gradient and analytical ultracentrifugation and its application.

Module 3 12hrs

Chromatography – General principles and definition, Partition, absorption, gas-liquid chromatography, paper chromatography and TLC. Principles of Gel filtration, affinity chromatography, HPLC and ion-exchange chromatography.

Electrophoresis - PAGE, SDS-PAGE, isoelectric focusing, 2D electrophoresis, agarose gel electrophoresis, recovery of DNA from agarose gels, Pulse-field gel electrophoresis.

Module 4 12hrs

Immunochemical techniques - antibodies and their specificity, antigen - antibody interactions, immunoassay, western blotting, ELISA, immune electrophoresis. Radioisotopes and dosimetry, radiation counters, Radio isotopes and safety. Labelling of Antibodies. Principle and application of UV- visible spectrophotometer, fluorescence spectroscopy.

Recommended readings:

1. The Principles and practices of electron microscopy. Watt IM, Cambridge Univ. press, London, 1989.
2. Gordon M.H and Macrae, M. Instrumental analysis in biological sciences, Blackie and sons Ltd. London, 1998.
3. Principles of physical biochemistry. Vanholdem W.C. and Johnson, P.S. Printice Hall, 1998.
4. Principles & techniques in practical biochemistry. Wilson, K and Walker, J.M. Foundation books, New Delhi, 1994

Bioinstrumentation –Practical- 36 hrs

1.Separation and identification of amino acids by paper chromatography.
2.Separation and identification of sugars and lipids by TLC.
3.Separation of proteins by ion exchange chromatography
4.Separation of proteins by gel filtration.

5.Dialysis.
6.Isolation of mitochondria by differential centrifugation.
7.Separation of proteins by SDS-PAGE
8.Amplification of gene by PCR.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Explain different tools and techniques used in plant science research.	K2	**2, 3**	N/R/G
2	Explain the principle and applications of analytical instruments.	K5	**2, 3**	N/R/G
3	Develop basic microscopic and instrumentation skills.	K5	**2, 3**	N/R/G
4	Develop basic knowledge about the Immune-chemical techniques.	K3	**2, 3**	N/R/G
5	Develop practical skills in centrifugation, chromatography and electrophoresis.	K3	**2, 3**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

COMBINATIONS OF PRACTICAL EXAMINATIONS OF MSc INTEGRATED PROGRAMME IN BASIC SCIENCES- BIOLOGY

SEMESTER IV

COURSE CODE	TITLE
IP20BS4CRP1	Plant Anatomy and Physiology and Bioinstrumentation
IP20BS4CRP2	Animal Anatomy and Physiology and Cell Biology
IP20PH4CMP1	Biophysics
IP20CH4CMP1	Inorganic Chemistry and Bio-organic and Green Chemistry

SEMESTER V

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS5CR01	Genetics	Theory	3	3
IP20BS5CR02	Evolutionary Biology And Ethology	Theory	3	3
IP20BS5CR03	Biostatistics	Theory	3	3
IP20BS5CR04	Environmental Biology And Human Rights	Theory	3	3
IP20BS5CR05	Soft Skill Development	Theory	4	3
P20BS6CRP2	Evolutionary Biology And Ethology (P)	Practical	2	0
P20BS6CRP3	Environmental Biology And Human Rights(P)	Practical	2	0
P20BS6CRP3	Biostatistics (P)	Practical	2	0
P20BS6CRP4	Genetics (P)	Practical	2	0
	Mini Project		1	0
Total			25	15

IP20BS5CR01-GENETICS

3 credits **54 hrs**

Module 1 10hrs

Introduction to Genetics: Mendelism – Mendel's Law of segregation, Law of Independent Assortment. Chi-square test & its applications, Chromosomal basis of segregation & Independent assortment.

Module 2 10hrs

Extension of Mendelian principles: Codominance, Incomplete dominance, Gene interactions, Pleotrophy, Genomic imprinting, Penetrance and expressivity, Phenocopy. Concept of gene – Allele, Multiple alleles, Pseudoalleles, Complementation test.

Module 3 10hrs

Non-Mendelian inheritance & linkage studies: Linkage and crossing over, Linkage maps and interference and Coincidence, Intragenic recombination, Polygenic inheritance, Sex determination in animals and plants. X Chromosome inactivation in mammals, X linked inheritance, Sex limited and sex influenced characters. Cytoplasmic inheritance – maternal effects.

Module 4 8hrs

Bacterial and Viral genetics: Genetics of Bacteria and their viruses, Bacterial Conjugation, Bacterial Transformation, Transduction, Lytic and Lysogenic cycle, Bacteriophage genetics.

Module 5 6hrs

Human Genetics – Pedigree analysis, Karyotype, Genetic disorders (syndromes)

Module 6 10hrs

Mutations: Mutations – Types of Mutations, Chemical mutagens, Radiation mutagenesis, Detection of mutations. Structural rearrangements of chromosomes: Deletion, Duplication, Translocation, Inversion; Numerical variation in Chromosomes – Aneuploidy, Euploidy.

Recommended readings:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Genetics - A Conceptual Approach (2012), 6th ed., Pierce, B.A., W.H. Freeman & Co.(New York), ISBN:13:978-1-4292- 7606-1 / ISBN:10:1-4292-7606-1.
3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

Genetics- Practical (36 hrs)

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

1. Study of Linkage, recombination, gene mapping using marker based data from Drosophila.
2. Study of sexual dimorphism in Drosophila.
3. Study of mutants in D. melanogaster.
4. Study of inheritance pattern of mono and dihybrid crosses, sex-linked inheritance & multiple allelism (ABO and MN blood group typing)
5. PTC testing in a population and calculation of allele and genotype frequencies.
6. Study of abnormal human karyotype and pedigree analysis (dry lab).
7. Determination of chiasma frequency and terminalization coefficient in Allium cepa & Poekilocerus picta.
8. Restriction enzyme digestion plasmid DNA & estimation of size of a DNA fragment after electrophoresis using DNA markers.
9. Construction of Restriction digestion maps from data provided.
10. Demonstration of DNA fingerprinting.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Explain the principles of heredity and pattern of inheritance.	K2	**3, 5**	N/R/G
2	Analyze gene interactions, multiple allelism, linkage and its significance.	K5	**3, 5**	N/R/G
3	Explain the mechanism of sex determination.	K5	**3, 5**	N/R/G
4	Appraise the concept of genes, inheritance of traits and genetic disorders.	K3	**3, 5**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS5CR02- EVOLUIONARY BIOLOGY AND ETHOLOGY

3 credits **54 hrs**

Module 1 10hrs

Introduction to Evolution: Molecules to Organisms: The first ten billion years (universe and earth arise, the atmosphere, rocks and continents), Origin of life (origin of the molecules of life-molecules, membranes, protocells, the first cells, eukaryotic organelles and organisms)

Theories of Evolution: Voyages of discovery, Theories of Evolution (Lamarckism, Darwinism, Mendel's theory of heredity, Neo-Darwininan Synthesis). Evidences for evolution.

Module 2 10hrs

Natural selection: Survival of the fittest, Types of Natural selection (Stabilizing, Directional, Disruptive, Sexual, Group selection, frequency dependent and density dependent selectors) , Selection in relation to constraint, changing environments and plasticity, fitness, and balanced polymorphism.

Module 3 8hrs

Evolutionary genetics: Basic population genetics: Hardy-Weinberg genetic equilibrium; basic one-locus models of mutation, migration and selection; genetic polymorphism; average effect of an allele, breeding value for fitness; breeding value; random genetic drift and inbreeding.

Module 4 8hrs

Speciation and molecular evolution: Species concepts; reproductive isolation mechanisms and patterns; different models of speciation; phyletic gradualism, punctuated equilibrium; neutral theory of molecular evolution; molecular clocks, phylogeny construction.

Module 5 8hrs

Population biology: Population growth, biological interactions within populations, competition, niche segregation, predation, symbiosis; Coevolution: Parasitism and viral pathogens, insects and host plants, plant evolution

Module 6 10hrs

Human Origins & cultural evolution: Primate evolution, Chimpanzees and Humans, Earliest Hominids, Australopithecines: the southern apes of Africa, Bipedalism and brain size, origins of Homo, Out of Africa, Humans as hunter-gatherers; Cultural and Social evolution: Instincts and learned behaviour, Learning, society and culture, cultural evolution dominating phenotypic evolution, Social Darwinism, inheritance of social behaviour.

Recommended readings:

1. Brown, Genomes, Bios, 1999.
2. Strickberger, Evolution, Jones and Barlett, 2000.
3. Jobling et al, Human Evolutionary Genetics, Garland, 2004.
4. Daniel Hartal and Andrew Clark. Population genetics, 3rdedition.
5. Ridley, M. (2004) Evolution. III Ed. Blackwell.
6. Futuyma, D. (1998) Evolutionary Biology. III Edn. Sinauer Assoc. Inc

Evolutionary Biology And Ethology -Practical (36 Hrs)

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Evidences of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era

2. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus

3. Living fossils - Eg. Limulus, Peripatus ,Latimeria, Sphaenodon

4. Vestigial, Analogous and Homologous organs using photographs, models or specimen

Variations

5. Sampling of human height, weight and BMI for continuous variation

6. Sampling for discrete characteristics (dominant vs. recessive) for discontinuous variations e.g. hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group) Selection Exemplifying Adaptive strategies

7. Coloration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using specimens

Neo-Darwinian Studies

8. Calculations of genotypic, phenotypic and allelic frequencies from the data provided

9. Simulation experiments using coloured beads/playing cards to understand the effects of selection and Genetic drift on gene frequencies

Phylogeny

10. Digit reduction in horse phylogeny (study from chart),

11. Study of horse skull to illustrate key features in equine evolution

12. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominine features

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Knowledge Level	PSO No.	
1	Understand the concept on the origin of life, theories on organic evolution and its evidences	K2	**1, 3**	N/R/G
2	Apply the principles of population genetics to study the progression of biological evolution	K5	**1, 3**	N/R/G
3	Details about speciation and molecular evolution	K5	**1, 3**	N/R/G
4	Detailed knowledge about human origin and evolutionary events.	K2	**1, 3**	N/R/G
5	Understand the science of animal behavior and on the concept of learning	K2	**1, 3**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS5CR03- BIOSTATISTICS

3 credits **54 hrs**

Module 1 Basics of Biostatistics 10hrs

Scope and Significance of Biostatistics. Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources). Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting.

Descriptive Statistics: Basic statistical concepts. Reduction of data frequency distribution. Graphical representation of frequency distribution-histogram, frequency curve, cumulative frequency curve. Measures of central tendency and dispersion. Relative dispersion and coefficient of variation.

Sampling techniques: Random sampling. Simple random sampling and stratified random sampling. Use of random number tables, sample size determination

Module 2 Measures of Dispersion 8hrs

Introduction, Characteristics. Quartiles and Percentiles. Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Relative Measures of Dispersion. Calculations/Problems for frequency table. Standard error. Skewness and Kurtosis

Module 3 Correlation Analysis 8hrs

Correlation - types and methods of correlation analysis, Problems for Karl Pearson‟s correlation coefficient and Spearman‟s rank correlation.

Module 4 Regression Analysis 8hrs

Regression and Line of Best Fit, Types and methods of regression analysis. Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of strait line through regression equation). Comparing correlation and regression. Probit Analysis Scatter diagram. Product moment correlation coefficient and its properties. Rank correlation coefficient. Simple linear regression. Method of least squares. Curve fitting. Exponential and power curves. Coefficient of determination.

Module 5 Theory of Probability 8hrs

Probability and Distributions: Simple space. Events. Probability and conditional probability. Addition and multiplication theorems of probability. Probability distributions. Binomial, Poisson and normal distributions. Illustrations.

Module 6 Testing of Hypothesis 12hrs

Hypothesis and types, Confidence Interval, Methods and Errors. Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test – test of independence and goodness of fit (Problem for 2×2 table only). Student‟s „t‟ test (Problem for small samples comparing mean of two variable). F-test, Analysis of Variance (ANOVA - One way), Kruskal Wallis test . Mc Nemar and Mann Whitney U test Test of Significance: Statistical hypothesis. Type–1 and Type–2 errors, level of significance, size and power of a test. Definition of Chi-square, t and F distributions. Central

limit theorem. Tests for the mean, equality of two means, variance (for large and small samples). Large samples tests for proportions. Chi-square test for goodness of fit and for independence of attributes in contingency tables. Confidence interval.

