

**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)  
KOTHAMANGALAM, KERALA - 686666**

**NAAC Accredited 'A+' Grade Institution**

Email: [mac@macollege.in](mailto:mac@macollege.in)

[www.macollege.in](http://www.macollege.in)



**SCHEME AND SYLLABUS  
FOR  
POST GRADUATE PROGRAMME  
UNDER CREDIT AND SEMESTER SYSTEM  
MAC-PG-CSS 2020  
IN  
ZOOLOGY**

**EFFECTIVE FROM THE ACADEMIC YEAR 2020-21  
BOARD OF STUDIES IN ZOOLOGY (PG)**

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# ACADEMIC COUNCIL

## COMPOSITION – With Effect From 01-06-2020

**Chairperson** : **Dr. Shanti. A. Avirah**  
Principal  
Mar Athanasius College (Autonomous), Kothamangalam.

**Experts/Academicians from outside the College representing such areas as Industry, Commerce, Law, Education, Medicine, Engineering, Sciences etc.**

1. **Dr. Winny Varghese**  
Secretary  
Mar Athanasius College Association  
Kothamangalam .
2. **Prof. Dr. V.N. Rajasekharan Pillai**  
Former Vice-Chairman  
University Grants Commission,  
New Delhi.
3. **Dr. R.K. Chauhan**  
Former Vice-Chancellor, Lingaya's University,  
Faridabad, Haryana -121002
4. **Dr. Sheela Ramachandran**  
Pro-Chancellor,  
Atmiya University  
Rajkot.
5. **Prof. Kuruvilla Joseph**  
Senior Professor and Dean,  
Indian Institute of Space Science and Technology (IIST),  
Department of Space, Govt. of India, Valiyamala, Thiruvananthapuram
6. **Dr. M.C. Dileep Kumar**  
Former Vice Chancellor  
SreeSankaracharya Sanskrit University  
Kalady, Kerala, India
7. **Dr. Mathew. K.**  
Principal  
Mar Athanasius College of Engineering,  
Kothamangalam, Kerala - 686 666

8. **Adv. George Jacob**  
Senior Advocate  
High Court of Kerala  
Ernakulam

**Nominees of the University not less than Professors**

9. **Dr. Biju Pushpan**  
SAS SNDP Yogam College  
Konni
10. **Dr. Suma Mary Sacharia**  
UC College  
Aluva
11. **Dr. V.B. Nishi**  
Associate Professor  
Sree Shankara College, Kalady.

**Member Secretary**

12. **Dr. M.S.Vijayakumary**  
Dean – Academics  
Mar Athanasius College (Autonomous)  
Kothamangalam

**Four teachers of the college representing different categories of teaching staff by rotation on the basis of seniority of service in the college.**

13. **Dr. Bino Sebastian. V** (Controller of Examinations)
14. **Dr. Manju Kurian**, Asst. Professor, Department of Chemistry
15. **Dr. Smitha Thankachan**, Asst. Professor, Department of Physics
16. **Dr. Asha Mathai**, Asst. Professor, Department of Malayalam

**Heads of the Departments**

17. Dr. Mini Varghese, Head, Department of Hindi
18. Dr. Jayamma Francis, Head, Department of Chemistry
19. Dr. Igy George, Head, Department of Economics

20. Ms. Shiny John, Head, Department of Computer Science
21. Dr. Deepa. S, Head, Department of Physics
22. Sri. Dr. Rajesh.K. Thumbakara, Head, Department of Mathematics
23. Dr. Aji Abraham, Head, Department of Botany
24. Dr. Selven S., Head, Department of Zoology
25. Dr. Diana Ann Issac, Head, Department of Commerce
26. Smt. Sudha. V, Head, Department of Statistics
27. Dr. Aswathy Balachandran, Head, Department of English
28. Dr. Diana Mathews, Head, Department of Sociology
29. Dr. Jani Chungath, Head, Department of History
30. Dr. Seena John, Head, Department of Malayalam
31. Mr. Haary Benny Chettiamkudiyil, Head, Department of Physical Education
32. Ms. Shari Sadasivan, Head, Department of International Business
33. Ms. Sheeba Stephen, Head, Department of B. Com Tax Procedure and Practice
34. Dr. Julie Jacob, Head, Department of Biochemistry
35. Ms. Nivya Mariyam Paul, Head, Department of Microbiology
36. Ms. Jaya VinnyEappen, Head, Department of Biotechnology
37. Ms. ShaliniBinu, Head, Department of Actuarial Science
38. Prof. Dilmol Varghese , Head, Department of M. Sc Zoology
39. Ms. Simi. C.V, Head, Department of M.A.History
40. Ms. Bibin Paul, Head, Department of M. A. Sociology
41. Ms. Sari Thomas, Head, Department of M.Sc Statistics

## BOARD OF STUDIES IN ZOOLOGY (PG)

NAME	Designation and Details
<b>CHAIRMAN</b>	
<b>Dr. Selven S.</b>	Assistant Professor and Head Department of Zoology Mar Athanasius college (Autonomous) Kothamangalam <a href="mailto:selsubran@gmail.com">selsubran@gmail.com</a> 9447667461
<b>EXPERT</b> from outside the Parent University	
<b>Dr. Koshi P.M.</b>	Associate Professor Department of Zoology St. Stephan's College Pathanapuram, Kollam <a href="mailto:koshypmkollaka@gmail.com">koshypmkollaka@gmail.com</a> 9447087260
<b>EXPERT</b> Nominated by the Vice Chancellor (MGU)	
<b>Dr. Y. Shibuvadhanan</b>	Professor and Head Department of Zoology University of Calicut Thenhippalam <a href="mailto:svardhanan@gmail.com">svardhanan@gmail.com</a> 9447108980
<b>MEMBER FROM INDUSTRY</b>	
<b>Dr. Sunesh Thampy</b>	Project Head Planet Earth Kaynes Technology India Pvt Ltd 23-25, Balagola food Industrial Area Metagalli P O. Mysore-570016 9995030563
<b>MERITORIOUS ALUMNUS</b>	
<b>Sri, Janish P. A.</b>	Assistant Professor Dept. of Zoology Maharajas College Ernakulam - 682011
<b>EXTERNAL EXPERT</b>	

<b>Dr. Shaju Thomas</b>	Associate Professor( Retired) Dept. of Zoology, Nirmala College Muvattupuzha
<b>MEMBER TEACHERS IN THE DEPARTMENT</b>	
<b>Dr. Aji C. Panicker</b>	Assistant Professor Dept of Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Dr. Aby P Varghese</b>	Assistant Professor Dept of Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Dr. Binitha R N.</b>	Assistant Professor Dept of Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Prof. Dilmol Varghese</b>	Assistant Professor Dept of PG Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Asha Kunjappan</b>	Assistant Professor Dept of PG Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Deepasree P.M</b>	Assistant Professor Dept of PG Zoology Mar Athanasius College(Autonomous) Kothamangalam
<b>Elizabeth Babu</b>	Assistant Professor Dept of PG Zoology Mar Athanasius College(Autonomous) Kothamangalam

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## **PREFACE**

Life Science have moved to the forefront of science and technology in the 21 st century and Zoology has become a dynamic and increasingly important subject with the advances in molecular biology and genetic studies, imparting fascinating and significantly new insights in to many aspects of animal life. Although the study of animal life is ancient, its scientific incarnation is relatively modern and the institutes are obliged to develop in depth understanding of various aspects of the subject.

The Zoology Department started functioning at Mar Athanasius College, Kothamangalam, since its establishment in the year 1955 offering undergraduate course in Zoology. The Department also offers Postgraduate course in Zoology which started functioning during the academic year 2012-13. The mesmerizing world of animal life is revealed through the syllabus which covers Biosystematics, Biochemistry, Genetics, Embryology, Cytology, Molecular Biology, Physiology, Microbiology and Biotechnology.

Mar Athanasius College was granted Autonomous status in the academic year 2016-17. As part of this, the institution decided to modify the syllabus of UG and PG programmes. For the same, a Board Of Studies for Zoology was constituted to revise the syllabus. All possible attempts have been made to update the syllabus by incorporating current and most recent developments in various branches of zoological sciences. The expertise of the board members were utilized to restructure the curricula including basic as well as advanced concepts in Zoology which may aid the students to persue higher studies in Zoology and also enable students to get employed in the biological research institutes and industries

By following the guidelines of UGC, use of animals was excluded from the practicals , substituting the same with virtual practicals.This curriculum of the zoologists, for the zoologists and by the zoologists developed with the united efforts may facilitate students for taking up and shaping a successful career.

Dr. Selven. S  
Chairman, PG Board of Studies  
Mar Athanasius College (Autonomous)  
Kothamangalam

**LIST OF PG PROGRAMMES**

<b>SL. NO.</b>	<b>PROGRAMME</b>	<b>DEGREE</b>	<b>FACULTY</b>
<b>1</b>	<b>ENGLISH</b>	<b>MA</b>	<b>LANGUAGE AND LITERATURE</b>
<b>2</b>	<b>ECONOMICS</b>	<b>MA</b>	<b>SOCIAL SCIENCES</b>
<b>3</b>	<b>SOCIOLOGY</b>	<b>MA</b>	<b>SOCIAL SCIENCES</b>
<b>4</b>	<b>HISTORY</b>	<b>MA</b>	<b>SOCIAL SCIENCES</b>
<b>5</b>	<b>MATHEMATICS</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>6</b>	<b>CHEMISTRY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>7</b>	<b>PHYSICS</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>8</b>	<b>BOTANY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>9</b>	<b>STATISTICS</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>10</b>	<b>ZOOLOGY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>11</b>	<b>BIOCHEMISTRY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>12</b>	<b>BIOTECHNOLOGY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>13</b>	<b>MICROBIOLOGY</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>14</b>	<b>ACTUARIAL SCIENCE</b>	<b>M.Sc</b>	<b>SCIENCE</b>
<b>15</b>	<b>FINANCE AND TAXATION</b>	<b>M.Com</b>	<b>COMMERCE</b>
<b>16</b>	<b>MARKETING AND INTERNATIONAL BUSINESS</b>	<b>M.Com</b>	<b>COMMERCE</b>

*Mar Athanasius College(Autonomous), Kothamangalam*  
**REGULATIONS OF THE POSTGRADUATE PROGRAMMES**  
**UNDER CREDIT SEMESTER SYSTEM**  
**MAC-PG-CSS2020**  
**(2020 Admission onwards)**

**1. SHORT TITLE**

- 1.1 These Regulations shall be called “Mar Athanasius College (Autonomous) Regulations (2020) governing Postgraduate Programmes under the Credit Semester System (MAC-PG-CSS2020)”.
- 1.2 These Regulations shall come into force from the Academic Year 2020-2021.

**2. SCOPE**

- 2.1 The regulations provided herein shall apply to all Regular Postgraduate (PG) Programmes, M.A. /M.Sc. /M.Com. conducted by Mar Athanasius College (Autonomous) with effect from the academic year 2020-2021 admission onwards.

**3. DEFINITIONS**

- 3.1 ‘**Academic Committee**’ means the Committee constituted by the Principal under this regulation to monitor the running of the Post-Graduate programmes under the Credit Semester System (MAC-PG-CSS2020).
- 3.2 ‘**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 on each day. A sequence of 18 such academic weeks constitutes a semester.
- 3.3 ‘**Audit Course**’ is a course for which no credits are awarded.
- 3.4 ‘**CE**’ means **Continuous Evaluation (Internal Evaluation)**
- 3.5 ‘**College Co-ordinator**’ means a teacher from the college nominated by the Principal to look into the matters relating to MAC-PG-CSS2020 for programmes conducted in the College.

- 3.6 **‘Comprehensive Viva-Voce’** means the oral examinations conducted by the appointed examiners and shall cover all courses of study undergone by a student for the programme.
- 3.7 **‘Common Course’** is a core course which is included in more than one programme with the same course code.
- 3.8 **‘Core Course’** means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.
- 3.9 **‘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/evaluation etc., to meet effective teaching and learning needs.
- 3.10 **‘Course Code’** means a unique alpha numeric code assigned to each course of a programme.
- 3.11 **‘Course Credit’** One credit of the course is defined as a minimum of one hour lecture /minimum of 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.
- 3.12 **‘Course Teacher’** means the teacher of the institution in charge of the course offered in the programme.
- 3.13 **‘Credit (Cr)’** of a course is a numerical value which depicts the measure of the weekly unit of work assigned for that course in a semester.
- 3.14 **‘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.**
- 3.15 **‘Cumulative Grade Point Average(CGPA)’** is the value obtained by dividing the sum of credit points in 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. CGPA determines the overall performance of a student at the end of a programme.  
**(CGPA = Total CP obtained/ Total credits of the programme)**
- 3.16 **‘Department’** means any teaching Department offering a programme of study in the institution.

- 3.17 'Department Council'** means the body of all teachers of a Department in a College.
- 3.18 'Dissertation'** means a long document on a particular subject in connection with the project /research/ field work etc.
- 3.19 'Duration of Programme'** means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be 4 semesters spread over two academic years.
- 3.20 'Elective Course'** means a course, which can be substituted, by equivalent course from the same subject.
- 3.21 'Elective Group'** means a group consisting of elective courses for the programme.
- 3.22 'ESE' means End Semester Evaluation (External Evaluation).**
- 3.23 'Evaluation'** is the process by which the knowledge acquired by the student is quantified as per the criteria detailed in these regulations.
- 3.24 External Examiner** is the teacher appointed from other colleges for the valuation of courses of study undergone by the student in a college. The external examiner shall be appointed by the college.
- 3.25 'Faculty Advisor'** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.
- 3.26 'Grace Grade Points'** means grade points awarded to course(s), recognition of the students' meritorious achievements in NSS/ Sports/ Arts and cultural activities etc.
- 3.27 '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.
- 3.28 'Grade Point Average (GPA)'** is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade point obtained in the course by the sum of the weights of Course.  $(GPA = \frac{\sum WGP}{\sum W})$
- 3.29 'Improvement Course'** is a course registered by a student for improving his performance in that particular course.

- 3.30** ‘**Internal Examiner**’ is a teacher nominated by the department concerned to conduct internal evaluation.
- 3.31** ‘**Letter Grade**’ or ‘**Grade**’ for a course is a letter symbol (A+, A, B+, B, C+, C, D) which indicates the broad level of performance of a student for a course.
- 3.32** **MAC-PG-CSS2020 means Mar Athanasius College Regulations Governing Post Graduate programmes under Credit Semester System, 2020.**
- 3.33** ‘**Parent Department**’ means the Department which offers a particular postgraduate programme.
- 3.34** ‘**Plagiarism**’ is the unreferenced use of other authors’ material in dissertations and is a serious academic offence.
- 3.35** ‘**Programme**’ means the entire course of study and Examinations.
- 3.36** ‘**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 centre 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.
- 3.37** ‘**Repeat Course**’ is a course to complete the programme in an earlier registration.
- 3.38** ‘**Semester**’ means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each.
- 3.39** ‘**Seminar**’ means a lecture given by the student on a selected topic and expected to train the student in self-study, collection of relevant matter from various resources, editing, document writing and presentation.
- 3.40** ‘**Semester Grade Point Average(SGPA)**’ is the value obtained by dividing the sum of credit points (CP) obtained by the student in the various courses taken in a semester by the total number of credits for the course in that semester. The SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester ( $SGPA = \frac{\text{Total CP obtained in the semester}}{\text{Total Credits for the semester}}$ ).

- 3.41 ‘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.
- 3.42 ‘Weight’** is a numeric measure assigned to the assessment units of various components of a course of study.
- 3.43 University** means Mahatma Gandhi University Kottayam to which the college is affiliated.
- 3.44 ‘Weighted Grade Point (WGP)’** is grade points multiplied by weight.  
( $WGP=GP \times W$ )
- 3.45 ‘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.

#### **4. ACADEMIC COMMITTEE**

- 4.1. There shall be an Academic Committee constituted by the Principal to Manage and monitor the working of MAC-PG-CSS2020.**
- 4.2. The Committee consists of:**
1. Principal
  2. Dean, Administration
  3. Dean, Academics
  4. IQAC Coordinator
  5. Controller of Examinations
  6. One Faculty each representing Arts, Science, Commerce, Languages, and Self Financing Programmes

#### **5. PROGRAMME STRUCTURE**

- 5.1** Students shall be admitted to post graduate programme under the various Faculties. The programme shall include three types of courses, Core Courses, Elective Courses and Common core courses. There shall be a project with dissertation and comprehensive viva-voce as core courses for all programmes. The programme shall also include assignments / seminars/ practical’s etc.

**5.2** No regular student shall register for more than 25 credits and less than 16 credits per semester unless otherwise specified. The total minimum credits, required for completing a PG programme is 80.

**5.3. Elective Courses and Groups**

**5.3.1** There shall be various groups of Programme Elective courses for a Programme such as Group A, Group B etc. for the choice of students subject to the availability of facility and infrastructure in the institution and the selected group shall be the subject of specialization of the programme.

**5.3.2** The elective courses shall be either in fourth semester or distributed among third and fourth semesters. There may be various groups of Elective courses (three elective courses in each group) for a programme such as Group A, Group B etc. for the choice of students, subject to the availability of facility and infrastructure in the institution.

**5.3.3** The selection of courses from different elective groups is not permitted.

**5.3.4** The elective groups selected for the various Programmes 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 group selected for the students who are admitted in a particular academic year for various programmes shall not be changed.

**5.4 Project Work**

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

**5.4.2** Project work shall be carried out under the supervision of a teacher of the department concerned.

**5.4.3.** A candidate may, however, in certain cases be permitted to work on the project in an Industrial/Research Organization on the recommendation of the supervising teacher.

**5.4.4** There shall be an internal assessment and external assessment for the project work.



- 5.4.5.** The Project work shall be evaluated based on the presentation of the project work done by the student, the dissertation submitted and the viva-voce on the project.
- 5.4.6** The external evaluation of project work shall be conducted by two external examiners from different colleges and an internal examiner from the college concerned.
- 5.4.7** The final Grade of the project (External) shall be calculated by taking the average of the Weighted Grade Points given by the two external examiners and the internal examiner.
- 5.5** **Assignments:** Every student shall submit at least one assignment as an internal component for each course.
- 5.6** **Seminar Lecture:** Every PG student shall deliver one seminar lecture as an Internal component for every course with a weightage of two. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the various resources, editing, document writing and presentation.
- 5.7** **Test Papers(Internal):**Every PG student shall undergo at least two class tests as an internal component for every course with a weight one each. The best two shall be taken for awarding the grade for class tests.
- 5.8.** **No courses shall have more than 5 credits unless otherwise specified.**
- 5.9.** **Comprehensive Viva-Voce** -Comprehensive Viva-Voce shall be conducted at the end of fourth semester of the programme and its evaluation shall be conducted by the examiners of the project evaluation.
- 5.9.1.** Comprehensive Viva-Voce shall cover questions from all courses in the Programme.
- 5.9.2.** There shall be an internal assessment and an external assessment for the Comprehensive Viva-Voce.
- 6. ATTENDANCE**
- 6.1.** 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.

- 6.2** 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 a maximum 15 days in a Semester based on the specific recommendations of the Head of the Department or teacher concerned.
- 6.3** Those who could not register for the examination of a 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.
- 6.4.** A Regular student who has undergone a programme of study under earlier regulation/ Scheme and could not complete the Programme due to shortage of attendance may repeat the semester along with the regular batch subject to the condition that he has to undergo all the examinations of the previous semesters as per the MAC-PG-CSS2020 regulations and conditions specified in 6.3.
- 6.5** A student who had sufficient attendance and could not register for fourth semester examination can appear for the end semester examination in the subsequent years with the attendance and progress report from the principal.

## **7. REGISTRATION/ DURATION**

- 7.1** A student shall be permitted to register for the programme at the time of admission.
- 7.2** A student who registered for the Programme shall complete the Programme within a period of four years from the date of commencement of the programme.
- 7.3** Students are eligible to pursue studies for additional post graduate degree. They shall be eligible for award of degree only after successful completion of two years (four semesters of study) of college going.

## **8. ADMISSION**

- 8.1** The admission to all PG programmes shall be done through the Centralised Allotment Process of Mar Athanasius College (Autonomous), Kothamangalam (MAC-PG CAP) as per the rules and regulations prescribed by the affiliating university and the Government of Kerala from time to time.

- 8.2** The eligibility criteria for admission shall be as announced by the Parent University from time to time.

## **9. ADMISSION REQUIREMENTS**

**9.1** Candidates for admission to the first semester of the PG programme through CSS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of Mahatma Gandhi University as eligible thereto.

**9.2** Students admitted under this programme are governed by the Regulations in force.

## **10. PROMOTION:**

**10.1** A student who registers for the end semester examination shall be promoted to the next semester

**10.2** A student having 75% attendance and who fails to register for examination of a particular semester will be allowed to register notionally and is promoted to the next semester, provided application for notional registration shall be submitted within 15 days from the commencement of the next semester.

**10.3** The medium of Instruction shall be English except programmes under faculty of Language and Literature.

## **11. EXAMINATIONS**

**11.1 End-Semester Examinations:** The examinations shall be at the end of each Semester of three hour duration for each centralised and practical course.

**11.2** Practical examinations shall be conducted at the end of each semester or 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 Studies of the programmes.

**11.3** 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**

- 12.1 **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 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.
- 12.2 **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.
- 12.3 **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) of each course. Letter grade shall be assigned to each course based on the categorization provided in 12.16.
- 12.4 **Internal evaluation:** The internal evaluation shall be based on predetermined transparent system periodic written tests, assignments, seminars, lab skills, records, viva-voce etc.
- 12.5 Components of 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 BOS 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.
- 12.7 **The model of the components and its weightages for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are shown in below:**

**a) For Theory (CE) (Internal)**

Sl. No.	Components	Weightage
i.	Assignment	1
ii.	Seminar	2
iii.	Best Two Test papers	2(1 each)
<b>Total</b>		<b>5</b>

(Average grade of the best two papers can be considered. For test paper all the Questions shall be set in such a way that the answers can be awarded A+, A, B, C, D, E grades)

**b) For Theory (ESE) (External)**

Evaluation is based on the pattern of Question specified **in 12.15.5**

**c) For Practical (CE) (Internal)**

Components	Weightage
Written / Lab Test	2
Lab Involvement and Record	1
Viva	2
<b>Total</b>	<b>5</b>

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

**d) For Practical (ESE) (External)**

Components	Weightage
Written / Lab Test	7
Lab Involvement and Record	3
Viva	5
<b>Total</b>	<b>15</b>

(The components and weightage of the practical (External) can be modified by the concerned BOS without changing the total weightage 15)

**e) For Project (CE) (Internal)**

Components	Weightage
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva	1
<b>Total</b>	<b>5</b>

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

**f) For Project (ESE) (External)**

Components	Weightage
Relevance of the topic and analysis	3
Project content and presentation	7
Project viva	5
<b>Total</b>	<b>15</b>

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

**g) Comprehensive viva-voce (CE) (Internal)**

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	5
<b>Total</b>	<b>5</b>

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

**h) Comprehensive viva-voce (ESE) (External)**

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	15
<b>Total</b>	<b>15</b>

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

12.8 All grade point averages shall be rounded to two digits.

12.9 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.

**12.10 There shall not be any chance for improvement for Internal Grade.**

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

12.12 **External Evaluation.** The external examination in theory courses is to be conducted by the College at the end of the semester. The answers may be written in English or 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.

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.

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

**12.15. Pattern of Questions**

12.15.1 **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.**

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

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

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

12.15.5 Weight: Different types of questions shall be given different weights to quantify their range as follows:

Sl. No.	Type of Questions	Weight	Number 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

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

#### 12.17 **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(G)	Grade 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

#### 12.18 **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
up to 1.99	D	Deficient(Fail)

12.19 **No separate minimum is required for Internal Evaluation for a pass, but a minimum grade is required for a pass in an External Evaluation.**

**However, a minimum C grade is required for pass in a Course**

12.20 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.



12.21 **Improvement of Course-** The candidate who wish to improve the grade/grade point of the external examination of the of a 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. This facility is restricted to first and second semester of the programme.

12.22 **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 practical /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)

12.23 **Semester Grade Point Average (SGPA) and Cumulative Grade Point**

**Average (CGPA) Calculations.** The SGPA is the ratio of sum of the credit point of all courses taken by a student in a 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.

$$\text{Semester Grade Point Average -SGPA (S}_j\text{)} = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

(SGPA= Total credit Points awarded in a semester / Total credits of the semester)

Where 'S<sub>j</sub>' is the j<sup>th</sup> semester, 'G<sub>i</sub>' is the grade point scored by the student in the i<sup>th</sup> course 'C<sub>i</sub>' is the credit of the i<sup>th</sup> course.

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

$$\text{Cumulative Grade Point Average (CGPA)} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

(CGPA= Total credit Points awarded in all semester / Total credits of the programme)

Where 'C<sub>i</sub>' is the credit for the i<sup>th</sup> semester, 'S<sub>i</sub>' is the SGPA for the i<sup>th</sup> semester. The **SGPA** and **CGPA** shall be rounded off to 2 decimal points.

For the successful completion of semester, a student shall pass all courses and

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score a minimum **SGPA** of 2.0. However a student is permitted to move to the next semester irrespective of her/his **SGPA**

### **13. GRADE CARD**

13.1 The Institution 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 PG Programme.
- d) Name of Semesters
- e) Name and Register Number of students
- f) Code, Title, Credits and Max GPA (Internal, External & Total) of each course (theory & practical), project, 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) Separate Grade card will be issued.
- l) 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. AWARD OF DEGREE** - 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.

### **15. MONITORING COMMITTEE**

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluations conducted.

**16. RANK CERTIFICATE**

Rank certificate shall be issued to candidates who secure positions 1<sup>st</sup> and 2<sup>nd</sup>. 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. Rank certificate shall be signed by the Principal and the Controller of Examinations.

**17. GRIEVANCE REDRESSAL COMMITTEE**

17.1 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.

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

18. **FACTORY VISIT / FIELD WORK/VISIT** to a reputed research institute/ student interaction with renowned academicians may be conducted for all Programmes before the commencement of Semester III.

19. Each student may undertake **INTERNSHIP/ON THE JOB TRAINING** for a period of not less than 15 days. The time, duration and structure of Internship/On The Job Training can be modified by the concerned Board of Studies.

**20. TRANSITORYPROVISION**

Notwithstanding anything contained in these regulations, the Principal 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.

