

# **UNIVERSITY OF CALICUT**



## **B.Sc. ZOOLOGY PROGRAMME**

**[CBCSS UG 2019]**

### **SYLLABUS**

**Core Courses**

**Open Courses**

**Complementary Courses**

**&**

**Model Question Papers**

**EFFECTIVE FROM 2019 ADMISSION**

**Members of Board of Studies in Zoology (UG)**  
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**INTRODUCTION,  
GUIDELINES  
AND  
GENERAL INFORMATION**

**B.Sc. ZOOLOGY PROGRAMME**  
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**INTRODUCTION**

The Higher Education Programme in Kerala has been witnessing a drastic change from 2009 admission onwards with the introduction of Semesterisation and Grading at the undergraduate level. As a continuation of this trend, UGC has recognized the importance of Outcome Based Education (OBE) to be incorporated in the Choice Based Credit and Semester System (CBCSS) for UG curriculum. A course in General Higher Education Programme in India needs to be designed and conducted to facilitate the students to meet the identified Course Outcomes (COs). The course outcomes address a subset of Programme Outcomes (POs) identified by the university or the autonomous institutions that offer the programme. Also, the course outcomes address the Programme Specific Outcomes (PSOs) identified by the Branch/Department. Keeping in view of the implementation of OBE-CBCSS of UGC, Kerala State Higher Education Council conducted three days workshop during 12 -14 February 2019 with the title “*Redesigning of Courses for Outcome Based Education (OBE)*” for the Board of Studies in UG Programme under Faculty of Science at Tagore Nikethan, University of Calicut.

Vide U.O No. GA I/J2/3601/08 (Vol. II) dated 19.06.2009, regulations for CBCSS for UG curriculum was implemented from 2009 admission onwards under the University of Calicut, as per the directions of Kerala State Higher Education Council. The regulations of CBCSS for UG curriculum was also modified [U.O. No. 3797/2013/CU dated 07.09.2013] and implemented from 2014 admission onwards under the University of Calicut, as per the recommendations of Hridayakumari Committee appointed by the Govt. of Kerala. The Academic Council in its special meeting held on 28.02.2019 has approved the CBCSS UG regulations 2019 [U.O No. 4368/2019/Admn dated, 23.03.2019] and has, therefore, been accorded to implement the regulations for Choice Based Credit and Semester System for Under Graduate curriculum-2019 (CBCSS UG Regulations 2019) for all UG Programme under CBCSS regular and SDE/Private registration in the university of calicut, w.e.f. 2019 admission.

Board of Studies in Zoology (U.G.) of University of Calicut [constituted as per U.O.No.10961/2016/Admn. Dated 07.09.2016] reviewed and meticulously analyzed the existing and continuing syllabi of B.Sc. Zoology Programme. BoS received many requests and suggestions regarding the course structure, content and credit distribution that are to be incorporated in to the existing syllabus. BoS also discussed the details of the syllabus of B.Sc. Zoology programme in the context of outcome based education and the regulations of CBCSS UG curriculum 2019. Accordingly, BoS has framed the curriculum, course structure, course content, instructional hours, scheme of instruction, scheme of evaluation, credits, mark distribution, duration of examination and model question papers of B.Sc. Zoology Programme [CBCSS UG] with the present requirements of the teaching and learning process.

In addition, the semester-end examinations (total 6 semesters) to be conducted by the university, a system of continuous evaluation through *Internal*

Assessment by the faculty members of the Department of Zoology of the respective institutions must be adopted for Zoology Core, Open and Complementary courses. The distribution of marks is 80% for external evaluation and 20% for internal assessment.

The syllabus for the six semesters of B.Sc. Degree Programme with Zoology as Core course of study which contain provision for both theory and practical components in all six semesters and complementary courses also contain both theory and practical components in four semesters.

Some changes are also made in the combination of core course content in the fifth and sixth semesters in order to complete the teaching process in time especially in the tight schedule of the semesters. Further, some pertinent topics are suggested for *seminar/ assignment* for theory courses with a view to enrich the UG Programme.

The practical courses offered are designed in such a way that they support the theory topics and also impart the basic skills and techniques required of them. In addition to the items for practical, a *Project work* forms an integral part of the curriculum during the sixth semester. *Field study/study tour* to the research institution/museum and places of biological/zoological importance/ecological interest is a compulsory element of the curriculum. Requirement to visit places of importance of elective subject area is also a compulsory element. Attempts have also been made to update the syllabus, considering the needs of the time and conforming to the work load prescribed by the university.

Accordingly, the BoS meeting held on 12.04.2019 at Calicut University took the decision **to implement the revised syllabus w.e.f. 2019 B.Sc. Zoology admission.**

## **AIMS AND OBJECTIVES**

The Board of Studies in Zoology (UG) recognizes that curriculum, course content and assessment of scholastic achievement play complementary roles in shaping education. The revised Outcome Based Education- Choice Based Credit and Semester System for Under Graduate (UG) Curriculum for B.Sc. Zoology Programme envisages undergraduate education as a combination of general and specialized education with outcome based, simultaneously introducing the concepts of breadth and depth in learning. Besides recalling information, the learning process is aimed to acquire the ability for problem solving, and critical and creative thinking in students. The present attempt is to prepare the students for lifelong learning by drawing attention to the vast world of knowledge of animals and introducing them to the methodology of systematic academic enquiry. The crew of the syllabus ensures firm footing in fundamental aspects of Zoology and wide exposure to modern branches of Zoology to the students.

The expected outcome of the syllabus:

- To know the scope and importance of Zoology.
- To develop scientific temper among students.

- To inculcate interest in nature and living forms and their conservation.
- To make the students eco-friendly by creating a sense of environmental awareness in them.
- To give better exposure to the diversity of life forms.
- To give awareness about natural resources and their importance in sustainable development.
- To study different ecological sites for animals in their natural habitats by field study.
- To provide opportunities for the application of the acquired knowledge in day-to-day life.
- To develop skills in doing experiments, familiarizing equipments and biological specimens.
- To undertake scientific projects which help to develop research aptitude in students.
- To expose students to various fields in biological sciences and to develop interest in related disciplines.
- To attain interdisciplinary approach to understand the application of the subject in daily life.
- To familiarize the emerging areas of Zoology and their applications in various spheres of biological sciences and to appraise the students of its relevance in future studies.

## AN OVERVIEW

### Definitions and Structure

**Title** shall be called “Regulations for Choice Based Credit and Semester System for Under Graduate Curriculum 2019” (CBCSS UG 2019). **Programme** means the entire course of study and examinations lead to the award of a degree. **Duration of programme** means period of time required for the conduct of undergraduate programme i.e. six semesters distributed in a period of 3 years. The odd semesters (1, 3 and 5) shall be from June to October and the even semesters (2, 4 and 6) shall be from November to March. **Academic week** is a unit of five working days in which distribution of work is organised from Monday to Friday with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester. **Semester** constitute minimum of 18 weeks (16 instructional weeks and 2 weeks for examination).

**Course** means a segment of subject matter to be covered in a semester. The graduate programme includes five types of courses, *viz.*, common, core, complementary, open, audit /ability enhancement and improvement courses.

**Common course** means a course that comes under the category of courses for English and additional language, a selection of both is compulsory for all students undergoing undergraduate programme. Every undergraduate student shall undergo 10 common courses [6 English courses and 4 additional language courses] for completing the programme. **Core courses** are major (core) courses in a subject related to a particular degree programme. Core courses are offered by the parent department. There are 17 core courses including a project work and field study.

**Complementary course** means a course which is generally related to the core subject. It covers two disciplines in B.Sc. degree programme that are distributed in the first four semesters. There shall be one **Open course** in the 5<sup>th</sup> semester. This is a course outside the field of specialisation of the student, which can be opted by his/her choice. **Audit course/Ability Enhancement course** is a course which is mandatory. There shall be one Audit course each in the first four semesters. These courses are not meant for class room study. The credits of audited courses are not counted for SGPA or CGPA. **[Improvement course** is a course registered by a student for improving his/her performance.]

**Course code** of each course shall have a unique alphanumeric code number, which includes abbreviation of the subject in three letters, the semester number (1 to 6) in which the course is offered, the code of the course (A to E) and serial number of the course (01,02. ....). (A: Common course, B: Core course, BE: Core Elective course, C: Complementary course and D: Open course, E: Audit course) For example: ZOL5B06 represents a core course of serial number 06 offered in 5<sup>th</sup> semester in B.Sc. Zoology programme.

Each course shall have certain credits. **Credit** is a unit of academic input measured in terms of weekly contact hours/course content assigned to a course. **Extra Credit** is the mandatory additional credit awarded to a student over and above the minimum credits required in a programme, for participating in co-curricular activities and social activities outside the regular class hours, like NCC, NSS and Swatch Bharath. Those students who could not join in any of the above activities have to undergo Calicut University Social Service Programme (CUSSP). Extra credits are not counted for SGPA or CGPA.

**Grade** in a course is a letter symbol (O, A+, A, B+, B, C, P, F, I and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on his/her performance in various examinations. Each letter grade is assigned a '**Grade point** (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course. **Grade Point** means point given to a letter grade on 10 point scale. **Strike off the roll:** A student who is continuously absent for 14 days without sufficient reason and proper intimation to the Principal of the college shall be removed from the roll.

**Department** means any teaching department in a college offering a course of study approved by the university as per the Statutes and Act of the University. **Department Co-ordinator** is a teacher nominated by a Dept. Council to co-ordinate all the works related to CBCSS UG undertaken in that department including continuous evaluation. **Department Council** means the body of all teachers of a department in a college. **Parent Department** means the Department which offers a particular degree programme. **Course teacher:** A teacher nominated by the Head of the Department shall be in charge of a particular course.

**College Co-ordinator** is a teacher nominated by the college council to co-ordinate the effective running of the process of CBCSS including internal evaluation undertaken by various departments within the college. She/he shall be the convener for the college level monitoring committee. **College level monitoring committee:** A monitoring Committee is to be constituted for CBCSS UG at the

college level with Principal as Chairperson, college co-ordinator as convener and department co-ordinators as members. The elected college union chairperson shall be a member of this committee. **Faculty Adviser** means a teacher from the parent department nominated by the Department Council, who will advise the student in the academic matters and in the choice of open courses.

**Project work & Field study:** Every student of a UG programme shall have to work on a project under the supervision of a faculty member. A field study/study tour for 5 days is compulsory during the tenure of the B.Sc. Zoology programme.

**Grace Marks:** Grace marks may be awarded to a student for meritorious achievements in co-curricular activities (in Sports/Arts/NSS/NCC/Student Entrepreneurship) carried out besides the regular hours. Such a benefit is applicable and limited to a maximum of 8 courses in an academic year spreading over two semesters. In addition, maximum of 6 marks per semester can be awarded to the students of UG Programme, for participating in the College Fitness Education Programme (COFE).

**Attendance:** A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester. Attendance shall be maintained by the Department concerned.

A student is required to acquire a minimum of **140** credits for passing the degree programme, of which 120 credits are to be acquired from class room study and shall only be counted for SGPA and CGPA.

<b>Common courses:</b>	<b>38 credits</b> (22 for English courses + 16 for Additional languages).
<b>Core courses:</b>	<b>55 credits</b> (including 3 credits for project work & field study).
<b>Open course:</b>	<b>3 credits</b>
<b>Complementary courses:</b>	<b>24 credits</b> (12 credits each for Chemistry and Botany)
<b>Audit courses:</b>	<b>16 credits</b> (4 credits per course in first 4 semesters)
<b>Extra credits:</b>	<b>4 credits</b> (4 credits in first 4 semesters)

If more Extra credit activities are done by a student that may be mentioned in the Grade card. *The credits of audited courses or extra credits are not counted for SGPA or CGPA.* The successful completion of all the courses (common, core, complementary and open courses) prescribed for the degree programme with 'P' grade shall be the minimum requirement for the award of degree.

#### **CALICUT UNIVERSITY SOCIAL SERVICE PROGRAMME (CUSSP)**

In this programme, a student has to complete 12 days of social service. This has to be completed in the first four semesters; 3 days in each semester. For the regular programme the student has to work in a Panchayath or Local body or in a hospital/ poor home or old age home or in a Pain & palliative centre or any social work assigned by the College authorities. Students who engaged in College Union

activities and participate in sports and cultural activities in Zonal level have to undergo only 6 days of CUSSP during the entire programme. The whole documents regarding the student should be kept in the college and the Principal should give a certificate for the same. The list of students (successfully completed the programme) must be sent to the university before the commencement of the fifth semester examinations. A college level co-ordinator and a department level co-ordinator shall be appointed for the smooth conduct of the programme.

### **AUDIT COURSES/ABILITY ENHANCEMENT COURSES**

These are courses which are mandatory for a programme but not counted for the calculation of SGPA or CGPA. There shall be one Audit course each in the first four semesters. These courses are not meant for class room study. The students can attain only pass (Grade P) for these courses. At the end of each semester, there shall be examination conducted by the college from a pool of questions (Question Bank) set by the University. The Question paper shall be of 100 marks of 3 hour duration. The students can also attain these credits through online courses like SWAYAM, MOOC etc (optional). The list of passed students must be sent to the University from the colleges at least before the fifth semester examination. The lists of courses in each semester with credits are given below.

**Table 1. AUDIT COURSES: CREDITS IN FIRST 4 SEMESTERS**

<b>Sl.No.</b>	<b>Semesters</b>	<b>Courses</b>	<b>Credits</b>	<b>Marks</b>	<b>Duration of Exam</b>
1	I	Environmental studies	4	100	3 hrs
2	II	Disaster Management	4	100	3 hrs
3	III	*Human Rights/Intellectual Property Rights/ Consumer Protection	4	100	3 hrs
4	IV	*Gender studies/Gerontology	4	100	3 hrs
		<b>Total</b>	<b>16</b>	<b>400</b>	

*\*College can opt any one of the courses.*

**Table 2. CREDITS AND MARKS DISTRIBUTION OF B.Sc. ZOOLOGY PROGRAMME**

**[Course Structure]**

Semesters	Common course: Credits		Core Course Zoology: Credits	Open Course: Credits	Complementary course: Credits		Total Credits	Audit course: Credits	Extra Credits
	English	Addl Language			Chemistry	Botany			
I	3+3	4	2	--	2	2	16	4	
II	4+4	4	2	--	2	2	18	4	
III	4	4	3	--	2	2	15	4	4
IV	4	4	3+4*	--	2+4*	2+4*	27	4	
V	--	--	4+4+4+4	3	--	--	19	--	
VI	--	--	3+3+3+3 +2+4*+4 **+3**	--	--	--	25	--	
Total	22 Credits (550 Marks)	16 Credits (400 Marks)	55 Credits (1450 Marks)	3 Credits (75 Marks)	12 Credits (400 Marks)	12 Credits (400 Marks)	120 Credits (3275 Marks)	16 Credits (400 Marks)	4 Credits (100 Marks)
	<b>38 Credits (950 Marks)</b>		<b>82 Credits (2325 Marks)</b>				<b>120 Credits (3275 Marks)</b>	<b>#16 Credits (400 Marks)</b>	<b>#4 Credits (100 Marks)</b>

**Grand Total: 3775 Marks; 140 Credits (Minimum)**

*\*Practical (12 Credits)*

*\*\*Project work & Field study (3 Credits).*

Credits acquired from class room study and counted for SGPA and CGPA: 120

Total 140 credits [120+16+4] are required for completing UG programme.

#Credits of audit course (16) and extra credits (4) are mandatory and not counted for SGPA or CGPA calculation.

**Table 3. COURSEWISE MARK DISTRIBUTION OF B.Sc. ZOOLOGY PROGRAMME**

Courses			No. of Courses	Marks per Course	Total Marks	Grand Total Marks
Common Courses	English	Theory	6	75 x 2 = 150 100 x 4 = 400	550	550
	Additional Language	Theory	4	100	400	400
Core Courses	Zoology	Theory	13	75 x 9 = 675 100 x 4 = 400	1075	1450
		Practical	3	100	300	
		Project work and Field study	1	75	75	
Open course	Zoology/Other streams	Theory	1	75	75	75
Complementary courses	Chemistry	Theory	4	75 x 4 = 300	300	400
		Practical	1	100	100	
	Botany	Theory	4	75 x 4 = 300	300	400
		Practical	1	100	100	
	Total Marks					3275
Audit courses		Theory	4	400	400	400
Extra credits			4		100	100
	Total Marks					500

**Grand Total: 3775 Marks (3275+500); 140 Credits (Minimum)**

**Table 4. SEMESTER WISE DISTRIBUTION OF CREDITS AND MARKS**

B.Sc. Zoology Programme  
Total Credits: 140; Total Marks: 3775

<b>Semester</b>	<b>Course</b>	<b>Credits</b>	<b>Marks</b>
<b>I</b>	Common course: English	3	75
	Common course: English	3	75
	Common course: Additional Language	4	100
	Core Course I: Animal Diversity: Non-chordata Part-I	2	75
	Complementary course: Chemistry	2	75
	Complementary course: Botany	2	75
	Audit Course: Environmental studies	4	100
	<b>Total</b>	<b>20</b>	<b>575</b>
<b>II</b>	Common course: English	4	100
	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course II: Animal Diversity: Non-chordata Part-II	2	75
	Complementary course: Chemistry	2	75
	Complementary course: Botany	2	75
	Audit Course: Disaster Management	4	100
	<b>Total</b>	<b>22</b>	<b>625</b>
<b>III</b>	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course III: Animal Diversity: Chordata Part-I	3	75
	Complementary course: Chemistry	2	75
	Complementary course: Botany	2	75
	Audit Course: Human Rights/Intellectual Property Rights/ Consumer Protection	4	100
	<b>Total</b>	<b>19</b>	<b>525</b>
<b>IV</b>	Common course: English	4	100
	Common course: Additional Language	4	100
	Core course IV: Animal Diversity: Chordata Part-II	3	75
	Core course V: Zoology Core Practical – I [Practical I*A +I*B+ I*C+ I*D]	4	100
	Complementary course: Chemistry	2	75
	Complementary course: Chemistry Practical	4	100
	Complementary course: Botany	2	75
	Complementary course: Botany Practical	4	100
	Audit Course: Gender studies/Gerontology	4	100
	Extra credits (Maximum)	4	100
	<b>Total</b>	<b>35</b>	<b>925</b>

<b>Semesters</b>	<b>Course</b>	<b>Credits</b>	<b>Marks</b>
<b>V</b>	Core Course VI: Cell Biology and Genetics	4	100
	Core Course VII: Biotechnology, Microbiology and Immunology	4	100
	Core Course VIII: Biochemistry and Molecular Biology	4	100
	Core Course IX: Methodology in Science, Biostatistics and Bioinformatics	4	100
	Open course: Any other streams	3	75
	<b>Total</b>	<b>19</b>	<b>475</b>
<b>VI</b>	Core Course X: Physiology and Endocrinology	3	75
	Core Course XI: Reproductive and Developmental Biology	3	75
	Core Course XII: Environmental and Conservation Biology	3	75
	Core Course XIII: Ethology, Evolution and Zoogeography	3	75
	Core Course XIV: Elective course (Any one below) [01] Human Genetics [02] Aquaculture, Animal Husbandry & Poultry science [03] Applied Entomology	2	75
	Core Course XV: Zoology Core Practical- II [Practical II*A + II*B]	4	100
	Core Course XVI: Zoology Core Practical- III [Practical III*A+ III*B]	4	100
	Core Course XVII: Project Work and Field study	3	75
	<b>Total</b>	<b>25</b>	<b>650</b>
	<b>Grand Total</b>	<b>140</b>	<b>3775</b>

**Table 5**  
**B.Sc. ZOOLOGY (CORE) PROGRAMME**  
**STRUCTURE OF CORE, OPEN AND ELECTIVE COURSES**

*Course code, Title, Instructional hours, Credits, Marks and Examination duration in various semesters*

**Total Credits: 58**  
**(w.e.f. 2019 Admission)**

Semester	Core/Open/ Elective courses	Code	Course Title	Instructional hours/week	Instructional hrs in a semester	Credits	External Marks	Internal marks	Total marks	Duration of Exam (hrs)
I	Theory I	ZOL1B01T	Animal Diversity : Nonchordata Part-I	2	36	2	60	15	75	2
	Practical I*A	--	Practical related to ZOL1B01T	2	36	*	--	--	--	
II	Theory II	ZOL2B02T	Animal Diversity : Nonchordata Part-II	2	36	2	60	15	75	2
	Practical I*B	--	Practical related to ZOL2B02T	2	36	*	--	--	--	
III	Theory III	ZOL3B03T	Animal Diversity: Chordata Part-I	3	54	3	60	15	75	2
	Practical I*C	--	Practical related to ZOL3B03T	2	36	*	--	--	--	
IV	Theory IV	ZOL4B04T	Animal Diversity: Chordata Part-II	3	54	3	60	15	75	2
	Practical I*D	--	Practical related to ZOL4B04T	2	36	*	--	--	--	
	Practical-I {I*A +I*B+ I*C+ I*D}	ZOL4B05P	Zoology Core Practical I (Practical related to ZOL1B01T,02T,03T and 04T)	8	144	4	80	20	100	4
V	Theory V	ZOL5B06T	Cell Biology and Genetics	3	54	4	80	20	100	2.5
	Theory VI	ZOL5B07T	Biotechnology, Microbiology and Immunology	4	72	4	80	20	100	2.5
	Practical II*A	--	Practical related to ZOL5B06T & 07T	4	72	**	--	--	--	
	Theory VII	ZOL5B08T	Biochemistry and Molecular Biology	4	72	4	80	20	100	2.5
	Theory VIII	ZOL5B09T	Methodology in Science, Biostatistics and Bioinformatics	3	54	4	80	20	100	2.5
	Practical II*B	--	Practical related to ZOL5B08T, & 09T	4	72	**	--	--	--	
	#Open Course +++ (for other streams)	ZOL5D01T ZOL5D02T ZOL5D03T	• Reproductive Health and Sex Education • Nutrition, Health & Hygiene • Applied Zoology (Any one) #	3	54	3	60	15	75	2
VI	Theory IX	ZOL6B10T	Physiology and Endocrinology	3	54	3	60	15	75	2
	Theory X	ZOL6B11T	Reproductive and Developmental Biology	3	54	3	60	15	75	2
	Practical III*A	--	Practical related to ZOL6B10T & 11T	4	72	**	--	--	--	
	Theory XI	ZOL6B12T	Environmental and Conservation Biology	3	54	3	60	15	75	2
	Theory XII	ZOL6B13T	Ethology, Evolution and Zoogeography	3	54	3	60	15	75	2

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Semester	Core/Open/ Elective courses	Code	Course Title	Instructional hours/week	Instructional hrs in a semester	Credits	External Marks	Internal marks	Total marks	Duration of Exam (hrs)
	Theory XIII Elective Course##	ZOL6B14BE01T ZOL6B14BE02T ZOL6B14BE03T	<ul style="list-style-type: none"> <li>Human Genetics</li> <li>Aquaculture, Animal Husbandry &amp; Poultry science</li> <li>Applied Entomology (Any one) ##</li> </ul>	3	54	2	60	15	75	2
	Practical III*B	--	Practical related to theory core course ZOL6B12T, 13T & ZOL6B14 BE01T/ BE02T/ BE03T	4	72	**	--	--	--	
			Project work / Field study	2	32	***	--	--	--	
	Practical II (II*A +II*B)	ZOL6B15P	Zoology Core Practical II (Practical related to ZOL5B06T, 07T, 08T, 09T)	8	144	4**	80	20	100	4
	Practical III (III*A +III*B)	ZOL6B16P	Zoology Core Practical III (Practical related to ZOL6B10T, 11T, 12T, 13T & 14T E01/E02/E03)	8	144	4**	80	20	100	4
		ZOL6B17PF	Project work & Field study	--	--	3***	60	15	75	
			<b>Total</b>			<b>58</b>	<b>1220</b>	<b>305</b>	<b>1525</b>	

#### Core courses 1450 + Open course 75 = 1525 Marks

Scheme of evaluation: External 80 % +Internal 20 %

\* Practical examination for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> semesters will be held at the end of IV semester.

\*\* Practical examination for 5<sup>th</sup> and 6<sup>th</sup> semesters will be held at the end of VI semester.

\*\*\* Evaluation of Project work and Field study will be held at the end of VI semester.

External evaluation of Project work (60 Marks) and Field study report (15 Marks) will be conducted at the end semester VI after Practical III (External:80% Marks + Internal:20 % marks; **Total: 75 Marks**). (It includes a Viva-voce based on report of Project work and field study).

Project: External 48 marks + Internal 12 marks = **60 marks**

Field study report: External 12 marks +Internal 3 marks = **15 marks**

# Open course of any one course (ZOL5D01T/ ZOL5D02T/ ZOL5D03T) opted by the dept. is for other streams.

Open course Theory: 80% marks for external and 20% marks for internal evaluation.

+++ See Appendix of Open course

## Elective course of any one course (ZOL6B14T BE01/ ZOL6B14T BE02/ ZOL6B14TBE03) opted by the dept. is for Core course.

**B.Sc. ZOOLOGY OPEN COURSE**  
*[For students of other streams]*

**STRUCTURE OF OPEN COURSE**

**Course code, Title, Instructional hours, Credits, Marks and Duration of Examinations**

**Total Credits: 3 (External 80% and Internal 20%)  
 (w.e.f. 2019Admission)**

Semester	Open Course	Code	Course content	Instructional hrs/ week	Instructional hrs in a semester	Credits	External Marks	Internal marks	Total marks	Duration of Exam (hrs)
V	Theory [Any one]	ZOL5D01T	Open Course 01 : Reproductive Health and Sex Education	3	54	3	60	15	75	2
		ZOL5D02T	OpenCourse 02 : Nutrition, Health and Hygiene							
		ZOL5D03T	OpenCourse 03 : Applied Zoology							
	<b>TOTAL</b>			<b>3</b>	<b>54</b>	<b>3</b>	<b>60</b>	<b>15</b>	<b>75</b>	<b>2</b>

*Open course of any one course (ZOL5D01T/ ZOL5D02T/ ZOL5D03T) opted by the dept. is for students of other streams.*

There shall be one open course in core subjects in the fifth semester. The open course shall be open to all the students in the institution except the students in the parent department. The students can opt that course from any other department in the institution. Each department can decide the open course from a pool of three courses offered by the University. For open courses there shall be a minimum of 10 and maximum of 75 students per batch. Total credits allotted for open course is 3 and the hours allotted is 3. If there is only one programme in a college, they can choose either language courses or physical education as open course.

## **OUTCOMES AND OUTCOME BASED EDUCATION (OBE)**

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Outcomes are what the students are expected to be able to do at the end of a unit of learning. The unit of learning is three year formal programme.

An Outcome:

- Should unambiguously state what the student should be able to do/perform.
- What the students do or perform are observable and assessable?
- Students should be able to understand what it means (comprehensible).
- Should be able to provide guidance to students in planning their learning.

Outcome Based Education (OBE) was introduced by William Spady in early 1990s for American school system and eventually adapted by higher education systems. This is an approach to education in which decisions about the curriculum and instructions are driven by the exit learning outcomes that the students should display at the end of a programme or a course. OBE establish the conditions and opportunities within the system that enable and encourage all students to achieve those essential outcomes. A system based on outcomes gives top priority for learning, accomplishments and results.

### **Advantages of OBE**

- *Relevance:* Outcome based education promotes fitness for practice and education for capability.
- *Discourse:* The process of identification of the outcomes within an institution promotes discussion of fundamental questions.
- *Clarity:* An explicit statement of what the educational process aims to achieve clarifies the curriculum for both students and teachers, and provides a focus for teaching and learning.
- *Provision of a Framework:* OBE provides a robust framework for integration of the curriculum.
- *Accountability:* By providing an explicit statement of what the curriculum is setting out to achieve, OBE emphasizes accountability.
- *Self Directed Learning:* If students are clear about what they are trying to achieve, they can take more responsibility for their own learning. OBE thus promotes a student-centered approach to learning and teaching.
- *Flexibility:* OBE does not specify educational strategies or teaching methods.
- *Guide for Assessment:* The outcomes provide the framework for student examinations.
- *Facilitates Curriculum Evaluation:* The outcomes provide benchmarks against which the curriculum can be judged.

### **Three levels of Outcomes:**

- Programme Outcomes (POs)
- Programme Specific Outcomes (PSOs)
- Course Outcomes (COs)

Programme Outcomes (POs) indicate the generic knowledge, skills and attitudes that every student graduating from a UG programme should attain. While every course of the programme can address only a subset of POs, all the core courses together should be able to address all the POs.

### 1. Programme Outcomes (POs) for General Undergraduate Programme:

- PO1. **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
- PO2. **Problem Solving:** Understand and solve the problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired from humanities/ sciences/mathematics/social sciences.
- PO3. **Effective Communication:** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
- PO4. **Effective Citizenship:** Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
- PO5. **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
- PO6. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

### 2. Programme Specific Outcomes (PSOs):

PSOs are specific to a programme and are to be attained at the time of graduation from the programme. They are to be identified by a committee with representation from all stakeholders.

#### B.Sc. Zoology Programme

PSOs	Program Specific Outcomes
PSO1	Understand the biological diversity and grades of complexity of various animal forms through their systematic classification and process of organic evolution.
PSO2	Understand the roles of plants, animals and microbes in the sustainability of the environment and their interaction among themselves and deterioration of the environment due to anthropogenic activities.
PSO3	Understand the concepts and principles of biochemistry, immunology, physiology, ethology, endocrinology, developmental biology, cell biology, genetics, molecular biology and microbiology and develop technical skills in biotechnology, bioinformatics and biostatistics.
PSO4	Perform laboratory procedures as per standard protocols in the areas of animal diversity, systematics, cell biology, genetics, biochemistry, molecular biology, microbiology, physiology, immunology, developmental biology, environmental biology, ethology, evolution and science methodology,

\* PSOs related to elective courses are excluded since they are college specific.

### 3. Course Outcomes (COs):

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Course outcomes are statements that describe significant and essential learning that the learners have achieved and can reliably demonstrate at the end of the course. Course outcomes are what the student should be able to do at the end of the course.

### CORE COURSE: SCHEME OF INSTRUCTION

For B.Sc. Zoology Programme, Zoology is the core course. It is to be taught during all the six semesters. Course code, title, instructional hours, distribution of credits and marks, and other details of B.Sc. Zoology Programme are shown in Tables 2 to 5. The syllabus includes theory as well as practical components (see Table 5).

#### A. Theory

The total number of theory core courses is 13. One core course each is to be studied during the first four semesters (2 credits each for theory courses in 1<sup>st</sup> & 2<sup>nd</sup> semesters, 3 credits each in 3<sup>rd</sup> & 4<sup>th</sup> semesters) with 2 hrs of examination. Four courses each with 4 credits and 2.5 hrs of examination in 5<sup>th</sup> semester and 5 courses [3 credits each for 5 courses with 2 hrs examination] in 6<sup>th</sup> semesters of the programme. Towards achieving vocationalisation, 3 core courses are prescribed under Elective course for 6<sup>th</sup> semester. An institution can choose any one of the following.

Elective courses: 01. Human Genetics (Code: e.g., ZOL6B14TBE01)  
02. Aquaculture, Animal Husbandry and Poultry science  
03. Applied Entomology

For developing learning, understanding and presentation skills of students, some pertinent topics are suggested for Seminar/Assignments. Questions from topics allotted for assignments/seminar are for internal assessment only.

#### B. Practical

Practical courses corresponding to each theory course will be conducted during the corresponding semesters. A combined practical examination relating to the first four core courses 01, 02, 03 and 04 will be held at the end of the fourth semester and that will be designated as Practical I (Code: ZOL4B05P) with 4 credits. Practical related to core courses 06 to 09 of the 5<sup>th</sup> semester form Practical II [4 credits; Code: ZOL6B15P] and 10 to 14 of 6<sup>th</sup> semester form Practical III [4 credits; Code: ZOL6B16P]. Practical examinations II and III will be conducted at end of the sixth semester.

**Record:** Any candidate, who turns up for a practical examination, must submit a certified bonafide record/report of work done by him/her duly attested by the teacher-in-charge and the Head of the Department at the time of practical examinations. Record should contain hand-drawn specimens with classification and notes/ mountings/dissections/sketches/experiments and results with scientific accuracy. All practical examinations are of 4 hours duration.

**C. Project and Field study (ZOL6B17PF):**  
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**1. Project work**

Students are assigned to undertake a project work during 6<sup>th</sup> semester on problems pertaining to biological science. Scientific study on the topic selected is required to be carried out under the supervision and guidance of faculty members. A group consisting of not more than 12 students can undertake one research project. Each student has to actively participate in the project work. The problem/topic chosen by an earlier batch of students for their project work shall not be repeated by a latter batch. A certificate to this effect has to be attached by the Head of the department.

A well documented project report duly attested by the Supervising teacher and the Head of department must be submitted by each candidate for evaluation separately on the day of 3<sup>rd</sup> practical examination in the sixth semester. The project must contain the following components.

- |   |               |
|---|---------------|
| 1. Introduction with citations of relevant literature | 4. Results    |
| 2. Objectives of the study                            | 5. Discussion |
| 3. Methodology  | 6. References |

**2. Field Study**

A field study/study tour for 5 days is compulsory during the tenure of the B.Sc. Zoology programme, preferably in the V or VI semester. A total of at least 4 days should be kept apart for visiting research institution/museum, and places of biological interest and ecological importance. One day trip should be associated with Elective course chosen. A detailed tour report certified by the Teacher-in-charge of the study tour and also by the Head of the Department, specifying the places and institutions visited, date and time of visit, details of observations made must be submitted by each student in "**hand written**" mode for evaluation during the day of 3<sup>rd</sup> practical examination in the sixth semester. The field study/study tour report is compulsory for each student appearing for practical examination.

**EXAMINATIONS**

There shall be university examinations at the end of each semester. **A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester.** Practical examinations shall be conducted by the university at the end of fourth and sixth semesters. External evaluation of Project work and field study report shall be conducted on a separate day after the completion of core course practical examination in the sixth semester.

## EVALUATION AND GRADING

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Mark system is followed instead of direct grading for each question. The evaluation scheme for each course shall contain two parts: viz., Internal evaluation (20% marks) and External evaluation (80% marks). The marks secured for internal assessment only need to be sent to university by the college concerned. After internal and external evaluation, marks are entered in the answer scripts. All other calculations, including grading will be done by the university using the software. For each course in the semester, letter grade and grade point are introduced in 10 point Indirect Grading System. Each course is evaluated by assigning marks with a letter grade (O, A+, A, B+, B, C, P, F, I, Ab) to that course by the method of indirect grading.

**Table 7. TEN POINT INDIRECT GRADING SYSTEM**

Percentage of Marks (Both Internal & External put together)	Grade	Interpretation	Grade Point Average (G)	Range of Grade points	Class
95 and above	O	Outstanding	10	9.5 - 10	First Class with Distinction
85 to below 95	A+	Excellent	9	8.5 – 9.49	
75 to below 85	A	Very good	8	7.5 – 8.49	
65 to below 75	B+	Good	7	6.5 – 7.49	First Class
55 to below 65	B	Satisfactory	6	5.5 – 6.49	
45 to below 55	C	Average	5	4.5 – 5.49	Second Class
35 to below 45	P	Pass	4	3.5 – 4.49	Third Class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

## CORE COURSE: SCHEME OF EVALUATION

B.Sc. Zoology Programme comprises 13 theory courses (one each in first 4 semesters, four in 5<sup>th</sup> and five in 6<sup>th</sup> semesters), 3 practical courses, and 1 course of project work & field study. The scheme of evaluation for core course theories, practicals, project work & field study contain two parts: viz., internal evaluation (20% marks) and external evaluation (80%marks).

### A. THEORY [CORE COURSE]: EVALUATION SCHEME

The evaluation scheme for each course contains two parts; viz. internal evaluation and external evaluation.

#### I. INTERNAL EVALUATION

The internal evaluation will be a continuous process. It will be done by the faculty members of the department of Zoology of the institution where the candidate is pursuing the study. The internal assessment shall be based on a transparent system involving student's performance in class tests, class room participation based on attendance in theory courses, assignments and seminars in respect of theory courses. For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the marks of the best one should be

taken. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be notified on the notice board at least one week before the commencement of external evaluation. There shall not be any chance for improvement for internal marks. The course teacher(s) shall maintain the academic record of each student registered for the course, which shall be forwarded to the university by the college Principal after obtaining the signature of both course teacher and Head of the department.

