CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala

CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN ZOOLOGY

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 10th April 2019

CONTENTS

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Dr.Sosamma Oommen
Chairman
Board of Studies

10.04.2019
Kottayam

PREFACE

Established in 1955, the Department of Zoology started B.Sc Degree programme since its inception and M.Sc programme in 1982. It is a recognised research centre of Mahatma Gandhi University and so far 15 Ph.Ds were awarded to its credit. The department moves ahead to fulfil its vision to foster critical thinking and learning process that cut across various disciplines of biological sciences, nurturing love for nature and its inherent values towards sustainable future.

The curricular process taken up tries to do justice to the vision and mission envisaged giving due importance to the study of animal science at different levels. The M.Sc. syllabus is being revised under CBCS scheme incorporating recent advances and emerging trends. The programme spreads across four semesters offering twelve core courses, four elective courses and six practical courses. Entomology is offered as the elective/specialized course in the final semester. In addition, the students have to submit a research dissertation in the fourth semester. This post graduate programme being research linked tries to ignite the research mind of the learners. It is expected that students who are successfully completing four semesters of M.Sc. in Zoology could acquire sufficient knowledge and skill to meet the needs in their future career and endeavors, benefitting themselves and the society at large. This syllabus is the outcome of the concerted effort of the board of studies as well as experts in the various areas of animal science.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1. These regulations shall be called **"CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019"**

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. **Credit** is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course**.**

3.8. **Department** means any teaching department in the college.

3.9. **Dean of Academic Affairs** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. **Dean of Student Affairs** is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

3.11. **Department Council** means the body of all teachers of a department in the college.

3.12. **Department Coordinator** is a teacher nominated by a Department Council to co-ordinate the ^{In}-Semester examination of the PG programme in that department.

3.13. **Faculty Advisor** means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. **Course Teacher** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. **In-Semester Assessment (ISA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. **End Semester Assessment (ESA)** means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. **Internal Examiner** means a teacher working in the college.

3.18. **External Examiner** means a teacher from outside the college.

3.19. **Grace Marks** shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. **Grade Point** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. **College Average (CA)** means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous).

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programme is **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:
(a) In-Semester Assessment (ISA)
(b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

A. IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) Attendance

Percentage of attendance	Mark
90 and above	6
85 - 89	5
80 - 84	4
76 - 79	3
75	2
Below 75	0

Maximum marks = 6

(ii) Assignment (One assignment per course)

Evaluation Component	Mark
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) Major Seminar

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) Test paper

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

B. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

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

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20
2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		**22**	**12**	**-**	**100**

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40.Questions should be equally distributed among the courses in a semester. There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. **IN-SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. **IN- SEMESTER ASSESSMENT**

Evaluation Component	**Mark**
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END -SEMESTER ASSESSMENT**

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	**Mark**
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	**Mark**
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.
Level 2: **College level**: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10^{th} of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

(a) Name of the College
(b) Title of the Postgraduate Programme
(c) Name of the Semester
(d) Name and Register Number of the student
(e) Date of publication of result
(f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
(g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
(h) College average (CA) of the marks of all courses
(i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester
(j) Semester Grade Point Average (SGPA) and corresponding Grade.
(k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-
CP = C × GP, where C is the Credit and GP is the Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-
SGPA = TCP/TC, where TCP is the Total Credit Point of that semester, ie, $\sum_1^n$ CPi*;*
TC is the Total Credit of that semester ie, $\sum_1^n$ Ci*, where n is the number of courses in that semester*

Cumulative Grade Point Average (CGPA) is calculated using the formula:-
CGPA = TCP/TC, where TCP is the Total Credit Point of that programme ie, $\sum_1^n$ CPi*;*
TC is the Total Credit of that programme, ie, $\sum_1^n$ Ci *, where n is the number of courses in that programme*

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months 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.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I

(Model Mark Cum Grade Card)

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Affiliated to Mahatma Gandhi University Kottayam

(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)

MARK CUM GRADE CARD

Section :

Name of the Candidate :

Unique Permanent Registration Number :

Degree :

Programme :

Stream :

Name of the Examination :

Date of Publication of Result :

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA: **SG:**

Checked by **Section Officer** **Controller of Examinations**

Date:

Annexure II

CMS COLLEGE KOTTAYAM (AUTONOMOUS)
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Affiliated to Mahatma Gandhi University Kottayam, Kerala
(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

PHOTO

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name: UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :

Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1 Semester 2 Semester 3 Semester 4					

Date: **Controller of Examinations**

Annexure III

(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1

(Decimals are to be rounded mathematically to the nearest whole number)

Table 1

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Credit point and Credit point average

Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 2

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

Credit point (**CP**) of a paper is calculated using the formula $\boldsymbol{CP = C \times GP}$**,where C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

SGPA/CGPA = $\frac{TCP}{TC}$**, where TCP is the Total Credit Point; TC is the Total Credit**

NOTE

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme **only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO No.	Graduate Programme Outcomes
GPO.1	**Critical Thinking**: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	**Effective Communication:** Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	**Social Consciousness:** Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	**Multidisciplinary Approach:** Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	**Subject Knowledge:** Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.
GPO.6	**Lifelong Learning**: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES

PSO No.	Intended Programme Specific Outcomes (PSO) *Upon completion of M. Sc. Zoology Programme, the graduates will be able to:*	GPO No.
PSO-1	Understand recent developments in the principles and practices of systematics and taxonomy, henceforth analyze link between the origin, evolution, phylogeny and adaptive radiation of invertebrates and vertebrates.	1,5
PSO-2	Understand the fundamental and functional aspects of ecosystem thereby enabling the learner to understand, think and evolve strategies that are used to mitigate threats to biodiversity such as conserving natural resources, ecosystem restoration and equip the students to use various tools and techniques to coordinate and participate in field activities	3
PSO-3	Understand and analyze the advanced concepts in cell biology, biochemistry, developmental biology, genetics, evolution, microbiology, immunology, research methodology, statistics and physiology	1,4
PSO-4	Generate an awareness about the biology of insects for its diversity, functional aspects and application in agricultural pest management, sericulture, apiculture, lac culture and forensic science there by impart skill as well a source of self-employment.	2,4
PSO-5	Analyse the innovative ideas in the field of biochemistry, physiology, genetics, microbiology, developmental biology, bioinformatics, taxonomy, economic zoology and ecology to develop the interest for thorough observation and performing experiments in the respective fields	1,4
PSO-6	Explain the recent developments in genetic engineering, biotechnology, immunology, general informatics and bioinformatics to provide wide opportunity in research to address the societal needs.	3,6,2
PSO-7	Understand and apply, advanced tools and techniques related to biological sciences such as biophysics, bioenergetics, Instrumentation, Microbiology, Immunology, Biochemistry, Biotechnology and their potential applications in Animal Biology	6
PSO- 8	Coordinate and present appropriate applications of knowledge through effective written, verbal, graphical/ virtual communications and interact fruitfully with people from diverse backgrounds	6

PROGRAMME DESIGN

The post graduate programme in Zoology is a two year programme of four semesters. There are four components for the programme namely, the core courses, elective courses, practical courses and the project spread over four semesters. There are five courses in each semester, one dissertation towards the end of the course and a comprehensive viva at the end of the fourth semester. There are 16 core courses and the four elective courses are spread over the third and fourth semesters. The total credits for completing a PG programme is 80.

The Course Design is given below:

Sl No	Course Type	No of Courses	Total Credits
1	Core courses	12	45
2	Elective courses	4	15
3	Practical courses	6	16
4	Viva voce	1	1
5	Dissertation	1	3
	TOTAL	**24**	**80**

PROGRAMME STRUCTURE

Semester	Course Code	Course	Teaching hours/ week	Credit	Total Credits
I	ZY1921101	Biosystematics and animal diversity	4	4	19
	ZY1921102	Evolutionary Biology and Ethology	3	3	
	ZY1921103	Biophysics, instrumentation and biological techniques	4	4	
	ZY1921104	Biostatistics, computer application and research methodology	4	4	
	ZY1921601	Practical 1	10	4	
II	ZY1922105	Ecology- principles and practices	4	4	19
	ZY1922106	Genetics and bioinformatics	4	4	
	ZY1922107	Developmental Biology	3	3	
	ZY1922108	Biochemistry	4	4	
	ZY1921602	Practical 2	10	4	
III	ZY1923109	Animal physiology	4	4	19
	ZY1923110	Cell and molecular biology	4	4	
	ZY1923111	Microbiology and biotechnology	4	4	
	ZY1923112	Immunology	3	3	
	ZY1923603	Practical 3	5	2	
	ZY1923604	Practical 4	5	2	
IV	ZY1924301	Entomology: morphology and taxonomy	4	4	23
	ZY1924302	Entomology: Anatomy and physiology	4	4	
	ZY1924303	Applied Entomology	4	4	
	ZY1924304	Vector and Vector Borne diseases	3	3	
	ZY1924305	Insect Toxicology	3	3	
	ZY1924701	Practical 5	5	2	
	ZY1924702	Practical 6	5	2	
	ZY1924801	Project	-	3	
	ZY1924901	Comprehensive Viva Voce	-	1	
		Total			**80**

Elective courses offered:

1. ZY1924301- Entomology: morphology and taxonomy
2. ZY1924302- Entomology: Anatomy and physiology
3. ZY1924303- Applied Entomology
4. ZY1924304- Vector and Vector Borne diseases
5. ZY1924305- Insect Toxicology

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

S. No.	Course	Course
1.	ZY1921101	Biosystematics and Animal diversity
2.	ZY1921102	Evolutionary Biology and Ethology
3.	ZY1921103	Biophysics, Instrumentation and Biological techniques
4.	ZY1921104	Biostatistics, Computer application and Research
5.	ZY1921601	Practical I- Biosystematics and Animal diversity, Evolutionary Biology and Ethology Biophysics, Instrumentation and Biological techniques, Biostatistics, Computer application and Research methodology

Course	Details				
Code	ZY1921101				
Title	**BIOSYSTEMATICS AND ANIMAL DIVERSITY**				
Degree	M.Sc.				
Branch	Zoology				
Year/Semester	1/I				
Type	Theory				
Credits	4	Hrs/week	4	Total hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Apply the various taxonomic procedure for collection, preservation and curation of living things	Ap	1
2.	Evaluate the taxonomic characters and apply this for the identification and classification of living things	E	1
3	An in-depth knowledge on classical, modern methods and molecular techniques employed in systematics and apply these methods for construction of Phylocode, Barcode, and phylogenetic trees.	Ap	1
4	Construct taxonomical keys for identification of taxa	C	1
5	Apply the rules and ethics of ICZN for the scientific naming and designation of types	Ap	1
6	Evaluate the concept of species and diversity within the species	E	1
7	Analyze the origin, diversification, modifications and evolutionary relationships among invertebrates and the vertebrates	An	1
8	Analyze the major geological events and principles the led to the origin of multicellularity	An	1
9	Evaluate the phylogenetic position of protostomes and deuterostomes	E	1
10	Evaluate adaptive radiations among the major phyla that helped them to evolve into their current form	E	1

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
BIOSYSTEMATICS		**22**	
1.0	**Biological classification and Taxonomic Procedures**	**14**	
	Self study- Hierarchy of categories and higher taxa, Levels of organization in animal kingdom		

1.1	**Biological classification** - Three Domain Concept in Systematics, two, five and six kingdom classification	1	2
1.2	Concept of species	2	6
1.3	Taxonomic diversity within species.	2	6
1.4	**Taxonomic Procedures**- Collection, preservation, curetting and process of identification.	2	1
1.5	Taxonomic characters of different kinds- quantitative and qualitative analysis of variation	1	2
1.6	Process of typification, different zoological types and their significance.	1	5
1.7	Keys- its types and uses	1	4
1.8	Keys- merits and demerits	1	4
1.9	International Code of Zoological Nomenclature (ICZN)- Introduction	1	5
1.10	Rules and formation of Scientific names of different taxa, Homonymy and Synonymy	1	5
1.11	Ethics in taxonomy- authorship, suppression of data, undesirable practices in taxonomy	1	5
2.0	**Methods and techniques of Biosystematics**	**8**	**3**
2.1	Classical and modern methods- Typological, Phenetics, Evolutionary, Cladistics	2	3
2.2	Phylogenetic and Molecular Taxonomy	1	3
2.3	**Techniques of Biosystematics** - Phylocode, Tree of Life and Bar-coding of Life.	**2**	**3**
2.4	Molecular Phylogeny-use of Proteins, DNA and RNA	2	3
2.5	Phylogenetic trees.	1	3
ANIMAL DIVERSITY		**50**	
3.0	**Introduction and origin of multicelluarity**	**9**	
3.1	**Introduction** -Origin of Protists	**1**	**7**
3.2	Prokaryotes and Eukaryotes	1	7
3.3	**Origin of multi-cellularity** - Edicaran and Burgess Shale fauna.	**2**	**8**
3.4	Cambrian explosion- causes and consequences.	2	8
3.5	Cropping and Red Queen principle.	1	8
3.6	Possible theories of metazoan origin.	1	8
3.7	Symmetry, Coelom and Metamerism-evolutionary trends.	1	8
4.0	**Ancestry of Nonchordates**	**16**	
4.1	**Lower Metazoans** -Evolutionary relationships - Porifera, Cnidaria, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudocoelomata	**2**	**7**
4.2	Adaptive modifications- Porifera, Cnidaria, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudocoelomata	2	7

4.3	**Protostomes and Deuterostomes-** Phylogenetic position of Molluscs **Self study-** Larval forms of Annelids, Molluscs, Arthropods and Echinoderms, classification of arthropoda and echinodermata	**1**	**9**
4.4	Adaptive Radiation in gastropods	1	10
4.5	Adaptive Radiation in Annelids	1	10
4.6	Phylogeny of Arthropod-Monophyly and Polyphyly	1	9
4.7	Reasons for the success of Arthropods	1	7
4.8	Adaptive Radiation in Arthropoda	2	10
4.9	**Lesser Protostomes -** Phylogeny- Sipuncula, Echiura, Phoronida	**2**	**9**
4.10	Phylogeny- Brachipoda, Onychophora and Chaetognatha	2	9
4.11	**Deuterostomes- Echinoderms -** Adaptive radiation	**1**	**10**
5.0	**Hemichordates and Vertebrate Phylogeny**	**25**	
5.1	**Hemichordates -** Position in the animal kingdom	**1**	**7**
5.2	Phylogeny and evolutionary significance	1	9
5.3	**Vertebrate Phylogeny- Pisces** -Agnatha, Ostracoderms and Gnathostomes	**2**	**9**
	Self study- Cephalochordates and Urochordates		
5.4	Placoderms, Acanthodians, Chondrichthyes and Osteichthyes	2	9
5.5	Structural and Functional adaptations of fishes	2	7
5.6	**Vertebrate Phylogeny- Tetrapods -** Tetrapod phylogeny - modern Amphibians	**1**	**9**
5.7	Ampibians- diversity and distribution	2	7
5.8	Origin of Reptiles	1	7
5.9	Adaptive radiation in Reptiles	2	10
5.10	Skull of reptiles and its importance in biosystematics.	1	2, 7
5.11	Mesozoic world of reptiles and extinction.	1	8
5.12	**Vertebrate Phylogeny- Birds and Mammals** - Origin of birds	**2**	**7**
	Self study- classification of birds and mammalia		
5.13	Origin of Mammals	2	7
5.14	Phylogeny of Mammalia with special reference to Primate order	2	9
5.15	Adaptive radiation in mammals	3	10