Recommended reading

1. Cambell. R.C, Statistics for Biologists, Cambridge University Press, UK, 1967.
2. Fry J.C., Biological data analysis, a practical approach, IRL Press, Oxford, U.K, 1993.
3. Snedecor P.S., Statistical Methods, Affiliated East-West press, New Delhi, 2000.
4. Primer of Biostatistics, 7th edition (2011), Stanton Glantz, McGraw-Hill Medical. ISBN- 13: 978-0071781503.
5. Biostatistics: A Foundation for Analysis in the Health Sciences,10th edition (2013), Wayne W Daniel and Chad L. Cross, Wiley. ISBN-13: 978-1118302798.
6. Biostatistical Analysis, 5th edition (2009), Jerrold H. Zar, Pearson. ISBN-13: 978-0131008465.

Biostatistics -Practicals- (36 hrs)

1. Calculation of corrected mean, and standard deviation (Problems can be solved using scientific calculator).

2. Derive regression equation for protein, cholesterol and creatine using Optical density and Concentration

3. Drawing best line of fit for protein, cholesterol and creatine (Problems can be solved using scientific calculator).

4. Calculation of Pearson correlation coefficient.

5. Calculation of regression coefficient and regression equation („x" on „y" only)

6. Calculation of Chi -square value (2x2 table only)

7. Calculation of „t" value (for small sample comparing two samples)

8. MS Excel: Preparation of graphs (bar, histogram, frequency polygon, frequency curve, pie diagram and ogives)

9. MS Excel/PH Stat/SPSS: Basic statistics (mean, median, mode, standard deviation), Correlation Analysis, Regression analysis , Test of significance (T test between two sample or sample and population), Chi-square test, Problems using one way ANOVA

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	
1	Apply basic statistical skills in research.	K2	**3, 5**	N/R/G

2	Develop basic computer skills necessary for conducting research and apply them for preparation of research reports.	K5	**3, 5**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS5CR05- SOFT SKILL DEVELOPMENT

3 credits **54 hrs**

Module 1 14hrs

Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. Self-Discovery: Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.

Module 2 16hrs

Interpersonal Communication: Interpersonal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective. Non-Verbal Communication: Importance and Elements; Body Language. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.

Module 3 14hrs

Interview Skills: Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview. Tips for Success. Presentation Skills: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness. Etiquette and Manners – Social and Business. Time Management – Concept, Essentials, Tips. Personality Development – Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.

Module 4 14hrs

Decision-Making and Problem-Solving Skills: Meaning, Types and Models, Group and Ethical Decision-Making, Problems and Dilemmas in application of these skills. Conflict Management: Conflict - Definition, Nature, Types and Causes; Methods of Conflict Resoultion. Stress Management: Stress - Definition, Nature, Types, Symptoms and Causes; Stress Analysis Models and Impact of Stress; Measurement and Management of Stress

Module 5 14hrs

Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviour; Assertivness Skills. Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence. Note: Each topic in all the above units will be supplemented by practice exercises and classroom activities and projects.

Recommended readings:

1. Managing Soft Skills for Personality Development – edited by B.N.Ghosh, McGraw Hill India, 2012. b. English and S
2. Soft skills for young managers by M.S. Rao 2011 Dream Tech press, New Delhi
3. Soft Skill Development by Prashant A. Dhanwalkar, S.R. Sharma and Gunjan Sharma, 2015, Sai Jyothi Publication, Nagpur

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will beable to*:	KnowledgeLevel	PSO No.	
1	Understanding of various skills required while attending an interview	K2	**7**	N/R/G
2	Knowledge about leadership qualities and how to improve	K5	**7**	N/R/G
3	Knowledge about interpersonal communication and skills to improve personality	K5	**7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS5CR04- ENVIRONMENTAL BIOLOGY AND HUMAN RIGHTS

3 credits **54 hrs**

Module 1. ECOSYSTEM 8 hrs

Basic concepts and Components of ecosystem: Abiotic (Sunlight, temperature, soil, water, atmosphere) and Biotic components (Producers, consumers, decomposers), Ecological pyramid- number, biomass, energy, Functions of ecosystem: Productivity-Food chain-Food web-Energy flow-Laws of Thermodynamics. Types of Ecosystem: Terrestrial-Forest-Grassland-Desert, Aquatic-Marine, Fresh water, Wetland &Biome Concept of limiting factors: Liebig's and Shelford's laws of limiting factors. Biogeochemical cycles: Concept, gaseous and sedimentary cycles, Carbon cycle, Nitrogen cycle. Renewable resources (solar, wind, hydroelectric, biomass and geothermal) and Non renewable resources (mineral and metal ore, fossil fuels)

Module 2. CONCEPTS OF POPULATION AND COMMUNITY 7 hrs

Concept of population: Population attributes- Population growth forms, Basic concepts of growth rates, density, natality, mortality, growth curves Animal interactions: Positive-Commensalism- Mutualism- Proto co-operation, NegativePredation-Parasitism-Competition-Antibiosis Characteristics of a community: Species diversity- richness, evenness, stratification, dominance, ecological indicators, Ecotone and Edge effect, Keystone species, Concepts of Ecological Niche and Guild, Ecological succession, community evolution- climax.

Module 3 BIODIVERSITY AND ENVIRONMENTAL ISSUES 16 hrs

Introduction to Biodiversity: Types of biodiversity- Alpha, Beta and Gamma diversity. Concept and importance of Biodiversity: Levels of Biodiversity-Species diversity, Genetic diversity, Microbial, Ecosystem diversity, India as a mega-diversity nation, Biodiversity hotspots Global Environmental Issues: Ozone depletion, Greenhouse effect, Global warming, Climate change, Carbon trading, carbon credit; Carbon sequestration, Acid rain, Oil spills, Nuclear accidents, IPCC/UNFCC. National Environmental issues: Deforestation, forest fire, pollution(air, water, soil, noise thermal, nuclear- brief account only) , solid waste management, sewage, drinking water crisis and water logging, Toxic products and disaster: Types of toxic substances – degradable, non degradable, Impact on human – case studies: Endosulphan tragedy, Bhopal disaster Flood, drought, cyclone, earthquake and landslide (Management and mitigation) Local Environmental issues: Landscape alteration, sand mining, quarrying, changing crop pattern, conversion of paddy lands, Threats to water resources of Kerala: Degrading Mangrove and wetland ecosystems of Kerala, RAMSAR sites, Marine ecosystem crisis- pollution, overfishing etc. Impact of tourism on Environment.

Module 4. CONSERVATION OF BIODIVERSITY 5 hrs

Protected area concept – Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept. Conservation reserves Concept of threatened fauna – IUCN categories - extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern and data deficient. Red and Green Data Books. Man–animal conflict (Tiger, Elephant,) – causes and concern Water conservation- rainwater harvesting, watershed management Environmental laws (Brief account only): The Wildlife Protection Act, 1972, Biodiversity Act, 2002.

Module 5 HUMAN RIGHTS 18 Hrs

Unit 1 - Human Rights An Introduction to Human Rights, Meaning, concept and development –History of Human Rights-Different Generations of Human Rights- Universality of Human Rights- Basic International Human Rights Documents - UDHR, ICCPR, ICESCR.-Value dimensions of Human Rights

Unit 2 - Human Rights and United Nations Human Rights co-ordination within UN system-Role of UN secretariat- The Economic and Social Council- The Commission Human Rights-The Security Council and Human rights. The Committee on the Elimination of Racial Discrimination- The Committee on the Elimination of Discrimination Against Women- the Committee on Economic, Social and Cultural Rights- The Human Rights Committee- Critical Appraisal of UN Human Rights Regime.

Unit 3- Human Rights National Perspective Human Rights in Indian Constitution – Fundamental Rights- The Constitutional Context of Human Rights-directive Principles of State Policy and Human Rights- Human Rights of Women-children –minorities- Prisoners- Science Technology and Human Rights- National Human Rights Commission- State Human Rights Commission- Human Rights Awareness in Education.

Recommended readings:

1. Erach Bharucha 2008 (UGC). Text Book of Environmental Studies of Undergraduate course. University Press.
2. J.B Sharma (2009), Environmental studies' - 3rdEd. University science Press
3. Misra S.P., Pandy S.N. 2009Essential Environmental Students, Ane books Pvt. Ltd.
4. P.D Sharma (2012), Ecology and Environment' - 11th Ed. Rastogi Publications
5. R.B Singh & Suresh Mishra Paulami Maiti (1996), Biodiversity – Perception, Peril and Preservation' — PHI Learning , Environmental Law in India: Issues and Responses
6. Rajagopalan,R. 2005.Environmental Studies from Crisis to Cure. Oxford University Press, New Delhi.
7. Paul R.C., 2000.Situations of Human Rights in India. Efficient offset printers.
8. ArunkumarPalai(1999) National Human Rights Commission of India, Atlantic publishers
9. Sharma P.D. (2005)Environmental biology and Toxicology, Rastogi publication
11. Meera Asthana and Astana D.K.1990 Environmental pollution and Toxicology Alkaprinters.
12. Odum, E.P. 1971.Fundamentals of Ecology.W.B. Saunders CollegePublishing, Philadelphia
13. Alan Beeby, 2006 Anne – Maria Brennan First Ecology, Ecological principles and Environmental issues . International students edition Sec. edition Oxford University Press.
14. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
15. Stiling Peter (2002). Ecology: Theories and applications. Prentice Hall of India pvt. Ltd. New Delhi.
16. Landis, Wayne and Hing-hoYu, Baca Raton, 1995. Introduction to Environmental Toxicology: Impacts of chemicals upon Ecological systems: Lewis Publishers.

Environmental biology an Human Rights 36 hrs

1. Estimation of dissolved Oxygen
2. Estimation of carbon di oxide
3. Estimation of soil organic carbon (Demonstration only)
4. Identification of marine/ fresh water planktons
5. Counting of plankton using plankton counting chamber
6. Study of equipments - Sechi disc, Plankton net
7. Study of sandy shore fauna, rocky shore fauna.
8. Study of animal Association
9. Visit to any two important areas of bio diversity: 1. Forest, 2.Sea shore, 3. Mangrove, 3. Wet lands, 4. Bird sanctuary, 5. Wild life sanctuary, 6. Sacred groves Field study (compulsory)

CO No.	***Expected Course Outcomes*** ***Upon completion of this course, the students will be able to:***	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Identify various types of natural resources, human impact on these resources, and common resource management practices	K1	3, 7	N/R/G
2	Develop skills and a commitment to act independently and collectively to sustain and enrich the environment.	K2	3	N/R/G
3	Understand the multidisciplinary nature, important theories and concepts of environmental science, ecosystems, natural resources and conservation	K2	3	N/R/G

4	Describe environmental hazards and risks and the social and economic ramifications	K5	3	N/R/G
5	Familiarize with the major environmental problems its causes and potential solutions	K2	3	N/R/G
6	Identify issues and problems relating to the human rights.	K2	7	N/R/G
7	Analyse country's situation or international situation in terms of human rights.	K4	7	N/R/G
8	Create awareness on various environmental acts in India	K6	3	N/R/G
*PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

SEMESTER VI

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS6CR01	Plant Reproduction and Breeding	Theory	3	3
IP20BS6CR02	Animal Reproduction and Breeding	Theory	3	3
IP20B6CR03	Molecular Biology	Theory	3	3
IP20BS6CR04	Research methodology	Theory	2	1
IP20BS6CR05	Occupational Biology	Theory	3	3
IP20BS6CRP1	Plant Reproduction and Breeding (P)	Practical	2	2
IP20BS6CRP2	Animal Reproduction and Breeding (P)	Practical	2	2
IP20BS6CRP3	Molecular Biology (P)	Practical	2	2
IP20BS6CRP4	Occupational Biology(P)	Practical	2	2
	Mini Project		3	4
Total			25	25

IP20BS6CR01- PLANT REPRODUCTION AND BREEDING

54 hrs **3 credits**

Module 1 12 Hours

Introduction to Plant reproduction: Floral morphology, parts of angiosperm flower. Transition of shoot apex to flowering apex, Specification of floral organs, ABC – Model.

Microsporangium and male gametophyte: Structure of anther, microsporogenesis, structure of pollen grains.

Megasporangium and female gametophyte: Structure and types of ovules, Megasporogenesis, Structure of typical embryo sac.

Pollination and Fertilization: Structural adaptations of pollen dispersals, pollen viability, storage and germination. Pollen- pistil interaction – Genetic control of pollen – pistil interaction and pollen allelopathy, Pollen sterility: Genetic and cytoplasmic male sterility, chemical induction of male sterility, utilization of male sterility in hybrid seed production. Agents of pollination, Double fertilization.