**21. REPEAL**

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the

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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.

**22. Credits allotted for Programmes and Courses**

22.1 Total credit for each programme shall be **80**.

22.2 Semester-wise total credit can vary from 16 to 25

22.3 The minimum credit of a course is 2 and maximum credit is 5

23. **Common Course:** If a course is included as a common course in more than one programme, its credit shall be same for all programmes.

24. **Course Codes:** The course codes assigned for all courses (Core Courses, Elective Courses, Common Courses etc.) shall be unique.

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

**M.Sc. Zoology Programme with practical - Total Credits 80- Scheme of the syllabus**

Semester	Course-Code	Course Name	Type of the Course	Teaching Hours Per Week	Credit	Total Credits
I	PG20ZY101	Biosystematics and Animal Diversity	core	4	4	19
	PG20ZY102	Evolutionary Biology and Ethology	core	4	4	
	PG20ZY103	Biochemistry	core	4	4	
	PG20ZY104	Biostatistics, Computer application and Research methodology	core	3	3	
	PG20ZYP1	Practicals of Animal diversity: Evolutionary, Ethological and Biochemical methods and Approaches	core	10	4	
II	PG20ZY205	Ecology- Principles and Practices	core	4	4	19
	PG20ZY206	Cell and Molecular biology	core	4	4	
	PG20ZY207	Genetics	core	4	4	
	PG20ZY208	Biophysics, Instrumentation and Biological Techniques	core	3	3	
	PG20ZYP2	Practicals of Ecological, Molecular, Hereditary, Biophysical Approaches and Biological Techniques	core	10	4	

III	PG20ZY309	Developmental Biology	core	4	4	19
	PG20ZY310	Biotechnology and Bioinformatics	core	4	4	
	PG20ZY311	Advances in Animal physiology	core	4	4	
	PG20ZY312	Microbiology and Immunology	core	3	3	
	PG20ZYP3	Practicals of Developmental , Physiological, Microbial, Immunological and Biotechnological Methods	core	10	4	
IV	PG20ZY413	Elective – Concepts of Environmental Science, Biodiversity, Conservation and Microbial ecology	Elective	5	4	23
	PG20ZY414	Elective – Environmental Pollution and Toxicology	Elective	5	4	
	PG20ZY415	Elective - Environmental Management and Climatology	Elective	5	4	
	PG20ZYP4	Practical of Environmental Science	core	10	4	
	PG20ZY4P	Dissertation/Project	core		5	
	PG20ZY4V	Viva - voce	core		2	
	<b>Total</b>					<b>80</b>

## Appendix

### 1. Evaluation first stage – Both internal and external to be done by the teacher)

Grade	Grade Points	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
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
Upto1.99	D	Deficient(Fail)

### Theory-External-ESE

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

Type of Question	Qn. No.'s	Grade Awarded	Grade Point	Weights	Weighted Grade Point
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
<b>Calculation :</b>					
<b>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 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
Assignment	1	A	4	4	

Seminar	2	A+	5	10	<b>WGP/Total Weight= 24/5 =4.8</b>
Test Paper 1	1	A+	5	5	
Test Paper 2	1	A+	5	5	
<b>Total</b>	<b>5</b>			<b>24</b>	<b>A+</b>

**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
Written/Lab Test	7	A	4	28	<b>WGP/Total Weight= 58 / 15 = 3.87</b>
Lab involvement & record	3	A+	5	15	
Viva	5	B	3	15	
<b>Total</b>	<b>15</b>			<b>58</b>	<b>B</b>

**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
Written/ Lab Test	2	A	4	8	<b>WGP/Total Weight=17/5 =3.40</b>
Lab involvement & record	1	A+	5	5	
Viva	2	C	2	4	
<b>Total</b>	<b>5</b>			<b>17</b>	<b>B</b>

**Project-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
Relevance of the topic & Analysis	3	C	2	6	<b>WGP/Total Weight = 56/15= 3.73</b>

Project Content & Presentation	7	A+	5	35	
Project Viva- Voce	5	B	3	15	
Total	15			56	B

**Project-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
Relevance of the topic & Analysis	2	B	3	6	WGP/Total Weight= 21/5 = 4.2
Project Content & Presentation	2	A+	5	10	
Project Viva- Voce	1	A+	5	5	
Total	5			21	A

**Comprehensive viva-voce-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
Comprehensive viva-voce	15	A	4	60	WGP/Total Weight = 60 / 15 = 4
Total	15			60	A

**Comprehensive viva-voce-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
Comprehensive viva-voce	5	A+	5	25	WGP/Total Weight = 25/ 5 = 5
Total	5			25	A+



**2. Evaluation Second stage-(to be done by the College)**

**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 and its Continuous Evaluation (CE) (Internal Evaluation) grade is A. The consolidated grade for the course PC-1 is as follows

Evaluation	Weight	Grade awarded	Grade Points awarded	Weighted Grade Point
External	3	A	4.20	12.6
Internal	1	A	4.40	4.40
Total	4			17
Grade of a course.	GPA of the course = Total weighted Grade Points/Total weight = $17/4 = 4.25 = \text{Grade A}$			

**3. Evaluation Third stage-(to be done by the College)**

**Semester Grade Point Average (SGPA)**

Course code	Title of the course	Credits (C)	Grade Awarded	Grade Points(G)	Credit Points (CP=C X G)
01	PC-1	5	A	4.25	21.25
02	-----	5	A	4.00	20.00
03	-----	5	B	3.80	19.00
04	-----	2	A	4.40	8.80
05	-----	3	A	4.00	12.00
<b>TOTAL</b>		<b>20</b>			<b>81.05</b>
<b>SGPA</b>	<b>Total credit points / Total credits = <math>81.05/20 = 4.05 = \text{Grade- A}</math></b>				

**4. Evaluation Third stage-(to be done by the College)**

**Cumulative Grade Point Average (CGPA)**

If a candidate is awarded three A+ grades in semester 1(SGPA of semester 1), semester 2(SGPA of semester 2), semester 4(SGPA of semester 4) and B grades in semester 3(SGPA of semester 3). Then CGPA is calculated as follows:

Semester	Credit of the Semesters	Grade Awarded	Grade point (SGPA)	Credit points
I	20	A+	4.50	90
II	20	A+	4.60	92
III	20	B	3.00	60

IV	20	A+	4.50	90
TOTAL	<b>80</b>			<b>332</b>
<p><b>CGPA= Total credit points awarded / Total credit of all semesters = 332 / 80= 4.15</b>  <b>( Which is in between 4.00 and 4.49 in 7-point scale)</b>  <b>Therefore the overall Grade awarded in the programme is A</b></p>				

### **ELIGIBILITY FOR ADMISSION**

Academic eligibility should be satisfied as on the last date of submission of academic data. No candidate shall be admitted to the PG programme unless he/she possess the qualifications and minimum requirements thereof, as prescribed by Mahatma Gandhi University from time to time.

**If an applicant for admission is found to have indulged in ragging in the past or if it is noticed later that he/she had indulged in ragging, admissions shall be denied or he/she will be expelled from Mar Athanasius College (Autonomous), Kothamangalam.**

Candidates should have passed the corresponding Degree Examination under the 10 + 2 + 3 pattern with one core/main subject and two complementary/subsidiary subjects from any of the Universities in Kerala or of any other University recognized by Mahatma Gandhi University as equivalent thereto for admission, subject to the stipulation regarding marks.

OR

Candidates who have passed Degree examination with Double or Triple main subject and candidates who have passed the Degree Examination in Vocational or Specialized Programmes are also eligible for admission. However, they have to submit copy of the Equivalency/Eligibility Certificate from Mahatma Gandhi University, stating that, their Qualifying Examination is recognized for seeking admission to the relevant P.G. Degree Programme(s) as applicable, at the time of admission. This provision is not applicable in the case of those applicants who have passed their qualifying examination from MG University.

#### **The minimum requirements for admission to PG Degree Programme:**

##### **M Sc Zoology**

<b>Graduates who have passed qualifying examination in CBCS (2017)/CBCSS (2013) pattern</b>	<b>Graduates who have passed qualifying examination in CBCSS (2009) pattern</b>	<b>Graduates who have passed qualifying examination in other patterns</b>
Graduation in Zoology with not less than CGPA/CCPA of 5.00 out of 10.00 in the Core Group (Core +	Graduation in Zoology with not less than CGPA of 2.00 out of 4.00 in the Core Group (Core + Complementary +	Graduation in Zoology with not less than 50% marks in the Part III subjects (Main/Core+

Complementary + Open Courses)	Open Courses)	subsidiaries/Complementaries).
<b>No weightage marks.</b>		

**The Open course under core group is taken only for reckoning the eligibility for applying for the PG programmes concerned. But a candidate cannot apply for the respective PG programmes solely on the basis of the open course selected under core group.**

**Relaxation in Marks in the qualifying examination:**

- (i) Kerala Scheduled Caste/Scheduled Tribe Category:** The minimum grade in the qualifying examination for admission to the PG Degree programme is 'C' in the seven point scale for CBCSS and a pass for pre CBCSS applicants.
- (ii) SEBC Category:** A relaxation of 3% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.7 for CBCS (2017),CCPA of 4.7 for CBCSS (2013), CGPA of 1.88 for CBCSS (2009)applicants and 47% marks for pre-CBCSS applicants for admission to M Sc. Zoology programme.
- (iii) OEC Category:** A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009) applicants and 45% marks for pre - CBCSS applicants for admission to M Sc. Zoology Programme.
- (iv) Persons with Disability category:** A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009) applicants and 45% marks for pre - CBCSS applicants for admission to M Sc. Zoology Programme.

## **M.Sc. ZOOLOGY DEGREE PROGRAMME**

(MAHATMA GANDHI UNIVERSITY REGULATIONS PGCSS2019 FROM 2019-20 ACADEMIC YEAR)

### **1. AIM OF THE PROGRAM**

To provide quality education in Zoology with different specializations and motivate the students for self-employment in applied branches of Zoology.

To inculcate the spirit of natural resource conservation and conduct filed studies and different projects of interests in Zoology.

### **2. ELIGIBILITY FOR ADMISSIONS**

B Sc. Zoology with 50% marks

### **3. MEDIUM OF INSTRUCTION AND ASSESSMENT**

English

### **4. FACULTY UNDER WHICH THE DEGREE IS AWARDED**

Science

### **5. SPECIALIZATIONS OFFERED, IF ANY**

Fishery Science, Environmental Sciences, Entomology and Medical Microbiology.

### **6. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees**

Two years having four semesters

**PROGRAMME OUTCOME**

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

**PROGRAMME SPECIFIC OUTCOMES (PSO)**

<b>PSO No.</b>	<b>Upon completion of M. Sc Zoology Programme, the students will be able to:</b>	<b>PO No.</b>
<b>PSO-1</b>	Practice scientific creativity and disseminate the knowledge for the benefit of society	1,2,3
<b>PSO-2</b>	Plan, execute and appraise high quality research in the pure and applied biological sciences	2,3,5
<b>PSO-3</b>	Develop a sense of responsibility towards environment conservation, sustainable development and pursue life long learning.	4,5
<b>PSO-4</b>	Experiment and perform conceptual skills in various branches of biological sciences	1,2,3
<b>PSO-5</b>	Identify important problems having biological component, create environmental consciousness among fellow citizens and work towards development of the nation.	3,4,5

**PROGRAM STRUCTURE**

SEMESTER	CODE	TITLE OF THE COURSE	Type of the course	Hours per week	Credit
Semester 1	PG20ZY101	Biosystematics and Animal Diversity	Theory	4	4
	PG20ZY102	Evolutionary Biology and Ethology	Theory	4	4
	PG20ZY103	Biochemistry	Theory	4	4
	PG20ZY104	Biostatistics, Computer application and Research methodology	Theory	3	3
	PG20ZYP1	Practicals of Animal diversity: Evolutionary, Ethological and Biochemical methods and Approaches	Practical	10	4
Semester 2	PG20ZY205	Ecology- Principles and Practices	Theory	4	4
	PG20ZY206	Cell and Molecular biology	Theory	4	4
	PG20ZY207	Genetics	Theory	4	4
	PG20ZY208	Biophysics, Instrumentation and Biological Techniques	Theory	3	3
	PG20ZYP2	Practicals of Ecological, Molecular, Hereditary, Biophysical Approaches and Biological Techniques	Practical	10	4
Semester 3	PG20ZY309	Developmental Biology	Theory	4	4
	PG20ZY310	Biotechnology and Bioinformatics	Theory	4	4
	PG20ZY311	Advances in Animal physiology	Theory	4	4
	PG20ZY312	Microbiology and Immunology	Theory	3	3

	PG20ZYP3	Practicals of Developmental , Physiological, Microbial, Immunological and Biotechnological Methods	Practical	10	4
Semester 4	PG20ZY413	Elective – Concepts of Environmental Science, Biodiversity, Conservation and Microbial ecology	Theory	5	4
	PG20ZY414	Elective – Environmental Pollution and Toxicology	Theory	5	4
	PG20ZY415	Elective - Environmental Management and Climatology	Theory	5	4
	PG20ZY416	Elective – Morphology and Taxonomy	Theory	5	4
	PG20ZY417	Elective – Anatomy and Physiology	Theory	5	4
	PG20ZY418	Elective – Applied Entomology	Theory	5	4
	PG20ZY419	Elective – General Microbiology and Parasitology	Theory	5	4
	PG20ZY420	Elective – Bacteriology, Virology and Mycology	Theory	5	4
	PG20ZY421	Elective – Clinical Microbiology	Theory	5	4
	PG20ZYP4	Practical of Environmental Science	Practical	10	4
	PG20ZY4P	Dissertation/Project			5
	PG20ZY4V	Viva - voce			2



# FIRST SEMESTER

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PG20ZY101:BIOSYSTEMATICS AND ANIMAL DIVERSITY

PG20ZY102:EVOLUTIONARY BIOLOGY AND ETHOLOGY

PG20ZY103:BIOCHEMISTRY

PG20ZY104:BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH  
METHODOLOGY

PG20ZYP1:PRACTICALS OF ANIMAL DIVERSITY: EVOLUTIONARY,  
ETHOLOGICAL AND BIOCHEMICAL METHODS AND  
APPROACHES

**Objectives:**

- To give a thorough understanding in the principles and practice of systematics

**PG20ZY101 BIOSYSTEMATICS AND ANIMAL DIVERSITY**

**72 Hours (20+52) 4 hrs/week**

**Credit – 4**

- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Identify the various taxa of organisms and establish their relationship and to name.	U	F	1,2
CO2	Classify organisms and arrange them in hierarchical order	AP	P	1,4
CO3	Interpret the ecological role of various organisms in the animal Kingdom	AN	C	2,4
CO4	Examine the relationship between abiotic and biotic factors, various biological interaction	E	MC	3,5
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**BIOSYSTEMATICS**

**20 hrs**

**Module I. Biological Classification**

**3hrs**

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curation and process of identification. Taxonomic characters of different kinds. Process of typification, different zoological types and their significance.

**Module II. Methods of Biosystematics**

**5 hrs.**

Classical and modern methods-Typological, Phenetics, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life

**Module III. Taxonomic Publications**

**4 hrs.**

[*Self study*- Keys, types, use of keys, merits and demerits. International Code of Zoological Nomenclature(ICZN)], Rules and formation of Scientific names of different taxa. Homonymy and Synonymy. Ethics in taxonomy- authorship, suppression of data, undesirable practices in taxonomy.

**Module IV. Concepts and Techniques in Systematics**

**8hrs.**

Three Domain Concept in Systematics, two, five, six and eight kingdom classification. Concept of species-taxonomic diversity within species.

Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

**ANIMAL DIVERSITY**

**52hrs.**

**Module I. Introduction**

**3 hrs.**

Origin of Protists. Prokaryotes and Eukaryotes. Levels of organization in animal kingdom.

**Module II. Multi-cellularity**

**6 hrs.**

Edicaran and Burgess Shale fauna. Cambrian explosion- causes and consequences.

Cropping and Red Queen principle. Possible theories of metazoan origin.

Symmetry, Coelom and Metamerism-evolutionary advantages.

**Module III. Lower Metazoans**

**5 hrs.**

Porifera, Cnidaria-Polymorphism, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudocoelomata-evolutionary relationships and adaptive modifications only.

**Module IV. Protostomes and Deuterostomes**

**10 hrs.**

Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids. Phylogeny of Arthropod-Monophyly and Polyphyly, Reasons for the success of Arthropods. Major classes under Arthropoda and adaptive radiation.

**Module V. Lesser Protostomes**

**2 hrs.**

Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha- Phylogeny only.

**Module VI. Echinoderms**

**2 hrs.**

Classification and adaptive radiation.

[*Self study*-Larval forms of Annelids, Molluscs, Arthropods and Echinoderms.Impact of sedentary life on the organization of invertebrates].

**Module VII. Hemichordates**

**2 hrs.**

Position in the animal kingdom, phylogeny and evolutionary significance

**Module VIII. Ancestry of Chordates**

**8 hrs.**

Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostracoderms and Gnathostomes-Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes.

**Module IX. Terrestrial Vertebrates**

**6 hrs.**

Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats.

Reptiles – origin and adaptive radiation. [*Self study*-Skull of reptiles and its importance in biosystematics]. Mesozoic world of reptiles and extinction.

**Module X. Birds and Mammals**

**8 hrs.**

Origin of birds and mammals. Structural and functional modifications for aerial life. Orders under class Aves.

Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders.

[*Self study*-Adaptive radiation in mammals.]

**REFERENCES**

Alfred, J.R.B and Ramakrishna. 2004. *Collection, Preservation and Identification of Animals*. Zoological Survey of India Publications, Calcutta.

Anderson, T.A. 2001. *Invertebrate Zoology* (2<sup>nd</sup> edn). Oxford University Press, New Delhi.

Barnes, R. D. 1982. *Invertebrate Zoology* (6th edn). Toppan International Co., NY

Barrington, E. J. W. 1969. *Invertebrate Structure and Functions*. English Language Book Society.

Benton, M.J. 2005. *Vertebrate Paleontology* (3<sup>rd</sup> edn). Blackwell Publishing Com. Oxford, UK.

Campbell, N.A and J.B. Reece .2009. *Biology* (8<sup>th</sup> edn). Benjamin Cummings Publ. NY, USA

David, M. H, Craig Moritz and K.M. Barbara. 1996. *Molecular Systematics*. Sinauer Associates, Inc. Hyman, L. H. 1940 –1967. *The Invertebrates* (6 vols). McGraw-Hill Companies Inc. NY

Hickman Jr., Cleveland, Larry Roberts, Susan Keen, Allan Larson, and David Eisenhour .2011. *Animal Diversity*. McGraw-Hill Companies, Inc. NY

Kapoor, V.C. 1991. *Theory and Practice of Animal Taxonomy*. Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.

Margulis,Lynn and M.J.Chapman 2001. *Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth*(4<sup>th</sup>edn.). W.H.Freeman &Company,USA

Mayr, E .1969. *Principles of Systematic Zoology*. McGraw Hill Book Company, Inc., NY.

Mayr, E. 1997. *This is Biology: The Science of Living world*. Universities Press Ltd.

Narendran, T.C. 2008. *An introduction to Taxonomy*. Zoological survey of India.

Niles, E. 2000.*Life on earth: an Encyclopedia of Biodiversity, Ecology and Evolution* (Vol.1&II).ABC-CLIO,Inc.CA,USA

Pat, W. 1996. *Invertebrate Relationships-Patterns in Animal Evolution*.Cambridge University Press.

Pechenik, J. A. 2000. *Biology of the Invertebrates* (4<sup>th</sup> edn). McGraw-Hill Companies, Inc. NY, USA.

Pough Harvey F, Christine M .Janis and John B. Heiser .2002. *Vertebrate Life* ( 6<sup>th</sup> edn). Pearson Education Inc. New Delhi.

Romer, A.S. and T.S. Parsons. 1985. *The Vertebrate Body*. (6th edn.) Saunders, Philadelphia.

Rupert E.Edward.,R.S.Fox and R.D.Barnes.2006.*Invertebrate Zoology: A Functional Evolutionary Approach*. Thomson/Cole, Singapore

Strickberger, M.W. 2005. *Evolution*. Jones and Bartett Publishers, London. Waterman, A.J. 1971. *Chordate Structure and Function*. Macmillan Co. London

Winston, J.E.2000. *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press,Columbia, USA.

Young, J.Z. 1950. *Life of Vertebrates*. Clarendon Press, Oxford, UK.

**PG20ZY102 EVOLUTIONARY BIOLOGY AND ETHOLOGY**

**72 Hours (45+27)**

**Credit- 4**

**Objectives:**

- To provide an understanding on the process and theories in evolutionary biology
- To help students develop an interest in the debates and discussion taking place in the field of evolutionary biology
- To equip the learners to critically evaluate the debates and take a stand based on science and reason
- To expose students to the basics and advances in ethology, and generate an interest in the subject in order to understand the complexities of both animal and human behavior

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Define the process and theories in Evolutionary biology	R	F	2,3
CO2	Describe the mechanism by which evolution occurs	AP	P	4,5
CO3	Analyze the evidence for evolution and its required corollaries	AN	C	1,2
CO4	Understand the advances in Ethology and generate an interest in the subject in order to understand the complexities of both animal and human behaviour	U	MC	3,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**EVOLUTIONARY BIOLOGY 45 hrs.**

**Module I. Concepts in Evolution 5 hrs.**

Concepts of variation, adaptation, struggle, fitness and natural selection-spontaneity of mutation and the evolutionary synthesis. Neutral Evolution, Molecular Evolution. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium).

**Module II. Origin and Evolution of Life 10 hrs.**

Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers,

[*Self study*-Concept of Oparin - Haldane, Miller-Urey Experiments]. The RNA world. Idea of Panspermia. The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Anaerobic metabolism- origin of photosynthesis and aerobic metabolism.

**Module III. Geological Timescale** **5 hrs.**

Major events in evolutionary timescale. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences.

**Module IV. Evidences of Evolution** **2 hrs.**

[*Self study*-Evidences from morphology and comparative anatomy, embryological, physiological and biochemical, palaeontological evidences- Fossils, fossil formation]. Molecular evidences in evolution.

**Module V Population Genetics** **9 hrs.**

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Isolating mechanisms and speciation. Micro Macro and Mega evolution. Co-evolution.

**Module VI. Developmental and Evolutionary Genetics** **6 hrs.**

Evo-Devo, Heterochrony, Heterotopy, Heterometry and Heterotypy.

Developmental genes and gene co-option. Evolution of plasticity and complexity.

Evolution of sex.

**Module VII. Primate Evolution and Human Origins** **8 hrs.**

Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin, hominid fossils. Cytogenetic and molecular basis of origin of man-African origin of modern man. Mitochondrial Eve, Y chromosomal Adam - early migration, hunter-gatherer societies. Evolution of human brain-communication, speech and language.

**ETHOLOGY** **27 hrs.**

**Module 1. Introduction** **2 hrs.**

Historical background, Scope of ethology. Stimulus-Response, Causal factors, Quantitative aspects – Duration, interval, frequency. Behaviour bouts.

**Module II. Neurophysiological Aspects of Behaviour** **3 hrs.**

Reflex action, Kinesis, Taxes, Fixed action patterns. Sherrington's neuro-physiological concepts in behaviour– Latency, summation, fatigue.

**Module III. Motivation** **3 hrs.**

Goal oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives.

Hormones and behaviour, Psycho-hydrologic model of motivation.

**Module IV. Learning** **4 hrs.**

Short and long term memory, Habituation, [*Self study*-Classical conditioning (Pavlov's experiments)], Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting.

**Module V. Communication** **3 hrs.**

Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual.

Dance language of honey bees, Pheromonal communication (Ants and mammals).

**Module VI. Reproduction and Behaviour** **3 hrs.**

Reproductive strategies, Mating systems, Courtship, Sexual selection- patterns, parental care and investment.

**Module VII. Complex Behaviour** **4 hrs.**

Orientation, Navigation, [*Self study*-Migration (Fishes and birds)], Navigation cues.

Biological rhythms – Circadian, Circannual, Lunar periodicity, Tidal rhythms.

Genetics of biological rhythms.

**Module VIII. Social Behaviour** **3 hrs.**

Sociobiology (Brief account only) Aggregations – schooling in fishes, herding in mammals, Group selection, Kin selection, altruism, reciprocal altruism, inclusive fitness, co-operation, territoriality, alarm call, social organization in insects and primates.

**Module IX. Stress and Behaviour** **2 hrs.**

Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance.

**REFERENCES**

**Evolutionary Biology**

Arthur, W. 2011. *Evolution – A Developmental Approach*. Wiley-Blackwell, Oxford, UK

Camilo J. Cela - Conde and Francisco J. Ayala. 2007. *Human Evolution-Trails from the Past*. Oxford University Press. Oxford, UK

Campbell, B.G. 2009. *Human Evolution*. Transaction Publishers, NJ, USA



Charles W. Fox and Janson B.Wolf . 2006. *Evolutionary Genetics-Concepts and Case Studies*. OxfordUniversity Press, NY. USA

Carroll, SB. 2005. *Endless Forms Most Beautiful: The New Science of Evo-Devo*. WW Norton, New York

Cleveland P.Hickman, Jr., Larry S. Roberts and Allan Larson. 2011. *Integrated Principles of Zoology*. (11<sup>th</sup> edn.). McGraw-Hill, NY, USA.

Darwin, C.D. 1859. *On the Origin of Species by Means of Natural Selection*. John Murray, London.

Dan, G. and Li,W.H. 2000. *Fundamentals of Molecular Evolution*. (2<sup>nd</sup> edn.). Sinauer Associates Inc.MA, USA

Elliott,Sober.2008. *Evidences and Evolution: The Logic Behind the Science*. Cambridge University Press,UK.

Futuyma,D.J.1986. *Evolutionary Biology*.(2<sup>nd</sup> edn.). Sinauer Associates Inc. MA, USA. Gould, S,J. 2002. *The Structure of Evolutionary Theory*. Harvard University Press, MA, USA.