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11. Campbell, N.A and J.B. Reece .2009. Biology (8th edn). Benjamin Cummings Publ. NY,USA
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22. Romer, A.S. and T.S. Parsons. 1986. The Vertebrate Body. (6th edn.) Cengage Learning.
23. Strickberger, M.W. 2014. Evolution (5^{th} edtn). Jones and Bartett Publishers, London.
24. Urry A.Lisa, Cain L. Michael, Wasserman A. Steven, Minorsky V. Peter and Jane B. Reece 2016. Campbell's Bology (11^{th} edn). Pearson
25. Waterman, A.J. 1971. Chordate Structure and Function. Macmillan Co. London
26. Winston, J.E. 1999. Describing species: Practical Taxonomic Procedures for Biologists. Columbia University Press,Columbia, USA.
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Course	Details				
Code	ZY1921102				
Title	**EVOLUTIONARY BIOLOGY AND ETHOLOGY**				
Degree	MSc				
Branch(s)	Zoology				
Year/Semester	1/I				
Type	Core				
Credits	3	Hours /week	3	Total Hours	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Create curiosity for learning the scientific way of the origin of life, first cell and eukaryotic-prokaryotic origin	C	3
2	Understand the basics of prehistoric time periods and events, fossils and extinction	U	3
3	Understand the advanced approaches in evolutionary biology and molecular level of evolutionary pathways.	U	3
4	Create scientific temper and rational thoughts by observing the evidences for evolution	C	3
5	Analyse the ideas of human evolution and thus acquiring knowledge about the basic scientific findings about our origin	An	3
6	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 behaviour.	Un	1

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
Evolutionary Biology		**34**	
1.0	**Origin and Evolution of Life**	**10**	
1.1	Critical analysis of Oparin – Haldane hypothesis & Miller-Urey experiment. The RNA world, GADV-protein world.	2	1
1.2	The First Cell-Methanogens-Oxygen and photosynthesis-Cyanobacteria	1	1
1.3	Stromatolites-Banded iron formations	1	1
1.4	Evolution of Prokaryotes, Origin and evolution of eukaryotes	2	1

1.5	Origin of nucleus- gene structure	2	1
1.6	Introns early and introns late hypothesis,HGT(Horizontal Gene Transfer), Endosymbiosism	2	1
2.0	**The Geological Timescale and Primate evolution**	**10**	
2.1	Origin of earth (brief mention only), Geological time scale - eras, periods and epochs (mention major events)	1	2
2.2	Fossils- fossilization and its significance, Tools and techniques in estimating evolutionary time scale.	2	2
2.3	Mass extinction and its consequences,Anthropocene	1	2
2.4	Primate Evolution **:** Stages in Primate evolution- Prosimii, Anthropoidea and Hominids (brief mention about human ancestor fossils upto *Homo luzonensis)*	1	5
2.5	Origin of humans : Cradle of Human evolution- OOA(Out of Africa) hypothesis- aridity hypothesis	1	5
2.6	Turnover-pulse hypothesis- savannah hypothesis	1	5
2.7	Mitochondrial Eve and Lucy, Y chromosomal Adam, Paternal mtDNA trasmission	1	5
2.8	Early migration,hunter- gatherer societies	1	5
2.9	Evolution of communication, speech and language in humans (brief account only). Social evolution	1	5
3.0	**Molecular evolution and Evolving thoughts in evolution**	**14**	
3.1	Gene and genome evolution	1	3
3.2	Molecular clocks, Gene duplication, molecular divergence, genetic distance,	1	3
3.3	Significance of Molecular clocks hypothesis in evolution.	1	3
3.4	Hardy-Weinberg Law & Factors affecting gene frequency in a population	2	3
3.5	Neutral theory of Kimura	1	4
3.6	Micro, Macro and Mega evolution. Co-evolution, Red Queen principle.	1	4
3.7	Punctuated equilibrium vs Gradualism, Natural selection and selective breeding	1	4
3.8	Evidences : Rose Mary and Peter Grant (Molecular evolution in Darwinian finches), Evolution of MDR-TB (Multi drug resistant TB), Evolution of HIV, Evolution occurred in	2	4

	Italian Wall lizard, *Podarcis sicula,*		
3.9	EVO-DEVO concept of evolution, Heterochrony, Heterotopy, Heterometry and Heterotypy.	2	4
3.10	Evolution of plasticity and complexity, Evolution of Sex: conjugation in paramecium- Chlamydomonas reproduction- sexual reproduction in Volvox	2	4
Ethology		**20**	
4	**Evolution and social behaviour**	**11**	
4.1	Reproductive strategies, Mating systems, Courtship, Sexual selection- patterns, parental care and investment	3	6
4.2	Kin selection, altruism, reciprocal altruism, inclusive fitness, co-operation, territoriality, alarm call	2	6
4.3	Social organization in insects and primates , Sociobiology and Evolution of social behaviour	2	6
4.4	Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance	1	6
4.5	Learning- Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting	3	6
5	**Understanding the complex behaviour**	**9**	
5.1	Communication Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees,	2	6
5.2	Pheromonal communication (Ants and mammals).	2	6
5.3	Migration (Fishes and birds), Navigation cues.	2	6
5.4	Biological rhythms - Circadian, Circannual, Lunar periodicity, Tidal rhythms.	1	6
5.5	The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy	2	6

References

Evolutionary Biology

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Web Resources

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Ethology

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2. Aubrey Manning and Mariam Stamp Dawkins. 2000. An Introduction to Animal Behaviour (5th Edn).Cambridge University Press, U.K.
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Web Resources:

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Course	Details				
Code	ZY1921103				
Title	**BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES**				
Degree	MSc.				
Branch(s)	Zoology				
Year/Semester	1/I				
Type	Core				
Credits	4	Hour/week	4	Total Hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the basic biophysical principles	U	7
2	Analyze biophysical properties and functioning of living system	An	7
3	Understand the doctrines of thermodynamics and bioenergetics to assess the flow of energy in the living system	U	7
4	Understand the principle, functioning and applications of the tools and techniques available for studying biochemical and biophysical nature of life	U	7
5	Accustom the learner to use tools and techniques for research in biology	C	7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	**Biophysics of life**	**10**	
1.1	Diffusion - kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Graham's law	2	1
1.2	Biological significance in animals and plants	1	1
1.3	Electrochemical gradient, Gibbs-Donnan equillibrium.	1	1
1.4	Osmosis - osmotic concentration and osmotic pressure, Van't Hoff's laws.	2	1
1.5	Biological significance of osmosis in animals and plants.	1	2
1.6	Biophysics of cell membrane: physico-chemical properties of cell membrane	2	2
1.7	Conformational properties of cell membranes, artificial membrane	1	2
2	**Bioenergetics and Radiation Biophysics**	**14**	
2.1	Free energy, redox couple and redox potential	1	3
2..2	Bioenergetics of photosynthesis	1	3
2.3	Bioenergetics of carbohydrate and fatty acid oxidation	1	3
2.4	Bioenergetics of electron transport and oxidative phosphorylation	1	3
2.5	Chemiosmotic theory and binding change mechanism of ATP synthesis	2	3
2.6	Ionizing radiation, units of radioactivity, exposure and dose.	1	3
2. 7	Interaction of radiation with matter – photoelectric effect, ion pair production, absorption and scattering of electrons.	2	3
2.8	Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates.	2	3
2.9	Cellular effects of radiation: somatic and genetic	1	3
2.10	Nuclear medicine: internally administered radioisotopes, application of radioactive tracers	1	3

2.11	Radiation protection and therapy	1	3
3	**Microscopy, Chromatography & Electrophoresis**	**19**	
3.1	Principles of microscopy	1	4,5
3.2	Differential interference contrast (Nomarsky) microscopy, Confocal microscope	1	4,5
3.3	Polarizing microscope, immunofluorescence microscopy	1	4,5
3.4	Electron microscope –TEM, SEM	1	4,5
3.5	Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching, negative staining.	2	4,5
3.6	Scanning tunneling and atomic force microscopes	1	4,5
3.7	Image processing methods in microscopy	1	4,5
3.8	Principles of chromatography	1	4,5
3.9	Paper chromatography, thin layer chromatography	1	4,5
3.10	Ion exchange chromatography, gel permeation chromatography	1	4,5
3.11	Affinity chromatography, gas chromatography	1	4,5
3.12	High performance liquid chromatography	1	4,5
3.13	Principles of electrophoresis	1	4,5
3.14	Paper electrophoresis, gel electrophoresis	1	4,5
3.15	Polyacrylamide gel electrophoresis – SDS and non SDS	1	4,5
3.16	Agarose gel electrophoresis, disc electrophoresis	1	4,5
3.17	High voltage electrophoresis, immunoelectrophoresis, isoelectric focusing	2	4,5
4	**Spectroscopy, Centrifugation and other techniques**	**21**	
4.1	Principle and applications of colorimetry and spectrophotometry	1	4,5
4.2	Spectroscopy: Flame emission spectroscopy – ICP, atomic absorption spectroscopy	2	4,5
4.3	Infrared spectroscopy, nuclear magnetic resonance spectroscopy	2	4,5
4.4	Structure determination using X-ray crystallography	1	4,5
4.5	Circular dichroism spectroscopy, ESR spectroscopy, mass spectroscopy	2	4,5
4.6	matrix-assisted laser desorption/ionization, surface plasmon resonance	1	4,5

4.7	Basic principles of sedimentation	1	4,5
4.8	Types of centrifuges, analytical and preparative centrifugation	1	4,5
4.9	Differential and density gradient centrifugation	1	4,5
4.10	Dosimetry: ionization chamber, GM counter	1	4,5
4.11	Solid and liquid scintillation counters, autoradiography	1	4,5
4.12	Advancement in nanotechnology, nanobiology, nanosensors and nanomedicines	3	4,5
4.13	Patch-clamp recording, ECG, Brain activity recording	1	4,5
4.14	PET, MRI, fMRI and CA	2	4,5
4.15	DNA Sequencer	1	4,5
5	**Biological and Histological Techniques**	**8**	
5.1	Fixation, preparation of temporary and permanent slides,	1	4
5.2	Whole mounts, smears, squashes and sections.	1	4
5.3	Microphotography	1	4
5.4	Cytochemical and histological methods, microtome techniques, fixation, staining, immunohistochemistry, immunocytochemistry	3	4
5.5	Principle of the histochemical detection of carbohydrates, proteins and lipids and nucleic acid	2	4

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Course	Details				
Code	ZY1921104				
Title	**BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY**				
Degree	M.Sc.				
Branch	Zoology				
Year/Semester	1/I				
Type	Core				
Credits	4	Hours/week	4	Total Hours	4

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Improve analytical and critical thinking skills through problem solving	Ap	3
2	Understand the steps involved in statistical investigations	U	3
3	Analyze the significances of statistical measures in biological research	An	3
4	Apply computer technology in the field of life science allied research	Ap	3
5	Develop enthusiasm and awareness about the concepts tools and protocols of biological research	Ap	3
6	Identify the fundamental idea and ethical approach to carry out original research in biology	U	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Fundamentals of biostatistics**	**16**	
1.1	Statistics and biology Steps in Statistical Investigation (General account only) • Defining the problem • Collection of data • Organizing and presentation of data • Analysis of data • Interpretation	1	2
1.2	Collection of data –Various methods Classification of data-Frequency distribution	2	2

	Organizing and presentation of data-Charts and diagrams		
1.3	Statistical Analysis Tools – Parametric and Non-Parametric Analysis. Bivariate and Multivariate Analysis.	1	2
1.4	Definitions and objectives of averaging Characteristics of a good average Types of averages	1	2
1.5	Arithmetic mean- Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.6	Harmonic mean- Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.7	Geometric mean- Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.8	Median- Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.9	Mode- Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.10	Definitions and properties Range-Definition ,Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.11	Quartile deviation- Definition, Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.12	Mean deviation- Definition, Problems based on ungrouped and grouped data Merits and Demerits	1	1
1.13	Standard deviation- Definition ,Problems based on ungrouped and grouped data Merits and Demerits Mean deviation Vs Standard deviation	1	1
1.14	Standard Error, Definition and Significances Skewness and Kurtosis - Problems based on ungrouped and grouped data Merits and Demerits	2	1
2.0	**Measure of association between variables and probability theory**	**12**	
2.1	Types and methods of correlation analysis	1	1
2.2	Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation	2	1
2.3	Regression-Definition, Dependent and independent variable Types of regression analysis	2	1

	Line of Best Fit		
2.4	Measures of regression- Graphic Method Regression equation	3	1
2.5	Probability-Definitions and terminology	1	1
2.6	Theorems in Probability(problems based on addition ad multiplication theorems)	2	1
2.7	Probability distributions – Binomial, Poisson and Normal (Brief Account only).	1	1
3.0	**Testing of hypothesis and vital statistics**	**9**	
3.1	Definition Test of significance Steps in hypothesis testing	1	2,3
3.2	Hypothesis types –Null and Alternate Errors in hypothesis testing-Type 1 and Type 2 Confidence Interval and level of significance	1	2,3
3.3	Z Test (Problem for small samples)	1	1,2,3
3.4	Student's 't' test (Problem for small samples comparing mean of two variable).	1	1,2,3
3.5	**Non parametric test** Chi- Square Test (Problem for 2×2 table only).	1	1,2,3
3.6	Analysis of Variance (ANOVA - One way analysis only)	2	1,2,3
3.7	Vital Statistics - Introduction, uses Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).	2	1
4.0	**Computer applications**	**18**	
4.1	Introduction- Definition Characteristic of a computer Types of computers Organization of a digital computer system	2	4
4.2	Components of a digital computer system: Input devices Primary memory Secondary memory CPU Output devices Motherboard PSU Add on cards	2	4
4.3	Computer terminology (Brief account only) File File Extensions Folder Temporary File Booting Formatting BIOS disk Partitions	2	4