For 2/3 credit courses the external examination is for 60 marks and 2 hours of duration. Such courses have an internal component of 15 marks (60 external + 15 internal = 75 marks). 4/5 credit courses have an external examination of 80 marks and 2.5 hours duration. The internal mark for such courses is 20 (external 80+ internal 20 = 100 marks). The distribution of internal marks shall be as follows:

**Table 8. Criteria for Internal Evaluation of Theory courses**

Sl. No.	Criteria	Maximum internal marks 15 (2/3 credit courses – Type 1)	Maximum internal marks 20 (4/5 credit courses – Type 2)
1	Test paper (1) (40%)	6	8
2	Assignment (20%)	3	4
3	Seminar (20%)	3	4
4	Attendance (20%)	3	4
<i>Total Marks</i>		<b>15</b>	<b>20</b>

**Table 8.1. Pattern of Test paper for Type 1 [2/3 credit courses]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
1 Hour	Short answer	6	6	2	10
	Paragraph	3	3	5	10
	Essay	2	1	10	10
<b>Total marks</b>					<b>30</b>

**Table 8.2. Pattern of Test paper for Type 2 [4/5 credit courses]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
1.15 Hour	Short answer	6	6	2	10
	Paragraph	5	5	5	20
	Essay	2	1	10	10
<b>Total marks</b>					<b>40</b>

**Table 8.a. Split up of internal marks for Test Paper [40%]**

Sl. No.	Range of Marks in test paper	Out of 6 [Maximum internal marks 15]	Out of 8 [Maximum internal marks 20]
1	85 to 100%	6	8
2	65 to below 85%	5	6
3	55 to below 65%	4	4
4	45 to below 55%	3	3
5	35 to below 45%	2	2
6	Below 35%	1	1

**Table 8.b. Criteria for Internal Evaluation of Assignment [20%]**

Sl. No.	Criteria	Out of 3 [Maximum internal marks 3]	Out of 4 [Maximum internal marks 4]
1	Submission in time	1	1
2	Content	2	3
3	<b>Total Marks</b>	<b>3</b>	<b>4</b>

**Table 8.c. Criteria for Internal Evaluation of Seminar [20%]**

Sl. No.	Criteria	Out of 3 [Maximum internal marks 3]	Out of 4 [Maximum internal marks 4]
1	Excellent	3	4
1	Good	2	3
2	Average	1	1
3	<b>*Total Marks</b>	<b>3</b>	<b>4</b>

*\*Based on clarity, communication skills, use of AV aids and answer to questions.*

**Table 8.d. Split up of internal marks for Attendance [20%]**

Sl. No.	Range of Marks in test paper	Out of 3 [Maximum internal marks 15]	Out of 4 [Maximum internal marks 20]
1	85 and above	3	4
2	75 to below 85%	2	2
3	50 to below 75%	1	1
4	below 50%	0	0

## II. EXTERNAL EVALUATION

Theory examinations will be conducted at the end of each semester. External evaluation carries 80% of marks. All question papers shall be set by the University. The external question papers may be of uniform pattern with 80/60 marks. The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks. The external examination in theory courses is to be conducted by the university with question papers set by external experts.

### **Scheme of Examination (2/3 credit course)**

The external question papers are of 60 marks and internal evaluation of 15 marks. Duration of external examination is 2 hrs. The pattern of question paper for external examination is as given below. The students can answer all the questions in Sections A & B. But there shall be ceiling (maximum marks that can be scored) in each section.

**Table 9. Pattern of Question Paper for Theory Type 1 [60 Marks]**  
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Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
2 Hours	<b>Section A:</b> Short answer	12	12	2	20
	<b>Section B:</b> Paragraph	7	7	5	30
	<b>Section C:</b> Essay	2	1	10	10
<b>Total Marks</b>					<b>60</b>

**Scheme of Examination (4/5 credit course):**

The external question papers are of 80 marks and internal evaluation of 20 marks. Duration of each external examination is 2.5 hours. The pattern of question papers for external examination is as given below. The students can answer all the questions in Sections A & B. But there shall be ceiling (maximum marks that can be scored) in each section.

**Table 10. Pattern of Question Paper for Theory Type 2 [80 Marks]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
2.5 Hours	<b>Section A:</b> Short answer	15	15	2	25
	<b>Section B:</b> Paragraph	8	8	5	35
	<b>Section C:</b> Essay	4	2	10	20
<b>Total Marks</b>					<b>80</b>

**B. PRACTICAL [CORE COURSE]: EVALUATION SCHEME**

Practical corresponding to each core course will be conducted during the corresponding semesters. Internal evaluation of core course Practical I will be conducted at 4<sup>th</sup> semester and Practical II & III at 6<sup>th</sup> semester. Internal evaluation carries 20% of the total marks in each practical.

**I. INTERNAL EVALUATION**

**Table 11. Criteria of Internal Evaluation for Practical I, II and III [20 marks for each practical]**

Sl. No.	Criteria	Marks
1	Attendance	4
2	Lab involvement, Performance & punctuality	4
3	Class test (1 No.)	8
4	Record	4
<b>Total Marks</b>		<b>20</b>

**Table 11a. Attendance**

Sl. No.	Attendance (%)	Marks
1	85 and above	4
2	75 to below 85%	2
3	50 to below 75%	1
4	below 50%	0

**Table 11.b. Lab involvement, Performance & Punctuality**

Sl. No.	Criteria	Marks
1	Excellent	4
2	Very Good	3
3	Good	2
4	Average	1
5	Below Average	0

**Table 11.c. Class Test [1]**

Sl. No.	Criteria	Marks
1	85 to 100%	8
2	65 to below 85%	6
3	55 to below 65%	4
4	45 to below 55%	3
5	35 to below 45%	2
6	Below 35%	1

**Table 11.d. Record**

Sl. No.	Criteria	Marks
1	Punctuality in submission	1
2	Contents	2
3	Scientific accuracy and neatness	1
	<b>Total Marks</b>	<b>4</b>

### III. EXTERNAL EVALUATION

Practical corresponding to each core theory course will be conducted during the corresponding semesters. External evaluation will be done by a team consisting of **one internal examiner and one external examiner.**

A combined University practical examination related to the first four core theory courses (Practical I\*A, I\*B, I\*C and I\*D) will be conducted at the end of fourth semester and that will be designated as Practical I (ZOL4B05P). Practical related to V semester core theory courses (Practical II\*A and II\*B) form Practical II (ZOL6B15P) and Practical related to VI semester core theory courses, (Practical III\*A, and III\*B) form Practical III (ZOL6B16P). Practical II and III examinations will be conducted at the end of 6<sup>th</sup> semester. Credits for Practical I, II & III are 4 each. **All external practical examinations are of 4 hours duration.**

Any candidate, who turns up for a practical examination, must submit a certified and bonafide record/ report of work done by him/ her duly attested by the Teacher- in -charge and the Head of the Department at the time of practical examinations.

For external evaluation of the record of Practical - I, *One* mark may be given to the local biodiversity report done by the students on Nonchordate group of animals during I or II semester and also *one* mark for local biodiversity report on Chordate groups during III or IV semester (1+1+14= Total 16 marks).

All practical examinations will have a viva voce, during which the examiner may ask questions based on the principles/methodology/concepts of the experiments performed during the practical examinations (3 marks).

**Table 12. Scheme of question paper for Practical I**

Question Nos.	Nature of questions	Total no. of questions	Marks for each question	Marks	Duration
I : Q 1-6	Spotters: Identification and classification (up to order in the case of chordates and up to class in the case of non-chordates); habits/habitat/sketches/ descriptions/ peculiarities/reasons/ significance etc.	6	3	18	4 hours
II: Q 7	Minor : Mountings/dissections/ display/ Sketches	1	9	9	
III: Q 8	Minor : Mountings/ dissections/ display/sketches	1	12	12	
IV: Q 9	Major : Mountings/dissections	1	22	22	
	Viva-voce			3#	
V:Record	-	-	-	16*	
	<b>Total Marks</b>			<b>80</b>	

\* For external evaluation of the Practical Record I, *One* mark may be given to the local biodiversity report done by the students on Nonchordate group of animals during I or II semester and also *one* mark for local biodiversity report on Chordate groups during III or IV semester (1+1+14= Total 16 marks).

# viva- voce: Examiner may ask questions based on the principles/methodology/ concepts of the experiments performed during the practical examinations.

**Table 13. Scheme of question paper for Practical II and III**

Question Nos.	Nature of questions	Total no. of questions	Marks for each question	Marks	Duration
I : Q 1-6	Spotters from various core courses: slides/specimens/apparatus/experimental set up etc.; Identification, sketches/descriptions/ reasons importance/ significance etc.	6	3	18	4 hours
II: Q 7	Minor expt. : from various sections - results/explanation/ graphs/sketches etc.	1	9	9	
III: Q 8	Minor expt. : from various sections - results/explanation/ graphs/ sketches etc.	1	12	12	
IV: Q 10	Major expt.: from various sections- results/ explanation/ sketches etc.	1	22	22	
Viva-voce				3#	
V:Record	-	-	-	16	
	<b>Total Marks</b>			<b>80</b>	

# Viva voce – Examiner may ask questions based on the principles/methodology/concepts of the experiments performed during the practical examinations

### C. PROJECT WORK & FIELD STUDY [CORE COURSE]: EVALUATION SCHEME

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#### a. Project work

A well documented project report duly attested by the Supervising teacher and the Head of department must be submitted by each candidate for evaluation, separately on the day of 3<sup>rd</sup> practical examination during semester VI. Report of the project work has an internal and external evaluation.

##### *Pass conditions*

- Submission of the project report and presence of the student for viva are compulsory for internal evaluation. No marks shall be awarded to a candidate if she/ he fail to submit the Project Report for external evaluation.
- The student should get a minimum P Grade in aggregate of external and internal.
- There shall be no improvement chance for the marks obtained in the project report.
- In the extent of student failing to obtain a minimum of Pass Grade, the project work may be re-done and a new internal mark may be submitted by the parent department. External examination may be conducted along with the subsequent batch.

#### b. Field Study

A detailed report of field study /study tour certified by the Teacher -in- charge and also by the Head of the Department specifying the places and institutions visited, date and time of visit, details of observations made etc. must be submitted by each student in "**hand written**" mode for evaluation during the day of 3<sup>rd</sup> practical examination in VI semester. The field study/study tour report is compulsory for each student appearing for practical examination. Evaluation of the field study also has both internal and external components.

Evaluation of the project report and field study report will be conducted after Practical III examination in the VI semester on a separate day. Each student shall appear for a **viva- voce** on the *project work and field study* before a team of **two external examiners**. The questions will be based on project report and field study. Marks shall be given according to their performance.

**Table: 14. Evaluation of Project and Field study**

Sl. No.	Components	External Marks	Internal Marks	Total Marks
1	Project	48	12	60
2	Field study/ study tour	12	3	15
<b>Total Marks</b>		<b>60</b>	<b>15</b>	<b>75</b>

**I. INTERNAL EVALUATION (12+3=15 Marks)****PDF Compressor Free Version**

The supervising teachers will assess the project report and field study report and award internal marks.

**Table 15: Criteria for Internal evaluation of Project [12 Marks; 20%]**

Sl. No.	Components	Marks
1	Originality	2
2	Methodology	2
3	Scheme/Organisation of Report	4
4	Viva-voce	4
<b>Total Marks</b>		<b>12</b>

**Table 16: Criteria for Internal evaluation of Field study/Study tour report [3 Marks; 20%]**

Sl. No.	Criteria	Marks
1	Content of field study report	2
2	Viva-voce related to field study	1
<b>Total Marks</b>		<b>3</b>

**II. EXTERNAL EVALUATION (48+12 = 60)****Table 17: Project work & Field study: External Examination Scheme**

	Project work			Project Total Marks (48)	Field study			Field study Total Marks (12)	Grand Total (60)
Relevance of the topic, statement of objectives	Presentati on, quality of analysis/ use of statistical tools, references	Finding s and recomm endatio ns	Viva- voce		Field study related to elective course	Visit to places of general biological and ecological interest	Viva- voce related to field study		
<b>10 Marks</b>	<b>10 Marks</b>	<b>14 Marks</b>	<b>14 Marks</b>		<b>2 Marks</b>	<b>8 Marks</b>	<b>2 Marks</b>		

**DEGREE PROGRAMME**

**ZOOLOGY OPEN COURSE**

In the fifth semester, three open courses are prescribed in Zoology for undergraduate programme for students from other streams. Department of the Institution can choose **any one** of the following open course for students from other streams. The open course is to be taught in 3 hrs per week with a total of 58 instructional hours in the 5<sup>th</sup> semester and with 3 credits (Table 6).

**Table 18: Open courses in Zoology for undergraduate programme (For students from other streams)**

	Open courses	Code	Course content
Theory (Any one)	01	ZOL5D01T	Reproductive Health and Sex Education
	02	ZOL5D02T	Nutrition, Health and Hygiene
	03	ZOL5D03T	Applied Zoology

**OPEN COURSE: SCHEME OF EVALUATION**

The evaluation scheme of the open course also has internal (20%) and external (80%) components.

**I. INTERNAL EVALUATION [15 marks]**

**Table 19. Criteria for Internal Evaluation of Open course [15 marks]**

Sl. No.	Criteria	Marks
1	Test paper (1)	6
2	Assignment	3
3	Seminar	3
4	Attendance	3
<b>Total Marks</b>		<b>15</b>

**Table 19.1. Pattern of Test paper [30 Marks]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
1 Hour	Short answer	6	6	2	10
	Paragraph	3	3	5	10
	Essay	2	1	10	10
<b>Total marks</b>					<b>30</b>

**Table 19.a. Split up of internal marks for Test Paper [40%]**

Sl. No.	Range of Marks in test paper	Out of 6 [Maximum internal marks 15]
1	85 to 100%	6
2	65 to below 85%	5
3	55 to below 65%	4
4	45 to below 55%	3
5	35 to below 45%	2
6	Below 35%	1

**Table 19.b. Criteria for Internal Evaluation of Assignment [20%]**

Sl. No.	Criteria	Out of 3 [Maximum internal marks 3]
1	Submission in time	1
2	Content	2
3	<b>Total Marks</b>	<b>3</b>

**Table 19.c. Criteria for Internal Evaluation of Seminar [20%]**

Sl. No.	Criteria	Out of 3 [Maximum internal marks 3]
1	Excellent	3
1	Good	2
2	Average	1
3	<b>*Total Marks</b>	<b>3</b>

*\*Based on way of presentation, content, answer to questions etc.*

**Table 19.d. Split up of internal marks for Attendance [20%]**

Sl. No.	Range of Marks in test paper	Out of 3 [Maximum internal marks 15]
1	85 and above	3
2	75 to below 85%	2
3	50 to below 75%	1
4	below 50%	0

## II. EXTERNAL EVALUATION (60 Marks)

**Table 20. Pattern of Question Paper for Open Course [Theory]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
2 Hours	<b>Section A:</b> Short answer	12	12	2	20
	<b>Section B:</b> Paragraph	7	7	5	30
	<b>Section C:</b> Essay	2	1	10	10
<b>Total Marks</b>					<b>60</b>

### INTERNAL ASSESSMENT: PRECAUTIONS

The process of Internal Assessment must be transparent. There should not be any chance for favoritism, victimization and discrimination. To avoid unpleasant situations being created, the following precautions may be taken:

1. Assignments and answer scripts of class tests are to be returned after evaluation. Grievances, if any, may be redressed forthwith. Then the papers may be collected and kept in the Department for (at least 2 years) future reference and shall be made available for verification by the university. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teach the course.
2. Tabulated statement of internal evaluation must be put up on the department notice board prior to its despatch to the university.

3. A grievance redressal committee may be constituted at the department level to supervise re-tests, seminars, evaluation of assignments etc. Every student has the right to appeal against any injustice in the internal assessment/evaluation. In order to address the grievance of students a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level. This can be raised at three levels.

1. He/she may appeal against the injustice to the concerned teacher.
2. If not satisfied, he/she may plead to the Head of the Department, who will then discuss the case with the faculty members of the Department and come to a conclusion.
3. If the candidate again feels that justice has not been served at this level too, he/she may bring the matter before the Principal for a final hearing. The Principal will constitute a committee consisting of two senior members of the college council [nominated by the Principal]; Head of the Department of Zoology and the Principal (Chairman) himself / herself. The decision taken by the committee shall be final and binding.

The Attendance and Progress Certificate in respect of all candidates, who appear for the university examination, shall be sent to the university not later than the closing date of the corresponding year.

**SYLLABUS**  
**CORE COURSES**

**FIRST SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE- I [Theory]

**ANIMAL DIVERSITY: NON-CHORDATA PART- I**

Code: ZOL1B01T

[DIVERSITY, ADAPTATIONS AND FUNCTIONAL ANATOMY OF PROTOZOANS AND  
ACOELOMATE AND PSEUDOCOELOMATE NON-CHORDATES]

**[36 hours] [2 hours per week] [2 Credits]**

**COURSE OUTCOMES (COs)**

COs	Course Outcome Statements
CO1	Describe the principles of classification and nomenclature (5 hrs)
CO2	Explain the five kingdom classification of living organisms (1 hr)
CO3	Understand the concepts of classification of animals (4 hrs)
CO4	Explain the classification with examples and characteristic features of kingdom Protista and describe the morphology and structural organization of <i>Paramecium</i> (6 hrs)
CO5	Describe the characteristic features of subkingdom Mesozoa (1 hr)
CO6	Explain the classification of phylum Porifera and elucidate the salient features of each class (3 hrs)
CO7	Describe the characteristic features of phylum Cnidaria and Ctenophora, illustrate the classification of phylum Cnidaria down to classes and explain the structural organization of <i>Obelia</i> (8 hrs)
CO8	Explain the salient features of phylum Platyhelminthes and illustrate its classification down to classes (3 hrs)
CO9	Explain the characteristic features and classification of super-phylum Aschelminthes and phylum Nematoda (3 hrs)
CO10	Elucidate the characters of Pseudocoelomate minor phyla Rotifera and Gastrotricha (2 hrs)

**Question paper pattern for external examination**

*[Module 1-4: Short answer 5x2=10 marks, Paragraph 3x5=15 marks, Essay 1x10= 10 marks  
Module 5-10: Short answer 7x2=14 marks, Paragraph 4x5=20 marks, Essay 1x10=10 marks]*

**Section A. CONCEPTS OF CLASSIFICATION OF ORGANISMS**

**MODULE 1. Principles of classification and nomenclature (5 hrs)**

Systematics: natural and classical. Nomenclature: Binomial and Trinomial nomenclature; International rules of Zoological nomenclature (brief account); Mention modern trends in systematics: Chemotaxonomy, Serotaxonomy, Cytotaxonomy, Evolutionary taxonomy, Numerical taxonomy (Phenetics), Cladistics (Phylogenetics), Molecular systematics, DNA barcoding.

**[Short answers/paragraphs/Essays]**

**MODULE 2. Five kingdom classification of living organisms (1 hr)**

Mention Cavalier-Smith's eight kingdom classification also.

**[Short answers/Paragraphs]**

**MODULE 3. Concepts of classification of animals (4 hrs)**

Classification based on number of cells, tissue or organ system level of organization, development of germ layers, development of symmetry, development of coelom, segmentation, homology and analogy of organs and their origin, development of mouth and digestive tract (brief account).

**[Short answers/Paragraphs]**

**Section B. CLASSIFICATION OF KINGDOM PROTISTA**  
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**MODULE 4. Kingdom: PROTISTA (6 hrs)**

Characteristic features and classification of Kingdom Protista down to phyla.  
[Salient features of the major groups of protists given below with notes on the examples cited]

Phylum: Rhizopoda	e.g. <i>Entamoeba</i>
Phylum: Dinoflagellata	e.g. <i>Noctiluca</i>
Phylum: Parabasilia	e.g. <i>Trichonympha</i>
Phylum: Apicomplexa [=Sporozoa]	e.g. <i>Plasmodium</i>
Phylum: Ciliophora	e.g. <i>Vorticella</i> .

Type **Paramecium**: Morphology and structural organization [as revealed by compound microscopy]; locomotion, nutrition, excretion, osmoregulation and reproduction; conjugation in detail.

*[Short answers/Paragraphs/Essays]*

**Section C. KINGDOM: ANIMALIA**

Salient features of the Major Phyla of animals and their diversity.

[Habits, habitat, morphology, functional anatomy and life history of representative types (wherever specified) and classification of each phylum down to classes, except otherwise mentioned, and examples thereof: Study of animal diversity with typical examples from each class, with emphasis on ecological and adaptive features, economic importance and such other points of biological interest expected. Only very brief account of each example is to be studied.]

**MODULE 5. Subkingdom: MESOZOA (1 hr)**

A brief account of Dicyemid (=Rhombozoans) mesozoans [e.g. *Dicyema*] and Orthonectid mesozoans [e.g. *Rhopalura*]

*[Short answers/Paragraphs]*

**MODULE 6. Subkingdom: PARAZOA (3 hrs)**

**Phylum: PORIFERA**

Classification down to classes and salient features of each class.

Class Calcarea (=Calcispongiae)	e.g. <i>Leucosolenia</i>
Class Demospongiae	e.g. <i>Spongilla</i>
Class Hexactinellida (=Hyalospongiae)	e.g. <i>Euplectella</i>

Give an account of canal system (Asconoid, Syconoid, Leuconoid and Rhagonoid);  
Mention amphiblastula, parenchymula and sponge gemmule.

*[Short answers/Paragraphs/Essays]*

**MODULE 7. Subkingdom: METAZOA (8 hrs)**

**Phylum CNIDARIA [=COELENTERATA] (7 hrs)**

Classification of the phylum down to classes and salient features of each class.

Class Hydrozoa	e.g. <i>Halistemma</i> , <i>Physalia</i>
Class Scyphozoa	e.g. <i>Rhizostoma</i>

Class Anthozoa e.g. *Adamsia*, *Zoanthus*, and *Madrepora*  
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 Type **Obelia**: Morphology and life cycle.  
 Polymorphism in cnidarians with special reference to siphonophores.

**Phylum CTENOPHORA [=ACNIDARIA] (1 hr)**

Unique features as exemplified by *Pleurobrachia*; mention ctenophore larva.

[Short answers/Paragraphs/Essays]

**MODULE 8. ACOELOMATA (3 hrs)**

**Phylum PLATYHELMINTHES**

Classification down to classes and salient features of the following classes.

Class Turbellaria	e.g. <i>Bipalium</i>
Class Trematoda	e.g. <i>Fasciola</i>
Class Cestoda	e.g. <i>Taenia</i>

Type **Dugesia** (Planaria): Structural organization, Digestive system, locomotion and reproduction.

[Short answers/Paragraphs/Essays]

**MODULE 9. PSEUDOCOELOMATA (3 hrs)**

**Super Phylum: ASCHELMINTHES**

Classification down to phyla; highlight the heterogeneous nature of animals of this group.

**Phylum: NEMATODA**

Characteristic features of *Ascaris*.

Examples: *Ancylostoma*, *Enterobius*, *Wuchereria*

[Short answers/Paragraphs/Essays]

**MODULE 10. PSEUDOCOELOMATE MINOR PHyla (2 hrs)**

Salient features of the following pseudocoelomate minor phyla:

Phylum <b>Gastrotricha</b>	e.g. <i>Chaetonotus</i>
Phylum <b>Rotifera</b>	e.g. <i>Brachionus</i>

[Short answers/Paragraphs]

**Topics for assignments/seminars**

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Nutrition in protozoans.
2. Reproduction in protozoans.
3. Parasitic protozoans of man.
4. Helminth parasites of man.
5. Reef building corals and coral reefs.

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**SECOND SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE- II (Theory)

**ANIMAL DIVERSITY: NON-CHORDATA PART – II**

Code: ZOL2B02T

[DIVERSITY, ADAPTATIONS & FUNCTIONAL ANATOMY OF COELOMATE NON-CHORDATES]

**[36 hours] [2 hours per week] [2 Credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Explain the classification with examples and characteristic features of phylum Annelida and describe the morphology and structural organization of <i>Neanthes</i> (7 hrs)
CO2	Describe the distribution, peculiarities and affinities of phylum Onychophora (2 hrs)
CO3	Explain the classification of phylum Arthropoda; elucidate the salient features of each class and describe the morphology and structural organization of <i>Penaeus</i> (11 hrs)
CO4	Describe the characteristic features of phylum Mollusca, illustrate its classification down to classes and explain the structural organization of <i>Pila globosa</i> (8 hrs)
CO5	Explain the salient features of phylum Echinodermata and illustrate its classification down to classes (4 hrs)
CO6	Understand the salient features and affinities of phylum Hemichordata (1 hr)
CO7	Elucidate the characters of coelomate minor phyla Phoronida, Ectoprocta and Echiura (3 hrs)

**Question paper pattern for external examination**

[Module 1-3: Short answer 7x2=14 marks, Paragraph 4x5=20 marks, Essay 1x10= 10 marks]

Module 4-7: Short answer 5x2=10 marks, Paragraph 3x5=15 marks, Essay 1x10=10 marks]

**COELOMATA**

**MODULE 1. Phylum ANNELIDA (7 hrs)**

Classification down to subclasses; salient features of the following classes and subclasses:

1. Class Polychaeta e.g. *Arenicola*
2. Class Clitellata
  - Subclass Oligochaeta e.g. *Megascolex*
  - Subclass Hirudinea e.g. *Hirudinaria*, *Haemadipsa*

Type: ***Neanthes*** [Nereis]

[Morphology, body wall, digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system. Mention Heteronereis stage and Trochophore larva.]

**[Short answers/Paragraphs/Essays]**

**MODULE 2. Phylum ONYCHOPHORA (2 hrs)**

*Peripatus* [distribution, peculiarities and affinities].

**[Short answers/Paragraphs]**

**MODULE 3. Phylum ARTHROPODA (11 hrs)**

Classification down to classes (mention the five subphyla and 16 arthropod classes); salient features of the following classes:

[brief account only]

e.g. *Limulus*

e.g. *Heterometrus (Palamnaeus), Heteropoda* (Huntsman spider, Order *Araneae*).  
Mention ticks and mites (Subclass *Acar*).

4. Class Chilopoda

e.g. *Scolopendra, Scutigera*

5. Class Diplopoda

e.g. *Spirostreptus, Julus*

6. Class Crustacea

e.g. *Sacculina, Eupagurus*

7. Class Insecta

e.g. *Lepisma, Mantis, Tabanus, Troides minos* (Southern Birdwing butterfly), *Papilio buddha* (Malabar Banded Peacock), *Apis*.

Type: ***Penaeus indicus*** [Prawn]

[Morphology, digestive system, respiratory system, blood vascular system, excretory system, nervous system, sense organs (statocyst, compound eye in detail), reproductive system and development] [Details of larval stages not expected].

**[Short answers/Paragraphs/Essays]**

#### MODULE 4. Phylum MOLLUSCA (8 hrs)

Classification down to classes; Mention Nudibranchs and *Nautilus*. Salient features of the following classes:

1. Class Aplacophora

e.g. *Chaetoderma*

2. Class Polyplacophora (=Amphineura)

e.g. *Chiton*

3. Class Monoplacophora

e.g. *Neopilina*

4. Class Gastropoda

e.g. *Turbinella*

5. Class Bivalvia (=Pelecypoda)

e.g. *Perna*

6. Class Scaphopoda

e.g. *Dentalium*

7. Class Cephalopoda (=Siphonopoda)

e.g. *Sepia*

Type: ***Pila globosa*** [Apple Snail]

[Morphology, digestive system, respiratory system, blood vascular system, excretory system, nervous system, sense organs (osphradium in detail) and reproductive system].

**[Short answers/Paragraphs/Essays]**

#### MODULE 5. Phylum ECHINODERMATA (4 hrs)

Classification down to classes [of extant forms only]; salient features of the following classes and brief account of examples:

1. Class Crinoidea

e.g. *Antedon*

2. Class Asteroidea

e.g. *Astropecten*

3. Class Ophiuroidea

e.g. *Ophiothrix*

4. Class Holothuroidea

e.g. *Holothuria*

5. Class Echinoidea

e.g. *Echinus*

Structural peculiarities of *Asterias* (star fish); water vascular system in detail.

**[Short answers/Paragraphs/Essays]**

## MODULE 6. Phylum HEMICHORDATA (1 hr)

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*Balanoglossus*: Salient features and affinities.

[Short answers/Paragraphs]

## MODULE 7. COELOMATE MINOR PHYLA (3 hrs)

Salient features of the following coelomate minor phyla; mention examples specified [structure and life history not required].

- |                                       |                      |
|---------------------------------------|----------------------|
| 1. Phylum <b>Phoronida</b>            | e.g. <i>Phoronis</i> |
| 2. Phylum <b>Ectoprocta [Bryozoa]</b> | e.g. <i>Bugula</i>   |
| 3. Phylum <b>Echiura</b>              | e.g. <i>Bonellia</i> |

[Short answers/Paragraphs]

### Topics for Assignments/Seminars

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students).

- 1] Larval forms in Crustacea and their significance.
- 2] Metamorphosis in insects.
- 3] Social organization in insects.
- 4] Economic importance of molluscans.
- 5] Insect vectors of human diseases.

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**THIRD SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
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 ZOOLOGY CORE COURSE – III (Theory)

**ANIMAL DIVERSITY: CHORDATA PART - I**

CODE: ZOL3B03T

[TAXONOMY, DIVERSITY, STRUCTURAL ANATOMY AND ADAPTATIONS OF CHORDATES]

**[54 hours] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
CO1	Explain the characteristics of chordates and outline classification of the phylum Chordata (2 hrs)
CO2	Describe the salient features and affinities of subphylum Urochordata and its classification down to classes; elucidate the morphology and structural organization of <i>Ascidia</i> (5 hrs)
CO3	Explain the salient features and affinities of subphylum Cephalochordata with reference to <i>Branchiostoma</i> (4 hrs)
CO4	Describe the salient features of subphylum Vertebrata, illustrate its classification down to classes and elucidate the characteristics of division Agnatha (3 hrs)
CO5	Enumerate the salient features of superclass Pisces and illustrate its classification down to orders and the morphology and structural organization of <i>Mugil cephalus</i> (12 hrs)
CO6	Describe the salient features and affinities of class Amphibia and its classification up to orders; explain the morphology and organ systems of <i>Hoplobatrachus tigerinus</i> (13 hrs)
CO7	Elucidate the characteristic features of the class Reptilia and its classification down to orders; describe the morphology and organ systems of <i>Calotes versicolor</i> (15 hrs)

**Question paper pattern for external examination**

*[Module 1-3: Short answer 4x2=8 marks, Paragraph 2x5=10*

*Module 4-7: Short answer 8x2=16 marks, Paragraph 5x5=25 marks, Essay 2x10=20 marks]*

**MODULE 1. Introduction [2 hrs]**

Chordate characters (fundamental, general and advanced); chordates versus non-chordates; diversity of chordates; outline classification down to classes; salient features of each subphylum.

***[Short answers/Paragraphs]***

*[Type studies with special emphasis on morphology and various functional systems such as integumentary, digestive, respiratory, circulatory, excretory, nervous and reproductive systems. Also mention the evolutionary significance]*

**MODULE 2. Subphylum UROCHORDATA [Tunicata] [5 hrs]**

Classification of the subphylum down to classes. Affinities of urochordates with cephalochordates and vertebrates.

Class Ascidiacea e.g. *Herdmania*

Class Larvacea e.g. *Oikopleura*

Class Thaliacea e.g. *Doliolum*

Type: **Ascidia** [Morphology and retrogressive metamorphosis]; add a note on neoteny and paedogenesis.

***[Short answers/Paragraphs]***

**MODULE 3. Subphylum CEPHALOCHORDATA [4 hrs]**

Type: **Branchiostoma** [=Amphioxus]

Morphology and anatomical features; digestive system in detail; primitive,

degenerate and specialized features [affinities and systematic position to be emphasized].

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**[Short answers/Paragraphs]**

#### **MODULE 4. Subphylum VERTEBRATA [3 hrs]**

Salient features of subphylum vertebrata and its outline classification down to classes.

Division 1. AGNATHA

Characters, classification down to classes and examples: *Myxine*; *Petromyzon*

[mention *Ammocoetes* larva]

**[Short answers/Paragraphs]**

Division 2. GNATHOSTOMATA

#### **MODULE 5. Superclass PISCES [12 hrs]**

Classification of Pisces down to orders; salient features of the following extant groups:

**Class Chondrichthyes** [Cartilaginous fishes]

Subclass Selachii e.g. *Scoliodon*, *Trygon*

Subclass Holocephali e.g. *Chimaera*

**Class Osteichthyes** [Bony fishes]

Subclass **Sarcopterygii**

1. Order Crossopterygii [Coelacanth] e.g. *Latimeria*

2. Order Dipnoi [Lung fishes] e.g. *Neoceratodus*, *Protopterus*, *Lepidosiren* (Add a note on the distribution of lung fishes).

Subclass **Actinopterygii**

1. Superorder Chondrostei e.g. *Acipenser*

2. Superorder Holostei e.g. *Amia*, *Lepidosteus*

3. Superorder Teleostei [Spiny-rayed fishes] e.g. *Sardinella*, *Rastrelliger*

Type: ***Mugil cephalus*** (Grey Mullet)

[Morphology, body wall, digestive system, respiratory system, circulatory system, excretory system, sense organs (neuromast organ in detail) and reproductive system].

Sub-terranean fishes from Kerala: *Aenigmachanna Gollum* (Gollum Snakehead), *Kryptoglanis shajii*, *Horaglanis krishnai* (Blind Catfish) & *Monopterus digressus* (Blind cave eel). Mention recent addition to ornamental fish trade - *Sahyadria denisonii* (Miss Kerala).

**[Short answers/Paragraphs/Essays]**

Super class **TETRAPODA**

#### **MODULE 6. Class AMPHIBIA [13 hrs]**

Classification of Amphibia down to orders with examples [of extant forms only].

Subclass **Stegocephalia** (extinct)

Subclass **Lissamphibia**

1. Order Apoda (=Gymnophiona) e.g. *Ichthyophis*, *Uraeotyphlus*

2. Order Caudata (=Urodela) e.g. *Necturus*, *Ambystoma*, mention Axolotl larva.

3. Order Anura (=Salientia) e.g. *Duttaphrynus*, *Rhacophorus*

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Type: *Hoplobatrachus tigerinus* (Indian Bullfrog)

[Morphology, body wall, skeletal system, digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system].

Mention about the diversity of bush frogs, dancing frogs and night frogs in Western Ghats and the discovery of *Nasikabatrachus sahyadrensis* (Purple frog).

**[Short answers/Paragraphs/Essays]**

## **MODULE 7. Class REPTILIA [15 hrs]**

Classification of class Reptilia down to orders and salient features of the following orders (only extant forms):

### Subclass I - Anapsida

1. Order Cotylosauria [stem reptiles] e.g. *Hylonomus*
2. Order Chelonibia [common turtles, tortoises etc.] e.g. *Melanochelys*, *Chelone*

### Subclass II - Diapsida

1. Order Rhynchocephalia e.g. *Sphenodon*
2. Order Squamata
  - Suborder Lacertilia (Lizards) e.g. *Chamaeleo*, *Hemidactylus*
  - Suborder Ophidia (Snakes)

Common venomous and non-venomous snakes of Kerala: a] *Python molurus* b] *Ptyas mucosus* c] *Gongylophis* (= *Eryx*) *conicus* d] *Indotyphlops braminus* e] *Bungarus caeruleus* f] *Naja naja* g] *Daboia russellii* h] *Ophiophagus hannah*

Identification key for venomous and non-venomous snakes.

3. Order Crocodilia e.g. *Crocodylus*, *Gavialis*

[Mention the extinct subclasses **Euryapsida**, **Parapsida** and **Synapsida** (mammal-like reptiles) and mention the origin of mammals from synapsids].

Type: *Calotes versicolor* (Garden Lizard)

[Morphology, body wall, skeletal system (exclude skull bones), digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system].

**[Short answers/Paragraphs/Essays]**

## **Topics for Assignments/Seminars**

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Migration of fishes.
2. Parental care in fishes.
3. Parental care in amphibians.
4. Snake venom: nature; composition; antivenin; poly antivenins; prophylaxis.
5. Accessory respiratory organs in fishes.
6. Economic importance of fishes.

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**FOURTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE-IV (Theory)

**ANIMAL DIVERSITY: CHORDATA PART-II**

Code: ZOL4B04T

[TAXONOMY, DIVERSITY, STRUCTURAL ANATOMY AND ADAPTATIONS OF CHORDATES –  
 AVES AND MAMMALS]

**[54 hours] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Describe the classification of class Aves down to orders, salient features of each order with suitable examples (11 hrs)
CO2	Describe the external characters and functional systems of <i>Columba livia</i> (14 hrs)
CO3	Enumerate the salient features and classification of class Mammalia down to orders with suitable examples (11 hrs)
CO4	Elucidate the external characters and functional systems of <i>Oryctolagus cuniculus</i> (14 hrs)
CO5	Compare the circulatory, excretory and nervous systems of vertebrates (4 hrs)

**Question paper pattern for external examination**

[Module 1-2: Short answer 5x2=10 marks, Paragraph 3x5=15 marks, Essay 1x10= 10 marks]

[Module 3-4: Short answer 5x2=10 marks, Paragraph 3x5=15 marks, Essay 1x10=10 marks]

[Module 5: Short answer 2x2=4 marks, Paragraph 1x5=5 marks]

**CLASS: AVES [25 hrs]**

**MODULE 1. Classification of Aves [11 hrs]**

Classification of class Aves down to the orders specified; mention at least one example for each order.

Subclass **Archaeornithes**

**[2 hrs]**

- Order Archaeopterygiformes e.g. *Archaeopteryx lithographica* – a brief account on its discovery and evolutionary significance.

Subclass **Neornithes**

**[2 hrs]**

Super order Palaeognathae [=Ratitae]

- Order Casuariiformes e.g. *Casuarius* (Cassowary)
- Order Dinornithiformes [=Apterygiformes] e.g. *Apteryx* (Kiwi)
- Order Rheiformes e.g. *Rhea*
- Order Struthioniformes e.g. *Struthio* (Ostrich)

Super order Neognathae [=Carinatae]

**[7 hrs]**

- Order Galliformes [pheasants, quail, turkeys, grouse] e.g. *Pavo cristatus*
- Order Anseriformes [screamers, water fowls] e.g. *Anas poecilorhyncha*
- Order Passeriformes [perching birds] e.g. *Passer domesticus*
- Order Piciformes [woodpeckers, barbets, honeyguides] e.g. *Dinopium*
- Order Coraciiformes [kingfishers & allies] e.g. *Alcedo atthis*
- Order Apodiformes [swifts, humming birds] e.g. *Apus nipalensis*
- Order Strigiformes [owls] e.g. *Bubo*
- Order Cuculiformes [cuckoos, roadrunners, turacos] e.g. *Eudynamys*
- Order Psittaciformes [parrots, lorries, cockatoos] e.g. *Psittacula krameri*
- Order Gruiformes [cranes, rails, coots, bustards] e.g. *Ardeotis nigriceps*

16. Order Charadriiformes [plovers, gulls, terns, auks, sand pipers] e.g. *Tringa*  
 17. Order Columbiformes [pigeons, doves, dodos, sand grouse] e.g. *Columba*  
 18. Order Falconiformes [diurnal birds of prey – falcons, hawks] e.g. *Myiavus*  
 19. Order Ciconiiformes [herons, storks, ibis, spoon bills] e.g. *Ardeola grayii*  
 20. Order Pelecaniformes [pelicans, cormorants] e.g. *Pelecanus*  
 21. Order Sphenisciformes [Impennae] e.g. *Aptenodytes* (penguin)  
 22. Order Phoenicopteriformes [flamingos] e.g. *Phoenicopus*

Recent Extinctions: Passenger Pigeon [*Ectopistes migratorius*], Dodo [*Raphus cucullatus*], Pink-headed Duck [*Rhodonessa caryophyllacea*], Elephant Bird [*Aepyornis*].