Hall, B.K and Hallgrimsson, B. 2008. *Strickberger's Evolution* (4<sup>th</sup> edn). Jones and Bartlett Pub.London,UK

Hall, B.K. and Olsen, W. M., (Ed). 2007. *Keywords and Concepts in Evolutionary DevelopmentalBiology*. Discovery Publishing House, New Delhi,

Hall, B.K., Pearson, R. and Muller, G.B. 2003. *Environment, Evolution and Development: Toward aSynthesis*. MIT Press,Cambridge MA, USA

Kimura,M. 1983. *The neutral theory of molecular evolution*.Cambridge University Press

Margulis, L and Michael J. C.1998. *Kingdoms & Domains: An Illustrated Guide to the Phyla of Lifeon Earth* (4<sup>th</sup>edn.).W. H. Freeman and Company,USA

Richard E. M and Levin, R B.1988. *The Evolution of Sex: An Examination of Current Ideas*. Sinauer Associates Inc. MA, USA

Stearns C.S.1987. *The Evolution of Sex and its Consequences*. Birkhäuser, Basel, Switzerland.

West- Eberhard M.J. 2003. *Developmental Plasticity and Evolution*. Oxford University Press, Oxford, UK.

Arumugan.N. 2010.*Organic Evolution*. Saras Publication. Nagercoil, Tamilnadu.

**WebResources**                      <http://www.talkorigins.org>                      <http://www.ucmp.berkeley.edu>  
<http://www.academicearth.org>

## **Ethology**

Alcock John.2009. *Animal Behaviour : An Evolutionary Approach* (8<sup>th</sup> edn). Sinauer Associates Inc. Sunderland, Massachusetts.

Aubrey Manning and Mariam Stamp Dawkins. 2000. *An Introduction to Animal Behaviour* (5<sup>th</sup> Edn). Cambridge University Press, U.K.

Eibl – Ebesfeldt, I. Hol.1970. *Ethology : The Biology of Behaviour*. Reinhart & Winston. New York. Fatik Baran Mandal .2009.*A Textbook of Animal Behaviour*. PHI Learning Private Limited, New Delhi.

Hauser, M.1998. *The Evolution of Communication*. MIT Press, Cambridge, Mass. USA.

Jeffrey C. Hall.2003. *Genetics and Molecular Biology of Rhythms in Drosophila and other Insects*.Elsevier Science, USA.

Judith Goodenough, Betty McGuire .2010. *Perspectives of Animal Behaviour*. John Wiley & Sons Inc.USA.

Krebs, J. R. and N.B. Davis.2000. *An Introduction to Behavioral Ecology*. Blackwell Scientific Publications, Oxford.

Lee Alan Dugatkin .2009. *Principles of Animal behaviour* (2<sup>nd</sup> edn). W.W. Norton and Company.

Lee C. Drickamer, Stephen H.Vessey, Elizabeth Jakob.2002. *Animal Behaviour –Mechanisms, Ecology,Evolution* (5<sup>th</sup>edn).McGraw-Hill Publishing Company, New York

Macfarland, D1998. *Animal Behaviour – Psychobiology, Ethology and Evolution*. Pitman publication Ltd. London.

Scott,Graham.2005. *Essential animal behavior*. Blackwell Publications Company, Oxford ,UK

Thorpe, W.H.1979.*The origins and rise of Ethology*. Heinmann Educational Books, London.university press, U.K.

Wilson, E.O.2000. *Sociobiology: The new synthesis*. Harvard Univ. Press, Cambridge, Mass. USA.

**Web Resources** [www.animalbehavioronline.com/modestable.html](http://www.animalbehavioronline.com/modestable.html)

**72 Hours (4hrs/week)**

**Credit- 4**

**Objectives:**

- To understand the chemical nature of life and life process
- To provide an idea on structure and functioning of biologically important molecules
- To generate an interest in the subject and help students explore the new developments in biochemistry

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Know the chemical nature of life and life process and demonstrate an understanding of fundamental biochemistry principles	U	F	1,3
CO2	Use current biochemical and molecular techniques to plan and carry out experiments.	AP	C	2,5
CO3	Investigate new developments in biochemistry	E	P	4,1
CO4	Illustrate the relationship of organic compounds and homeostasis in biological organism	C	MC	2,3
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**Module I. Introduction**

[*Self study*-Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.]

**Module II. Carbohydrates**

**10 hrs.**

[*Self study*-Monosaccharides: Classification and nomenclature, Biological importance, Structural representations of sugars-Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars]

Reactions of monosaccharides: Oxidation, reduction, ester formation, osazone formation. Glycosidic bond.

Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.

Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextran, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

### **Module III. Proteins**

**10 hrs.**

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins.

Primary structure of protein (*e.g.* insulin). Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- *e.g.* Myoglobin. Quaternary structure – *e.g.* Haemoglobin.

### **Module IV. Lipids**

**10 hrs.**

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification, nomenclature.

Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes.

Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmalogens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins.

Prostaglandins- structure, types, synthesis and functions.

### **Module V. Nucleic Acids**

**4 hrs.**

Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; DNA regulatory protein folding motifs .Biological roles of nucleotides and nucleic acids.

### **Module VI. Enzymes**

**8 hrs.**

Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site.

Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations

### **Module VII. Carbohydrate Metabolism**

**9 hrs.**

Major metabolic pathways- Glycolysis – Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis,

Cori cycle. Glycogen metabolism- Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca<sup>+2</sup> Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis. Pentose Phosphate pathway.

**Module VIII. Metabolism of Proteins**

**5 hrs.**

Amino acid metabolism-Deamination, Transamination and Trans-deamination. Urea cycle. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.

**Module IX. Metabolism of Lipids**

**7 hrs.**

Beta oxidation, alpha oxidation and omega oxidation of fatty acids. *De novo* synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides.

**Module X. Nucleic Acid and Free radical Metabolism**

**4 hrs.**

Catabolism of purines and pyrimidines.

Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems.

**Module XI. Microbial Metabolism**

**5 hrs.**

Energy acquisition by chemotrophs and phototrophs, fermentation, anaerobic oxidations, chemosynthesis, microbial photosynthesis, regulation of metabolism

**REFERENCES**

Creighton, T.E. *Protein Structure and Molecular Properties*. 1993.

W.H. Freeman & Co, NY. Deb, A.C.2004. *Fundamentals of Biochemistry*. New Central Book Agency (P) Ltd. New Delhi.

Elliott, W.H . and C. Elliott. 2003. *Biochemistry and Molecular Biology*. Oxford University Press, Oxford, UK.

Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi. 2007. *Outlines of Biochemistry*. (5<sup>th</sup> edn). John Wiley & Sons Inc., NY.

Garret, R.H. and C.M. Grisham. 1995. *Biochemistry*. Saunders College Publishers, USA.

Lenhninger, A.L. 2008. *Principles of Biochemistry*. (5<sup>th</sup> edn). CBS Publishers and Distributors, New Delhi.

Hanes, B. D. and N.M. Hooper. 1998. *Instant notes: Biochemistry*. University of Leeds, Leeds, UK.

Horton, H.R., Morsan, L.A., Scrimgeour, K.G ., Perry, M.D and J.D. Rawn. 2006. *Principles of Biochemistry*. Pearson Education International, New Delhi.

Jeffrey. C. Pommerville, *Alcamo's Fundamentals of Microbiology*. Ninth edition. Jones and Batlett Publishers, Sudbury, Massachusetts, USA

Keith Wilson and John Walker. 2008. *Principles and Techniques of Biochemistry and Molecularbiology* (6<sup>th</sup>edn). Cambridge University Press, UK.

Murray, K., Granner, D.K., Maynes, P.A and V.W.Rodwell. 2006. *Harper's Biochemistry* (25<sup>th</sup> edn). McGraw Hill, New York, USA.

Oser, B.L.1965. *Hawk's Physiological Biochemistry*. Mc Graw Hill Book Co. New Delhi.

Palmer Trevor. 2001.*Enzymes: Biochemistry,Biotechnology & Clinical chemistry*. Horwood Publ.Com.,England.

Rama Rao, A.V.S.S. 1986. *Text Book of Biochemistry*. L.K. & S Publishers, New Delhi.

Stayer, L. 2011. *Biochemistry*. (7<sup>th</sup> edn). W.H. Freeman & Co. NY.

Vasudevan, D.M. and S.Sreekumar. 2000. *Text of Biochemistry for Medical Students*. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi

Voet, D. and J.G. Voet.2004. *Biochemistry*. John Wiley & Sons.,NY.

Zubay, G.1989. *Biochemistry*. McMillan Publishing Co., New York.

**G20ZY104BIOSTATISTICS, COMPUTER APPLICATION  
AND RESEARCH METHODOLOGY**

**54 Hours (26+16+12)**

**3hrs/week**

**Credit-3**

**Objectives:**

- To impart concepts, generate enthusiasm and make awareness about the tools/gadgets and accessories of biological research.
- To equip the learner to carry out original research in biology.
- To help the students to improve analytical and critical thinking skills through problem solving
- To provide hands on training in the use of various tools and techniques suggested in the course

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Recall the practices in future for further experiments	R	F	2,4
CO2	Identify the processes involved in scientific method and design of experiment	U	C	5,1
CO3	Practice analytical and critical thinking through problem solving	AP	P	3,1
CO4	Analyze the advantages of using computers in the statistical analysis of data generated by studies and experiments	AN	MC	5,2
CO5	Create enthusiasm and awareness about tools, techniques and accessories in biological research	C	P	4,2
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**BIOSTATISTICS**

**26 hrs.**

**Module 1.Basics of Biostatistics**

**4 hrs.**

Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources).

Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias.

Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table).

Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs.

Statistical Analysis Tools - Parametric and Non-Parametric; Interpretation and Forecasting.

[ *Self study*-Statistics and Biostatistics – scope and significance.]

**Module II. Measures of Central Tendency** **3 hrs.**

[*Self study*-Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode].

Calculations/Problems for different data (raw, frequency table-Direct Method).

Harmonic and Geometric Mean (Brief account only).

**Module III. Measures of Dispersion** **4 hrs.**

[*Self study*-Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation.] Calculations/Problems for frequency table

Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only).

**Module IV. Correlation Analysis** **3hrs.**

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

**Module V. Regression Analysis** **3 hrs.**

Regression and Line of Best Fit , Types and methods of regression analysis.

Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of straight line through regression equation).

**Module VI. Theory of Probability** **2 hrs.**

Measures of Probability and Theorems in Probability. Probability distributions – Binomial, Poisson and Normal (Problems not required).

**Module VII. Testing of Hypothesis** **5 hrs.**

Hypothesis and types, Confidence Interval.



Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test (Problem for 2×2 table only).

Student's 't' test (Problem for small samples comparing mean of two variable).

F-test and Analysis of Variance (ANOVA - One way) (Brief account only).

**Module VIII. Vital Statistics** **2 hrs.**

Introduction, uses, records and system of classification of vital statistics.

Sample registration system, Sample design, Survey of causes of death and Age classification.

Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).

Life tables (Brief account only).

**COMPUTER APPLICATIONS** **16 hrs.**

**Module I. Basics of Computers** **1 hrs.**

Types of Computers. Binary Number System, Digital and Analog systems.

Hardware/Software/Firmware.

**Module II. Hardware Basics** **4 hrs.**

Memory -Classification and Types of memory; memory devices; Units.

Input Devices -Types, working and functions. Output Devices –Types, working and functions.

CPU components - Processors, Mother boards, SMPS, Accessory Cards – Graphic /Sound/ Networking/ Bluetooth/Wifi (Brief account only).

New Generation Computers - Servers, Laptop; Palmtop; Cyborgs; Robotics, Zoobotics (Brief account only).

**Module III. Software Basics** **4 hrs.**

System Software/Operating System -System Files; Working of OS; DOS, Windows, Linux and UNIX (Brief account only).

Application Software -Programs and Packages, Calculator, MS Paint, MS Word, MS Excel, MS PowerPoint, Publisher, Acrobat Reader, E Book Reader, Explorer, Photoshop.

Virus and Antivirus (Brief account only).

Statistical Software (MS Excel, PH Stat, SPSS).

MS Access and R programming (Brief account only).

**Module IV Networking, Internet and Information Technology 3 hrs.**

[*Self study*-Computer Communication -Network Topology, Media of networking, Networking Protocols, PAN, LAN, WAN, MAN, INFLIBNET, Modem and Gateway]

Internet and Internet Services -World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall. Cyber Crime and Cyber Laws, Cyber security (Brief account only).

**Module V. Computer applications in biological science and daily life 4hrs**

Global Information System -BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books Publishing. Mobile applications in biology- Complete biology, Biology dictionary, Genetics and evolution, Basic Molecular biology.

Banking, Automatic telling machine (ATM), smart card, credit card business basics, home banking, secure electronic transaction (SET), Electronic cash or digi cash, electronic bank.

**RESEARCH METHODOLOGY 12hrs.**

**Module I. Concepts of Research 3 hrs.**

Basic concepts of research -Meaning, Objectives, Motivation and Approaches.

Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical).

Research methods versus Methodology, Research and scientific method. Research Process.

**Module II. Research Designs 4 hrs.**

Research Design -Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs.

Development of a research plan -Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs.

**Module III. Scientific Documentation and Communication 2 hrs.**

[*Self study*-Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications)].

Bibliography (MLA, APA, Harvard), Plagiarism and plagiarism checkers.

[Selfstudy-Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference]

**Module IV. Information Science, Extension and Ethics**

**3 hrs.**

Sources of Information -Primary and secondary sources.

Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications.

[Self study-Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution]

**REFERENCES**

Ahuja,V.K. 2010. *Law of Copy Rights and Neighbouring Rights : National and International Perspectives*. Lexis Nexis- Butterworths Wadhwa, Nagpur

Ahuja,V.K. 2007. *Law Relating to Intellectual Property Rights*. Lexis Nexis-Butterworths Wadhwa, Nagpur.

Anitha Goel.2010. *Computer Fundamentals*. Pearson Education India.

Bailey,N.T.J. 1994. *Statistical Methods in Biology* (3<sup>rd</sup>edn). Cambridge University Press.

Biju Dharmapalan. 2012. *Scientific research methodology*. Narosa Publishing House. New Delhi.

Bright Wilson. 1990. *An Introduction to Scientific Research*. Dover Publications. NY.

Chap T.Le.2003.*Introductory Biostatistics*. John Wiley & Sons, NJ, USA.

Clough,P.and C.Nutbrown.2002. *A Student's Guide to Methodology: Justifying Enquiry*. Sage, London.

Daniel, W.W. 2006. *Biostatistics: A Foundation for Analysis in the Health Sciences* (7<sup>th</sup> edn). John Wiley & Sons, New York.

Debbie Holmer, Peter Moody and Diana Dine. 2006. *Methods for the bioscience*. Oxford University Press. New Delhi.

Biju Dharmapalan. 2012. *Scientific Research Methodology*. Narosa Publishing House, New Delhi

Finney ,D.J. 1980.*Statistics for Biologists*. Chapman and Hall, London

Frank, Harry and Steven C. Althoen, 1995. *Statistics: Concepts and Applications*. Cambridge University Press

Glenn McGee.2003. *Pragmatic Bioethics*. The MIT Press, MA, USA

Gurumani.N. 2014. *Research methodology for biological Science*. MJP Publishers, Chennai. Inda.

Jeremy R. Garret.2012. *The Ethics of Animal Research*. The MIT Press, MA. USA

Kothari C.R., 2009. *Research Methodology: Methods and Techniques* (2<sup>nd</sup>edn.). NewAge International Publishers, New Delhi.

Pagano, M and K.Gauvreau. 2000. *Principles of Biostatistics*. Brooks/Cole, CA, USA Paul Oliver.2005. *Writing Your Thesis*. Vistaar Publications.New Delhi.

Peter Medawar.1979. *Advice to Young Scientist*. Harper and Row, London.

Phillippe Cullet.2005. *Intellectual Property Protection and Sustainable Development*. Lexis Nexis-Butterworths Wadhwa, Nagpur

Prabhakara ,G.N. 2006.*Biostatistics*.Jaypee Bro. New Delhi

Pradeep Sinha and Priti Sinha.2010.*Computer Fundamentals*. BPB Publications., New Delhi.

Rajathi A. and P. Chandran, 2010. *SPSS for You*. MJP Publishers, Chennai.

Shane Torbert.2011. *Applied Computer Science*. Springer-verlag, New York.

Sudipto Das.2010. *A Complete Guide to Computer Fundamentals*. Lakshmi Publishers (P) Ltd. New Delhi

Sundar Rao,P.S.S and J.Richard.2006.*Introduction to Biostatistics and Research Methods* (4<sup>th</sup> edn). Prentice Hall, New Delhi.

WHO.2011. *Laboratory Quality Standards and Their Implementation*. WHO Regional Office. New Delhi.

Zar, Jerrold H. 2008. *Biostatistical Analysis* (3<sup>rd</sup>edn.). Pearson Education Inc., New Delhi.

**PG20ZYP1: PRACTICALS OF ANIMAL DIVERSITY: EVOLUTIONARY, ETHOLOGICAL AND BIOCHEMICAL METHODS AND APPROACHES**

**180 Hours (10hrs./week)**

**Credit-4**

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Identify common animals, the morphology and their importance in the living world	AP	F	2,4
CO2	Explain the behaviour of experimental animals under various conditions.	R	C	5,1
CO3	Demonstrate the evolution and behaviour of organisms in different situations.	U	MC	1,3
CO4	Record various organic compounds in human blood	C	P	4,3
CO5	Predict the possibility of new generation diseases in human.	E	P	5,2
CO6	Relate statistical tools in the biological field.	AP	F	1,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**ANIMAL DIVERSITY**

1.Study of museum specimens - 40 invertebrates and 20 vertebrates (List the studied items with brief descriptions. Diagrams not necessary).

2.Larval forms – any 10 larvae from different taxa

3. Study of 5 minor phyla specimens.

4. Study of any 5 connecting links between phyla

5.Study of the skull of vertebrates - Varanus, Bird, Dog, Rabbit

6.Preparation of dichotomous key of 4 specimens up to family (of any three taxa).

Insects

Fishes

Snakes

7. Preparation of Cladogram based on the specimens provided (at least five museum specimen).

8. Calculating gene frequencies and genotype frequencies in the light of Hardy-Weinberg Law in human/other populations.

9. Study of fish in response to three temperatures (Normal and -5/+ 5<sup>0</sup>C) of water in a microenvironment and preparation of an ethogram

10. Study of the grooming behaviour in insects/bird

11. Study of geotaxis in earthworm.

12. Study of phototaxis in *Drosophila*

### **Biochemistry**

1. Quantitative estimation of blood glucose by Anthrone

2. Estimation of proteins by Lowry *et al.* method

3. Quantitative estimation of blood urea acid

4. Quantitative estimation of cholesterol in the blood

5. Estimation of alkaline and acid phosphatases.

6. Determination of acid number of an edible oil.

7. Determination of iodine number of an edible oil.

### **Biostatistics**

*(Problems can be solved using scientific calculator).*

***These exercises can be done as assignments of the theory sessions***

1. Calculation of mean, median and mode from grouped data

2. Calculation of mean deviation and standard deviation from grouped data

3. Calculation of Pearson correlation coefficient.

4. Calculation of regression coefficient and regression equation ('x' on 'y' only)

5. Calculation of 'Z' value (small sample only)

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

7. Calculation of 't' value (for small sample comparing two variable)

8. Draw line graph, vertical bar diagram, horizontal bar diagram, histogram, frequency polygon, frequency curve, pie diagram and ogives on graph paper for simple grouped data.

### **Computer Applications**

1. MS Excel: Preparation of table

2. MS Excel: Preparation of graphs (bar, pie and ogives)

3. MS Excel: Formula writing (Addition, Subtraction, Multiplication, Division, Power and Root)

MS Excel: Correlation Analysis

4. MS Power Point: Preparation of a presentation with minimum 5 slides based on First Semester theory topics

5. PH Stat/R: Basic statistics (mean, median, mode, standard deviation)
6. PH Stat: Chi square test
7. PH Stat: Students t test
8. PH Stat : Regression

# SECOND SEMESTER

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PG20ZY205 ECOLOGY: PRINCIPLES AND PRACTICES

PG20ZY206 CELL AND MOLECULAR BIOLOGY

PG20ZY207 GENETICS

PG20ZY208 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL  
TECHNIQUES

PG20ZYP2 PRACTICALS OF ECOLOGICAL, MOLECULAR, HEREDITARY,  
BIOPHYSICAL APPROACHES AND BIOLOGICAL TECHNIQUES



## PG20ZY205 ECOLOGY: PRINCIPLES AND PRACTICES

72 Hours (4hrs/week)

Credit- 4

### Objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Identify the rules and acts as a major approach to conservation of environment	AP	F	3,5
CO2	Recognise the current environmental issues based on ecological principles	U	P	4,1
CO3	Identify the causes and consequences of human interference on environment	R	C	5,2
CO4	Practice positive approach towards the conservation of nature and natural resources	AN	MC	3,4
CO5	Plan biotechnological method in the cleaning up of environment	E	P	1,2
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### Module I. Ecology and Environment

11 hrs.

Ecology- its relation to other sciences and its relevance to human civilization, subdivisions of ecology. Subdivisions of ecology- autecology, synecology, paleoecology, genecology, ecosystem ecology, chemical ecology, physiological ecology, evolutionary ecology, taxonomic ecology.

[*Self study*-Definition, history and scope of ecology, sub divisions of ecology, Ecology Vs Environmental science]

### Module II. Ecosystem - Structure and Function

13 hrs.

Pathways in ecosystem, energy in the environment-Laws of thermodynamics, energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles- patterns and types (CNP).

### Module III. Population Ecology

13 hrs.

Population group properties, density and indices of relative abundance, Concept of rate. Natality and mortality. Population age structure, Growth forms and concept of carrying capacity.

Population fluctuations, density dependent and density independent controls. Life history strategies, r & k selection.

Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.

Population interactions- types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition.

Concept of metapopulation. Levin's model of metapopulation. Comparison of Metapopulation and Logistic population model. Metapopulation structure.

#### **Module IV. Community Ecology**

**10 hrs.**

Concept of community - community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax. Species diversity in community and its measurement-Alpha diversity, Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity-Sorensen's similarity index, Whittaker's index, Evenness, Gamma diversity, Guild and its functioning in the community.

Drivers of species diversity loss and conservation.

[*Self study*-Community interactions]

#### **Module V. Resource Ecology**

**15 hrs.**

Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources-deforestation, forest scenario of India. Aquatic resources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Sand mining and its impacts.

Wetland reclamation- causes and consequences. Depletion of resources and impacts on quality of life.

Energy Resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques, Ecosystem Modelling (Brief account only).

#### **Module VI. Applied Ecology**

**5 hrs.**

Land and landscape processes, Ecological principles at work with landscapes, use of soil survey, aerial photos, topographic maps in landscape management. [*Self study*-Environmental Pollution-types, causes and consequences. Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management- aerobic and anaerobic systems] Concept of bioreactors in waste management. Liquid wastes and sewage.

Bioremediation- need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters.

Radiation Biology - natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters (two case studies), Disposal of radioactive wastes.

Toxicology- Principles, toxicants- types, dose and effects, toxicity of heavy metals.

## **Module VII. Biogeography and Conservation**

**5 hrs.**

Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Western Ghats and its significance.

Principles and major approaches to conservation and environmental management. Role of UN-conventions, protocols; Climate change and the emerging discussions – mitigation and adaptation; Role of UNFCCC and IPCC. [*Self study*-Country specific laws- mention major environmental/ conservation laws and rules in India-Wildlife Protection Act 1972 amended 1991, Forest Conservation Act, 1980, Air (Prevention and Control of Pollution) Act 1981, Water (Prevention and Control of Pollution) Act 1974, amended 1988, The Environment Protection Act, 1986 and Rules, 1991. The Biological Diversity Act 2002, Rules 2004]

Restoration Ecology- need and policies, case studies and success stories - global and national;

Global environmental problems and debates - past and present; Participatory resource management, community reserves, sacred groves,

Role of Intergovernmental and Non-governmental organizations in conservation-IUCN, WCMC, WRI, WWF, CI and Green Peace. National and Local NGOs.

[*Self study*-Ecological foot print, carbon footprint, carbon credit and eco-taxes].

## **REFERENCES**

Abbasi, S.A. and Ramasami, E.V. 1998. *Biotechnological Methods of Pollution Control*.

Oxford University Press, Hyderabad.

Benton, A.H. and Werner, W.E. 1976. *Field Biology and Ecology*. Tata McGraw Hill, New Delhi.

Boitani, L and T.K.Fuller.2000.*Research Techniques in Animal Ecology*. Columbia University Press,USA.

Daniel,C.D. 2010.*Environmental Science*.(8<sup>th</sup> edn).Jones and Bartlett Publishers.

Dash, M.C and Dash,S.P.2011. *Fundamentals of Ecology*.(3<sup>rd</sup> edn). Tata Mc Graw hill education (P) Ltd.

Forman, R.T.T. and Godron,M.1986.*Landscape Ecology*. John Wiley & Sons, New York

- Mani, M.S. *Ecology and Biogeography in India*. 1974. Dr. W. Junk, The Hague.
- Misra, S P and Pandey S. N. 2009. *Essential Environmental Studies*. Ane Books Pvt. Ltd.
- Odum, E P. 1996. *Fundamentals of Ecology*. W.B Saunders College Publishing, Philadelphia.
- Peter, H.R., Berg, L.R., and Hassenzahl, D.M. 2008. *Environment*. (5<sup>th</sup> edn.). John Wiley Publishers.
- Pianka, E. R. 1981. *Competition and Niche Theory in "Theoretical Ecology"*. (2<sup>nd</sup> edn.). In: May, R.M. (Ed.). Blackwell, London.
- Rana, S.V.S. 2009. *Essentials of Ecology and Environmental Science*. (4<sup>th</sup> edn.). PHI learning Pvt. Ltd., New Delhi
- Simons, I.G. 1981. *Ecology of Natural Resources*. Edwin-Arnold Ltd., London.
- Tietenberg, T. 2004. *Environmental and Natural Resource Economics*. (6<sup>th</sup> edn.). Pearson, New Delhi.
- Tyler, M. G. 2007. *Living in the Environment*. (15<sup>th</sup> edn). Thomson Brooks/Cole, New York.

## PG20ZY206CELL AND MOLECULAR BIOLOGY

72 Hours (4 hrs/week)

Credit- 4

### Objectives:

- To help study the structural and functional details of the basic unit of life at the molecular level
- To motivate the learner to refresh and delve into the basics of cell biology
- To introduce the new developments in molecular biology and its implications in human welfare

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Know the structural and functional details of the basic unit of life	U	F	3,1
CO2	Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology	AP	P	4,2
CO3	Analyze the new developments in molecular biology and its implications in human welfare	AN	C	5,3
CO4	Engage in review of scientific literature in the area of biomedical sciences	C	MC	1,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### Module I. Cellular Membranes

5 hrs.