	Default Operations Defragmentation		
4.4	New Generation Computers- Artificial intelligence and Zoobotics	1	4
4.5	Software basics: Operating systems Working of an OS CLI vs GUI DOS, Windows and linux (brief account only)	2	4
4.6	Application softwares Working of application programs MS office package Acrobat Reader, E Book Reader, internet browsing software, Photoshop Statistical softwares	2	4
4.7	Computer language -Classification and types, HTML, C and Java (brief account only) Steps in programming	2	4
4.8	Network Topology, essential Hardware for networking , Networking Protocols PAN, LAN, WAN, MAN	2	4
4.9	Internet and Internet Services World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines	1	4
4.10	Global Information System INFLIBNET, BIOSIS, Medline and Medlars, AGRIS E Journals and E Books Publishing.	1	4
4.11	System security Virus ,Worms, Spyware ,Adware, Ransomware Antivirus software Firewall Cyber Crime and Cyber Laws (Brief account only).	1	4
5.0	**Research methodology**	**17**	
5.1	Science and Life Sciences: Basic concepts - Knowledge, Information and Data - Science, Pseudoscience. Life Science - Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements.	2	5,6
5.2	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.	3	5,6
5.3	Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating the research problem, Selecting the problem and necessity of defining the	3	5,6

	problem. Literature review -Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review. Hypothesis -Null and alternate hypothesis and testing of hypothesis -Theory, Principle, Law and Canon.		
5.4	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. Data collection techniques.	3	5,6
5.5	Scientific Documentation and Communication: Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications). Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.	3	5,6
5.6	Information Science, Extension and Ethics: Sources of Information -Primary and secondary sources. Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Internet -Search engines and software, Online libraries, e-Books, e-Encyclopedia, TED Talk, Institutional Websites. Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards. Extension: Lab to Field, Extension communication, Extension tools. Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.	3	5,6

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Course	Details				
Code	ZY1921601				
Title	**PRACTICAL 1:BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGYAND ETHOLOGY, BIOPHYSICS AND INTRUMENTATION, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY**				
Degree	M. Sc.				
Branch(s)	Zoology				
Year/Semester	I/I				
Type	Core Practical				
Credits	4	Hours/week	10	Total Hours	180

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Identify invertebrates and vertebrates in relation to their systematic position and unique features	U	1
2	Identify larval forms based on morphological features	U	1
3	Analyze the skull of vertebrates and interpret the feeding habit based on the architecture	An	1
4	Analyze the systematic position and evolutionary relationships of different taxa through the construction of cladogram and taxonomic key	An	1
5	Analyze how the change in allelic frequencies leads to evolution through population genetics problems	An	1
6	Identify the behavioural patterns of organisms	U	3
7	Identify and apply the various biophysical tools, instruments and techniques used in biological research	Ap	7
8	Apply statistical measures both manual and computer aided for execution of biological research	Ap	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-n RememberU- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Biosystematics and animal diversity, evolutionary biology and ethology**	**74**	
1.1	Study of museum specimens - 70 invertebrates and 30 vertebrates (List the studied items with brief descriptions. Diagrams not necessary).	20	1
1.2	Larval forms – any 10 larvae from different taxa	8	2
1.3	Study of the skull of vertebrates - Varanus, Crocodile, Bird, Dog, Rabbit/ Rat	8	3
1.4	Preparation of dichotomous key of 4 specimens up to family (insects/spiders/ fishes/ snakes of any	8	4

	three taxa).		
1.5	Preparation of Cladogram based on the specimens provided (at least five museum specimen).	8	4
1.6	Calculating gene frequencies and genotype frequencies in the light of Hardy-Weinberg Law in human/ other populations.	10	5
1.7	Study of fish in response to three temperatures (Normal and + 50C) of water in a microenvironment and preparation of an ethogram	8	6
1.8	Study of the grooming behaviour in insects/bird	4	6
2.0	**Biophysics/instrumentation/biological techniques**	**36**	
2.1	Micrometry- principle and measurement of microscopic objects: Low power and high power.	8	7
2.2	Camera Lucida drawing with magnification and scale.	4	7
2.3	Principle and working of phase contrast microscope, micro-photographic equipment , pH meter ,Colorimeter, Ultracentrifuge, Laminar air flow, Soxhllet extractor, Flame Photometer ,Spectrophotometer, Rotor Evaporator ,GC/MS	16	7
2.4	TLC using amino acids from purified samples and biological materials.	8	7
3.0	**Biostatistics**	**32**	
3.1	Calculation of mean, median and mode from grouped data	4	8
3.2	Calculation of mean deviation and standard deviation from grouped data	4	8
3.3	Calculation of Pearson correlation coefficient.	2	8
3.4	Calculation of regression coefficient and regression equation (X on Y and Y on X)	4	8
3.5	Test of significance: Calculation of ‘Z’ value (small sample only)	4	8
3.6	Calculation of Chi square value (2×2 table only)	4	8
3.7	Calculation of t value (for small sample comparing two variable)	2	8
3.8	Graphical representation of data: 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.	8	8
4.0	**Computer applications**	**38**	
4.1	MS Excel: Preparation of graphs (bar, histogram, pie, ogives, ,Scatter plot)	4	8
4.2	MS Excel: Formula writing (Addition, Subtraction, Multiplication, Division, Power and Root)	2	8
4.3	Construction of frequency distribution using excel	4	
4.4	MS Excel: Correlation Analysis	2	8
4.5	MS Excel-ANOVA (one way analysis)	2	8
4.6	MS Power Point Preparation of a presentation with	8	8

	minimum 5 slides based on First Semester theory topics		
4.7	PH Stat: Basic statistics (mean and standard deviation –Ungrouped data)	2	8
4.8	PH Stat: Chi square test	2	8
4.9	PH Stat: t test	2	8
4.10	PH Stat : Regression	2	8
4.11	Creating a personal blog and posting an article on any biological topic	8	8

SEMESTER II

S. No.	Course Code	Course
1.	ZY1922105	Ecology- principles and practices
2.	ZY1922106	Genetics and bioinformatics
3.	ZY1922107	Developmental Biology
4.	ZY1922108	Biochemistry
5.	ZY1922602	Practical II- Ecology- principles and practices, Genetics and bioinformatics, Developmental Biology, Biochemistry

Course	Details		
Code	ZY1922105		
Title	**ECOLOGY- PRINCIPLES AND PRACTICES**		
Degree	MSc		
Branch(s)	Zoology		
Year/Semester	1/II		
Type	Core		
Credits	4	Hrs./Week: 4	Total Hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand basic theories and principles of ecology	U	2,5
2	Understand structure and function of ecosystem and various methods for its monitoring	U	2,5
3	Generate and understanding about the theories, structure, measurement and various phenomenon related to population and community ecology	U	2,5
4	Apply the basics of diversity indices in taxonomical research areas	Ap	2,5
5	Learn current environmental issues based on ecological principles	U	2
6	Acquire critical understanding on anthropogenic activities on environment and knowledge of ecology is vital in taking conservation measures.	U	2
7	Apply the knowledge of environmental biotechnology for mitigating emerging environmental issues.	Ap	2

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Ecology and Environment**	**10**	
1.1	Physical Environment - biotic and abiotic interactions.	1	1
1.2	Concept of Homeostasis and limiting factors;	1	1
1.3	Concepts of habitat , Micro habitat and niche, niche width and overlap, fundamental and realized niche	2	1
1.4	Resource partitioning, character displacement.	1	1
1.5	Cybernetic nature of ecosystem,	1	1
1.6	stability through feedback control and through redundancy of components;	1	1
1.7	Resistance and resilience stability.	1	1
1.8	Ecosystem monitoring- GIS, Remote sensing, GPS, Astro-ecology	1	1,2
1.9	EIA- tools and techniques, ecosystem modelling	1	1,2

2.0	**Ecosystem - Structure and Function**	**10**	
2.1	Structure and function of ecosystem, types of ecosystem (brief mention only)	2	1,2
2.2	Laws of thermodynamics, energy flow in the ecosystem.	2	1,2
2.3	Primary productivity and productivity measurements.	2	1,2
2.4	Decomposition, Biogeochemical cycles- patterns and types (Gaseous and Sedimentary).	2	1,2
2.5	Ecosystem development-Ecological succession, concept of climax	2	1,2
3.0	**Population and community Ecology**	**20**	
3.1	Population Ecology: Group properties, Concept of rate. Natality and mortality.	2	1,3
3.2	Population age structure, Growth forms and concept of carrying capacity.	2	1,3
3.3	Population fluctuations, density dependent and density independent controls	2	1,3
3.4	Life history strategies, r & k selection.	1	1,3
3.5	Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.	2	1,3
3.6	Population interactions- types, positive and negative, interspecific and intraspecific interactions.	2	1,3
3.7	Concept of metapopulation, Levin's model of metapopulation,	1	1,3
3.8	Comparison of Metapopulation and Logistic population model.	1	1,3
3.9	Concept of community: Size and structure of biotic community	1	1,3
3.10	Qualitative characters of community	1	1,3
3.11	Nature of community, Keystone species.	1	1,3
3.12	Species diversity in community, Species richness and Evenness	1	1,3,4
3.13	Diversity and measurements 1. Alpha diversity (Simpsons index, Shannon index)	1	1,3,4
3.14	2. Beta diversity(Sorensens similarity index) 3. Gamma diversity	2	1,3,4
4	**Resource Ecology**	**20**	
4.1	Natural Resources Conventional and non-conventional energy sources, Energy use pattern in different parts of the world, recent issues in energy production and utilization;	2	5
4.2	Sustainable development, Energy audit and Green technology	2	6
4.3	Mineral resources with reference to India. Impact of mining on environment, Sand mining and its impacts.	2	5
4.4	Forest resources- deforestation, forest scenario of India, Western Ghats and its ecological significance	2	5
4.5	Aquatic resources - Freshwater and water scarcity,	2	5,6

	water conservation measures - case studies from India and Kerala		
4.6	Riverine ecosystem- Riparian vegetation and Water shed management	1	6
4.7	Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites with special emphasis on Vembanad wetlands	2	6
4.9	Wetland reclamation- causes and consequences. Depletion of resources and impacts on quality of life.	2	6
4.10	Soil ecology: soil properties - (physical and chemical), mineral (inorganic) constituents of soils, soil organic matter, soil biota,	1	6
4.11	microbial control of soil nutrient availability, plant-soil feedbacks and ecosystem development, soil quality degradation,	1	6
4.12	Climate change-mitigation and adaptation, climate resilience, soil carbon sequestration,	2	6
5	**Environmental stresses and their management**	**13**	
5.1	Types of environmental pollution and their biological effects- Air, Water, Soil, Noise, Radiation	5	5
5.2	Toxicology- Basic concepts and Principles, Evaluation of toxicity – Acute toxicity, chronic toxicity, Bioassays	2	5
5.3	Accumulation of toxicants in organisms-Bio-concentration, bio-magnification, bio-transformation;	2	5,6
5.4	Invasive alien species of plants and animals	1	6
5.5	Biotechnological principles and environmental management.: bioremediation, phytoremediation, biofilms, bioscrubbers	3	7

References

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Web link

https://www.sciencedaily.com

Course	Details				
Code	ZY1922106				
Title	**GENETICS AND BIOINFORMATICS**				
Degree	M.Sc				
Branch	Zoology				
Year/Semester	1 / II				
Type	Core				
Credits	4	Hrs./Week	4	Total Hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the principles, mechanism and pattern of inheritance	**U**	**3**
2.	Analyze the fine structure and molecular aspects of genetic material	**An**	**3,5**
3	Understand the concepts of epigenetics, quantitative and population genetics, Advanced Human Genetics	**U**	**3**
4	Identify the mechanism involved in DNA replication and Gene mutation	**Ap**	**5**
5	Explore the applications of the emerging field of bioinformatics	**C**	**6**
6	Effectively use the existing software and extract information from large databases so as to use this information in computer modeling	**C**	**5,6**

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	**Transmission Genetics**	**12**	
1.1	Extensions of Mendelian principles: a) Incomplete dominance b) Codominance c) Interaction of genes (Epistasis, Supressors) d) Lethal alleles e) Penetrance and expressivity f) Plieotropy g) Phenocopy.	2	1
1.2	Evolution of gene concept - Definition of factors, alleles, multiple alleles, pseudoalleles, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Cistron, Recon and Muton	2	2
1.3	The standard genetic code, redundancy and	2	2

	Wobble.DNA Structure- alternate forms of the Double Helix. Gene synthesis (in vitro synthesis) – works of Khorana and Kornberg		
1.4	Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns.	1	2
1.5	Genes-within-genes (overlapping genes) Bacteriophage Ö X174.	1	2
1.6	Transposable elements:**Bacteria:** IS elements, composite transposons, Tn3 elements, medical significance.	1	1,2
1.7	**Eukaryotes**-P elements, Retrotransposons, significance of transposons.	1	1,2
1.8	Extra Chromosomal Inheritance: Chloropast-Variegation in 4'Oclock plant and mutation in Chlamydomonas: Mitochondria- Poky in Neurospora, Petite in Saccharomyces, Maternal effect- Shell coiling in Limnaea, Infectious heredity in Paramecium (Kappa Particle)	2	1,2
2	**Molecular cytogenetics**	**15**	
2.1	Genome size and C-value Paradox. Structure of eukaryotic chromosome, nucleosome model.	1	2
2.2	Chromosome condensation - euchromatin and heterochromatin. Kinetics of renaturation: Cot and Cot curve	1	2
2.3	Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Chromosome banding techniques.	1	2
2.4	DNA Replication: The Meselson-Stahl experiment, semi conservative replication of DNA in chromosomes,	1	4
2.5	Theta replication, rolling-circle replication,	1	4
2.6	Molecular mechanisms of eukaryotic replication.	1	4
2.7	Gene Mutation: Molecular basis of gene mutation	1	2,4
2.8	Mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation,	1	2,4
2.9	The Ames test for mutagen/carcinogen detection. DNA damage and repair mechanisms	1	2,4
2.10	Genetic Linkage, Recombination: Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination,	2	2,4
2.11	Stern's Experiment; molecular mechanisms of recombination (Holliday model), Gene conversion	1	2,4
2.12	Chromosome Mapping: Recombination mapping with two-point and three –point test cross in *Drosophila*, Coincidence and Interference.	1	2,4
2.13	Genetic mapping by tetrad analysis in *Neurospora*. Mitotic recombination. Genetic recombination in Phage, rII locus	1	2,4