Rediscovery of Jerdon's Courser [*Cursorius bitorquatus*] & Forest Owlet [*Athene blewitti*].

**[Short answers/Paragraphs/Essays]**

**MODULE 2.Type: *Columba livia* (Rock Pigeon) [14 hrs]**

[External characters, integumentary system (structure of feather in detail – exclude development of feather), skeletal system (skull excluded), digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system].

**[Short answers/Paragraphs/Essays]**

**CLASS: MAMMALIA [25 hrs]**

**MODULE 3. Classification of Mammalia [11 hrs]**

Classification of class Mammalia down to the orders cited with examples specified.

**Subclass Prototheria**

**[2 hr]**

Infraclass **Ornithodelphia** [egg-laying mammals]

1. Order Monotremata e.g. *Ornithorhynchus* [Platypus],  
*Tachyglossus* [= *Echidna*]

**Subclass Theria**

**[2 hr]**

Infraclass **Metatheria** [marsupials]

2. Order Marsupialia e.g. *Didelphis* [Opossum], *Macropus* [Kangaroo]

Infraclass **Eutheria** [true placental mammals]

**[7 hrs]**

3. Order Edentata e.g. *Bradypus* (Sloth), *Dasypus* (Armadillo)  
*Myrmecophaga* (Spiny ant-eater)
4. Order Pholidota e.g. *Manis* (Pangolin/ Scaly ant-eater)
5. Order Lagomorpha [rabbits and hares] e.g. *Lepus nigricollis* (Indian Hare)
6. Order Rodentia e.g. *Funambulus*, *Ratufa* (Giant squirrel)
7. Order Soricimorpha [shrews, moles] e.g. *Suncus murinus*, *Crocidura*
8. Order Erinaceomorpha e.g. *Paraechinus micropus* (Indian Hedgehog)
9. Order Chrysochloridea e.g. Golden mole of South Africa
10. Order Dermoptera [colugos] e.g. *Cynocephalus volans* (flying lemur)
11. Order Chiroptera e.g. *Pteropus*, *Pipistrellus*, *Kerivoula picta* (Painted bat)
12. Order Primates e.g. *Loris*, *Macaca*, *Gorilla*, *Pongo*, *Hylobates*, *Homo*
13. Order Carnivora e.g. *Phoca* (Seal), *Odobenus* (Walrus), *Panthera sp.*,  
*Viverricula indica* (Civet), *Lutrogale* (Otter),

- Cuon alpinus* (Wild dog).
14. Order Cetacea e.g. *Physeter* (Sperm whale), *Delphinus* (Dolphins), *Phocaena* (Porpoise), *Balaenoptera* (Baleen whale)
15. Order Artiodactyla e.g. *Sus scrofa cristatus* (Wild Boar), *Bos gaurus* (Gaur), *Giraffa* (Giraffe), *Hemitragus* [Tahr], *Rusa* (= *Cervus*) *unicolor* (Sambar deer), *Axis axis* (Spotted deer), *Moschiola* (Mouse deer), *Antilope cervicapra* (Blackbuck).
16. Order Perissodactyla e.g. *Equus caballus* (Horse), *Rhinoceros*
17. Order Sirenia e.g. *Trichechus* (Manatee), *Dugong*
18. Order Proboscidea e.g. *Elephas maximus indicus* [Indian elephant], *Elephas maximus borneensis* [Borneo pigmy elephant], *Loxodonta africana* [African savanna elephant] and *Loxodonta cyclotis* [African forest elephant].
19. Order Hyracoidea e.g. Hyrax (Coney)
20. Order Tubulidentata e.g. Aardvark

[Short answers/Paragraphs/Essays]

**MODULE 4.** Type: ***Oryctolagus cuniculus*** (European Rabbit) [14 hrs]

[External features, integumentary system, skeletal system (dentition in detail – skull excluded), digestive system, respiratory system, circulatory system (exclude arterial and venous systems), excretory system, sense organs and reproductive system].

[Short answers/Paragraphs/Essays]

**MODULE 5. Comparative Anatomy [4 hrs]**

Compare the circulatory, excretory and nervous systems of vertebrates.

[Short answers/Paragraphs]

**Topics for Assignments/ Seminars**

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Aquatic mammals and their adaptations
2. Dentition in mammals [adaptations related to food]
3. Endangered mammals of Kerala
4. Flying mammals
5. Migration in birds
6. Flight adaptations in birds
7. Flightless birds

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**B. Sc. ZOOLOGY PROGRAMME**  
**ZOOLOGY [CORE COURSE] PRACTICAL – I: ANIMAL DIVERSITY**

Code: ZOL4B05P

[Practical I\*A+ I\*B+ I\*C+ I\*D]

**[144 hours] [2 hrs per week] [Spread over first 4 semesters] [4 Credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Identify and describe specified protists and acoelomate & pseudocoelomate non-chordates and perform the culture of selected protists; understand the histological features of coelenterate, platyhelminth and nematode. (36 hrs)
CO2	Identify and describe specified coelomate non-chordates and the transverse sections of annelids; Perform mounting of the specified organs of selected non-chordates. (36 hrs)
CO3	Identify and describe specified chordates and specified bones of chordates; Prepare key for identification of venomous snakes; Perform mounting and dissection of specified organ systems of chordates. (36 hrs)
CO4	Identify and describe selected vertebrates and specified bones of vertebrates. (36 hrs)

**FIRST SEMESTER B. Sc. DEGREE PROGRAMME**

CORE COURSE PRACTICAL- I\*A

**ANIMAL DIVERSITY: NONCHORDATA Part - I**

[36 hours] [2 hrs per week]

*[Students are expected to make sketches with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches.]*

**MODULE 1. [36 hrs]**

**Section A. Study of the following Non-chordate specimens:**

*(Choose useful and harmful forms from different habitats. All animals intended for type study are to be included. Slides / museum preparations are to be used; charts / models may be used in exceptional cases. Students are expected to identify the specimens by their generic names and assign them to the respective phyla and classes).*

- Protists:** *Amoeba, Noctiluca, Ceratium, Entamoeba, Trichonympha, Paramecium* [any 4]
- Poriferans:** *Leucosolenia/Scypha or Spongilla, Sponge gemmule, spicules*
- Cnidarians:** Sedentary hydrozoans: *Hydra, Obelia, Obelia medusa* [any 2]  
Pelagic hydrozoans: *Physalia/Velella*  
Pelagic scyphozoan: *Aurelia/ Rhizostoma*  
Common anthozoans: *Adamsia, Edwardsia, Madrepora, Fungia, Tubipora*  
*Gorgonia* [any 3]
- Platyhelminths:** Free living flat worm: *Bipalium Dugesia*  
Parasitic flat worms: *Fasciola/Taenia solium*
- Aschelminths:** Parasitic round worms: *Ascaris/Ancylostoma/Wuchereria*
- Minor Phyla :** *Sipunculus/Bonellia* or any other specimen
- Local Biodiversity Record:** Observe water samples from the locality for live protists and make a field note.

8. Demonstration of culture methods of Protists [*Amoeba*/ *Euglena*/ *Paramecium*].

### Section B. Histology

Transverse sections of a coelenterate [*Hydra*], a platyhelminth [*Dugesia*] and a nematode (*Ascaris* male & female).

## SECOND SEMESTER B. Sc. DEGREE PROGRAMME

CORE COURSE PRACTICAL- I\*B

### ANIMAL DIVERSITY: NON-CHORDATA Part- II

[36 hours] [2 hrs per week]

#### MODULE 2. [36 hrs]

##### Section A. Study of the following Coelomate Non-chordate specimens:

1. **Annelids** : Polychaetes: *Aphrodite*, *Chaetopterus*, *Arenicola*, *Tomopteris* [any 2]

Common earthworm: *Megascolex* / *Pheretima*

Leech: *Hirudinaria*, *Haemadipsa*, *Branchellion* [any 2]

2. **Arthropods**: Items of evolutionary / taxonomic importance - *Limulus*,  
*Streptocephalus* [any 1]

Common fouling barnacle - *Lepas* / *Balanus*

Parasitic crustaceans- *Sacculina*, *Cymothoa*, *Argulus* [any 2]

Crustacean of the sandy shore- *Emerita* / *Albunea*

Symbiotic crustacean - *Eupagurus*

Economically important crustacean - *Penaeus*, *Scylla* [any 1]

Vectors - *Cyclops*, *Aedes*, *Musca*, *Xenopsylla* [any 2]

Insect pests - *Lepisma*, termite queen,

Pest of paddy, pest of coconut, pest of stored grains [any 5]

Aquatic insects - *Belostoma*, *Nepa*, *Ranatra* [any 2]

Predatory insect - Dragonfly, Ant-lion, *Mantis* [any 1]

Insect which camouflages - *Carausius* / *Phyllium*

Common myriapods - *Scolopendra*/ *Scutigera*, *Julus*/  
*Spirostreptus*/ *Jonespeltis* [any 2]

Common arachnids - *Palamnaeus*/ *Buthus*,

Spider/ tick/ mite [any 2]

3. **Molluscs**: Inter tidal mollusks - *Chiton*, *Patella*, *Haliotis*, *Onchidium*,  
*Aplysia* [any 2]

Ornamental gastropods - *Cypraea*, *Murex*, *Turbinella* [any 2]

Poisonous gastropod - *Conus*

Pelecypods of economic importance - *Perna*, *Pinctada*,  
*Teredo*, *Ostrea* [any 2]

Scaphopod - *Dentalium*

Cephalopods of economic/evolutionary importance  
- *Sepia*, *Loligo*, *Octopus*, *Nautilus* [any 3]

4. **Echinoderms**: *Antedon*, *Asterias*, *Ophiothrix*, *Cucumaria*,  
*Echinus*, cake urchin, heart urchin

[any 3]

5. **Hemichordate:** *Balanoglossus*

6. **Onychophoran:** *Peripatus* (Evolutionary significance)

7. **Local Biodiversity Record:** Observation of butterflies/dragonflies or any other Non-chordate group of the locality and prepare a field note.

**Section B. Histology**

Compare TS of any two annelids [*Neanthes*/ Earth worm/ Leech].

**Section C. Mountings**

1. Earthworm : Setae (a few loose setae) [Minor]
2. *Neanthes*: Parapodium [Minor]
3. *Penaeus* : Appendages [Minor]
4. Cockroach : Salivary apparatus [Major]
5. Honeybee/ plant bug: Mouth parts [Minor]

**Section D. Dissections (Digital versions to be downloaded or procured as per UGC guidelines)**

1. *Penaeus* : Nervous system [Major]
2. Cockroach : Nervous system [Major]

**THIRD SEMESTER B. Sc. ZOOLOGY PROGRAMME**

CORE COURSE PRACTICAL- I\*C

**ANIMAL DIVERSITY: CHORDATA Part - I**

[36 hours] [2 hrs per week]

[Students are expected to make sketches with notes, while they study the specimens in the laboratory and field. The record must carry notes of all specimens, mountings and dissections. Emphasis must be on scientific aspects. The record sheets related to part I and part II must be bound together to get a single Record.]

**MODULE 3. [36 hrs]**

**Section A. Study of the following Chordate specimens:**

(Students are expected to identify the specimens by their generic names and assign them to the respective phyla /classes/ orders)

1. **Urochordates** : *Ascidia*, ascidian tadpole, *Salpa*, *Doliolum* [any 2]
2. **Cephalochordates** : *Branchiostoma*
3. **Agnathans** : *Myxine*, *Petromyzon*, Ammocoetes larva [any 1]
4. **Fishes** :
  - a. Common elasmobranchs - *Chiloscyllium*, *Stegostoma*, *Sphyrna*, *Pristis*, *Trygon*, *Narcine*, *Astrapes* [any 3]
  - b. Common edible fishes (marine) - *Sardinella*, *Rastrelliger*, *Cynoglossus*, *Parastromateus*, *Trichiurus*, *Cybbium*, *Thunnus* [any 3]
  - c. Common edible fishes (Inland) - *Etrophus*, *Mugil*, *Wallagonia*, *Tilapia*, *Catla*, *Cirrhina*, *Labeo*, *Cyprinus* [any 3]
  - d. Fishes with special adaptive features - *Hippocampus*, *Belone*, *Hemiramphus*, *Exocoetus*, *Tetraodon*, *Pterois*, *Ostracion*,

*Heteropneustes, Clarias, Arius, Anabas, Channa, Echeineis, Antennarius, Amphisila, Anguilla*

[any 5]

5. **Amphibians:** Common amphibians - *Duttaphrynus, Euphlyctis, Rhacophorus, Ambystoma, Axolotl larva, Ichthyophis/Uraeotyphlus*

[any 3]

**6. Reptiles :**

- a. Common lizard - *Hemidactylus, Calotes, Mabuya (Eutropis)* [any 1]
- b. Lizards with special adaptations - *Draco, Chamaeleo, Phrynosoma* [any 2]
- c. Non venomous snakes - *Ptyas, Gongylophis, Lycodon, Indotyphlops* [any 2]
- d. Venomous snakes - *Naja, Daboia, Bungarus, Echis* [any 2]
- e. Water snake – *Hydrophis / Enhydis / Xenochrophis*
- f. Arboreal snake – *Dendrelaphis / Python / Ahaetulla*

7. Key for identification of venomous and non-venomous snakes.

8. **Local Biodiversity Record:** Observe fishes/amphibians or any other vertebrate group (any one group) of the locality in their natural habitat and prepare a field note.

**Section B. Histology**

1. *Branchiostoma* - T. S. through pharyngeal region

**Section C. Mountings**

- 1. Sardine: Cycloid scale [Minor]
- 2. Shark: Placoid scale [Minor]
- 3. Shark/Frog/*Calotes*: Brain [Minor] - Demonstration only.

**Section D. Dissections (Digital versions to be downloaded or procured as per UGC guidelines)**

- 1. Mullet/ Sardine: Alimentary canal (Major)
- 2. Shark: IX and X cranial nerves on one side (Major) – Demonstration only.
- 3. Frog: V cranial nerve - branches, root and ganglion on one side (Major)  
Demonstration only
- 5. Frog/*Calotes*: Arterial system on one side (demonstration only).

**Section E. Osteology**

- 1. Frog: Typical, 8th, 9<sup>th</sup> Vertebrae,
- 2. Frog: Pectoral & Pelvic girdles
- 3. Snake Vertebra [show zygosphenes and zygantrum]
- 4. Carapace and plastron of turtle/tortoise.

**FOURTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**

**CORE COURSE PRACTICAL- I\*D**

**ANIMAL DIVERSITY: CHORDATA Part - II**

[36 hours] [2 hrs per week]

**MODULE 4. [36 hrs]**

**Section A. Study of the following Vertebrate specimens:**

**1. Birds:**

- a. Fossil bird - *Archaeopteryx*
- b. Flightless bird - *Rhea, Struthio* [any 1]
- c. Wetland birds - Jacana, Duck, Egret, Heron, Ibis, Stork [any 2]

- d. Shore birds – Gulls, Plovers, Terns [any 1]  
 e. Migratory birds – Pelican, Crane, Flamingo [any 1]  
 f. Birds of Prey – Falcon, Eagle, Kite, Shikra, Owl [any 2]  
 g. Features and adaptations of: duck, parrot, king fisher, owl, kite and wood pecker [draw sketches of the beaks and feet of 4 birds]

## 2. Mammals:

- a. Common insectivore – *Suncus*, Hedgehog [any 1]  
 b. Common rodent – *Rattus*, *Bandicoota*, *Funambulus* [any 1]  
 c. Common bat of Kerala – *Pteropus*, *Megaderma*, *Pipistrellus* [any 1]  
 d. Small Carnivore – Jungle Cat, *Herpestes*, Civet [any 1]  
 e. Primate – *Loris* or any other species

## 3. Local Biodiversity Record: Observe birds/mammals (any one group) of the locality in their natural habitat and prepare a field note.

## Section B. Osteology

- a. Pigeon/ Domestic Fowl: Cervical vertebra, Pectoral girdle and Sternum, Pelvic girdle with Synsacrum [mention the component bones].  
 b. Rabbit: Skull showing dentition, Atlas, axis, typical vertebra, scapula and pelvic girdle.

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- Arumugam, N., Nair, N.C., Leelavathy, S., Soundara Pandian, N., Murugan, T. & Jayasurya (2010). *Practical Zoology Volume I. Invertebrata*. Saras Publications, Tamil Nadu.
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**FIFTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE- V [Theory]

**CELL BIOLOGY AND GENETICS**

Code: ZOL5B06T

**[54 hours] [3 hours per week] [4 Credits]**

**COURSE OUTCOMES (COs)**

<b>COs</b>	<b>Course outcome Statements</b>
CO1	Understand the principles and applications of various types of light microscopes, electron, Scanning-tunnelling and Atomic force microscope and illustrate the histological and histochemical processing of tissues (7 hrs)
CO2	Explain the basic structure of a eukaryotic cell and the structure and functions of plasma membrane, mitochondria, lysosome, cytoskeletal elements and interphase nucleus (12 hrs).
CO3	Illustrate the nucleosome organization of chromatin and higher order structures; structure of chromosomes and giant chromosomes (2 hrs).
CO4	Enumerate eukaryotic cell cycle and cell division by amitosis, mitosis and meiosis (4 hrs)
CO5	Explain the causes of transformation, characteristics of transformed cells and the role of protooncogenes and tumor suppressor genes in malignant transformation; mechanism and significance of apoptosis (2 hrs)
CO6	Enumerate allelic and non-allelic gene interactions; supplementary, complementary, polymeric, duplicate and modifying genes and polygenic inheritance (5 hrs).
CO7	Illustrate multiple allelism and solve problems related to blood group inheritance (4 hrs).
CO8	Explain characteristics of linkage groups and linkage map; crossing over and calculation of recombination frequency; sex-linked, sex-influenced and sex-limited characters; sex differentiation and disorders of sexual development (8 hrs).
CO9	Describe the mechanisms of sex determination including chromosomal, genic, haploid-diploid mechanisms; the hormonal and environmental influence on sex determination and gynandromorphism (3 hrs).
CO10	Explain mutagenesis, mutagens and chromosomal and gene mutations (3 hrs).
CO11	Enumerate the classification and grouping of human chromosomes; numerical and mutational human autosomal and sex chromosomal anomalies; polygenic human traits and genetic counseling (4 hrs).

**Question paper pattern for external examination**

*[Module 1-5 Short answer 7x2=14 marks; Paragraph 4x5=20 marks; Essay2x10=20 marks; Module 6-11 Short answer 8x2=16 marks; Paragraph 4x5=20 marks; Essay2x10=20 marks]*

**Section A: CELL BIOLOGY (27 hrs)**

**MODULE 1. Techniques in Cell Biology (7 hrs)**

**Microscopy**

**(4 hrs)**

Light microscope: principles and uses; use of oil immersion objective. Types of light Microscopes: Bright-field, Phase contrast and Fluorescence microscope. Camera lucida: Principle and uses. Micrometry. Electron microscope: Principle, applications; advantages and disadvantages. Principles and applications of - Scanning Electron Microscope (SEM); Scanning-tunnelling microscope and Atomic force microscope.

**Histological Techniques****(2 hrs)**

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Preparation of materials for light microscopy (for temporary and permanent mounts): Fixation: common fixatives: buffered formalin, ethanol, Bouin's solution and Carnoy's fluid (mention composition). Processing of the fixed tissue: mention dehydration, infiltration, and embedding. Sectioning: Rotatory microtome (brief description), uses. Staining: Mention deparaffinization, hydration, staining, dehydration and mounting. Histological stains: Haematoxylin and Eosin. Vital stains: Neutral red and Janus green.

**Histochemical Techniques****(1 hr)**

Mention the techniques for the demonstration of proteins (mercuric bromophenol blue method), carbohydrates (PAS) and lipids (Sudan)

*[Short answers/Paragraphs]*

**MODULE 2. Structure of eukaryotic cell (12 hrs)****Plasma membrane****(6 hrs)**

Chemical composition and structure (unit membrane concept and fluid mosaic model), membrane lipids and membrane fluidity; significance of membrane fluidity; membrane proteins-integral proteins, peripheral proteins and lipid-anchored proteins; membrane carbohydrates.

Interactions between cells and their environment – extracellular space, glycocalyx, extracellular matrix - Mention basal lamina, collagen, fibronectin, proteoglycans and laminins.

Interaction of cells with other cells – cell adhesion molecules, selectins, immunoglobulins, integrins and cadherins. Modifications of the plasma membrane – microvilli, desmosomes, nexuses, tight junction and gap junction.

Functions: trans-membrane transport mechanisms – diffusion, osmosis, active transport, ion transport (channels), co-transport, bulk trans-membrane transport – exocytosis, endocytosis. Membrane receptors: Mention insulin receptor.

**Mitochondria****(2 hrs)**

Ultra-structure; mitochondrial membranes; functions of mitochondria; Biogenesis of mitochondria.

**Lysosomes****(1 hr)**

Structure and function; polymorphism in lysosomes, lysosomal enzymes. Concept of GERL (Golgi body – Endoplasmic Reticulum – Lysosome complex).

**Cytoskeleton****(1 hr)**

Location, ultrastructure, biochemical composition and functions of microfilaments, intermediate filaments and microtubules.

**Interphase nucleus****(2 hrs)**

General structure and functions; nucleo-cytoplasmic index; ultrastructure of nuclear membrane and nuclear pore complex (NPC), functions of NPC; Nucleoplasm - Composition and function; Nucleolus - Structure, composition, nucleolar organizer, nucleolar cycle and functions of nucleolus. Chromatin: Euchromatin and heterochromatin.

*[Short answers/Paragraphs/Essays]*

### **MODULE 3. Structure of chromatin (2 hrs)**

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Nucleosome organization and higher order structures; Chromosome structure; Giant chromosomes - Polytene chromosomes: structure, puffs and bands; Endomitosis; significance. Lamp brush chromosomes: structure, loops and significance.

*[Short answers/Paragraphs]*

### **MODULE 4. Cell Cycle & Cell division (4 hrs)**

Cell Cycle: G<sub>1</sub>, S, G<sub>2</sub> and M phases – Check points; G<sub>0</sub> phase. Cell division: Amitosis (brief account); Mitosis: description of all stages, cytokinesis and significance; Meiosis: description of all stages and significance. Role of centriole in animal cell division.

*[Short answers/Paragraphs/Essays]*

### **MODULE 5. Cancer and Apoptosis (2 hrs)**

Characteristics of cancer cells; causes of transformation; protooncogenes and tumor suppressor genes and their role in transformation. Apoptosis, mechanism of apoptosis and its significance.

*[Short answers/Paragraphs]*

## **Section B: GENETICS (27 hrs)**

### **MODULE 6. Interaction of genes (5 hrs)**

Allelic interactions: incomplete dominance and co-dominance with examples. Non-allelic interactions: epistasis (inheritance of plumage colour in poultry), mention dominant and recessive epistasis. Supplementary genes (example: inheritance of comb pattern in poultry). Complementary genes, mention any one example. Polymeric genes, mention one example. Duplicate genes, mention one example. Modifying genes. Atavism, Penetrance and Expressivity. Polygenic (quantitative) inheritance (example: skin colour in man).

*[Short answers/Paragraphs]*

### **MODULE 7. Multiple alleles (4 hrs)**

Definition and characteristics; example: coat colour in rabbits. Blood group genetics: ABO blood group system; MN blood group and Bombay phenotype. Inheritance of Rh factor; mention erythroblastosis foetalis. Problems related to blood group inheritance (5 problems). Isoalleles, mention any one example.

*[Short answers/Paragraphs/Essays]*

### **MODULE 8. Linkage and Recombination (8 hrs)**

Definition and characteristics of linkage groups, Morgan's work on *Drosophila*. Types of linkage: complete and incomplete - examples; Linkage groups.

Crossing over and recombination, Calculation of Recombination Frequency and Percentage; Linkage map, Map Distance; Mitotic Recombination (brief).

Sex-Linked Characteristics: Types of sex-linkage - X linked characters - Colour blindness and haemophilia in humans, holandric genes – hypertrichosis.

Dosage compensation – Barr body – Lyon hypothesis.

Sex-Influenced and Sex-Limited Characteristics.

Sex Differentiation: Testis-determining factor (TDF), Müllerian inhibition factor. Disorders of Sexual Development (short notes) - XX males and XY females, Point mutations in the *SRY* gene and testicular feminization.

**[Short answers/Paragraphs/Essays]**

### **MODULE 9. Sex determination (3 hrs)**

Chromosomal mechanism of Sex-Determination: Male heterogametic and female heterogametic mechanism of sex determination. Genic Sex Determining Systems - Genic balance (ratio) theory of Bridges. Haploid-diploid mechanism of sex determination, honey bee as example.

Environmental Sex Determination: Example – *Bonellia*, Crocodile.

Hormonal influence on sex determination: Example - sex reversal in fowl and free martin in cattle; Gynandromorphism – types and causes. Intersex (brief).

**[Short answers/Paragraphs/Essays]**

### **MODULE 10. Mutations (3 hrs)**

Chromosome mutations: numerical (euploidy and aneuploidy) and structural changes (deletion, duplication, insertion, inversion, translocation).

Gene mutations: types- spontaneous, induced, somatic, gametic, forward and reverse. Types of point mutations- deletion, insertion, substitution, transversion and transition. Mutagenesis- Natural and artificial mutagenesis, Mutagenic agents: a) UV radiation and ionising radiation b) Base analogues, alkylating and intercalating agents.

**[Short answers/Paragraphs/Essays]**

### **MODULE 11. Human Genetics and Genetic counselling (4 hrs)**

Classification and grouping of human chromosomes (Patau's scheme). Chromosomal anomalies and disorders: Autosomal - (Down's, Patau's, Edward's and Cri du Chat syndromes). Sex chromosomal - (Turner's and Klinefelter's syndromes). Gene mutations: Autosomal mutation - albinism, PKU, alkaptonuria, galactosemia, Tay-Sach's syndrome, Gaucher's disease, Sickle cell anaemia, thalassemia and brachydactyly. Sex chromosomal mutations: haemophilia, Lesch-Nyhan syndrome, dermal hypoplasia. Polygenic traits: cleft palate / lip, club foot and hydrocephaly. Eugenics, Euthenics and Euphenics.

**[Short answers/Paragraphs]**

### **Topics for assignments/seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Ribosomes: structure and functions
2. Golgi bodies: structure and functions
3. Cytoplasmic or extra nuclear inheritance:
  - a) Shell coiling in *Limnaea*
  - b) Endo-symbionts like kappa particle and sigma.
4. Mendel's experiments on pea plants
5. Mendel's laws of inheritance

## **REFERENCES**

### **Module 1-5 (Cell Biology)**

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- Gerald Karp (2013): *Cell Biology*; 7<sup>th</sup> Edition, ISBN-10: 1118318749, Wiley, 872 pages
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### **Module 6-11 (Genetics)**

- Brooks, R. J. (2008): *Genetics: Analysis and Principles*. 3<sup>rd</sup> Edition, ISBN-10: 0071287647, Irwin/McGraw-Hill, 844 pages
- Gardner, E. J., Michael J. Simmons and Peter Snustad (2006): *Principles of Genetics*. 8<sup>th</sup> Edition, ISBN-10: 8126510439, Wiley, 740 pages
- Good Enough, U. (1979): *Genetics*. 2<sup>nd</sup> Revised edition, ISBN-10: 003050886X, Holt R&W
- John Ringo (2004): *Fundamental Genetics*- Online ISBN 9780511807022 Cambridge University Press, 462 pages
- Peter Snustad & Michael J. Simons (2011): *Principles of Genetics*; 6<sup>th</sup> Edition, ISBN 1118129210, JW & S, 784 pages
- Read Andrew and Dian Donnai (2015): *New Clinical Genetics*, 3<sup>rd</sup> Edition, ISBN-10: 0073525308, McGraw Hill, 480 pages
- Ricki, L. (2011): *Human Genetics: Concepts and Applications*. 10<sup>th</sup> Edition, WCB MGH
- Robert H. Tamarin (1998): *Principles of Genetics*, 6<sup>th</sup> Edition, ISBN-10: 0697354628 William C Brown Pub, 680 pages
- Tom Strachan and Andrew Read (2018): *Human Molecular Genetics*, 5<sup>th</sup> Edition, ISBN 9780815345893 JW & S, 770 pages

**FIFTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**  
**ZOOLOGY CORE COURSE- VI [Theory]**  
**BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY**

Code: ZOL5B07T

**[72 hours] [4 hours per week] [4 Credits]**

**COURSE OUTCOMES (COs)**

<b>COs</b>	<b>Course Outcome statements</b>
<b>CO1</b>	Illustrate the steps in genetic engineering and animal cell culture (12 hrs)
<b>CO2</b>	Explain transfection methods, transgenic animals and ethical issues of transgenic animals (5 hrs)
<b>CO3</b>	Enumerate the applications of biotechnology (7 hrs)
<b>CO4</b>	Understand the biological diversity of microbial forms and the various techniques for handling microbes in the laboratory (8 hrs)
<b>CO5</b>	Enumerate the basic structure and life cycle of bacteria and virus (8 hrs)
<b>CO6</b>	Understand the industrial and medical importance of microorganisms (8 hrs)
<b>CO7</b>	Describe different types of immunity and the cells and organs of the immune system (6 hrs)
<b>CO8</b>	Explain antigen, antibody, immunity and major histocompatibility complex (9 hrs)
<b>CO9</b>	Enumerate autoimmune and immunodeficiency diseases and immunology of tumor and organ transplantation (9 hrs)

**Question paper pattern for external examination**

*[Module 1-3 Short answer 3x2=6 marks; Paragraph 2x5=10 marks; Essay 2x10=20 marks;  
Module 4-6 Short answer 6x2=12 marks; Paragraph 3x5=15 marks; Essay 1x10=10 marks  
Module 7-9 Short answer 6x2=12 marks; Paragraph 3x5=15 marks; Essay 1x10=10 marks]*

**Section A: BIOTECHNOLOGY (24 hrs)**

**MODULE 1: Genetic Engineering and Animal cell culture (12 Hrs)**

**Genetic Engineering (10 hrs)**

Concept and scope of biotechnology – Mention branches of biotechnology. Introduction to the concept of Recombinant DNA Technology: Cloning vectors (Plasmid, pBR322, Phages, Cosmids, Virus vectors, YAC vector and Bac vector).

Enzymes: Type II Restriction endonucleases, polynucleotide kinase, exonuclease, terminal transferase, reverse transcriptase and DNA ligase.

Construction of Recombinant DNA: Preparation of vector and donor DNA, Joining of vector DNA with the donor DNA, Introduction of recombinant DNA into the host cell and selection of transformants (brief account).

**Animal Cell Culture (2 hrs)**

Cell culture media (Natural and Defined), Preparation and Sterilization, Primary cell culture, Cell Lines, Pluripotent Stem Cells, Cryopreservation of cultures. Somatic cell fusion and HAT selection of hybrid clones – production of monoclonal antibodies.

*[Short answers/Paragraphs/Essays]*

**MODULE 2: Transgenic Organisms (5 hrs)**

Transfection Methods: (Chemical treatment, Electroporation, Lipofection, Microinjection, Retroviral vector method, Embryonic stem cell method and Shot Gun Method). Transgenic Animals: (Fish, Pig, Sheep, Rabbit, Mice, Goat and

Insects), Knock Out Mice. Human Cloning and Ethical Issues of transgenic Animals.

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*[Short answers/Paragraphs/Essays]*

### **MODULE 3: Applications of Biotechnology (7hrs)**

Molecular diagnosis of genetic diseases (Cystic Fibrosis, Huntington's Disease and Sickle Cell Anemia). Vaccines and Therapeutic agents, Recombinant DNA in Medicines (Recombinant Insulin and Human Growth Hormone).

Human gene therapy (gene therapy for severe combined immune deficiency).

Enzymes in detergents and leather industries, Heterologous protein production, Biofiltration, Bioremediation, Bioleaching, Molecular pharming and Bioreactors.

Molecular markers (brief account) RFLP, RAPD, VNTR, SNPs and their uses.

*[Short answers/Paragraphs/Essays]*

### **Section B: MICROBIOLOGY (24 hrs)**

#### **MODULE 4: Introduction and Methods in Microbiology (8 hrs)**

##### **Introduction**

**(1 hr)**

Microbial Diversity: Archaeobacteria, Eubacteria, Prochlorophyta, Algae, Fungi, Protozoa, Viruses, Viroids, Prions, Mycoplasma and Rickettsias

##### **Methods in Microbiology**

**(7 hrs)**

Sterilization: Physical and Chemical methods - Dry and Moist Heat, Pasteurization, Radiation, Ultrasonication. Disinfection, Sanitization, Antiseptics, Sterilants and Fumigation. Preparation of culture media: Selective, Enrichment and Differential media. Plating techniques and Isolation of pure colonies. Staining: Simple staining, Negative staining and Gram staining. Culture preservation techniques: Refrigeration, Deep freezing, Freezing under liquid Nitrogen and Lyophilisation.

*[Short answers/Paragraphs]*

#### **MODULE 5: Basic Concepts in Bacteriology and Virology (8 hrs)**

Bacteria: Structure of a typical Bacterium, Different types of bacterial culture (Batch, Synchronous, Arithmetic), Bacterial growth: Growth phases, Methods of growth determination.

Basic Concepts of Virology: General characteristics and classification of viruses. Bacteriophages: Diversity, lytic and lysogenic Phages (Lambda and P1 Phage), Applications of bacteriophages. Oncogenic Viruses. Prevention and control of Viral diseases: Antiviral compounds, Interferons and viral vaccines.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 6: Industrial and Medical Microbiology (8 hrs)**

##### **Industrial Microbiology**

**(4 hrs)**

Bioengineering of microorganisms for industrial purposes: Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) - citric acid, ethanol, wine, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase). Bioinsecticides (Bt) and Steroid biotransformation.

**Medical Microbiology****(4 hrs)****PDF Compressor Free Version**

Normal microflora of the human body: skin, throat, gastrointestinal tract and urogenital tract. Diseases caused by: (with reference to causative agent, symptoms and mode of transmission).

- a) Bacteria: anthrax, tuberculosis, typhoid, whooping cough, pneumonia, cholera, gonorrhea, and syphilis.
- b) Viruses: polio, chicken pox, herpes, hepatitis, rabies, dengue, AIDS and chikungunya.
- c) Protozoa: malaria, kala-azar and toxoplasmosis.
- d) Fungi: dermatomycoses and opportunistic mycoses

Bacterial drug resistance.

*[Short answers/Paragraphs/Essays]*

**Section C: IMMUNOLOGY (24 hrs)****MODULE 7: Cells and organs of immune system (6 hrs)****Introduction****(1 hr)**

Immunity: Natural and acquired, active and passive, immunization, vaccines, mechanisms of innate immunity - barriers, inflammation, phagocytosis.

**Cells of the immune system****(3 hrs)**

B- cells, T – cells, NK cells, monocytes, macrophages, neutrophils, basophils, eosinophils, mast cells, and dendritic cells (APCs).

**Organs of the immune system****(2 hrs)**

Lymphoid organs: Primary (thymus, bone marrow) and secondary (lymph nodes, spleen).

*[Short answers/Paragraphs]*

**MODULE 8: Antigens, antibodies, immunity and MHC (9 hrs)****Antigens****(3 hrs)**

Types, factors for immunogenicity, exogenous antigens, endogenous antigens, adjuvant, haptens, epitopes, antigen-antibody reaction - precipitation reaction, agglutination reaction, agglutination inhibition reaction.

**Immunoglobulins****(2 hrs)**

Structure, classification and biological functions. Mention immunoglobulin gene families –  $\kappa$  and  $\lambda$  light chain families and the heavy chain family.

**Immunity****(2 hrs)**

Types of Immunity: humoral and cell mediated immunity, primary and secondary response, generation of cytotoxic T- cells (CTLs), NK cell mediated cytotoxicity, ADCC and cytokines (brief).

**Major Histocompatibility Complex****(2 hr)**

MHC, HLA, Class I MHC, Class II MHC molecules and structure. Mention Class III MHC.

*[Short answers/Paragraphs/Essays]*

**MODULE 9: Autoimmune and Immunodeficiency diseases, Tumor and transplantation immunology (5 hrs)**

**Autoimmune diseases (2 hrs)**

Auto immune diseases: Systemic (SLE, multiple sclerosis and rheumatoid arthritis). Organ specific-(Hashimoto's thyroiditis, Grave's disease, Myasthenia gravis)

**Immunodeficiency disease (3 hrs)**

Primary (Bruton's Disease, Di-George syndrome and SCID)

Secondary (AIDS) – Clinical course of HIV – acute infection, seroconversion, window period, chronic latent phase - lymph adenopathy and crisis phase. Mention anti-retroviral therapy (ART)

**Tumor immunology (2 hrs)**

Malignant transformation of cells, tumor antigens, immune response to tumor antigens.