Membrane structure and chemistry, dynamic nature of the plasma membrane, membrane functions, membrane potentials, ion channels.

[*Self study*- membrane transport – Diffusion and osmosis, Facilitated diffusion, Active transport,Bulk transport. Nucleus and nuclear membrane]

### Module II. Cell junctions, Cell adhesion and Extracellular matrix

6hrs.

Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan,Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions,Gap junctions and Plasmodesmata.

### Module III. Cell Organelles

4 hrs.

Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria.

[ *Self study*- Lysosome, Chloroplasts, Peroxisomes and Glyoxysomes]

**Module IV. Cytoskeleton and Cell Motility**

**5 hrs.**

Microtubules, Microfilaments, Intermediate filaments, Molecular motors, Non muscle motility and contractility.

**Module V. Cell Signaling**

**12 hrs.**

Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers.

Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors).

Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP<sub>3</sub>), Di-acyl glycerol (DAG). Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI-3 kinase), Transforming growth factor (TGF) signaling pathway. Convergence, divergence and crosstalk among different pathways.

[ *Self study*- Basic principles of cell communication]

**Module VI. Cellular Reproduction**

**5 hrs.**

Cell cycle: Steps in cell cycle, Control of cell cycle, Checkpoints in cell cycle.

Apoptosis- extrinsic and intrinsic pathways, significance

[*Self study*- Mitosis and meiosis]

**Module VII. Cancer**

**6hrs**

Basic properties of a cancer cell, Types of cancer, Causes of cancer, Genetics of cancer, Tumour suppressor gene, Oncogene.

New strategies for combating cancer: Immunotherapy, Gene therapy, Inhibiting cancer promoting proteins, Inhibiting formation of new blood vessels.

**Module VIII. Gene Expression**

**15 hrs.**

Relationship between genes and proteins, Protein synthesis - Transcription in prokaryotes and eukaryotes-rRNA, tRNA and mRNA, RNA processing in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes, initiation, elongation and termination, post transcriptional modifications, protein sorting, signal sequences and signal hypothesis.

**Module XI. Gene Regulation**

**14 hrs.**

Regulation of gene expression in *E. coli* : Catabolite repression, *Trp* operon in *E.coli*-repression and attenuation, *Ara* operon in *E.coli*-positive and negative controls. Riboswitches. CRISPR CAS system and its applications. General introduction to gene regulation in eukaryotes at

transcriptional, post transcriptional and translational levels, transcription factors, enhancers and silencers, Chromatin-remodelling complexes, RNA interference (RNAi).

[ *Self study*- Fundamentals of gene regulation, Lac operon]

## REFERENCES

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. And Walter, P. 2008. *Molecular Biology of the Cell*. Garland Science.- Taylor and Francis group, USA.
- Becker, W.M., Kleinsmith, L.J. and Hardin, J. 2007. *The World of the Cell*. Pearson, New Delhi.
- Clark, D.P. 2010. *Molecular Biology*. Elsevier Publishers, London.
- Cooper, G.M. and Hausman, R.E. 2009. *The cell: A Molecular Approach* (5<sup>th</sup> edn). Sinauer Associates, Inc, ASM Press, Washington DC.
- Griffiths, A.J.F., Wesler, S.R., Carroll, S.B. and Doebley, J. 2008. *Introduction to Genetic Analysis*. W H Freeman and Company, USA
- Hyde, D.R. 2010. *Genetics and Molecular Biology*. Tata McGraw Hill Education Private Ltd., New Delhi.
- Karp, G. 2010. *Cell and Molecular Biology* (6<sup>th</sup> edn). John Wiley and Sons, Inc. NJ, USA.
- Klug, W.S. and Cummings, M.R. 2004. *Concepts of Genetics*. Pearson International, New Delhi.
- Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. 2011. *Lewin's Genes X*. Jones and Bartlett publishers, NY.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. 2007. *Molecular Cell Biology* (6th edn). W H Freeman & Company.
- Pierce, B.A. 2008. *Genetics: A conceptual approach*. W H Freeman and Company.
- Pollard, T.D. and Earnshaw, W.C. 2008. *Cell Biology*. Saunders Elsevier.
- Snustad, D.P. and Simmons, M.J. 2010. *Principles of Genetics*. John Wiley and Sons.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2009. *Molecular Biology of the Gene*. Pearson.

**PG20ZY207GENETICS****72 Hours (4hrs/week)****Credit-4****Objectives:**

- To give an in-depth understanding on the principles and mechanisms of inheritance
- To help study the fine structure and molecular aspects of genetic material
- To provide an opportunity to learn the importance of inheritance in Man

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Describe principles and mechanism of inheritance	R	C	3,5,
CO2	Describe applications and techniques of modern genetic technology as well as select the correct techniques to solve genetic problems	AP	F	2,4
CO3	Able to learn the importance of inheritance in man and role of genetic mechanisms in evolution	AN	P	1,3
CO4	Understand the nature of heritable traits in families and populations to provide insight in to cellular and molecular mechanisms	U	MC	1,4
CO5	Understand how genetic concepts affect broad social issues including health and disease, food and natural resources, environmental sustainability etc.	U	C	3,2
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**Module I. Principles of Genetic Transmission****5 hrs.**

[*Self study*-Mendel's principles, incomplete dominance and co-dominance]. Gene action-from genotype to phenotype-penetrance and expressivity, gene interaction-epistasis, pleiotropy, genomic imprinting, phenocopy. Inbreeding, Heterosis and hybrid vigour.

**Module II. Molecular Organization of Chromosomes****8 hrs.**

Genome size and C-value Paradox. Structure of eukaryotic chromosome-nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Polytene chromosomes and Lampbrush chromosomes. Chromosome banding techniques.



**Module III. Gene Fine Structure**

**8 hrs.**

The definition of gene. The standard genetic code, redundancy and Wobble. DNA Modern findings on the nature of gene: Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns. Genes-within-genes (overlapping genes) Bacteriophage Ö X174.

Transposable elements in Bacteria –IS elements, composite transposons, Tn3 elements, medical significance. Transposable elements in Eukaryotes-P elements, Retrotransposons, Significance of transposons.

**Module IV. Genetic Linkage, Recombination and Chromosome Mapping** **15 hrs.**

Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination, Stern’s Experiment; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two-point and three –point test cross in *Drosophila*, Coincidence and Interference.

Genetic mapping by tetrad analysis in *Neurospora*. Mitotic recombination.

Genetic recombination in Phage, rII locus, complementation test, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.

[*Self study*-Recombination in bacteria- transformation, transduction, conjugation and sex- duction]

**Module V. Gene Mutation** **6 hrs.**

Chromosomal mutations – structural, numerical, lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation, The Ames test for mutagen/carcinogen detection.

DNA damage and repair mechanisms

**Module VI. DNA Replication**

**7 hrs.**

The Meselson-Stahl experiment, semi conservative replication of DNA in chromosomes, Theta replication, rolling-circle replication, molecular mechanisms of eukaryotic replication.

**Module VII. Human Genetics**

**5 hrs.**

Karyotype, pedigree analysis, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping. QTL mapping, genotype-environment interactions.

**Module VIII. Genetic mechanism of sex determination in humans** **5hrs**

Evidence and role of SRY gene, SF-1 gene, autosomal sex reversal gene-SOX-9. DAX-1 gene, WNT-4 gene.

[Self study-Sex determination. Sex linkage, sex limited and sex influenced characters in man]

**Module X. Extra Chromosomal Inheritance** **5 hrs.**

Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

**Module XI. Epigenetics** **8 hrs.**

Epigenetics - from phenomenon to field, chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *Saccharomyces cerevisiae*, position effect variegation, heterochromatin formation and gene silencing in *Drosophila*.

**REFERENCES**

Ajoy Paul, 2012. Textbook of genetics from genes to genomes. Books and allied (P) Ltd. Kolkata, India

Brooker, 1999. *Genetics: Analysis and Principles*. Addison- Wesley, NY.

David Allis and Thomas Jenuwein, 2007. *Epigenetics*. Cold Spring Harbor Laboratory Press.

Hartl, D.L. 2000. *A Primer of Population Genetics*. Sinauer Associates, Inc, Massachusetts.

Gardner. J.E., Simmons, J.M and D.P. Snustad. 2007. *Principles of Genetics* (8<sup>th</sup> edn). John Wiley, India.

Gilbert, S.F. 2006. *Developmental Biology* (9<sup>th</sup> edn). Sinauer Associates, Inc., Publishers, Massachusetts.

Griffiths *et al.*, 2002. *Modern Genetic Analysis*. W.H. Freeman, NY, USA.

Hartl, L.D., and E.W. Jones. 2009. *Genetics: Analysis of Genes and Genomes* (7<sup>th</sup> edn). Jones & Bartlett Pub., Inc. MA, USA.

Herskowitz I.H, 1977. *Principles of Genetics*. Collier Macmillan.

Lewin B, 2008. *Genes* (9<sup>th</sup> edn). Jones and Bartlett Publishers Inc.

Klug, W.S. and Michael R. Cummings, 2009. *Concept of Genetics*. Pearson Education. Inc.

Russel, J.P., 2010. *Genetics*. Pearson International Edn.

Snustard, P and M. J. Simmons, 2010. *Principles of Genetics*. John Wiley and Sons

Strickberger, M.W. 1968. *Genetics*. Macmillan Publishing Co.

Watson *et al.*, 2004. *Molecular Biology of Gene* (5<sup>th</sup> edn.). Pearson Education Inc.

## PG20ZY208 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

**54 Hours (24+30)**

**Credit- 3**

**Objectives:**

- To learn the biophysical properties and functioning of life processes
- To introduce the tools and techniques available for studying biochemical and biophysical nature of life
- To equip the learner to use the tools and techniques for project work/ research in biology

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Learn the biophysical properties and function of life process	U	F	1
CO2	Know the techniques available for studying biochemical and biophysical nature of life	R	C	3,4
CO3	Recall and relate the concept of radioactivity and its application	AP	P	5,1
CO4	Equip the learner to use the tools and techniques for project work/research in biology	C	MC	2,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

<b>BIOPHYSICS</b>	<b>24 hrs.</b>
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**Module I. Diffusion and Osmosis** **6 hrs.**

Diffusion -Kinetics of diffusion, Fick’s law of diffusion and diffusion coefficient, Biological significance in animals and plants, Gibbs-Donnan equilibrium.

[*Self study*-Osmosis- osmotic concentration and osmotic pressure], Van’t Hoff’s laws.

Biological significance of osmosis in animals and plants.

**Module II. Biophysics of Cell Membrane** **6 hrs.**

[*Self study*-Membrane Transport – endocytosis, exocytosis] Nutrient transport across membranes, porins facilitated diffusion, porter molecules; Facilitated transport: symport, antiport, uniport, anion porter, glucose porter; Active transport: proton pumps, Na<sup>+</sup> K<sup>+</sup> pumps and Ca<sup>++</sup> pumps, ionic channels. Artificial membranes.

**Module III. Bioenergetics** **6 hrs.**

[*Self study*-Thermodynamics- Laws of thermodynamics, Entropy, Enthalpy, Free energy]

Reversible thermodynamics and irreversible thermodynamics; Systems – open, closed and isolated. Photo bioenergetics. Photosynthesis – light and dark reactions, Redox couple and redox potential.

**Module IV. Radiation Biophysics**

**6 hrs.**

Ionizing radiation, units of radioactivity, exposure and dose, dosimetry

Interaction of radiation with matter – Photoelectric effect, ion pair production, absorption and scattering of electrons.

Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation : somatic and genetic.

Nuclear medicine : Internally administered radioisotopes. Radiation protection and therapy.

**INSTRUMENTATION & BIOLOGICAL TECHNIQUES**

**30hrs.**

**Module I. Microscopy**

**6 hrs.**

Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope –Scanning Tunnelling and Atomic Force Microscopes.

[*Self study*-Light microscope and dark field microscope, Phase contrast microscope, Polarizing microscope, birefringence fluorescence microscope, TEM, SEM and camera lucida]

**Module II. Chromatography**

**5 hrs.**

Paper chromatography, Thin layer chromatography, Ion exchange chromatography.

Gel permeation chromatography, Affinity chromatography, Gas chromatography High pressure liquid chromatography (HPLC), High pressure thin layer chromatography (HPTLC).

**Module III. Electrophoresis**

**4 hrs.**

Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE), Agarose gel electrophoresis , immuno-electrophoresis.

**Module IV. Colorimetry, Spectrophotometry and Spectroscopy**

**5 hrs.**

Principle and applications of colorimetry. Spectroscopy :Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic-resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

**Module V. Centrifugation**

**2hrs.**

Basic principles of sedimentation, Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation.

**Module VI. Assays 3 hrs.**

Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA).ELIFA

**Module IX. pH meter**

**1 hr.**

Principle and working. Types of pH meters.

**Module X. Biological and Histological Techniques**

**4 hrs.**

Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching,negative staining.

Cytochemical and histological methods- Microtome techniques, fixation, staining. Detection of carbohydrates, proteins, lipids and DNA

**REFERENCES**

Ackerman, E. 1962. *Biophysical Science*. Prentice Hall Inc. NJ, USA

Alonso, A., and Arrondo, J.L.R.2006. *Advanced Techniques in Biophysics*.Springer,UK

Arora, M. P. 2007.*Biophysics*. Himalaya Publishing House, New Delhi

Baker, E.J. and Silverton R.E. 1978. *Introduction to Medical Laboratory Technology*.ELBS.London,UK

Das, D. 1991. *Biophysics and Biophysical Chemistry*. Academic Publishers, Calcutta.

Edward, A.L. 1997. *Radiation Biophysics*. Academic Press,NY,USA.

Ernster, L. (Ed.). 1985. *Bioenergetics*. Elsvier, NewYork,USA.

Ghatak K.L. 2011.*Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi

Gupta A. 2009. *Instrumentation and Bio-Analytical Techniques*.PragatiPrakashan, Meerut.

Hoope, W. *et.al*. 1983. *Biophysics*. Springer Verlag, Berlin

Lehninger, A.L.1971. *Bioenergetics*. W.A. Benjamin, London,UK.

Narayanan, P. 2000. *Essentials of Biophysics*.New Age International (P) Ltd. Publishers, New Delhi.

Pearse, A.G.E. 1980. *Histochemistry*. Vol.& Vol. II. Churchill Livingstone, NY, USA.

Pradeep T. 2007. *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*.Tata McGraw Hill Education Pvt. Ltd., New Delhi.

Roy, R.N. 1996. *A Textbook of Biophysics*. New Central Book Agency (P) Ltd. Calcutta

Sandhu, G.S. 1990. *Research Techniques in Biological Sciences*. Anmol Publications, New Delhi

Srivastava,P.K. 2006. *Elementary Biophysics.An Introduction*.Narosa Publishing House, New Delhi.

Varghese, T. and Balakrishna, K.M.2012. *Nanotechnology-An Introduction to Synthesis, Propertiesand Applications of Nanomaterials*. Atlantic Publishers and Distributors. (P) Ltd. New Delhi

Weesner, F.M. 1960. *General Zoological Microtechniques*. The Williams & Wilkins Co., Baltimore, USA

**PG20ZYP2:PRACTICALS OF ECOLOGICAL, MOLECULAR,  
HEREDITARY, BIOPHYSICAL APPROACHES AND BIOLOGICAL  
TECHNIQUES**

**180 Hours (10 hrs./week)**

**Credit-4**

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Gain experience to develop ecological hypothesis and designing observational and experimental studies in field and laboratory settings.	U	C	2
CO2	Analyze interactions within the context of specific habitats and analyze the key factors that influence the habitats	AN	F	1,2
CO3	Evaluate the relationships among ecological interactions	E	P	3,4
CO4	Acquire deep understanding of Mendelian genetics and its application, population genetics and microbial genetics	R	MC	5,1
CO5	Learn about applied genetics and gene mapping methods	R	C	3,5
CO6	Acquire exhaustive knowledge on the culture of microbes, application of microbes in industry.	AP	F	2
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**Ecology**

1. Study of Pond/ wetland/ River/ forests ecosystem- Food web and food chain and pyramid

(no museum specimen). Record the date, time, methodology, and observations in the record book.

2. Determination of soil organic carbon and chlorides.

3. Separation and identification of soil arthropods using Berlese funnel.

4. Qualitative and Quantitative study of marine planktons.

5. Estimation of primary productivity (Gross and Net).

6. Principles and application of the following instruments: Rain Guage, Plankton Net, Secchi Disc, GPS.

**Field Study Report:** Three days field study covering River/ Wetland/ Marine and forests/ grassland.

Record ecosystem components (Soil, water, flora, fauna) and interactions. Viva based on Field study.

### **Biophysics/Instrumentation/Biological Techniques**

1. Micrometry- principle and measurement of microscopic objects: Low power and high power.
2. Preparation of whole mounts- 5nos
3. Camera Lucida drawing with magnification and scale.
4. Principle and working of micro-photographic equipment, Flame photometer, magnetic stirrer, Spectrophotometer
5. Study of pH and conductivity using pH and conductivity meter (2different samples).
6. TLC using amino acids from purified samples and biological materials.
7. Demonstration of Gel electrophoresis, ELISA
8. Rate of salivary amylase activity on starch (colorimetry)
9. Effect of different pH on salivary amylase activity (colorimetry)
10. Influence of temperature on salivary amylase activity – Calculation of Q 10

### **Genetics**

1. Culture, sexing and etherization of *Drosophila*.
2. Study of lifecycle of *Drosophila* (*Plot graph*)
3. Study of Mutants in *Drosophila*.
4. Genetics problems
  - Di hybrid cross,
  - Test cross
  - Sex linked inheritance.
  - Epistasis
5. Construction of gene map using recombination frequencies
6. Abnormal human karyotypes (any five).
7. Squash preparation and identification of salivary gland chromosomes in *drosophila*



8. Study of sex chromatin in buccal smear (Human)

**Cell and Molecular biology**

1. Squash preparation of grasshopper testis to study meiotic stages.
2. Determination of mitotic index in the squash preparation of onion root tip.
3. Effect of drugs on cell division (Colchicine or any other inhibitor)
4. Preparation of Microtome section, spreading and histochemical staining of
  - Carbohydrates (PAS),
  - Protein (Bromophenol blue),
  - Lipids (Sudan Black),
  - DNA (Fuelgen stain).

# THIRD SEMESTER

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PG20ZY309 DEVELOPMENTAL BIOLOGY

PG20ZY310 BIOTECHNOLOGY AND BIOINFORMATICS

PG20ZY311 ADVANCES IN ANIMAL PHYSIOLOGY

PG20ZY312 MICROBIOLOGY AND IMMUNOLOGY

PG20ZYP3 PRACTICALS OF DEVELOPMENTAL , PHYSIOLOGICAL, MICROBIAL,  
IMMUNOLOGICAL AND BIOTECHNOLOGICAL METHODS

**PG20ZY309 DEVELOPMENTAL BIOLOGY****72 Hours (4hrs/week)****Credit - 4****Objectives:**

- To introduce the concepts and process in developmental biology
- To help students understand and appreciate the genetic mechanisms and the unfolding of the same during development
- To expose the learner to the new developments in embryology and its relevance to Man

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Describe the basic concepts of process in Developmental biology	U	F	1,3
CO2	Illustrate the development process through various model organisms	AP	C	4
CO3	Apply the knowledge of new developments in developmental biology for human welfare	AP	P	5,2
CO4	Relate the role of developmental genetics in defining biological process	E	MC	3
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**Module I. Introduction: Basic Concepts of Development****8 hrs.**

Potency of embryonic cells, Commitment, Specification (Autonomous and Conditional), Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages. Genomic equivalence and Cytoplasmic determinants.

**Module II. Fertilization and Early development****8hrs.**

[*Self study*-Spermatogenesis,Oogenesis.Fertilization-biochemical and molecular aspects, Polyspermy. Mechanisms and significance of cleavage.Blastulation and Gastrulation, Parthenogenesis.]

Early development and axis specification in *Caenorhabditis elegans*,*Vulval induction in C.elegans*.

**Module III. Development of Model organisms-Drosophila****8 hrs.**

Early development and axis specification in *Drosophila* (cleavage, midblastula transition, gastrulation). Anterior-posterior patterning in *Drosophila* (Maternal effect genes,zygotic genes, gap genes, pair rule genes, segment polarity genes; homeotic selector genes,realisator genes),Dorsal-ventral patterning and left right patterning, Dorsal protein gradient

**Module IV. Axis and Pattern Formation in Amphibians**

**6 hrs.**

Axis formation in amphibia -Anterior-posterior patterning in Amphibia.Hox code hypothesis.

Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer. Neural induction, Regional specificity of induction.

**Module V. Cellular Interactions in Development**

**10 hrs.**

Genetic specificity of induction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP). Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and cell death pathway.

**Module VI. Differential Gene Expression**

**14 hrs.**

Differential gene transcription - exons and introns, promoters, silencers, enhancers, transcription factors, dosage compensation, differential RNA processing; Control of gene expression: translational and post translational control of gene expression.

**Module VII. Metamorphosis and Regeneration**

**10 hrs.**

Metamorphosis of Amphibians and Insects; Hormonal control of metamorphosis.Heterochrony-neoteny, progenesis (Brief accounts); regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration; Lens regeneration in amphibia; Bone and neural regeneration (Medical -Advances in regeneration).

**Module VIII. Teratogenesis**

**4 hrs.**

Malformations and disruptions, Gene-phenotype relationship, Autophenotype, Allophenotype and Pleiotrophy; Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens.

**Module IX. Human Welfare and Developmental Biology**

**4 hrs.**

[*Self study*-Infertility-Test tube babies (*In vitro* fertilization and embryo transfer)] .Cloning experiments- (Amphibians, Mammals and Human). Stem cells and their applications, ethical issues.

**REFERENCE**

Balinsky, B.I.2004. *An Introduction to Embryology*. W.B.SaundersCo.,Philadelphia.

Berril, N.J. 1979. *Developmental Biology*.Tata McGraw-Hill Pub.Co.Ltd.,New Delhi.

Gilbert, S.F. 2006. *Developmental Biology* (9<sup>th</sup>edn).Sinauer Associates Inc., Publishers, Massachusetts, USA

Hopper, A.F. and Hart ,N.H.1985. *Foundations of Animal Development*.Oxford University Press, Oxford.

Lewis Wolpert. 2007. *Principles of Development*. Oxford University Press.Oxford

Saunders, J.W.1982. *Developmental Biology-Patterns,Principles and Problems*. Macmillan Publishing Co.,New York.

Subramanian, T. 2002. *Developmental Biology*.Alpha Science International Ltd.,New Delhi

Sunstard,D.P., Simmons, M. J. and J.B Jenkins.1997. *Principles of Genetics*. John Wiley and sons, New York.

Wolpert L. and C. Tickle. 2011. *Principles of Development*.(4<sup>th</sup>edn). Oxford University Press, Oxford, UK

## PG20ZY310 BIOTECHNOLOGY AND BIOINFORMATICS

72 Hours (57+15) (4hrs/week)

Credit- 4

### Objectives:

- To give students an intensive and in-depth learning in the field of biotechnology
- To understand the modern biotechnology practices and approaches with an emphasis in technology application, medical, industrial, environmental and agricultural areas
- To familiarize the students with public policy, biosafety, and intellectual property rights issues related to biotechnology
- To expose the learners to the emerging field of bioinformatics and equip them to take up bioinformatics studies

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Describe the basic concepts of techniques in biotechnology and bioinformatics	U	C	1
CO2	Identify the applications of biotechnology in the field of tissue culture, agriculture and industry	R	F	3
CO3	Apply the techniques in biotechnology and bioinformatics for environment & human welfare	AP	P	4,5
CO4	Differentiate between various biological databases & tool for extracting specific information	AN	MC	2,5
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### BIOTECHNOLOGY

57 hrs.

#### Module 1.Introduction to Biotechnology

[*Self study*]-Historical aspects, definitions and scope of Biotechnology. Biotechnology i

#### Module II. Tools and Techniques in Recombinant DNA Technology

8 hrs.

Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Restriction enzymes and DNA modifying enzymes.

Polymerase chain Reaction- different types and applications. Chromosome walking, chromosome jumping, DNA foot printing. Molecular Markers and Probes-SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH.

#### Module III. DNA Sequencing and Cloning methods

10 hrs

DNA sequencing methods- Maxam and Gilberts chemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Site directed mutagenesis, molecular chimeras.

Cloning Methodologies - Gene isolation : Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene- cohesive end ligation, homopolymer tailing, extending linkers. Methods of rDNA transfer to host cells-  $\text{CaCl}_2$  treatment, Virus delivery. Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.

[ **Self study-** Blotting techniques- Southern, Northern, Western, Dot Blot, DNA finger printing].

#### **Module IV. Tissue culture and preservation methods**

**10 hrs**

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics.

#### **Module V. Transgenic animal technology**

**5 hrs**

Transfection Methods:  $\text{CaPO}_4$  precipitation, Short Gun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.

#### **Module VI. Biotechnology in Healthcare**

**6 hrs.**

Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non medical. Introduction to Biochips and their application in modern sciences

#### **Module VII. Biotechnology in Industry and Agriculture**

**6 hrs.**

Microbial enzymes and biotransformation- Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life. Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology -concept and basics.

**Module VIII. Environmental Biotechnology**

**4 hrs.**

Biodegradation of xenobiotic compounds. Bioremediation

and Biore Restoration. Microbial leaching and mining. Transgenics and environment.

**Module IX. Biopolymers and Biofuels**

**4hrs.**

Degradable, biodegradable and compostable plastics. Types of biopolymers-from living organisms, polymerisable molecules. Production of biofuels, advantages of biodiesel. Bio hydrogen-microbial fuel cells (MFCs)

**4 hrs.**

**Module X. Intellectual Property Rights, Biosafety and Bioethics**

Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights.

Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments, Protection of New GMOs. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to GATT, WTO, WIPO and TRIPS.

Biosafety concepts and issues. General guidelines for recombinant DNA research activity. Biosafety protocol 2000.

Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity *etc.*

**BIOINFORMATICS**

**15 hrs.**

**Module 1. Introduction to Bioinformatics**

**1 hrs.**

Computation biology, Bioinformatics, applications of bioinformatics and scope of bioinformatics.

**Module II. Biological Databases**

**3 hrs.**

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.