2.14	Complementation test, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.	1	2,4
3	**Quantitative genetics, Population Genetics, Human genetics and Epigenetics**	**15**	
3.1	Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, complex traits, complex pattern of inheritance, quantitative traits, threshold traits, estimation of heritability, QTL mapping	1	3
3.2	Genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity.	2	3
3.3	Genetic mapping of Mendelian traits::Karyotype, Pedigree, Pattern of inheritance.	1	3
3.4	Human genome and mapping - Somatic cell fusion, cell hybrids and Radiation hybrids, Genetic and physical map distances, Two-point mapping - LOD score analysis	2	3
3.5	The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project.	2	3
3.6	Eugenics, Genetic counseling, Gene therapy, Management of genetic disorders	2	3
3.7	Human genetics and legal, social and ethical considerations.	1	3
3..8	Epigenetics: A brief history of epigenetics - overview and concepts;	1	3
3.9	Chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis,	1	3
3.10	Epigenetics in *saccharomyces cerevisiae,* position effect variegation,	1	3
3.11	Heterochromatin formation and gene silencing in *Drosophila.*	1	3
4	**Bioinformatics**	**20**	
4.1	Definitions of bioinformatics, Scope of bioinformatics - history, scope of bioinformatics in research, business and employment opportunities.	3	5
4.2	Bioinformatics in India- current status and future implication.	2	5
4.3	Biological Databases: Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ;	2	5
4.4	Protein sequence databases: SWISSPROT, PIR	2	5
4.5	Structure databases: PDB, ND	2	5
4.6	Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL	2	5,6
4.7	Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.	2	5,6
4.8	Sequence Analysis: Types of sequence alignment,	2	6

	methods of sequence alignment, scoring schemes, gaps and gap penalties,		
4.9	Phylogenetics analysis- tree styles, tree building method, evolution of macromolecular sequence tools for making and drawing trees (phylip and clustlw).	3	6
5	**Genomics and Proteomics**	**10**	
5.1	Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing	1	6
5.2	Study of transcriptome (By sequence analysis, and, Microarray analysis) and Proteome	1	6
5.3	Data mining in proteomics – Microarrays, significance of proteomics	1	6
5.4	Structure based drug designing: Introduction to basic concepts, Molecular recognition by receptor and ligand design, Generation of Rational Approaches in Drug design	2	6
5.5	Introduction to drug designing, Discovering a drug, Target identification and validation, Identifying the lead compound, Optimization of lead compound.	2	6
5.6	Systems Biology: Introduction , Metabolomics	2	6
5.7	Gene network, synthetic biology.	1	6

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Bioinformatics

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Course	Details				
Code	ZY1922107				
Title	**DEVELOPMENTAL BIOLOGY**				
Degree	M.Sc.				
Branch(s)	Zoology				
Year/Semester	1/II				
Type	Core				
Credits	3	Hours / week	3	Total hours	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Impart in-depth knowledge regarding basic concepts of development.	U	3
2	Develop detailed understanding of the events that lead up to and comprise the process of fertilization and the events after fertilization.	U	3
3	Be familiar with Early Development of Model organisms like *Caenorhabditis elegans*, *Drosophila and frog*	Ap	3
4	Provide adequate information regarding the genetic pathway and cellular interactions involved in development.	Ap	3
5	Analyse the molecular basis of development.	An	3
6	Students get adequate information regarding metamorphosis and regeneration	U	3, 8
	Make the students aware about modern implications of developmental biology	Ap	3, 8

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Basic Concepts of Development**	**7**	
1.1	Potency of embryonic cells, Commitment	1	1
1.2	Specification (Autonomous and Conditional), Induction	2	1
1.3	Competence, Determination and Differentiation	1	1
1.4	Morphogenetic gradients	1	
1.5	Genomic equivalence and Cytoplasmic determinants	1	1
1.6	Cell fate and cell lineages	1	1
2.0	**Fertilization and Early development**	**14**	
2.1	Spermatogenesis, Oogenesis, Fertilization- (biochemical and molecular aspects), Mechanisms and significance of cleavage. Blastulation and Gastrulation, Parthenogenesis. (**Self study)**	**0**	2
2.2	**Invertebrate model organisms**: *Caenorhabditis elegans and Drosophila.* Specification in *Drosophila* (cleavage, midblastula transition, gastrulation)	3	3
2.3	Anterior-posterior patterning in *Drosophila* (Maternal effect genes,zygotic genes, gap genes, pair rule genes, segment polarity genes; homeotic selector genes, realisator genes)	3	3
2.4	Dorsal-ventral patterning and left right patterning in *Drosophila.* Dorsal protein gradient.	2	3
2.5	Vertebrate model organism: Frog: Axis formation in amphibia , Anterior-posterior patterning in Amphibia.	3	3
2.6	Hox code hypothesis, Nieuwkoop centre and mesodermal polarity	2	3
3.0	**Cellular Interactions & Differential Gene Expression in Development**	**11**	
3.1	Molecular basis of mesoderm induction: Transcription factors induced in the organizer. Neural induction, Regional specificity of induction,	3	5
3.2	Genetic specificity of induction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP)	3	5
3.3	Surface receptors and signal transduction pathway - RTK pathway, Smad pathway,Wnt pathway, Hedgehog pathway and cell death pathway	3	4

3.4	DNA methylation	2	5
4.0	**Metamorphosis, Regeneration & Teratogenesis**	**16**	
4.1	Basics of metamorphosis in Amphibians and Insects	2	6
4.2	Hormonal control of metamorphosis	2	6
4.3	Heterochrony- neoteny, progenesis (Brief accounts);	1	6
4.4	Regeneration**:** Different types of regeneration; Histological processes during regeneration	2	6
4.5	Polarity and Metaplasia in regeneration	2	6
4.6	Bone and neural regeneration (Medical -Advances in regeneration).	2	6
4.7	Teratogenesis and teratogenic agents.	2	7
4.8	Malformations and disruptions, Gene – phene relationship, Autophene, Allophene	2	7
4.9	Environmental oestrogens.	1	7
5.0	**Human Welfare and Developmental Biology**	**6**	
5.1	*In vitro* fertilization and embryo transfer – recent trends	2	7
5.2	Stem cells and their applications, ethical issues.	2	7
5.3	Cloning experiments- (Amphibia, Mammals and Human).	2	7

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    New Delhi
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Course	Details				
Code	ZY1922108				
Title	**BIOCHEMISTRY**				
Degree	M.Sc				
Branch	Zoology				
Year/Semester	1 / II				
Type	Core				
Credits	4	Hrs./Week	4	Total Hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the basic chemistry and biophysical chemistry of molecules, interactions and body fluids	U	3
2.	Describe the structure, classification and function of major bio molecules	R	3
3	Understand the biochemical integrity of various life processes and the metabolic pathways	U	3
4	Create an awareness on diseases associated with levels of various biomolecules and the importance of nutrients in keeping the wellbeing of the body	C	3
5	Analyze the lack of enzymes in the metabolic pathway which can lead to diseases	An	5
6	Explore the new developments in biochemistry	C	5
7	Develop awareness on the importance of vitamins, minerals free radicals and antioxidants	Ap	3
8	Explain classification, the specificity of enzymes, and the chemistry involved in enzyme action	R	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
	Self study: Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance, Buffers - biological importance	**0**	**1**
1.0	**Carbohydrates and metabolism**	**19**	
1.1	Carbohydrates-Classification, chemical structure and Biological importance,	2	2
1.2	Monosaccharides- aldoses, and ketoses, cyclic structure of monosaccharides, Isomerism-	2	2

	stereoisomerism, anomers and epimers		
1.3	Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.	1	2
1.4	General reaction and properties. Mutarotation and inversion of sugars,	1	2
1.5	Disaccharides- examples	1	2
1.6	Polysaccharides- Homopolysaccharides – examples, Heteropolysaccharides -examples	2	2
1.7	Metabolism: Major metabolic pathways- Glycolysis – Fate of pyruvate, Citric acid cycle and its significance. Central role of citric acid cycle	**2**	3
1.8	Oxidative and substrate level phosphorylation	**1**	3
1.9	Gluconeogenesis, Cori cycle	**2**	3
1.10	Glycogen metabolism- Glycogenesis, Glycogenolysis	**1**	3
1.11	Glycogen metabolism- Adenylate cascade system, Ca+2 Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis	**2**	3
1.12	Minor metabolic pathways of carbohydrates- Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism	**2**	3
1.13	Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria.	**1**	3
2.0	**Proteins and metabolism**	**17**	
2.1	Proteins: Structure, classification and properties of amino acids. Amphoteric properties of amino acids, P*k* value and iso-electric point of amino acids.	1	2
2.2	Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins.	2	2
2.3	Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Primary structure of protein (*e.g.* insulin). Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Tertiary structure- *e.g.* Myoglobin. Quaternary structure – *e.g.* Haemoglobin.	3	2
2.4	Fibrous proteins- examples, Chaperons.	1	2
2.5	Ramachandran angles and Ramachandran map. New developments in structural identification of proteins- brief account only	1	6
2.6	**Metabolism of Proteins:** Amino acid metabolism-Deamination, Transamination and Trans-deamination. Formation and disposal of	**3**	3

	ammonia.		
2.7	Urea cycle	**2**	3
2.8	Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.	**2**	3
2.9	Synthesis of biologically significant compounds from different amino acids with special reference to glycine, glutamic acid	**1**	3
2.10	Synthesis of biologically significant compounds from different amino acids- phenylalanine, tyrosine and tryptophan, Inborn errors of protein metabolism	**1**	3
3.0	**Lipids and metabolism**	**15**	
3.1	Lipids: Classification, structure and Biological importance of lipids, Tay Sachs Disease	2	2
3.2	Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides), Physical properties. Omega- 3- fatty acids and PUFA	1	2
3.3	Reactions-Hydrolysis, Saponification Rancidity,	1	2
3.4	Analysis of checking fats and oils (Fat constants).	1	2
3.5	Waxes. Compound lipids: Phospholipids, Sphingolipids, Glycolipids,	1	2
3.6	Derived Lipids, Steroids: Biologically important steroids,	1	2
3.7	Prostaglandins- structure, types, synthesis and functions	1	2
3.8	Metabolism of Lipids: Oxidation of fatty acids- Alpha, beta and omega oxidation	2	3
3.9	*De novo* synthesis of fatty acids	2	3
3.10	Metabolism of cholesterol synthesis and its regulation	1	3
3.11	Biosynthesis of triglycerides	1	3
3.12	Metabolism of ketone bodies – Ketogenesis, Ketolysis, Ketosis	1	3
4.0	**Nucleic Acids, metabolism and Nutrients**	**11**	
4.1	Nucleic acids: Structure of nucleic acids and nucleotides	1	2
4.2	Characteristic features of A, B, C and Z DNA.	1	2
4.3	Structural organization of tRNA	1	2
4.4	Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities,	2	2
4.5	Denaturation, renaturation of nucleic acids	1	2
4.6	Biological roles of nucleotides and nucleic acids. Lesch Nyhan syndrome, Xanthinuria	1	2,5

4.7	Metabolism of Nucleic acids: Catabolism of purines and pyrimidines	2	3
4.9	Nutrients: Major minerals- Role of Calcium, Magnesium, Sodium, Potassium, Chloride	**1**	7
4.10	Minor minerals- Role of Phosphorus, Sulphur and Iron	**1**	7
4.11	Vitamins (self study), Free radicals, Antioxidants	**0**	7
5.0	**Enzymes**	**8**	
5.1	Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme.	1	8
5.2	Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, theories.	1	8
5.3	Enzyme kinetics: Michaelis-Menten equation. Km value and its significance.	2	8
5.4	Enzyme velocity and factors influencing enzyme velocity.	1	8
5.5	Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition.Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification**..**	2	8
5.6	Enzyme engineering and its applications	1	8

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Course	Details				
Code	ZY1922602				
Title	**ECOLOGY, GENETICS AND BIOINFORMATICS, DEVELOPMENTLA BIOLOGY AND BIOCHEMISTRY (PRACTICAL)**				
Degree	M.Sc				
Branch(s)	Zoology				
Year/Semester	1/II				
Type	Practical				
Credits	4	Hrs/Week	10	Total hours	180

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand and identify adaptations, feeding habit of organisms from different ecosystems, their interactions, diversity etc..	U	5
2	Analyze and determine the amount water and soil parameters	An	5
3	Understand the process of primary productivity	U	5
4	Understand technological and modern advancements in ecological monitoring , imaging etc..	U	5
5	Observe and understand sexual dimorphism, Mutation and development in Drosophila	U	5
6	Apply Mendelian principles of genetics to solve problems in genetics	Ap	5
7	Understand and apply the tools in bioinformatics	U	5
8	Understand and identify the pathways in chick, frog and mammalian development	U	5
9	Apply basic principles of biochemistry and perform biochemical reactions with major biomolecules and determine their presence and quantity	Ap	5

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Experiment	Course Description	Hrs.	CO. No.
1.0	**ECOLOGY**	**96**	
1.1	Study of Pond/ wetland/ River ecosystem (any one) – Collect, identify and preserve atleast 20 organisms, study the feeding habits and adapatations of them, construct a Food web and food chain using the specimens collected. Record the date, time, methodology, and observations in the record book.	15	1
1.2	Study of pH and conductivity of water samples using pH and conductivity meter.	4	2
1.3	Estimation of primary productivity in a water body.	4	
1.4	Quantitative estimation of salinity, phosphates and nitrates in water samples.	6	2
1.5	Separation and identification of soil arthropods using Berlese funnel	4	1
1.6	Determination of soil organic carbon and chlorides	6	2
1.7	Qualitative and Quantitative study of marine/freshwater planktons.	4	1
1.8	Principles and application of the following instruments: Rain Guage, Plankton Net, Secchi Disc, GPS.	3	4
1.9	**Field Study:** Conduct Two days field study covering Forest/ grassland or River/ Wetland/ Marine ecosystems. Record ecosystem components (Soil, water, flora, fauna) and their interactions. Prepare a field study report and submit. There will be Viva voce based on the Field study.	50	1
2.0	**GENETICS AND BIOINFORMATICS**	**32**	
2.1	Culture, sexing and etherization of Drosophila.	4	5
2.2	Study of Mutants in Drosophila.	4	5
2.3	Genetics problems (Di hybrid cross, test cross and sex linked inheritance).	4	6
2.4	Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.	4	7
2.5	Methods of sequence alignment-BLAST and ClustalW.	4	7
2.6	Phylogenetic tree using PHYLIP.	4	7
2.7	Gene Prediction using GENSCAN/GRAI.	4	7
2.8	Protein structure visualization using RASMOL	4	7
3.0	**DEVELOPMENTAL BIOLOGY**	**32**	
3.1	Study of the developmental stages of Drosophila	2	5
3.2	Study of the developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill) using permanent slides.	4	8
3.3	Study of serial sections of embryo (tadpole and chick).	4	8
3.4	Vital staining of early gastrula of chick - Window method.	4	8
3.5	Preparation of Shell-less cultures of chick embryos	4	8

3.6	Chorioallantoic membrane grafting with chick embryo limb buds	4	8
3.7	Blastoderm mounting of chick embryo using vital stains.	4	8
3.8	Morphological and histological details of different types of mammalian placenta	2	8
4.0	**BIOCHEMISTRY**	**20**	**9**
4.1	Quantitative estimation of blood glucose by Folin-Wu/Anthrone /DNS/O-Toluidine/Enzymatic method	4	9
4.2	Estimation of proteins by Biuret/ Lowry etal. method	4	9
4.3	Quantitative estimation of blood urea/ creatine/ uric acid	4	9
4.4	Quantitative estimation of cholesterol in the blood	4	9
4.5	Estimation of alkaline and acid phosphatases	4	9