**Transplantation Immunology (2 hrs)**

Transplantation Antigens, Various organ transplantation (liver, kidney, heart, skin), Xenotransplantation

**[Short answers/Paragraphs/Essays]**

**Topics for assignments/seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Microbiological analysis of drinking water
2. Biogas plant
3. Social acceptance of biotechnology
4. Biofertilizers
5. DNA vaccines
6. Immunity and malnutrition

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#### **Module 7-9 (Immunology)**

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- Andrew E Williams (2011) *Immunology Mucosal and Body Surface Defenses*, 1st Edition, ISBN: 0470090049, Wiley and Blackwell, 398 pages
- David Male, Jonathan Brostoff, David Roth and Ivan Roitt (2013) *Immunology*, 8<sup>th</sup> Edition, ISBN: 9780323080583, Elsevier, 482 pages
- Helen Chapel, Mansel Haeney, Siraj Misbah & Neil Snowden (2014) *Essentials of Clinical Immunology* 6<sup>th</sup> Edition, ISBN: 978-1-118-47295-8, Wiley Blackwell, 376 pages
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- Kenneth Murphy, Paul Travers & Mark Walport (2009) *Janeway's Immunobiology*, 7th Edition, ISBN 978-0-8153-4123-9, Garland Science, 865 pages
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**FIFTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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 ZOOLOGY CORE COURSE- VII [Theory]

**BIOCHEMISTRY AND MOLECULAR BIOLOGY**

Code: ZOL5B08T

**[72 hours] [4 hours per week] [4 Credits]**

**COURSE OUTCOMES (COs)**

<b>COs</b>	<b>Course Outcome statements</b>
CO1	Understand the elements of biological importance and the non-covalent interactions that stabilize biomolecules (1 hr).
CO2	Describe the classification, types, structure, reactions and biological roles of carbohydrates, and diabetes Type I and II (6 hrs)
CO3	Enumerate the properties and classification of amino acids and their standard abbreviations; hierarchical levels of protein structure, classification, separation, purification and sequencing of proteins (7 hrs).
CO4	Explain the classification and functions of lipids and fatty acids; chemistry and structure of nucleic acids and sequencing of DNA (7 hrs)
CO5	Understand the classification, nomenclature and properties of enzymes; enzyme action, co-enzymes, cofactors, isozymes, ribozymes and allosteric enzymes (3 hrs)
CO6	Explain glycolysis, Krebs's cycle, glycogenesis, glycogenolysis, gluconeogenesis, HMP pathway; amino acid and fatty acid oxidation and oxidative phosphorylation (12 hrs).
CO7	Describe the mechanism of DNA duplication and the role of enzymes (4 hrs).
CO8	Understand the concept of gene and gene expression; genetic code and wobble hypothesis (6 hrs).
CO9	Explain the mechanism of transcription and post-transcriptional modification of hnRNA (7 hrs).
CO10	Enumerate the processes of translation and post-translational modification and targeting of peptides (7 hrs).
CO11	Describe the regulation of <i>trp</i> operon, C-value, repetitive DNA, satellite DNA, selfish DNA, overlapping genes, pseudogenes, cryptic genes, transposons and retrotransposons (8 hrs).
CO12	Explain the structure and life cycle of bacteriophages and the gene transfer mechanisms in bacteria (4 hrs).

**Question paper pattern for external examination**

*[Module 1-6 Short answer 7x2=14 marks; Paragraph 4x5=20 marks; Essay 2x10=20 marks; Module 7-12 Short answer 8x2=16 marks; Paragraph 4x5=20 marks; Essay 2x10=20 marks]*

**BIOCHEMISTRY (36 hrs)**

**MODULE 1. Introduction (1 hr)**

Elements of biological importance; non-covalent bonds that stabilize biomolecules – Hydrogen bonds, hydrophobic interactions and Van der Waals Interactions.

*[Short answer questions]*

**MODULE 2. Carbohydrates (6 hrs)**

Monosaccharides: Aldoses and ketoses, trioses, tetroses, pentoses and hexoses; glyceraldehyde, dihydroxyacetone, ribose, deoxyribose, ribulose, glucose and fructose. Cyclization of pentoses and hexoses, optical activity and mutarotation, inversion and invert sugar, monosaccharides as reducing agents, Osazones.

Disaccharides: Glycosidic bond, reducing and non-reducing disaccharides, maltose and sucrose as examples.

Polysaccharides: Starch and glycogen, amylose and amylopectin, homo and heteropolysaccharides.

Biological functions of carbohydrates; Mention diabetes Type I and II.

*[Short answers/Paragraphs]*

### **MODULE 3. Amino acids, peptides and protein (7 hrs)**

Proteinogenic amino acids, abbreviations (three letter and single letter) of the standard amino acids, structure and classification and general properties of amino acids, isoelectric point, peptide bonds, nonstandard amino acids.

Peptides and proteins: Classification of proteins - simple, conjugated and derived. Structure of proteins: primary, secondary, tertiary and quaternary structure. Denaturation of proteins.

Separation and purification of proteins: Paper chromatography, column chromatography, ion exchange chromatography, size exclusion chromatography, affinity chromatography and high - performance liquid chromatography (Brief account only). Polyacrylamide Gel Electrophoresis.

Sequencing of peptides: Sanger's method, Edman degradation procedure and Mass spectrometry (Brief account only)

*[Short answers/Paragraphs/Essays]*

### **MODULE 4. Lipids and Nucleic acids (7 hrs)**

#### **Lipids**

**(2 hrs)**

Classification and functions (simple, compound, derived and miscellaneous lipids).

Fatty acids: saturated and unsaturated; triglycerides; mention phospholipids; lecithins; cephalins; phosphoinositides; prostaglandins and cholesterol. Mention the clinical significance of lipid profile estimation.

#### **Nucleic acids**

**(5 hrs)**

Chemistry and structure of purines and pyrimidines, structure of nucleotides (ATP, dATP and cAMP), Watson – Crick model of DNA, Different forms of DNA, secondary and tertiary structure of tRNA. Sequencing of DNA by Sanger's method. Mention Maxam-Gilbert sequencing.

*[Short answers/Paragraphs/Essays]*

### **MODULE 5. Enzymes and co-enzymes (3 hrs)**

Classification, nomenclature and properties of enzymes; Active centre, mechanism and theories of enzyme action, enzyme inhibition, co-enzymes (NAD, FAD) and cofactors. Mention isozymes, ribozymes and allosteric enzymes.

*[Short answers/Paragraphs/Essays]*

### **MODULE 6. Metabolism of carbohydrates, proteins and lipids (12 hrs)**

Glycolysis, Kreb's cycle, glycogenesis, glycogenolysis, gluconeogenesis and HMP pathway. Amino acid oxidation and production of urea.  $\beta$ -oxidation of fatty acids.

Brief account on redox reactions, redox potentials, electrochemical gradients, electron transport chain, oxidative phosphorylation, proton gradient and chemiosmotic synthesis of ATP.

*[Short answers/Paragraphs/Essays]*

**MOLECULAR BIOLOGY (36 hrs)**  
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**MODULE 7. DNA Replication (4 hrs)**

Semi-conservative and semi-discontinuous, priming of Okazaki fragments, primer removal and joining of Okazaki fragments, Meselson and Stahl experiment.

*[Short answers/Paragraphs/Essays]*

**MODULE 8. Gene and genetic code (6 hrs)**

**Gene concept**

**(2 hrs)**

Classical and modern concepts, housekeeping and luxury genes. Gene action: gene expression and gene products; one gene one enzyme hypothesis; one gene one polypeptide hypothesis. Central dogma of molecular biology, reverse transcription and modified central dogma.

**Genetic code**

**(4 hrs)**

Deciphering of genetic code, experiments of Nirenberg and Khorana, codon assignments, properties of the genetic code and wobble hypothesis.

*[Short answers/Paragraphs/Essays]*

**MODULE 9. Transcription (7 hrs)**

RNA polymerases of eukaryotes and prokaryotes; promoters, terminators, enhancers and silencers.

Transcription unit, mono and polycistronic transcription units; coupling of transcription with translation in bacteria.

Initiation, elongation and termination of transcription (brief account).

Post transcriptional modification of the primary transcript – hnRNA, capping, poly (A) tailing and splicing (brief account), spliceosomes.

*[Short answers/Paragraphs/Essays]*

**MODULE 10. Translation (7 hrs)**

Activation of amino acids and aminoacyl tRNA synthetases; role of tRNA as adaptor molecules in translation. Role of ribosomes and active centres of ribosomes. Initiation, elongation and termination of translation.

Post translational modification of the peptide chain: cleavage, formation of disulfide-bridges, acetylation, glycosylation, myristoylation, sulphation, hydroxylation, prenylation, nitrosylation, ubiquitination and SUMOylation.

Protein folding and role of molecular chaperones; Protein targeting (brief account)

*[Short answers/Paragraphs/Essays]*

**MODULE 11. Regulation of gene expression and organization of genome(8 hrs)**

**Regulation of gene expression**

**(4 hrs)**

Operon organization of bacterial transcription units; *trp* operon and its regulation. Regulatory RNAs – ncRNAs, miRNAs, piRNAs, siRNAs and RNA interference. Mention CRISPR–Cas9 and targeted genome editing.

**Organization of genome**

**(4 hrs)**

Sequence components of eukaryotic genome – non-repetitive, moderately repetitive and highly repetitive DNA; satellite DNA. Mention selfish DNA. C-value and C-value paradox. Overlapping genes, pseudogenes, cryptic genes, transposons and

retrotransposons. Human genome and human genome project (brief account). Mitochondrial and chloroplast genome (brief account).

**[Short answers/Paragraphs/Essays]**

**MODULE 12. Genetics of bacteria and phages (4 hr)**

Conjugation in bacteria. Transduction – generalized and specialized; sexduction.

Structure and life cycle of a bacteriophage; temperate and virulent phages; lysogeny and lysis.

**[Short answers/Paragraphs]**

**Topics for assignments/seminar**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. B-Complex vitamins as co-enzymes
2. Different types of eukaryotic RNAs
3. Biological functions of steroids
4. Lac operon and its regulation
5. Role of enzymes in DNA replication

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  - Gangane, S. D.(2008): *Human Genetics* 3<sup>rd</sup> Edition, ISBN 10: 8131211282, Elsevier
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  - Jocelyn E Krebs, Elliot S. Goldstein and Stephen T. Kilpatrick (2017) *Lewin,s GENES XII*, ISBN-10: 1284104494, Jones and Bartlett Publishers Inc, 838 pages
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  - Lynn Jorde John Carey Michael Bamshad (2015): *Medical Genetics* 5<sup>th</sup> Edition, ISBN: 9780323188357, Elsevier, 368 pages.
  - Nancy Craig, Rachel Green, Carol Greider, Gisela Storz, Cynthia Wolberger and Orna Cohen-Fix (2014): *Molecular Biology-Principles of genome function* 2<sup>nd</sup> Edition, ISBN-10: 0198705972, Oxford, 936 pages.
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**FIFTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE- VIII [Theory]

**METHODOLOGY IN SCIENCE, BIOSTATISTICS AND BIOINFORMATICS**

Code: ZOL5B09T

**[54 hours] [3 hours per week] [4 Credits]**

**COURSE OUTCOMES (COs)**

COs	Course Outcome Statements
CO1	Explain science, its importance, disciplines and the major steps in formulating a hypothesis, various hypothesis models, theory, law and importance of animal models, simulations and virtual testing (6 hrs)
CO2	Illustrate the principles and procedures in designing experiments and elaborate the requirements for carrying out experiments (4 hrs)
CO3	Describe the ethical concerns in practicing science (5 hrs)
CO4	Understand the Scope and role of statistics; methods and procedures of sampling; Construction of tables, charts and graphs (5 hrs)
CO5	Calculate central tendency and measures of dispersion and application of its knowledge on hypothesis testing as well as in problem solving (10 hrs)
CO6	Enumerate major biological databases and database search engines (8 hrs)
CO7	Perform DNA and protein sequence analysis, including sequence alignment and sequence similarity search using BLAST, FASTA, CLUSTAL W and CLUSTAL X (4 hrs)
CO8	Understand molecular phylogenetics and tools and methods for construction of phylogenetic trees (3 hrs)
CO9	Explain genome sequencing technologies, functional genomics, proteomic technologies and molecular docking and drug design (9 hrs)

**Question paper pattern for external examination**

*[Module 1-3: Short answer 5x2=10 marks, Paragraph 2x5=10 marks, Essay 1x10= 10 marks  
Module 4-5: Short answer 5x2=10 marks, Paragraph 2x5=10 marks, Essay 1x10=10 marks;  
Module 6-9: Short answer 5x2=10 marks, Paragraph 4x5=20 marks, Essay 2x10 = 20 marks]*

**Section A: METHODOLOGY IN SCIENCE (15 hrs)**

**MODULE 1. Science, Scientific Studies and Methods (6 hrs)**

**Science and Scientific Studies**

Science as a human activity; scientific attitude; Empiricism; Science disciplines; Interdisciplinary approach.

**Scientific Methods**

*Major steps:* Observation, Defining the problem, Collection of information, Formulation of a hypothesis, Experimentation, Analysis of the results and Conclusion based on interpretation of the results.

*Methods in scientific enquiry:* Inductive and deductive reasoning.

*Hypothesis:* Formulation of a hypothesis, different thought processes in developing hypothesis (analogy, induction, deduction and intuition), hypothetico-deductive model, testing hypothesis, auxiliary hypothesis, adhoc hypothesis.

Theories and laws in science; peer review; importance of models, simulations and virtual testing (brief account).

**[Short answers/Paragraphs/Essays]**

## **MODULE 2. Experimentation (4 hrs)**

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Types of experiments; design of an experiment: principles and procedures; necessity of units and dimensions; repeatability and replications; documentation of experiments; Planning of Experiments: design, selection of controls, observational and instrumental requirements; Test animals used in experiments.

*[Short answers/Paragraphs/Essays]*

## **MODULE 3. Ethics in Science and Animal Ethics (5 hrs)**

Scientific information: Depositories of scientific information – primary, secondary and digital sources; Sharing of knowledge: transparency and honesty, Publications, Patents, Plagiarism.

Constitution of India Article 51A (g); Prevention of cruelty to animals Act of 1960 - Section 17.1(d), Committee for the purpose of control and supervision of experiments on animals (CPCSEA).

*[Short answers/Paragraphs]*

## **Section B: BIOSTATISTICS (15 Hrs)**

### **MODULE 4. Introduction (5 hrs)**

Definition; scope; role of statistics in life sciences; terminology and variables.

Sample and Sampling: Sample size, sampling errors, methods of sampling.

Collection/documentation of data of the experiments.

Classification of data; Presentation of data: Tabular, Graphical and Diagrammatic (histogram, frequency polygon and frequency curve; line diagram, bar diagram and pie diagram).

*[Short answers/Paragraphs/Essays]*

### **MODULE 5. Analysis and Interpretation of data (10 hrs)**

Measures of central tendency: (*raw data, discrete series data, continuous series data- problems are to be discussed*)

a) Mean, b) Median and c) Mode.

Measures of Dispersion: (*raw data, discrete series data, continuous series data - problems to be discussed*)

a) Range, b) Mean deviation, c) Standard deviation, d) Standard error.

Hypothesis testing and Interpretation of results: (*problems to be discussed*)

a) 't' test, b) F- test - ANOVA

Significance of statistical tools in data interpretation; Statistics-based acceptance or rejection of hypothesis.

*[Short answers/Paragraphs/Essays]*

## **SECTION C: BIOINFORMATICS (24 hours)**

### **MODULE 6. Introduction and Biological Databases (8 hrs)**

Overview of bioinformatics, Scope and application of Bioinformatics.

Major Databases in Bioinformatics: Biological databases, Features of a good database. Classification format of biological databases.

*Primary databases:* Nucleotide sequence databases – Mention EMBL, DDBJ, Genbank; Protein sequence databases – Mention Swiss Prot, PIR, MIPS.

*Structure databases:* PDB, NDB.

*Special databases* – PROSITE, Pfam, CATH, OWL, PubMed.

*Secondary databases:* Mention PROSITE, PRINTS. Databases of patterns, motifs and profiles, EST databases, SNP databases.

*Metabolite databases* – Mention KEGG, EcoCyc.

*Database Search Engines:* Entrez at NCBI of USA, SRS at EBI of England, STAG at DDBJ of Japan. Data retrieval with Entrez and SRS.

Sequence submission to NCBI.

**[Short answers/Paragraphs/Essays]**

### **MODULE 7. Sequence Analysis (4 hrs)**

Web based and standalone tools for DNA and protein sequence analysis. Types of sequence alignment, methods of sequence alignment. Sequence similarity search – pair wise and multiple sequence alignments; BLAST, FASTA, CLUSTAL W, CLUSTAL X.

**[Short answers/Paragraphs]**

### **MODULE 8. Molecular Phylogenetics (3 hrs)**

Basics of Phylogenetics; molecular evolution and molecular phylogenetics, cladistics and ontology. Gene Phylogeny versus species phylogeny. Phylogenetic tree construction methods and programmes. Forms of Tree representation.

**[Short answer/Paragraphs]**

### **MODULE 9. Genomics and Proteomics (9 hrs)**

Genome sequencing technologies; Sanger capillary sequencing, Roche 454 (pyrosequencing), Illumina/Solexa, SOLiD System, Single molecule sequencing. Whole genome sequence assembly, annotation and analysis. Functional Genomics: Microarrays, SAGE, ESTs; Transcriptomics; Metabolomics. Metagenomics: Concept and applications.

#### **Proteomics**

Aims, strategies and challenges in proteomics. Brief account on proteomics technologies: 2D-electrophoresis, iso-electric focusing, LC/MS-MS, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-protein interactions: experimental and computational methods; structural proteomics. Deriving function from sequence databases.

#### **Cheminformatics**

Molecular docking and drug design; Structural Bioinformatics in drug discovery

**[Short answers/Paragraphs/Essays]**

#### **Topics for seminar/ assignment**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Findings that changed the course of science.
2. Prepare a table showing the height of 20 students in a class. Calculate the mean height.

3. What are the mathematical properties of SD? How is it a better measure of Dispersion than range? Calculate the arithmetic mean and the SD of the frequency distribution obtained from a sample of data.
4. Report an experimental data in tabular / graphical form.
5. Viral genome database (ICTVdb, VirGen).
6. Bacterial Genomes database (Genomes OnLine Database –GOLD, Microbial Genome Database-MBGD).

## REFERENCES

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- Gieryn, T. F. (1999) *Cultural Boundaries of Science*, ISBN 9780226292625, Chicago Press, 412.
- Ruxton, G. D. and Colegrave, N. (2016) *Experimental Design for the Life Sciences*, 4<sup>th</sup> Edition, ISBN 9780198717355, Oxford University Press, 224 pages
- Victoria, E. McMillan. (2006) *Writing Papers in the Biological Sciences*, 4<sup>th</sup> Edition ISBN 10: 0312440839, Bedford Books, Boston, 296 pages
- Yadav, K. (2002) *Teaching of Life Sciences*, ISBN-10: 817041672, Anmol Pubns., Delhi, 290p.

### Module 4-5 (Biostatistics)

- Antonisamy B, Prasanna S. Premkumar and Solomon Christopher (2017) *Principles and Practice of Biostatistics*, ISBN-10: 8131248879, Elsevier, 390 pages
- Bailey, N. T. J (1995): *Statistical Methods in Biology*, 3<sup>rd</sup> Edition, CUP, 272 pages
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- Wayne W. Daniel and Chad L. Cross (2014) *Biostatistics: Basic Concepts and Methodology for the Health Sciences*, 10<sup>th</sup> Edition, ISBN-10: 8126551895, Wiley, 954 pages

### Module 6-9 (Bioinformatics)

- Anna Tramontano (2006): *Introduction to Bioinformatics*, ISBN-10: 1584885696, Chapman & Hall, 192 pages.
- Atwood and Parry-Smith (1999): *Introduction to Bioinformatics*. ISBN 9780582327887, Pearson Education Asia, New Delhi, 218 pages
- Caroline St. Clair and Jonathan Visick (2013): *Exploring Bioinformatics* 2<sup>nd</sup> Edition, ISBN 10: 1284034240, Jones & Bartlett, 300 pages
- Christoph W. Sensen (2007): *Essentials of Genomics and Bioinformatics*, ISBN 9783527305414, Wiley John & Sons, pages 405
- Dan E. Krane and Michael L Raymer, (2003). *Fundamental concepts of bioinformatics*, ISBN: 0-8053-4633-3, Benjamin Cummings
- Ghosh Z. and Bibekanand M. (2008) *Bioinformatics: Principles and Applications*. ISBN 10: 0195692306, Oxford University Press, 560 pages
- Hooman Rashidi and Lukas K. Buehle (2005): *Bioinformatics Basics*, 2<sup>nd</sup> Edition, ISBN 9780849312830, Taylor & Francis, 360 pages
- Jeffrey Augen (2004): *Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine*, ISBN-10: 0321173864, Addison-Wesley, 408p.
- Jeremy Ramsden (2015): *Bioinformatics - An Introduction* 3<sup>rd</sup> Edition, ISBN 978-1-4471-6701-3, Springer, 308 pages
- Jonathan Pevsner (2015): *Bioinformatics and Functional Genomics* 3<sup>rd</sup> Edition, ISBN: 978-1-118-58178-0, Wiley, 1160 pages
- Malcom Campbell and Laurie J. Heyer (2006): *Discovering Genomics, Proteomics and Bioinformatics*, 2<sup>nd</sup> Edition, ISBN 10: 9780805382198, Pearson, 464 pages

**B. Sc. ZOOLOGY PROGRAMME**  
**ZOOLOGY [CORE COURSE] PRACTICAL – II**

Code: ZOL6B15P

**[Practical II\*A + Practical II\*B] [4 Credits]**

**PRACTICAL II\*A:** CELL BIOLOGY, GENETICS, BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY [72 hours] [4 hrs /week]

**PRACTICAL II\*B:** BIOCHEMISTRY, MOLECULAR BIOLOGY, METHODOLOGY IN SCIENCE, BIOSTATISTICS & BIOINFORMATICS[72 hours] [4 hrs/week]

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Perform experiments in cell biology and genetics including demonstration of Barr body in buccal epithelial cells of man, polytene chromosome in the salivary glands of <i>D. Melanogaster</i> larva, mitotic division in onion root tip cells, micrometry of microscopic objects, prepare whole mounts of microscopic objects, and calculate mitotic and metaphase index from slides.
CO2	Enumerate the inheritance of major human genetic traits, pedigree chart, normal and abnormal human karyotypes, phenotypic differences of male and female <i>Drosophila</i> and solve problems on Monohybrid, dihybrid crosses, blood groups and sex-linked inheritance.
CO3	Understand electrophoresis, PCR, Northern blotting, Southern blotting and Western blotting, DNA sequencing and fingerprinting and isolation of genomic DNA.
CO4	Perform gram staining and preparation of culture media for bacteria and demonstrate bacterial motility by standard laboratory protocols.
CO5	Understand the detection of human blood groups and organs of immune system
CO6	Perform standard biochemical tests for the detection of reducing and nonreducing sugars, polysaccharides, proteins and lipids.
CO7	Understand the staining of mitochondria, tissue homogenization and isolation of nuclei, effect of colchicines of cell division, extraction of DNA and polyacrylamide and agarose gel electrophoresis
CO8	Solve basic problems in biostatistics and Bioinformatics

**FIFTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**

**PRACTICAL II\*A**

CELL BIOLOGY, GENETICS, BIOTECHNOLOGY, MICROBIOLOGY & IMMUNOLOGY [72 hrs] [4 hrs/week]

**Section A: Cell Biology**

1. Study of diversity of eukaryotic cells – methylene blue staining of buccal epithelium and striated muscle cells (Minor).
2. Temporary mount of buccal epithelial cells to observe Barr body (Major).
3. Mitosis: stages in onion (*Allium cepa*) root meristem by squash preparation (major).
4. Calculation of mitotic index and metaphase index in root meristem of *Allium cepa* (Major).
5. Study of the polytene chromosome of *Drosophila melanogaster* using salivary gland cells of 3<sup>rd</sup> instar larva (Demonstration only).

6. Measurement of size of microscopic objects using ocular and stage micrometres (Major).
7. Tissues (permanent slides of epithelial tissues, smooth muscle, cartilage, bone).
8. Preparation of permanent whole mount (Demonstration).
9. Study of different stages of meiosis in grass hopper testes (Demonstration).
10. Vital staining of mitochondria using insect flight muscle/check epithelium/yeast (Minor)

### **Section B: Genetics**

1. Scheme of Pedigree chart.
2. Study of inheritance of human traits: (use Pedigree charts). Blood groups, Eye colour.
3. Genetic problems on Monohybrid, dihybrid crosses; blood groups; sex-linked inheritance (minimum ten problems to be worked out).
4. Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting.
5. Study through photographs of the Karyotype: Down's, Klinefelter's, Turner's and Edward's Syndrome.
6. Study of phenotypic characters in male and female *Drosophila*

### **Section C: Biotechnology**

1. Study of the principle and applications of Electrophoretic apparatus.
2. PCR-Principle and applications.
3. Study of transgenic animals.
4. Southern blotting (Principle and methodology - using flowcharts/diagrams/by visiting a diagnostic Lab)

### **Section D: Microbiology**

1. Gram staining for the identification of Gram positive and Gram negative bacteria (*Lactobacillus* and *Rhizobium*) (Major).
2. Bacterial motility by hanging-drop method (Demonstration).
3. Preparation of culture media for bacteria (Synthetic Media, Natural Media, Simple Media, Differential Media and Selective Media).
4. Methylene blue reduction test for assessing the quality of raw milk (Demonstration).
5. Preparation of a fungal smear – Lactophenol cotton blue staining & mounting (Minor)

### **Section E: Immunology**

1. Identification of human blood groups (A B O and Rh).
2. Histological study of spleen, thymus and lymph nodes through slides/photographs.
3. ELISA (methodology of detection of biomolecules using flowcharts/diagrams/by visiting a diagnostic Lab)
4. Western blotting (methodology of detection of specific proteins using flowcharts/diagrams/by visiting a diagnostic Lab)

## REFERENCES

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  - Mukesh Kumar (2018) *Practical Microbiology for Undergraduates, 3<sup>rd</sup> Edition*, ISBN-10: 8183602363, Jain Brothers
  - Panjarathinam R (2009) *Practical Medical Microbiology*; 1<sup>st</sup> Edition, ISBN-10: 9350907348, Jaypee Brothers Medical Publishers, 192 pages
  - Pranab Dey (2014) *Diagnostic cytology, 1<sup>st</sup> Edition*, ISBN-10: 9351520668 Jaypee Brothers Medical Publishers, 544 pages
  - Shaw G. W. (1973) *Laboratory Book: Cytology, Genetics and Evolution*, ISBN-10: 0719527295.
  - Sundara S. Rajan: *Practical Manual of Microbiology*; ISBN-10: 8126110104, Anmol Publications, 166 pages
  - Susan Mahler Zneimer (2016) *Cytogenetic Laboratory Management: Chromosomal, FISH and Microarray-Based Best Practices and Procedures*; 1<sup>st</sup> Edition, ISBN-10: 9781119069744, Wiley-Blackwell, 840 pages

## PRACTICAL II\*B

### BIOCHEMISTRY, MOLECULAR BIOLOGY, METHODOLOGY IN SCIENCE, BIOSTATISTICS & BIOINFORMATICS

**[(72 hrs) (4 hrs/week)]**

#### **Section A: Biochemistry**

1. Detection of organic constituents (carbohydrates, proteins and lipids only) from sample solutions (Major)
  - a) Detection of reducing sugar: Glucose/Fructose/Maltose [Fehling's test, Benedict's test, Moore's test, cupric sulphate test, rapid furfural test (any three) (Major).
  - b) Detection of monosaccharides [Barfoed's test]
  - c) Detection of non-reducing sugars: Sucrose [Hydrolysis test].
  - d) Identification of functional groups of carbohydrates [Selivanoff's test]
  - e) Detection of polysaccharides: Starch [Lugol's iodine test, confirmatory heating & cooling test].
  - f) Detection of proteins: [Biuret test, Nitric acid test, Xanthoproteic test].
  - g) Detection of lipids: [Sudan III or IV test, Spot test].
2. Preparation of Normal, molar and standard solutions and serial dilutions.
3. Separation of amino acids (or any other compounds) from a mixture by using paper chromatography (Demonstration).
4. Determination of concentration of unknown solutions using Photo electric colorimeter (Demonstration).

#### **Section B: Molecular Biology** (Any four items)

1. Cell fractionation and isolation of nucleus (demonstration).
2. Study of the effects of Colchicine on mitosis in the root meristem of *Allium cepa*.
3. Differential staining for DNA and RNA in human cheek epithelial cells (demonstration).
4. Poly acrylamide gel electrophoresis (Demonstration).
5. Agarose gel electrophoresis (Demonstration).

6. Isolation of DNA from animal tissues (Demonstration)
7. Isolation of RNA from animal tissues (Demonstration)

### **Section C: Methodology in Science, Biostatistics and Bioinformatics**

(Any 10 items of the following)

1. Design an experiment to prove a hypothesis by testing the specificity of the enzyme salivary amylase on starch.
2. Measure the size of given leaves / any sample of data and calculate the mean, median and mode (raw data, discrete series & continuous series).
3. Measure the size of given shells / any sample of data and represent it in a graphical form and interpret it.
4. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.
5. Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical form. Compare by t-test.
6. Construct a frequency curve with mean  $\pm$  SD using suitable data. Draw the same in Excel or using any free software and record it.
7. Prepare a frequency polygon with mean  $\pm$  SD utilizing appropriate data.
8. Draw a bar diagram with mean  $\pm$  SD employing suitable data.
9. Construct a histogram with mean  $\pm$  SD utilizing suitable data. Do the same with software
10. Draw a pie diagram using suitable data. Draw the same in Excel or using any free software.
11. Formulate a hypothesis of any scientific observation made by you.
12. Sequence retrieval from databases (demonstration).
13. Sequence similarity search using BLAST.
14. Multiple sequence alignment.
15. Construction of phylogenetic tree (Demonstration).
16. Docking studies (Demonstration).

### **REFERENCES**

- Bansal M P (2015) *Molecular Biology and Biotechnology: Basic Experimental Protocols* The Energy and Resources Institute, TERI, 392 pages
- Campbell A M and Heyer L J (2006) *Discovering genomics, proteomics and Bioinformatics*, 2<sup>nd</sup> Edition, ISBN-10: 9780805382198, Benjamin Cummings, 464 pages
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**SYLLABUS**  
**OPEN COURSES [ZOOLOGY] 1 TO 3**

**FIFTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**  
 ZOOLOGY OPEN COURSE- I (Theory)

**REPRODUCTIVE HEALTH AND SEX EDUCATION**

Code: ZOL5D01T

**[54 hours] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
CO1	Understand the reproductive health, and importance of sex education for teen and youth. (2 hrs)
CO2	Explain the chromosomal mechanism of sex determination and sex chromosomal anomalies. (3 hrs)
CO3	Describe the structural and functional features of human reproductive system, fertilization, implantation, pregnancy, gestation, placenta, parturition and lactation. (17 hrs)
CO4	Explain the scope of reproductive technologies in infertility management and the assisted reproductive techniques. (10 hrs)
CO5	Understand the different methods of prenatal diagnosis and associated ethical issues (4 hrs)
CO6	Describe the different methods of fertility control. (4 hrs)
CO7	Understand the symptoms, mode of transmission, diagnosis and treatment of different sexually transmitted diseases and their socio economic dimensions. (7 hrs)
CO8	Describe sexual orientation, sexual abuse and myths (5 hrs)
CO9	Understand the ethical aspects of sex (2 hrs)

**Question paper pattern for external examination**

*[Module 1-3: Short answer 4x2 = 8marks; Paragraph 3x5=15 marks; Essay 1x10 = 10 marks]*

*Module 4-6: Short answer 3x2 = 6 marks; Paragraph 2x5=10 marks; Essay 1x10 = 10 marks]*

*Module 7-9: Short answer 5x2 =10 marks; Paragraph 2x5=10 marks.]*

**MODULE 1. Introduction (2 hrs)**

Definition; Reproductive health - problems and strategies; reproductive rights; importance of sex education for teen and youth.

*[Short answers/Paragraphs]*

**MODULE 2. Sex determination and Chromosomal anomalies (3 hrs)**

Chromosomal mechanism of sex determination; Barr body; twin studies; sex reversal; Sex chromosomal anomalies: Turner's syndrome and Klinefilter's syndrome.

*[Short answers/Paragraphs]*

**MODULE 3. Human Reproduction (17 hrs)**

Male reproductive system: Structure of testis, male accessory organs; Semen production and composition; ejaculation. Spermatogenesis.

Female reproductive system: Structure of human ovary; development of primary follicle; structure of graafian follicle; fallopian tubes; uterus; external genitalia; mammary glands. Oogenesis.

Menstrual cycle and hormonal control; brief account of fertilization, implantation, pregnancy, gestation, placenta, parturition and lactation (Brief account on hormonal control of lactation).

*[Short answers/Paragraphs/Essays]*

#### **MODULE 4. Infertility and Assisted reproductive technologies (10 hrs)**

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Infertility: Causes and problems in male and female. Infertility management: semen collection, preservation and storage, artificial insemination, surrogacy. Cryopreservation and embryo transfer: Collection, care and preservation of embryos. *In vitro* fertilization (IVF) and embryo transfer: Major steps; Test tube babies. Assisted Reproductive Techniques (ART): GIFT, ZIFT, ICSI, oocyte donation and embryo donation.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 5. Prenatal Diagnosis (4 hrs)**

Different methods: Ultrasonography, amniocentesis, chorionic villus sampling and alpha-fetoprotein estimation; female foeticide: ethical issues and laws (Mention-PNDT Act).

*[Short answers/Paragraphs]*

#### **MODULE 6. Fertility Control (4 hrs)**

Natural methods; artificial methods; chemical methods; hormonal methods; contraceptive devices; surgical contraception; abortion, legal termination of pregnancy.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 7. Sexually transmitted infectious diseases (7 hrs)**

Symptoms, mode of transmission, diagnosis, treatment and prophylaxis of AIDS, syphilis, gonorrhea, herpes (genital), human papilloma virus and genital warts, hepatitis, gonococcal vulvo vaginitis, Trichomonal vaginitis. Mention the term venereal disease. Socio economic dimensions of STD.

*[Short answers/Paragraphs]*

#### **MODULE 8. Sexual orientation, sexual abuse and myths (5 hrs)**

Homosexuality and bisexuality (mention LGBT), oral sex, animal sex, cyber sex, sexual abuse, premarital and extramarital sex, sexual perversions, paraphilia, child abuse, prostitution, sexual hygiene, protection of children from sexual offences (POCSO) Act, 2012 (brief account only), sexual myths.

*[Short answers/Paragraphs]*

#### **MODULE 9. Ethical aspects of sex (2 hrs)**

Healthy relationship with opposite sex, role of counseling, gender discrimination in family and society.

*[Short answers/Paragraphs]*

#### **Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Sexual counseling
2. Marriage counseling
3. Population explosion and birth control
4. Functions of male and female hormones
5. Hormones of pregnancy

## REFERENCES

PDF Compressor Free Version

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<http://www.biologydiscussion.com/essay/reproductive-health-in-human-problems-and-strategies/5167>  
<http://stayteen.org/sex-ed/article/why-sex-education-important>  
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**FIFTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**

ZOOLOGY OPEN COURSE- II (Theory)

**NUTRITION, HEALTH AND HYGIENE**

Code: ZOL5D02T

**[54 hours] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
CO1	Describe the basic concepts in nutrition (3 hrs)
CO2	Demonstrate the understanding of nutrients and energetics (19 hrs)
CO3	Enumerate the vitamins and minerals and their roles in human nutrition (5 hrs)
CO4	Explain balanced diet, RDA and factors that affect it and meal planning for various categories of people (4 hrs)
CO5	Illustrate diet therapy and dietary management of various conditions (3 hrs)
CO6	Explain health, fitness and hygiene (5 hrs)
CO7	Describe the major communicable, non-communicable, congenital and sexually transmitted human diseases (11 hrs)
CO8	Perform first aid management in emergency situations (4 hrs)

**Question paper pattern for external examination**

*[Module 1-5: Short answer 7x2=14 marks, Paragraph 5x5=25 marks; Essay 1x10=10 marks  
Module 6-8: Short answer 5x2=10 marks, Paragraph 2x5=10 marks, Essay 1x10=10 marks]*

**Section A: NUTRITION (34 hours)**

**MODULE 1. Key concepts in Nutrition (3 hrs)**

**Basic Nutrition Concepts:** Nutrition, Food energy - Kilocalories, Nutrients, Nutrient Density. Nutritional needs of body, classification of foods.

**Factors Influencing Food Selection:** Flavor, Demographics, Culture and Religion, Social and Emotional Influences, Health, Environmental Concerns, Food industry and media (short notes only)

**Nutrients and non-nutrients:** Six classes of nutrients: Carbohydrates, Fats, Protein, Vitamins, Minerals, Water; functions of these nutrients. Mention essential nutrients.

*[Short answers/Paragraphs]*

**MODULE 2. Nutrition and Energetics (19 hrs)**

**Digestion, Absorption and Metabolism (14 hrs)**

Classification, Sources and nutritional significance of carbohydrates, proteins and fats. Gastrointestinal tract, digestion and absorption of carbohydrates, proteins and fats. Mention dietary fibers, essential and non essential amino acids, saturated, unsaturated and essential fatty acids. Deficiency of Protein — Protein energy malnutrition (PEM), Kwashiorkor, Marasmus.