Endosperm and Embryo: Endosperm development, types; Embryogeny – Structure o dicot and monocot embryo; Seed formation.

Module 2 6 Hours

Incompatibility: Types of Incompatibility, methods to overcome Incompatibility, Delayed pollination, bud pollination, Intra-ovarian pollination, test tube fertilization, somatic hybridization, egg transformation, ovary and embryo culture.

Apomixis and Polyembrony:- Types of Apomixis, Embryology of gametophytic-apomicts, apomixis and plant breeding, Polyembrony- A brief account

Module 3 4 Hours

Introduction to Plant breeding: Concept and scope of plant breeding, a brief historical account of plant breeding, objectives, significance, problems of plant breeding. National and International institutes, location, aims, achievements. Prospects of plant breeding.

Module 6 Hours

Methods of Plant breeding: Plant introduction, Procedure of plant introduction – quarantine regulations, acclimatisation, agencies of plant introduction in India. Selection (pure line, mass, pedigree analysis, single seed descent, clonal selection).

Module 5 10 Hours

Hybridisation: Definition, types. Methods and steps in hybridization. Heterosis, In breeding depression. Genetics of heterosis and inbreeding depression. Heterosis in self and cross pollinating plants and its application. Handling segregating generation - pedigree method, bulk method, back cross method. Polyploidy and breeding- its significance. Breeding for abiotic and biotic stress resistance (Brief account). Marker assisted breeding.

Module 6 10 Hours

Mutation breeding: Mutagens and crop improvement. Spontaneous and induced mutations, effects of mutation. Physical and chemical mutagens; principles and working of Gamma gardens, methods of mutation breeding, mutations in oligogenic traits, mutations in polygenic traits, limitations of mutation breeding, achievements of mutation breeding. Role of mutations in Plant Breeding.

Module 7 6 Hours

Plant genetic resources: Definition, classification, genetic diversity, significance of genetic diversity, erosion of genetic diversity, dangers of erosion. Germplasm collection and conservation, methods. Concepts of asexual seeds, Seed certification.

Recommended reading

1. Bhojwani S.S. & Bhatnagar, S.P. The embryology of Angiosperms. Kalyani Publishers, NewDelhi.2001
2. Johri B.M. Ambegaokar, K.B. and Srivastava P.S. Comparative Embryology of Angiosperms, Vol. I& II, Springer Verlag.
3. Chahal, G.S. & Gosal S.S. Principles & Procedures of Plant Breeding Biotechnological and Conventional Approaches, Narosa Publishing House, New Delhi.
4. Singh, P. 2001. Essentials of Plant Breeding, Kalyani Publishers, Hyderabad.
5. Allard, R. W. 1999. Principles of Plant Breeding. John Willey & Sons, New York.
6. Dana, S. 2001. Plant Breeding. Naya Udyog. Calcatta.
7. Singh. B. D. 1995. Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.

Plant Reproduction & Breeding Practical (36 Hrs)

1. Dissect and study reproductive parts of flower

2. C. S. of anther, embryo sac and embryo

3. Breeding by emasculation, bagging and artificial cross pollination

4.Tests for Pollen Sterility/Viability – In vitro pollen germination/Staining.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs

1	Illustrate the mechanism of reproduction of angiosperms.	K2	**1**	N/R/G
2	Compare breeding techniques and their applications.	K5	**1,2,4**	N/R/G
3	Develop basic knowledge about germplasm collection and conservation.	K5	**1**	N/R/G
4	Develop interest in plant breeding including basics laboratory test associated with plant breeding	K3	**2, 6**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS6CR02- ANIMAL REPRODUCTION AND BREEDING

3 credits **54 hrs**

Module 1 10 hrs

Introduction: Invertebrates: Reproduction in Coelenterates, Annelida and Arthropoda with special reference to insects, male and female reproductive systems, hormones, pheromones and their role in sex differentiation and gonadal activity. Mollusca and Echinodermata: Male and female reproductive systems, Gamete diversity, comparative embryonic development.

Vertebrates: Reproduction in vertebrates: Fishes, Amphibians, Reptiles and Birds: Male and female reproductive systems, Reproductive patterns - Ovipary, Ovo-vivipary and vivipary.

Module 2 8 hrs

The Female Reproductive System in mammals: Comparative anatomy and physiology of the mammalian and sub-mammalian ovary and ductal system. Follicular growth, Ovarian hormones, two cell theory of Estrogen biosyntheis. Autocrine, Paracrine, Endocrine regulation of Ovarian functions.

Module 3 8 hrs

The Male Reproductive System in mammals: Comparative anatomy and physiology of the Mammalian and sub-mammalian testis and sex accessory glands: Function and organisation of Testis, Spermatogenic cycle, Testicular androgens, Autocrine, Paracrine, Endocrine regulation of Testicular function, semen and its biochemical nature.

Module 4 8 hrs

Fertilization in Mammals: Pre-fertilization events, bio-chemistry of fertilization and post-fertilization events. Implantation and its hormonal regulation, delayed implantation. Placenta as an endocrine tissue; foeto- placental Module. Gestation and its hormonal regulation.

Module 5 10 hrs

Regulation of mammalian reproduction: The Pituitary gland: Functional cytology, adenohypophyseal hormones, their chemistry and physiology. The hypothalamus and its neuro secretory centres: structure of Neurosecretory cells, the hypothalamic, principles: syntheis, storage, release and chemistry. The phenomenon of neuro-endocrine integration and the hypothalamo hypophyseal gonadal axis, mammary gland, endocrinology of lactation.

Module 6 10 hrs

Animal Breeding: Concepts, development and applications breeds and breed structure, basic breeding methods; Silkworm, sheep and poultry and cattle; genetic principles in animal breeding, heredity and environment, Heritability, repeatability, methods of their estimations; genotypic, phenotypic and environmental correlations. Traits for selection, breeding efficiency and inbreeding, out breeding, top crossing, grading, cross breeding, criss- crossing, triple crossing system. Artificial insemination, infertility and assisted reproduction.

Recommended readings:

1. Balinsky, B.I. 1981. An Introduction to Embryology, 5th ed. W. B. Sunders Co. West Washington Square, Philadelphia.
2. Bodemer, C.W.1968. Modern Embryology, Holt, Reinhart Winston Inc. NY. Chicago.
3. Enerjee, G.C.1987.A text Book of Animal Husbandry, 6th ed. Oxford and IBH Pub. Co. NY. Delhi, Calcutta & Mumbai.
4. Dalton, D. C. 1987. An Introduction to Practical Animal Breeding. English Language Book Society Collins.
5. Gordon I (1983) Controlled Breeding in Farm Animals. Paragon Press, Oxford, NY & Sydney
6. Hafez, E.S.E. (1987).Reproduction in Farm Animals, 5th ed. Lea & Febigar, Philadelphia.

Animal Reproduction & Breeding- Practical (36 Hrs)

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

1.Reproduction in animals with models of vertebrates and invertebrates

2.Identification of sperms in insects, annelids, amphibians, and mammalian (slides)

3.Sperm counting, studies on process of fertilization (slides/Rat)

4.Visit to breeding research station/ and institutes- GKVK, IISC, Animal house etc. and report writing

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Discuss the differences between the reproductive structure of invertebrates and vertebrates along with practical sessions	K2	**1,2**	N/R/G
2	Detailed study on male and female reproductive systems of mammals	K5	**1**	N/R/G

3	Develop knowledge on hormonal regulation of mammalian reproduction	K5	**1**	N/R/G
4	Illustrate the mechanism of animal breeding	K2	**1,2,6**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS6CR03- MOLECULAR BIOLOGY

3 credits **54 hrs**

Module 1 8 hrs

Introduction to molecular biology: History of molecular biology, prokaryotic and eukaryotic cell composition, organization of chromosomes in prokaryotic and eukaryotic cells, model organisms in the study of molecular biology (E. coli, Sachharomyces, Arabidopsis, C. elegans, Drosophila, Mus musculus, Homo sapiens)

Module 2 10 hrs

Nucleic acids: Structure and function of DNA (DNA as a storehouse of information; genes are mutable units; DNA is the genetic material; topology of nucleic acids; isolating the gene), the structure of eukaryotic chromosomes (chromatin and nucleosomal organization, DNA packing in several layers, interphase chromosomal architecture, nucleosomal remodeling allows access to DNA). Structure, function and biogenesis of different types of DNA.

Module 3 10 hrs

Replication, repair and recombination: The replicon- Module of replication (mapping of origin of replication, replicon in bacterial vs eukaryotic genomes, rolling circle model of DNA replication, bacterial replication and cell cycle, plasmid propagation and plasmid incompatibility), Primosomes and Replisomes (apparatus for DNA replication, DNA polymerases, Okazaki fragments, Leading and Lagging strand synthesis, common events in priming replication at origin, methylation regulating initiation at origin), DNA repair mechanisms, recombination (breakage and reunion involves heteroduplex DNA, Holliday junction)

Module 4 8 hrs

Transcription and post-transcriptional modifications: Transcription complex (promoters, factors, RNA polymerases), initiation-elongation-termination of transcription, mono-cistronic and poly-cistronic RNAs, Transcription factors and their functions (zinc-fingers, helix-loop-helix, leucine zippers, homeo domains, steroid receptors), inhibitors of transcription, Post transcriptional modifications of m-RNA, t-RNA and r-RNA, apparatus for nuclear splicing (spliceosome and lariat formation, alternative splicing, self-splicing by group I introns).

Module 5 8 hrs

Translation: Genetic code- General features of Genetic code. Mechanism of protein synthesis: initiation, elongation and termination in Prokaryotes and eukaryotes. Inhibitors of protein synthesis Post-translational modifications. Protein sorting and targeting. Signal hypothesis – signal sequences, signal recognition particle.

Module 6 10 hrs

Gene regulation in prokaryotes, eukaryotes and phages: Transcriptional and post-transcriptional control of gene expression in prokaryotes and eukaryotes: control at initiation (RNA polymerase-promoter

interactions), a panoply of operons (Lactose and Tryptophan operon), control of RNA structure (termination and anti-termination), Phage strategies (lytic cascade and lysogenic repression).

Recommended reading:

1. Cell and Molecular Biology. De Roberts and De Roberts., Saunders College, USA 6th edition.
2. Molecular Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore & Darnell. Freeman Press, 6th edition.
3. Cell Biology. Karp G., McGraw Hill book comp. New York. 2010 6th edition.
4. The Cell : A molecular approach. Cooper, G.M. ASM Press, USA 2009, 5th edition.
5. Genes V: Benjamin Lewin. Oxford University Press, 1995
6. Cell Biology. Pollard. J.P. and Earnshow, W.C. Saunders, 2002.
7. Molecular biology of the cell. Albert, B., Johnson, A., Raff, M., Robert, K., Walter, P. Garland Sciences, NY, 5th edition.
8. The Cell –A molecular approach. Cooper, G.M. Princeton Publishers, NY, 2000.
9. Molecular Cell Biology. Lodin, H., Berk, A., Zipursky, S.L., Matsudain, P., Baltimore, D. and Darneil, T. Will Freeman company, NY, 6th edition.

Molecular Biology- Practical- (36 hrs)

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

1. Isolation of nucleic acids from plant (young leaves, Allium cepa) and animal (butterfly or silkworm larva, adult Uzi fly, Drosophila larva) by CTAB and SDS-Proteinase K method

2. Isolation of plasmid DNA from bacterial culture using DNA extraction kit

3. Extraction of total RNA from bacterial culture using RNA isolation kit

4. Estimation of DNA content by Diphenylamine(DPA) method

5. Estimation of RNA by Orcinol method

6. Estimation of protein by Bradford method

7. Separation of nucleotide bases by paper chromatography

8. Agarose gel electrophoresis of DNA and RNA

9. Polyacrylamide gel electrophories of proteins

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/

				Global developmental needs
1	Differentiate the basic structures of DNA and RNA	K2	**1**	N/R/G
2	Discuss the DNA replication machinery in prokaryotes and eukaryotes.	K2	**1,3**	N/R/G
3	Discuss the DNA transcription machinery in prokaryotes and eukaryotes.	K2	**1,3**	N/R/G
4	Detailed study on DNA translation machinery	K2	**1,3**	N/R/G
4	Detailed study on nucleic acids and isolation of genetic materials	K2	**1,2,3**	
5	Analysis of various gene regulation mechanism	K3	**1,6**	

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS6CR04- RESEARCH METHODOLOGY

2 credits **36 hrs**

Module 1 6 hrs

Research methodology: Nature of Research: Concept, Meaning and Definition. Introduction to research methods, concepts of research – basic v/s applied research, Historical and Descriptive/ Analytical Research, Conceptual and Experimental/ Empirical Research.