SEMESTER III

S. No.	Course Code	Course
1.	ZY1923109	Animal physiology
2.	ZY1923110	Cell and molecular biology
3.	ZY1923111	Microbiology and biotechnology
4.	ZY1923112	Immunology
5.	ZY1923603	Practical 3. Cell and molecular biology, Microbiology and biotechnology
6.	ZY1923604	Practical 4. Animal physiology,

Course	Details				
Code	ZY1923109				
Title	**ANIMAL PHYSIOLOGY**				
Degree	M.Sc.				
Branch(s)	Zoology				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours / week	4	Total hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Develop detailed understanding of the organization of the human body and the major functional systems	U	5
2	Understand homeostatic mechanism of the major functional systems in invertebrates and vertebrates	U	5
3	Provide adequate knowledge about osmo-regulation in animals living in different habitats.	U	5
4	Analyse the coordination of body functions by chemical messengers and disorders of hormonal imbalance in man.	An	5, 8
5	Students get adequate information regarding sensory system and physiology of different senses	U	5, 8
6	Take students to higher levels of learning about the human reproductive cycles, different aspects related to child birth and reproduction.	Ap	5, 8
7	Take students to higher levels of learning about the human reproductive cycles, different aspects related to child birth and reproduction.	Ap	5, 8

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember;
U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Nutrition, Digestion and Absorption**	**4**	
1.1	Nutrition in animals: Mechanisms of food intake in different animals – **Self study**	0	1
1.2	Neuronal and hormonal regulations of nutritional intake, hunger drive, thirst.	2	1
1.3	Physiology of digestion and absorption. Symbiotic digestion – **Self study**	0	1
1.4	Obesity- causes and consequences, outline of hormonal involvement, Leptin: synthesis, secretion and its role in adipogenesis.	2	1
2.0	**Circulation, Respiration, Osmoregulation and Excretion**	**23**	
2.1	Circulation: Circulatory mechanisms and fluid compartments. Movement of body fluids by somatic muscles, open system, closed system, lymph channels.	3	1
2.2	Circulatory shock, Circulatory arrest.	1	2
2.3	Types of hearts- chambered heart, tubular heart, ampullar heart, lymph heart, neurogenic and myogenic heart.	1	1
2.4	Pace makers and specialized conducting fibers.	2	2
2.5	Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat. human congenital heart diseases	3	2
2.6	Respiration: Respiration in invertebrates and vertebrates.	2	2
2.7	Pulmonary ventilation, respiratory muscles, surfactants	2	2
2.8	Respiration in unusual environment – foetal and neonatal respiration, high altitude, diving	2	2
2.9	Osmoregulation in fresh water, marine and terrestrial animals	2	3
2.10	Regulation of urine formation - Hormonal regulation of urine formation. Regulation of water balance, electrolyte balance and acid-base balance.	3	3
2.11	Dialysis, artificial kidney, kidney transplantation	2	3
3.0	**Neuro, Sensory and Muscle Physiology**	**28**	
3.1	**Neurophysiology**: Modifications of synaptic transmission during fatigue, acidosis, alkalosis, hypoxia and drugs.	3	4
3.2	Mechanism of excitatory and inhibitory pathway	2	4
3.3	Neuromuscular Junction: organization and properties of neuromuscular junction	2	4

3.4	Neural control of muscle tone and posture.	1	4
3.5	Sensory Physiology:Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, electro and thermoreceptors.	3	4, 5
3.6	Modality of sensation, Neuromodulators	1	4, 5
3.7	Secondary sense cells, transduction, relationship between stimulus, intensity and response, Sensory coding	3	5
3.8	Chemical senses: taste, smell, mechanism of reception.	2	5
3.9	Mechanoreceptors: hair cell, organs of equilibrium, mechanism of hearing.	2	5
3.10	Physiology of vision.	1	2
3.11	Pain receptors, headache and thermal senses, pain suppression (analgesia). Tactile sensation: touch receptors, transmission of signals	2	5
3.12	Special problems of premature infants- Physiological role of touch and environment in premature infants- Kangaroo care, infant massage, supportive environment.	2	5
3.13	**Muscle Physiology:** Comparative physiology of skeletal, smooth and cardiac muscles.	1	2
3.14	Red and white muscles, Catch muscle and fibrillar muscle.	1	2
3.15	Muscle proteins, Energetics of muscle contraction.	2	2
4.0	**Thermoregulaion**	**5**	
4.1	Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.	1	2
4.2	Impact of temperature on the rate of biological functions. Arrhinius equilibrium, Q 10.	1	2
4.3	Temperature compensation and temperature regulation in poikilotherms and homeotherms. Adaptations for extreme environments, aestivation and hibernation	3	2
5.0	**Endocrinology & Reproductive physiology**	**12**	
5.1	Vertebrate endocrine system.	2	4
5.2	Synthesis, physiologic role, control and mechanisms of hormone action.	3	6
5.3	Neuro-endocrine regulation of hormone action.	2	6
5.4	Bioamines, Ecosanoids, Chalones, Lumones, Phytohormones, Synthetic hormones.	2	6
5.5	Reproductive physiology: Reproductive cycles of mammals and their hormonal control.	2	6
5.6	Physiology of implantation, pregnancy, parturition, and lactation	1	6

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Course	Details				
Code	ZY1923110				
Title	**CELL AND MOLECULAR BIOLOGY**				
Degree	M.Sc.				
Branch	Zoology				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	4	Total Hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Analyze the structural and functional aspects of the basic unit of life at the molecular level	An	3
2	Evaluate how the cell to cell communications are established and the impacts of signaling in biological systems at molecular level	E	3
3	Analyze the regulated sequence of events involved in cell cycle at the molecular level	An	3
4	Analyze the mechanisms of gene expression and various regulatory pathways involved- in both prokaryotes and eukaryotes at the molecular level	An	3
5	Understand the properties and genetic basis of cancer at the molecular level	U	3
6	Identify the new developments in molecular biology and its implications in human welfare	U	5

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO No.
1.0	**Cell membrane, cell junctions, cell adhesion and extracellular matrix**	**10**	
1.1	Cell membrane: Membrane structure and chemistry,	2	1
1.2	Dynamic nature of the plasma membrane Membrane functions, membrane potentials, ion channels.	2	1
1.3	Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan,Fibronectin.	2	1
1.4	Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.	2	1
1.5	Interaction of cells: Selectins, Immunoglobulins, Cadherins, Adherens.	2	1
2.0	**Cell organelles and cytoskeleton**	**8**	
2.1	Cell organelles: Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria.	4	1
2.2	Cytoskeleton: Microtubules, Microfilaments, Intermediate filaments	2	1
2.3	Molecular motors	1	1
2.4	Non muscle motility and contractility.	1	1
3.0	**Cell signaling**	**15**	
3.1	Messengers: Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers.	2	2
3.2	Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors).	2	2
3.3	Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG).	2	2
3.4	Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA)	2	2
3.5	GPCR pathway in rod cells	1	2
3.6	Receptor protein tyrosine kinase and Ras-MAP kinase pathway	1	2
3.7	JAK-STAT pathway	1	2
3.8	Calcium phosphatidyl- inositol pathway	1	2
3.9	Phospho Inositide 3-kinase (PI- 3 kinase),Transforming growth factor (TGF) signaling pathway	1	2
3.10	Regulation of signaling pathways.	1	2
3.11	Convergence, divergence and crosstalk among different pathways.	1	2

4.0	**Cellular reproduction and cancer**	**12**	
4.1	Cell cycle: Steps in cell cycle	1	3
4.2	Control of cell cycle	1	3
4.3	Checkpoints in cell cycle	1	3
4.4	Control of cell division and cell growth	2	3
4.5	Apoptosis- extrinsic and intrinsic pathways, significance	1	3
4.6	Role of p53 in cell division	1	3
4.7	Cancer: Causes of cancer and Genetics of cancer, Tumour suppressor gene, Oncogene.	2	5
4.8	Role of p53 in cancer	1	5
4.9	New strategies for combating cancer: Immunotherapy, Gene therapy, Inhibiting cancer promoting proteins, Inhibiting formation of new blood vessels.	2	5,6
5.0	**Gene expression and regulation of gene expression**	**27**	
5.1	Gene expression: Relationship between genes and proteins	1	4
5.2	Transcription in prokaryotes and eukaryotes	4	4
5.3	RNA processing in prokaryotes and eukaryotes	3	4
5.4	Translation in prokaryotes and eukaryotes	3	4
5.5	post transcriptional modifications	2	4
5.6	protein sorting, signal sequences and signal hypothesis	2	4
5.7	Regulation of gene expression: Regulation of gene expression in *E. coli* Catabolite repression	1	4
5.8	*Trp* operon in *E.coli*-repression and attenuation	2	4
5.9	*Ara* operon in *E.coli*-positive and negative controls	2	4
5.10	Riboswitches	1	4
5.11	gene regulation in eukaryotes at transcriptional, post transcriptional and translational levels	4	4
5.12	Chromatin-remodelling complexes	1	4
5.13	RNA interference (RNAi). Gene editing (CRISPR-CAS system)	1	4

References

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Course	Details				
Code	ZY1923111				
Title	**MICROBIOLOGY AND BIOTECHNOLOGY**				
Degree	M.Sc				
Branch	Zoology				
Year/Semester	2/III				
Type	Core				
Credits	4	Hrs./Week	4	Total Hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the basic and applied aspects of microbiology	**U**	**3**
2.	Analyze the strategies involved in recombinant DNA technology and environmental biotechnology	**An**	**6,7**
3	Understand the mechanism of microbial metabolism, interaction and ecology	**U**	**3**
4	Identify the role of biotechnology in health care, industry and agriculture	**Ap**	**7**
5	Understand the principles of animal biotechnology	**U**	**7**
6	Apply the knowledge gained about intellectual property rights, biosafety and bioethics	**Ap**	**6**

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember;

U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	**Bacteriology and Virology**	**19**	
1.1	Introduction to Microbiology: Methods of Microbiology, Main group of microorganisms, general characters.	1	1
1.2	Classification, approaches to microbial classification, outline classification, Bergey's manual.	1	1
1.3	Functional Anatomy of Prokaryotic Cells: Cell	1	1

	structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions..		
1.4	The prokaryotic cell envelope, peptidoglycan structure, gram positive and negative cell walls	1	1
1.5	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.	1	1
1.6	Microbial Metabolism: Energy acquisition by chemotrophs and phototrophs, glycolysis (Embden-Meyerhof pathway).	2	3
1.7	Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Regulation of metabolism.	1	3
1.8	Nutrition and Growth: Common nutrient requirements, nutritional types, growth factors, uptake of nutrients by the cell. Culture media. Reproduction and exponential growth, the growth curve.	1	3
1.9	Physical requirements for bacterial growth and influence of environmental factors on growth.	1	3
1.10	**Microbial Interactions** Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals.	1	3
1.11	Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites.	1	3
1.12	Microbial Ecology**:** Bacteria in Agriculture (Biofertilizers- Rhizobium) growth promoting bacteria, Azospirillum. (Biopesticides – Bacillus thurengiensis)	1	1,3
1.13	Economic importance of bacteria: A brief account of economic importance- Industry-brewing, Medicine-vaccines, steroid biotransformation, hormones and environment bioleaching, bioremediation.	1	1
1.14	**Virology:** Properties of viruses**,** structure and chemical composition, genetic composition eclipse, host interaction and specificity**.**	1	1
1.15	Classification: RNA virus , DNA virus, plant virus, animal virus, bacteriophage	1	1
1.16	Viral replication - lysis and lysogeny, Viroids and prions. Nature and significance. Pathogenic virus, oncovirus.	1	1
1.17	Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases.	1	1
1.18	Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.	1	1
2	**Applied Microbiology**	**11**	

2.1	Bacteria of air, water and soil. Microbes associated with food production and spoilage, microbiology of milk and dairy products.	2	1
2.2	Microbial indicators of food safety and quality control**:** Principles of quality control and microbiological criteria, Indicators of product quality and microbiological safety of foods, Hazard analysis	2	1
2.3	Medical mycology: Dimorphism Mycoses –Superficial, Opportunistic, Systemic, Antifungal agents	2	1
2.4	Epidemiology of human diseases**:** Mechanism of microbial pathogenicity. Normal microbial population on human body, microbial diseases- recent outbreaks	1	1
2.5	Nosocomial infection: Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programmes, preventing nosomical infections and surveillance	2	1
2.6	Control of microorganism- physical, chemical and antimicrobial agents. Biological weapons and bioterrorism.	2	1
3	**Genetic Engineering**	**15**	
3.1	Tools in Genetic engineering: Cloning hosts : *E. coli*, *Saccharomyces*, Plant and animals cells	1	2
3.2	Gene transfer (Physical, microinjection and vector mediated methods)	1	2
3.3	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.	1	2
3.4	Restriction enzymes and DNA modifying enzymes (Restriction and modification enzymes, Other nucleases, Polymerases, Ligase, Kinases and Phosphatases),	1	2
3.5	Cloning Methodologies - Gene isolation: Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis.	1	2
3.6	Splicing and integration of isolated gene-cohesive end ligation, homopolymer tailing, extending linkers.	1	2
3.7	PCR: Principle, Methodology, Types - RT-PCR, RAPD, AFLP, ISSR, inverse PCR and Real time PCR and their applications	2	2
3.8	DNA sequencing methods: Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing method.	1	2
3.9	Capillary gel electrophoresis for DNA sequencing and NGS recent methods of DNA sequencing and	1	2

	their applications		
3.10	Chromosome walking, chromosome jumping, DNA foot printing	1	2
3.11	Molecular Markers and Probes- SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. Site directed mutagenesis, molecular chimeras.	2	2
3.12	Methods of rDNA transfer to host cells: $CaCl_2$ treatment, Virus delivery.	1	2
3.13	Selection and screening of the transformed cells: Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.	1	2
4	**Animal Biotechnology**	**12**	
4.1	Cell and Tissue culture**:** Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation.	2	5
4.2	Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications	2	5
4.3	Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Control and prevention of contamination	2	5
4.4	Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture.	2	5
4.5	Tissue engineering: strategies and developments in tissue engineering, Biomaterials.	1	5
4.6	**Cryopreservation** - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics.	1	5
4.7	Somatic cell nuclear transfer: Reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.	2	5
5	**Applications of Biotechnology**	**15**	
5.1	**Biotechnology in Healthcare** Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders	1	4
5.2	Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine.	1	4
5.3	Biosensors-different types, applications - medical and non medical.	1	4
5.4	Biochips introduction and their application in modern sciences.	1	4
5.5	**Biotechnology in Industry:** Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstream processing.	1	4