*[Short answers/Paragraphs/Essays]*

**Energy Metabolism (5 hrs)**

Energy value of macronutrients, factors affecting the caloric value of foods, PFV (Physiological Fuel Value) of foods, low calorie modifications, Bomb calorimeter, Basal metabolic rate (BMR), factors affecting BMR; Thermic effect of food and thermogenesis. Energy balance and Body mass index (BMI).

*[Short answers/Paragraphs/Essays]*

**MODULE 3: Vitamins and Minerals (5 hrs)****Vitamins****PDF Compressor Free Version****(4 hrs)**

Fat soluble — A, D, E, K.; Water soluble vitamins — B Complex — Thiamine, Riboflavin, Niacin, Pantothenic Acid, Folic Acid, Vitamin B 12, Biotin and Pyridoxine, Vitamin C. Sources and effects of deficiency.

**Macro and Micro Minerals****(1 hr)**

Physiological functions, sources and deficiency: Calcium, Phosphorous, Iron and Iodine.

*[Short answers/Paragraphs/Essays]***MODULE 4. Meal Planning (4 hrs)**

Characteristics of a nutritious Diet: Adequate, Balanced, Moderate and Varied diet. Nutrient requirement and meal planning for adults; changes in nutrient requirement according to sex, age & activity. RDA (recommended dietary allowance), Factors affecting RDA. Special nutritional requirements and conditions: Pregnancy, lactation and weaning.

*[Short answers/Paragraphs]***MODULE 5. Clinical Dietetics (3 hrs)**

Therapeutic modification of normal diet. Etiology, symptoms and dietary management in peptic ulcer, diarrhoea, obesity, hypertension, diabetes mellitus, nephritis, cirrhosis of liver and lactose intolerance.

*[Short answers/Paragraphs]***Section B: HEALTH AND HYGIENE (20 hours)****MODULE 6. Health and Hygiene (5 hrs)**

Relationship between Food, Nutrition & Health. Physical, psychological and sociological health. Body fitness: Principles of exercise programming, Exercise, Yoga, cycling & walking. Hygiene: Personal hygiene, Oral Hygiene and Sexual Hygiene. Tobacco Use: Smoking habits, Active and passive smoking, composition and effects of tobacco smoke. Alcohol Use: Alcoholism, Physiological effects of alcohol and abuse of alcohol.

*[Short answers/Paragraphs]***MODULE 7. Human Diseases (11 hrs)**

*Communicable diseases:* Bacterial (Cholera and Typhoid), Viral (Measles and Poliomyelitis), Fungal (Candidiasis), Protozoan (Amoebiasis and Malaria), Helminth (Ascariasis and Taeniasis).

*Non-Communicable diseases:* Blood pressure (Hypertension and Hypotension); Cerebral haemorrhage and stroke; Coronary thrombosis, Atherosclerosis and Arteriosclerosis; Diabetes: Type I and Type II; Cancer: Thyroid and Breast cancer; Congenital diseases: Autism, Dyslexia, Down and Foetal alcoholic Syndrome;

*Sexually transmitted diseases (STD):* Syphilis and Gonorrhea

*Vectors and diseases:* Anopheles, Aedes, Culex and Xenopsylla

*[Short answers/Paragraphs/Essays]*

## **MODULE 8. First Aid Management in Emergency Situation (4 hrs)**

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Dog bite; Insect sting: scorpion, Bee and wasp; Snake bite: venomous and Non-venomous snakes; Haemotoxic Venom and Neurotoxic Venom; Antivenom and Polyvalent snake antivenom; First aid for Road accidents and drowning; Risks of self-medication practices

**[Short answers/Paragraphs]**

### **Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Non-nutritive components of food: food additives and preservatives.
2. Tobacco abuse.
3. Drugs and narcotics abuse.
4. Hepatitis and sub types A, B & C.
5. Nutrition in outer space.
6. Integrated Child Development Services (ICDS).
7. Mid-Day Meal Scheme (MDMS).
8. Special Nutrition Programme.
9. Balwadi Nutrition Programme.
10. National Nutrition Policy of 1993.

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- John Hall (2015): Guyton and Hall *Textbook of Medical Physiology*; 13<sup>th</sup> Edition, Hardcover ISBN: 9781455770052, Paperback ISBN: 9781455770168, Elsevier, 1168 pages
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**FIFTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY OPEN COURSE- III (Theory)

**APPLIED ZOOLOGY**

Code: ZOL5D03T

**[54 hours] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
<b>CO1</b>	List and describe the pests and vectors, their habits, damages and control measures and mechanisms of insect pest management. (18 hrs)
<b>CO2</b>	Develop personal, academic, employability and self-management skills in apiculture, lac-culture, sericulture and vermiculture (11 hrs)
<b>CO3</b>	Demonstrate an understanding of the various strategies in pisciculture, prawn culture, mussel culture and pearl culture (4 hrs)
<b>CO4</b>	Recognize the significance of poultry farming and its economic implications in rural India (6 hrs)
<b>CO5</b>	Reviews Indian breeds of cattle and goats and the strategies in their breeding (6 hrs)
<b>CO6</b>	Recognize the significance of parasitic mode of life and their implications in human health (9 hrs)

**Question paper pattern for external examination**

*[Module 1: Short answer 3x2=6 marks, Paragraph 2x5=10 marks, essay 1x10=10 marks;*

*Module 2: Short answer 1x2=2 marks, Paragraph 1x5=5 marks, essay 1x10=10 marks;*

*Module 3-6: Short answer 8x2=16 marks, Paragraph 4x5=20 marks]*

**MODULE 1. Vectors and Pests (18 hrs)**

**Insect Pests**

**(8 hrs)**

Definition of pest and Types of pests. Nature of damage caused and control measures of the following pests:

(a) Pests of paddy: *Spodoptera mauritia* (Rice swarming caterpillar), *Leptocorisa acuta* (Rice bug); (b). Pests of coconut: *Oryctes rhinoceros* (Rhinoceros beetle), *Rhynchophorus ferrugineus* (Red palm weevil); (c). Pests of stored products: *Sitophilus oryzae* (Rice weevil), *Callasobruchus chinensis* (Pulse beetle); Termites.

***[Short answers/Paragraphs/Essays]***

**Insect Pest Management**

**(5hrs)**

Principles of Cultural control, Mechanical controls, Biological control, Chemical control, Integrated pest management (IPM)

***[Short answers/Paragraphs/Essays]***

**Vectors of Human Diseases**

**(5 hrs)**

*Mention habits, disease caused and control measures of the following*

Blackflies, Sandflies, Tsetse flies, Mosquitoes: *Anopheles*, *Culex* & *Aedes*, Soft ticks and Hard ticks, Ectoparasitic insects: human lice, rat flea.

***[Short answers/Paragraphs]***

**MODULE 2. Animal Breeding and Animal Cultures (11 hrs)**

**(a) Apiculture:** Brief description of adaptations of social bees used for honey harvesting – mention *Apis dorsata*, *Apis cerana*, *Apis florea*, and *Tetragonula iridipennis*; Bee keeping equipments and methods; Honey bee products: bee wax

and its uses, chemical composition of honey and uses; Bee pollination, Economics of bee keeping.

**(b). Sericulture:** Brief description of *Bombyx mori* (Mulberry silk moth); Silkworm rearing and extraction of silk, Economics of sericulture; Types of silk: Tassar, Muga and Eri silk.

**(c). Lac-culture:** History, Morphology of lac insect, host plants, Natural infection, Artificial infection (inoculation), methods in lac-culture and economics of lac products.

**(d). Vermiculture:** Varieties of earthworms and their economic importance, Methods of vermicomposting: basic requirements, preparation of vermibed, collection of compost, vermiwash, Effect of vermiwash on yield and quality of crops.

**[Short answers/Paragraphs/Essays]**

### **MODULE 3: Aquaculture (4hrs)**

Brief account on Pisciculture, Prawn culture, Mussel culture, Pearl culture and ornamental fish culture (with examples).

**[Short answers/Paragraphs]**

### **MODULE 4: Poultry Farming (6 hrs)**

Introduction, Importance of egg production, Nutritive value of eggs, factors affecting egg size; Breeds of fowl: a) Exotic breeds: Rhode Island Red, Plymouth Rock, New Hampshire. b) Indigenous breeds: Chittagong, Gangus; Brief notes on Poultry Housing and Equipment.

**[Short answers/Paragraphs]**

### **MODULE 5: Animal Husbandry (6 hrs)**

Introduction, Exotic and Indian breeds of Cattle and Goats, Artificial insemination, Storage of semen, Embryo transfer technology, Short notes of common diseases: Anthrax, Foot and mouth diseases, Rinderpest, Brucellosis, Peste des Petits Ruminants (PPR).

**[Short answers/Paragraphs]**

### **MODULE 6: Parasitology (9 hrs)**

Introduction – Commensalism, Phoresis, Parasitism, Symbiosis, Host-parasite Relationship, Physiology, immunology and biochemistry of parasitism, Mention Definitive host, Intermediate host, Reservoir and Zoonosis.

Human Parasites: Mention the habits, habitat, life cycle, mode of infection, control measures of the following parasites: *Entamoeba histolytica*, *Giardia lamblia*, *Leishmania donovani*, *Plasmodium vivax*, *Taenia solium* and *Wuchereria bancrofti*.

**[Short answers/Paragraphs]**

### **Topics for Assignments / Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Genetic engineering applications in Animal Breeding
2. Mosquitoes and their Control
3. Fire Ants
4. National Project for Cattle and Buffalo Breeding
5. National Action Plan for Egg & Poultry-2022

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- Mahesh Kadam, Ranjit Patil, Milind Bhujbal, 2017. Animal Husbandry and Dairy Management: A Basic Approach to Livestock Production and Management, LAP LAMBERT Academic Publishing, 88 pages.
- Santhanam R. 1990. Fisheries Science, ISBN: 978-8170350859, Daya Publishing House, 186 pages.
- Khanna S. S. and Singh, H. R. 2014 *A Textbook Of Fish Biology And Fisheries*, ISBN: 9789384337124, Narendra Publishing House-Delhi, 610 pages.
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**SIXTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE – IX [Theory]  
**PHYSIOLOGY AND ENDOCRINOLOGY**

Code: ZOL6B10T

**[54 hrs] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcomes Statements</b>
CO1	Describe the regulation of digestion in man, nutrition in pregnancy and infancy, nutritional disorders, balanced diet, starvation, fasting and obesity. (5 hrs)
CO2	Understand the mechanism of transport and exchange of respiratory gases and its neurophysiological control and physiological problems in diving mammals, new-born and aged individuals. (6 hrs)
CO3	Describe functions, composition, coagulation, transfusion, agglutination and clinical analysis of blood, haemoglobinopathies, types of heart and common cardio-vascular problems. (6 hrs)
CO4	Understand the osmoregulatory mechanisms in animals; excretion and its hormonal control and common renal disorders in man. (6 hrs)
CO5	Explain the ultrastructure of skeletal muscles and biochemical events and energetics of muscle contraction. (5 hrs)
CO6	Understand the different types of nerve cells, glial cells and nerve fibres, and the mechanism of nerve impulse transmission (6 hrs)
CO7	Understand the types, physiology and significance of bioluminescence, and the structure and functions of electric organs. (2 hrs)
CO8	Describe invertebrate neuro-endocrine organs and hormones, vertebrate endocrine glands, their hormones and functions (12 hrs)
CO9	Understand the concept of neurosecretion and the mode of action of peptide and steroid hormones. (6 hrs)

**Question paper pattern for external examination**

*Module 1-7: Short answer 7x2 =14 marks; Paragraph 4x5 =20 marks; Essay 2x10 =20 marks  
Module 8-9: Short answer 5x2 =10 marks; Paragraph 3x5 =15 marks.*

**Section A: PHYSIOLOGY (36 hours)**

**MODULE 1. Nutrition (5 hrs)**

Regulation of digestive activity: Nervous and hormonal control; Ruminant digestion; Nutrition in pregnancy, infant nutrition, breast feeding, composition of breast milk; Importance of dietary fibres; Balanced diet; Nutritional disorders: anorexia, acidity, ulcer, flatulence; starvation, fasting and its significance; Obesity: causes and consequences.

*[Short answers/Paragraphs]*

**MODULE 2. Respiration (6 hrs)**

Gaseous exchange and transport of respiratory gases (brief account), Oxygen-Haemoglobin dissociation curve; Respiratory pigments, structure and properties of Hb; Neurophysiological control of respiration; Physiological problems in diving mammals, new-born and aged individuals.

*[Short answers/Paragraphs/Essays]*

**MODULE 3. Circulation (6 hrs)**

Blood: functions and composition; Coagulation of blood (Enzyme cascade theory); Clinical analysis of blood, ESR; Haemodynamics; Haemostasis, haemolysis and

jaundice, haemoglobinopathies; Blood transfusion and agglutination, aphaeresis.

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Types of heart; ECG; Common cardio-vascular problems: Abnormal variations in BP, Tachycardia, Bradycardia, Myocardial infarction, heart failure, cerebral hemorrhage and cerebro-vascular accident.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 4. Osmoregulation and Excretion (6 hrs)**

Osmoconformers and osmoregulators; Water conservation in desert forms; Osmotic and ionic regulation in terrestrial, fresh water and marine animals; Types of excretion, urea cycle; Human kidney: Urine formation with counter-current mechanism and hormonal regulation; Common renal disorders: haematuria, uremia, proteinuria, renal hypertension, nephritis, renal calculi, oedema, acidosis and alkalosis; Dialysis.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 5. Muscle Physiology (5 hrs)**

Structure of vertebrate skeletal muscle: EM structure of Myofibrils and Myofilaments, contractile proteins; Mechanism of muscle contraction: Ultra structural changes (sliding filament theory); physiology, biochemistry and energetics of muscle contraction; energy sources, role of creatine phosphate, cori cycle; Muscle twitch, fatigue, tetany and rigor mortis.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 6. Nerve Physiology (6 hrs)**

Different types of nerve cells; glial cells, giant nerve fibre of crustaceans and cephalopods; regeneration of medullary fibres, neurotrophins; Nerve impulse transmission, synapses and neuromuscular junctions, synaptic transmission (electrical and chemical), neurotransmitters.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 7. Bioluminescence and Bioelectricity (2 hrs)**

Classification of bioluminescence: symbiotic, extracellular and intracellular; Physiology and significance of light production; Structure and functions of electric organs.

*[Short answers/Paragraphs/Essays]*

### **Section B: ENDOCRINOLOGY (18 hrs)**

#### **MODULE 8. Invertebrate and Vertebrate endocrinology (12 hrs)**

Neuro- endocrine organs and hormones in crustaceans and insects.

Classification of hormones: Amine, peptide and steroid hormones; Endocrine glands in man (hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal, thymus, pineal and gastro-intestinal): their hormones and functions (brief account); Hormonal disorders.

Hormones of reproduction: Testes, ovaries and placenta, their hormones and physiological effects; role of hormones in female sexual cycle; hormone related female and male sexual dysfunctions.

*[Short answers/Paragraphs]*

## **MODULE 9. Concept of neurosecretion and hormonal action (6 hrs)**

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Hypothalamus-hypophyseal interactions, hypothalamus releasing and inhibiting hormones and their roles, Neuro-hormonal integration, Neuro-endocrine pathways, Regulation of hormone secretion.

Hormonal action :Hormone receptors; Mechanism of action of peptide and steroid hormones; mode of action of insulin and thyroxine; positive and negative feedback regulation.

### ***[Short answers/Paragraphs]***

### **Topics for assignments/seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. History, aim, scope and branches of Physiology.
2. Absorption of carbohydrates, proteins, and lipids.
3. Conducting system of the heart.
4. Composition and functions of lymph.
5. Gross and micro structure of human kidney.
6. Endocrine disorders in man : Cushing's disease, Addison's disease, diabetes mellitus, diabetes insipidus, dwarfism, gigantism, cretinism, myxedema and goitre.

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**SIXTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**  
 ZOOLOGY CORE COURSE – X [Theory]

**REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY**

Code: ZOL6B11T

**[54 hrs] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome statements</b>
CO1	Explain the reproductive strategies in invertebrates and vertebrates and structural and functional features of human reproductive system (6 hrs)
CO2	Describe process of fertilization, pregnancy, gestation, placentation, parturition and lactation in humans. (3 hrs)
CO3	Explain the scope of reproductive technologies in infertility management; prenatal diagnostic techniques and methods of fertility control (5 hrs)
CO4	Understand the phases and theories of development, and classification of eggs (3 hrs)
CO5	Enumerate the types of cleavage, arrangement of blastomeres, germ layers and their derivatives, cell lineage in Planocera and different types of blastula. (3 hrs)
CO6	Illustrate the early developmental process of egg in <i>Amphioxus</i> , frog, chick and man (22 hrs)
CO7	Explain the basics of cell differentiation and its genetic control, stem cells and applications of stem cell technology (3 hrs)
CO8	Describe parthenogenesis, types, and significance (2 hrs)
CO9	Explain fate map construction, Spemann's constriction experiments on amphibian embryos, organizers in development, embryonic induction, gradient experiments in sea urchin eggs, cloning experiments in sheep and teratogenesis (7 hrs)

**Question paper pattern for external examination**

Module 1-3: Short answer 2x2 =4 marks; Paragraph 3x5=15 marks.

Module 4-9: Short answer 10x2 =20 marks; Paragraph 4x5=20 marks; Essay 2x10=20 marks

**SECTION A: REPRODUCTIVE BIOLOGY (14 hrs)**

**MODULE 1. Introduction and Human Reproductive system (6 hrs)**

**Introduction to Reproductive Biology (1 hr)**

Importance and scope. Reproductive strategies in invertebrates and vertebrates; semelparity and iteroparity. Sex patterns; Mention sex reversal with examples.

*[Short answers/Paragraphs]*

**Human Reproductive system (5 hrs)**

Male reproductive system: structure of testis, semen production and composition. Female reproductive system: structure of ovary and graafian follicle, ovulation, mention corpus haemorrhagicum, corpus luteum and corpus albicans. Accessory reproductive organs.

Secondary sexual characteristics. Menstrual cycle and its hormonal control (brief account of oestrous cycle in mammals). Gametogenesis: spermatogenesis and oogenesis.

*[Short answers/Paragraphs]*

**MODULE 2. Fertilization, Pregnancy, Gestation, Placentation, parturition and lactation (3 hrs)**

Fertilization: Fertilizin and anti-fertilizin, capacitation, agglutination, sperm penetration, activation of egg and amphi-mixis. Physiological and biochemical

changes during and after fertilization. Pregnancy, Gestation, Placentation, parturition and lactation.

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*[Short answers/Paragraphs]*

### **MODULE 3. Reproductive technologies (5 hrs)**

#### **Reproductive technologies (3 hrs)**

Infertility and its management: Brief account of semen collection, preservation, storage, artificial insemination, surrogacy.

Cryopreservation and embryo transfer: Collection, care and preservation of embryos; *in vitro* fertilization and embryo transfer: major steps; Test tube babies.

Assisted Reproductive Techniques (ART): GIFT, ZIFT, ICSI, oocyte donation and embryo donation.

#### **Prenatal Diagnosis (1 hr)**

Different Prenatal Diagnostic techniques (invasive and non-invasive); Prevention of Female foeticide - ethical issues and laws (Mention-PNDT Act).

#### **Fertility control (1 hr)**

Natural methods, artificial methods, chemical methods, hormonal methods, surgical contraception, removal of gonads and uterus; abortion.

*[Short answers/Paragraphs]*

## **SECTION B: DEVELOPMENTAL BIOLOGY (40 hrs)**

### **MODULE 4. Introduction and Types of eggs (3 hrs)**

#### **Introduction to Embryology (1 hr)**

Historical Perspective (brief account): Mention phases in development. Theories: preformation, epigenesis, recapitulation and germplasm theory.

#### **Types of eggs (2 hrs)**

Classification of eggs with examples based on: Amount of yolk (micro, meso & macrolecithal); Distribution of yolk (iso, centro and telolecithal); Presence or absence of shell (cleidoic & non cleidoic); Types of development (determinate and indeterminate).

Egg membranes: primary, secondary and tertiary; functions of egg envelopes.

*[Short answers/Paragraphs/Essays]*

### **MODULE 5. Cleavage and cell lineage (3 hrs)**

Types of cleavage with examples based on: Plane of cleavage (Meridional, Vertical, Equatorial and Latitudinal); Amount of yolk (Holoblastic and Meroblastic); Types of development (Determinate and Indeterminate); Pattern of arrangement of blastomeres (Radial and Spiral).

Germ layers and derivatives. Cell lineage studies in Planocera (brief account only). Different types of blastula.

*[Short answers/Paragraphs]*

### **MODULE 6. Development of Amphioxus, frog, chick and man (22 hrs)**

#### **Early development of Amphioxus (3 hrs)**

Brief account of fertilization. Cleavage, Blastulation, Gastrulation and Neurulation.

**Development of Frog****(8 hrs)**

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Fertilization, Cleavage, Blastulation and fate map, Gastrulation (Morphogenetic movements) and formation of germ layers, neurulation and notochord formation, mesoderm and coelom formation; organogeny of brain and eye. Hormonal control of amphibian metamorphosis.

**Development of Chick****(7 hrs)**

Structure of egg; fertilization, cleavage, blastulation, gastrulation and formation of germ layers. Salient features of chick embryo at primitive streak stage, 24, 33 and 48 hours stages. Development and functions of extra embryonic membranes.

**Development of Man****(4 hrs)**

Cleavage and formation of morula, development of blastocyst, implantation, gastrulation up to the formation of germ layers. Human placenta; functions of placenta.

*[Short answers/Paragraph/Essays]*

**MODULE 7. Cell Differentiation and Gene action during development (3 hrs)**

Cell differentiation, totipotency, pluripotency, dedifferentiation and redifferentiation. Controlled gene expression during development; Homeotic genes, Mention Hox-genes. Stem cells – embryonic and adult stem cells; their significance and applications.

*[Short answers/Paragraphs]*

**MODULE 8. Parthenogenesis (2 hrs)**

Definition and types. Natural parthenogenesis: Arrhenotoky, Thelytoky, Obligatory and Facultative. Artificial parthenogenesis. Significance of parthenogenesis.

*[Short answers/Paragraphs]*

**MODULE 9. Experimental Embryology & Teratology (7 Hrs)****Experimental Embryology****(5 hrs)**

Construction of fate map, vital staining, marking with carbon particles and radioactive tracing. Spemann's constriction experiments on amphibian embryos, potency of nuclei and importance of Grey crescent. Organizers in amphibian development (primary, secondary & tertiary organizers). Embryonic induction. Gradient experiments in sea urchin eggs. Cloning experiments in sheep.

**Teratology****(2 hrs)**

Environmental disruption in animal development: Teratogenic agents and their effects (alcohol, drugs, nicotine and other chemicals), infections (Herpes virus, Cytomegalovirus and Rubella virus), metabolic imbalance (malnutrition and autoimmunization) (brief account).

*[Short answer/Paragraphs]*

### Topics for assignments/seminars

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Development of foetal membranes in man.
2. Types of placenta (brief account).
3. Regeneration in animals.
4. Factors affecting regeneration.
5. Factors inducing parthenogenesis.
6. Structure of different types of eggs (Amphioxus, frog, insect)

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**SIXTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**  
**ZOOLOGY CORE COURSE –XI [Theory]**

**ENVIRONMENTAL AND CONSERVATION BIOLOGY**

Code: ZOL6B12T

**[54 hrs] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course outcome statements</b>
CO1	Explain the structure of ecosystem and its functioning through energy flow and nutrient cycling (6 hrs).
CO2	Enumerate biogeochemical cycles and understand the concept of limiting factors (5 hrs).
CO3	Describe the ecology of population, community and habitat as a self regulating system (14 hrs)
CO4	Understand various types of population interactions and appraise the co-evolution (3 hrs).
CO5	Comprehend the diverse environmental and sustainability challenges ranging from local to global and the establishment of perfect harmony between economic development, social issues and environmental conservation (4 hrs).
CO6	Enumerate the several tools and techniques employed for studies on populations, communities and ecosystems. (4 hrs)
CO7	Understand the threats to biodiversity, and strategies adapted for the conservation of diversity of organisms (10 hrs)
CO8	Describe the various international strategies for conserving biodiversity (4 hrs)
CO9	Describe the toxic chemicals, their toxicity levels and the health hazards caused by them (4 hrs).

**Question paper pattern for external examination**

*[Module 1-6: Short answer 9x2=18 marks, Paragraph 5x5=25 marks, Essay 1x10= 10 marks  
Module 7-9: Short answer 3x2= 6 marks, Paragraph 2x5=10 marks, Essay 1x10=10 marks]*

**Section A: ENVIRONMENTAL BIOLOGY (36 hrs)**

**MODULE 1. Introduction, Ecosystem and Energetics (6 hrs)**

Introduction to Environmental biology: Definition, divisions of ecology, modern branches and scope.

**Ecosystem-Structure and functions:** Concept of ecosystem, characteristics; Structure (components) of ecosystem (pond as an example); Mention kinds of ecosystems.

**Ecosystem Energetics:** Photosynthetic production and energy fixation; Energy flow in the ecosystem, Energy flow and laws of thermodynamics, Energy transfer and energy transformations [Trophic dynamics or community dynamics (Lindeman's model of energy flow)]; Ecological efficiency.

Productivity of ecosystem: Concept of productivity- standing crops, material removed and production rate; Kinds of productivity: a) Primary productivity (GPP, NPP, NCP) b) Secondary productivity).

*[Short answer/Paragraph/Essays]*

**MODULE 2. Biogeochemical Cycles and Limiting factors (5 hrs)**

**Biogeochemical Cycles:** Basic types of biogeochemical cycles: Gaseous cycles (Carbon and nitrogen cycles) Sedimentary cycle (Phosphorous cycle).

**Limiting factors:** Basic concepts. Leibig's law of minimum; Shelford's law of tolerance and combined concept of limiting factors. Ecological indicators.

*[Short answer/Paragraph/Essays]*

### **MODULE 3. Population, Community and Habitat Ecology (14 hrs)**

#### **Population Ecology**

Properties of population: density, natality, mortality, age distribution, biotic potential, environmental resistance, migration, emigration, immigration and carrying capacity. Population growth forms, J and S shaped curves.

#### **Community Ecology**

Biotic community: Definition and kinds of communities.

Characteristics: Species diversity, abundance, dominance, stratification, succession, growth forms, trophic structure, co-existence, interdependence and key stone species; Concept of ecotype, ecotone and edge effect.

#### **Habitat ecology**

- a) Marine ecology: Biotic divisions of the marine habitat, their characteristics. Pelagic realm- planktonic and nektonic adaptations. Benthic realm – littoral and abyssal adaptations. Adaptations of animals of rocky, sandy and muddy sea shores.
- b) Fresh water ecology: Lentic and lotic habitats, their characteristics, faunal characteristics and adaptations.
- c) Terrestrial ecology: Tropical wet evergreen forests and Tropical dry deciduous forests, their characteristics, adaptations of animals of forests.

***[Short answer/Paragraph/Essays]***

### **MODULE 4. Population Interactions (3 hrs)**

- a) Intraspecific interactions b) Inter specific interactions: Positive interactions- Mutualism, Commensalism and Proto-cooperation (with examples). Negative interactions- Competition, Predation and Parasitism (with examples).

***[Short answer/Paragraph/Essays]***

### **MODULE 5. Social issues and Environment (4 hrs)**

Sustainable development; Joint Forest Management; Goals of United Nations; Environmental ethics: Issues and possible solutions, Habitat destruction and its consequences- socio-ecological concern: wetland, paddy fields, mangrove, river encroachment, sand and clay mining; Ecological impacts of tourism.

Disaster management: Natural & Artificial - floods, drought, earthquake, cyclone and landslides.

***[Short answer/Paragraphs]***

### **MODULE 6. Ecological tools and Techniques (4 hrs)**

Commonly used techniques for study of animal populations: a) Sampling of animal populations b) Trapping and collecting various groups of organisms [insects, aquatic organisms, soil organisms, birds and mammals] c) Marking of animals d) Determination of age in animal groups d) Determination of home range and territory e) Estimation of number of animals in a population f) Indirect method of estimating wild animal populations g) Recent trends- Camera trapping, Radio collaring and Remote sensing

***[Short answer/Paragraphs]***

**Section B: CONSERVATION BIOLOGY (14 hrs)**  
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**MODULE 7. Biodiversity (10 hrs)**

Introduction, Components of biodiversity: Genetic diversity, species diversity (mention Shannon diversity index and Simpson's dominance index), community diversity and ecosystem diversity, landscape diversity; Levels of diversity in community and ecosystem diversity: Alpha, beta and gamma diversities.

Hot spots of biodiversity. Mention hotspots in Indian region (Western Ghats and Sri Lanka, Himalayas, Indo Burma and Sundaland).

Threats to biodiversity; Loss of biodiversity and its causes.

Threatened species, Extinction of species, Red data book and IUCN Red list categories.

Conservation of biodiversity and wildlife: conservation measures; Wild life (protection Act) 1972, Conservation projects: Project Tiger, Elephant, Lion, Crocodile, Gangetic Dolphins, Kashmir Red Deer and Brow-antlered Deer (Sangai).

Biodiversity conservation strategies: Protection of endangered species- *Ex situ conservation* (conservation in Seed banks, Gene banks, Germ plasm banks, Zoo, Botanical gardens etc.).

*In situ conservation*: Wildlife Sanctuaries -Thattekkad bird sanctuary, ParambikulamWLS, PeriyarWLS, Malabar WLS); National Parks- Eravikulam NP & Silent Valley NP; Biosphere Reserves - Nilgiri BR & Agasthyamalai BR; Community reserve- Kadalundy.

**[Short answer/Paragraph/Essays]**

**MODULE 8. Global strategy for conservation (4 hrs)**

Brief notes on i) Stockholm conference/Declaration (1972), ii) IUCN, iii) WWF, iv) UNEP, v) CITES, vi) Rio Declaration vii) Rio convention on Biodiversity, 1992 (Rio Earth Summit, 1992), Rio (2012). viii) Kyoto Agreement (1997), Paris Agreement (2016) and Conference of the Parties (COP) on climate change (2018), ix) Ramsar convention (2018).

**[Short answer/Paragraphs]**

**Section C: TOXICOLOGY (4 hrs)**

**MODULE 9. Toxicants and public health hazards (4 hrs)**

- a. Toxic chemicals (biocides, automobile emissions, heavy metals, fertilizers, food additives, xenobiotics, radioactive wastes).
- b. Classification of poisons; Physico-chemical characteristics and mode of action of poisons; Accidental, suicidal and homicidal poisonings; Signs and symptoms of common poisoning and their antidotes.
- c. Levels of toxicity: Acute, sub acute, chronic, Dose-response relationship. Measures of toxicity: LD<sub>50</sub> and LC<sub>50</sub>.

**[Short answer/Paragraphs]**

**Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Environmental factors (Temperature, water, light, soil) and their influence on organisms.

2. Concept of habitat and niche.
3. Food chains and food web.
4. Major biomes of the world.
5. Ecological pyramids.
6. Ecological succession, basic types and processes in succession.
7. Environmental pollution-Land, water, air, sound and radiation.
8. Global warming and Ozone depletion.
9. Individual responsibilities – Role of Governmental and Non-Governmental Organizations in biodiversity conservation – Chipko, Green peace WWF
10. Food additives.

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**SIXTH SEMESTER B.Sc. ZOOLOGY PROGRAMME**  
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ZOOLOGY CORE COURSE –XII [Theory]

**ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY**

Code: ZOL6B13T

**[54 hrs] [3 hours per week] [3 credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
CO1	Describe the patterns and mechanisms of animal behaviour (5 hrs)
CO2	Illustrate biological rhythms and the chemical basis of communication (7 hrs)
CO3	Identify major evolutionary transitions over time, and explain the tools and evidences that support current hypotheses of the history of life on earth (8 hrs)
CO4	Describe the evidences for evolution and its required corollaries (5 hrs)
CO5	Explain the various theories of evolution ( 6 hrs)
CO6	Describe the mechanisms by which evolution occurs (5 hrs)
CO7	Recognize the significance of reproductive isolation in reducing gene flow between populations, biological and morphological species concepts and distinguish between prezygotic and postzygotic barriers to reproduction (7 hrs)
CO8	Review the events in human evolution (3 hrs)
CO9	Explain ecological and historical foundations for understanding the distribution and abundance of species, and their changes over time and comprehend the basic principles of biogeography as a discipline (8 hrs)

**Question paper pattern for external examination**

*[Module 1-2: Short answer 4x2=8 marks, Paragraph 2x5=10 marks;*

*Module 3-8: Short answer 5x2=10 marks, Paragraph 4x5=20 marks, Essay 2x10=20 marks;*

*Module 9: Short answer 3x2=6 marks, Paragraph 1x5=5 marks]*

**Section A: ETHOLOGY (12 hrs)**

**MODULE 1. Patterns and Mechanisms in Animal Behaviour (5 hrs)**

**Introduction and Patterns of behavior (4 hrs)**

History (brief), scope of ethology. (a) Innate behaviour: Orientation-taxes/kinesis, simple reflexes, instincts, motivation. (b) Learned behaviour: Habituation, conditioned reflex, trial and error learning; latent learning, imprinting, insight learning, memory and learning.

**Neural mechanism in behavior (1 hr)**

Role of hypothalamus in thirst and feeding; role of cerebral cortex in emotional behavior; mammalian limbic system and control of behavior (brief account).

*[Short answers/Paragraphs]*

**MODULE 2. Biological rhythm and Sociobiology (7 hrs)**

**Biological clocks/rhythms (4 hrs)**

Photoperiodism, circadian rhythm; migration, orientation, navigation and homing; diapause, hibernation and aestivation (brief account)

**Sociobiology (3 hrs)**

Social groups in termites and elephants; Chemical communication: classification and significance of pheromones (mention human pheromones also).

*[Short answers/paragraphs]*

**Section B: EVOLUTION (34 hrs)**  
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**MODULE 3. Course of Evolution (8 hrs)**

**History of Evolutionary thought (1 hr)**

History of evolutionary thought: Ideas of evolution during Pre-Darwinian, Darwinian and Post-Darwinian periods (brief account).

**Origin of life (6 hrs)**

Biochemical origin of life (Modern hypothesis–Oparin-Haldane Theory). Major steps in the biochemical evolution of life (brief account): Origin of Earth and the primordial atmosphere, formation of simple organic molecules, formation of macromolecules or polymers, and formation of coacervates, microspheres, protocells and full-fledged living cells; origin of mitochondria and chloroplast. Experimental evidence for biochemical origin of life: Urey-Miller experiment; Other experiments; Modern ideas on the origin of life. Mention origin of prokaryotes and eukaryotes.

**History of Life on Earth (1 hrs)**

Geological time scale (simple chart), mention Cambrian explosion. Fossils, Fossilization and Dating of fossils (brief account). Living fossils: *Peripatus*, *Limulus* and *Sphenodon* as examples.

*[Short answers/Paragraphs/Essays]*

**MODULE 4. Evidences of Organic Evolution (5 hrs)**

i) Morphological and anatomical, ii) physiological and biochemical, iii) embryological, iv) palaeontological, v) molecular, vi) taxonomical evidences and vii) biogeographical evidences

*[Short answers/Paragraphs/Essays]*

**MODULE 5. Theories of Evolution (6 hrs)**

Lamarck's theory: Explanation of the major postulates of the Lamarck's theory with examples, Criticism against Lamarckism, Neo-Lamarckism, Present status of Lamarckism.

Darwin's theory: Explanation of important postulates of Darwin's theory, Examples for natural selection, Criticism against Darwinism, Neo-Darwinism (Synthetic theory of evolution).

Weismann's germplasm theory; Mutation theory of De Vries. Mention the contributions of Wallace.

*[Short answers/Paragraphs/Essays]*

**MODULE 6. Concepts of Evolutionary Process (5 hrs)**

Genetic basis of evolution: i) Mutations (brief account of gene and chromosomal mutations), ii) Variations: somatic (environmental) variations and genetic (hereditary) variations, iii) Hardy-Weinberg Principle: Hardy-Weinberg Equilibrium, Factors that upset Hardy-Weinberg Equilibrium, iv) Genetic drift: effects on population, Evolutionary bottleneck and Founder effect, genetic drift and natural selection, importance of genetic drift in evolution; theory of punctuated equilibrium and its relevance.

*[Short answers/Paragraphs/Essays]*

## **MODULE 7: Nature of Evolution (7 hrs)**

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Species and Speciation: Species concept: phylogenetic and biological species concepts; General characteristics and subdivisions of species: subspecies, semi species, sibling species, cline and deme.

Speciation: Types of speciation i) Phyletic speciation ii) Quantum speciation iii) Gradual speciation; Major methods of natural speciation: Allopatric, parapatric and sympatric speciation.

Isolation and Isolating mechanisms: Types of isolating mechanisms i) Geographic isolation: mention examples, ii) Reproductive isolation (a) Prezygotic isolation (habitat, seasonal, ethological, morphological, physiological and cytological isolation with examples), (b) Postzygotic isolation (hybrid inviability, hybrid sterility and F2 breakdown isolation with examples).

Adaptive Radiation (Divergent Evolution): cause and significance, adaptive radiation in Darwin's finches; Convergent Evolution; Pre-adaptation; Co-evolution (mention examples also).