**Module III. Sequence Analysis**

**3 hrs.**

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees.

**Module IV. Genomics and Proteomics**

**3 hrs.**

Structural genomics, functional genomics, comparative genomics, data mining in proteomics,

**2 hrs.**



## Module V. Systems Biology

Introduction , System networks, applications

## Module VI. Synthetic biology.

3hrs.

Introduction and application, Minimal genome, synthetic cell and its clinical relevance

## REFERENCES

### Biotechnology

Dale, Jeremy W and Schantz, Malcom V. 2002. *From Gene to Genomes*. John Wiley and Sons Ltd, NY, USA

Das, H.K. 2007. *Text book of Biotechnology*. Wiley India Pvt. Ltd. New Delhi

Doyle, Alan and Griffith Bryan J. 1999. *Cell and Tissue Culture- Laboratory Procedures in Biotechnology*. Wiley International, NY.

Freshney, Ian, R. 2006. *Culture of Animal Cell* (5th edn). Wiley- Liss publications.

Pandian, T.T. and Kandavel, D. 2008. *Text Book of Biotechnology*. I.K International Publishing House, New Delhi.

Primrose, S.B., Twyman, R.M., and Old, R.W. 2001. *Principle of Gene Manipulation* (6th edn). Blackwell Science Ltd, London.

Singh .B.D. 2006. *Biotechnology*. Kalyani Publishers, New Delhi.

Sobti, R. C. and Pachauri, Suparna S. 2009. *Essentials of Biotechnology*. Ane Books Pvt. Ltd. New Delhi.

Thakur, I.S. 2011. *Environmental biotechnology-Basic concepts and applications*. 2<sup>nd</sup> edition . I.K. International Pvt.Ltd.

### Bioinformatics

Alberghina, L and H.V. Westerhoff (Eds). 2008. *Systems Biology-Definitions & Perspectives*. Springer-Verlag, Berlin.

Attwood T.K. and Parry Smith, D. 2006. *Introduction to Bioinformatics*. Pearson Education.

Bourne P. E and Weissig H, 2003. *Structural Bioinformatics*. Wiley -Liss. USA

David W. M. 2004. *Bioinformatics, Sequence and Genome Analysis* (2<sup>nd</sup> edn). CSHP, New York

Krane, D. E and M.L. Raymer. 2006. *Fundamental concepts of Bioinformatics*. Pearson Education, New Delhi

Lesk A. M, 2005. *Introduction to Bioinformatics*. Oxford Press, New Delhi

Pengcheng Fu and Sven Panke, (Eds.) 2009. *Systems Biology and Synthetic Biology*. John Wiley & Sons, Inc. NJ,USA

Tisdall J. D, 2001. *Beginning Perl for Bioinformatics*.O'Reilly Media Inc.CA,USA

Masaru Tomita and Takaai Nishioka, 2005. *Metabolomics. The Frontier of Systems Biology*. Springer Japan.

Vikram Singh and Pawan.K.Dhar. 2015. *Systems and Synthetic biology*. Springer Publications. New york

## PG20ZY311 ADVANCES IN ANIMAL PHYSIOLOGY

72Hours. (4hrs/week)

Credit-4

### Objectives:

- To study and compare the functioning of organ systems across the animal world
- To give an over view of the comparative functioning of different systems in animals
- To learn more about human physiology

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Outline the basic knowledge of human physiology	R	P	1,2
CO2	Discuss how separate biological systems interact to yield integrated physiological response	U	C	4
CO3	Apply the theoretical models of human physiology to define, solve & evaluate problems	AP	F	5
CO4	Compare the functioning of organ systems across the animal world	E	MC	3,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### Module I. Nutrition, Digestion and Absorption

6 hrs.

[*Self study*-Nutrition in animals Physiology of digestion and absorption.] Structural and biochemical adaptations to special dietary pattern, symbiotic digestion.

Neuronal and hormonal regulation of nutritional intake, hunger drive, thirst.

[*Self study*- Obesity-causes and consequences, BMI, BAI, WC, WHR], outline of hormonal involvement, Leptin: synthesis, secretion and its role in adipogenesis.

### Module II. Circulation

8 hrs.

Circulatory mechanisms and fluid compartments, movement of body fluids by somatic muscles, [*Self study*-open system, closed system, lymph channels]

Circulatory shock, Circulatory arrest.

[*Self study*-Types of hearts- chambered heart, tubular heart, ampullar heart, lymph heart, neurogenic and myogenic heart.] Pace makers and specialized conducting fibers. Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat, effects of exercise on cardiovascular physiology. ECG - its principle and significance. Blood buffers, Human congenital heart diseases.

### Module III. Respiration

Respiration in vertebrates.

Pulmonary ventilation, respiratory muscles, surfactants. Respiratory centers and periodic breathing. Regulation of respiration. Respiration in unusual environment – foetal and neonatal respiration, high altitude, diving. [*Self study*-Structure and functioning of respiratory pigments] Metabolic rate : basal metabolic rate and its measurement]

### Module IV. Osmoregulation and Excretion

4hrs.

[*Self study*-Osmoregulation in fresh water, marine and terrestrial animals]

Excretion in vertebrates. Physiology and regulation of urine formation, Hormonal regulation of urine formation. Regulation of water balance, electrolyte balance and acid-base balance. Dialysis, artificial kidney, kidney transplantation.

### Module V. Nerve Physiology

10hrs.

Neuroanatomy of the central and peripheral nervous system. Electrical and chemical transmission. Synaptic transmission. Modifications of synaptic transmission during fatigue, acidosis, alkalosis, hypoxia and drugs. Mechanism of excitatory and inhibitory pathway. Neuromuscular Junction: organization and properties of neuromuscular junction, neuromodulators. Neural control of muscle tone and posture.

### Module VI. Sensory and Effector Physiology

10 hrs.

Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding. Chemical senses: taste, smell, mechanism of reception.

Mechanoreceptors: hair cell, organs of equilibrium, [*Self study*-vertebrate ear], mechanism of hearing, electro and thermoreceptors.

Vision: [*Self study*-Structure of invertebrate and vertebrate eye]. Physiology of vision.

Pain: pain receptors, headache and thermal senses, pain suppression (analgesia).

Tactile sensation: touch receptors, transmission of signals, special problems of premature infants, Physiological role of touch and environment in premature infants- Kangaroo care, infant massage, supportive environment.

**Module VII. Muscle Physiology**

**6 hrs.**

Comparative physiology of skeletal, smooth and cardiac muscles. Skeletal muscle- ultra structure and molecular organization. Red and white muscles, muscle proteins. Mechanism of muscle contraction and relaxation. Energetics of muscle contraction. Catch muscle and fibrillar muscle.

**Module VIII. Thermoregulation**

**4 hrs**

Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Impact of temperature on the rate of biological functions. Arrhenius equilibrium, Q 10.

Temperature compensation and temperature regulation in poikilotherms and homiotherms. Adaptations

for extreme environments, aestivation and hibernation.

**Module IX. Endocrinology**

**12 hrs.**

[*Self study*-Invertebrate and vertebrate endocrine system. Endocrine glands]

Synthesis, physiologic role, control and mechanisms of hormone action.

Neuro-endocrine regulation of hormone action. Endocrine disruptors-phytoestrogens, food additives, xenobiotics.

**Module X. Reproductive physiology**

**6 hrs**

[*Self study*-Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control]. Physiology of implantation, pregnancy, parturition, and lactation.

Impact of senescence and age on reproduction.

**REFERENCES**

Bentley, P.J. 1998. *Comparative Vertebrate Endocrinology* (3<sup>rd</sup> edn). Cambridge University Press

Bray, J.J., Cragg, P. A, Macknight, A.D, Mills, R.S and Taylor, D.W 1986. *Lecture Notes on human Physiology*. ELBS, New Delhi.

Brijlal Gupta and J.A. Ramsay, 1977. *Transport of Ions and Water in Animals*. Academic Press, New York.

Chatterjee, C.C. 1997. *Human Physiology*. Medical allied agency, Calcutta.

Ganong, W.F 1987. *Review of Medical physiology*. Appleton and Lang, Norwalk.

Guyton, A.C. 1996. *Text Book of Medical physiology*. Prism Books Pvt.Ltd.Bangalore

Hill, W.R., Wyse, G.A and Anderson, M. 2007. *Animal Physiology* (2<sup>nd</sup> edn). Sinauer Associates

Inc. Publishers, MA, USA.

- Hoar, W.S. 1983. *General and Comparative Physiology*. Prentice Hall of India, New Delhi.
- Hochachka, P.W. and Somero, G.N. 1984. *Biochemical Adaptation*. Princeton University Press, New Jersey.
- Hochachka, P.W. and Somero, G.N. 2002. *Biochemical Adaptation: Mechanism and Process in Physiological Evolution*. Oxford University Press, New York.
- Ian Kay. 1998. *Introduction to Animal Physiology*. Bios Scientific Publishers Ltd., Oxford, UK
- Keele, C.A., Neil, E. and Joels, N. 1982. *Samson Wright's Applied Physiology*. Oxford University Press
- Knut Schmidt-Neilsen. 1997. *Animal physiology: Adaptations and Environment* Cambridge University Press
- Larsson, P.R. et al., 2002. *William's Text Book of Endocrinology* (10<sup>th</sup> edn). W.B. Saunders, Philadelphia
- Moyers, D.C and Schulte, P.M. 2007. *Principles of Animal Physiology* (2<sup>nd</sup> edn). Benjamin Cummings, CA, USA
- Prosser, C.L and Brown, F.A. 1973. *Comparative Animal Physiology*. W.B Saunders Company, Philadelphia
- Randall, D., Burgren, W. and French, K. 1997. *Eckert Animal physiology*. W.H. Freeman & Co, New York.
- Squires, E.J. 2003 *Applied Animal Endocrinology*, CABI Publications, UK.
- Susil.K.Khetan. 2014. *Endocrine disruptors in the environment*. Wiley Publications. New York.
- Timothy J. Bradley. 2009. *Animal Osmoregulation*. OABS, Oxford University Press, UK.
- Wilmer, P., G. Stone and I. Johnston. 1997. *Environmental Physiology of Animals* (2<sup>nd</sup> edn). Blackwell Publishers, NY, USA.

**PG20ZY312 MICROBIOLOGY AND IMMUNOLOGY**

**Total: 54 Hours. (18+36) Credit- 3**

**Objectives:**

- To provide an over view of the microbial world, its structure and function
- To familiarize the learner with the applied aspects of microbiology
- To provide an intensive and in-depth knowledge to the students in immunology
- To help the learner to understand the role of immunology in human health and well-being
- To familiarize the students the new developments in immunology

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Define the morphological structure & functional features of microbial world	U	P	4
CO2	Identify causative agents of diseases in human and other organisms	R	C	5
CO3	Use immunological guidelines in the treatment of diseases	AN	F	2,3
CO4	Apply technologies in the identification of malignant disease	AP	MC	1
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**MICROBIOLOGY**

**18hrs.**

**Module I. Introduction to Microbiology**

**3 hrs.**

[*Self study*-Main group of microorganisms, general characters]

Classification, approaches to microbial classification, outline classification, Bergey’s manual. Normal microbial population in human body.

**Module. Methods of Microbiology**

[ *Self study*-Sterilization, staining of microorganisms- simple, negative, differential, microchemical, cytological. Observation of microorganisms, measurement of microbial size and numbers, sample collection. Precautions and safety measures]

**Module II. Functional Anatomy of Prokaryotic Cells**

**8hrs.**

Cell structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions.The prokaryotic cell envelope, peptidoglycan structure, gram positive and negative cell walls. Components outside the cell wall: capsules, slime layers and s-

layers, pili and fimbriae, flagella and motility. The endomembrane system, mitochondria and chloroplasts, cell wall and pellicle in protists.

[Self study-Morphology, size, shape and cell arrangement, useful and harmful bacteria].

### Module III. Virology and Mycology

7 hrs.

Properties of viruses, structure and chemical composition, genetic composition eclipse, host interaction and specificity. Classification, RNA virus , DNA virus, plant virus, animal virus ,bacteriophage, lysis and lysogeny, Viral replication. Virioids and prions. Nature and significance. Pathogenic virus, oncovirus.

Characteristics of fungi, classification, fungal intoxicants, fungal diseases of skin and r

## IMMUNOLOGY

36hrs.

### Module I. Overview of the Immune System

2 hrs.

Types of Immunity- Innate and acquired, Passive and active. Humoral and cell-mediated immune responses. Haematopoiesis. B-cell and T-cell maturation and differentiation.

[Self study- Cells, tissues and organs involved in immune system.]

### Module II. Antigens and Antibodies

5 hrs.

Antigen processing and presentation. Monoclonal antibodies and abzymes. Genetic model compatible with Ig structure. Multi- gene organization of Ig genes. Variable region gene arrangements. Generation of antibody diversity. Expression of Ig genes and regulation of Ig genes transcription.

[Self study- Antigen-structure and properties, Haptens, Adjuvants, Epitopes, Immunoglobulins-structure, classes and functions].

### Module III. Antigen –Antibody Interactions

5 hrs.

Antigen- Antibody reactions. Biological consequences of antigen-antibody reaction, Serological reactions, RAST.

[Self study-Types of antigen-antibody reactions - Cross-reaction, Precipitation, Agglutination].

### Module IV. The Complement System

3 hrs.

Terminal sequence of complement activation (MAC). Classical, Alternate and Lectin Pathways. Complement activation, Regulation of complement system. Biological consequences of complement activation. Complement deficiencies.

### Module V. Hypersensitivity and Immune Effector Mechanisms

5 hrs.

Types of Hypersensitivity, Inflammatory Cells. Types of Inflammation- acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines.



Therapeutic uses of cytokines.

### **Module.VI. Major Histocompatibility Complex**

**6 hrs.**

General organization and inheritance of MHC. MHC molecules and genes. Genomic map of H-2 Complex in the mouse. HLA Complex in humans. MHC-peptide interaction. Expression of MHC molecules on different cell types. Biological significance of MHC. HLA typing

### **Module.VII. Immunity in Health and Disease**

**10 hrs.**

Immune response during bacterial (tuberculosis),Parasitic (Malaria) and viral (HIV) infections. Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD).Acquired Immunodeficiency Disease (AIDS). Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Delhi resistance.

Transplantation immunology. Immunologic basis of graft rejection. Clinical manifestation of graft rejection. General and specific immunosuppressive therapy. Clinical transplantation. Tumour immunology. Vaccines, Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, Synthetic peptide vaccines, Multivalent subunit vaccines

[**Self study**- Mechanism of microbial pathogenicity. Microbial diseases, Nosocomial infections.]

### **REFERENCES**

#### **Microbiology**

Arora,D.R. and Arora,B. 2008. *Text Book of Microbiology*. CBS Publishers and Distributers,

Delhi

Chakraborty, P. A.2009. *Text Book of Microbiology*. New Central Book Agency.New Delhi

Harma and Kanika.2009.*Manual of Microbiology Tools and Techniques*. Ane Books Pvt. Ltd.

New Delhi

Ingraham, J. L. and Ingraham, C. A. 2000. *Microbiology* (2<sup>nd</sup>edn). Brooks/Cole-Thomson Learning,MA,USA.

Jeffery. C. Pommerville. Alcamo's Fundamentals of Microbiology. Jones and Bartlett publishers. USA.

Laning, M Prescott. John,P. Harley and Donald A Klein. 2008. *Microbiology* (7<sup>th</sup>edn). McGraw

Hill International,NJ, USA

Talaro, Park.,Kathelee, N and Talaro,Arthur. 2002. *Foundations of Microbiology*.McGraw Hill

Higher Education,NY

Wheelis, Mark. 2010. *Principles of Modern Microbiology*. Jones and Bartlett Publishers,NY,USA.

## **Immunology**

Abbas, A.K., Lichtman,A.K and Pober , J.S. 1997. *Cellular and Molecular Immunology*. W.B. Saunders Co. New York

Ashim K. Chakravarthy. 1998. *Immunology*. Tata McGraw-Hill, New Delhi.

Chakraborty, A.K. 2006. *Immunology and Immunotechnology*. Oxford University Press,New Delhi

Darla,J, Wise & Gordeon,R.Carter. 2004. *Immunology- A Comprehensive Review*. Iowa State University Press. A Blackwell Science Co,USA

David Male,Jonathan Brostoff, David Roth and Ivan Roitt. 2006. *Immunology*. Mosby, Edinburgh,UK

Goldsby, R.A.,Kindt, T.J. and Osborne, B.A.2000. *Immunology* (4<sup>th</sup> edn.). W.H. Freeman and Co. NY,USA.

Hannigan, B. M., Moore, C. B. T. and Quinn, D. G. 2010. *Immunology*. Viva Books, New Delhi.

Helen Chappel and Mased Harney, 2006. *Essentials of Clinical Immunology* (5<sup>th</sup> edn.)

Blackwell Scientific Publications

Ivan M. Roitt, 2002. *Essential of Immunology*. ELBS, New Delhi.

Khan. F.H. 2009. *The Elements of Immunology*. Pearson Education.New Delhi.

Kuby J, 2000. *Immunology* (7<sup>th</sup> edn.). WH Freeman & Co. New York.

Richard Coico and Geoffrey Sunshine. 2009. *Immunology: A short course*. Wiley-Blackwell,CA,USA

**PG20ZYP3PRACTICALS OF DEVELOPMENTAL , PHYSIOLOGICAL, MICROBIAL, IMMUNOLOGICAL AND BIOTECHNOLOGICAL METHODS**

**180 Hours (8hrs./week)**

**Credit-4**

**Developmental Biology**

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Describe the morphological and histological studies of mammalian placenta & embryo	U	C	1
CO2	Identify different developmental stages in frog and chick	R	F	4,5
CO3	Examine the various constituents in human blood	AP	P	3,5
CO4	Describe the various aspects in preparation of culture media, culturing & identification of microorganisms	AN	C	2,1
CO5	Identify & illustrate various bioinformatics tools for data retrieval	C	MC	3
CO6	Demonstrate & practice various immunological techniques	E	C	1,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

1. Identification of different developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill).
2. Vital staining of early gastrula of chick – window method.
3. Blastoderm mounting of chick embryo using vital stains.
4. Morphological and histological studies of different types of placenta in mammals.
5. Study of serial sections of embryo (tadpole and chick).

**Animal Physiology**

1. Effect of drugs on the heartbeat of human being (using PhysioEX 9.0)
2. Oxygen consumption in fish (normal and stressed). Graphical representation and interpretation.
3. Kymograph: working principle and applications.
4. Virtual Practicals in Physiology

(Use of PhysioEX 9.0 : *Laboratory Simulations in Physiology* by P.Zao.,T.Stabler., L.A.Smith and E.Griff. 2011.is suggested) for muscle and nerve physiology practical for class room training and for practical examination in order to replace Frog as per UGC guidelines).

Any four of the following:

- (1) Muscle Twitch and the Latent Period
- (2) The effect of stimulus Voltage on Skeletal Muscle Contraction
- (3) Tetanus
- (4) Fatigue
- (5) Receptor Potential
- (6) The Action Potential Threshold
- (7) Importance of Voltage –Gated Na<sup>+</sup> Channels

5. Differential count of Human WBC

6. Haematocrit and ESR of Human blood

7. Feeding activity of paramecium

8. Effect of different concentration of NaCl solution (0.1%-2%) on the diameter of RBCs (preferably human) and determination of the concentration, which is isotonic to the blood from a plot of diameter of RBC against concentration of NaCl

### **Biotechnology**

1. Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei.

2. Isolation of genomic DNA

3. Isolation of plasmid DNA

### **Bioinformatics**

1. Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, ExPasy.

2. Methods of sequence alignment-BLAST and Clustal omega.

3. Phylogenetic tree using Clustal omega

4. Gene Prediction using GENSCAN/GRAI.

5. Protein structure visualization using RASMOL

### **Microbiology**

1. Sterilization, disinfection and safety in microbiological laboratory.

2. Preparation of culture media

(a) liquid media – nutrient broth, peptone water

(b) Solid media – Nutrient Agar, MacConkey' Agar..

3. Culturing of microorganisms

(a) broth culture

- (b) pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture
- (c) serial dilution and standard plate count, calculation of Cfu/ml in water samples
- 4. Identification of microorganisms-
  - (a) Staining techniques- gram staining of mixed cultures, negative staining and spore staining. Antibiotic sensitivity (different natural fluids )
  - (a) Oxidase test
  - (b) Catalase test
  - (c) Oxidation/fermentation (O/F) test
- 5. Staining and enumeration of microorganisms: using haemocytometer
- 6. Environmental sample analysis
  - a) MPN and Coliform count in water
  - b) Isolation and enumeration of soil bacteria
  - c) Identification of symbiotic bacterioids from root nodules of leguminous plants
  - d) Bacteriological analysis of milk- methylene blue reductase test.

### **Immunology**

1. Separation of lymphocytes from whole blood.
2. Blood Typing in Man.
3. WIDAL Test. Western Blotting –Demonstration
4. Rocket Immuno electrophoresis- Demonstration

**Note:** Virtual Practical developed by the Ministry of Human Resources, Govt. of India and available in the web

site: [www.vlab.ac.in](http://www.vlab.ac.in) can be availed for demonstration

# FOURTH SEMESTER

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## **ELECTIVE COURSE: ENVIRONMENTAL SCIENCE**

PG20ZY413	CONCEPTS OF ENVIRONMENTAL SCIENCE, BIODIVERSITY CONSERVATION BIOLOGY AND MICROBIAL ECOLOGY
PG20ZY414	ENVIRONMENTAL POLLUTION AND TOXICOLOGY
PG20ZY415	ENVIRONMENTAL MANAGEMENT AND CLIMATOLOGY
PG20ZYP4	PRACTICALS OF ENVIRONMENTAL SCIENCE

**PG20ZY413 CONCEPTS OF ENVIRONMENTAL SCIENCE,  
BIODIVERSITY CONSERVATION AND MICROBIAL ECOLOGY**

**90 Hrs. (5hrs./week)**

**Credit- 4**

**Objectives:**

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of microbial environment
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Define & describe the concept of environment and biodiversity conservation.	R	C	1,2
CO2	Enable the learner to describe & distinguish the threats of biodiversity & strategies for biodiversity conservation	E	F	3,5
CO3	Enable the learner to practice & apply various conservation methods for sustainable development.	E	P	4
CO4	Able to question & criticize the threats of biodiversity	AP	P	2,4
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

**Module I. Introduction to Environmental Science**

**4 hrs**

Definition, Principle and Scope of environmental science- its relation to other sciences. Ecosystems of the world- terrestrial ecosystems, aquatic ecosystems. Floristic and zoogeographical realms.

**Module II. Models and Principles in ecology**

**7hrs**

Fundamental concepts, structure of natural systems, natural succession, self sustaining systems in ecosystem, factors contributing to homeostasis, resilience.

[Self study- Basic concept of ecosystem, abiotic and biotic factors]

**Module III. Biodiversity 8 hrs**

Biodiversity-concepts and patterns. Distribution of biodiversity. Biodiversity hotspots and their characteristics, global distribution.

Types of biodiversity-wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services.

**Module IV. Threats to Biodiversity 5hrs**

Causes of biodiversity loss. Tools and techniques for biodiversity estimation-biodiversity indices, relative abundance, Species diversity and genetic diversity.

**Module IV. Strategies for biodiversity conservation 10 hrs**

*In-situ* conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. *Ex-situ* conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; *In-vitro* Conservation: germplasm and gene bank; tissue culture: pollen and spore bank, DNA bank. H.I.P.P.O, GEF-World Bank initiatives.

CBD, IPRs, National and international programmes for biodiversity conservation. CITES and TRAFFIC. Indian Biodiversity Act 2002 and laws, National Board of Biodiversity, State Board of Biodiversity. Ecosystem people and traditional conservation strategies; People's participation in conservation-PFM, community reserve and People's Biodiversity Register (PBR). Biodiversity Management Committee (BMC). Wildlife values and eco-tourism, wildlife distribution in India, problems in wildlife protection-Policies and programmes. Threatened animals of India.

**Module V. Biological Invasions 12 hrs**

Introduction Elton's hypothesis – Invasion patterns and process biological attributes for invasion: Reproductive potential, Allelopathy Phenotypic plasticity, fitness to the new environment. Hypotheses for invasion success: Natural enemy hypothesis evolution of invasiveness hypothesis, empty niche hypothesis, novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals). Databases of biological invasions. Impacts and management of invasions: impacts of exotics on biodiversity, productivity, nutrient cycling.

Management: Bio-control programmes, mechanical and chemical control Positive utilization Quarantine and EIA of biological invasion.

**Module VI. Microbial Ecology 6hrs.**

Bacteria of air, water and soil. Microbes in extreme environments-extremophiles; acidophile, alkaliphile, endolith, halophile, piezophile, psychrophile, thermophile, xerophile. Environmental significance of microbes

[**Self study-** Symbiosis, commensalism. Mutualism, Cooperation, competition, predation, antagonism. Parasitism ]



**Module VII. Role of microbes in biosphere** **8hrs**

Biogeochemical cycles and microorganisms-Nitrogen cycle, carbon cycle, sulphur cycle and phosphorus cycle. Microorganisms and organic matter decomposition-humus, mineralization, degradation of cellulose, lignin, starch. Syntrophism in soil

**Module VIII. Microbes and mankind** **15hrs**

Role of microbes in soil formation and soil fertility, agricultural microbiology-microbes and crop production, microbial pesticides, biofertilizers, agricultural pathogens.

Food microbiology-fermentative role, SCP, microbes in dairy products, food spoilage

Aquatic microbiology-microbes in sea, domestic water, microbes in sewage and waste water treatment.

Industrial microbiology-bioactive products, enzymes, organic acids, biofuel, aroma compounds antibiotics, industrial waste water treatment.

**Module IX. Conservation and Sustainable Development** **15 hrs**

Anthropocene - agricultural society, industrial society, industrial revolution and resource utilization, environmental consequences. Modern agriculture and green Revolution-environmental impacts. Tragedy of the commons. Basic needs-Imperatives relating to sustainable development. Johannesburg Conference 2002 and follow up Conference on sustainable development. The earth charter; Securing Sustainable futures, Millennium Development Goals and Strategies (MDG), Sustainable Development Goals (SDGs-2030); need and scope for evolving participatory, community based environmental management strategies. Education for sustainability. Building sustainable societies and lifestyles. Ecological Foot Print analysis and its significance. Environmental concerns in traditional societies, Gandhian environmentalism.