5.6	Microbial enzymes and biotranformation- Microbial production of enzymes, fermentation, - Enzyme engineering and applications. Food Industry- Single cell protein, probiotics. Biotransformation-brief account	1	4
5.7	Biotechnology in Agriculture: Transgenic plants- Plants with resistance to Pests, plants with increased shelf life.	1	4
5.8	Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology -concept and basics	1	4
5.9	**Environmental Biotechnology:** Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds.	2	2,4
5.10	Bioremediation and Biorestoration. Microbial leaching and mining. Biofuels. Transgenics and environment	1	2,4
5.11	Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments,	1	6
5.12	Protection of New GMOs. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to History of GATT, WTO, WIPO and TRIPS.	1	6
5.13	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.* Ethics in post genomic era-genetic testing and genetic screening.	2	6

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Microbiology

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2. Apurba S. Sastry , Sandhya Bhat 2018 *Essentials of Medical Microbiology* Jaypee Brothers Medical Publishers; Second edition
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Biotechnology

1. Bernard R. Glick and Jack J. Pasternak 2002. *Molecular Biotechnology: Principles and Applications of Recombinant DNA* **Publisher:** American Society for Microbiology; 3rd Revised edition edition
2. Das, H.K. 2007. *Text book of Biotechnology*.Wiley India Pvt. Ltd. New Delhi
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Course	Details				
Code	ZY1923112				
Title	**IMMUNOLOGY**				
Degree	MSc				
Branch(s)	Zoology				
Year/Semester	2/III				
Type	Core				
Credits	3	Hours /week	3	Total Hours:	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Recall the overview in the field of immunology	R	3
2	Examine the advanced molecular- theoretical approach in Antigen and antibodies and the interactions between them	Ap	3,6
3	Understand the organisation, expression and regulation of Major Histocompatibility Complex	U	3
4	Create intensive and in-depth knowledge in immunological pathways like, complement system, inflammations, hypersensitivity etc.	C	3
5	Understand the role of immune system in human health and well-being	U	3
6	Understand the advanced techniques in immunological diagnosis and other immunological techniques	U	6,7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**The Immune System**	**16**	
1.1	Types of Immunity- Innate and acquired, Passive and active.	1	1
1.2	Humoral and cell-mediated immune responses.	1	1
1.3	Haematopoiesis.	1	1
1.4	B cell and T-cell maturation and differentiation	2	1
1.5	Antigens and Antibodies: Antigen processing and presentation	2	2
1.6	Genetic model compatible with Ig structure.	1	2
1.7	Multi- gene organization of Ig genes.	1	2
1.8	Variable region gene arrangements.	1	2
1.9	Generation of antibody diversity.	2	2
1.10	Monoclonal antibodies as abzymes.	1	2
1.11	Antigen –Antibody Interactions : Affinity and Avidity, Cross reactivity.	2	2
1.12	Precipitation and Agglutination reactions.	1	2
2.0	**Major Histocompatibility Complex :**	**7**	
2.1	General organization of MHC molecules and genes	1	
2.2	H-2 Complex in mouse and HLA Complex in humans.	1	3
2.3	MHC-peptide interaction. Expression of MHC molecules on different cell types.	2	3
2.4	Regulation of MHC expression.	2	3
2.5	HLA typing (Brief mention only)	1	3
3.0	**Immune Effector Mechanisms**	**11**	
3.1	The Complement System : Complement activation - classical, alternative and lectin pathways, MAC	2	4
3.2	Regulation of complement system	1	4
3.3	Biological consequences of complement activation	1	4
3.4	Inflammation- types- acute and chronic.	1	4
3.5	Cytokines - Properties and functions	2	4
3.6	Therapeutic uses of cytokines. Chemokines.	1	4
3.7	Hypersensitivity – Types and mechanisms	2	4
3.8	Allergy	1	4
4.0	**Immunity in Health and Disease**	**13**	
4.1	Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections	2	5
4.2	Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD).	2	5

4.3	Acquired Immunodeficiency Disease (AIDS)	1	5
4.4	Autoimmunity. Organ- specific autoimmune diseases.	1	5
4.5	Systemic auto-immune diseases.	1	5
4.6	Transplantation immunology - Clinical manifestation of graft rejection	1	5
4.7	General and specific immunosuppressive therapy	1	5
4.8	Clinical transplantation, Immunologic basis of graft rejection. MHC and graft rejection	2	5
4.9	Vaccines. Whole organism vaccines.	1	5
4.10	Purified macromolecules as vaccines. DNA and Recombinant vector vaccines.	1	5
5.0	**Immunological Techniques**	**7**	
5.1	RIA, ELISA, Radio-allergosorbent Test (RAST)	2	6
5.2	Immunoprecipitation. Immunofluorescence.	1	6
5.3	Flow cytometry and fluorescence.	1	6
5.4	Immunoelectron microscopy.	1	6
5.5	Knock-out and Knock-in technology.	1	6
5.6	Inducible gene targeting – the Cre/lox system.	1	6

References

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Course	Details				
Code	ZY1923603				
Title	**CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY**				
Degree	M.Sc				
Branch	Zoology				
Year/Semester	2/III				
Type	Practical				
Credits	2	Hrs./Week	5	Total Hours	90

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Analyse and identify the various meiotic and mitotic stages	An	3
2.	Calculate mitotic index in normal cell and observe the effect of drugs on cell division	Ap	3
3	Identify the salivary gland chromosomes	Ap	3
4	Understand and apply the various histochemical staining techniques for the identification of biomolecules	Ap	3
5	Isolate genomic DNA and plasmid DNA	Ap	3
6	Understand and apply the knowledge involved in sterilization techniques and culture techniques, media preparation	Ap	3,5
7	Understand the methods to identify and enumerate microorganisms	U	3,7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Cell Biology**	**14**	
1.1	Squash preparation and identification of grasshopper testis to study meiotic stages	4	**1**
1.2	Determination of mitotic index in the squash preparation of onion root tip	4	2
1.3	Effect of drugs on cell division (Colchicine or any other inhibitor)	2	2
1.4	Salivary gland chromosomes in *Drosophila* / *Chironomus* larva	4	3
2.0	**Tissue processing and histochemical staining**	**16**	
2.1	Carbohydrates (PAS)	4	4
2.2	Protein (Bromophenol blue)	4	4
2.3	lipids (Sudan Black),	4	4
2.4	DNA (Fuelgen stain)	4	4
3.0	**Molecular Biology**	**12**	
3.1	Cell fractionation and Differential Centrifugation -Isolation of mitochondria and nuclei	2	5
3.2	Isolation of DNA	2	5
3.3	Separation of genomic DNA using Agarose gel electrophoresis	4	5
3.4	Isolation of Plasmid DNA	4	5
4	**Microbiology**	**32**	
4.1	Sterilization, disinfection and safety in microbiological laboratory.	2	6
4.2	Preparation of culture media**:** liquid media – nutrient broth , peptone water	2	6
4.3	Solid media – Nutrient Agar, Mac Conkey' Agar, Semi solid agar, Firm agar	4	6
4.4	Culturing of microorganism: Broth culture, pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture	2	7
4.5	Serial dilution and standard plate count, calculation of Cfu/ml in water samples. Isolation and preservation of bacterial culture	4	7
4.6	Staining techniques- gram staining of mixed cultures, negative staining and spore staining	2	7
4.7	Antibiotic sensitivity (different natural fluids)	4	7
4,8	Oxidase test	4	7
4.9	Catalase test	4	7
4.10	Oxidation/fermentation (O/F) test	4	7
5.0	**Staining and enumeration of microorganisms**	**18**	
5.1	Using haemocytometer	4	7
5.2	Nephelometry/ Turbidimetry	4	7
5.3	Coliform count in water	4	7
5.4	Isolation and enumeration of soil bacteria	2	7

5.5	Identification of symbiotic bacterioids from root nodules of leguminous plants	2	7
5.6	Bacteriological analysis of milk- methylene blue reductase test	2	7

References

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2. Apurba Sankar Sastry, and Sandhya Bhat K 2018**.** *Essentials of Practical Microbiology* Jaypee Brothers Medical Publishers
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Course	Details				
Code	ZY1923604				
Title	**ANIMAL PHYSIOLOGY, IMMUNOLOGY**				
Degree	M.Sc.				
Branch	Zoology				
Year/Semester	2/III				
Type	Practical				
Credits	2	Hrs/week	5	Total hours	90

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the working principle and processes of instruments and techniques used in Physiology and Immunology	U	3, 7
2	Understand and observe the physiological processes using lower organisms	U	3
3	Develop skills to conduct hematological studies and evaluate its results	Ap	3, 7
4	Evaluate the difference between myogenic and neurogenic heart by assessing the effect of drugs on the heart beat of cockroach	E	3
5	Evaluate the affect of stress on Oxygen consumption and lactic acid content using fish as model organism	E	3
6	Evaluate the different factors influencing the rate of enzyme action	E	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Enzyme Kinetics**	**14**	
1.1	Rate of salivary amylase activity on starch (colorimetry)	3	6
1.2	Effect of different pH on salivary amylase activity (colorimetry)	5	6
1.3	Influence of temperature on salivary amylase activity – Calculation of Q 10	6	6
2.0	**Physiological experiments**	**23**	

2.1	Effect of drugs on the heartbeat of cockroach (Result with graphical representation corresponding to different concentration and time intervals expected)	4	2, 4
2.2	Oxygen consumption in fish (normal and stressed). Graphical representation and interpretation.	6	5
2.3	Kymograph: working principle and applications.	1	1
2.4	Observation on the effect of decreasing PO2 of water on the respiratory rate of a fish and determination of the lactic acid content of the muscle	3	5
2.5	Feeding activity of paramecium	4	2
2.6	The threshold for sugar of the tarsal taste organ of butterflies	2	2
2.7	Effect of temperature on the movement of insects (graph plotes showing the relationship between temperature and time of movement)	3	2
3.0	**Virtual Practicals in Physiology** -*Use of PhysioEX 9.0	**12**	
3.1	(1)Muscle Twitch and the Latent Period	3	1
3.2	(2)The effect of stimulus Voltage on Skeletal Muscle Contraction	3	1
3.3	(3)Tetanus	3	1
3.4	(4) The Action Potential Threshold	3	1
4.0	**Haematological studies**	**19**	
4.1	Differential count of Human	5	3
4.2	Haematocrit and ESR of Human blood	5	3
4.3	WBC Effect of different concentration of NaCl solution (0.1% -2%) on the diameter of RBCs (preferably human) and determi nation of the concentration , which is isotonic to the blood from a plot of diameter of RBC against concentration of NaCl	5	3
4.4	Preparation of haemin crystals.	2	3
4.5	Clotting time of blood	1	3
4.6	Bleeding time	1	3
5.0	**Immunology**	**22**	
5.1	Separation of lymphocytes from whole blood.	3	1
5.2	Separation of T and B lymphocytes	2	1
5.3	Blood Typing in Man.	1	1

5.4	WIDAL Test.	2	1
5.5	Western Blotting –Demonstration	2	1
5.6	ELISA -Demonstration	2	1
5.7	Rocket Immuno electrophoresis- Demonstration	2	1
5.8	Identification of Autoimmune disorders (Pictures may be used)	2	1
5.9	Demonstration of single radial immunodiffusion using Mancini's technique	3	1
5.10	Demonstration of double immunodiffusion using Ouchterlony's method	3	1

*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.

SEMESTER IV

S. No.	Course Code	Course - Entomology specialisation courses
1.	ZY1924301	Entomology: morphology and taxonomy
2.	ZY1924302	Entomology: Anatomy and physiology
3.	ZY1924303	Applied Entomology
4.	ZY1924304	Vector and Vector Borne diseases
5.	ZY1924305	Insect Toxicology
6.	ZY1924701	Practical 5. Entomology: morphology and taxonomy
7.	ZY1924702	Practical 6. Entomology: Anatomy and physiology, Applied Entomology, Insect toxicology/ Vector and Vector Borne diseases

Course	Details				
Code	ZY1924301				
Title	**ENTOMOLOGY: MORPHOLOGY AND TAXONOMY**				
Degree	MSc.				
Branch(s)	Zoology				
Year/Semester	II/IV				
Type	Core				
Credits	4	Hours/week	4	Total Hours	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Comprehensive understanding of insect taxonomy	U	4
2	Understand in details about the various morphological parts of insects	R	4
3	Evaluate the economic and medical importance of insects	E	4
4	Discuss the development and Behaviour of insect in fine points	U	4
5	Encourage research aptitude among students by familiarizing frontier areas of entomology	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Introduction**	**4**	
1.1	Scope and importance of insects	1	1
1.2	Origin and evolution of insects	2	1
1.3	Fossil insects	1	1
2.0	**Insect Morphology**	**20**	
2.1	General segmentation and divisions of the body; Primary and secondary segmentation	2	2
2.2	General morphology of head (Opisthognathus, Prognathus, Hypognathus). head segmentation	1	2
2.3	Head skeleton; tentorium; modifications in head	1	2

	capsule		
2.4	Cephalic appendages; antennae, structure, functions and types	1	2
2.5	Mouth parts, various modifications, feeding mechanisms	2	2
2.6	General morphology of thorax; thoracic segmentation, thoracic skeleton and thoracic appendages	2	2
2.7	Wings – structure, venation, wing articulation, wing coupling apparatus, wing modifications	2	2
2.8	Legs-structure and adaptive radiation of legs, locomotion	1	2
2.9	Morphology of abdomen and its appendages	1	2
2.10	External genitalia-structure and diversity of male and female genitalia. Grasshopper, Drosophila, Cockroach, Dragonfly	2	2
2.11	Sense organs – structure and classification of sense organs (Hair organs, plate organs, campaniform organs, compound eyes and vision)	3	2
2.12	Light and sound producing organs – structure of light producing organs, production of light	1	2
2.13	Stridulatory organs in various insects	1	2
3	**Insect Classification**	**34**	
3.1	Methods of Insect collection and preservation	1	1,5
3.2	General characters, biology and habits of different orders of insects; classification of insects up to families 1. Order: Ephemeroptera Family: Ephemeridae, Potamanthidae, Baetidae, Ecdyuridae	1	1,5
3.3	2. Order: Plecoptera Family: Pteronarcidae, Perlidae, Nemuridae, Capniidae	1	1
3.4	3. Order: Odonata Family: Lestidae, Agrionidae, Gomphidae, Libellulidae	1	1
3.5	4. Order: Embioptera Family: Ephemeridae, Oligoneuriellidae, Ephemerellidae, Ecdyuridae	1	1
3.6	5. Order: Orthoptera Family: Tettigoniidae, Gryllidae, Gryllotalpidae, Gryllacridae	1	1
3.7	6. Order: Phasmatodea Family: Phasmidae, Bacillidae, Phyllidae, Bacunculidae	1	1
3.8	7. Order: Grylloblattodea Family: Grylloblattidae	1	1
3.9	8. Order: Diplogossata Family: Hemimeridae	1	1
3.10	9. Order: Dermaptera	1	1