Module 2 6 hrs

Research processes: Research design, identification of research gaps, Research problems: Identification, selection and formulation of hypothesis, conceptualization of research problems, data tools and techniques.

Module 3 6 hrs

Sources of data: Primary and secondary data: Survey – Sampling techniques, systematic random sampling, multiple random sampling and positive random sampling.

Module 4 6 hrs

Designing of Experiments: Questionnaires and interview methods, data processing and data analysis: Presentation and prediction of research findings, Statistical tools

Module 5 6 hrs

Review of literature: Identification of sources of literature, Types of literature, Collection and Review of research literature, and their evaluation. Necessity and importance of review of literature.

Module 6 6 hrs

Presentation of Research findings: Report/ thesis writing/ research correspondence, General strategies for preparation of Research Proposal, Data representation in Technical Reports, Poster presentation in Scientific conferences and Workshops. Preparation of manuscripts for national and international journals. Yardsticks employed in evaluation of manuscripts for publication. Citation index & impact factor of journals.

Recommended reading

1. Louis Cohen, Research Methods in Education (6th Edition), Lawrence Manion, and Keith Morrison, Paperback Publications, 2007.
2. Robert K. Yin, Case Study Research: Design and Methods: (Applied Social Research Methods), Paperback Publications, 2003.
3. Jane Ritchie and Jane Lewis, Qualitative Research Practice: A Guide for Social Science Students and Researchers, Paperback, 2003.
4. Stephen F. Davis, Handbook of Research Methods in Experimental Psychology, Black Well Publications, Lonodn, 2005.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Understand and comprehend the basics in research methodology and applying them in research/project works.	K2	1,3	N/R/G
2	Develop the ability to choose methods appropriate to research aims and objectives.	K5	1,2,5	N/R/G
3	Explain key research concepts and issues.	K5	1,3	N/R/G
4	Explain the comprehension of principles and elements of research methodology.	K2	1,3	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

IP20BS6CR05- OCCUPATIONAL BIOLOGY

3 credits **54 hrs**

Module 1 Apiculture 14 hrs

Definition, Different species of honey bees, Organization of honey bee colony, Social life and adaptation of honey bees. Communication among honey bees. Bee keeping methods and equipments, Management and maintenance of an apiary, Growth period, honey flow period and dearth period Division of the colony, uniting two colonies, , replacing old queen with new queen, swarming management, monsoon management. Enemies of bees. Diseases of bees. Agencies supporting apiculture.

Module: 2 Quail farming (Coturnix coturnix) 8 hrs

Introduction, care of quail chicks, care of adult quails, care of breeding quails, ration for quail, care of hatching eggs, health care, use of quail egg and meat.Sources of quality chicks.

Module: 3 Aquaculture 14 hrs

Advantages and salient features of aquaculture, Types of Aquaculture, Biotic and abiotic features of water, Importance of algae in aquaculture, Common cultivable fishes of Kerala, Fish diseases, Composite fish culture, Integrated fish culture, Carp culture, Prawn culture Mussel culture Pearl culture. Processing & Preservation.

Aquarium management - Setting up of an aquarium, Establishment of commercial ornamental fish culture Module. Fish Transportation - Live fish packing and transport Common diseases of aquarium fishes and their management. Aquaponics (a brief introduction only).

Module 4 Horticulture 10 Hours

Introduction to Horticulture, Definition, history, Disciplines of horticulture - pomiculture, olericulture, floriculture, arboriculture.

Plant propagation: seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation.

Vegetative propagation: natural and artificial; artificial methods - cutting, layering, grafting and budding, advantages and disadvantages of vegetative propagation.

Floriculture: Introduction, nature and scope. Fresh and dry flower arrangements. Production of Cut flowers and foliage plants

Module 5 Gardening 8 Hours

Types of garden: brief study on ornamental garden, indoor garden, kitchen garden, aquatic garden, vertical garden, medicinal garden, terrace garden, terrarium

Garden implements - budding knife, secateurs, hedge shear, hand cultivator, sprayers, lawn mower, garden rake, spade.

Garden designing: garden components - lawns, shrubs and trees, borders, topiary, hedges, edges, walks, drives.

Plant growing structures: green house, mist chamber, glass house.

Potting mixture – components; vermicomposting

Modern trends: Bonsai, terrarium, aquaponics and arboriculture

Recommended readings:

1. Christopher E P, 1958. *Introductory Horticulture*.McGraw – Hill, New York.
2. Esau K, 1965. Plant Anatomy.Wiley, New York.
3. Fahn A, 1985. *Plant Anatomy*.Pergamon Press, Oxford.

4. Hartman H T, D E Kester, 1991. *Plant Propagation: Principles and Practices*. Prentice Hall of India, New Delhi.
5. Kumar N, 1994. *Introduction to Horticulture*.Rajalakshmi Publications, Nagercoil.
6. Pandey B P, 1984. *Plant Anatomy*. S Chand and Company, New Delhi.
7. Vasishta V C, 1978. *Plant Anatomy*. S Nagin and Company, Jalandhar.
8. NPCS Board, The complete book on Bee keeping and honey processing, NIIR Project
9. consultancy services, 106E, Kamala nagar, Delhi- 110007.
10. Shukla G.S, & Updhyay V.B, Economic zoology ,Rastogi Publ. Meerut.
11. Pradip.V.Jabde , Text book of applied zoology, 2005
12. Applied Zoology, Study Material Zoological Society of Kerala , CMS college Campus
13. Chauhan, H.V.S. Poultry, Disease, diagnosis and treatment, Wiley eastern Ltd Delhi.
14. Otieno.F.O 2014. Quail farming: markets & market strategies
15. Pillai T.V.R., Aquaculture, principles and practices.
16. Ronald j. Roberts (1978) Fish pathology , Cassel Ltd London.
17. Harisankar J. Alappat& A. Bijukumar, Aquarium Fishes. B. R. Publ. Corporation, Delhi.
18. MPEDA, A hand Book on AquafarmingOrnamentalfishes, MPEDA, Kochi.
19. Amber Richards. 2014. Aquaponics at home.
20. Pradip.V. Jabde. 1993. Text book of applied zoology
21. Venkitaraman, P.R,1983, Text book of Economic zoology(SudharsanaPuubl. Kochi)
22. Addison Webb, Bee Keepingfor profit and pleasure, Agrobios Ltd.
23. Applied Zoology, Study Material Zoological Society of Kerala , CMS college Campus
24. George cust& Peter Bird, Tropical Fresh water Aquaria, Hamlyn London.
25. Verreth J. Fish larval nutrition, Chapman & Hall Publ.
26. Bone Packer. 2014. Aquaponic system

Occupational Biology- Practical (36 hrs)

General Identification, Economic importance, Morphology, scientific names and common names of the following
Economic important and morphology of culturable fishes (Catla, Rohu, Grass carp, Common carp, Silver carp, *Etroplus suratensis*, Oreochromis /Tilapia, *Mugil cephalus* and *Anabas Testudineus*)
Four species of honey bees
Economic importance and morphology of shell fishes (Any three species of prawn, two marine mussels, pearl oyster - *Pinctada fucata*
Castes of bees
Bee keeping equipments, Beehive, Smoker, honey extractor, Queen Cage, Bees wax, Honey,
Tests for determining the adulteration in honey.
Mounting of pollen basket
Mounting of mouth parts of honey bee
Grafting, budding and layering
Familiarization with garden tools
Identification of garden components and plant growing structures
Visit to established horticultural/agricultural gardens
Demonstration of Bonsai, terrarium and flower arrangement

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Knowledge Level	PSO No.	Relevance to Local/ National/ Regional/ Global developmental needs
1	Understand different species of culturable fishes,ornamental fishes, fish culture practices, management of fish culture, fish processing and Preservation.	K2	1	N/R/G
2	Construct an ornamental fish culture unit for self employment	K3	2,4	N/R/G
3	Construct and maintain quail farming practices for self-employment	K3	2,4	N/R/G
4	Apply the concept of vermicomposting to undertake waste management measures	K3	2,4	N/R/G
5	Monitor and maintain apiculture as hobby or as an additional income	K3	2,4	N/R/G
6	Understand different honey bee species, bee products and earthworm species	K2	1	N/R/G
7	Identify fish diseases, apiculture tools and equipments	K1	1,2	N/R/G
8	Carry out qualitative test for honey adulteration	K6	2	N/R/G
9	Produce fish seed by breeding ornamental fishes and Prepare artificial feed for fish culture	K3	2,4	N/R/G

*PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

COMBINATIONS OF PRACTICAL EXAMINATIONS OF MSc INTEGRATED PROGRAMME IN BASIC SCIENCES- BIOLOGY

SEMESTER VI

COURSE CODE	TITLE
IP20BS6CRP1	Occupational Biology and Plant Reproduction and Breeding
IP20BS6CRP2	Evolutionary Biology and Ethology and Animal Reproduction and Breeding
IP20BS6CRP3	Environmental Biology and Human Rights and Biostatistics
IP20BS6CRP4	Genetics and Molecular Biology

SEMESTER VII

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS7CR01	Pathology	Theory	5	4
IP20BS7CR02	Biomedical Sciences	Theory	5	4
IP20BS7CR03	Microbiology and Immunology	Theory	5	4
IP20BS7CR04	Systems Biology	Theory	4	3
IP20BS7CRP1	Pathology (P)	Practical	2	2
IP20BS7CRP2	Microbiology and Immunology (P)	Practical	2	2
IP20BS7CRP3	Biomedical Sciences and Systems Biology (P)	Practical	2	1
Total			25	20

PATHOLOGY

Theory:72 hrs **4 credits**

PLANT PATHOLOGY:

Module I: Introduction to plant pathology (8 hrs)

Disease concept, disease description and diagnosis, life-cycle strategies of plant pathogens, Classification of plant diseases based on; (a) Major causal agents - biotic ((fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites - *Viscum*, *Dendropthoe*) and abiotic (nutrient and mineral deficiencies, effect of pollution) (b) General symptoms; Spread and transmission of plant diseases by wind, water, seeds and vectors

Module II Mechanism of infection, pathogenesis and defense (16 hrs)

Process of infection- mechanical, physiological and enzymatic action. Penetration and entry of pathogens in to host tissue. Host- parasite interaction. Enzymes and toxins in pathogenesis. Defence mechanisms in plants (structural and biochemical); Plant disease management- exclusion, eradication and protection. Different pesticides and fungicides and their application. gene for gene concept, disease management with special emphasis on biological control; integrated management by cultural, chemical, biological and host resistance method, importance of plant quarantine in disease management; Biotechnological approaches to disease resistance (brief study only).

Module III Common plant diseases (12 hrs)

Study of the following diseases with Recommended Reading to the symptoms, causal organisms, disease cycle and control measures

(a) Cereals: Rice - blast disease, bacterial blight, wheat rust
(b) Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease; Citrus - bacterial canker
(c) Fruits: Banana - leaf spot; Mango - Anthracnose; Papaya – mosaic, Pineapple -Mealybug wilt
(d) Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease.
(e) Oil seeds: Coconut - grey leaf spot, bud rot disease.
(f) Rubber yielding: *Hevea braziliensis* - abnormal leaf fall, powdery mildew.
(g) Cash crops: Arecanut - nut fall disease.
(h) Beverages: Tea - blister blight; Coffee - rust.

ANIMAL PATHOLOGY

Module IV Animal Pathology- An introduction (8 hrs.)

Introduction to animal pathology: the causation, progression, transmission, course and termination of disease. Zoonotic diseases, causative organisms, spread, control measures.

Module V Animal Pathogenesis (14 hrs.)

Study of animal pathogenesis: Various degenerations, pathological changes affecting digestive, respiratory, nervous, reproductive, cardiovascular, circulatory and growth disturbances, reversible and irreversible cell injuries, different types of inflammation with special emphasis on chemical mediators. Animal oncology.

Module VI Disease and management (12hrs.)

Fungal, viral and bacterial diseases of animals including disease management: Foot & mouth diseases of cattle, bird flu, marine white spot disease, parasitology among animals. Diagnostic tests, Immunization, vaccines.