**[Short answers/paragraphs/Essays]**

## **MODULE 8: Evolution of Modern Man (3 hrs)**

Evolutionary trends in humans; Fore-runners of anthropoids-*Parapithecus*; Fore-runners of apes-*Dryopithecus*; Fore-runners of modern man-*Ramapithecus* (*Kenyapithecus*), *Australopithecus* (The ape-man), *Homo habilis* (The handy man), *H. erectus* (Pithecantropines), *H. sapiens neanderthalensis* (Neanderthal man), *Homo sapiens fossilis* (The Cro-magnon), *Homo sapiens sapiens* (Modern man), mention Denisoans and Malayan man.

**[Short answers/paragraphs/Essays]**

## **Section C: ZOOGEOGRAPHY (8 hrs)**

### **MODULE 9: Zoogeographical realms and Biogeography of India (8 hrs)**

#### **Geographical Distribution (4 hrs)**

(a) Geographical distribution of animals: Cosmopolitan, discontinuous, bipolar and isolated distribution. (b) Barriers in animal distribution: Physical, climatic and biological barriers.

#### **Zoogeographical realms (2 hrs)**

Zoogeographical regions with specific fauna (faunal regions): Palaearctic region, Nearctic region, Neotropical region, Ethiopian region, Oriental region and Australian region; brief description on Wallace line, Weber line and Wallacea.

#### **Insular fauna (1 hr)**

Faunal characteristics of continental (Madagascar and Sri Lanka) and oceanic islands (Galapagos and New Zealand).

#### **Biogeography of India (1 hr)**

Biogeographical zones of India: Himalayan, Desert zone, Semi-arid zone, Western Ghats, Deccan plateau, Gangetic plain, North east Indian zone, Island zone and Coastal zone (brief account).

**[Short answer/Paragraphs]**

## Topics for Assignments / Seminars

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Old theories on origin of life: i) Theory of abiogenesis ii) Theory of biogenesis iii) Theory of special creation iv) Theory of Panspermia.
2. Evolution of Vertebrate Groups: Evolution of agnathans, fishes, amphibians, reptiles, birds and mammals (brief account).
3. Evolution of horse
4. Polypliody and Evolution
5. Ancestry of human population of India

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### Module 3-8 (Evolution)

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### Module 9 (Zoogeography)

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**SIXTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
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 ZOOLOGY ELECTIVE CORE COURSE- I (Theory)

**HUMAN GENETICS**

Code: ZOL6B14BE01T

**[54 hours] [3 hours per week] [3 Credits]**

**COURSE OUTCOMES [COs]**

<b>COs</b>	<b>Course Outcome Statements</b>
CO1	Explain the characteristics, nomenclature and classification of human chromosomes; non-disjunction of chromosomes and the phenotypic effects of chromosome structural modifications (16 hrs)
CO2	Understand the construction of pedigrees of Sex-linked and Autosomal dominant and recessive gene mutation disorders and presentation of molecular genetic data in pedigrees (4 hrs)
CO3	Enumerate the major autosomal and X-linked dominant and recessive human genetic disorders (8 hrs)
CO4	Explain multifactorial inheritance (4 hrs)
CO5	Understand the basic genetics of reproduction and development (9 hrs)
CO6	Explain the prenatal diagnostic techniques, major genetic services and genetic counseling (9 hrs)
CO7	Describe human genetic variations, archaeogenetics of South Asia and genetic origin of Indian populations (4 hrs)

**Question paper pattern for external examination**

*[Module 1-3: Short answer 3x2=6 marks, Paragraph 5x5=25 marks, Essay 1x10=10 marks]*

*Module 4-5: Short answer 4x2=8 marks, Paragraph 2x5=10 marks]*

*Module 6-7: Short answer 5x2=10 marks, Essay 1x10=10 marks]*

**MODULE 1. Human chromosomes (16 hrs)**

**Classification and nomenclature**

**(9 hrs)**

History of classification and nomenclature of human chromosomes – various conferences and their contributions: Denver, Chicago, Paris and Stockholm Conferences. Characteristics of A to G groups of chromosomes. Various banding techniques - G-banding, Q-banding, R-banding, C-banding, Y-banding, NOR banding. Fluorescence in-situ hybridization (FISH)

**Non-disjunction of Chromosomes**

**(2 hrs)**

Meiotic non-disjunction, mitotic non-disjunction, non-disjunction of autosomes, non-disjunction of sex chromosomes and mosaicism

**Chromosome structural modification and the human phenotype**

**(5 hrs)**

Ring chromosome, Iso chromosomes, Philadelphia chromosome, Cri-du-chat syndrome (5p-syndrome) Prader willi syndrome, Fragile X- Syndrome (Martin Bell syndrome), Burkitt's lymphoma (14q+ syndrome)

*[Short answers/Paragraphs/Essays]*

**MODULE 2. Human Pedigrees (4 hrs)**

Gathering family history, Symbols of Pedigree, construction of pedigrees, Pedigrees of Sex-linked and Autosomal (dominant and recessive), X-linked dominant and recessive gene mutation disorders. Presentation of molecular genetic data in pedigrees.

*[Short answers/Paragraphs]*

### **MODULE 3. Chromosomal Disorders (8 hrs)**

#### **Autosomal dominant disorders**

**(4 hrs)**

Familial hyper cholesterolemia, metabolic and genetic control of cholesterol, Huntington's disease. Marfan's syndrome (Arachnodactyly). Ehlers-Danlos Syndrome (Rubber man or the Elastic Woman).

#### **Autosomal recessive disorders**

**(2 hrs)**

Cystic fibrosis - CF gene and protein, Detection of CF homozygotes and carriers, hereditary microcephaly.

#### **X-linked dominant and recessive disorders**

**(2 hrs)**

Duchenne muscular dystrophy, identification of the DMD gene, carriers and hemizygotes, X-SCID.

*[Short answers/Paragraphs/Essays]*

### **MODULE 4. Multifactorial Inheritance (4 hrs)**

Congenital heart diseases (ASD and VSD), Alzheimer's disease, Schizophrenia, Intelligence

*[Short questions]*

### **MODULE 5. Genetics of Reproduction and Development (9 hrs)**

Prenatal development: genes and hormones. Errors in sexual development: Defects of androgen target cells-deficiency of 5-alpha reductase, congenital adrenal hyperplasia (CAH) and sex reversal.

Maternal effect genes, Segmentation and pattern formation genes, Adhesion molecules and genes, Genomic imprinting, Inbreeding in isolates. Consanguinous marriages, twin studies, biology of twinning, analysis of twin data.

*[Short answers/Paragraphs/Essays]*

### **MODULE 6. Prenatal diagnosis, Genetic Services and Genetic Counselling (9 hrs)**

#### **Prenatal diagnosis and genetic services**

**(5 hrs)**

Amniocentesis, chorionic villi sampling (CVS), foetoscopy, ultrasonography (USG), Alpha foeto protein screening, prenatal sexing. Test tube babies; Karyotyping; Genetic sequencing and future medicine.

#### **Genetic counseling**

**(4 hrs)**

Procedures and ethical concerns; History of counseling; Methods of genetic counselling - marriage counselling, directive and non- directive reason for seeking counseling; Psychodynamics of genetic counselling.

*[Short answers/Essays]*

### **MODULE 7. Evolutionary Genetics (4 hrs)**

Human genetic variation - haplogroups; Human races, human variability messages from mitochondrial DNA. Archaeogenetics: Genetics and archaeogenetics of South Asia - out of Africa theory. Genetic origin of Indian populations - Indian Genome Variation initiative. Pharmacogenetics and Ecogenetics (Brief account), Mention phenocopy

*[Short answers]*

### Topics for assignments/seminar

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Mitochondrial DNA mutations in human disease.
2. Sequence components of the human genome.
3. Organization of the human genome.
4. Sex linked disorders.
5. Autism spectrum disorder.

### REFERENCES

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ZOOLOGY ELECTIVE CORE COURSE- II (Theory)

**AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY SCIENCE**

Code: ZOL6B14BE02T

**[54 hours] [3 hours per week] [3 Credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Explain aquaculture and the process of prawn, mussel and pearl culture (10 hrs).
CO2	Illustrate the methodology of pisciculture and understand common culture fishes and ornamental fishes (13 hrs)
CO3	Identify major fishing crafts and gear and enumerate fish utilization and preservation (13 hrs)
CO4	Enumerate the poultry rearing techniques and understand major breeds of fowl (7 hrs)
CO5	Understand the major breeds of cattle, cattle feeds and diseases of cattle (6 hrs)
CO6	Illustrate the steps in dairy processing and identify the role of dairy development in rural economy (5 hrs).

**Question paper pattern for external examination**

[Module 1-3: Short answer 6x2=12 marks, Paragraph 4x5=20 marks; Essay 2x10=20 marks  
Module 4-6: Short answer 6x2=12 marks, Paragraph 3x5=15 marks]

**MODULE 1. Aquaculture (10 hrs)**

**Types of aquaculture**

**(3 hrs)**

Brief account of classification of aquaculture based on:

Environment – Freshwater, brackish water and mariculture.

Temperature – Warm water/cold water culture.

Culture techniques – pond aquaculture, cage culture, pen culture, raft culture, pole culture, rack culture and long line culture.

Number of species – Mono culture and poly culture.

Type of organism – prawn culture, shrimp culture, edible oyster culture, lobster culture etc.

**Mariculture**

**(7 hrs)**

Prawn culture: Important cultivable species in India, seed collection, spawning and larval rearing, induced breeding, types of culture systems - Pokkali culture, culture in bheries/ponds, culture and harvesting.

Mussel culture: *Perna indica*, *Perna viridis*, Seed collection, artificial seed production, induced spawning, culture techniques and harvesting.

Pearl culture: Method of pearl formation, selection and preparation of host, preparation of nucleus and implantation, post-operation care, post-operation culture and collection of pearls.

**[Short answers/Paragraphs/Essays]**

**MODULE 2. Pisciculture (13 hrs)**

- i. Egg collection; induced spawning; construction, preparation and maintenance of ponds; manuring; feeding and harvesting. Cryopreservation of fish germplasm, semen bank and preservation media.
- ii. Biology and culture of following Indian major carps: *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*.

- iii. Biology and culture of Exotic carps: *Cyprinus carpio* (common carp), *Hypophthalmichthys molitrix* (Silver carp).
- iv. Inland fishes and Fisheries (Brief account): *Channa*, *Clarias* and *Etroplus suratensis*
- v. General account and fishery aspect of Sardine, Shark and Tuna. Mention GIFT Tilapia and Nutter (*Pygocentrus nattereri*)
- vi. Ornamental fisheries: Common aquarium fishes: e.g: *Carassius auratus* (Gold fish), *Pterophyllum* spp. (Angel fish), *Astronotus ocellatus* (Oscar cichlid), *Poecilia reticulata* (Guppy), *Poecilia sphenops* (Black molly), aquarium management.
- vii. Plankton and Fishery production: Zoo and Phytoplankton – Vertical migration – Plankton and Productivity.

**[Short answers/Paragraphs/Essays]**

**MODULE 3. Fishing Crafts and Gear, fish preservation and utilization (13 hrs)**

- Fishing crafts – Mention Catamaran, Canoes and dug-out-canoes.
- Fishing gears – Gillnet/drift gillnet, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing.
- Fish Spoilage and Preservation: Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting and smoking.
- Fish utilisation: Nutritive value, bye products, liver oil, body oil, fish meal, fish flour, Isinglass, glue, skin, fin soup, lime, chitin and chitosan.
- Diseases and parasites of Fish: Fungal infection – Epizootic Ulcerative Syndrome (EUS), Saprolegnia, Fin and tail rot disease, Dropsy.
- Mud banks of Kerala coast.

**[Short answers/Paragraphs/Essays]**

**MODULE 4. Poultry science (7 hrs)**

- Egg production, cable bird production, nutritive value and bye products.
- Breeds of fowl – Exotic –Rhode Island Reds, Plymouth Rock, Naked Neck and Leghorn; Indigenous – Gramapriya, Giriraja and Kalinga Brown.
- Poultry rearing: Selection of eggs, hatching, incubation, brooding, sexing and vaccination.
- Poultry housing: Free range system, Semi-intensive system (deep litter system and individual cage system).
- Equipments for feeding: Nutrients for starting, growing, laying hen.
- Common poultry feeds, food rations and feed formulation.
- Common diseases of poultry (Ranikket, Pullorum and Fowl pox)

**[Short answers/Paragraphs]**

**MODULE 5. Animal husbandry (6 hrs)**

Introduction: History, origin, domestication.

Breeds of cattle:

Dairy breeds: Sindhi, Gir

Draught breeds of cattle: Nagori, Kangayam

Dual purpose breeds: Ongole, Hariana

Exotic breeds: Jersey, Holstein – Friesian

Native breeds: Conservation programmes, Vechur cow and Kasargod Dwarf

Feeding: Common cattle feeds, fodder

Common diseases: Anthrax, Foot & Mouth disease.  
Parasites of cattle

Meat hygiene: Slaughter and clean meat production – Zoonotic diseases.

**[Short answers/Paragraphs]**

#### **MODULE 6. Dairy science (5 hrs)**

- i. Role of dairy development in rural economy, employment opportunities, white revolution.
- ii. Dairy processes: Straining, Filtration, Cooling, Chilling, Clarification, Pasteurisation, Freezing, Recombined milk, Soft curd milk, Skimmed and toned milk.
- iii. Artificial milk, Milk adulteration.

**[Short answers/Paragraphs]**

#### **Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Role of physical and chemical factors in aquaculture.
2. Sea weed culture: e.g: Grassilaria, Sargassum.
3. Dairy products, manufacture and nutritive value.
4. Milk and milk spoilage.
5. Crab and lobster culture.

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**SIXTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**  
**PDF Compressor Free Version**  
 ZOOLOGY ELECTIVE CORE COURSE- III (Theory)

**APPLIED ENTOMOLOGY**

Code: ZOL6B14BE03T

**[54 hours] [3 hours per week] [3 Credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Describe the branches of entomology and insect services (6 hrs)
CO2	Identify and explain the lifecycle, damages and control of insect pests of crop plants and domestic animals (26 hrs)
CO3	Review the insect control strategies (11 hrs)
CO4	List and describe the useful insects and the products derived from bees, silkworms and lac insects (11 hrs)

**Question paper pattern for external examination**

*[Module 1: Short answer 2x2=4 marks, Paragraph 1x5=5 marks;*

*Module 2: Short answer 6x2=12 marks, Paragraph 3x5=15 marks, Essay 1x10=10 marks;*

*Module 3-4: Short answer 4x2=8 marks, Paragraph 3x5=15 marks, Essay 1x10=10 marks]*

**Section A: AGRICULTURAL ENTOMOLOGY**

**MODULE 1. General Introduction and Insect services (6 hrs)**

**Introduction to Entomology**

**(4 hrs)**

Branches of Entomology: Agricultural, Forest, Veterinary, Medical, Forensic, Industrial, Nutritional and Cultural Entomology. Classification of Class Insecta to Orders. Generalized morphological organization of an insect.

**Insects in service of man**

**(2 hrs)**

Insects as pollinators, parasitoids, scavengers (enhancing soil fertility), pollution indicators, model organisms for scientific research; herbivory for weed control; insects in medicine and forensic science; insects of aesthetic value; use of insect pheromones and hormones.

*[Short answers/Paragraphs]*

**MODULE 2. Harmful Insects: pests of crops and domestic animals (26 hrs)**

**Insects as enemies of man**

Definition of pests, kinds of insect pests, causes of pest outbreak, pests injurious to plants and animals, vectors of diseases.

**a) Pests of paddy** (Life cycle, damage and control measures)

1. *Nilaparvata lugens* (Brown plant leafhopper)
2. *Leptocorisa acuta* (Rice bug)
3. *Cnaphalocrocis medinalis* (Rice leaf folder)

**b) Pests of coconut** (Life cycle, damage and control measures)

1. *Oryctes rhinoceros* (Rhinoceros beetle)
2. *Opisina arenosella* (Black headed caterpillar)
3. *Rhynchophorus ferrugineus* (Red palm weevil)

**c) Pests of Sugarcane** (damage and control measures)

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1. *Chilo infuscatellus* (Sugar cane shoot borer)
2. *Scirpophaga nivella* (Sugar cane top borer)
3. *Saccharioccocus sacchari* (Cane mealy bug)

**d) Pests of plantation crops:** Two example for each, damage and control measures.

- |          |  |
|----------|--|
| Coffee   | 1. <i>Xylotrechus quadripes</i> (Coffee white stem borer)  |
|          | 2. <i>Coccus viridis</i> (Coffee green bug)                |
| Tea      | 1. <i>Helopeltis antonii</i> (Tea mosquito bug)            |
|          | 2. <i>Toxoptera aurantii</i> (Tea aphid)                   |
| Rubber   | 1. <i>Saissetia nigra</i> (Scale insect)                   |
|          | 2. <i>Aetherastis circulata</i> (Bark feeding caterpillar) |
| Pepper   | 1. <i>Longitarsus nigripennis</i> (Pollu beetle)           |
|          | 2. <i>Laspeyresia hemidoxa</i> (Top shoot borer)           |
| Cardamom | 1. <i>Sciothrips cardamomi</i> (Cardamom thrips)           |
|          | 2. <i>Eupterote canarica</i> (Cardamom hairy caterpillar)  |

**e) Pests of fruit plants:** Two example for each, damage and control measures.

- |        |  |
|--------|--|
| Banana | 1. <i>Odoiporus longicollis</i> (Pseudostem borer)       |
|        | 2. <i>Pentalonia nigronervosa</i> (Banana aphid)         |
| Mango  | 1. <i>Batocera rufomaculata</i> (Mango stem borer)       |
|        | 2. <i>Orthaga exvinacea</i> (Mango leaf webber)          |
| Cashew | 1. <i>Neoplocaederus ferrugineus</i> (Cashew stem borer) |
|        | 2. <i>Lamida moncusalis</i> (shoot and blossom webber)   |

**f) Pests of vegetables:** Two example for each, damage and control measures.

- |               |  |
|---------------|--|
| Lady's finger | 1. <i>Helicoverpa armigera</i> (fruit borer)           |
|               | 2. <i>Earias vitella</i> (Spotted bollworm)            |
| Brinjal       | 1. <i>Leucinodes orbonalis</i> (Shoot and fruit borer) |
|               | 2. <i>Henosepilachna vigintioctopunctata</i>           |
| Cucurbits     | 1. <i>Bactrocera cucurbitae</i> (Melon fly)            |
|               | 2. <i>Raphidopala foveicollis</i> (Pumpkin beetle)     |

**f) Pests of stored products:** damage and control measures

1. *Tribolium castaneum* (Rust red flour beetle)
2. *Callasobruchus chinensis* (Pulse beetle)

**g) Pests of domestic animals**

- |                  |                                       |
|------------------|---------------------------------------|
| 1. Domestic fowl | <i>Menopon gallinae</i> (Shaft louse) |
| 2. Goat          | <i>Oestrus ovis</i>                   |
| 3. Cattle        | <i>Tabanus striatus</i>               |

**[Short answers/Paragraphs/Essays]**

**MODULE 3. Control of Insect Pests (11 hrs)**

a) Natural control    b) Applied control or artificial control

Prophylactic and curative methods: cultural, mechanical, legal methods; biological and chemical methods.

Biological control: Ecological, biological and economic dimensions of biological control. Mention any three important biological control projects undertaken in India. Merits and demerits.

Chemical control: Classification of insecticides- mode of entry, mode of action, on chemical nature; botanical insecticides; insecticide residue, resistance and

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resurgence of insect pests; pesticide appliances (hand compression sprayer, knapsack sprayer and rocker sprayer); environmental degradation of pesticides (brief account).

Autocidal and Pheromonal control (brief accounts)

Integrated pest management (IPM) – Features and advantages

**[Short answers/Paragraphs/Essays]**

## **Section B: INDUSTRIAL ENTOMOLOGY**

### **MODULE 4: Industrial Entomology (11 hrs)**

Productive insects:

- a) Honey bee: Apiculture in India: Scope, Diversity, Castes, Morphological and communicative adaptations. Bee products – Honey and bee wax, composition and uses,
- b) Silk moth: Types of silk worms (mulberry, eri, muga, tassar), life cycle of mulberry silkworm; sericulture and moriculture: processing and extraction of silk; composition and uses of silk.
- c) Lac insect: lac host plants, different strains of lac insects, cultivation, inoculation, harvesting and propagation of lac, composition and uses of lac.

**[Short answers/Paragraphs/Essays]**

### **Topics for Assignments/Seminars**

1. Biology of major insect vectors of human diseases, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla*, *Pediculus*, *Cimex* and *Phthirus*.
2. Diseases and its control measures: Filariasis, Yellow fever, Dengue, Typhus fever and Kala-azar.
3. Insects as source of protein for human
4. Causes of success of insects
5. Bee diseases and enemies.
6. Diseases of silkworms.
7. Enemies of lac insects.

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**B. Sc. ZOOLOGY PROGRAMME**  
**ZOOLOGY [CORE COURSE] PRACTICAL – III**

Cod: ZOL6B16P

**[Practical III\*A + Practical III\*B] [4 Credits]**

**PRACTICAL III\*A:** PHYSIOLOGY, ENDOCRINOLOGY, REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY [72 hours] [4 hrs /week]

**PRACTICAL III\*B:** ENVIRONMENTAL AND CONSERVATION BIOLOGY, ETHOLOGY, EVOLUTION, ZOOGEOGRAPHY & ELECTIVE COURSE [72 hours] [4 hrs/week]

**COURSE OUTCOMES [COs]**

COs	Course Outcome Statements
CO1	Perform standard laboratory experiments for the estimation of Hb, presence of hCG/abnormal constituents in urine, detection of blood pressure, bleeding and clotting time and identification of formed elements in blood (46 hrs)
CO2	Identify selected stages in the development of frog and chick and chosen larval forms of invertebrates and vertebrates (26 hrs)
CO3	Carry out experiments of laboratory standards to estimate water quality parameters including, dissolved Oxygen, Carbon dioxide, hardness and pH; determination of adulteration of selected food items and identify marine planktons and soil organisms (28 hrs)
CO4	Demonstrate the behavioural response of earthworm/dipteran larva to selected stimuli (11 hrs)
CO5	Describe homologous, analogous and vestigial organs, connecting links, adaptive radiation and evolution of man (11 hrs)
CO6	Illustrate zoogeographical realms, Wallace line, Weber line, Wallacea and the distribution of <i>Peripatus</i> , lung fishes, <i>Sphenodon</i> , monotremes and marsupials (11 hrs)
CO7	Identify the normal and selected abnormal human karyotypes and inheritance of chosen traits from pedigree charts, ornamental and other culture fishes and chosen beneficial and harmful insects (11 hrs)

**SIXTH SEMESTER B. Sc. ZOOLOGY PROGRAMME**

**PRACTICAL III\*A:**

PHYSIOLOGY, ENDOCRINOLOGY, REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY

**[72 hours] [4 hrs/week]**

**Section A. PHYSIOLOGY AND ENDOCRINOLOGY (46 hrs)**

1. Detection of Abnormal constituents of urine [glucose, ketone bodies and albumin] (Major).
2. Preparation human blood smear to study the formed elements (Major).
3. Osmotic response of RBC to saline solutions of different concentrations (Minor).
4. Determination of Hb content in man using Haemoglobinometer (Minor)
5. Determination blood clotting time (Demonstration).
6. Determination of blood pressure (Demonstration).
7. Determination of Body mass index (individuals).
8. Study of the histology of the following endocrine glands - pituitary, thyroid, adrenal and endocrine pancreas using slides/photographs.
9. Detection of pregnancy using standard kits (Demonstration).

**Section B. REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY****(26 hrs)**

1. Demonstration of chick blastoderm.
2. Induced ovulation in fish.
3. Study of life cycle in *Drosophila*.
4. Spotters:
  - Types of eggs (Insect, Amphioxus, frog, chick, and human).
  - Cleavage in frog (use slides / diagrams/models).
  - Shark: Yolk sac placenta.
  - Development of Frog: Blastula, gastrula, neurula.
  - Development of Chick: 18, 24, 32, 48 hours of incubation.
  - Mammal: Any two mammalian embryos.
  - Larval forms of invertebrates (any five) and vertebrates (any two).

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- G.K. Pal and Parvathy Pal (2016): Text book of practical physiology, 4<sup>th</sup> Edition, ISBN-10: 8173719969, Orient blackswan
- V.P. Varshney , Mona Bedi (2018): Ghai's Textbook of Practical Physiology, 9<sup>th</sup> Edition, ISBN-10: 9352705327, Jaypee Brothers, 376 pages

**PRACTICAL III\*B**

ENVIRONMENTAL AND CONSERVATION BIOLOGY,  
ETHOLOGY, EVOLUTION, ZOOGEOGRAPHY & ELECTIVE [HUMAN  
GENETICS/AQUACULTURE, ANIMAL HUSBANDRY & POULTRY  
SCIENCE/APPLIED ENTOMOLOGY]

**[72 hrs] [4hrs/week]****Section A: ENVIRONMENTAL AND CONSERVATION BIOLOGY (28 hrs)**

1. Estimation of dissolved O<sub>2</sub> in water sample using Winkler's method (Major).
2. Estimation of dissolved CO<sub>2</sub> in pond and tap water (Major).
3. Estimation of total hardness of water (Major).
4. Determination of pH using pH paper / digital pH meter (Minor).
5. Extraction of soil organism by hand picking, floatation and Berlese funnel method (Minor).
6. Study of marine planktons (any five items up to genus level) (Minor).
7. Study of a pond ecosystem and preparation of food chains and food web (Minor).
8. Detection of food adulteration in selected food items (Minor).
  - i) Detection of starch and urea in milk.
  - ii) Detection of tea adulterated by colouring.
  - iii) Detection of maida and chalk powder in wheat flour.

**Section B: ETHOLOGY, EVOLUTION & ZOOGEOGRAPHY (33 hrs)**  
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**Ethology** (Any three) **(11 hrs)**

1. Demonstration of the effect of alarm pheromones in ants.
2. Demonstration of phototaxis using Earth worm.
3. Study of Chaetotaxis in third instar larvae of *Drosophila melanogaster* to odours [Fructose, Yeast and Ethyl acetate].
4. Locomotory behaviour of dipteran larvae (Housefly/blowfly/fruitfly): on different types of substrata (writing paper, plastic sheet and sand paper).
5. Effects of light intensity and light quality on the rate of locomotion of dipteran larva.

**Evolution** **(11 hrs)**

Study of models, charts and specimens related to comparative study of:

1. Study of homologous organs (limbs of 5 different groups of vertebrates).
2. Study of analogous organs (wings of bird, insect and bat).
3. Study of any four vestigial organs in humans.
4. Study of evolution of man based on three hominid fossils.
5. Study of connecting links (*Peripatus* and *Archeopteryx*).
6. Study of adaptive radiation in feet of birds / mouth parts of insects.

**Zoogeography** **(11 hrs)**

1. Preparation of world map to show six zoogeographical realms.
2. Preparation of world map to show islands of zoogeographical significance.
3. Preparation of world map to show Wallace line, Weber line and Wallacea.
4. Locate the distribution of following animals in the world map: *Peripatus*, lung fishes, *Sphenodon*, monotremes, marsupials

**Section C: ELECTIVE COURSE [11 hrs]**  
**[Human Genetics/Aquaculture, Animal Husbandry & Poultry**  
**Science/Applied Entomology]**

**HUMAN GENETICS**

1. Problems on (a) autosomal dominant and recessive (b) polygenic traits (skin colour), (c) Sex linkage (X-linked genes and Y-linked genes).
2. Study of identical and fraternal twins.
3. Dermatoglyphics: Identification of arch, loop and whorl patterns; total ridge count in male and female; Tri- radii, importance of atd angle, simian line.
4. Ischiara chart (to detect red-green colour blindness).
5. Seminars on genetics in cardiology, oncology and genetic counselling, Pre-natal sexing, amniocentesis, importance of genetic screening.
6. Pedigree studies and identification of the nature of inheritance from pedigree chart (any one trait).
7. Identification of human karyotypes (Edwards and Patau's) from ideogram

**AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY SCIENCE**

1. Culture of fish food organisms: protozoans, rotifers and crustaceans.
2. Maintenance of spawn and its transportation to hatching or rearing tanks.

3. Identification of major food fishes (fresh water, estuarine and marine – 5 from each group)
4. Study of different crafts and gears.
5. Study of common ornamental fishes (record any seven with photograph).
6. Breeding techniques: preparation of hormone extracts and injection of hormones to fishes; Eyestalk ablation in prawns.
7. Study of fish products and by-products.
8. Identification of larval forms of prawn, pearl oyster, mussel, lobster and crab.
9. Identification of major edible crustaceans and molluscs.
10. Identification of edible sea weeds.

### APPLIED ENTOMOLOGY

1. Identification and brief notes on the following pests : Any two pests of paddy; coconut; banana; mango; cashew; coffee; tea; rubber; pepper; cardamom and pests of vegetables. Pests of stored products (any two).
2. Study of damage caused by pests (damaged parts of plants, fruits and seeds, wood etc. may be used).
3. 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.
4. Identification and economic importance of the following
  - a) Honey bee and bee products
  - b) Silkworm moth: life cycle stages, silk fibre
  - c) Lac insect and stick lac or shellac.
5. Preparation of : a) tobacco decoction, b) kerosene soap emulsion, c) neem kernel suspension
6. Pesticide appliances: Dusters or sprayers a) Hand compression sprayer b) Rocker sprayer c) Knapsack sprayer/duster d) Hand automizer (any 3)

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**UNIVERSITY OF CALICUT  
B.Sc. DEGREE PROGRAMME**

**SYLLABUS  
COMPLEMENTARY COURSE: ZOOLOGY**

**B.Sc. ZOOLOGY COMPLEMENTARY COURSE**  
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**INTRODUCTION**

Board of Studies in Zoology (U.G.) of University of Calicut reviewed the existing Zoology complementary courses and decided to revise and update the B.Sc. Zoology Complementary syllabus. The Board recommended that the revised syllabus may be implemented for the B.Sc. Degree Programme of the University of Calicut, which offers Zoology as one of the Complementary subjects, **with effect from 2019 admission.**

Accordingly, course content, scheme of instruction, evaluation, credits, marks and duration of examinations of B.Sc. Zoology Complementary Courses are modified. Course outcomes are also introduced for each complementary course. The course structure includes both theory and practical components to be dealt with during the first four semesters of the programme. Accordingly there will be four complementary theory courses, one each in the first four semesters of the B. Sc. Programme and the theory examinations will be conducted at the end of the respective semester. There is only one practical course and its examination will be conducted at the end of the fourth semester. The practical course is designed in such a way that they support the theory course in first four semesters and also impart the basic skills on techniques expected of a zoology student. Attempts have been made to update the syllabus by incorporating the recent trends in various branches of Zoology, conforming to the workload prescribed by the University.

**COMPLEMENTARY COURSE: SCHEME OF INSTRUCTION**

Zoology is one of the Complementary courses of the B.Sc. Degree Programme. It is to be taught during the first four semesters of the programme. Course title, scheme of instruction and evaluation, distribution of credits and marks and other details of B.Sc. Zoology Complementary Course is shown in Table 1. The syllabus includes Theory as well as Practical components.

**Theory**

The total number of theory complementary courses is four [ZOL1C01T, ZOL2C02T, ZOL3C03T and ZOL4C04T], one in each semester. All the four courses have a credit of 2 each with a total of 8 credits.

**Practical**

The practical related to theory courses, (I\*A, I\*B, I\*C and I\*D) are to be conducted in the four semesters. External university practical examinations will be held only at the end of the 4<sup>th</sup> semester [ZOL4C05P; 4 credits]. **Record:** A candidate who appears for the practical examination must submit an authentic record of work done by him/her. Hand-drawn sketches of whole animals/ mountings/ sections/dissections are compulsory. The record should contain the scientific name, phylum and class (for vertebrates order also) of the specimens with notes on identifying features and zoological importance, if any.

**Table 1**

## B.Sc. ZOOLOGY (COMPLEMENTARY) PROGRAMME

### Structure of complementary course

**Course code, Title, Instructional hours, Credits, Marks and Duration of Examinations in four semesters**

**Total Credit: 12 (External 80% and Internal 20%)  
(2019 Admission onwards)**

Semesters	Complementary Course	Code	Course title	Instructional hours/ week	Instructional hours in a semester	Credits	External Marks	Internal marks	Total marks	Duration of Exam (hrs)
I	Theory I	ZOL1C01T	Animal Diversity and Wildlife Conservation	2	36	2	60	15	75	2
	Practical I*A	--	Practical related to theory course ZOL1C01T	2	36	*			--	
II	Theory II	ZOL2C02T	Economic Zoology	2	36	2	60	15	75	2
	Practical I*B	--	Practical related to the theory course ZOL2C02T	2	36	*			--	
III	Theory III	ZOL3C03T	Physiology and Ethology	3	54	2	60	15	75	2
	Practical I*C	--	Practical related to theory course ZOL3C03T	2	36	*			--	
IV	Theory IV	ZOL4C04T	Genetics and Immunology	3	54	2	60	15	75	2
	Practical I*D	--	Practical related to theory course ZOL1C01T & ZOL4C04T	2	36	*			--	
	Practical I*A+ I*B+ I*C+ I*D	ZOL4C05P	Zoology Complementary Practical (Practical I*A, I*B, I*C & I*D)	--	144	4	80	20	100	4
	<b>TOTAL</b>					<b>12</b>	<b>320</b>	<b>80</b>	<b>400</b>	

**Total credits for the B.Sc. Zoology Complementary Programme = 12 credits**

Scheme of evaluation: External 80 % + Internal 20 %

- \* Practical examinations for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> semesters will be held at the end of 4<sup>th</sup> semester.
- Theory examinations are of 2 hours duration
- Practical examination is of 4 hrs duration.
- A panel of two examiners (one internal and one external) will evaluate the University practical examination at the end of semester IV.

**COMPLEMENTARY COURSE: SCHEME OF EVALUATION**  
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Zoology Complementary courses comprise 4 theory courses (one each in first 4 semesters (Total 8 credits) and 1 practical course (4 credits) at the end of fourth semester. Total credits for the complementary course is 12.

**THEORY: EVALUATION SCHEME**

The scheme of evaluation for complementary course contains two parts: *viz.*, internal evaluation (20% marks) and external evaluation (80% marks).

**1. INTERNAL EVALUATION**

The internal evaluation will be a continuous process. It will be done by the faculty members of the department of Zoology of the institution where the candidate is pursuing the study. The internal assessment shall be based on a transparent system involving student's attendance, performance in class tests, assignments and seminars in respect of theory examinations. The colleges shall send the marks obtained for internal examination to the university. Internal evaluation carries 20% (15 marks) of the total marks (75). The distribution of marks shall be as follows.

**Table 2. Criteria for Internal Evaluation of Complementary course [15 marks]**

Sl. No.	Criteria	Marks
1	Test paper (1)	6
2	Assignment	3
3	Seminar	3
4	Attendance	3
Total Marks		15

**Table 2.1. Pattern of Test paper [30 Marks]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for each question	Ceiling of Marks
1 Hour	Short answer	6	6	2	10
	Paragraph	3	3	5	10
	Essay	2	1	10	10
Total marks					30

**Table 2.a. Split up of internal marks for Test Paper [40%]**

Sl. No.	Range of Marks in test paper	Out of 6 [Maximum internal marks 15]
1	85 to 100%	6
2	65 to below 85%	5
3	55 to below 65%	4
4	45 to below 55%	3
5	35 to below 45%	2
6	Below 35%	1

**Table 2.b. Criteria for Internal Evaluation of Assignment [20%]**

Sl. No.	Criteria	Out of 3
1	Submission in time	1
2	Content	2
3	<b>Total Marks</b>	<b>3</b>

**Table 2.c. Criteria for Internal Evaluation of Seminar [20%]**

Sl. No.	Criteria	Out of 3
1	Excellent	3
1	Good	2
2	Average	1
3	<b>*Total Marks</b>	<b>3</b>

*\*Based on way of presentation, content, answer to questions etc.*

**Table 2.d. Split up of internal marks for Attendance [20%]**

Sl. No.	Range of Marks in test paper	Out of 3
1	85 and above	3
2	75 to below 85%	2
3	50 to below 75%	1
4	below 50%	0

## 2. EXTERNAL EVALUATION

External evaluation carries 80% (60 marks) of the total marks (75). University theory examination will be conducted at the end of each semester. The pattern of question papers for external examination is as given below. The students can answer all the questions in Sections A & B. But there shall be ceiling (maximum marks that can be scored) in each section.

**Table 3. Pattern of Question Paper for Complementary course [Theory]**

Duration	Pattern	Total number of questions	Number of questions can be answered	Marks for Each question	Ceiling of Marks
2 Hours	<b>Section A:</b> Short answer	12	12	2	20
	<b>Section B:</b> Paragraph	7	7	5	30
	<b>Section C:</b> Essay	2	1	10	10
<b>Total Marks</b>					<b>60</b>

**PRACTICAL [COMPLEMENTARY]: EVALUATION SCHEME**  
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Practical corresponding to each complementary course will be conducted during the corresponding semesters. Internal evaluation of complementary Practical course will be conducted at 4<sup>th</sup> semester (End semester). Internal evaluation carries 20% [20 marks] of the total marks (100) in each practical. The colleges shall send only the marks obtained for internal examination to the university. External evaluation carries 80% [80 marks] of the total marks (100).