	Family: Forficulidae, Labiduridae, Apachyidae, Arixeniidae		
3.11	10. Order: Blattaria Family: Blattidae, Blaberidae, Phyllodromiidae, Panesthiidae	1	1
3.12	11, Order: Manteodea Family: Mantoididae, Deroplatidae, Oligonycidae, Toxoderidae	1	1
3.13	12. Order: Zoraptera Family: Zorotypidae	1	1
3.14	13, : Isoptera Family: Termitidae, Rhinotermitidae, Kalotermitidae, Termopsidae,	1	1
3.15	14. Order: Psocoptera Family: Atropidae, Psocidae, Lepidopsocidae	1	1
3.16	15, Order: Phthiraptera Family: Menoponidae, Philopteridae, Phthiridae, Pediculidae	1	1
3.17	16. Thysanoptera Family: Tripidae, Phloeothripidae, Merothripidae	1	1
3.18	17. Order: Heteroptera Family: Scutelleridae, Pentatomidae, Reduviidae, Cimicidae, Belostomatidae	1	1
3.19	18. Order: Homoptera Family: Fulgoridae, Aphididae, Coccidae, Lacciferidae, Adelgidae	1	1
3.20	19. Order: Coleoptera Family: Caraboidae, Lampyridae, Elateridae, Cerambycidae, Curculionidae	1	1
3.21	20. Order: Strepsiptera Family: Stylopidae, Elenchidae	1	1
3.22	21. Order: Hymenoptera Family: Evaniidae, Formicidae, Vespidae, Apidae, Xylocopidae	1	1
3.23	22. Order: Megaloptera Family: Corydalidae, Sialidae,	1	1
3.24	23. Order: Raphidiodea Family: Raphididae, Inocellidae	1	1
3.25	24. Order: Neuroptera Family: Myrmeleontidae, Chrysopidae, Mantispidae, Ascalaphidae	1	1
3.26	25. Order: Mecoptera Family: Bittacidae, Panorpidae, Boreidae	1	1
3.27	26. Order: Trichoptera Family: Hydroptilidae, Hydropsychidae, Leptoceridae	1	1
3.28	27. Order: Lepidoptera Family: Pieridae, Papilionidae, Nymphalidae, Bombycidae, Sphingidae	1	1

3.29	28. Order: Diptera Family: Culicidae, Simuliidae, Tabanidae, Muscidae, Drosophilidae	1	1
3.30	29. Order: Aphaniptera Family: Pulicidae, Leptopsyllidae, Ceratophyllidae	1	1
3.31	30. Order: Thysanura Superfamily: Machiloidea, Lepismatoidea	1	1
3.32	31. Order: Aptera Superfamily: Campodeidae, Japygidae	1	1
3.33	32. Order: Protura Family: Eosemtomidae, Protentomidae, Acerentomidae	1	1
3.34	33. Order: Collembola Family: Poduridae, Entomobryidae, Sminthuridae	1	1
4	**Behaviour**	**8**	
4.1	Communication; acoustic, visual, tactile and chemical methods	2	4
4.2	Adaptations of parasitic and predatory insects	2	3,4
4.3	Study of aquatic insects; factors influencing the aquatic life, food capture – modifications, anchorage, locomotion, respiration, oviposition and adaptations of swimming forms	4	4
5	**Insect Development**	**6**	
5.1	Egg, structure and adaptations	1	4
5.2	General pattern of embryonic development	1	4
5.3	Polyembryony; parthenogenesis and paedogenesis	1	4
5.4	Metamorphosis	2	4
5.5	Diapause	1	4

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11. Pathak S.C. Ed. 1986. *Recent Advances in Insect Physiology, Morphology and Ecology*. Today and Tomorrow Printers and Publishers, New Delhi.
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Course	Details				
Code	ZY1924302				
Title	**ENTOMOLOGY: ANATOMY AND PHYSIOLOGY**				
Degree	M.Sc.				
Branch	Zoology				
Year/Semester	2/IV				
Type	Theory				
Credits	4	Hrs/week	4	Total hours	72

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the fundamental anatomy of insects	U	4
2	Analyze and integrate the physiology of nervous coordination, digestion, circulation, respiration, excretion and reproduction in insects	An	4
3	Analyze the role of microbes in normal physiology of insects	An	4
4	Analyze the unique metabolic pathways through which insects maintain structural and functional integrity	An	4
5	Evaluate the role of hormones and pheromones in the anatomy and physiology of insects	E	4
6	Evolve management strategies	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**The Integument, gas exchange and homeostasis**	**21**	
1.1	Integumantary system: Anatomy and histology - physical and chemical properties	2	1
1.2	Chemistry of the cuticle	2	1
1.3	Moulting and sclerotization	1	1
1.4	Gaseous exchange: Organization and structure of tracheal system: trachea, trachioles, spiracles and air sacs	2	1,2
1.5	Movement of gases within the tracheal system: Diffusion, discontinuous gas exchange, active	2	1,2

	ventilation		
1.6	Respiratory pigments	1	1,2
1.7	Gas exchange in aquatic insects: closed and open tracheal system	2	1,2
1.8	Gas exchange in endoparasitic insects	1	1,2
1.9	Gas exchange in insect eggs	1	1,2
1.10	Homeostasis: Anatomy and histology of malphigian tubules- Hemiptera, Coleoptera and Lepidptera	2	1,2
1.11	Nephro-rectal complex and labial glands	1	1,2
1.12	Physiology of excretion- Synthesis of uric acid	1	1,2
1.13	Physiology of excretion- formation of excreta	1	1,2
1.14	Salt and water balance- terrestrial, freshwater, brackish water and salt water (Mention Hormonal control)	2	1,2
2.0	**Digestion, circulation, metabolism and immune mechanisms**	**24**	
2.1	Digestion: Anatomy and histology of gut	2	1,2
2.2	Modification of gut (filter chamber)	1	1,2
2.3	Physiology of digestion and absorption- wood, keratin, wax and silk	2	1,2,3
2.4	Extra intestinal digestion	1	1,2
2.5	Role of microbe in digestion	1	1,2
2.6	Circulatory system: Structure of insect circulatory system- dorsal vessel, dorsal and ventral diaphragm and accessory pulsatile organs	2	1,2
2.7	Haemolymph - plasma and haemocytes- composition	2	1.2
2.8	Functions of haemocytes	1	1.2
2.9	Course of circulation	1	1,2
2.10	Heart beat and its regulation- cardioacceleratory peptides	1	1,2
2.11	Metabolism of insecticides	1	1,2
2.12	Diapause as a metabolic process	1	1,2
2.13	Fat body- structure and development	2	1,4,6
2.14	Storage and utilization of energy and nutrients	1	1,4
2.15	Intermediary metabolism- Glycolysis, glycerol phosphate shuttle	1	1,4,6
2.16	Intermediary metabolism- Trehalose biosynthesis	1	1,4.6
2.17	Flight metabolism	1	1,2
2.18	Cell mediated and humoral immunity	1	1,2,6
2.19	Transferrins, Dscam- short notes	1	1,2,6

3.0	**Muscular system**	**4**	
3.1	Structure of muscle	1	1,2
3.2	Skeletal and visceral muscles	1	1,2
3.3	Physiology- Neuromuscular junctions	1	1,2
3.4	Excitation of muscle fibers, role of fast and slow axons	1	1,2
4.0	**Insect coordination and communication**	**18**	
4.1	Basic components and anatomy of nervous system	2	1,2
4.2	Physiology- reception and transmission of stimuli	2	1,2
4.3	Physiology- production and conduction of nerve impulses	2	1,2
4.4	Physiology of Chemoreception	1	1,2
4.5	Photoreception- Form and Movement Perception, Distance perception	1	1,2
4.6	Spectral Sensitivity and Colour vision	1	1,2
4.7	Sensitivity to polarized light	1	1,2
4.8	Endocrine organs- corpora cardiac, corpora allata, molt glands and prothoracic glands	2	1,5
4.9	Hormones and their functions	2	1,2,5
4.10	Regulation of hormone titer	1	1,2,5
4.11	Insect communication**:** Insect semiochemicals and communication- Pheromones (types), kairomones, synomones	1	1,5,6
4.12	Insect semiochemicals and communication- Environmental, neural and Endocrine interaction	2	1,5,6
5.0	**Reproductive system**	**5**	
5.1	Anatomy of the internal reproductive organs- Male insect	1	1,2,6
5.2	Anatomy of the internal reproductive organs- Female insect	1	1,2,6
5.3	Spermatozoa, transfer of sperm to the female	1	1,2,6
5.4	Oogenesis and ovulation	1	1,2,6
5.5	Fertilization and oviposition	1	1,2,6

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Course	Details				
Code	ZY1924303				
Title	**APPLIED ENTOMOLOGY**				
Degree	M.Sc				
Branch	Zoology				
Year/Semester	1/IV				
Type	Elective				
Credits	4	Hrs./Week	4	Total Hours	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand insects encountered in agricultural fields.	U	4
2	Envisages an insight on economically important pests of various foods, fiber and household	An	4
3	Understands various insect pest management methods and its significance	U	4
4	Learn to apply various agricultural equipment and understand the effect of chemicals and its dosages in agricultural pest management	Ap	4
5	Manage and Practice Apiculture, Sericulture and lac culture units and understand the economically important insects	Ap	4
6	Understand the importance of insects in crime detection	U	4
7	Learn to apply the pest control methods wisely to minimise ecological backlash	Ap	4
8	Discuss the evolutionary significance of insect plant interaction and insect animal interaction	An	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Insect Pests and Insect Host Interactions**	**15 hrs.**	
1.1	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.	2	1
1.2	Causes of pest outbreak. Pest resurgence and replacement (secondary pest outbreak). Causes and management of resurgence and replacement	2	1
1.3	Forecasting pest outbreaks and surveillance (Short term and long term forecasting); Forecasting based on observations – climatic and empirical factors	2	1
1.4	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).	2	1
1.5	**Insect Host Interactions:** Selection of hosts (plants and animals)	1	8
1.6	Evolution of phytophagy and haematophagy in insects	2	8
1.7	Insect host resistance, Recent trends in insect host interaction	2	8
1.8	Insect pollinator – plant interaction.	2	8
2.0	**Insect Pests of Crops**	**17 hrs.**	
2.1	Life history, nature of damage and control measures of major pests of **1. Paddy** *Leptocorisa acuta, Scirpophaga incertulas,Spodoptera mauritia* *Orseolia oryzae, Nilaparvata lugens (self study)* *Tryporyza incertulus, Dicladispa armigera,* *Cnaphlcrosis medinalis*	1	2
2.2	**2. Coconut** *Oryctes rhinoceros, Rhyncophorus ferrugineus, Opisina arenosella, Aceria guerreronis* (self study) *Leucopholis coneophora*	1	2
2.3	**3. Cotton** *Helicoverpa armigera, Dysdercus cingulatus, Pectinophora gossypiella, Agrotis Ipsilon,* Cotton stem borer, Mealy bugs	2	2
2.4	**4. Mango** *Batocera eufomaculata, Idioscopus niveoparsus,*	1	2

	Dacus dorsalis **5. Cashew** *Plocaderus ferrugineus, Helopeltis antonii, Thylocoptila panrosema*		
2.5	**6. Sugar cane** *Chilo infescatellus, Chilo saccharifagus, Scirpophaga excerphalis* *Pyrilla perpusilla, Sesamia inferens, Aphanisticus aeneus Kerremans, Heteronychus annulatus Bates*	2	2
2.6	**7. Pulses** *Exelastis atmosa, Melanogromyza obtuse, Callosobranchus chinensis (pulse beetle)* **8.Stored products** Tribolium castaneum, *Sitophilus oryzae, Trogoderma granarium* *Callasobruchus chinensis, Corcyra cephalonica* (self study) *Tenebrio molitor*	2	2
2.7	**9.Coffee** *Xylosandrus compactus, Xylotrechus quadripes, Coccus viridis* **10. Tea** *Emposca flavescens, Helopeltis theivora, Xyleborus fornicates*	1	2
2.8	**11. Banana** *Cosmopolites sorditis, Pentalonia nigronervosa (self study)* *Odeoporus longicollis, Spatoptera lituca* **12. Pepper** *Longitassus nigripennis, Cydia hemidoxa*	1	2
2.9	**13. Cardamom** *Sciothrips cardamom, Dichocrocis punctiferalis* **14. Turmeric** *Conogethes punctiferalis, Aspidiella hartii, Udaspes folus* **15. Ginger**, *Aspidiella hartii, Udaspes folus, Adoretus sinicus*	1	2
2.10	**16. Tapioca** *Aleurodicus disperses, Bemisia tabaci, Aonidomytilus albus* **17. Rubber** *Saissetia nigra, Mealy bug, Termites* **18. Vegetables** *Leucinodes orbonalis, Euzophera perticella, Henosepilachna viginti octopunctata, Urentius hystricellus,P thorimaca operculella, Pieris brassicae (self study)* *Raphidopalpa foveicollis, Baris trichosanthis*	2	2