Recommended reading

1. K S Bilgrami, H C Dube. *A text book of modern plant pathology*.
2. Gareth Johnes. *Plant pathology: principles and practice.*
3. R S Mehrotra. *Plant Pathology*.
4. M N Kamat. *Practical plant pathology*.
5. V K Gupta, T S Paul. *Fungi and Plant disease.*
6. Malhotra, Aggarwal Ashok. *Plant Pathology*.
7. Rangaswamy, A Mahadevan. *Diseases of crop plants in India*.
8. B P Pandey. *Plant Pathology*.
9. George N Agrios (2006). *Plant pathology* (V Edn). Elsevier Academic Press.
10. JD Smyth, An Introduction to Animal Parasitology, 3rd edition, CUP, 19
11. S.H. Gillespie & P.M. Hawkey ed. Medical Parasitology – A Practical Approach, OUP,1995
12. F.E.G. Cox ed., Modern Parasitology, Blackwell Publishing, 1993.

Expected Outcomes:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs

1	Knowledge about various plant and animal disease concepts and diagnosis	K2, K4	**3**	N/R/G
2	Acquire knowledge about plant pathogens, diseases, and their management	K3, K5	**3**	N/R/G
3	Acquire knowledge on pathogenesis in animal	K2, K4	**3**	N/R/G
4	Provide students with essential medical knowledge and a broad understanding of human disease	K2, K3	**1, 3**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

BIOMEDICAL SCIENCES

Theory: 72 hrs **4 credits**

Module I Stem Cells (14 hrs)

Definition and characteristics, classification of stem cells (embryonic stem cells and adult stem cells), stem cell niche, stem cell division and its control, induced pluripotent stem cell generation & application, hemopoietic stem cell disorders: classification and manifestations, principle and procedure of bone marrow transplantation.

Regenerative biology - Tissue regenerative capacity, Regeneration in planaria, zebrafish, axolotl, and mammals, Facultative stem cells, Trans differentiation, De-Differentiation and plasticity.

Module II Human Cytogenetics (12 hrs)

Human chromosomes and karyotypes, sex determination, X and Y chromosomes, evolution of human chromosomes, fragile sites mutagenesis studies, causes of chromosome breakage, SCE/MN, In-situ Hybridization, chromosome and cancer, studies of prenatal chromosomes, Somatic cell hybrids in gene mapping, chromosomal disorders/ syndromes, Chromosome banding techniques — G, C, R, Q, T. FISH,

Module III Cancer Biology (**12 hrs)**

: Different types of tumors, factors and mechanism involved in tumor formation, oncogenes, tumor suppressor genes, methods of detection of cancer, tumor markers, treatment-chemotherapy, radio therapy, immunotherapy and gene therapy for cancer.

Module IV Human Microbial diseases (10 hrs)

Mode of infection, symptoms, epidemiology and control of AIDS, Hepatitis B, Rabies, Tetanus, Typhoid, STD, TB, Cholera, Aspergillosis, Histoplasmosis, Cryptococcosis, Leprosy, H5N1 and H1N1; Arboviral diseases: Yellow fever, Dengue, Japanese Encephalitis, Chickungunia, Kyasanur forest disease- epidemiology and management.

Module V Haematology and transfusion science (**12 hrs)**

: Structure, function and production of blood cells, platelet structure and function haemostasis, fibrinolysis, thrombosis. Types of anaemias, haemoglobinopathies and thalassaemias, Haematological malignancy. Transfusion science, Genetics, inheritance, structure and role of red cell antigens, the preparation, storage and use of blood components, the selection of appropriate blood components for transfusion and possible adverse effects, immune mediated destruction of blood cells, health and safety aspects of handling blood.

Module VI Disease diagnostics (12 hrs)

: Nervous system, perspective and behaviour, Neural disorders and repair.

DNA finger printing in Forensic science- Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine. Cyber Forensic Investigation

Disease diagnosis. Enzymes in diagnosis of human diseases and Health care. Acetylcholinesterase, angiotensin converting enzyme (ACE), Pseudocholinesterase, 5'-nucleotidase (5NT), Glucose-6-phosphate dehydrogenase (GPD) and other red cell enzymes; CK isoforms, Immunoreactive trypsinogen (IRT) and Chymotrypsin; Amylase isoenzymes, Macro amylases, Isoenzymes (CK, LD, ALP). SGOT and SGPT. Diagnosis of Diabetes mellitus and Glucosurea.

Recommended Reading

1. Enzyme Technologies for pharmaceutical and biotechnological applications by Herbert A Kirst, Wu- Kuang Yeh, Milton J.
2. Developmental Biology, 6th Edition, by Scott F. Gilbert
3. Hematology, by William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman Molecular Biology of the Cell, 3rd Edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson
4. Caul.E (1992) Immuno-flourescent–antigen detection techniques in diagnostic microbiology, PubHealth Lab services
5. Cruick shank et. all Medical microbiology
6. Goding, M.J.W Monoclonal Antibodies: principles and practice – (1983) Academic press. 7.Kuby.J (1992) Immunology 4th Edn. Richard A. Goldsby Kindt & Oshome Eds W.H.Feeman &CoNY
7. Zaiko, G.E (2004) Biotechnology and agriculture & Food industry, Nova publishers
8. A. V. Hoffbrand, P. A. H. Moss, J. E. Pettit, Essential haematology- Medical – 2006
9. Atul B. Mehta, A. V. Hoffbrand, Haematology at a glance- Medical – 2005

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Relevance to Local/ National/ Regional/ Global developmental needs	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	To know more about stem cells and its application in the field of medicine and biology	N/R/G	**3, 5**	N/R/G

2	Acquire knowledge on various cytogenetic techniques like in situ hybridization and gene mapping etc	N/R/G	**5**	N/R/G
3	Detailed knowledge about cancer and its therapeutical methods	N/R/G	**3, 6**	N/R/G
4	Insights into various microbial diseases and disease diagnostic methods	N/R/G	**3, 5, 6**	N/R/G
5	Knowledge about transfusion science	N/R/G	**6**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

MICROBIOLOGY AND IMMUNOLOGY

Theory:72hrs **4 credit**

MICROBIOLOGY

Module I - Introduction to Microbiology (13 hrs)

Scope of Microbiology; Outline classification of bacteria, fungi and viruses. Nutritional classification of bacteria. Growth curve.Bacterial morphology.Classification of Bacteria according to Bergey's manual of systematic bacteriology. Ultrastructure of Gram positive and Gram negative bacteria; Cell membrane, cell wall, flagella, pili,fimbriae,capsule and slime,ribosome and endospores.

Module II - Microbial Infections (8 hrs)

Primary and secondary infections; Cross infection; Nosocomial infection; Endogenous and exogenous infections, Epidemic, endemic and pandemic; Modes of transmission of diseases: by food, water, air and vectors.

Module III - Methods in Microbiology (14 hrs)

Methods of sterilization and disinfection: Physical; Chemical Preparation of culture media: Selective media; Enrichment media; Enriched media; Differential media Plating techniques and isolation of pure colonies; Aerobic and anaerobic cultivation Culture preservation techniques: Refrigeration, Deep freezing, Freezing under liquid nitrogen; Lyophilization

IMMUNOLOGY

Module IV - Introduction to Immunology (15 hrs)

Historical account; Cells and organs of immune system; Lymphocytes, their origin and differentiation (B-Lymphocytes and T-Lymphocytes); antigens, types and classification; complement system.

Types of Immunity: Innate and acquired, humoral and cellular;

Humoral immunity - B-lymphocytes and their activation; structure and function of immunoglobulins; immunoglobulin classes and subclasses,idiotypes and idiotypic antibodies

Cellular immunity - Major histocompatibility complex. Thymus derived lymphocytes (T cells) their classification, antigen presenting cells (APC) - macrophages, dendritic cells, langerhans cells, their origin and functions; mechanisms of phagocytosis; identification of cell types of immune system; immunosuppression, immune tolerance.

Module V - Immune hypersensitivity (10 hrs)

Mechanisms of T cell activation, cytokines and their role in immune response; Leukocyte migration and inflammation; hypersensitivity of macrophage activation and granuloma formation, immune regulations, immune response to infectious organisms, Vaccines.

Module VI – Transplantation and Autoimmunity (12 hrs)

Transplantation and Grafting: Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanisms of immunity to tumor antigens.

Autoimmunity: Auto-antibodies in humans, pathogenic mechanisms, experimental models of

auto immune diseases, treatment of auto immune disorders.

Recommended Readings

1. Bilgrami, Sinha. Essentials of Microbiology.
2. Carpenter P L (1967). Microbiology. W B Saunder & Co. Philadelphia.
3. Dube H C (2008). Fungi, Bacteria and Viruses. Agrobios.
4. Kanika Sharma (2005). Manual of Microbiology: Tools and Techniques. Ane Books.
5. Kumar H D (1990). Modern concepts of Microbiology. Vikas public. Delhi.
6. Lansing M Prescott, Harley, Klein (1999). Microbiology.
7. Pelczar Michael J, Adams M R, Chan E C S, Krieg Noel R (2000). Microbiology. Tata McGraw Hill.
8. Pelczar (1990). Microbiology. T M H.
9. Purohit S S (1997). Microbiology: Fundamentals and application. Agrobotanical.
10. Powar C B, Daginawala H F (1991). General Microbiology Vol II. Himalaya Publishing House.
11. Salle A J (1978). Fundamentals of Bacteriology. Asia TMH
12. Dubey R C, Maheswari D K (2004). Microbiology. S Chand.
13. Sharma P D (2003). Microbiology. Restogi pub.
14. F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. Medical Microbiology.
15. L R Haahelm, J R Pattison, R J Whitley. Clinical virology.
16.Roitt's Essential Immunology,by Delves, Martin, Burton &Roitt, 12th edition, Wiley-Blackwell, 2011.
17.Kuby Immunology. Owen, Punt, Stranford, 7th edition, Macmillan, 2013. 18. Cellular & Molecular Immunology, Abbas et al.,7th edition, Elsevier, 2011.

Expected Outcomes:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Insights into various microbiology techniques and its application in the field of biology	K2, K3	**3, 6**	N/R/G
2	Explain the significance of microbiology as a scientific discipline	K2, K5	**1, 3**	N/R/G

3	Basic knowledge in immunology and cellular immunity	K2	**1, 3**	N/R/G
4	Knowledge about various immunotechniques and its applications	K2, K3	**5, 7**	N/R/G
5	Detailed knowledge about autoimmunity	K2	**3**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

SYSTEMS BIOLOGY

Theory:72 hrs **4 credit**

Module I System Biology- An introduction (11 hrs.)

Systems biology definition, component level and system level, complexity, levels of complexity; DNA, RNA, protein -DNA interaction, pathways, organs and system, population, ecology. Systems structure – Biological systems, functions and mechanisms. metabolic systems, signal transduction systems, neural networking systems, dynamics, stress response, simulation, tools.

Module II Enzymes (12 hrs.)

Control of enzyme activity & metabolic pathways: models account for the behavior and regulation of enzymes, significance of allosteric and cooperative behavior of enzymes. Metabolic pathways - general consideration, amplification of signals, formulation of theories for control of metabolic pathways, examples. Regulation of glycolysis, gluconeogenesis and glycogen metabolism. Heat shock response. Enzymes in organized systems: Models of multi-enzyme complexes, Pyruvate dehydrogenase from *E. coli* and mammalian Tissues. Tryptophan synthase. Organ cloning, regenerative medicine.

Module III System behavior analysis (14 hrs.)

System behavior analysis: database, cell/tissue simulation, system analysis, software, mathematical modelling, hypothesis generation, experimental planning, data presenting. Redundancy, robustness, modular design, structural stability. Identification of DNA- Protein interactions, computational analysis of DNA- Protein interaction. Mathematical methods for identification of gene regulation networks. Mathematical and computational analysis of metabolic reaction networks.

Module IV Modeling and Application in Systems Biology (13 hrs.)

Strategies relating to In-silico Modeling of biological processes, Metabolic Networks, Signal transduction pathways, Gene Expression Patterns. Applications of Systems Biology Markup language (SBML), E-cell and V- cell Simulations and Applications; Synthetic genomics – Methods and applications. Patient models, disease models, disease risk

Module V Next Generation Sequencing (8 hrs)

Next Generation Sequencing (NGS): Pyrosequencing, Illumina, Ion Torrent. Pros and cons of sequencing technique

Module VI Molecular Docking and Drug Discovery (14 hrs.)

Multidisciplinary approach, Application of systems biology; application in neurological sciences, in cancer biology. Introduction to molecular docking, inter relation with bioinformatics, types of molecular docking, role of molecular docking in drug discovery, Visualisation tool – Rasmol, tools used for molecular docking: Auto Dock Vina, GOLD, MOE-Dock. Parameters of docking, The drug discovery process, techniques in drug designing. Steps of drug design and administration. Pharmaceutical applications. Future scope.