**REFERENCES**

Alongi, D. M. 1998. *Coastal Ecosystem Processes*. CRC Press, New York.

Chapman, G.P. 1977. *Human and Environmental Systems: A Geographer's Appraisal*. Academic Press, London.

Chapman, J.L. and Reiss, M.J. 2005. *Ecology: Principles and Applications*. Cambridge University Press, London.

Cunningham, P. William and Cunningham. A.M. 2011. *Principles of Environmental Science- Inquiry and Applications*. 4<sup>th</sup> Edition. Tata Mc Graw Hill Education Pvt.Ltd, NewDelhi

- Daniel. D.Chiras. 2012.*Environmental Science*.9<sup>th</sup> edition. Jones and Bartett India.Pvt.Ltd. New Delhi
- Elton, C.S. 1958. *The Ecology of Invasion by Plants and Animals*. Methuem, London.
- Forman, R.T. 1995. *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge Univ. Press, Cambridge, UK
- Forman, R.T.T. and Godron, M. 1986. *Landscape Ecology*. John Wiley & Sons, New York.
- Fox, C.W., Roff, D.A. and Fairbairn, D.J. 2001. (Eds.). *Evolutionary Ecology: Concepts and Studies*. Oxford University Press.
- Kamaljith S Bawa, Richard B Primack and Meera Anna Oomen. 2011. *Conservation biology- A Primer for South Asia* Universities Press Pvt.Ltd. Hyderabad. India
- Krebs, C.J. 2008. *Ecology: The Experimental Analysis of Distribution and Abundance*. (6<sup>th</sup> edn.). Benjamin Cummings Publ., USA.
- Krishnamurthy, K.V. 2004. *An Advanced Textbook on Biodiversity: Principles and practice*. Oxford and IBH. Publ. Co. New Delhi.
- Kurian Joseph and Nagendran, R. 2004. *Essentials of Environmental Studies*. Pearson Education( Singapore) Pvt.Ltd. New Delhi.
- Levin, S. A. 2000. (Ed.). *Encyclopedia of Biodiversity*. Academic Press.
- Mayhew, P.J. 2006. *Discovering Evolutionary Ecology: Bringing Together Ecology and Evolution*. Oxford University Press.
- Miller, G.T. 2004. *Environmental Science*. Thomson, California.
- Odum, E.P. and Barrett, G. W. 2005. *Fundamentals of Ecology*. Thomson Asia Pvt. Ltd., Singapore
- Primack, R.B. 1998. *Essentials of Conservation Biology*. Sinauer Associates.
- Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press, UK.
- Ray,JG. 2010. *Basic Principles of Ecology and Environment*. Pratibha Publications, Changanacherry, Kerala.

- Ramakrishnan, P.S. 1991. *Ecology of Biological Invasion in the Tropics*. International Scientific Publications, New Delhi.
- Ramakrishnan, P.S. 1992. *Shifting Agriculture and Sustainable Development*. UNESCO, MAB, Paris.
- Rana, S.V.S. 2005. *Essentials of Ecology and Environmental Science*. Prentice Hall of India, New Delhi
- Rose, M.R. and Mueller, L.D. 2006. *Evolution and Ecology of the Organisms*. Pearson Prentice Hall. New Jersey. USA.
- Singh, J.S., Singh, S.P. and Gupta, S. R. 2006. *Ecology, Environment, and Resource Conservation*. Anamaya Publ., New Delhi.
- Smith, T.M. and Smith, R.L. 2006. *Elements of Ecology*. (6<sup>th</sup> edn.). Pearson. New Delhi
- Soule, M.E. 1986. (Ed.). *Conservation Biology*. Sinauer Associates, New York.
- Steiner, F. 1999. *The Living Landscape: An Ecological Approach to Landscape Planning*. (2<sup>nd</sup> edn.). McGraw Hill, Inc., New York.
- Steiner, F. 1999. *The Living Landscape: An Ecological Approach to Landscape Planning*, 2nd Edition. McGraw Hill, Inc., New York.
- Venugopal Rao. 2010. *Environmental Science and engineering*. PHI Learning Pvt.Ltd. New Delhi
- Williamson, M. 1996. *Biological Invasion*. Chapman & Hall, London.

## PG20ZY414 ENVIRONMENTAL POLLUTION AND TOXICOLOGY

90 Hrs (5hrs/week)

Credit – 4

### Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of pollution
- To take up further studies and research in the field

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Able to define, and memorize different types of pollution & sources of pollution.	R	C	1
CO2	Explain the impacts of different pollution on human health & environment.	U	F	3,4
CO3	Apply different measures to control pollution in their daily life	AP	P	5
CO4	Enable the student to examine different methods for treatment of water & air for quality.	E	MC	2
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### Module I. Introduction

5 hrs.

Brief history of human civilization, industrialization and urbanization. Definition of pollution. Different types of pollution- Air, Water and soil and their local, regional and global aspects.

### Module II. Air Pollution

14 hrs.

Sources and classification of air pollution ; particulates and gaseous pollutants in the atmosphere. Primary and secondary pollutants. Effects of air pollutants on human health, animals, vegetation, materials and structures.

Air pollution monitoring - methods, air quality standards; ISI, EPA.

Sampling and measurement of particulate matters (SPM) - gaseous pollutants, CO<sub>2</sub>, CO, NO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S, oxidants, ozone and hydrogen fluoride.

Control of gaseous emission: adsorption by liquids, adsorption by solids, combustion and condensation. Control of SO<sub>2</sub>, NO<sub>x</sub>, CO, CO<sub>2</sub> and hydrocarbons. Sick building syndrome.

[Self study- GHGs, climate change, carbon foot print and carbon trade]

### **Module III. Water Pollution**

**20 hrs.**

Sources of water pollution-Domestic (municipal sewage), industrial and agricultural. Health effects of water pollution. Water borne and water related diseases. Effects of water pollution on aquatic system. Water quality standard for potability - Pollution parameters, BOD, COD, Coliform bacteria.

Treatment of water for potable purpose (mixing, sedimentation, coagulation, filtration and disinfection) Primary and secondary treatment. Sludge disposal. Biological treatment: Kinetics of Biological growth - activated sludge treatment - trickling filters - anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process.

Advanced waste water treatment - removal of dissolved organics and inorganic - precipitation, iron exchange, reverse osmosis, electro dialysis, adsorption and oxidation.

Removal of nutrients. Removal of heavy metals - overall waste water treatment for sewage water. Water pollution treatment using constructed wetlands Bioremediation; traditional water purification techniques.

### **Module IV. Soil Pollution**

**13 hrs.**

Sources of soil pollution; - agricultural, industrial and domestic. Hazardous waste compounds, formulations and classes of substances, chemical classification of hazardous waste.

Soil factors affected by pollution – physico-chemical and biological impacts. Case studies on soil pollution in wetland and Highland soils in Kerala. Control of soil pollution. Soil quality parameters and test method.

### **Module V. Noise, Thermal and Oil Pollution**

**7hrs.**

Properties of sound and noise. Effects of noise on People and ecosystem. Basic principles of noise control. National and International Standards. Assessment and measurement of sound.

Thermal Pollution-causes and consequences

Oil pollution – causes and consequences (any two case studies).

### **Module VI. Radiation Pollution**

**8 hrs.**

Radiation pollution- Definition, Radioactivity, Radionuclide, Radiation emissions, sources, Radioactive decay and buildup. Biological effects of radiation. Radioactive pollution impacts on ecosystem. Nuclear reactor disasters (Any two case studies), safety standards.

### **Module VII. Light Pollution(Photo Pollution)**

**3 hrs**

Urban sky glow, Light Trespass, Glare, Clutter, Effects of light Pollution

### **Module VII. Toxicology**

**20 hrs.**

Definition, scope and history of toxicology, Acute and chronic toxicity, selective toxicity, dose, synergism and antagonism.

Dose – Response relationships – Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC<sub>50</sub>; Margin of safety; Toxicity curves; Cumulative toxicity and LD<sub>50</sub> and CTF. Toxic chemicals in the Environment – Biochemical aspects of As, Cd, Pb, Hg, Cu, O<sub>3</sub>, PAN, pesticides, MIC and other carcinogens. Bio accumulation and biomagnification.

Occupational toxicology- hazardous chemicals, disorders from chemical exposure at work, assessment of occupational hazards.

Toxicity testing; Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC<sub>50</sub>, Limitation and importance of bioassay, acute toxicity (single); sub acute toxicity; chronic toxicity; teratogenicity, carcinogenicity and mutagenicity.

Bio-monitoring of toxic chemicals - objectives, programs and parameters, concepts of bio indicators. Bio-transformation of Xenobiotics (Selective Toxicity).

## REFERENCES

APHA-AWWA-WPCF, 1989. *Standard Methods for the Examination of water and Waste water*. (17<sup>th</sup> edn.). Publishers.

Butter, G.C.1988. *Principles of Ecotoxicology*. John Wiley and Sons.

Cockerham, G.L. and Shane, B.S. 1994. (Eds.). *Basic Environmental Toxicology*. CRC Press.

Eisenbude, M. 1998. *Environmental Radioactivity*. Academic Press , NY.

Fellenberg, G.1999.*Chemistry of Pollution*. John Wiley and Sons, New Delhi

Hayes,W.A.2001. *Principles and Methods of Toxicology*.CRC Press,NY.

James, P. Lodge, J.R, Year. *Methods of Air sampling and Analysis* (3rd Edn.). ISc Lewis Pub., INC.

Klaassen,C.D and J.B.Walkins. 2003. *Essentials of Toxicology*. Mc Graw –Hill Professional New

Delhi Lutgens, F.K. and Tarbuek, J.E.1992.*The Atmosphere*. Prentice Hall, New Jersey.

Niesink, R.J.M., De Vries, J. and Hollinger, M.A. 1996. (Eds.).*Toxicology- Priniples and Applications*. CRC Press.

Oehme, W.F. 1989. *Toxicity of Heavy Metals in Environment*. Marcel Dakkar Inc., New York.

Purnima,B.b., A.K.Janin and Arun.K.Jain.2011.*Waste Water Engineering Including Air Pollution*. Laxmi Publications (P) Ltd. New Delhi

Samuel, G.1990. *Nuclear Engineering*. Academic Press, N.Y.

Wilber, C.G.1989. *Biological aspects of Water Pollution*. Charles C. Thomas Publishers, Illinois, USA.

## PG20ZY415 ENVIRONMENTAL MANAGEMENT AND CLIMATOLOGY

90Hrs ( 5hrs/week)

Credit – 4

### Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment and climate
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Describe the basic principles of management of physical, social & economic environment	R	F	2
CO2	Discuss the impact of climate change on environment	U	C	1
CO3	Practice different management strategies for forest, grassland, wetland, reclaimed land etc....	AN	P	3,4
CO4	Apply different environment programes for the conservation of environment	AP	MC	5
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

### Module 1. The Physical Environment

15 hrs

Lithosphere - Weathering and soil formation, - soil colloids, adsorption and exchange of anions and cations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faults and dykes and other geological formations and their environmental significance. Geomorphological processes-plate tectonics, sea floor spreading, mountain building, evolution of continents and structural deformation.

Atmosphere -Physico-chemical characteristics, divisions, composition and significance of atmospheric components.

Hydrosphere -Visible and invisible hydrosphere, Range of aquatic habitats, water cycles between earth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sea level changes, River basins and watershed. Physico-chemical characteristics of water- diffusion of oxygen from the atmosphere to surface waters. Influence of pH, turbidity and light on aquatic life.

[Self study- Physical and chemical properties of soil, Biomes and distribution of life on earth].

## **Module II. Environmental Management**

**20 hrs.**

Basic principles: Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Intergated landscape management. Cost-benefit analysis and Resource economics. Environmental modeling- simulation modeling, input-output modeling, Linear programming, Software and resource management.

Tool box for environmental management – An over view of Ecological foot prints,SEA, Ecological Economics, conflict resolution strategies. Eco funds.

Environmental auditing and standards Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) ISO 14000, 14001 and 26001; OHSAS 18001.

## **Module III. Ecosystem Management**

**18 hrs.**

An overview Population, Resources and ecosystem management Exponential growth in human numbers and the implications.

Major management concepts and methodologies The five basic laws of Ecology and their relevance for ecosystems management; paradigm shifts in the management of Ecosystems- influence of economics in ecology.

Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas. Environmental planning and management of – waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands.

Eco restoration/remediation; local knowledge and management systems.

## **Module VII. Solid Waste Management**

**12 hrs.**

Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems- composting, vermicomposting; Biodigesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary land fills and open dumping yards. Management of plastic and e-waste. Better management strategies (any two model case studies). Treatment process for unsegregated waste, fixation of hazardous solid waste prior to disposal, hazardous waste in land fill.

Hazardous waste (Management and Handling) Rules 1989 - the Manufacture Storage and Import of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 - Plastic Act 1999. Extended producer responsibility. Recent amendments

## **Module IV. Environmental Impact Assessment (EIA)**

**10 hrs**

Introduction- Definition, history, Aim, principles, concept and scope. Baseline data collection, Methods and steps - Adhoc method, checklist method, matrices, Map overlays method, network method, index method.



Impact assessment and impact evaluation-EIA Processes, Stages, EIA Statement Environment management plan- Risk assessment and disaster management programme. Life Cycle Assessment (LCA) and its significance.

**Module V. Weather and Climate**

**6 hrs**

Definitions and scope of climatology, weather and climate, components of climate system, earth's thermal environment, earth intercepts solar radiation, seasonal variation in intercepted solar radiation, air temperature in relation to altitude, global circulation of air masses, wind and earth's rotation on ocean currents, climatic types and zones.

Global climatic phenomena-*El Nino* and *La Nina*, causes and factors of climate change. Effect of climate change on ecosystems. Organisms and microclimate.

**Module VI. Climate of India**

**4 hrs**

Climatic regions of India, tropical monsoon climate-onset, rain bearing systems, break in the monsoon, retreat of monsoon. Monsoon in Kerala, oceanic and continental influence.

**Module VII. Impact of Climatic Change on Environment**

**5 hrs**

Global climatic change, - floods, tsunami, drought, avalanche, earthquakes, lightening. Effects of global warming on – environment, land use pattern, ocean, biodiversity, agriculture, human health. Natural disaster management. Measures to reduce climatic change- Aforestation, restoration of traditional agricultural practices, sequestering CO<sub>2</sub>, IPCC, UNFCCC.

**REFERENCES**

Agarwal, N.K. 2004. *Essentials of GPS*. Spatial Networks Pvt. Ltd., Hyderabad.

Agarwal, S.K. 2002. *Eco informatics*. APH Publishing Corporation, Hyderabad.

Asit K. Biswas *et.al.*, 1987. *EIA for Developing Countries*. United Nations University,

Tokyo. Carter,L.1996. *Environmental Impact Assessment*. McGraw Hill,New Delhi

Coronel, C., Morris, S. and Rob, P. 2009. *Database Systems: Design, Implementation and Management*.9th edn., Course Technology.

Eagles, P.F.J.1987. *The planning and Management of Environmentally Sensitive areas*.

Longman Group Ltd., USA.

Elachi, C. 1978. *Introduction to Physics and Techniques of Remote sensing*. John Wiley Pub., N.Y.

Ewing B., D. Moore, S. Goldfinger, A. Oursler, A. Reed, and M. Wackernagel. 2010.

Floyd F., and Sabins Jr.,W.H. 1987. *Remote Sensing, Principles and Interpretation*. Freeman & Company, New York, 2nd Ed., 1987.

Gadgil, M. and Guha, R. 1995. *Ecology and Equity- The Use and Abuse of Nature in Scheme and Syllabus of M.Sc Zoology – MAC-PG-CSS 2020*

*Contemporary India*, Penguin India.

Gadgil, M. and Guha, R. 1998. *The Fissured Land; An Ecological History of India*; Oxford University Press, New Delhi.

Goldsmith, B. 1992. (Ed.) *Monitoring for Conservation and Ecology*. Chapman and Hall, London.

Jorgensen, S.E. 1996. *Applications of ecological modeling in environmental management*. Elsevier Sci. Co., London.

Jorgensen, S. E., Chon, T S. and Recknagel, F. A., 2009. *Handbook of Ecological Model inand Informatics*. WIT Press

Kang-tsung, C. 2000. *Introduction to GIS*. Tata Mc Graw Hill, New Delhi.

Knight, R L and White, L. 2009. *Conservation for a New Generation Redefinig Natural ResourcesManagement*. Island Press, USA

Kurian Joseph and Nagendran, R. 2004. *Essentials of Environmental Studies*. Pearson Education (Singapore) Pvt.Ltd. New Delhi.

Lawrence, D.P. 2003. *Environmental Impact Assessment: Practical Solutions to Recurrent Problems*. John Wiley and Sons, New Delhi.

Lillesand, T.M.and Kiefer, R.F. 1994. *Remote Sensing and Image interpretation*. John Wiley & Sons, New York.

Maguire, D., Batty, M., Goodchild, M., (Eds.) 2005. *GIS, Spatial Analysis, and Modeling*, Esri Press, USA

Meadows, D., Randers, J. and Meadows, D. 2004.*Limits to Growth: The 30 Year Update* London, Earthscan.

Meffe, G. K., L. ,Nielsen, R. ,Knightand Schenborn. 2002. *Ecosystem Management: Adaptive, CommunityBased Conservation*.Plenum Press.

Miller. G.T., Jr. 2004. *Environmental Science*. Thomson, California.

Milner Gulland,E.J. and J Marcus Rowcliffe, 2007. *Conservation and Sustainable Usea handbook of Techniques*. Oxford University Press

Muralikrishna, I.V. 2001. *Spatial Information Technology- RS and GIS*. Vol.I and II BS

Peter Calow. 1998. (Ed.) *Handbook of Environmental Impact Assessment*. Mc Graw Hills Inc.,

New Delhi.

Prabodh. K.Maiti and Paulami Maiti. 2011. *Biodiversity, Perception, Peril and Preservation*.

PHI Learning. Pvt.Ltd. New Delhi.

Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press, UK.

Rao,D.P (Ed).1998. *Remote Sensing for Earth Resources*. Association of Exploration

Geophysicist,Hyderabad

Simon Dresner 2008. *The Principles of Sustainability Solutions*. Earthscan paperbacks, *The Ecological Footprint Atlas 2010*. Oakland: Global Footprint Network.

S.V.S. Rana. 2010. *Essentials of Ecology and Environmental Science*. 4<sup>th</sup> edition. PHI Learning. Pvt.Ltd. New Delhi.

Tyler Miller, G Jr, 2005. *Advantage Series: Sustaining the Earth An Integrated Approach*

(with CD ROM and Info Trac). 7th Edition., Thomson/Brooks Cole, USA

UN General Assembly.2010. *Keeping the promise: a forward-looking review to promote an agreed action agenda to achieve the Millennium Development Goals by 2015*. Report of the SecretaryGeneral.

Westman W.E 1995. *Ecology, Impact Assessment and Environmental Planning*. John Wiley and sons. NY,USA.

World Commission on Environment and Development.1987. '*Our Common Future*', New York:

Oxford University Press

### **Web Resources**

[www.moef.gov.in](http://www.moef.gov.in) (of Ministry of Environment and Forests, Govt. of India)

[www.millenniumassessment.org](http://www.millenniumassessment.org). (for Millennium Ecosystem Assessment Synthesis Reports)

[www.unep.org](http://www.unep.org)

**PG20ZYP4PRACTICAL OF ENVIRONMENTAL SCIENCE**

**180 Hours (10 hrs/week)**

**Credit –4**

COUSRE OUTCOME	Upon completion of this course, the students will be able to:	Cognitive Level	Knowledge Level	PSO No.
CO1	Recall & reproduce different soil parameters commonly used	R	C	1
CO2	Classify different soil samples according to their texture and pH	U	P	3,4
CO3	Illustrate different soil quality analysis test and find out the amount of different minerals present in soil samples	AP	F	5,2
CO4	Name and memorize the standards for drinking water	R	MC	4
CO5	Enable the learner to illustrate the presence of different toxic chemicals in water	E	C	2,1
CO6	Carry out water quality analysis tests and to interpret the data	C	P	3
Cognitive Level	R –Remember ,U-Understanding, AP-apply, AN-Analyze, E-Evaluative, C-Create			
Knowledge Level	F-Factual, C-Conceptual, P-Procedural, MC-Meta cognitive			

1. Soil texture using micrometry from two different sites.
2. Determination of moisture content.
3. Determination of Potassium and Sodium using Flame photometer
4. Determination of soil pH from at least three different locations and correlate it with the soil type.
5. Determination of Chloride, Calcium, Magnesium and Phosphorous.
6. Determination of Calcium Carbonate in Egg shell- (Three different types of egg; calculate the mean value and the standard deviation, and compare it with the standard values).
7. Identification of trophic levels from gut analysis (Fish)
8. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices (This can be done as part of the three / four day field study compulsory for this elective).
9. Water Quality Analysis:
  - a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Sulphate
  - b. Determination of total dissolved solids (TDS)

10. Toxicity Analysis of Water: For Chlorine, Ammonia, Copper and Chromium

11. Estimation of BOD and COD of polluted water

12. Isolation and Enumeration of microorganisms in soil (TBC or TMC).

13. Bacteriological quality testing of water and wastewater.

(a) Presumptive coliform test

(b) Confirmatory coliform test

14. Prepare a report on faunal diversity of a stipulated area during a month and submit

**Field Study Report:** (Three /four days-Mandatory)

Visit to Institutions engaged in environment /conservation research; a sanctuary/national park and an industrial /polluted area. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photographs of the activity. Group and individual assignments shall be preferred.

*(The activity suggested in Practical -It can be clubbed with this field study).*

**ELECTIVE COURSE: ENTOMOLOGY**

PG20ZY416 MORPHOLOGY AND TAXONOMY

PG20ZY417 ANATOMY AND PHYSIOLOGY

PG20ZY418 APPLIED ENTOMOLOGY

PRACTICALS OF MORPHOLOGY, ANATOMY & TAXONOMY.

INSECT PHYSIOLOGY & APPLIED ENTOMOLOGY.

## ELECTIVE ENTOMOLOGY

### Objectives:

- To introduce the insect diversity and its significance
- To study the economic and medical importance of insects
- To learn about the pests of crops and vectors of diseases and their control measures
- To provide skills for scientific study of insects
- To develop research aptitude among students by introducing frontier areas of entomology

### PG20ZY416 MORPHOLOGY AND TAXONOMY

**90 Hours (5 hrs/week)**

**Credit -4**

#### Module I. Introduction

**4 hrs**

Scope and importance of insects, Origin and evolution of insects (including theories), Fossil insects.

#### Module II. Insect Morphology

**26 hrs**

Segmentation and division of the body: General morphology of head (Opisthognathus, Prognathus, Hypognathus). Head segmentation; Head skeleton; Tentorium; Modifications in head capsule; Cephalic appendages; Antennae – Structure functions and types, Mouth parts – various modifications, feeding mechanisms.

General morphology of thorax (thoracic segmentation, thoracic skeleton and thoracic appendages); Wings- Structure, Venation, Wing articulation, Wing coupling apparatus, Wing modifications.

Legs-structure and adaptive radiation of legs, Locomotion; Morphology of abdomen and its appendages. External genitalia-structure and diversity of male and female genitalia. eg. Grasshopper, *Drosophila*, Cockroach, Dragonfly.

Sense Organs – Structure and classification of sense organs (Hair organs, Plate organs, Campaniform organs, Compound eyes and vision.); Light and Sound Producing Organs - Structure of light producing organs, Production of light, Stridulatory organs in various insects.

**Module III. Insect Classification**

**36 hrs**

Methods of Insect collection and preservation, Use of keys, kinds of keys, their merits and demerits. Classification of insects up to families; General characters, Biology and habits of different orders of insects (special emphasis on economically important insects). Vectors of human diseases (Diptera, Anoplura and Siphonoptera).

**Module IV. Social Organisation and Behaviour**

**16 hrs**

Social organisation and behaviour with reference to Termites, Ants and Honey Bees; Study of Gall forming insects (features, Gall formation, Types of Galls – open and Closed, Common Gall pests, adaptations for Gall making habits. Economic importance); Leaf mining insects – features forms of leaf mines, feeding habits. Ecological aspects of leaf mining; Communication – Acoustic, Visual, Tactile and chemical methods; Adaptations of parasitic and predatory insects; Study of aquatic insects (factors influencing the aquatic life, food capture – modifications, anchorage, locomotion, respiration, oviposition and adaptations of swimming forms.

**Module V. Insect Development**

**8 hrs**

Egg, structure and adaptations; General pattern of embryonic development; Polyembryony; Parthenogenesis; Paedogenesis; Metamorphosis; Diapause.

**REFERENCE**

- Ananthakrishnan T.N. 1998. *Dimensions of Insect Plant Interactions*. Oxford and IBH Pub.Co. Pvt. Ltd. N. Delhi.
- Awasthy V.B. 1998. *Introduction to General and Applied Entomology*. ELBS, London
- Carde R.T. and W.J.Bell. 1995. *Chemical Ecology of Insects* (2<sup>nd</sup> edn). Chapman and Hall, NY.
- Chapman R.F. 1982. *The Insects Structure and Functions*. ELBS, London.
- Essig E.O. 1982. *College Entomology*. (Indian Reprint) Satish Book Enterprises Agra.
- Fenmore P.G. and A. Alkaprakash. 1992. *Applied Entomology*. Wiley Eastern Ltd. New Delhi.
- Mani M.S. 1974. *Modern Classification of Insects*. Satheesh Book Enterprise, Agra.
- Mani M.S. 1982. *A General Text Book of Entomology*. Oxford and IBH, New Delhi.
- Metcalf C.L. and Flint W.P. (revised by Metcalf R.L.) 1962. *Destructive and Useful Insects*. McGraw-Hill Book Co. NY, USA
- Nayar K.K., Ananthakrishnan T.N. and Devid B.V. 1976. *General and Applied Entomology*. TATA McGraw Hill New Delhi.



Oster G.F. and Wilson E.O. 1978.*Caste and Ecology in the Social Insects*. Princeton University Press Princeton.

Pathak S.C. Ed. 1986. *Recent Advances in Insect Physiology, Morphology and Ecology*. Today and Tomorrow Printers and Publishers, New Delhi.

Richards O.W. and Devis R.G. 1993.*Imm's General Text Book of Entomology*, 10<sup>th</sup> Edn. Vol I and II.(Indian reprint). B.I. Publications Pvt. Ltd. NewDelhi .