	Bactocera cucurbitae, Anadevidia peponis, Epilachna spp., (self study) Aphids		
2.11	Locusts and Termites –life history and migration, damage and control	2	2
2.12	Social organisation and behaviour with reference to Termites and Ants	1	2
3.0	**Insect Pest Control**	**22 hrs.**	
3.1	Prophylactic methods. Curative methods- Cultural methods;	1	3
3.2	Mechanical methods; Physical methods; Legal methods.	1	3
3.3	Biological control- History, Agents of biological control – Pathogens, Parasitoids, Predators	2	3
3.4	The practice of biological control; classical biological control, Augmentation and conservation: inundative and inoculative releases, seasonal inoculative release;	2	3
3.5	Economic dimensions of biological control, Merits and demerits; Important biological control projects undertaken in India against insect pests and weeds.	2	3
3.6	Autocidal control – Sterile male technique, Mechanism of sterility Methods of sterilization:,Radiations, Chemosterilants, application- advantages and disadvantages, examples	1	3
3.7	Pheromonal control – Mode of application, pest management with pheromones. Advantages and disadvantages. Examples;	1	3
3.8	Insect growth regulators (IGRS): Major group of IGR's- Juvenile hormone agonists, ecdysone agonists, ecdysone antagonists, chitin synthesis inhibitors	1	3
3.9	Insect repellents – Definition, features of good repellents, types, applications in pest management, advantages and disadvantages and examples.	1	3
3.10	Insect antifeedants – Definition, types, applications, advantages, disadvantages, examples.	1	3
3.11	Microbial control of crop pests by employing bacteria, virus and fungi. Mode of action, advantages and disadvantages, examples	2	3
3.12	Insect attractants – definition, types, application in pest management. Advantages and disadvantages and examples	1	3
3.13	Pest management – concepts, definition, characteristics, pest management strategies and	2	3

	techniques integrated pest management – definition,		
3.14	IPM in agro ecosystem, Preventive practice, therapeutic practice, guidelines for developing IPM. IPM of rice.	2	3
3.15	Ecological backlash and its management Insecticide resistance- Genetic, Physiological and biochemical mechanisms.	2	3,7
4.0	**Chemical Control**	**12 hrs.**	
4.1	Insecticide formulations, Insecticide appliances and applications	1	4
4.2	Classification of insecticides – based on mode of entry, mode of action , chemical nature, toxicity	2	4
4.3	Chemistry and mode of action of insecticides; Inorganic compounds as insecticides - Arsenic, fluoride and sulphur compound	1	4
4.4	Synthetic organic insecticides - Organochlorine compounds (DDT, BHC, Endosulfan – heptachlor, dieldrin). Organo phosphorous insecticides – monocrotophos, tetra ethyl pyrophosphate, parathion, carbamates – carbaryl, carbofuran	2	4
4.5	Botanical insecticides – chemical properties, mode of action and toxicity. (nicotine, rotenone, pyrethrum and neem	1	4
4.6	Ethnobotanical traditions. Synthetic pyrethroids – definition, uses as insecticides, mode of action (pyrethrin, allethrin).	2	4
4.7	Fumigants – definition, examples, methods of fumigation, hazards, precautions, advantages;	1	4
4.8	Insecticide synergists – definition, types of synergism, mode of action and examples	1	4
4.9	Pesticide impact on soil, wildlife and human health	1	4
5.0	**Insects of economic importance and Forensic Entomology**	**6**	
5.1	Biology and rearing of Silk worm, lac insect; Honey bees (self study)	3	5
5.2	Forensic Entomology: Insects of forensic importance. Examples	1	6
5.3	Methods in forensic entomology, Estimation of Post mortem index (PMI),	1	6
5.4	DNA techniques in forensic entomology. Scope of forensic entomology	1	6

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Course	Details				
Code	ZY1924304				
Title	**VECTOR AND VECTOR BORNE DISEASES**				
Degree	M Sc.				
Branch(s)	Zoology				
Year/Semester	2/IV				
Type	Elective				
Credits	3	Hours /week	3	Total Hours	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand vectors and mode of disease transmission by them	U	4
2	Identify the common vectors of domestic animals and man	U	4
3	Discuss the significance of insect vectors in transmitting human diseases which are of importance in public health	U	4
4	Understand and choose the appropriate method to alleviate and control the population of insect vectors	Ap	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	**Insect vectors: Mode of disease transmission**	**3**	
1.1	Epidemiological triad - vectors - pests - transmission - cyclic and secular trend of diseases.	1	1
1.2	Modes of disease transmission: vertical and horizontal transmission - biological, mechanical and contact	2	1
2.0	**Vectors of Domestic Animals and Man**	**6**	
2.1	Insects vectors of human diseases belong to diptera, anoplura, siphonoptera	2	2
2.2	Identification, nature of attack	2	2
2.3	Control measures of insect pest of domestic animals-cattle, sheep and goat, fowl ,duck, dog	2	2
3.0	**Insects as vectors of human diseases of public health importance**	**20**	
3.1	Mosquitoes: Biology: life cycle Salient features of Mosquitoes – Anopheles, Aedes, Culex	2	3
3.2	Mansonia Sand flies: Biology of Phlebotomus.	2	3
3.3	Other dipterans: Breif account of Black flies, Horse flies, Tsetse flies, House flies	3	3
3.4	Myiasis causing flies	1	3
3.5	Biting midges: Fleas: Salient features of important species of Xenopsylla	2	3
3.6	Ctenocephalides	1	3
3.7	Pulex , Tunga	2	3
3.8	Bugs and Lice: Biology and distribution of Bed bugs,	1	3
3.9	Triatomine bugs: Head louse, Body louse.	3	3
3.10	Ticks and Mites: Biology of Ixodid	1	3
3.11	Argasid ticks.	1	3
3.12	Biology of mites - Salient features	1	3
4.0	**Parasites and Pathogens of vector borne diseases**	**10**	
4.1	Malarial Parasites: Life cycle	1	4
4.2	Lymphatic Filarial Parasites: Life cycle	1	4
4.3	Arboviral pathogens, Classification of Arboviruses - Dengue,	1	4
4.4	Chikungunya	1	4
4.5	Japanese encephalitis	1	4
4.6	Kyasanur Forest Disease (KFD)	1	4
4.7	West Nile	1	4
4.8	Yellow fever viruses - Geographic distribution Bacterial (plague)	1	4
4.9	rickettsial pathogens.	1	4

4.10	Leishmaniasis, Trypanosomiasis (Brief account)	1	4
5.0	**Control of Insect vectors**	**15**	
5.1	Control of mosquitoes and other flies - Black flies, Sand flies	1	5
5.2	Biting midges, Tabanids, Stable flies	1	5
5.3	Insecticide spraying : larviciding - indoor residual spraying - space spraying	1	5
5.4	Alternatives - biological control - environmental management including source reduction	1	5
5.5	Tsetse fly: Traps and insecticide impregnated screens	1	5
5.6	Insecticide spraying (ground and aerial).	1	5
5.7	Triatomine bugs: control measures Control of bedbugs, fleas, lice, ticks, mites Bedbugs: Detection - repellents household measures, prevention	3	5
5.8	Control of cockroaches and house flies , Cockroaches: cleanliness and hygiene, chemical and biological control, baits and traps - repellents	3	5
5.9	House flies: Environmental sanitation and hygiene, Mechanical - Biological and Chemical control.	3	5

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Course	Details				
Code	ZY1924305				
Title	**INSECT TOXICOLOGY**				
Degree	M.Sc.				
Branch(s)	Zoology				
Year/Semester	2/IV				
Type	Core				
Credits	3	Hour/week	3	Total Hours	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the concepts and mechanisms associated with molecular toxicology related to insects	U	4
2	Overview of problems in insect toxicology including resistance to pesticides and the protection of non-target species	R	4
3	Analyse exposure, properties of chemicals, and biological mechanisms that contribute to toxicity in insect	An	4
4	Predict potential consequences of unintended exposures to non-target species.	U	4
5	Develop methods and strategies to address problems in insect toxicology.	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Introduction to toxicology**	**10**	
1.1	History of chemical control; pesticide use and pesticide industry in India.	1	1
1.2	Principles of toxicology	1	1
1.3	Evaluation of insecticide toxicity	1	1
1.4	Joint action of insecticides- synergism, potentiation and antagonism	2	1
1.5	Factors affecting toxicity of insecticides	1	1
1.6	Insecticide compatibility, selectivity and phytotoxicity	1	1
1.7	Classification of insecticides and acaricides based	2	1

	on mode of entry mode of action and chemical nature		
1.8	New promising compounds	1	1
2.0	**Insecticides Acting Through Ion Channels**	**23**	
2.1	Insect channels as targets for insecticides	2	3
2.2	Insecticides acting on chloride channels	1	3
2.3	GABA blockers. Lindane. Ciclodienes. Aldrin, Endrin, Dieldrin	2	3
2.4	Molecular characterization of insect acetylcholine receptors.	2	3
2.5	Insecticides that act at the nicotinic receptor, nicotine, chloronicotinyls, imidacloprid, acetamiprid	2	3
2.6	Mode of action of organophosphates and carbamates	1	3
2.7	Classification, diversity	1	3
2.8	Safety and Intoxication by organophosphates and carbamates, symptoms in mammals, Treatment	2	4
2.9	Midgut, bacterial toxins, lepidopteran toxins, toxicity, structure, activation	2	3
2.10	Midgut toxin receptors, models, cloning of putative receptors	2	5
2.11	Pesticides containing Bacillus thuringiensis toxins, transgenic plants/crops	2	5
2.12	Vegetative stage toxins, applications, overview of diverse toxin combinations in different transgenic crops	2	5
2.14	Mosquitocidal toxins	1	3
2.15	Midgut-specific toxin isolated from a nematode	1	3
3.0	**Insecticides Acting Through Hormone Receptors and affecting respiration**	**9**	
3.1	Hormone Receptors, growth regulators, JH agonist, methoprene and other juvenoids, ecdysone agonist, tebufenozide and similar compounds	2	3
3.2	Insect growth regulators, inhibitors of chitin synthesis, diflubenzuron, other compounds	2	3
3.3	Insecticides affecting respiration, mitochondria electron transport (Met) chain, Met site inhibitor	2	3
3.4	Rotenone, hydramethylnon, uncouplers of oxidative phosphorylation	2	3
3.5	Other miscellaneous insecticides, botanicals	1	5
4.0	**Insecticide Metabolism**	**5**	
4.1	Metabolism: enzymes involved in metabolism of xenobiotics	1	3
4.2	Mixed function oxidases (cytochrome P450)	1	3
4.3	Esterases, esterases and gene amplification, glutathione-S-transferases	2	3
4.4	Synergists and enzyme inhibitors, PBO, DEF	1	3
5.0	**Insecticide Resistance**	**7**	
5.1	Mechanisms: reduced penetration, metabolic	1	2

	resistance		
5.2	Resistance to organophosphates: esterases and gene amplification	1	2
5.3	Resistance in aphids	1	2
5.4	Target site insensitivity, implications present and future	1	4
5.5	Structure based drug design, new potential insect targets, new insecticides	2	5
5.6	Pesticide pipeline, new chemistries	1	5

Reference

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Course	Details				
Code	ZY1924701				
Title	**ENTOMOLOGY: MORPHOLOGY, ANATOMY AND TAXONOMY**				
Degree	MSc.				
Branch(s)	Zoology				
Year/Semester	2/IV				
Type	Practical				
Credits	2	Hour/week	4	Total Hours	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand in details about the various morphological parts of insects	U	4
2	Analyse the anatomy of different orders of insect	An	4
3	Familiarize the use and preparation of taxonomic keys for the identification insects	C	4
4	Understand collection, preservation and identification of insects	U	4
5	Evaluate the recent developments in entomology research and analyse the ecological niches	E	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember U- Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.1	Study of insect mouthparts (Grasshopper, plant bug, mosquito, honeybee, house fly)	5	1
1.2	Study of different types of antennae, genitalia and legs.	5	1
1.3	Sting apparatus –honeybee	4	1
1.4	Wings and wing venation in insects of 5 orders.	6	1
1.5	Study of sexual dimorphism in insects	6	2
1.6	Identify the insect up to family using the key	10	3
1.7	Dissection of nervous system in different insects (oryctes, grasshopper)	6	2
1.8	Dissection of reproductive system in insects (cockroach)	6	2
1.9	Dissection of stomatogastric nervous system –	6	2

	cockroach		
1.10	Identify the insect up to family using the key	10	3
1.11	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	10	4
1.12	Visit to institutions engaged in entomology research and different ecological niches. The field study is for 3-4 days. Submit the study report not less than 10 printed pages include photographs.	20	5

Course	Details				
Code	ZY1924702				
Title	**INSECT PHYSIOLOGY, VECTOR AND VECTOR BORNE DISEASES/ INSECT TOXICOLOGY, APPLIED ENTOMOLOGY**				
Degree	Post Graduate				
Branch	Zoology				
Year/Semester	2/IV				
Type	Elective -practical				
Credits	2	Hrs/week	5	Total Hours	90

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Evaluate and compare the physiology of digestion in herbivorous, carnivorous and omnivorous insect groups	E	4
2.	Learns to link the digestive enzymes of insects with the feeding habits	Ap	4
3	Examine the functioning of malpighian tubule in collecting material from abdominal cavity of insects	An	4
4	Analyze the haemolymph for cytologic study and for free amino acid	An	4
5	Identify vectors, life cycle and disease caused by them	Ap	4
6	Carry out lethal dose of pesticide in insects and analyze it statistically	An	4
7	Evaluate the effect of pesticide in insects	E	4
8	Identify the pests of crops, and vegetables	Ap	4
9	Identify the insects by observing the damaged parts	Ap	4
10	Understand and identify the sprayers used in the field to control insects insects encountered in agricultural fields.	U	4
11	Evaluate the economic importance of insects	E	4
12	Identify the types, diseases in silk worms and mountages	Ap	4
13	Create an insect collection box with economically important pests of various foods, fibre and household	C	4

*PSO-Program Specific outcome; CO-Course Outcome

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Physiology**	**36**	
1.1	Survey of digestive enzymes –amylase, invertase, protease and lipase in different parts of the gut of cockroach	8	1,2
1.2	Survey of digestive enzymes –amylase, invertase, protease and lipase in different parts of the gut of grasshopper	8	1,2
1.3	Survey of digestive enzymes –amylase, invertase, protease and lipase in different parts of the gut of dragonfly	8	1,2
1.4	Cockroach: Dye transport by Malpighian tubule using dyes	3	3
1.5	Cockroach: Identification of free aminoacids (at least 3) in haemolymph by paper chromatography.	6	4
1.6	Cockroach: Haemocytes –staining and identification	3	4
2.0	**a) Vector and Vector borne diseases**	13	
2.1	Vector and Vector borne diseases: Identification and study of insect pests / ectoparasites of man, domestic animals and wild animals: mosquitoes [different stages of life history], head louse, pubic louse, bird louse, rat flea, *Tabanus*, *Hippobosca*, a tick and a mite on dog / cat.	6	5
2.2	Identification of different types of mosquitoes	3	5
2.3	Vector borne diseases –life cycle of vector and disease caused by them	4	5
3.0	**Or b) Insect toxicology**	13	
3.1	Determine the LD 50 in insect for contact and fumigant toxicity of essential oil at various concentration and time intervals	4	6
3,2	Symptoms and signs shown by insects due to the toxic effect of different types of insecticides	6	7
3,3	Statistical problems to calculate LD 50	3	6
4.0	**Applied Entomology**	32	
4.1	Collection and identification of insect pests of different crop plants- fruit trees	4	8,11
4.2	Collection and identification of insect pests of different crop plants- vegetables	4	8,11
4.3	Collection and identification of insect pests of different stored products	4	8,11
4.4	Collection and preservation of economically important insects, their life stages, products, damaged parts.	7	8,9,11
4.5	Collection and identification of insect damages to	6	9,11

	various crop plants.		
4.6	Types of Insecticide appliances	3	10
4.7	Identification and economic importance of the following: (a) Honey bees and bee products (b) Silkworm moth-life cycle stages, silk fibre (c) Lac insect and stick lac or shellac.	2	11
4.8	a) Identification of different species of silkworm in India. b) Study of mountants: Chandrika, Natrika c) Study of diseases of silk worms: pebrine, flachery, grasserie, muscardine	2	12
4.9	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	9	13

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