Recommended reading

1. Jonathan Pevsner, "Bioinformatics and Functional Genomics" 2003 John Wiley & Sons, Inc.
2. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.
3. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.
4. Daniel P. Berrar, Werner Dubitzky, Martin Granzow, "A Practical Approach To Microarray Data Analysis" 2003 Kluwer Academic Publishers ISBN: 1-4020-7260-0
5. Molecular Modeling Principles and Applications, Andrew R. Leach, II ed. 2001. Prentice Hall
6. Murphy K.P. (ed.) Protein structure, stability, and folding (Humana Press, 2001)
7. Current Protocols in Protein Science, Wiley Publishers, 2005

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	To analyse the system behaviour	K4	**1, 3, 5**	N/R/G
2	Get deep insight into enzyme activity and metabolism	K2, K4	**3, 5**	N/R/G
3	Familiarize with techniques of molecular docking and some other bioinformatic methods	K2, K5, K6	**5, 6, 7**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

PRACTICALS

PATHOLOGY

Practical: 36 hrs **2 credits**

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Demonstration:

1. Make suitable micro preparations and identify the diseases mentioned with due emphasis on symptoms and causative organisms.
2. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.
3. Methods of studying plant and animal diseases- Scoring, Collection and preservation of samples.
4. Culturing of Nematodes – Isolation and pathogenesis
5. Identification of disease pathology in Animals: Grasserie, Flacherie, Muscardine, Pebrine, Foot and mouth diseases, Mastitis in cattle, coccidiosis, Scrapie, Brucellosis, Bird flu, Q Fever, Marine White Spot Disease in fishes.
6. Identification of insect pests of agricultural crops – Leaf roller, mealy bugs, stem borers, sap suckers.
7. General identification of vectors of animal disease (.5 nos).
8. Identification of histopathological slides of various diseases.
9. Identification and study of various histopathological slides of poultry, fishes, and domestic animals.
10. Field Visit to study crop diseases and animal disease.

Wet Lab:

1. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
2. Tests for seed pathology – seed purity test.
3. Calculation of Spore load on seeds using Haemocytometer.
4. Collection and preservation of pathogens or pests or affected parts of plants and animals.

MICROBIOLOGY AND IMMUNOLOGY

Practical: 36 hrs **2 credits**

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Demonstration:

1. Demonstration of ELISA
2. VDRL/ WIDAL test
3. Study of structural plant defences: viz. cuticle, wax, lignin, bark, thorns, prickles, trichomes, armour in different plants species including thigmonasty, camouflage, mimicry.

Wet Lab:

1. Separation of serum from blood samples
2. Isolation and enumeration of lymphocytes using haemocytometer
3. Isolation and enumeration of spleen cells (fish)
4. Purification of IgG from serum by ammonium sulphate fractionation method – Dialysis
5. ABO Blood group typing.
6. Immunodiffusion tests: Ouchterlony double immunodiffusion method (DID) and Single Radial immunodiffusion (SRID, Mancini method).
7. Quantitative and qualitative analysis of secondary metabolites in plants: alkaloids, glycosides, glycosinolates, terpinoids, phenolics, gammosis etc. in healthy and diseased plant/plant organs.

BIOMEDICAL SCIENCES & SYSTEMS BIOLOGY

Practical:18 hrs 1 credit

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Demonstration:

1. Chromosomal analysis, bright field technique, GTG and CBC banding
2. NOR staining and sex chromosome identification
3. Identification of organelles by marker enzymes: SDH, LDH, acid phosphatase
4. Fluorescence technique, Q & C banding, FISH
5. Immunoassay for detection of typhoid (kit method)
6. Karyotyping- normal karyotyping, Aneuploidy, Aberrations.
7. Labelling of DNA-probes by Nick –translation filter test
8. Gene expression measurement through DNA microarrays and SAGE.
9. Protein visualization using Rasmol
10. Drug Designing using Autodock

Wet lab:

1. Estimation of SGOT in blood samples by standard curve method
2.Estimation of SGPT in blood samples by standard curve method
3.Estimation of LDH in blood samples by standard curve method
4.Estimation of Creatinine in blood samples by standard curve method
5.Estimation of Cholesterol – hypercholesteremia samples
6.Estimation of Bilirubin
7.Estimation of blood glucose by glucose oxidase method
8. STD detection by agglutination method (kit method)

SEMESTER VIII

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS8CR01	Genomics and Proteomics	Theory	5	4
IP20BS8CR02	Animal Molecular Physiology	Theory	5	4
IP20BS8CR03	Plant Molecular Physiology	Theory	5	4
IP20BS8CR04	Genetic Engineering	Theory	4	3
IP20BS8CRP1	Genomics and Proteomics (P)	Practical	2	2
IP20BS8CRP2	Animal Molecular Physiology and Plant Molecular Physiology (P)	Practical	2	2
IP20BS8CRP3	Genetic Engineering (P)	Practical	2	1
Total			25	20

GENOMICS AND PROTEOMICS

Theory:72 hrs **4 credit**

Module I Introduction to Omics (2 hrs)
Genomics, Proteomics, Transcriptomics, Metagenomics, Structural genomics and functional genomics other omic approaches and its applications (Brief study only)

Module II Organization and structure of Genomes (10 hrs)
Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA- encoding genes, Functionally identical/similar genes, Diversity in size and organization of genes. Gene families: Multigene families – Classical gene families, families with large conserved domains, families with small conserved domains, Gene super families, Gene families in clusters, Pseudogenes, Repetitive DNA and transposable elements, Origin of gene families (Haemoglobin, Myoglobin as examples).

Module III Structural genomics and genome projects (25 hrs)
(a) Basic steps in genome sequencing. Shot gun sequencing of small genomes. Map based sequencing: Hierarchial shot gun sequencing (clone-by-clone approach) - steps involved; Whole genome shot gun approach - steps involved.
(b) Genome mapping: Genetic mapping and physical mapping. Cytogenetic and linkage map (brief study only). Molecular markers – RFLP, RAPD, AFLP, SSLP, SNP. Construction of linkage maps using molecular markers – E.g., RFLP maps. Physical mapping – restriction mapping, STS, SNP, EST
(c) Sequence assembly – methods used.
Next generation sequencing strategies – Pyrrosequencing
(d)Genome Projects: Human genome project, Rice genome project, Arabidopsis genome project, *E. coli* genome project, Drosophila Genome Project, Mouse genome project.

Module IV Functional genomics (12 hrs)
Transcriptome, expression profiling (mRNA profiling). Gene expression analysis using dot blotting and microarrays. Fabrication of microarrays – spotted arrays, *in situ* synthesis. Chromatin immunoprecipitation (ChIP) and its applications. Determination of gene functions - knock out and knock down mutants, antisense RNA and RNAi, gene overexpression.

Module V Comparative genomics (7 hrs)
Orthologs and Paralogs, gene identification by comparative genomics; comparative genomics as a tool in evolutionary studies. Metagenomics

Module VI Proteomics (16 hrs)
Proteome, proteomics. Separation and identification of cellular proteins by 2D gel electrophoresis and mass spectrometry. Protein expression analysis using Protein microarray, protein localization using GFP, other applications of GFP. Protein structure analysis: Structure prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure: Homology modeling, CASP, Ab initio prediction, Molecular dynamics & conformational energy calculation, Prediction of function.

Recommended Reading

1.T.A. Brown, Genomes, Bios, 2002.

2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.

3.Dale & Schartz, From Genes to Genomes, Wiley, 2003.

4.Hawley and Mori, The Human Genome, Academic, 1999.

5.Lewis, Human Genetics, WCB, 1999.

6.Liebler, Introduction to Proteomics, Humana, 2002.

7.Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.

8.Primrose & Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.

9.Strachan and Read, Human Molecular Genetics, Wiley, 1999.

10.Sudbery, Human Molecular Genetics, Prentice Hall, 2002.

Expected outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Knowledge in basic genomic and proteomic studies and its applications	K2, K3, K5	**3, 5, 7**	N/R/G
2	Detailed study on comparative genomics	K5	**3, 5, 7**	N/R/G
3	Discuss the Design drugs from data of functional genomics and proteomics	K4, K5	**3, 4, 7**	N/R/G
4	Describe proteins interaction, activity, modification and function	K2, K5	**3, 5, 7**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.	

ANIMAL MOLECULAR PHYSIOLOGY

Theory: 72 hrs **4 credit**

Module I Gastrointestinal Physiology

Gastrointestinal Physiology – Mechanism of gastric acid, pepsin and bicarbonate secretion, features of motor activity of gut, sphincters, specific patterns of motor activity, pattern of contraction. Digestion and absorption in gut.

Module II Excretory Physiology

Excretory Physiology – Renal hemodynamics. Glomerular filtration. Formation of urine, acid – base balance. Control of body fluid volume and osmolytes.

Module III Circulatory & Respiratory Physiology

Circulatory & Respiratory Physiology – Composition of blood, Blood cells, homeostasis, mechanism of blood clotting, organization of neuro cardiovascular reflexes, neuro-hormonal control of arterial pressure, integrated cardiovascular responses.

Mechanical properties of respiratory system. Mechanism of breathing, Tissue gas exchange, cellular respiration, control of breathing (chemical and neural).

Module IV Nervous and Sensory Physiology

Nervous and Sensory Physiology– Molecular mechanism of nerve impulse transmission, Synapses, NMJ, Cholinergic and Adrenergic systems, inhibitory neuro transmitters, structure and function of acetyl choline receptor. Mechanism of vision, taste, olfaction and auditory responses.

Module V Muscular Physiology

Molecular mechanism of contraction of Skeletal and Cardiac muscle, Muscle proteins, Neuromuscular junction, Cardiac action potential, pacemaker, contractile machinery, mitochondria and energy supply. Cardiac performance (ECG).

Module VI Endocrine and reproductive Physiology

Mechanism of Hormone action Genomic and Non-genomic pathway, Regulation of hormones (Feedback mechanism). Hormonal regulation of Reproduction (Estrous and menstruous cycle), Role of hypothalamo hypophyseal gonadal axis, steroid hormone receptors (ER Alpha, Beta and AR Alpha and Beta)

Recommended Reading

1. Bullock N, Boyle S, Wang M.B, Physiology, Lippincott Williams, New York, 2001.
2. Astrand P.P, Rodahl, Stromme, Text Book of Physiology, Kinetic Inc. New York, 2005.
3. William P. Stone G, Johnston I., Environmental Physiology of Animals, Blackwell Publishers, London, 2001.
4. Gerald Karp, Cell and Molecular Biology, Cell and Molecular Biology- Concepts and Experiments, John Wiley & Sons, New York, 1996.
5. Schimidt, Animal Physiology: Adaptation and Environment, 5th edition, Cambridge University Press, London, 1997.
6. Roberts M.B.V, Nelson Thrones, Biology: A Fundamental approach, Bristol, 2003.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Detailed knowledge about gastrointestinal and excretory physiological systems in human body	K2, K5	**1, 3**	N/R/G
2	Knowledge on circulatory and respiratory physiology	K2	**3**	N/R/G
3	Understand about muscular, nervous and sensory physiology	K2	**1, 3**	N/R/G
4	Familiarize with endocrine and reproductive physiology	K2	**1, 3**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

PLANT MOLECULAR PHYSIOLOGY

Theory: 72 hrs **4 credits**

Module I: Photobiology and Signal Transduction (15 Hours)

Role of Photoreceptors (Phototropins, Phytochromes, Cryptochromes and Zeaxanthin) on plant growth and development. Signal transduction in stomatal opening and phototropism; Red/Far Red, Green and Blue light stimulated stomatal opening. Structure, function, and mechanism of action of Cryptochromes.

Cellular and Molecular mechanism of Phytochrome: Phytochrome- the Red/Far-Red photoreceptor, structure, photo reversibility, properties, phytochrome induced whole plant responses- VLFRS, LFR & HIR and phytochrome induced Gene expression.

Module II: Biochemical signaling in plants (8 Hours)

Role of cyclic nucleotides, calcium calmodulin cascade, protein kinases, phosphatase and specific signaling mechanism (Membrane based receptors & nuclear based receptors).

Module III: Physiology of Flowering (10 Hours)

Floral stimulus and biochemical signaling involved in flowering: Circadian rhythms, molecular mechanism of photo-periodism and vernalization. Florigen concept, ABC model of flowering.