Ross H.H. *et.al.*1982.*A General Text Book of Entomology*.John Wiley Son's, N. York.

Snodgrass R.E. 1935.*Principles of Insect Morphology*.McGraw Hill Book Co. N. York.

Tembhare D.B. 1997. *Modern Entomology*. Himalaya Publishing House, New Delhi

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**PG20ZY417 ANATOMY AND PHYSIOLOGY**

**90 Hours (5hrs/week)**

**Credit - 4**

**Module I. Integumentary System**

**4 hrs.**

Anatomy and histology, Moulting and sclerotisation, Role of hormones.

**Module II. Digestive System**

**10 hrs.**

Anatomy and histology of gut. Modifications of gut (filter chamber).

Physiology of digestion of wood, keratin, wax and silk. Extra intestinal digestion. Role of microbe in digestion. Assimilation

**Module III. Circulatory System**

**8 hrs**

Anatomy and histology of dorsal vessel, dorsal and ventral diaphragms and accessory pulsatile organs. Composition and cellular elements in haemolymph; functions. Course of circulation and control of heart beat.

**Module IV. Respiratory System**

**10 hrs.**

Anatomy and histology of trachea, trachiole, spiracles and air- sacs.

Modifications of respiratory system-cutaneous respiration, diffusion, ventilation, control of ventilation, cyclic release of CO<sub>2</sub>, respiratory pigments.

**Module V. Muscular System**

**8 hrs.**

Histo-morphology of muscles, skeletal muscles and visceral muscles.

Neuromuscular junctions. Excitations of muscle fibres, role of fast and slow axons.

**Module VI. Fat Body and Intermediary Metabolism**

**6 hrs.**

Structure of fat body, Role of fat body in storage of reserves.

Intermediary metabolism-Glycolysis, Glycerol phosphate shuttle, Trehalose-biosynthesis

**Module VII. Excretory System**

**14 hrs.**

Anatomy and histology of Malpighian tubules ( Hemiptera, Coleoptera, Lepidoptera). Nephro-rectal complex

and labial glands. Physiology of excretion.

Absorption of water and ions, reabsorption of essential materials. Synthesis of uric acid, formation of excreta.

**Module VIII. Nervous System**

**14 hrs.**

Anatomy and histology of brain, ganglia and nerves. Physiology-reception and transmission of stimuli, production and conduction of nerve impulses.

Anatomy and histology of mechanoreceptors, photoreceptors and chemoreceptors. Sound production and light production.

**Module IX. Endocrine System**

**12 hrs.**

Histomorphology of neurosecretory cells and endocrine glands (corpora cardiaca, corpora allata and prothoracic glands). Hormones and their functions.

Types of pheromones and behavioural patterns. Pheromonal communications-allelochemicals; allomones, kairomones and synomones.

**Module X. Reproductive System**

**4 hrs.**

Reproductive system in male insects, Reproductive system in female insects.

**REFERENCES**

- Annual Review of Entomology* (1956 onwards) All Volumes.
- Beament, J.W.L. , Treherne, J.E. and V.B. Wigglesworth. 1972. *Advances in Insect Physiology*. Academic Trust London
- Bursell, E. 1970. *An Introduction to Insect Physiology*. Academic Press, Cambridge.
- Chapman, R.F. 1988. *The Insect : Structure and Function* (4<sup>th</sup> edn). ELBS , London.
- Gilbert L.I. and G.A. Kerkut .1975. *Comprehensive Insect Physiology, Biochemistry and Physiology*. Vol 1-12. Pergamon Press, Oxford.
- Pant, N.C. and Ghai (Ed.) 1981. *Insect Physiology and Anatomy* .Indian Council of Agricultural Research , New Delhi
- Pathak S.C (Ed). 1986. *Recent Advances in Insect Physiology Morphology and Ecology*. Today and Tomorrow Publishers, New Delhi
- Patton R. 1963. *Introductory Insect Physiology* .Saunders, USA
- Richards O.W. and R.G. Davis. 1977. *Imm's General Textbook of Entomology* ,Vol I. Chapman and Hall , London
- Rockstein M.(Ed). 1964. *Physiology of Insecta Vol.1-6* . Academic Trust New York.
- Simpson, Stephen. 2005. *Advances in Insect Physiology*. Elsevier, NY.
- Wigglesworth V.B. 1972. *Principles of Insect Physiology*. Methuen , London.

**90 Hours (5hrs/week)**

**Credit- 4**

**Module I. Insect Pests**

**8 hrs**

Kinds of pests (major and minor) – Key pests, sporadic pests, endemic pests, exotic pests, epidemic and pandemic pests, seasonal pests, occasional pests, regular pests, persistent pests. Causes of pest outbreak. Pest resurgence and replacement (secondary pest outbreak). Causes and management of resurgence and replacement. Forecasting pest outbreaks and surveillance (Short term and long term forecasting); forecasting based on observations – climatic and empirical factors.

Types of damage caused by insect pest to crops (Injury by chewing, piercing, sucking insects, internal feeders, subterranean insects, to stored products and indirect effect of feeding).

**Module II. Insect Pests of Crops**

**16 hrs**

Life history, nature of damage and control measures of major pests of paddy, coconut, cotton, sugar cane, mango, cashew, pulses, coffee, tea, banana, pepper, cardamom, turmeric and ginger, tapioca, rubber, vegetables, stored products; Locusts –life history and migration, damage and methods of control; Termites– life history, damage and control measures.

**Module III. Basic Principles of Insect Control**

**16 hrs**

Prophylactic methods. Curative methods- Cultural methods; Mechanical methods; Physical methods; Legal methods.

Biological control- History, ecological basis and agents of biological control – Parasites, Parasitoids, Predators; The practice of biological control (Conservation and enhancement, importation and colonisation, mass culture and release of natural enemies); Economic dimensions of biological control; merits and demerits; Important biological control projects undertaken in India against insect pests and weeds. Autocidal control

– Sterile male technique and other methods, Chemo sterilants, methods of sterilisation, application advantages and disadvantages. Examples; Pheromonal control – Mode of application, pest management with pheromones. Advantages and disadvantages. Examples;

Insect growth regulators (IGRS), Insect growth hormones and mimics (brief account).

Insect repellents – Definition, features of good repellents, types, applications in pest management, advantages and disadvantages, examples. Insect antifeedants – definition, applications, advantages, disadvantages, examples.

Microbial control of crop pests by employing bacteria virus and fungi. Mode of action, applications and examples; Insect attractants – definition, types, application in pest management. Advantages and disadvantages and examples.

Pest management – concepts, definition, characteristics, pest management strategies and techniques Integrated pest management – definition, IPM in agro ecosystem, Preventive practice, *Scheme and Syllabus of M.Sc Zoology – MAC-PG-CSS 2020*

therapeutic practice, guidelines for developing IPM. IPM of rice; Ecological backlash and its management (resistance of population to pest management tactics, Pest population resurgence and replacement, genetic physical and biochemical mechanisms, microbial and environmental degradation of pesticides.

#### **Module IV. Chemical Control**

**12 hrs**

Insecticide formulations, Insecticide appliances and applications; Classification of insecticides – based on mode of entry, mode of action, chemical nature, toxicity.

Chemistry and mode of action of insecticides; Inorganic compounds as insecticides - Arsenic, fluoride and sulphur compounds; Synthetic organic insecticides - Organochlorine compounds (DDT, BHC, Endosulfan– heptachlor, dieldrin).

Organo phosphorous insecticides – monocrotophos, tetra ethyl pyrophosphate, parathion, carbamates – carbaryl, carbofuran.

Botanical insecticides – chemical properties, mode of action and toxicity. (nicotine, rotenone, pyrethrum and neem; Ethnobotanical traditions. Synthetic pyrethroids – definition, uses as insecticides, mode of action (pyrethrin, allethrin).

Fumigants – definition, examples, methods of fumigation, hazards, precautions, advantages; Insecticide synergists – definition, types of synergism, mode of action and examples; Pesticide impact on wildlife and human health.

#### **Module V. Vectors of Domestic Animals and Man**

**10 hrs**

Insect vectors of human diseases belonging to diptera, anoplura, Syphonoptera (self study systematic and biology); Identification, nature of attack, and control measures of insect pest of domestic animals – cattle, sheep and goat, fowl, dog. Acarina – Morphology, biology and control measures.

#### **Module VI. Mode of Transmission and Epidemiology of Vector Borne Diseases**

**10 hrs**

Malaria, Filariasis, Yellow Fever, Dengu Fever, West Nile Disease, Chickungunia, Encephalitis, Kala-azar, Plague, Typhus, Kyasanur Forest Disease, Scabies – control of vectors. Vector control measures.

#### **Module VII. Beneficial Insects**

**10 hrs**

Biology and rearing of Honey bees, Silk worm, lac insect; Insects of forensic importance – crime detection using entomological science. Examples of forensically important insects; DNA techniques in forensic entomology.

#### **Module VIII. Insect Host Interactions**

**8 hrs**

Selection of hosts (plants and animals); Evolution of phytophagy and haematophagy in insects; Insect host resistance; Insect pollinator – plant interaction. Modern findings.

## REFERENCES

- Apple, J.L. and R.R. Smith .1976. *Integrated Pest Management*. Plenum Press, New York.
- Awasthi, V.B. 2002. *Introduction to General and Applied Entomology* (2nd edn). Scientific Publishers (India), Jodhpur.
- Byrd, J.H and J.L Castner (Eds).2000. *Forensic Entomology: The utility of arthropods in legal investigations*, CRC Press,London
- Dent, D.1991. *Insect Pest Management*. CAB International, UK
- Ghosh M.R. 1989. *Concepts of Insect Control*. Wiley Eastern Ltd. Bangalore and New Dehi
- Kettle, D.S.1995. *Medical and Veterinary Entomology*. CAB International.
- Metcalf, G.L. and W.P. Flint.1962. *Destructive and Useful Insects, their habits and control*. Tata McGraw Hill Publ. Co Ltd. New york
- Mullen, G. and Durden, L. (Eds).2002. *Medical and Veterinary Entomology*. Academic Press.
- Nayar, K.K., Ananthakrishnan, T.N. and B.V. David. 1976. *General and Applied Entomology*. Tata McGraw Hill Publ. Co. Ltd New Delhi
- Patton, W.S. and Crag, F.N. 1973. *A Textbook of Medical Entomology*. International Books and Periodicals, New Delhi
- Pedigo, L.P. 1996. *Entomology and Pest Management Practice*. Hall India, Pvt. Ltd. New Delhi
- Ramakrishna Ayyer, R.V. 1963. *A Handbook of Economic Entomology of South India*. Govt of Madras Publications
- Service, M.W.1996.*Medical Entomology for Students*. Chapman and Hall, UK
- Smith, K.V.G.1986. *A Manual of Forensic Entomology*. British Museum Natural History.
- Rao, V.P. Ghani, M.A., Sankaran T and Mathur, K.C. 1971. *A Review of Biological Control of Insects and Other Pest in South East Asia and Pacific region*. CAB, England.
- Srivastava, K.P.1996. *A Textbook of Applied Entomology Vol. I and II*. Kalyani Publishers, Ludhiana, New Delhi

Thacker, J.R.M. 2002. *An Introduction to Arthropod Pest Control*. Cambridge University Press, UK Wall, Richard and Sheares, David.1998. *Veterinary Entomology*. Chapman and Hall.

Walter G. 2003. *Insect Pest Management and Ecological Research*. Cambridge University Press, UK.

Yazdani, S.S. and Agarwal, M. L.1997. *Elements of Insect Ecology*. Narosa Publishing House, New Delhi.

Ananthakrishnan, T.N. (1992) *Dimensions of Insect – Plant Interactions*. Oxford and IBH Publishing Co.Ltd. New Delhi.

Atwal, A.S. 1986. *Agricultural Pests of India and South East Asia*. Kalyani Publications New Delhi.

Fenemore, P.G. and Prakash A. 1992. *Applied Entomology*. Wiley Eastern Ltd. New Delhi.

Hill, D.S. 1983. *Agricultural Insect Pests of Tropics and Their Control*. Cambridge University Press Cambridge.

Matsumura, F. (Ed). 1975. *Toxicology of Insecticides*. Plenum Press New York.

Nair, M.R.G.K. 1986. *Insects and Mites of Crops in India*. ICAR New Delhi.

Nair, M.R.G.K. 1978. *A Monograph of Crop Pests of Kerala and Their Control*. Kerala Agricultural University.

Pradhan, S.1969. *Insect Pests of Crops*. National Book Trust of India, New Delhi.



**PRACTICALS OF MORPHOLOGY,ANATOMY AND TAXONOMYINSECT  
PHYSIOLOGY AND APPLIED ENTOMOLOGY**

**180 hours. (10 hrs/week)**

**Credit- 4**

1. Study of mouthparts in insects (Grasshopper,plantbug,mosquito,honeybee, house fly)
2. Study of different types of antennae, genitalia and legs.
3. Sting apparatus –honeybee
4. Wings and wing venation in insects of 5 orders.
5. Study of sexual dimorphism in insects
6. Preparation of dichotomous keys with reference to various insect orders
7. Dissection of alimentary canal and associated glands of different insects (plant bug,honey bee,oryctes, grasshopper)
8. Dissection of nervous system in different insects (plantbug,honeybee,oryctes, grasshopper)
9. Dissection of reproductive system in insects (cockroach,oryctes ,grasshopper, Plant bug )
10. Dissection of stomatogastric nervous system –cockroach

Collection and preservation of insects (students are required to submit an insect collection belonging to 50 families-dry collection, wet collection, whole mounts and slides) at the time of practical examination.

**Field Study Report:**

Visit to two institutions engaged in entomology research and different ecological niches other than local area for collection of insects. The field study is for 3-4 days. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photographs of the activities. Group and individual assignments shall be preferred.

- 11.Survey of digestive enzymes –amylase,invertase,protease and lipase in different parts of the gut in cockroach,grasshopper, dragonfly
12. Dye transport by Malpighian tubule using dyes
13. Identification of free aminoacids (at least 3) in haemolymph by paper chromatography.

14. Haemocytes –staining and identification.
15. Collection and identification of insect pests of different crop plants,fruit trees,vegetables and stored products
16. Collection and identification of insect vectors of man and domestic animals.
17. Collection and preservation of economically important insects, their life stages, products, damaged parts.
18. Collection and identification of insect damages to crop plants. Insecticide appliances.
19. Determination of  $LC_{50}$  using probit analysis.
20. Collection – Students are expected to submit a collection consisting of insect pest of different crops, stored products, domestic animals and man. Useful insects, their life stages and products, parasites and predators

**ELECTIVE COURSE: MEDICAL MICROBIOLOGY**

PG20ZY419      GENERAL MICROBIOLOGY & PARASITOLOGY

PG20ZY420      BACTERIOLOGY, VIROLOGY & MYCOLOGY

PG20ZY421      CLINICAL MICROBIOLOGY

PRACTICALS OF GENERAL MICROBIOLOGY & PARASITOLOGY  
BACTERIOLOGY, VIROLOGY & MYCOLOGY  
CLINICAL MICROBIOLOGY

## ELECTIVE: MEDICAL MICROBIOLOGY

### Objectives:

To introduce the diversity of microbial world

To learn various pathogens, parasites and related diseases of man

To familiarise with various tools and techniques in the study of microbes and to manage a microbial laboratory

To provide skills and competency in the field of clinical microbiology

### PG20ZY419 GENERAL MICROBIOLOGY AND PARASITOLOGY

**90 Hours ( 5hrs/week)**

**Credit-4**

#### **Module 1. Historical Introduction to Microbiology**

**3 hrs.**

History, scope, relevance and future of microbiology.

#### **Module II . Nomenclature and Identification of Bacteria**

**12 hrs.**

Identification and nomenclature of bacteria - common biochemical tests for the identification.

Serological identification. Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems (halophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles). Identification and classification using molecular techniques.

#### **Module III. Sterilization and Control of Microbial Growth**

**20 hrs.**

Control of microorganisms by physical methods: heat, filtration and radiation; Sterilization equipments: Hot air oven and Pasteurization, Tyndallization.

Autoclaves- principles, precautions and applications; Filtration- types and methods Sterilization by radiation.

Chemical methods: phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; Disinfectants and their mechanisms of action.

Evaluation of antimicrobial agent effectiveness. Antibiotics- types, mechanism of action. Determination of MIC and MBC

Antibiotic sensitivity tests, antibiogram. Antimicrobial agents (bacterial, viral and fungal).

**Module IV. Microbial Growth and Cultivation of Bacteria**

**10 hrs.**

Growth and nutritional requirements of bacteria. Autotrophs, heterotrophs - enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Culture media, culture methods; Batch Culture - Synchronous growth - Techniques of pure culture.

**Module V. Study of Morphology of Bacteria**

**20 hrs.**

Microscopy, different types of microscopy.

Morphology and arrangement of bacteria, ultrastructure of bacteria. Cellular components of bacteria - sporulation and its mechanics.

Staining: Principle and Methods. Simple Staining and Differential staining, Common differential staining - Gram staining, Acid-fast staining (Ziehl-Neelson Method), Staining of Specific Structures, Spore staining (Schaeffer-Fulton Method), Capsule staining, staining of volutin granules, Negative staining.

Examination of bacterial motility.

Epidemiology of bacterial infections, Guidelines for the collection, Transport, Processing analysis, isolation of bacterial pathogens and reporting of cultures from specimens for bacterial infections.

**Module VI. Microbiology of Water, Milk and Food Substances**

**5hrs.**

Microbial contamination of water- types, sources, threats. Microbial contamination of milk. Food poisoning. Major food borne diseases. Methods of detection of microbial contamination of food, water and milk. Microbial standards of drinking water.

**Module VII. Parasites and Vectors**

**20 hrs.**

Study of Parasites- parasitism, types, origin and theories.

Structure and life cycle of the following parasites and pathogenesis of diseases caused: Also study their laboratory diagnosis, treatment and prevention, antiparasitic agents and susceptibility test (of each). Protozoan parasites-*Entamoeba histolytica*, *Plasmodium* sp., *Lieshmania*, *Trypanosoma*, *Trichomonas*, *Giardia*.

*Taenia*; Trematodes: *Schistosoma*; *Paragonimus*;

Helminthes – *Ascaris lumbricoides*, Hook Worm, Pin worm, Filarial Parasites.

Arthropod vectors of medical importance: definition, types, importance. Major vector borne diseases and their pathogens.

A brief study of the following insects, the major diseases they transmit, epidemiology of such diseases, control and preventive measures:

Mosquito, Sand fly, House fly, Tse-Tse fly, Fleas, Louse, Bed bug, Ticks, Mites

## REFERENCES

- Ananthanarayanan R. And C.K. Jayaram Panicker, 2006. *Text book of Microbiology*.Orient Long Man,New Delhi
- Case T.F, *et al.*, 2011. *Microbiology an Introduction* (9<sup>th</sup> edn.). The Benjamin/Cummings Publishing Company. Inc. NY, USA.
- Davis, D. and E. Ginsberg, 1990. *Microbiology* (4 edn.).Harper and Row Publishers, Singapore.
- England P.T. and A.Sher. (eds). 1988. *The Biology of Parasitism- A Molecular and Immunological Approach*. Alar. R. Liss.New York
- Ketchum P.A. 1988. *Microbiology -Concepts and Applications*. Oakland University Press.
- NZ. Markell, E.K., Voge, M and D.T. John. 2002. *Medical Parasitology*. W.B. Saunders, Philadelphia.
- Prescott M.C, J.P.Hardley and D.A. Clean.2001. *Microbiology*. ASM, USA
- Ross,N.E. and J.D.Mclaren (eds). 1986. *Pathophysiological Responses to Parasites*. British Society for parasitology, London.

**PG20ZY420 BACTERIOLOGY, VIROLOGY AND MYCOLOGY**

**90 Hours (5hrs/week)**

**Credits- 4**

**Module I. Pathogenesis**

**5 hrs.**

Mechanism of pathogenesis- bacterial and viral.

Prophylaxis of communicable diseases.

**Module II. Pathogenic Bacteria**

**25 hrs.**

Study of important properties, pathogenicity and laboratory identification of: *Staphylococci, Streptococci, Pneumococcus, Corynebacterium diphtheriae, Bacillus anthracis, Clostridium Neisseria, E.coli, Proteus, Klebsiella, Shigella* and *Salmonella. Vibrio, Pseudomonas, Haemophilus, Brucella.*

Study of important properties, pathogenicity and laboratory identification of: *Mycobacterium, Treponema, Leptospira, Yersinia, Bordetella, Mycoplasma, Actinomycetes, Rickettsiae* and *Chlamydiae* A brief study of bacteria viz. *Borrelia, Listeria, Campylobacter, Helicobacter* and *Legionella.*

**Module III. Bacterial Infections of Human Body**

**15 hrs.**

Bacterial infections of respiratory tract, Bacterial infections of gastro intestinal tract and food poisoning, Bacterial urinary tract infections, Bacterial infections of genital tract and reproductive organs, Bacterial infections of central nervous system, Skin and soft tissue infections, Bone and joint infections, Eye ear and sinus infections, Cardiovascular infections, Tissue samples for culture, Anaerobic infections, Zoonotic infections.

Infections associated with immunodeficiency and immune suppression, Pyrexia of unknown origin.

**Module IV. Virology**

**20 hrs.**

Study of properties of viruses viz., Alpha virus, Pox, Herpes Virus, Adeno, Orthomyxo virus, Paramyxo virus and Papova. Pathogenesis and laboratory diagnosis of diseases caused by these viruses.

Sudy of properties of viruses viz. Polio, Influenza, Rabies, and Rubella viruses, Hepatitis viruses, HIV and AIDS. Pathogenesis of these viral diseases, Immunology of viral infections

Oncogenic viruses, Slow viruses and Prion

**Module V. Control of Viruses and Emerging Viruses**

**5 hrs.**

Control of viral infections through vaccines, interferons and chemotherapeutic agents.

Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.

Emerging viruses

**Module VI. Bacteriophages**

**10 hrs.**

Structure and life cycle patterns of T-even phages; one step growth curve and burst size;

Bacteriophage typing; Structure of Cyanophages, Mycophages.

General principles of phage-bacterium interaction and growth cycle studies of RNA and

DNA phages. The biochemistry of phages infected bacterium. Phage genetics.

**Module VII. Mycology**

**10 hrs.**

Introduction, Classification of fungi, General techniques used in mycology. Cultivation of fungi, Staining of fungi.

Mycosis in man-Classification, pathogenesis and clinical findings in various superficial, cutaneous and systemic fungal infections. Opportunistic mycoses;Immuno compromised situation and mycological infections; emerging diseases. Antifungal agents (specific to disease to included in course) and their susceptibility test.



## REFERENCES

- Ananthanarayan and Jayaram Panicker. 2002. *Text Book of Microbiology*. Orient Longman.
- Belsche, R.B., 1991. *Text Book of Human Virology* (2nd edn.). Mosby, St.Louis.
- Dimock, N and L.Primrose.1987. *Introduction to Modern Virology* (3<sup>rd</sup>edn.). Oxford Blackwell.
- Duerdon, D.L.and Dresser, B.S. (eds).1991. *Anaerobes in Human Disease*. London Arnold.
- Emmons *et al.*, 1997. *Medical Mycology*. Lea and Febiger ,Philadelphia.
- Goodfellow, M and R.G. Board (ed).1989. *Microbiological Classification and Identification*.
- Grady F.O, H.P. Lambert, R.G. Finch, G. Greenwood.1997. *Antibiotic and Chemotherapy; Anti-infective Agents and their Use in Therapy* ( 7<sup>th</sup>edn).Churchil Livingstone, NY.
- Kwon-Chung, K.J and J.E. Bennet.1992.*Medical Mycology*. Lea &Febiger,Philadelphia,
- Larone,D.H.1980. *Laboratory Handbook of Medical Mycology*. Academic press New York.
- Mims C.A. and D.O. White,1994.*Viral Pathogenesis and Immunology*. Oxford Blackwell. Monica Cheesbrough 1991. *Medical Laboratory Manual for Tropical Countries*. Vol.2.ELBS
- Panicker, CKJ.1998. *Text book of Medical Parasitology*, Jaypee, New Delhi.
- Szanzislo,P.J. (edn) 1985.*Fungal Dimorphism; with Emphasis on Fungi Pathogenic for Humans*. Plenum, NY.
- Topley W.W.C. and G. Wilson. 2002. *Principles of Bacteriology, Virology and Immunity. SystematicBacteriology*: (8th edn.). BWW Publishers.
- White, D.C. and F.J. Fenner.2004. *Medical Virology*. (4<sup>rd</sup>edn.) Academic Press, New York.

## PG20ZY421CLINICAL MICROBIOLOGY

**90 Hours (5hrs./week)**

**Credit-4**

### **Module I. Introduction**

**5hrs.**

History of development of Medical Microbiology, Contributions made by eminent scientists.

Safety in Clinical Microbiology laboratory. Good laboratory practices. Microbiological safety cabinets-

Types. WHO safe code of practice for a clinical microbiology laboratory.

### **Module II. Epidemiology**

**15hrs.**

Factors predisposing to microbial pathogenicity Infections. Sources of infections. Mode of transmission of infections, nosocomial infections, opportunistic infections,

Normal microflora of human body. Identification of pathogens- cultural, biochemical, serological and molecular methods.

### **Module III. Laboratory Procedures for Microbiology**

**30hrs.**

Collection, transport, processing and microbiological examination of Blood, Sputum, stool, urine, Cerebrospinal fluid, genital specimens, throat and mouth specimens, nasopharyngeal swabs and aspirates, ear discharges, eye specimens, pus from wounds, abscesses, burns and sinuses, and effusions.

### **Module IV. Diagnosis of Viral Diseases**

**10hrs .**

Laboratory Diagnosis of Viral diseases

Specimens for viral diagnosis, Viral isolation and growth, Cell culture for viral detection

Detection of viral proteins, Detection of viral genetic material, Viral serology

### **Module V. Diagnosis of Fungal Diseases**

**10hrs.**

Laboratory diagnosis of fungal diseases.

Diagnostic procedures, Superficial, Cutaneous and Systemic mycosis.

### **Module VI. Laboratory Studies of Parasites**

**15hrs.**

Laboratory methods for diagnosis of parasitic infections.