**1. INTERNAL EVALUATION**

**Table 4. Criteria of Evaluation for Complementary Practical [20 marks]**

Sl. No.	Criteria	Marks
1	Attendance	4
2	Lab involvement, Performance & punctuality	4
3	Class test (1 No.)	8
4	Record	4
<b>Total Marks</b>		<b>20</b>

**Table 4.a. Attendance**

Sl. No.	Attendance (%)	Marks
1	85 and above	4
2	75 to below 85%	2
3	50 to below 75%	1
4	below 50%	0

**Table 4.b. Lab involvement, Performance & Punctuality**

Sl. No.	Criteria	Marks
1	Excellent	4
2	Very Good	3
3	Good	2
4	Average	1
5	Below Average	0

**Table 4.c. Class Test [One]**

Sl. No.	Criteria	Marks
1	85 to 100%	8
2	65 to below 85%	6
3	55 to below 65%	4
4	45 to below 55%	3
5	35 to below 45%	2
6	Below 35%	1

**Table 4.d. Record**

Sl. No.	Criteria	Marks
1	Punctuality in submission	1
2	Contents	2
3	Scientific accuracy and neatness	1
<b>Total Marks</b>		<b>4</b>

## 2. EXTERNAL EVALUATION

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Practical corresponding to each complementary course will be conducted during the corresponding semesters. A combined University practical examination related to the first four complementary theory courses (Practical I\*A, I\*B, I\*C and I\*D) will be held at the end of fourth semester. External evaluation carries 80% of (80 marks) the total marks (100 marks). External evaluation will be done by a team consisting of **one internal examiner and one external examiner**. All external practical examinations are of **4 hours** duration.

Any candidate, who turns up for a practical examination, must submit a certified and bonafide record / report of work done by him/ her duly attested by the Teacher- in- charge and the Head of the Department at the time of practical examinations.

**Table 5. Scheme of question paper for Complementary Practical**

Question Nos.	Nature of questions	Total no. of questions	Marks for each question	Marks	Duration
I : Q 1-6	Spotters: from various sections of courses: Identification/ sketches/ descriptions/ reasons /importance/ significance/ from Non chordata, Chordata, Histology, Osteology, Economic zoology etc.	6	3	18	4 hours
II: Q 7	Minor expt.: from various courses - results/explanation/ sketches etc.	1 (as per choice)	9	9	
III: Q 8	Minor expt.: from various sections – (Non chordata/ Chordata/ physiology/ Immunology etc.) results/ explanation/ sketches etc.	1 (as per choice)	12	12	
IV: Q 9	Major expt: from Non chordata/ Chordata/Physiology, Immunology etc.	1 (as per choice)	22	22	
Viva-voce				#3	
V:Record		-	-	16	
	<b>Total Marks</b>			<b>80</b>	

# Viva voce – Examiner may ask questions based on the principles/methodology/concepts of the experiments performed during the practical examinations.

# FIRST SEMESTER B.Sc. ZOOLOGY COMPLEMENTARY COURSE

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Theory Course- I

## ANIMAL DIVERSITY AND WILDLIFE CONSERVATION

Code: ZOL1C01T

[36 hrs] [2 hours/week] [3 credits]

### COURSE OUTCOMES [COs]

COs	Course Outcome Statements
CO1	Describe the general characters of protists and salient features of phylum – Rhizopoda, Ciliophora, Dinoflagellata and Apicomplexa (2 hrs)
CO2	Enumerate the salient features and examples of Phylum – Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Onychophora, Mollusca and Echinodermata, and the structural organization of <i>Peneaus</i> sp. (14 hrs)
CO3	Describe the characteristic features and classification of phylum Chordata with examples and, structural organization of <i>Oryctolagus cuniculus</i> (14 hrs)
CO4	Explain levels of biodiversity, threats to biodiversity, biodiversity hotspots, importance and strategies for conservation of wildlife and sustainable development (6 hrs)

### Question paper pattern for external examination

[Module: 1 Short answer 2x2=4marks]

Module: 2 Short answer 3x2 = 6marks, Paragraph 3x5=15 marks; Essay1x10=10 marks

Module: 3 Short answer 3x2= 6 marks; Paragraph 3x5=15 marks; Essay1x10=10 marks

Module: 4 Short answer 4x2=8 marks, Paragraph 1x5=5marks]

### Section A: PROTISTA

#### MODULE 1. Kingdom Protista (2 hrs)

General characters.

Salient features of protozoans.

Phylum Dinoflagellata: e.g. Noctiluca

Phylum Ciliophora: e.g. Vorticella

Phylum Rhizopoda: e. g. Amoeba

Phylum Apicomplexa: e.g. Plasmodium (exclude life cycle)

[Short answers]

### Section B: Animal Diversity

#### MODULE 2: Animal diversity: Nonchordata - Part I (14 hrs)

Salient features of phyla, classification down to classes

(8 hrs)

Phylum Porifera: e.g. *Leucosolenia*

Phylum Coelenterata: e.g. *Obelia*, *Aurelia*, *Sea anemone*

Phylum Platyhelminthes: e.g. *Fasciola*, *Schistosoma*

Phylum Aschelminthes: e.g. *Ascaris*, *Enterobius*

Phylum Annelida: e.g. *Arenicola*, *Hirudinaria*, *Megascolex*

Phylum Arthropoda: e.g. *Limulus*, *Sacculina*, *Eupagurus*,

Phylum Onychophora: e.g. *Peripatus*

Phylum Mollusca: e.g. *Perna*, *Teredo*, *Sepia*, *Pinctada*

Phylum Echinodermata: e.g. *Asterias*, *Holothuria*, *Sea urchin*

Type: *Penaeus* sp. (Exclude details of larval stages)

(6 hrs)

[Short answers/Paragraphs/Essays]

### MODULE 3. Animal diversity: Chordata - Part II (14 hrs)

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Phylum Chordata: Salient features, Mention classes

(6 hrs)

Sub phylum Urochordata e.g. *Ascidia*

Subphylum Cephalochordata e.g. *Branchiostoma*

Subphylum Vertebrata:

Div I. Agnatha e.g. *Petromyzon*, *Myxine*

Div II: Gnathostomata

Super class: Pisces

Class: Chondrichthyes: e.g. *Narcine*

Class: Osteichthyes: e.g. *Echeneis*, *Hippocampus*, *Heteropneustes*,  
*Scomberomorus*, Pomfret

Super class: Tetrapoda

Class Amphibia: e.g. *Ichthyophis*, *Salamandra*, *Rhacophorus*,  
*Duttaphrynus*, Mention - *Nasikabatrachus*  
*sahyadrensis*

Class Reptilia: e.g. *Chamaeleo*, *Chelone*, *Naja*, *Bungarus*, *Daboia*

Class Aves e.g. *Columba*

Class Mammalia e.g. *Pteropus*

Type: *Oryctolagus cuniculus*

(8 hrs)

External features, skeletal system, digestive system, respiratory system, circulatory system, sense organs and nervous system. [Exclude skin, skull bones, arterial system, venous system, lymphatic system, autonomous nervous system and endocrine system].

[Short answers/Paragraphs/Essays]

### Section C: Conservation Biology

#### MODULE 4. Conservation Biology

(6 hrs)

- I. Biodiversity, Levels of biodiversity (brief), significance and uses of biodiversity, threats to biodiversity- (fragmentation, invasive species, over exploitation, poaching, climate change), extinction of species, concept of threatened species.
- II Biodiversity hot spots, brief notes on hot spots that include Indian region (Western Ghats and Sri Lanka, Indo Burma, Himalayas and Sundaland); endemism.
- III Wild life management and conservation- Importance of wild life, strategies of conservation (*Ex situ* and *In situ*), mention Protection Acts- The Wildlife Protection Act, 1972.
- IV Sustainable development (concept)
- V. Red Data Book, IUCN, WWF (Brief account)

[Short answers/Paragraphs]

#### Topics for Assignments/Seminars

(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Project Tiger
2. Project Elephant

3. Operation Rhino

4. Ramsar Sites

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## SECOND SEMESTER B.Sc. ZOOLOGY COMPLEMENTARY COURSE

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Theory Course- II

### ECONOMIC ZOOLOGY

Code: ZOL2C02T

[36 hrs] [2 hours/week] [3 credits]

#### COURSE OUTCOMES [COs]

COs	Course Outcome Statements
CO1	Explain parasitism and the major protist, cestode, trematode and nematode parasites of man and major insect vectors of human diseases and their control (11 hrs)
CO2	Understand major beneficial and harmful insects, damages caused to host plants and their control measures (14 hrs)
CO3	Understand pisciculture, prawn, mussel and pearl culture (11 hrs)

#### Question paper pattern for external examination

[Module 1 Short answer 4x2=8 marks, Paragraph 3x5=15 marks]

Module 2 Short answer 5x2 = 10 marks, Paragraph 2x5=10 marks; Essay 1x10=10 marks

Module 3 Short answer 3x2=6 marks; Paragraph 2x5=10 marks; Essay 1x10=10 marks]

#### MODULE 1: Parasitism in relation to man (11 hrs)

##### Introduction, classification of parasites and hosts

(2 hrs)

Obligatory, facultative, external, internal, hyperparasites. Definitive, intermediate, carrier and reserve hosts. Infection and infestation - Mention Hyper infection and Auto infection. Modes of infection - Inoculative, contaminative, direct and retroinfection, zoonotic diseases

##### Human Parasites

(5 hrs)

Parasitic Protists – *Plasmodium vivax*, *Entamoeba histolytica*

Cestodes – *Taenia solium*, mention *T. saginata* and *Echinococcus granulosus*

Trematodes (Flukes) – *Schistosoma haematobium*

Nematodes – *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Enterobius vermicularis*

##### Vectors of human diseases

(4 hrs)

Insect vectors of human diseases and their control. *Anophales*, *Culex*, *Aedes*, *Xenopsylla*, *Cimex*, *Pediculus* and *Phthirus* (Diseases like malaria, filariasis, yellow fever, typhus fever, dengue, plague, chikungunya, kala azar).

[Short answers/Paragraphs]

#### MODULE 2. Useful Insects, Insect Pests and their control (14 hrs)

##### Insect Pests

(9 hrs)

Definition of Pests, Kinds of Pests, Causes of pest outbreak.

Nature of damage to host plants and control measures of the following pests. (Exclude structure and Life history of Pests).

- Spodoptera* sp. (rice swarming caterpillar)
- Leptocorisa* sp. (rice bug)
- Rhynchophorus* sp. (red palm weevil)
- Opisina* sp. (Black headed caterpillar, mention biological control)
- Aceria* sp. (Coconut mite)
- Helopeltis* sp. (tea bug)
- Cosmopolites* sp. (Banana rhizome weevil)
- Bactrocera* sp. (Fruit fly)

- i) *Batocera* sp. (mango stem borer)  
 j) *Sitophilus* sp. (Rice weevil)

**Insect control (2 hrs)**

Basic principles of chemical control and biological control. Integrated Pest Management (IPM) (Brief notes).

**Useful Insects (3 hrs)**

Apiculture, Sericulture & Lac culture: Economic importance. Predatory insects, insect parasitoids.

*[Short answers/Paragraphs/Essays]*

**MODULE 3. Aquaculture and Fishery Biology (11 hrs)**

**Brief Introduction mentioning its scope in Kerala. (1 hr)**

**Pisciculture (5 hrs)**

Egg collection and hatching, induced spawning. Nursery ponds, manuring, feeding and harvesting, Ornamental fish farming (brief account). Mention common species. Fish utilization

**Prawn culture. (2 hrs)**

Breeding and spawning of prawns, seed collection and culture, types of prawn farms, mention common species.

**Mussel farming (2 hrs)**

Seed collection, artificial collection of seeds, induced spawning, rearing of larvae, farming methods and harvesting.

**Pearl Culture (1 hr)**

Preparation of nuclei, preparation of host and graft tissue, implantation and nursing.

*[Short answers/Paragraphs/Essays]*

**Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. *Callosobruchus chinensis* (Pulse beetle).
2. *Eomenacanthus stramineus* (Chicken louse).
3. *Hippobosca maculata* (house fly).
4. *Tabanus striatus* (horse fly).
5. *Pediculus humanus* (head louse)

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# THIRD SEMESTER B.Sc. ZOOLOGY COMPLEMENTARY COURSE

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Theory Course- III

## PHYSIOLOGY AND ETHOLOGY

Code: ZOL3C03T

[54 hrs] [3 hours/week] [2 credits]

### COURSE OUTCOMES [COs]

COs	Course Outcome Statements
CO1	Describe the structure of plasma membrane and the various trans-membrane transport mechanisms (3 hrs)
CO2	Enumerate the constituents of normal diet and the mechanism of digestion and absorption of carbohydrates, proteins and lipids and the regulation of gastrointestinal function (4 hrs)
CO3	Explain the mechanism of transport of respiratory gases, control of respiration, respiratory problems and artificial ventilation (6 hrs)
CO4	Explain the structure and working of human heart and mechanism of regulation of heart beat; constituents of human blood and blood transfusion and cardiovascular problems (7 hrs)
CO5	Illustrate the structure of human kidney, the mechanism of urine formation, hormonal control of kidney function and kidney disorders; osmoregulation and urea cycle (6 hrs)
CO6	Enumerate the structure of myofibrils and myofilaments; muscle contractile and regulatory proteins and mechanism of muscle contraction (7 hrs)
CO7	Explain different types of nerve cells and glial cells, maintenance of resting membrane potential, generation and propagation of action potential and synaptic transmission (7 hrs)
CO8	Describe innate behavior, learned behavior, patterns of behavior and factors that affect behavior (8 hrs)
CO9	Enumerate biological rhythms, communication in animals and social organization in mammals (6 hrs)

### Question paper pattern for external examination

[Module 1-7 Short answer 9x2=18 marks, Paragraph 6x5=30 marks, Essay 1x10=10 marks  
Module 8-9 Short answer 3x2 = 6 marks, Paragraph 1x5=5 marks; Essay 1x10=10 marks]

### Section A. PHYSIOLOGY (40 hrs)

#### MODULE 1. Trans-membrane transport mechanisms (3 hrs)

Structure of Plasma membrane. Fluid mosaic model. Trans-membrane transport - passive & active mechanisms, vesicular transport

[Short answers/Paragraphs]

#### MODULE 2. Nutrition (4 hrs)

Constituents of normal diet. Digestion of carbohydrates, proteins and lipids. Absorption of nutrients (brief account). Brief account on the neural and hormonal control of gastrointestinal function. BMR and obesity

[Short answers/Paragraphs]

#### MODULE 3. Respiration (6 hrs)

Gaseous exchange and transport. Respiratory pigment – haemoglobin – properties. Control of respiration – neural & chemical (brief account). Respiratory problems - hypoxia, asphyxia, CO poisoning. Respiratory problem of high altitudes. Physiological adaptive mechanisms of diving mammals. Artificial ventilation; heart lung machine.

[Short answers/Paragraphs/Essays]

#### **MODULE 4. Body fluids and circulation (7 hrs)**

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Constituents of human blood. Agglutination, coagulation of blood and haemostasis. Haemolysis. Blood transfusion (short notes). Brief account on the structure and working of human heart. Pacemaker and conducting system of heart. Cardiac cycle and regulation of heart beat. Blood pressure and pulse. Cardiovascular problems (brief account) - arteriosclerosis and atherosclerosis, myocardial infarction, hypertension and thrombosis.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 5. Osmoregulation and Excretion (6 hrs)**

Osmoconformers and osmoregulators. Water retention and conservation in desert animals. Urea cycle. Ammonotelism, ureotelism and uricotelism. Hormonal control of kidney function. Kidney disorders, renal hypertension, nephritis and renal failure. Dialysis and kidney transplantation (short notes)

*[Short answers/Paragraphs/Essays]*

#### **MODULE 6. Muscle Physiology (7 hrs)**

EM structure of myofibrils and myofilament. Muscle - contractile proteins and major regulatory proteins. Chemistry and mechanism of muscle contraction. Energy for muscle contraction. Muscle twitch and muscle tetanus, isometric and isotonic contraction. All-or-none law and summation of stimuli. Muscle fatigue and rigor mortis.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 7. Nerve physiology (7 hrs)**

Mention different types of nerve cells and glial cells. Maintenance of resting membrane potential; generation and propagation of action potential. Threshold stimulus, all or none response. Synapse, types of synapses, synaptic transmission and neurotransmitters.

*[Short answers/Paragraphs/Essays]*

### **Section B. ETHOLOGY (14 hrs)**

#### **MODULE 8. Behaviour (8 hrs)**

##### **Innate behaviour**

Orientation, taxes and kinesis, simple reflexes and instincts, drive and motivation

##### **Learned behaviour**

Habituation, conditioned reflex, trial and error learning, latent learning, imprinting, insight learning

##### **Patterns of behaviour**

Habitat selection, sexual selection, co-operation, territoriality, aggression, courtship and agonistic behaviour.

##### **Proximate factors**

Neurological basis of behaviour, mention hormonal, biochemical, environmental and genetic factors that influence behaviour.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 9: Biological clocks/rhythms (6 hrs)**

Photoperiod, circadian rhythm, migration, navigation and homing instinct, diapause, hibernation and aestivation. Communication in animals. Social organization in mammals – Elephant as example

*[Short answers/Paragraphs/Essays]*

### Topics for Assignments/Seminars

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Role of enzymes in digestion of Carbohydrates, proteins and lipids.
2. Absorption of carbohydrates, proteins, and lipids.
3. Problems of Alcoholism
4. Common renal problems - Renal hypertension, nephritis, renal failure, edema, acidosis, uremia, haematuria and calculi.
5. Minamata disease

### REFERENCES

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- Chatterjee, C.C. (2016) *Human Physiology*, 11<sup>th</sup> Edition, ISBN 10: 8123928726, Medical Allied Agency.
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- Kim E. Barret, Susan M. Barman, Scott Boittano and Heddwen L Brooks (2016) *Ganong's Review of Medical Physiology*, 25<sup>th</sup> Edition, ISBN-10: 9789339223281, McGraw Hill Education
- Mark Ridley (1995) *Animal Behaviour: An Introduction to Behavioural Mechanisms, Development and Ecology*, 2<sup>nd</sup> Edition, ISBN-10: 0865423903, Wiley Blackwell, 296 pages
- Purohit, S.S. and Rajiv Ranjan (2009) *Ecology, Environment and Pollution*, ISBN 10: 8177541692, Agrobios.
- Rastogi, S.C. (2019) *Essentials of Animal Physiology*, 4<sup>th</sup> Edition, ISBN-10: 8122420141, New Age International, 596 pages
- Reena Mather (2016) *Animal Behaviour*, ISBN-13-9789350780480, Rastogi Pub.

## FOURTH SEMESTER B.Sc. ZOOLOGY COMPLEMENTARY COURSE

PDF Compressor Free Version

Theory Course- IV

### GENETICS AND IMMUNOLOGY

Code: ZOL4C04T

[54 hrs] [3 hours/week] [2 credits]

#### COURSE OUTCOMES [COs]

COs	Course Outcome statements
CO1	Describe human karyotype , chromosomal anomalies and polygenic inheritance (6 hrs)
CO2	Explain the mechanisms of sex determination (4 hrs)
CO3	Enumerate the concept of genes, gene expression, genetic code, transcription and translation (8 hrs)
CO4	Illustrate the mechanism of recombinant DNA technology and its practical applications (13 hrs)
CO5	Explain the types of cancer, causes of transformation and characteristics of transformed cells (5 hrs)
CO6	Identify the cells and organs of immune system, antigens and antibodies (7 hrs)
CO7	Enumerate antigen-antibody interaction, generation of B-cell and T-cell response and major immunotechniques (7 hrs)
CO8	Explain primary and secondary immunodeficiency diseases, autoimmune diseases, vaccination and vaccines (4 hrs)

#### Question paper pattern for external examination

[Module 1-5 Short answer 8x2=16 marks, Paragraph 5x5=25 marks, Essay 1x10=10 marks  
Module 6-8 Short answer 4x4= 8 marks, Paragraph 2x5=10 marks; Essay 1x10=10 marks]

### Section A: GENETICS (36 hrs)

#### MODULE 1. Human Genetics (6 hrs)

Normal human karyotype: Classification and grouping of human chromosomes (Patau's & Denver schemes). Chromosomal anomalies and disorders (short note only). Autosomal anomalies: Phenyl ketonuria & Sickle cell anemia. X-linked – Haemophilia and Colour blindness. Y-linked – Y-Chromosome infertility. Polygenic inheritance - Cleft palate or Cleft lip and diabetes mellitus. Prenatal diagnosis. Genetic counselling. Eugenics, Euthenics and Euphenics.

*[Short answers/Paragraphs/Essays]*

#### MODULE 2. Genetic Control of Sex (4 hrs)

Autosomes and sex chromosomes: Mention Barr body and its significance. Chromosomal mechanism of sex determination: genic balance theory. Control of sex; hormonal influence of sex determination; sex mosaics; gynandromorphism

*[Short answers/Paragraphs]*

#### MODULE 3. Genes and gene expression (8 hrs)

Modern concept of genes, split genes, pseudogenes, overlapping genes and transposons. Gene expression. Genetic code, transcription and translation (brief account)

*[Short answers/Paragraphs/Essays]*

#### **MODULE 4. Genetic Engineering (13 hrs)**

Brief account of recombinant DNA technology – role of enzymes (restriction endonucleases, exonucleases, DNA polymerase, DNA ligase, reverse transcriptase, alkaline phosphatase, polynucleotide kinase and terminal transferase). Cloning vectors – plasmid vectors (mention pBR322), phage vectors, cosmids, viruses and YAC vector. Construction of recombinant DNA (preparation of vector DNA and donor DNA, joining of vector and donor DNAs, introduction of recombinant DNA into the host cell and selection of transformants). Methods of gene transfer. Practical applications, advantages and potential hazards.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 5. Cytogenetics of Cancer (5 hrs)**

Types of cancer: brief account of sarcomas, carcinomas, melanomas, leukemia, lymphomas and blastomas. Characteristics of cancer cells: uncontrolled multiplication, loss of contact inhibition, metastasis, reduced cellular adhesion, metaplasia, invasiveness, growth factor secretion, cell surface alterations, alterations in transcriptome and proteome and protease secretion. Origin of Cancer: Carcinogens, oncogenic viruses, polygenic basis, hereditary predisposition to cancer

*[Short answers/Paragraphs]*

#### **Section B: IMMUNOLOGY (18 hrs)**

(Brief account of the following topics)

#### **MODULE 6. Cells and organs of immune system, antigens and antibodies (7 hrs)**

##### **Cells and organs of immune system**

Innate and adaptive immunity. Cells of immune system- B cell, T cell, NK cell and Antigen Presenting Cells (dendritic cells, macrophage cells). Organs of the immune system- Primary lymphoid Organs (Thymus, Bone Marrow), Secondary lymphoid Organs (Spleen, lymph node, MALT)

##### **Antigens**

Antigenicity, Immunogenicity and Haptens. Factors influencing immunogenicity. Mention human immunoglobulin gene families –  $\lambda$  and  $\kappa$  light chain families and heavy chain family and major histocompatibility complex (MHC) group of genes.

##### **Antibodies**

Structure, different classes and Function. Monoclonal antibodies-Hybridoma technology and applications.

*[Short answers/Paragraphs/Essays]*

#### **MODULE 7. Antigen-Antibody interaction & Generation of B-cell and T-cell response (7 hrs)**

##### **Antigen - antibody interaction**

Strength of Antigen-Antibody interaction. Cross reactivity, Precipitation reactions, and Agglutination reactions. Immunotechniques – Detection of biomolecules using ELISA, RIA, and Western blot. Southern blot, Northern blot and DNA Fingerprinting (Brief)

**Generation of B cell and T-cell response:**

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Humoral and cell-mediated response. Properties of B-cell and T-cell- epitopes. Activation and differentiation of B and T cells. Cytokines- brief

*[Short answers/Paragraphs]*

**MODULE 8. Immunodeficiency diseases, vaccines & vaccination (4 hrs)****Immunodeficiency diseases**

Primary (Bruton's disease, Di-George syndrome & SCID). Secondary types: AIDS- Mention Acute, Chronic and Crisis phase, Window period. Autoimmune disease- Mention Hashimoto's thyroiditis, Grave's disease, Myasthenia gravis and Systemic Lupus Erythematosus.

**Vaccines and Vaccination**

Principle of vaccination; mention Attenuated vaccines, Inactivated vaccines, Toxoid vaccines and DNA vaccines.

*[Short answers/Paragraphs/Essays]*

**Topics for Assignments/Seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Human genome
2. DNA tumor viruses
3. Human genome project
4. Structure of immunoglobulins and T-cell receptors

**REFERENCES**

- Darla J. Wise (2002) *Immunology, A Comprehensive Review*, 8<sup>th</sup> Edition, ASIN: B000RG1FTW, Blackwel, 182 pages
- Eldon John Gardner, Michael J. Simmons and Peter Snustad (1991) *Principles of Genetics*, 8<sup>th</sup> Edn, ISBN-10: 0471533971, Wiley, 714 pages
- Gangane, S.D (2012) *Human Genetics*, 2<sup>nd</sup> Edition, ISBN-10: 8131230228, Elsevier, 312 pages
- Ivan Roitt (1994): *Essential Immunology*, 8<sup>th</sup> Edition, ISBN-10: 0632033134, Blackwell Science, 456 pages
- Jenni Punt, Sharon Stranford, Patricia Jones and Judith A Owen (2018) *Kuby Immunology*, 8<sup>th</sup> Edition, ISBN-10: 1319114709, W.H. Freeman, 944 pages
- Jogchand, S.N.(2016) *Gene Biotechnology*, ISBN-978-93-5262-087-6, Himalaya Publishing House, 447 pages
- John Playfair and Gregory Bancroft (2014) *Infection and Immunity*, 4<sup>th</sup> Edition, ISBN: 9780199609505, OUP., 400 pages
- Mange, E.J. & Mange, A.P. (1999) *Basic Human Genetics*, Rastogi Pubs.
- Peter D. Snustad (2015) *Principles of Genetics*, 7<sup>th</sup> Edition, ISBN-10: 1119142288, Wiley, 627 pages
- Ricki, L.(2014) *Human Genetics: Concepts and Application*, 11<sup>th</sup> Edition, ISBN-10: 0076701654, McGraw Hill Education, 480 pages
- Scot F. Gilbert (2013) *Developmental Biology*, 10<sup>th</sup> Edition, ISBN-10: 0878939784, Sinauer Associates, 750 pages
- Twyman R M. (2001) *Instant notes in Developmental Biology*, Viva Books, 421 pages

**B.Sc. ZOOLOGY COMPLEMENTARY COURSE**  
**PRACTICAL**

Code: ZOL4C05P

**[Practical I\*A+I\*B+I\*C+I\*D] [4 Credits]**

**COURSE OUTCOMES [COs]**

COs	Course Outcome statement
CO1	Identify the salient features of the phylum; taxonomic position, habit, habitat, adaptations/importance of selected protists, non-chordates and chordates (36 hrs)
CO2	Describe major human parasites and economically important insects, molluscs and fishes (36 hrs)
CO3	Perform detection of human blood groups and prepare human blood smear as per laboratory standards; mounting of specialized organs of selected non-chordates and chordates, and demonstrate the presence of biomolecules in samples by standard laboratory protocols (36 hrs)
CO4	Illustrate the normal and selected abnormal human karyotypes and mode of inheritance of selected human genetic disorders and perform the dissection of earthworm and sardine to demonstrate the alimentary canal and <i>Penaeus</i> to demonstrate the nervous system (36 hrs)

**FIRST SEMESTER COMPLEMENTARY COURSE [PRACTICAL I \*A]  
[36 hrs] [2 hrs/week]**

**A. Animal Diversity**

- Phylum Dinoflagellata : *Noctiluca*  
 Ciliophora : *Vorticella*  
 Porifera : *Leucosolenia*  
 Coelenterata : *Obelia, Physalia, Rhizostoma* (Any 2).  
 Platyhelminthes : *Fasciola*  
 Aschelminthes : *Ascaris*  
 Annelida : *Chaetopterus / Arenicola, Hirudinaria*.  
 Arthropoda : *Eupagurus, Belostoma, Limulus, Sacculina* (Any 3).  
 Onychophora : *Peripatus*  
 Mollusca : *Chiton, Sepia/ Loligo, Octopus* (Any 2)  
 Echinodermata : *Asterias, Holothuria*.
- Chordata  
 Prochordates : *Ascidia/ Branchiostoma*.  
 Cyclostomata : *Petromyzon*.  
 Superclass: Pisces : *Narcine, Echineis, Hippocampus, Heteropneustes, Anguilla, Pomfret* (Any 3)  
 Class Amphibia : *Ichthyophis, Axolotl larva, Rhacophorus* (Any 2)  
 Class Reptilia : *Chamaeleo, Daboia, Bungarus*  
 Class Aves : *Columba*  
 Class Mammalia : *Pteropus* or any other Bat.

**B. Histology:** Study of the T.S. of *Hydra*, *Ascaris*, Earth worm (through typhlosolic region).

**C. Osteology:** Dentition (Rabbit), Pectoral and Pelvic girdles, typical vertebra

## REFERENCES

### PDF Compressor Free Version

- Jordan E. L. and P S Verma (2013) *Chordate Zoology*, 14<sup>th</sup> Edition, ISBN-10: 8121916399, S. Chand Publishres, 1076 pages
- Jordan E. L. and P S Verma (2009) *Invertebrate Zoology*, 15<sup>th</sup> Edition, ISBN-10: 9788121903677, S. Chand Publishres
- Jayasurya; N.C. Nair; N. Soundara Pandian; N. Arumugam; S. Leelavathy and T. Murugan: *Saras Practical Zoology Vol.1: Invertebrata*; ISBN : 9789382459231, Saras Publication, 424 pages
- Ghose K. C. and B. Manna (2007) *Practical Zoology*, ISBN-8173811822, New Central Book Agency 481 pages
- S.S. Lal (2016) *Practical Zoology INVERTEBRATE*, ISBN-10: 9350780089, Rastogi Publications
- R.L. Kotpal R. L. (2014) *Modern Text Book of Zoology: Invertebrates*, ISBN-10: 9350780402, Rastogi Publications
- Verma P S (2010) *A Manual of Practical Zoology Invertebrates*, ISBN-10: 8121908299, S. Chand Publishers

## SECOND SEMESTER COMPLEMENTARY COURSE [PRACTICAL I \*B]

[36 hrs] [2 hrs/week]

### Study of the following items

#### Parasites

*Entamoeba*, *Plasmodium*, *Schistosoma*, *Taenia*, *Ancylostoma*, *Enterobius*, *Wuchereria*, *Hirudinaria*, *Cimex* (Any 5).

#### Insect pests

*Spodoptera*, *Leptocorisa*, *Oryctes*, *Rhynchophorus*, *Opisina*; *Batocera*, Termite, *Sitophilus* (Any 5).

#### Useful insects

*Apis* (worker), *Bombyx* female (any one)

#### Ornamental fishes

*Poecilia reticulata* (guppy), *Poecilia sphenops* (Black molly), *Carassius auratus* (Gold fish), *Puntius denisonii*, *Pterophyllum scalare* (Angel fish), *Colisa* sp. (Gaurami), *Betta* sp. (Fighting fish), *Danio malabaricus* (Giant Danio) (Any three)

#### Culture fishes

*Catla catla* (Catla), *Labeo rohita* (Rohu), *Cirrhinus mrigala* (Mrigal), *Ctenopharyngodon idellus* (Grass Carp) (Any three)

#### Economically important items

*Perna*, *Pinctada*, *Teredo*, *Loligo*, *Penaeus*, *Scoliodon*, *Sardinella*, *Rastrelliger*, *Cybbium* (Any 5).

## REFERENCES

- Dhaliwal G.S., Ram Singh and Chhillar B.S. (2014) *Elements of Agricultural Entomology*, ISBN-10: 8127226300, Kalyani Publishers
- John O Donel Alexander (1984) *Arthropods and Human Skin*, ISBN 978-1-4471-1356-0, Springer.
- 'Living Jewels': A hand book on freshwater ornamental fish, The Marine Products Export Development Authority, Ministry of Commerce & Industry, Govt. of India.
- "Commercial Fin Fishes and Shell Fishes of India", The Marine Products Export Development Authority, Ministry of Commerce & Industry, Govt. of India.

**THIRD SEMESTER COMPLEMENTARY COURSE [PRACTICAL I \*C]**  
**PDF Compressor Free Version**  
**[36 hrs] [2 hrs/week]**

**Section A: Physiology**

1. Blood smear preparation and study of RBC and different types of WBCs.
2. Human blood grouping – ABO and Rh systems.
3. Detection of monosaccharides, polysaccharides, proteins & lipids.

**Section B: Mounting**

1. Earth worm: Setae in situ (minor), Spermatheca (minor)
2. *Penaeus*: Appendages (minor)
3. Cockroach: Salivary apparatus (major).
4. Honeybee: Mouth parts (minor).
5. Shark: Placoid scales (minor).

**REFERENCES**

- Jayasurya; N.C. Nair; N. Soundara Pandian; N. Arumugam; S. Leelavathy and T. Murugan: *Saras Practical Zoology Vol.1: Invertebrata*; ISBN : 9789382459231, Saras Publication, 424 pages
- K.C. Ghose and B. Manna (2007) *Practical Zoology*, ISBN-8173811822, New Central Book Agency 481 pages
- S.S. Lal (2016) *Practical Zoology Invertebrate*, ISBN-10: 9350780089, Rastogi Publications
- Stuart Ira (2013) *Human Physiology Laboratory manual*, 13<sup>th</sup> Edition, ASIN: B00E6TJHAK, Mc Graw Hill Education
- William Lutterschmidt and Deborah Lutterschmidt (2008) *Laboratory Exercises in Human Physiology*, 2<sup>nd</sup> Edition, ISBN-10: 0077229738, Mc Graw Hill, 256 pages

**FOURTH SEMESTER COMPLEMENTARY COURSE [PRACTICAL I \*D]**  
**[36 hrs] [2 hrs/week]**

**Section A: Dissections**

Earthworm: Alimentary canal upto 25<sup>th</sup> segment (minor)  
*Penaeus*: Nervous system (major)  
*Sardinella*: Alimentary canal (major)

**Section B: Genetics**

Study of the following (use slides/ models / charts / photographs)

1. Study of sex linked inheritance (haemophilia, sickle cell anaemia, color blindness)
2. Study of normal human karyotype (male and female) and abnormal karyotypes – Down's syndrome, Klinefelter's syndrome, Turners syndrome, Edwards syndrome ( Any two)

**REFERENCES**

- Jayasurya; N.C. Nair; N. Soundara Pandian; N. Arumugam; S. Leelavathy and T. Murugan: *Saras Practical Zoology Vol.1: Invertebrata*; ISBN : 9789382459231, Saras Publication, 424 pages
- Jayesh Sheth and Frenny Sheth (2014) *Genetics in Clinical Practice*, 1<sup>st</sup> Edition, ISBN-10: 9351521532, Jaypee Brothers
- K. C. Ghose and B. Manna (2015) *Practical Zoology*, ISBN-10: 8173819505, New Central Book Agency, 642 pages

- Robin L. Bennett (2010) *The Practical Guide to the Genetic Family History*, 2nd Edition, ISBN-10: 0470040726, Wiley Blackwell, 384 pages
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- S.S. Lal (2016) *Practical Zoology INVERTEBRATE*, ISBN-10: 9350780089, Rastogi Publications

## **MODEL QUESTION PAPERS**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**FIRST SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL1B01 - ANIMAL DIVERSITY: NON-CHORDATA PART- I**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is cladistics?
2. Explain molecular systematics.
3. Enumerate the eight kingdom classification.
4. What are protostomes? Give examples.
5. Explain mutualism with reference to *Trychonympha*.
6. Describe the characteristic features of *Rhopalura*.
7. What is gemmule? Mention its significance.
8. What are comb jellies?
9. Comment on measly pork.
10. Write a short account on the salient features of Phylum Gastrotricha.
11. What is wheel organ?
12. Differentiate between filariasis and elephantiasis.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Write a note on International Code of Zoological Nomenclature.
14. Describe the types and mechanisms of coelome formation.
15. Explain the various systems of nomenclature.
16. Write a brief account on the canal system in sponges.
17. Explain metagenesis with reference to *Obelia*
18. With a labeled diagram explain the digestive system of *Dugesia*.
19. Explain the salient features of Nematodes.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the process of conjugation in *Paramecium*.
21. Write an essay on polymorphism in Cnidarians.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**SECOND SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL2B02- ANIMAL DIVERSITY: NON-CHORDATA PART – II**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Comment on heteronereis
2. What is parasitic castration?
3. Write an account on Trilobites.
4. Explain the features of trochophore larva.
5. Write a note on the peculiarities of *Troides minos*.
6. Comment on Malabar Banded Peacock.
7. Write the branchial formula of *Penaeus indicus*.
8. What is osphradium? Mention its function.
9. Discuss the salient features of Phylum Phoronida.
10. Explain the peculiarities of *Bonellia*.
11. Write a note on the salient features of Ectoprocta.
12. What is evisceration?