Module IV: Defense mechanisms in plants (12 Hours)

Genetic basis of Plant-pathogen interactions, R genes and R-gene mediated Disease resistance. Multiple types of defense reactions activated by pathogen attack, Hypersensitive reactions, Role of Reactive oxygen species in plant resistance response, Nitric oxide signaling, Role of salicyclic acid and jasmonic acid in defense reactions, role of PR proteins and other defense other defense related proteins in signal transduction cascades.

Module V: Secondary metabolites (12 Hours)

Classification, chemical nature and functions of phenolics, terpenes and nitrogen containing compounds like alkaloids, cyanogenic glycosides and non-protein amino acids. Brief account on biosynthetic pathways of secondary metabolites.

Module VI: Stress Physiology (15 Hours)

Molecular, biochemical and physiological aspects of plant responses and adaptations to various abiotic stresses. Water stress: Role of solutes in cell osmotic adjustment, Role of Seed proteins. Freezing stress: chilling stress, Heat stress, salinity stress & oxygen deficiency and Oxidative stress in plants (free radicals, scavenging enzymes- superoxide dismutase, peroxides and catalase).

Recommended reading

1. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
2. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology of plants*. L K International Pvt. Ltd.
3. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole.
4. H Robert Horton, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall.
5. Frank B Salisbury, Cleon W Ross (1992). *Plant Physiology* (IV Edn). Wadsworth Publishing Company.
6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
7. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
8. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
9. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford
10. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
11. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
12. S Sadasivam, A Manickam (1996). *Biochemical methods* (II Edn). New age international Publishers.
13. Harborne TC (1981), *Phytochemical methods- A guide to modern techniques of plant analysis*, Chapmen and Hall.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs

1	Discuss about the molecular mechanisms of plant physiology	K2,, K4	**1, 3**	N/R/G
2	Detailed study on biochemical signalling mechanisms in plants	K3, K5	**3, 6**	N/R/G
3	Explain the defense mechanism in plants	K2	**3**	N/R/G
4	Detailed knowledge on stress physiology	K2, K5	**3, 5**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

GENETIC ENGINEERING

Theory: 54 hrs **3 Credits**

Module I - Introduction to Recombinant DNA technology (6 hrs)

Basic principles, tools and techniques; role of enzymes used in genetic engineering (endo and exonucleases, RNase, DNase, restriction endonucleases) DNA methylation, RNA modification, role of kinases, phosphatases, bacteriophage polynucleotide kinase, Ligases - reaction, methods of blunt end joining - linkers and adaptors

Module II - Vectors used for Recombinant DNA technology (12 hrs)

Vectors – necessary properties of a vector, plasmids (pBR322, pUC19/18, Ti) cosmids, phagemids, shuttle vectors, ARS, mini chromosomes, BACs, PACs, YACs, HACs (important features, construction and applications of each); Expression vectors used for expression of proteins in bacteria, yeast, plants and animal cell lines; Creation of recombinant DNA. Methods of screening and selection of recombinant cells – selectable markers, reporter systems – *Lac Z* system, GFP.

Module III – Chemical synthesis of DNA (5 hrs)

Phosphodiester, phosphotriester, and phosphite-triester method of DNA synthesis (brief study only). Phosphoramidite method, automated DNA synthesis. Artificial genome synthesis. Procedure of cDNA synthesis, reverse transcriptase PCR, real time PCR (brief study only).

Module IV - Gene cloning and expression (6 hrs)

Various techniques and strategies used in gene cloning in prokaryotes (*E. coli*) and eukaryotes (*Saccharomyces cerevisiae*, *Pichia pastoris*), Gene transfer methods: Physical, Chemical and Biological.Transformation into bacteria and yeast, transfection into plant and animal cells, selection of recombinant cells, expression of recombinant proteins (brief study only).

Module V - Gene Screening and DNA sequencing (12 hrs)

Genomic and cDNA library. Procedure for the construction of a genomic library using phage λ system. Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening. Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping

DNA sequencing - Dideoxy and chemical methods, sequence assembly, automated sequencing, and applications of DNA sequencing (synthetic oligonucleotides), Next Generation Sequencing (NGS).

Module VI - Application of recombinant DNA technology (12 hrs)

Overview of transgenic plants for herbicide, insect and disease resistance, stress resistance (Bt cotton, golden rice, tomato, corn, brinjal) and transgenic animals -cow, sheep, poultry, fish, dog; Uses of GM microbes: Bacteria and yeast- producing useful proteins, basic genetic research; Gene therapy: somatic cell and germline therapy, vectors used in gene therapy, *In vivo* and *ex vivo* therapy; Gene therapy of SCID, Cystic fibrosis, gene augmentation therapy,

Problems and fears associated with gene therapy; Recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines, edible vaccines; GMOs as biosensors.

Recommended Reading

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.

2. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.

3. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn). McGraw Hill.

4. T A Brown (2002). *Genomes* (II Edn). Bios.

5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.

6. Abul K Abbas, Andrew H Lichtmay, Shiv Pillai (2007). *Cellular and molecular immunology* (IV Edn). Elsevier.

7. Charles A Janeway Jr., Paul Travers, Mark Walport, Mark J Schiomchik (2007). *Immunobiology*. Garland science, Churchill Livingstone.

8. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.

9. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.

10. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology: Principles and applications of recombinant DNA*. ASM press.

11. S B Primrose, R M Twyman, R W Old (2001). *Principles of gene manipulation* (VI Edn). Blackwell Science.

12. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.

13. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.

14. P Nagarajan, N Senthilkumar (2002). *Molecular biology: Principles and methods*. Sree Narmatha printers, Coimbatore.

15. Joseph Sambrook, David W Russell (2001). *Molecular cloning: A laboratory manual*. Cold spring harbor laboratory press.

16. David P Clark (2010). *Molecular biology*. Elsevier.

17. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.

18. Desmond S T Nicholl (2010). *An introduction to genetic engineering* (III Edn). Cambridge.

19. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.

20. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.

21. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company

22. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.

23. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.

24. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Introduction to modern genetic engineering techniques and its application in the field of biology	K2, K3, K5	**3, 5, 6**	N/R/G
2	Insights into gene cloning techniques and vectors	K2, K4	**3, 5, 6**	N/R/G
3	Knowledge about DNA sequencing and recombinant DNA technology	K2, K3, K4	**3, 5. 6, 7**	N/R/G
4	Produce a genomic DNA library and screening for recombinants	K2, K6	**3, 7**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

PRACTICALS

GENOMICS & PROTEOMICS

Practical: 36 hrs **3 Credits**

Demonstration:

1.Restriction mapping of plasmid DNA

2. RAPD analysis

3. RFLP analysis

4. DNA fingerprinting analysis: Parentage detection

6.Homogenization, fractionation and separation of enzymes/ proteins in plants and animals

7.2D-PAGE separation of proteins

8.Superposition of structures; Secondary structure prediction of proteins;

9. Identification of membrane proteins;

10. Pattern searching in proteins (PROSITE);

11. Pattern searching in nucleic acids; Validation of 3D structures

12. Demonstration of EST/ STS/ Microarray analysis

ANIMAL MOLECULAR PHYSIOLOGY & PLANT MOLECULAR PHYSIOLOGY

Practical: 36 hrs **3 Credits**

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Demonstration:

1. Measurement of heart beat rate in Invertebrates. Influence of excitatory and inhibitory neurotransmitter on the rate.
2. Effect of ACh and DOPA on Skeletal muscle contraction (Using Kymograph)

Wet lab:

3. Effect of isotonic, hypotonic and hypertonic saline on erythrocyte
4. Estimation of RBC count and total WBC count using haemocytometer

5. Oxygen consumption in aquatic animals by Winkler titrimetric and dipping Oxygen electrode.
6. Estimation and separation of amino acids from various tissues including blood
7. Estimation of alkaloids in the given plant.
8. Estimation of Flavonoids in the given plant.
9. Estimation of Proline in the leaf tissue.
10. Estimation of antioxidant activity in a given plant.
11. Extraction and Estimation of total chlorophylls, carotenoids and total proteins in Normal (unstressed) and stressed plants.
12. Estimation of total Phenolics in the leaf tissues.

GENETIC ENGINEERING

Practical: 18 hrs **1 Credits**

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

Demonstration:

1.Callus Induction Techniques

2. Artificial seed production

3.Production of haploid plants by anther and pollen culture

4. Agrobacterium mediated transformation

5.Isolation and purification of plasmid DNA from E. coli

6.Fibroblast culture from chick embryo

7.Cell disruption techniques

SEMESTER IX

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS9CR01	Plant and Animal Biotechnology	Theory	5	4
IP20BS9CR02	Elective - Green Biotechnology	Theory	5	4
IP20BS9CR03	Elective - Bioprocess Technology	Theory	5	4
IP20BS9CC04	Elective - Biosafety, Bioethics and IPR	Theory	4	3
IP20BS9CRP1	Plant and Animal Biotechnology (P)	Practical	2	2
IP20BS9CRP2	Green Biotechnology (P)	Practical	2	1
IP20BS9CRP3	Bioprocess Technology and Biosafety, Bioethics and IPR (P)	Practical	2	2
Total			25	20

PLANT AND ANIMAL BIOTECHNOLOGY

Theory: 72 hrs **4 credits**

Plant Biotechnology

Module I Introduction to plant tissue culture (12 hrs)
Scope and importance of plant tissue culture – media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micropropagation, somatic embryogenesis, protoplast culture and somatic hybridization, selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

Module II Metabolic engineering of plants (10 hrs)

Plant cell culture for production of useful chemicals and secondary metabolites (hairy root culture, biotransformation, elicitation)- pigments, flavanoids, alkaloids, mechanism and manipulation of shikimate pathway. Production of industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

Module III Transformation techniques & GM technology (14 hrs)

Ti and Ri plasmids as vectors, role of virulence genes, design of expression vectors (35S promoter, genetic markers, reporter genes). Direct gene transfer methods – particle bombardment, electroporation and microinjection. Transgene stability & gene silencing. Crop improvement, productivity, performance and fortification of agricultural products. Strategies for engineering stress tolerance plants. Current status of transgenic plants in India and other countries. Importance of terminator gene technology. Environmental impact of herbicide resistance crops and super-weeds.

Animal Biotechnology

Module IV Introduction to animal cell culture (12 hrs)
Cell culture laboratory design, layout and maintenance. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO2, serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein-free defined media. Culture and maintenance of primary and established cell lines. Biology of cultured cells – culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and apoptosis. Expression of culture efficiency.

Module V Transgenic animals (14 hrs)
Methods involved in the production of transgenic animals. Gene knock-out and mice models of human diseases. Methods of animal cloning and their importance with Recommended Reading to domestic animals. Improvement of biomass, disease resistance, recombinant vaccines for poultry. Pharmaceutical products produced by mammalian cells – plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, cell culture-based vaccines.

Module VI Biosafety (10 hrs)

The Cartagena protocol on biosafety. Biosafety management: environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. National and international guidelines with regards to rDNA technology, transgenics and GM crops. Good manufacturing practice (GMP) and Good laboratory practices (GLP).

Recommended readings:

1. Ballinic C.A. et al., Animal Biotechnology, PErgamon press, New York 1989.
2. Glick B.R. and Pasternak J.J., Molecular Biotechnology, ASM Press, Washington DC, 2003. 3.Ratlege C. and Kristiansen B., Basic biotechnology, CUP, London 2001.
3. Shantharam D. et al., Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for sustainable development, 1999.
4. John Davis, Animal cell culture: Essential methods (1st ed), Wiley-Blackwell & Sons, 2011.
5. 6Kirakosyan A., and Kaufman P.B., Recent advances in Plant Biotechnology (1st edition ed.), Springer publishers, 2009.
6. Nickoloff J.A., Plant cell electroporation and electrofusion protocols- Methods in molecular biology, Humans Press, NJ, USA, 1995.
7. Heldt, Plant biochemistry and Molecular biology, Oxford and IBH Publishing Co., Delhi 1997.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Detailed knowledge in various techniques used in animal and plant biotechnology	K2, K4, K5	**3, 5, 6, 7**	N/R/G

2	To know about the modern techniques in plant tissue culture	K3, K5	**6**	N/R/G
3	Develop a detailed knowledge in Animal cell culture and transgenic animals	K2, K4, K5	**6**	N/R/G

PSO-Program Specific outcome; CO-Course Outcome;

Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.

ELECTIVE 1: GREEN BIOTECHNOLOGY

54 hrs **3 credits**

Module I Introduction to Green Biotechnology (6 hrs)

Definition, Introduction, Describe green biotechnology. History of green biotechnology. Concept and implication of Green Biotechnology, Aims, and Future with green biotechnology. Agriculturally important beneficial microorganism. Bio-fertilizers and their types its importance and applications.