Identification of animal parasites, Collection of specimens for the detection of parasites Intestinal protozoans, Blood protozoans, intestinal helminthes, blood helminthes

**Module VII. Handling of Laboratory Animals**

**5hrs.**

Care and management of laboratory animals. Legal requirements for animal experiments. General aspects of organization of animal experiments- Preparation of animals, common experimental procedures, Humane methods of killing animals. Handling of common laboratory animals: Rabbit, guinea-pig, mouse and rat.

**REFERENCES**

Baron E.J, L.R.Peterson and S.M. Finegold.1994. *Bailey and Scott's Diagnostic*

*Microbiology*.ASM, Washington,DC

Cowan, S.T. and K.J.Steel.1985. *Manual for the Identification of Medical Bacteria*. Cambridge University Press, London.

D.C. Kloss, W.E., and T.L. Bannermann.1995. *Manual of Clinical Microbiology* (6th edn.), American Society for Microbiology, Washington,USA

Goodman and Guilman's Pharmacological Basis of Therapeutics, 2000.Tenth Edition.

Gradwohl's clinical laboratory methods vol.II.1981.Academic Books, London.

Howard B.J, J.F.Keiser. T.F.Smith, A.S. Weissfeld, R.C. Tolton, .2002. *Clinical and Pathogenic Microbiology*.

Koneman E.W. D.Stephen, William A, Janda 2008. *Color Atlas and Textbook of Diagnostic Microbiology*. Tata McGraw Hill, NY.

Mackie and McCartney, 2008. *Practical Medical Microbiology* (14<sup>th</sup> edn). Churchill Livingstone,UK.

Monica Cheesbrough, . *Medical Laboratory Manual For Tropical Countries*. Vol.II. Microbiology. ELBS.

P.R.Murray, E.J.Baron, M,Patrick R. M,K.S.Rosenthal, G.S. Koayashi and M.A.Ptaller,1997. *Medical Microbiology*.

Sherris Jc.,1990.*Medical Microbiology, An Introduction to Infectious Diseases*. Ed.2. New York.

**PRACTICAL S OF GENERAL MICROBIOLOGY,  
PARASITOLOGY AND MYCOLOGY BACTERIOLOGY, VIROLOGY  
AND CLINICAL MICROBIOLOGY**

**180 hours (10 hrs./week)**

**Credit - 4**

1. Preparation of stains and various staining methods

Simple Staining, Gram's staining, Acid fast staining, Albert's staining

2. Sterilization-various Techniques: Autoclave, Hot air oven; Laminar flow chamber

3. Disposal of contaminated materials and Laboratory refuse.

4. Preparation of Antibiotic disc

5. Antibiotic sensitivity test-Kirby Bauer test and Tube dilution Method

6. Estimation of MIC

7. Test for Beta Lactamase.

8. Testing of disinfectants

9. Bacteriological test for water, air and food.

10. Examination of faeces for: Amoeba and cyst, Eggs, larva and adult helminthes

11. Examination of blood for plasmodium and Filariasis.

12. Collection of Specimen for Fungi

13. Preparation of special medium.

14. Inoculation, Incubation and Identification of Fungi-*Candida albicans*.

15. Slide culture Techniques.

16. Study of Morphological, cultural and Biochemical reactions of following organisms.

*Staphylococcus aureus, Streptococcus Species, E.coli, Klebsiella, Proteus, Salmonella  
Shigella, Pseudomonas.*

17.Slide agglutination

18.Anaerobic culture methods; Mcintosh Method

19.Slide Identification

*Neisseria gonoerrhoea, Mycobacterium, Tuberculosis, Mycobacterium leprae, Clostridium botulinum, C.tetani.*

20Viral Haemagglutination

21.Heamagglutination Inhibition test

22.Precipitation of serum and preservation for short and long term.

23.Widal test.

24.Immonodiffusion.

25.Various antigen-antibody reactions

Agglutination, Precipitation, Complement fixation, Passive Haemagglutination- latex agglutination test(RA,ASO,CRP AND TRUST ANTIGEN)

26.ELISA

**Field Study Report:** (Three to four days)

1. Visit to Institutions engaged in microbiology/virology research (*e.g.*, Vector Control Research Institute, Cherthala/ Virology Institute,Alapuzha/ Sree Chithra Institute, Thiruvananthapuram) ; 2. hospital with Pathology laboratory (*e.g.*, Government Medical College Hospital), 3. Visit a polluted area and document microbial diveristy. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity.

Group and individual assignments shall be preferred.

# MODEL QUESTION PAPERS

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**First Semester M.Sc. Degree Examination (CSS) - Zoology**

**PG20ZY101- Biosystematics and Animal Diversity**

**Time: 3Hours**

**Total Weight-30**

**Section I – Short answer type questions**  
**Weight- 1**

**Answer any 8 out of 10**

1. Distinguish between holotype and paratype.
2. What is Phenetics?
3. How jaws evolved? What is its evolutionary significance?
- 4..Write about eight kingdom classification .
5. Comment on the evolutionary significance of therapsids.
6. What are the reasons for the mass extinction of Mesozoic reptiles?
7. Huxley called birds as “Glorified Reptiles”. Substantiate this statement.
8. How Prototherians differ from Metatherians?
9. What is Phylocode? Comment on its significance.
10. Give a brief account on the significance of trocophore.

**Section II – Short essay type questions**  
**Weight -2**

**Answer any 6 out of 8**

11. Discuss the differences of Cladistics and typological approach in systematics.
12. Compare and contrast the five kingdom and six kingdom classifications.
13. Comment on the reasons for the success of Arthropods.
14. Explain Ethics in taxonomy.
15. Briefly describe the structural and functional adaptations of fishes for aquatic life.
16. Explain the Mesozoic world of reptile and extinction .
17. Comment on diversity of modern amphibians and briefly mention their major threats.
18. Give an account on the phylogeny of mammalian orders.

**Section III - Long essay type questions**  
**weight- 5**

**Answer any 2 out of 4**

19. What is a species? Discuss the merits and demerits of different definitions of species. Comment on the taxonomic diversity within species.
20. Write an essay about International Code of Zoological Nomenclature, Rules and formation of Scientific names of different taxa
21. Comment on the phylogenetic position of molluscs among invertebrates and describe molluscan adaptive radiation.
22. Write about the collection, preservation, curation and process of identification

**Model question Paper**

**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)  
First Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY102 – Evolutionary Biology and Ethology**

**Time: 3Hours**

**Total Weight-30**

**Section I – Short answer type questions**

**Weight-1**

**Answer any 8 out of 10**

1. What is endosymbiont theory?
2. Comment on neutral evolution.
3. Distinguish between intelligent design and evolutionary theory.
4. What is LUCA?
5. Define Hardy-Weinberg law.
6. Distinguish between heterotopy and heterometry.
7. Comment on RNA world.
8. What is founder effect? Give an example.
9. Briefly highlight a few advantages of chemical communication.
10. Differentiate between habituation and sensitization in animal behavior.

**Section II- Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Discuss Neutralist versus Selectionist approaches in evolution.
12. Comment on the contributions of Rosemary and Peter Grant in molecular evolution.
13. Discuss on biochemical origin of life and describe the experiment that supported the concept.
14. Which are the major mass extinctions in the geological past? How did they affect evolutionary process?
15. Give an account on evolution of sex and its advantages.
16. Explain biological rhythms influenced by the lunar cycle with examples.
17. What is the role of courtship in reproductive behavior? Add a note on the mating systems met within birds.

18. What is imprinting? Why is it a unique form of learning?

**Section III- Long essay type questions**

**Weight -5**

**Answer any 2 out of 4**

19. Discuss Darwinism in the light of modern developments in biology.

20. Describe hominid fossils and comment on the cytogenetic and molecular basis of origin of man.

21. Give an account on the social organization of primates

22. Describe the neurophysiological aspects of behaviour

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**First Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY103- Biochemistry**

**Time: 3Hours**

**Total Weight: 30**

**Section I – Short answer type questions**

**Weight- 1**

**Answer any 8 out of 10**

1. Define mutarotation of monosaccharides.

2. What is trehalose?

3. Distinguish between  $\alpha$  helix and  $\beta$  helix in the secondary structure of proteins.

4. Mention various types of phosphoglycerides.

5. Describe the different steps of substrate phosphorylation in glycolysis.

6. What is Ramachandran map? Comment on its significance.

7. Comment on the antiparallelity of two polynucleotide chains of the DNA molecule.

8. What is zinc finger?

9. Distinguish between Saponification number and Iodine number.

10. Comment on Ribozymes.

**Section II- Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Explain the chemical bonds responsible for the structure of proteins

12. Describe prostaglandins and its significance

13. Comment on the structural similarity of glycogen and amylopectin.

14. Distinguish Omega oxidation from Alpha oxidation

15. Give an account on the characteristics of different forms of DNA.

16. Explain on enzyme velocity and factors affecting it.

17. Discuss the process of microbial photosynthesis

18. Explain the structure of lactose, sucrose, maltose and trehalose

**Section III- Long essay type questions**

**Weight-5**

**Answer any 2 out of 4**

19. Illustrate pentose phosphate pathway and its significance.

20. Describe various modes of regulation of enzymes.

21. *De Novo* synthesis of palmitate is not a reversal of  $\beta$  oxidation. Discuss.

22. Write an essay on classification and properties of proteins



**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**First Semester M.Sc. Degree Examination (CSS)- Zoology**

**PG20ZY104 – Biostatistics, Computer Application and  
Research Methodology**

**Time: 3Hours**

**Total Weight: 30**

**Section I – Short answer type questions**

**Weight- 1**

**Answer any 8 out of 10**

1. What are non parametric tests?
2. Define the term harmonic mean and geometric mean.
3. Comment on the applications of probit analysis in toxicological studies.
4. Define the terms-Skeweness and Kurtosis.
5. Comment on electronic cash or digicash.
6. Explain the term IPR.
7. Differentiate between hardware and Firmware.
8. What is BIOSIS?
9. Give a brief account on UNIX.
10. What are Life tables?

**Section II- Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Compute mean and variance of the given data.

Class	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70
Frequency	2	3	8	12	16	5	2	2

12. Calculate Karl Pearson's correlation coefficient

X 12 9 8 10 11 13 7

Y 14 8 6 9 11 12 3

- 13 Discuss briefly about new generation computer.
14. Briefly explain operating system.
15. Write notes on statistical software used in biology.
16. Briefly describe different sampling methods.
17. Explain the various components included in project proposal writing.
18. Mention the steps required for the development of a research plan.

**Section III- Long essay type questions**

**Weight -5**

**Answer any 2 out of 4**

19. Explain the theorems of probability
20. Write a detailed account on different types of application soft wares

21. Write a detailed account on research design.
22. Write an essay on measures of central tendency.

**Model question Paper**  
**MAR ATHANASIUS COLLEGE (AUTONOMOUS)**  
**Second Semester M.Sc. Degree Examination (CSS)- Zoology**

**PG20ZY205- ECOLOGY: PRINCIPLES AND PRACTICES**

**Time: 3Hours**

**Total Weight: 30**

**Section I -Short answer type questions**

**Weight -1**

**Answer any 8 out 10**

1. Define ecological indicators. Give examples.
2. What is Gaia hypothesis? Who are the Proponents?
3. Comment on ecotone and edge effect.
4. What are Ramsar sites? Give two examples in India.
5. Which are the major minerals that occur in India? Comment on its availability.
6. What is logistic population model
7. Comment on Greenpeace.
8. Write a short note on the significance of the Western Ghats.
9. Briefly describe ecological succession.
10. Comment on trophic levels and food web.

**Section II- Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Describe the concepts of limiting factors.
12. what is climax community ?. Explain the theories regarding it ..
13. comment on any four energy sources
14. Describe the physical and chemical process of soil formation.
15. What are the possible ways to achieve sustainable development? Discuss.
16. Explain the role of bioremediation in environmental sanitation.
17. Discuss the concept of homeostasis in nature.
18. What is the principle of remote sensing? Describe the importance of remote sensing in ecological studies.

**Section III- Long essay type questions**

**Weight-5**

**Answer any 2 out of 4**

19. Explain population interactions. Comment on its ecological and evolutionary significance.
20. Write an essay on radio active pollution? Add a note on nuclear disasters.
21. Explain global climate change. Discuss the international efforts and discussions to mitigate climate change
22. Write an essay on Ecosystem monitoring.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Second Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY206 - CELL AND MOLECULAR BIOLOGY**

**Time: 3 hrs**

**Total weight: 30**

**Section I -Short answer type questions**

**Weight -1**

**Answer any 8 out of 10**

1. Briefly describe CRISPR
2. What is Microtubule organizing centre (MTOC)?
3. What are second messengers? Give examples.
4. Briefly describe signal hypothesis.
5. What are lysosomes?
6. Comment on protein sorting.
7. Write notes on catabolite repression.
8. Comment on RNAi.
9. Mention different types of receptors.
10. Comment on riboswitches.

**Section II- Short essay type questions Weight -2**

**Answer any 6 out of 8**

11. Give an account on ion channels in plasma membranes.
12. Discuss the structure and functions of intermediate filaments.
13. Give an account on the GPCR pathway in rod cells of the eye.
14. Describe the structure and functions of ribosome.
15. Narrate the different strategies for the treatment of cancer.
16. Explain apoptosis and mention its significance in organisms.
17. Write notes on extracellular matrix.
18. Discuss the extrinsic and intrinsic pathways of apoptosis.

**Section III – Long essay type questions Weight -5**

**Answer any 2 out of 4**

19. Explain the different aspects of cell cycle. Add a note on control and check points in cell cycle.
20. Compare and contrast the process of transcription in prokaryotes and eukaryotes.
21. Describe gene regulation in eukaryotes.
22. Write an essay on Ribosome.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Second Semester M.Sc. Degree Examination (CSS)- Zoology**

**PG20ZY207- GENETICS**

**Time: 3Hours**

**Total Weight: 30**

**Section I -Short answer type questions Weight -1**

**Answer any 8 out of 10**

1. What is Quantitative Trait Locus (QTL)?
2. Define R-loops.
3. What is Cot curve?
4. Account on SRY gene
5. What are interrupted genes? Comment on its functions.
6. What is histone code hypothesis?
7. Distinguish between epistasis and pleiotropy.
8. What is coincidence and interference in chiasma formation
9. Define chromosome theory of heridity
10. Comment on loss of function and gain of function muation

**Section II-Short essay type questions**

**Weight-2**

**Answer any 6 out of 8**

11. Differentiate between incomplete penetrance and variable expressivity.
12. Give a brief account on retrotransposons.
13. Describe the molecular structure of telomere and its significance.
14. Elucidate the unique aspects of eukaryotic DNA replication.
15. Explain on Ames test
16. Describe the steps involved in VNTR and RFLP.
17. Discuss the gene silencing mechanism in *saccaromyces*.
18. Describe the various chromosome banding techniques.

**Section III- Long essay type questions**

**Weight -5**

**Answer any 2 out of 4**

19. Explain the molecular mechanisms of chromosomal crossing over.
20. Write an essay on extra chromosomal inheritance
21. Explain DNA repair mechanisms
22. Write an essay on Recombination in bacteria.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Second Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY208-BIOPHYSICS, INSTRUMENTATION AND**  
**BIOLOGICALTECHNIQUES**

**Time: 3 Hours**

**Total weight: 30**

**Section I -Short answer type questions**

**Weight -1**

**Answer any 8 out of 10**

1. Write notes on Fick's law of diffusion.
2. Comment on Van't Hoff's laws.
3. Briefly describe facilitated diffusion.
4. How does entropy differ from enthalpy.
5. Distinguish between redox couple and redox potential.
6. Comment on HPLC
7. Distinguish between PAGE.
8. Briefly explain principle of colorimetry.
9. Comment on dosimetry.
10. Comment on the uses of radioactive tracers..

**Section II -Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Write notes on biological significance of osmosis in plants and animals.
12. Distinguish between endocytosis and exocytosis.
13. note on types of centrifuges.
14. Write a short essay on differential interference contrast microscopy.
15. Account on interaction of radiation with matter.
16. Describe flame emission spectroscopy.
17. Discuss Gibbs-Donnan Membrane Equilibrium and its significance.
18. Write notes of ELISA.

**Section III- Long essay type questions**

**Weight -5**

**Answer any 2 out 4**

19. Describe light and dark reactions of photosynthesis.
- 20 . Give an account on the working and uses of different types of electron microscopes.
21. Write an essay on the principle and uses of ion exchange chromatography and gel permeation chromatography
22. Write an essay on biological and cellular effects of radiation.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Third Semester M.Sc. Degree Examination (CSS)-Zoology**

**PG20ZY309 –DEVELOPMENTAL BIOLOGY**

**Time: 3Hours**

**Total Weight: 30**

**Section A -Short answer type questions Weight -1**

**Answer any 8 out of 10**

1. Define capacitation.
2. What is midblastula transition?
3. Comment on maternal effect genes and zygotic genes in drosophila.
4. What are realiser genes?
5. How are test tube babies produced?
6. What is environmental oestrogen?
7. What is genomic equivalence?
8. What are Hedgehog proteins? Why are they important?
9. What is teratogenesis?
10. Comment on potency of cells.

**Section B-Short essay type questions Weight -2**

**Answer any 6 out of 8**

11. Distinguish between autonomous and conditioned specification.
12. Describe the biochemical and molecular aspects of fertilization?
13. What are cadherins? Comment on their importance.
14. Write notes on embryonic stem cells and its applications.
15. What are the possible mechanisms of dosage compensation?
16. Describe post translational control of gene expression.
17. Discuss the Influence of yolk on cleavage.
18. Describe the histological processes that occur during regeneration.

**Section C-Long essay type questions Weight-5**

**Answer any 2 out of 4**

19. Give an account on the genetics of axis specification of Drosophila.
20. Explain the process of mesoderm induction in vertebrates
21. Describe the surface receptors and signal transduction pathways.
22. Write an essay on the biochemical and molecular aspects of fertilisation

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Third Semester M.Sc. Degree Examination (CSS)-Zoology**

**PG20ZY310 –BIOTECHNOLOGY AND BIOINFORMATICS**

**Time: 3Hours**

**Total Weight: 30**

**Section A -Short answer type questions Weight -1**

**Answer any 8 out of 10**

1. Comment on cosmids.
2. Briefly account on reporter genes.
3. What is cDNA library?
4. What is BankIt?
5. Mention about metabolomics?
6. What are the applications of stem cell technology in medicine?
7. Comment on cryogenics?
8. Write a note on gene knock-out?
9. What is SCP?
10. Comment on GATT.

**Section B-Short essay type questions Weight -2**

**Answer any 6 out of 8**

11. What are the different types of sequence alignment?
12. Mention the applications of proteomics in drug design
13. Explain PCR and its different types.
14. Delineate Maxam Gilbert's and Sanger's method of sequencing
15. Write a short account on DNA vaccines
16. Explain the basic techniques of mammalian cell culture.
17. Highlight the applications of transgenic animals.
18. Give a note on degradable, biodegradable and compostable plastics.

**Section C-Long essay type questions Weight-5**

**Answer any 2 out of 4**

19. Explain biosafety concepts and issues in detail.
20. Describe the different types of growth media, its properties and applications
21. Write an essay on primary and secondary databases
22. Write an essay on systems biology.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Third Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY311 – ADVANCES IN ANIMAL PHYSIOLOGY**

**Time: 3Hours**

**Total Weight: 30**

**Section I -Short answer type questions**

**Weight -1**

**Answer any 8 out of 10**

1. Mention the role of leptin in adipogenesis?
2. Distinguish between Red and White muscles?
3. What is modality of sensation?
4. Why Chalmers are important?
5. Comment on Blood buffers?
6. Write on the significance of Leydig cells.
7. Mention the role of Organ of Corti.?
8. What is ECG? Comment on its medical significance.
9. What are chemical messengers? Give four examples.
10. Write a brief note on estrous cycle.

**.Section-II Short essay type questions**

**Weight -2**

**Answer any 6 out of 8**

11. Give a brief account on Structural and biochemical adaptations to special dietary pattern?.
12. What is BMR? Explain its measurement.
13. How do hormones control the formation of Urine?
14. Explain the energetics of muscle contraction.
15. Describe the organizations and properties of neuromuscular junction?.
16. What are the mechanisms of temperature regulation in Poikilotherms and homiotherms?
17. Discuss the effect of exercise on cardiovascular system in man.
18. Give an account on physiology of implantation ,pregnancy and parturition ?

**Section III- Long essay type questions**

**Weight-5**

**Answer any 2 out of 4**

19. Explain the neurophysiology of vision?
20. Give an account on the synthesis, control of secretion and physiological action of thyroid hormone?
21. Describe the excitatory and inhibitory pathway of neurotransmission?
22. Write an essay on ultra structure and molecular organization in skeletal muscle.



**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Third Semester M.Sc. Degree Examination (CSS) – Zoology**

**PG20ZY312 – MICROBIOLOGY AND IMMUNOLOGY**

**Time: 3Hours**

**Total Weight: 30**

**Section I -Short answer type questions**

**Weight -1**

**Answer any 8 out of 10**

1. Outline classification of microorganisms?
2. Differentiate between gram positive and gram negative cell walls.
3. Mention the effect of papain and pepsin on immunoglobulins.
4. Write a note on ataxia.
5. Briefly explain multivalent sub unit vaccines.
6. Mention RAST
7. Comment on innate and acquired immunity.
8. Differentiate between Allograft and Autograft.
9. What are monoclonal antibodies?
10. Comment on complement fixation.

**Section – II Short essay type questions Weight-2**

**Answer any 6 out of 8**

11. Describe endogenous and exogenous antigen presentation.
12. Explain the structure of MHC.
13. Give an account on the haematopoiesis
14. Describe the role of cytokines in immunogenic reactions.
15. Explain the immune responses shown to viral infections.
16. Discuss the different pathways of complement activation.
17. Give an account on viral infection cycles.
18. What are the components outside the cellwall of prokaryotes?

**Section III- Long essay type questions Weight-5**

**Answer any 2 out of 4**

19. Classify virus
20. Give an account of the different serological reactions
21. Explain the genetic basis of antibody diversity.
22. Write an essay on different types of hyper sensitivity.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Fourth Semester M.Sc. Degree Examination (CSS) –Zoology**

**PG20ZY413Environmental Science – Concepts of Environmental science-  
Biodiversity, Conservation and Microbial Ecology**

**Time: 3 hours**

**Total Weight: 30**

**Section I-Short answer type questions Weight-1**

**Answer any 8 out of 10**

1. Distinguish between in- situ and ex- situ conservation?
2. What is autecology?
3. Comment on commensalism .
4. Give a brief note on genetic diversity.
5. What is phenotypic plasticity
6. Comment on water logging.
7. Distinguish between halophile and piezophile.
8. Comment on People’s participation in conservation.
9. What is SCP.
10. Comment on the role of GEF in conservation.

**Section II-Short essay type questions**

**Weight -2**

**Answer any 6out of 8**

11. Describe the role of microbes in soil.
12. Give an account on biofertilizers.
13. Explain the process of natural succession.
14. Describe the biodiversity indices.
15. Give an account on aquatic microbiology.
16. Compare and contrast sulphur and phosphorus cycle.
17. Discuss on modern agriculture and environmental impacts
18. Explain the hypothesis for invasion success.

**Section III-Long essay type questions Weight- 5**

**Answer any 2 out of 4**

19. Write an essay on basic needs and imperatives of sustainable development
20. Describe the values of biodiversity

21. Write an essay on role of microbes in industry.
22. Write an essay on various hypotheses for invasion success.

**Model question Paper**  
**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**  
**Fourth Semester M.Sc. Degree Examination (CSS) –Zoology**

**PG20ZY414- Environmental Pollution and Toxicology**

**Time: 3 hour**

**Total Weight: 30**

**Section I-Short answer type questions**

**Weight-1**

**Answer any 8 out of 10**

1. What is Threshold Limit Value (TLV)?
2. Define teratogenicity.
3. How is BOD significant in determining water quality standards?
4. Comment on carbon trade.
5. Distinguish between acute and chronic toxicity.
6. Which are the primary pollutants of air?
7. Write a short note on occupational hazards.
8. What is a bio digester? How it functions?
9. Comment on IPCC.
10. Give a brief account of bio transformation of xenobiotics.

**Section II- Short essay type questions**

**Weight-2**

**Answer any 6 out of 8**

11. Differentiate between bio accumulation and bio-magnification.
12. Give an account on Activated Sludge Treatment.
13. Describe how constructed wetlands can be used for water treatment.
14. Give an account on the hazards and management methods of e-waste.
15. What are the parameters of air quality determination?
16. How is bioremediation an effective tool for controlling pollution?
17. Give an account on toxic chemicals in the environment.
18. Write a short note on carcinogenicity and mutagenicity.

**Section III- Long essay type questions**

**Weight -5**

**Answer any 2 out of 4**

19. Elucidate the advanced methods of waste water treatment.
20. Describe soil pollution in highlands and wetlands of Kerala with case studies.
- 21..Write an essay on Air pollution monitoring methods.
- 22.Write an essay on occupational toxicology.

**Model question Paper**

**MAR ATHANASIOUS COLLEGE (AUTONOMOUS)**

**Fourth Semester M.Sc. Degree Examination (CSS) –Zoology**

**PG20ZY415- Environmental Management and Climatology**

**Time: 3 hours**

**Total Weight: 30**

**Section I-Short answer type questions**

**Weight-1**

**Answer any 8 out of 10**

1. Differentiate Rapid EIA and comprehensive EIA?
2. What is alternatives in EIA, give an example
3. Comment on LCA.
4. What is *El Nino*?
5. Write a note on biodigesters
6. Comment on environmental modeling techniques.
7. Distinguish between CSR and CER.
8. Comment on Eco-labelling.
9. Briefly describe on watershed.
10. Comment on Plastic Act 1999.

**Section –II Short essay type questions**

**Weight- 2**

**Answer any 6 out of 8**

11. What are soil colloids and mention on cation and anion exchange and its significance?
12. Explain tool box for environmental management.
13. Discuss the five basic laws of ecology.
14. Give an account on management practices for grasslands and wetlands.
15. What is eco restoration.
16. Comment on simulation modelling
17. Comment on ISO standards for environment management.
18. Give an account of environmental auditing.

**Section III Long Essay type Question**

**Weight – 5**

**Answer any 2 out of 4**

19. Write on impacts of global climatic change.
20. Discuss India's climatic regions and its monsoon systems.
21. Essay on plate tectonics and its consequences.
22. Write an essay on Impact of climatic change on environment.