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Explain the respiratory system of *Pila globosa*.
14. Write a note on the salient features of class Clitellata
15. Explain the salient features of class Merostomata with a suitable example.
16. Describe the digestive system of *Neanthes*.
17. Write an account on the affinities of *Peripatus*.
18. Explain the salient features of Cephalopoda with a suitable example.
19. Describe the affinities of *Balanoglossus*.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Write an essay on the appendages of *Penaeus indicus*.
21. With a suitable diagram describe the water vascular system of starfish.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL3B03 - ANIMAL DIVERSITY: CHORDATA PART - I**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Explain retrogressive metamorphosis.
2. What is paedogenesis?
3. Describe the structure of pharynx of *Ascidia*.
4. Explain the classification of Phylum Chordata down to classes.
5. Write the salient features of Agnatha.
6. Explain the peculiarities of Ammocoetes larva.
7. Illustrate the distribution of lung fishes.
8. Comment on the 9<sup>th</sup> vertebra of Frog.
9. What is neurotoxic snake venom? Give an example.
10. Describe the distribution of sphenodon.
11. Write a note on synapsida.
12. Give the scientific name of any four venomous snakes of Kerala.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Give an account on urinogenital system of Mullet.
14. Write an account on *Latimeria*.
15. Describe the respiratory system of *Hoplobatrachus tigerinus*.
16. Explain the affinity of Urochordates with Cephalochordates and Vertebrates.
17. Give an account on the morphology of *Amphioxus*.
18. Write the identification key for venomous and non-venomous snakes.
19. Distinguish between Osteichthyes and Chondrichthyes.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Give an account on the Arterial system of *Calotes*.
21. Write the salient features of class Amphibia and classify down to order, giving specific features with examples.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**FOURTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL4B04 - ANIMAL DIVERSITY: CHORDATA PART-II**

**Time: Two Hours**  
**Marks**

**Maximum: 60**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. List out the characteristic features of Order *Monotremata*.
2. What is synsacrum? Comment on its composition.
3. Comment on *Cursorius bitorquatus*
4. What is a brood parasite?
5. Write an account on any two extinct birds.
6. Briefly explain the salient features of super order Paleognathae.
7. What is dental formula? Write the dental formula of *Oryctolagus cuniculus*.
8. What is coprophagy?
9. Write an account on Golden Mole of South Africa.
10. Distinguish between an Indian and an African elephant.
11. What is metanephric kidney?
12. Write an account on meninges?

**(Ceiling: 20**

**marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Explain the respiratory system of *Columba livia*.
14. Write a note on the evolutionary significance of *Archaeopteryx lithographica*.
15. With a labeled diagram explain the pelvic girdle of *Oryctolagus cuniculus*.
16. Write notes on the adaptations of Chiropterans.
17. Discuss the peculiarities of Order *Marsupialia*.
18. Explain the salient features of Order *Cetacea* with examples.
19. Compare the circulatory systems of Class Amphibia and Reptilia.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the flight adaptations of birds.
21. Describe the digestive system of *Oryctolagus cuniculus*.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
ZOL5B06T – **CELL BIOLOGY AND GENETICS**

**Time: 2.5 Hrs**

**Maximum: 80 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is camera lucida? Mention its use.
2. Write a note on apoptosis.
3. Explain the significance of membrane fluidity.
4. Write a note on the structural organization of microtubules.
5. Explain the concept of GERL.
6. Describe the biogenesis of mitochondria.
7. How will you demonstrate the presence of proteins in tissue sections?
8. What are modifying genes? Give an example.
9. Write a note on disorders of sexual development.
10. Explain dosage compensation.
11. Write a short note on chromosomal mutations.
12. Explain sex chromosomal mutations with suitable examples.
13. What is gynandromorphism?
14. Comment on eugenics?
15. Explain environmental influence on sex determination with a suitable example.

**(Ceiling: 25 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

16. Describe the principle and applications of electron microscope.
17. Explain the structural organization of chromatin.
18. You are provided with a tissue sample. How will you process it for light microscopy.
19. Describe polygenic inheritance with a suitable example.
20. Explain incomplete linkage with an example.
21. What are gene mutations? Comment on different types of gene mutations.
22. Explain the Patau's scheme of classification of human chromosomes.
23. Illustrate the modifications of plasma membrane.

**(Ceiling: 35 marks)**

**Section C**

**III. Essay questions. Answer any two questions**

24. Explain meiosis with the help of labelled diagrams.
25. Describe the various mechanisms of sex determination.
26. Write an essay on trans-membrane transport.
27. Explain multiple allelism with a suitable example.

**(2x10 = 20 marks)**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL5B07T – BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY**

**Time: 2.5 Hrs**

**Maximum: 80 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Explain the structure of Yeast Artificial Chromosome.
2. Comment on knockout mice.
3. What are molecular markers? Mention their applications.
4. Write an account on viral vaccines.
5. What is Gram staining? Mention its application.
6. Comment on different types of bacterial culture.
7. Write a note on various types of oncogenic viruses.
8. Comment on interferons.
9. Write a note on the normal microflora of the human body.
10. What are adjuvants? Explain Freund's adjuvant.
11. Comment on cytokines.
12. Explain autoimmune disease with an example.
13. What are transplantation antigens? Mention their role in graft rejection.
14. Write a note on immune response to tumor antigens.
15. Differentiate between primary and secondary immunodeficiency diseases.

**(Ceiling: 25 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

16. Explain the steps in the production of monoclonal antibodies.
17. Write an account on the various methods of transfection.
18. Comment on the various methods of sterilization.
19. Differentiate between lysogenic and lytic phages.
20. Write an account on various culture preservation techniques.
21. Add notes on primary organs of the immune system.
22. What is immunization? Add notes on various vaccines.
23. With the help of a labeled diagram explain the structure of HIV.

**(Ceiling: 35 marks)**

**Section C**

**III. Essay questions. Answer any two questions.**

24. Explain the various steps in the construction of recombinant DNA.
25. Give a brief account on the structure of immunoglobulin and mention its classification.
26. Write an essay on the applications of biotechnology.
27. Explain the industrial applications of microorganisms.

**(2x10 = 20 marks)**

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**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
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Zoology: Core course  
ZOL5B08T – **BIOCHEMISTRY AND MOLECULAR BIOLOGY**

**Time: 2.5 Hrs**

**Maximum: 80 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Write a short note on Hydrogen bonding.
2. What are glycosidic bonds?
3. Enumerate the biological functions of carbohydrates.
4. What are peptide bonds?
5. Explain the clinical significance of lipid profile estimation.
6. Differentiate between glycogenesis and gluconeogenesis.
7. Explain oxidative phosphorylation.
8. Illustrate the central dogma.
9. Explain gene concept.
10. Describe the role of tRNA in translation.
11. What are amino acyl tRNA synthetases? Mention their function.
12. Write an account on the active centers of ribosomes.
13. Explain RNA interference.
14. What is c-value paradox?
15. Explain transduction.

**(Ceiling: 25 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

16. Give an outline classification of carbohydrates.
17. Write an account on the classification of enzymes.
18. Explain the  $\beta$  oxidation of fatty acids.
19. Write a note on amino acid oxidation.
20. Explain the properties of genetic code.
21. Write a note on the post translational modification of the peptide chain.
22. Explain the positive control of *trp* operon.
23. Briefly explain the life cycle of a temperate phage.

**(Ceiling: 35 marks)**

**Section C**

**III. Essay questions. Answer any two questions.**

24. Write an essay on the hierarchical levels of protein structure.
25. Describe the Watson – Crick model of DNA.
26. Explain the mechanism of replication of DNA.
27. Write an essay on the post transcriptional processing of hnRNA

**(2x10 = 20 marks)**

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**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)

Zoology: Core course

ZOL5B09T – **METHODOLOGY IN SCIENCE, BIOSTATISTICS AND BIOINFORMATICS**  
**Time: 2.5 Hrs** **Maximum: 80 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Give a short account on Gen Bank.
2. Expand the abbreviations of (1) BLAST & (2) FASTA.
3. What is the principle behind microarray?
4. Define metabolomics.
5. Distinguish cladistics and ontogeny.
6. What is Empiricism?
7. Differentiate auxiliary and adhoc hypothesis.
8. What is virtual testing? Comment on its importance in experiments.
9. Write notes on primary depository of scientific information.
10. Comment on Plagiarism.
11. Differentiate between primary and secondary data.
12. What are the different types of kurtosis?
13. Differentiate between census and sampling.
14. Define standard deviation.
15. Explain the advantages and disadvantages of standard deviation.

(Ceiling: 25 marks)

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

16. Give an account on Database Search Engines.
17. Explain briefly about types of sequence alignment.
18. What is phylogenetics? Give account on phylogenetic tree construction methods.
19. Discuss in detail about Sanger's method of DNA sequencing.
20. Explain various thought process in developing hypothesis.
21. Write notes on prevention of cruelty to animal act.
22. The average marks secured by 40 students were found to be 100. It was later found that one figure was wrongly read as 59 instead of the correct value of 67. Find the correct mean of marks?
23. Calculate Mean and SE of the following data.

Marks x	10-20	20-30	30-40	40-50	50-60	60-70	70-80
F	3	5	6	7	3	2	1

(Ceiling: 35 marks)

**Section C**

**III. Essay questions. Answer any two questions.**

24. Write an essay on Biological databases, highlighting any three biological databases.
25. Discuss in detail about principle and procedure involved in proteomics. What is protein-protein interaction mapping?
26. Give an account on principles and procedure of designing an experiment.
27. Certain manure was used on four plots of land A, B, C and D.  
The output of the crop in the beds of plots A, B, C and D is given below. Check the difference in crop production by using ANOVA.

(2x10 = 20 marks)

A	B	C	D
6	15	9	8
8	10	3	12
10	4	7	1
8	7	1	3

MODEL QUESTION PAPER  
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**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology-Open Course  
**ZOL5D01- REPRODUCTIVE HEALTH AND SEX EDUCATION**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is Barr body? Mention its significance.
2. What is Turner's syndrome? Explain.
3. What is spermatogenesis?
4. What are the accessory structures of Male reproductive system?
5. Differentiate GIFT and ZIFT.
6. Distinguish between Vasectomy and Tubectomy.
7. What is POSCO Act 2012?
8. Write a note on Gonorrhea? How it is transmitted?
9. Briefly explain sexual hygiene.
10. What is Gender discrimination?
11. Comment on Trichomonal vaginitis?
12. Give the symptoms of Syphilis.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Discuss various sex determination mechanisms in animals.
14. Explain spermatogenesis.
15. With the help of a neatly labeled diagram explain the structure of Graafian follicle.
16. What is prenatal diagnosis? Briefly describe amniocentesis and chorionic villus sampling.
17. Briefly describe the various fertility control methods.
18. Explain how to maintain healthy relationship with opposite sex.
19. Discuss the causes, symptoms, transmission and diagnosis of AIDS.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Discuss the various technologies used to solve infertility problems.
21. Explain menstrual cycle and its hormonal control in human.

**(1x10=10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Open course  
ZOL5D02T - **NUTRITION, HEALTH AND HYGIENE**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Differentiate between arteriosclerosis and atherosclerosis.
2. What is haemotoxic venom? Give examples.
3. Give an outline classification of nutrients.
4. Comment on factors affecting food selection.
5. Explain protein energy malnutrition with a suitable example.
6. Differentiate between saturated and unsaturated fatty acids.
7. What are essential amino acids? Give examples.
8. Explain the physiological roles of dietary minerals.
9. Explain balanced diet. Mention its significance.
10. Describe the physiological effects of alcohol abuse.
11. What is hygiene? Explain different types of hygiene.
12. Explain the relation between food, nutrients and health.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. What is BMR? Mention the factors affecting it.
14. Write a note on metabolism of carbohydrates.
15. Explain the physiological roles of vitamins.
16. Write a short note on meal planning and its significance.
17. Describe the dietary management of peptic ulcer and diarrhea.
18. Write an account on STDs with suitable examples
19. Explain the first aid for road accidents and drowning.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Write an essay on the mechanism of digestion of carbohydrates, proteins and fats.
21. Give a short account on various communicable bacterial, viral and protozoan diseases of man.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Open course  
ZOL5D03T – **APPLIED ZOOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Write a note on *Leptocorisa acuta*.
2. Review sandflies as vectors of human diseases.
3. Comment on *Sitophilus oryzae*.
4. Give an account on honey bee products.
5. Comment on the nutritive value of eggs.
6. Explain commensalism with a suitable example.
7. What is kala azar?
8. Write a short note on cycle of Ross.
9. What is foot and mouth disease?
10. Write a note on Indian breeds of cattle.
11. Give an account on embryo transfer technology.
12. What is vermiwash? Mention its significance.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Discuss mosquitoes as vectors of human diseases.
14. Write an account on the nature of damage caused and control measures of *Rhynchophorus ferrugineus*.
15. Write a note on rearing of *Bombyx mori* and the mechanism of extraction of silk.
16. Explain the various steps in pearl culture.
17. Describe the various breeds of fowl.
18. Discuss *Entamoeba histolytica* as a human parasite.
19. Explain the life history of *Taenia solium*.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Write an essay on various methods of insect pest management.
21. Describe the methods in lac culture. Add a note on economics of lac products.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
ZOL6B10- **PHYSIOLOGY AND ENDOCRINOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is balanced diet?
2. Distinguish between neurogenic and myogenic heart.
3. Differentiate osmoconformers and osmoregulators.
4. What is colostrum? Give its significance.
5. What are respiratory pigments? Name the blue coloured respiratory pigment present in Arthropods and Molluscs.
6. What are neurotransmitters? Give one example each for excitatory and inhibitory neurotransmitters.
7. Differentiate arteriosclerosis and atherosclerosis.
8. Give any two functions of testosterone.
9. What is diabetes insipidus? How is it caused?
10. Which hormone is called “fight or flight hormone”? Name the gland that secretes it.
11. What is exophthalmic goitre? How is it caused?
12. Differentiate between gonadal hormones and gonadotrophic hormones with examples.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Explain the osmoregulatory mechanisms in fresh water and marine animals.
14. Give a brief notes on coagulation of blood.
15. Explain Oxygen-Haemoglobin dissociation curve and its significance.
16. Write notes on physiology and significance of bioluminescence in organisms.
17. What is ornithine cycle? Explain.
18. Explain the role of sex hormones in menstrual cycle.
19. Describe role of hormones in insect metamorphosis.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Describe the physiology and chemistry of the muscle contraction.
21. What are neurons? Describe the physiology involved in the transmission of nerve impulses.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)

Zoology: Core course

**ZOL6B11- REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Enlist the hormones and their role in lactation.
2. Explain ZIFT and GIFT.
3. What are homeotic genes? Explain their significance.
4. Differentiate between arrhenotoky and thelytoky.
5. Define capacitation of sperm.
6. What is embryonic induction?
7. Mention 4 important functions of Allantois.
8. Explain cell lineage.
9. Describe the process of implantation in man.
10. Define fate map. Draw the fate map of Frog blastula.
11. Define teratogenesis. Explain the effects of nicotine and alcohol.
12. Explain the theory of epigenesis.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Briefly describe barrier methods of fertility control.
14. With the help of a neatly labeled diagram explain the structure of Graafian follicle.
15. What is prenatal diagnosis? Briefly describe amniocentesis and chorionic villus sampling.
16. With labelled diagram, describe the salient features of 33 hour chick embryo.
17. Describe the hormonal control of amphibian metamorphosis.
18. Give an account of Spemann's constriction experiments.
19. With reference to Drosophila, explain the role of genes in development.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question**

20. What is cleavage? Write an essay on the different types cleavages with suitable examples.
21. Describe the development of brain in frog embryo.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)

Zoology: Core course

**ZOL6B12 – ENVIRONMENTAL AND CONSERVATION BIOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Explain ecotone and edge effect.
2. Write a note on adaptations of animals of rocky shore.
3. Differentiate between primary and secondary productivity.
4. Mention the components of an ecosystem.
5. Enumerate the faunal characteristics of animals of lotic habitats.
6. Write a short account on ecological succession.
7. Explain commensalism with a suitable example.
8. What is proto-cooperation? Give an example.
9. Explain remote sensing and its applications in ecological studies.
10. Write notes on Ramsar convention.
11. Give a short account on various toxicants that cause health hazards.
12. Write a note on Rio convention on biodiversity.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Give a detailed account on the energy flow in an ecosystem.
14. Explain the different types of population growth forms.
15. Write a note on the properties of a population.
16. Explain habitat destruction and its consequences.
17. Describe the various mechanisms employed for trapping and collection of insects.
18. Explain the major threats to biodiversity.
19. Write an account on hot spots of biodiversity.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. What are biogeochemical cycles? Explain Nitrogen cycle.
21. Explain the strategies for the conservation of biodiversity.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course  
**ZOL6B13 – ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Explain innate behaviour with suitable examples.
2. Describe photoperiodism.
3. What are pheromones? Mention their biological roles.
4. Write a note on navigation and homing.
5. Explain punctuated equilibrium.
6. Describe natural selection with suitable examples.
7. Write a note on Neo-Darwinism.
8. What are living fossils? Give examples.
9. Describe Lamarck's theory of evolution.
10. Write a brief note on Wallace line.
11. Distinguish between continental and oceanic islands.
12. Write the faunal characteristics of Australian region.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Write a note on various patterns of behaviour.
14. Explain the role of hypothalamus in the control of behaviour.
15. Write a brief account on the evolution of man.
16. Explain adaptive radiation with suitable examples.
17. Describe the isolating mechanisms and their role in speciation.
18. Explain Hardy-Weinberg Equilibrium and the factors that upset it.
19. Give an account of various barriers in animal distribution.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Describe the Oparin-Haldane concept of origin of life on earth.
21. Write an essay on evidences of organic evolution.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course (Elective)  
**ZOL6B14BE01 – HUMAN GENETICS**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Write a note on FISH.
2. Explain non-disjunction of chromosomes.
3. Give an account on Ehler's Danlos syndrome.
4. Write an account on maternal effect genes.
5. Explain the inheritance of intelligence.
6. Comment on alzheimer's disease.
7. What is genomic imprinting?
8. Explain genetic counselling.
9. Comment on consanguinity.
10. Describe karyotyping
11. Write a short note on Indian Genome Variation Initiative.
12. What is phenocopy?

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Describe the classification and nomenclature of human chromosomes.
14. Write a note on autosomal recessive human disorders.
15. Explain the construction of pedigree.
16. Briefly explain X- linked dominant and recessive human disorders.
17. Explain the structural modifications of human chromosomes and their phenotypic effects.
18. Describe the biology of twinning and method of analysis of twin data.
19. Write a note on errors in sexual development.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the various chromosome banding techniques.
21. Write an essay on various prenatal diagnostic techniques.

**(1x10 = 10 marks)**

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**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Core course (Elective)  
ZOL6B14BE02 - **AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY  
SCIENCE**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Write the names of any four aquarium fishes.
2. Explain pokkali culture
3. Write a note on aquarium management.
4. Comment on mud banks.
5. What is chitosan? Mention its uses
6. Explain white revolution.
7. What is isinglass?
8. Write a note on the adulteration of milk.
9. Give an account on the common diseases of cattle.
10. Explain zoonotic diseases with a suitable example.
11. Describe the formulation of poultry feeds.
12. Enumerate the common diseases of poultry.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Write a short account on various types of aquaculture.
14. Explain the various steps in pisciculture.
15. Describe the biology and culture of Indian major carps.
16. Write an account on fish preservation techniques.
17. Write a short account on the breeds of fowl.
18. Explain the various steps in the processing of milk.
19. Describe the various breeds of cattle.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the various steps in pearl culture.
21. Write an essay on fishing crafts and gears.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)  
Zoology: Core course (Elective)  
ZOL6B14BE03 - **APPLIED ENTOMOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Explain the pest status of *Xylotrechus quadripes*.
2. Write a note on types of silkworms.
3. Briefly explain the processing and extraction of silk.
4. Mention the control measures of *Saissetia nigra*.
5. Write a short account on honey bee products and their uses.
6. Explain the damage caused by *Odoiporus longicollis*.
7. Write a note on pheromonal control of insects.
8. Name three pests of domestic animals.
9. What is moriculture?
10. Explain the control measures of *Raphidopala foveicollis*.
11. Name any three insecticide appliances.
12. Discuss the damages caused and control measures of *Toxoptera aurantii*

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Describe the damage caused and control measures of *Chilo infuscatellus* and *Scirpophaga novella*.
14. Write notes on the damage caused by *Nilaparvata lugens* and *Cnaphalocrocis medinalis*.
15. Discuss in detail any three important biological control projects undertaken in India.
16. Write an account on integrated pest management. Mention its advantages.
17. Give an account on the economic value and ecological services provided by insects.
18. Discuss the damages and control measures of *Tribolium castaneum* and *Callasobruchus chinensis*.
19. Write a note on lac culture.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Write an essay on the life cycle, damage caused and control measures of any three insect pests of coconut.
21. Describe the chemical control of insect pests. Mention its merits and demerits

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
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**FIRST SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)

Zoology: Complementary course

ZOL1C01 - **ANIMAL DIVERSITY AND WILDLIFE CONSERVATION**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Describe the salient features of phylum Dinoflagellata with a suitable example.
2. Comment on *Plasmodium vivax* as a human pathogen.
3. Describe the canal system in Porifera. Mention its significance.
4. Explain mutualism with respect to sea anemone.
5. Write a note on biodiversity hotspots.
6. What is Red Data book?
7. Write a short account on pearl formation.
8. Explain the adaptations of *Echeneis*.
9. Write a note on strategies for conservation.
10. Explain the adaptations of *Rhacophorus*.
11. What is neurotoxic venom? Give an example
12. Explain sustainable development.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Write a note on the evolutionary significance of *Peripatus*.
14. Explain metagenesis with respect to *Obelia*
15. Write a note on the parasitic adaptations of *Fasciola*.
16. Explain the structure of typical vertebra of Rabbit with labeled diagram.
17. Describe the salient features of subphylum Urochordata with a suitable example.
18. Write a note on the adaptations of *Pteropus*.
19. Describe the various threats to biodiversity.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the salient features and classification of phylum Annelida down to classes with example from each class.
21. With a neat labelled diagram, describe structure of heart of *Oryctolagus*.

**(1x10 = 10 marks)**

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**SECOND SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)  
Zoology: Complementary course  
ZOL2C02 – **ECONOMIC ZOOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is ancylostomiasis?
2. Differentiate between infection and infestation
3. What are zoonotic diseases?
4. What is bladder worm?
5. Discuss the damages caused and control measures of coconut mite.
6. What is induced spawning? Mention its application.
7. Discuss the damages caused by *Spodoptera* sp.
8. What are the different types of prawn farms?
9. Explain the control measures of *Cosmopolites* sp.
10. What are insect parasitoids?
11. Comment on *Sitophilus* sp.
12. Name the common cultivable prawn species.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Discuss mosquitoes as vectors of human diseases.
14. Write a note on *Wuchereria bancrofti*.
15. Comment on *Plasmodium vivax* as a human pathogen.
16. Write a short note on integrated pest management.
17. Give an outline classification of pests and the causes of pest outbreak.
18. Write a short account on pearl culture.
19. Comment on common cultivable ornamental fishes.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the various insect pest management strategies.
21. Describe the various steps in pisciculture.

**(1x10 = 10 marks)**

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**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
(CBCSS –UG)  
Zoology: Complementary course  
ZOL3C03 - **PHYSIOLOGY & ETHOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. What is circadian rhythm.
2. Write a note on social organization in elephants.
3. Differentiate between hibernation and aestivation.
4. Explain the mechanism of absorption of nutrients.
5. What is BMR? Mention the factors affecting it.
6. Differentiate between arteriosclerosis and atherosclerosis.
7. Write a note on respiratory problems of high altitudes.
8. Explain cardiac cycle.
9. What is summation of stimuli?
10. Differentiate between Osmoconformers and osmoregulators.
11. Write a note on hormonal control of kidney function.
12. Explain all or none law.

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Explain briefly the mechanism of muscle contraction.
14. Write a short account on the structure of the human heart.
15. Describe urea cycle.
16. Explain the neural and chemical control of respiration.
17. Briefly explain the digestion of carbohydrates, proteins and lipids.
18. Describe the fluid mosaic model of plasma membrane.
19. Give an account on communication behavior in animals.

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Describe the mechanism of nerve impulse transmission.
21. Explain the different kinds of behavior.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**PDF Compressor Free Version**  
**FOURTH SEMESTER B.Sc. DEGREE EXAMINATION**

(CBCSS –UG)  
Zoology: Complementary course  
ZOL4C04 – **GENETICS AND IMMUNOLOGY**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A**

**I. Short answer questions. Each question carries 2 marks.**

1. Write a note on cytokines.
2. What are haptens?
3. Mention the various cells of the immune system.
4. What is adaptive immunity?
5. Write a note on viral origin of cancer.
6. What are cosmids?
7. Comment on pseudogenes.
8. Explain the practical applications of genetic engineering.
9. What are transposons?
10. Explain genic balance theory.
11. Comment on gynandromorphism.
12. Explain polygenic inheritance

**(Ceiling: 20 marks)**

**Section B**

**II. Paragraph questions. Each question carries 5 marks**

13. Explain the Patau's scheme of classification of human chromosomes.
14. Describe the features of genetic code.
15. Write a note on various gene transfer methods.
16. Write a note on the process of transcription.
17. Describe the structure of immunoglobulin.
18. Explain the characteristics of cancer cells.
19. Write a note on ELISA

**(Ceiling: 30 marks)**

**Section C**

**III. Essay questions. Answer any one question.**

20. Explain the steps in the construction of recombinant DNA.
21. Write an essay on immunodeficiency diseases.

**(1x10 = 10 marks)**

MODEL QUESTION PAPER  
**FOURTH SEMESTER B.Sc. ZOOLOGY PROGRAMME (CBCSS-UG) CORE PRACTICAL EXAMINATION**

**PRACTICAL I:** ANIMAL DIVERSITY [Non chordata and Chordata]  
[ZOL4B05 P]: [Practical I\* A, I\* B, I \*C, & I \*D]

*(Digital versions of the mountings and dissections are to be done as per UGC guide lines if the software is available)*

**Time: 4 hours**

**Max: 80 Marks**

**I. Q. 1-6. Spotters: Do as directed. 6 items** **(6 x 3 =18 Marks)**

(Non-chordata - 2; Chordata – 2; Histology/Key – 1; Osteology – 1)

**II. Q. 7. Minor: Mount one of the following** **(9 Marks)**

*Earthworm:* Mount a few setae on a clean slide.

OR

*Honey bee/ Plant bug:* Mount the mouth parts on a clean slide.

**III. Q. 8. Minor: Mount one of the following. Sketch and label**

**(Mounting-9 + Sketch-3 =12 marks)**

*Nereis:* Mount the parapodium on a clean slide. Sketch and label

OR

*Mullet/Sardine:* Mount a few cycloid scales on a clean slide. Sketch and label

**IV. Q .9. Major: One of the following. Dissections (18 Marks) & Display (4 Marks).**

**(22 Marks)**

*Prawn:* Dissect and display the Nervous system.

OR

*Shark:* Digitally dissect/dissect and display the Heart and ventral aorta with branches on both sides.

**Viva voce**

**(3 marks)**

**V. Record:**

**(14+2=16 Marks)**

MODEL QUESTION PAPER  
**SIXTH SEMESTER B.Sc. ZOOLOGY PROGRAMME (CBCSS-UG)**  
**CORE PRACTICAL EXAMINATION**

**PRACTICAL II:** Cell Biology, Genetics, Biotechnology, Microbiology, Immunology, Biochemistry, Molecular Biology, Methodology in Science, Biostatistics and Bioinformatics  
[ZOL6B15 P]: [Practical II\* A+ II\* B]

**Time: 4 hours**

**Max: 80**

**Marks**

**I. Q. 1-6. Spotters: Do as directed. (6 items) (6 x 3 = 18 Marks)**

(**Cell Biology & Genetics** (2) – polytene chromosome, mitotic/meiotic stages, tissues, Barr body, micrometry, pedigree charts, karyotypes, male or female *Drosophila*, genetic traits; **Biotechnology, Microbiology & Immunology** (2) – electrophoretic apparatus, PCR, Southern blotting, milk quality, bacterial motility, blood grouping, section of spleen, thymus or lymph node, ELISA, western blotting; **Biochemistry, Molecular Biology, Methodology in Science, Biostatistics & Bioinformatics** (2) paper chromatography, colorimeter, electrophoretic apparatus, preparation of solutions of various normality/molarity or serial dilutions, phylogenetic tree, sequence similarity search, multiple sequence alignment).

**II. Q. 7. Minor: Any one of the following (9 Marks)**

Stain the buccal epithelial cells (striated muscle cells provided) with methylene blue. Submit the slide for valuation. Write down the principle of methylene blue staining of tissues/cells and the staining procedure.

(Slide - 6, Principle - 2, Procedure - 1)

**OR**

Detect biochemically the presence of reducing disaccharides/monosaccharides in the given sample. Conduct appropriate confirmatory tests also. Report the results in tabular form.

(Expt. - 6, Report of the results in tabular form - 3)

**OR**

Retrieve sequence of the beta-lactamase OXA gene for the organism *Escherichia coli* and *Pseudomonas taiwanensis* from NCBI in fasta format. Generate pairwise alignment for the sequences using BLAST. Analyze the result and note down the e-value and percentage identity. Write down the procedure.

(Procedure - 5, Sequence retrieval - 2, e-value - 1, % identity - 1)

**OR**

Identify the group of your own blood. Write down the principle and procedure.

(Experiment and result - 5, Principle and procedure - 4)

**OR**

Demonstrate the effect of colchicine on cell division using *Allium cepa*. Write the principle and procedure.

(Experiment and result - 5, Principle and Procedure - 4)

**III. Q. 8. Minor: Any one of the following. (3+9=12 Marks)**

a) Genetics Problem-(Monohybrid, dihybrid crosses; blood groups; sex-linked inheritance) (3 marks)

b) Measure the length of the leaves provided. Using the data plot a Frequency Polygon with mean  $\pm$  SD and submit it for evaluation. (9 marks)

(Measurement and Preparation of the data in table- 6, Graphical representation- 3)

**OR**

a) Genetics Problem (3 marks)

- PDF Compressor Free Version
- b) Stain the mitochondria in human cheek epithelial cells (insect flight muscle) using green B. Observe and submit the preparation for evaluation. Write the principle and procedure. (9 marks)  
(Preparation – 5, Principle and procedure 2, Sketch and label - 2)

**OR**

- a) Genetics Problem (3 marks)  
b) Prepare a smear of the fungal sample provided to you. Write down the principle and procedure (9 marks)  
(Preparation 6, Principle and procedure- 3)

**OR**

- a) Genetics Problem (3 marks)  
b) Find out the homologous sequences in *Enterobacteriaceae*, *Escherichia albertii*, *Cronobacter sakazaki*, *Shigella sonnei* and *Shigella flexneri* by performing BLASTp for the sequence given below and save the file as protein.fasta and execute their MSA using clustal omega and study the percentage similarity of each pair of sequences. Based on these scores identify which sequences are the most similar to each other. Also save the alignment file in fasta format.

```
>seq
MACKGTGNRTIAVYDLGGGTFDISIEIDEVDJEKTFEVLATNGDTHL
GGEDFDSRLINYLVEEFKKDQG
IDLRNDPLAMQRLKEAAEKAKIELSSAQQTVDNLPYITADATGPKHMN
IKVTRAKLESLVEDIVNRSIEP
LKVALQDAGLSVSDIDVILVGGQTRMPMVQKKVAEFFGKEPRKDVNP
DEAVAIGAAVQGGVLTCL (The sequence must be provided on the desktop)
```

(9 marks)

(Procedure 3, MSA 3, % similarity 2, Identification 1)

**IV. Q. 10. Major: Any one of the following. (22 Marks)**

Prepare a smear of your buccal epithelium to demonstrate Barr body. Write the principle and procedure. Comment on your results.

(Experiment and result – 18, Principle & Procedure – 2, Comment 2)

**OR**

By performing appropriate biochemical tests analyze the given three sample solutions for the presence of organic constituents, such as monosaccharides, polysaccharides, proteins and lipids. Submit the report in tabular form.

(Expt. and result - 18, Report of the results in tabular form - 4)

**OR**

Prepare a neatly stained squash preparation of onion root tip. Identify any two mitotic stages. Sketch and label.

(Expt. and result- 18, Identification - 2, Sketch - 2)

**OR**

Prepare a squash preparation of onion root tip. Calculate the mitotic/metaphase index. Write the procedure.

(Expt. and result – 18, Calculation – 4)

**OR**

Find out the diameter/length of the given object using stage and ocular micrometer. Write down the principle and procedure.

(Expt. and result – 15, Calculation. 4, Principle and Procedure – 3)

**OR**

Identify whether the given bacteria is Gram positive or negative by the Gram staining technique. Write the principle and procedure.

(Expt. and result – 18, Principle and procedure – 4)

**Viva-voce**

**(3 marks)**

**V. Record:**

**(16 Marks)**

**CORE PRACTICAL EXAMINATION**

**PRACTICAL III:** *Physiology, Endocrinology, Reproductive and Developmental Biology, Environmental and Conservation Biology, Ethology, Evolution, Zoogeography and Elective course.*

[ZOL6B16P] [Practical: III\*A+ III\*B]

**Time: 4 hours**

**Max: 80 Marks**

**I. Q. 1-6. Spotters: Do as directed. 6 items.**

**(6 x 3 =18 Marks)**

**(Physiology & Endocrinology** (Any 1) – Haemoglobinometer, sphygmomanometer, osmotic response of RBC, blood cells, sections of pituitary, thyroid, adrenal or endocrine pancreas, pregnancy detection; **Reproductive and Developmental Biology** (Any 2) - embryo/developmental stages/larval forms, placenta, *Drosophila* life cycle; **Ethology** (Any 1) photaxis, chemotaxis, locomotory behaviour; **Evolution** (Any 2) - homologous/analogous organs, vestigial organs, adaptive radiation, connecting links, evolution of man.

**II. Q. 7. Minor:** *One or two items from elective course.*

**(9 Marks)**

(Human Genetics/Aquaculture, Animal Husbandry and Poultry science/ Applied Entomology)

**III. Q. 8. Minor: Any one of the following.**

**(3+9=12 Marks)**

a. Mark the Australian realm in the map supplied and comment on its faunal characteristics. (3 marks)

b. Determine the haemoglobin content of human blood. Write the procedure (9 marks)

(Expt. and result – 7; Procedure – 2)

**OR**

a. Mark the Galapagos islands in the map supplied and comment on its faunal characteristics. (3 marks)

b. Determine the pH of the two samples provided by using pH indicator paper/pH meter. Write the procedure. Comment on its significance. (9 marks)

(Expt. and result – 5, Procedure - 3, Comment - 1)

**OR**

a. Comment on the faunal characteristics of the marked region in the world map provided to you (3 marks)

b. Detect the presence of starch and urea in the given sample of milk. Write down the procedure. (9 marks)

(Expt. & Result - 6, Procedure – 3)

**OR**

a. Comment on the special features of the marked region in the world map provided to you. (3 marks)

b. Construct a food web with specimens/names of items provided. Define and add a note on its ecological significance. (Mouse, Snake, Rabbit, Grasshopper, Grass, Lizard, Hawk Grasshopper) (9 marks)

(Food web - 6, Definition - 1, significance - 2)

**OR**

a. Mark the distribution of lung fishes in the world map provided. (3 marks)

b. Mount any two marine planktons in glycerin on clean slides. Identify them up to class and write notes on planktonic adaptations. (9 marks)

(Mountings - 2+2, Identification - 2, Adaptations - 3)

**IV. Q. 9. Major: Any one of the following.**

**(22 Marks)**

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You are provided with three urine samples. Analyze them for the presence of glucose, albumin and ketone bodies. Present your results in tabular form. Comment on your results.

*(Expt. results - 18, report of the results in tabular form - 2, Comment - 2)*

**OR**

Prepare a smear of your own blood. Identify any two WBCs. Sketch and label.

*(Expt. and result - 18, Identification - 2, Sketch - 2)*

**OR**

Estimate the amount of dissolved oxygen in the given sample using Winkler's method. Write down the principle and procedure.

*(Expt. and result-16, Principle and procedure - 4, Calculation - 2)*

**OR**

Estimate the amount of dissolved Carbon dioxide in the given sample. Write down the principle and procedure.

*(Expt. and result-16, Principle and procedure - 4, Calculation - 2)*

**OR**

Estimate the hardness of the given water sample. Write down the principle and procedure.

*(Expt. and result -16, Principle and procedure - 4, Calculation - 2)*

**Viva-voce**

**(3 marks)**

**V. Record:**

**(16 Marks)**

MODEL QUESTION PAPER  
**FOURTH SEMESTER B.Sc. ZOOLOGY (CBCSS-UG) COMPLEMENTARY PRACTICAL EXAMINATION**

**PRACTICAL:** Animal diversity, wildlife conservation, Economic zoology, Physiology, Toxicology, Ethology, Genetics and Immunology  
[ZOL4C05P]: [Practical I\*A, I\*B, I\*C & I\*D]

*(Digital versions of the mountings and dissections are to be done as per UGC guide lines if the soft ware is available)*

**Time: 4 hours**

**Max. : 80 Marks**

**I. Q. 1-6. Spotters: Do as directed. (6 items):** **18 Marks**

(Non chordata -1; Chordata - 2; Histology/Osteology -1; Economic Zoology-1; Genetics - 1) *(6 x 3 = 18 Marks)*

**II. Q.7. Minor: Any one item from the following:** **(9 Marks)**

Identify your own blood group and submit the slide for valuation. Write down the principle and procedure involved.

*(Expt. and result - 6, principle and procedure - 3)*

**OR**

Detect biochemically the presence of glucose, protein or lipid in the sample provided. Conduct an appropriate confirmatory test also. Submit the result in tabular form.

*(Expt. and result - 6, Report of the results in tabular form - 3)*

**III. Q.8. Minor: Any one item from the following:** **(12 Marks)**

Honey bee: Mount the mouth parts on a clean slide. Sketch and label.

*(10 + 2 = 12)*

**OR**

Shark: Mount a few placoid scales on a clean slide. Sketch and label.

*(10 + 2 = 12)*

**IV. Q.9. Major: One of the following:** **(22 Marks)**

*Penaeus*: Dissect and display the nervous system.

*(18+4 = 22)*

**OR**

Make a neatly stained smear of your own blood. Identify any two immunologically significant cells.

*(Preparation - 18, Identification - 2, Sketch and label - 2)*

**Viva – voce**

**(3 marks)**

**V. Record:**

**(16 Marks)**