Module II Carbon sequestration (8 hrs)

Carbon sequestration- Bio sequestration- carbon sequestration through biological process. Methods of carbon sequestration in Ocean. Methanogenic microbes for methane reduction. Biochemistry of methanogenesis, Natural occurrence of methanogenesis. Role of methanogenesis in global warming. Microbes for phytic acid degradation in agriculture and industry.

Module III Identification and Screening of micro-organisms for biodegradation (8 hrs)

Manipulation of Plastic Degrading Microbes. Genetic Engineering (GMOs) approaches to control environmental pollution. Genetic Engineering approach for bioremediation and phytoremediation. Biotech Plants for Bioremediation. Risk mitigation of genetically modified bacteria and plants designed for bioremediation.

Module IV Biotechnological Approach to Enhance the Growth and Biomass (9 hrs)

Biotechnological Approach to Enhance the Growth and Biomass. Application of Biotechnology for the Production of Biomass Based Fuels. Production of Fuels, Chemicals, and Materials from Biomass. Anaerobic biotechnological approaches for production of liquid energy carriers from biomass. Generation of alternate fuels from -Algae-based fuels, Biodiesel from plant source, Alcohol fuels from plant source, Recycling organic waste, etc.

Module V Bio-pesticides and their applications (13 hrs)

Bio-pesticides their types and its importance and applications. Different plant growth promoting rhizobacteria- Mechanisms of action, Pathogenic roles, Biocontrol agent, Nitrogen fixation, Symbiotic relationships. Introduction of biofuels, biodiesel and bioethanol. Procedure for production biofuels, biodiesel and bioethanol. Engineering of plant cell walls for enhanced biofuel production. Applications and current status of biofuels, biodiesel and bioethanol. Biotechnological approaches for production of biofuels, biodiesel and bioethanol. Current Worldwide status of transgenic research in production of biofuels, biodiesel and bioethanol

Module VI Biotechnology for crop improvement (10 hrs)

Genetic Engineering approaches to increasing crop productivity by manipulation of photosynthesis process genes. Nitrogen fixation and its improvement through genetic engineering approach. Concept of C3 andC4 carbon fixation cycle in plant. Marker-free transgenic concept and application. Controversy and disadvantage of use of markers in transgenic development. Biotechnological approaches for disease and pest resistant crops.

Recommended Readings

1. Kirkosyan A & Kaufman PB. 2009. Recent Advances in Plant Biotechnology. Springer.

2. Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.

3. Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors.

4. Kirkosyan A & Kaufman PB. 2009. Recent Advances in Plant Biotechnology. Springer.

5. Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.

6. Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors.

7. Pooja. 2010. Textbook of Green Biotechnology. Discovery Publishing House Pvt. Ltd.

8. Murray DC. 1993. Green Biotechnology. Dominant Publishers and Distributors.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Study to identify and screen microorganisms	K2, K3, K4	**3, 5**	N/R/G
2	Knowledge about Applications of green biotechnology in crop improvement and pesticide control	K2, K3, K6	**3, 5, 6**	N/R/G
3	Knowledge about application of biotechnology in various fields like environmental conservation	K2, K3, K6	**3, 5, 6**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

ELECTIVE 2: BIOPROCESS TECHNOLOGY

Theory: 72 hrs **4 Credit**

Module I: Concept of fermentation and bioprocess technology (12 Hrs)

The fundamental concept of Fermentation and bioprocess technology. Types of bioprocesses. Design and formulation of Media for industrial bioprocess. Criteria for medium design, carbon/nitrogen sources, nutrients. Sterilization of media.

Fermentation process. Role of microorganisms in fermentation. Types of fermentation - batch, fed batch, continuous fermentation submerged and solid-state fermentation process. Control during fermentation- pH, aeration, agitation, temperature, foam control

Module II: Basics of Bioprocessing (14 Hrs)

Raw materials for bioprocessing, comparison of chemical and biochemical processing based on energetics and environmental issues. Development of inocula, kinetics of enzymatic and microbial processes, optimisation studies, sterilization of media, air and equipment, modes of cell cultivation.

Media formulation, sterilization of equipments, gas compressor types and principles of compression, air filtration, solid and liquid handling. Industrially fermented broth (filtration and ultrafiltration), centrifugation, solvent extraction, chromatographic separation, liquid extraction of biopolymers and antibiotics ion exchange recovery of antibiotics and proteins

Module III: Bioreactors-design, types and operation (12 Hrs)

Bioreactors, general principles of bioreactor design and their operation, bioreactor design, criteria, operation. Types of bioreactors- – airlift, stirred tank, bubble column, rotary drum. Agitation and aeration in the bioreactor, impeller and sparger design.

Concept of scale up, scale up challenges. Influence of various bioprocess parameters viz. pH, temperature, medium components on product synthesis. Bioprocess monitoring and control, automated control vs manual control of bioprocesses.

Module IV: Downstream processing (12 Hrs)

Downstream processing: definition, cost involved in downstream processing. Typical steps involved in downstream processing. Criteria for downstream processing, Target application of product vs cost, separation of cells and broth. Typical unit operation for downstream processing filtration, centrifugation, chromatography, solvent extraction, HPLC. Methods for cell breakage for harvesting intercellular products.

Module V: Bioprocess Production and Waste Management (12 Hrs)

Commercial production of various bioprocess-based products (Bioethanol, butanol, citric acid, acetic acid). Antibiotics-penicillin, streptomycin, tetracycline. Single cell protein; amino acids:

glutamic acid, lysine. Types and nature of wastes generated from bioprocesses. Waste treatment and disposal methods

Module VI: Advanced Topics in Bioprocess Technology (10 Hrs)

Computer control of fermentation process, hardware and software application in fermentation technology, fermentation economics, fermentation biofertilizer production, fuel alcohol production, biogas production technology, silage production, aspartame.

Recommended Readings

1. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). Fermentation Microbiology and Biotechnology (II Edn). Taylor & Francis
2. Peter F Stanbury, Allan Whitaker (1999). Principles of Fermentation technology. Butterworth- Heinemann.
3. S. C. Prescott, Cecil Gordon Dunn (2004). Industrial Microbiology. CBS publishers and distributors.
4. Pauline M. Doran (1995). Bioprocess Engineering Principles. Academic Press Ltd.

Expected Outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Understand the basic principles and methods of fermentation	K2, K3, K6	**2, 5**	N/R/G
2	Knowledge about various bioprocesses	K2	**3, 5, 6**	N/R/G
3	Detailed knowledge on bioreactor designing and application	K2, K3, K6	**5, 6, 7**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

ELECTIVE 3: BIOSAFETY, BIOETHICS AND IPR

Theory :54 hrs **3 Credit**

Module I: Introduction to Biosafety and Laboratory Practices (10 Hrs)

Introduction and Development of Biosafety Practices, Definitions and Biosafety levels: 1, 2, 3, 4.

General lab requirements, Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP) Application of GMP in biosafety, especially in pharmaceuticals.

Biological safety cabinets: function and use. Centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response, Biosafety protocol 2000.

Module II: Biosafety Guidelines and Regulations (7 Hrs)

Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context). Biosafety assessment procedures in India and abroad. Role of Public and Non-Governmental Organizations (NGOs). Guidelines for research in transgenic plants and animals.

Module III Bioethics – Principles and Practice (12 Hrs)

What is Bioethics? Principles of bioethics: autonomy, beneficence, justice, non-maleficence, legality, morality and ethics, autonomy, human rights etc. Ethical conflicts in biotechnology - interference with nature,unequal distribution of risk and benefits of biotechnology Legal and Socio- economic Impacts of Biotechnology.

Ethical Issues in Genetically Modified Organisms: Foods and Crops. Use of Genetically ModifiedOrganisms and their Release in the Environment, their Handling and Disposal. General guidelines for recombinant DNA research activity.

Stem Cell Research and ethical issues involved in Stem Cell research. Animal Cloning, Human Cloning and their Ethical Aspects. Organ Transplantation and Ethical Issues. Bioethics in Biodiversity and Resource Management. Ethical, Legal and Social Implications of Human Genome Project. Genetics Studies on Ethnic Races.

Module IV: Bioethics in Research (9 Hrs)

Use of Animals in Research and Testing, and alternatives for animals in research-In-silco, in-vivo, in-vitro, ex-vivo, 3D printing, chip. Animal rights and animal laws in India-Prevention of cruelty to animals Act 1960 Wildlife protection act 1972 and Amendments, Biodiversity Act 2003. Animal protection initiatives - AnimalWelfare, Animal Welfare Board, India CPCSEA,

Working with Humans, harm, risk, and benefits,Consent. Testing of Drugs on Human Volunteers. Children and Vulnerable people, Equality, Anonymity, Confidentiality. Right to information- 2005.

Module V: Intellectual Property Right (9 Hrs)

Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Advantages and Disadvantages of IPR. Intellectual Property Rights and Agricultural Technology, and their Implications for India and other Developing Countries. International Organizations and Intellectual Property Rights.

Plagiarism. Need for plagiarism detection, plagiarism detection softwares. Artificial intelligence- ethical issues. Power analysis-introduction, and types of statistical power analysis

Introduction to - GATT, WTO, WIPO and TRIPS.

Module VI: Patent (7 Hrs)

Basics of Patents, Types of patents; Indian Patent Act 1970; – amendments of 1999, 2000, 2002 and 2005. Process Involved in Patenting. Patenting of Living Organisms, Traditional Knowledge, their commercial exploitation and protection. Infringement. Direct, Contributory, and Induced Infringement

Recommended Readings

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection. Oxford and IBH Publishing Co.New Delhi
2. Encyclopedia of Bioethics 5 vol set, 2003. ISBN - 10: 0028657748
3. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press
4. Ganguli. 2001. Intellectual property rights –Tata McGrawhill. ISBN - 10:0074638602

5. Goel D. and Parasar S. 2013. IPR, Bioethics and Biosafty, Pearson Publications
6. Marie, M. 2005. Animal Bioethics: Principles and Teaching Methods. Wageningen Academic Publishers
7. Wattal.1997. Intellectual Property Right. Oxford Publicatiopn House ISBN:0195905024
8. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
9. Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.

Expected outcome:

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will beable to*:	**Knowledge Level**	**PSO No.**	Relevance to Local/ National/ Regional/ Global developmental needs
1	Deep insight into laboratory practices and biosafety	K2, K3	**2, 5**	N/R/G
2	Understanding ethical issues related to biological experiments and the need for ethics in research	K2	**1, 2**	N/R/G
3	Knowledge about IPR and familiarize with the types and process of patent	K2	**1, 2, 7**	N/R/G
PSO-Program Specific outcome; CO-Course Outcome; **Knowledge Levels:** K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.				

PRACTICALS

BIOTECHNOLOGY

Practical : 36 hrs **2 credits**

Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos / virtual labs etc.

1. Solid – liquid separation method: sedimentation
2. Solid-liquid separation methods: Filtration.
3. Solid-liquid separation methods: Centrifugation.
4. Estimation of percentage of ethanol from fermented broth
5. Estimation of Lactic acid from fermented broth.
6. Production, isolation and purification of biopharmaceuticals/ antibiotics, Pencillium notatum.
7. Production of wine using yeast
8. Micro injection and transformation
9. RDNA technology

GREEN BIOTECHNOLOGY

Practical : 18hrs **1 credit**

1. Identification and efficiency assays of micro-organisms for biodegradation and bioremediation.
2. Isolation of *Bacillus thurigenesis*.
3. Isolation of plant growth promoting rhizobacteria.
4. Production of biofertilizers and biopesticides.

BIOPROCESS TECHNOLOGY & BIOSAFETY, BIOETHICS AND IPR

Practical:36hrs **2 Credit**

Demo Experiments:

1. Bioreactors – Components of a bioreactor and type of bioreactors
2. Demonstration of sterilization techniques
3. Demonstration of handling chemicals and biohazards safely
4. Patent drafting and application process- steps
5. Case Study of patent in Golden Rice
6. Safe handling of bacteria, viruses, and other microorganisms in lab
7. Ethical issues in animal experimentation- case study
8. Field visit to any Biotechnology lab to study Biosafety and Laboratory practical or industrial visit to a fermentation unit

SEMESTER X

COURSE CODE	COURSE TITLE	COURSE TYPE	HRS/ WEEK	TOTAL CREDIT
IP20BS10D	PROJECT-MAJOR	Theory		16
IP20BS10V	COMPREHENSIVE VIVA	Theory		4
Total				20