CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEGREE OF B. Sc. Zoology

BACHLOR OF SCIENCE IN ZOOLOGY

(CHOICE BASED CREDIT AND SEMESTER SYSTEM FOR UNDERGRADUATE CURRICULUM)

UNDER THE FACULTY OF SCIENCE

SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2019 – '20 ONWARDS)

BOARD OF STUDIES IN ZOOLOGY (UG)

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA - 680125, KERALA, INDIA

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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, Christ College (Autonomous).

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 Christ College (Autonomous), 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 Christ College (Autonomous), 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 Christ College (Autonomous),

w.e.f. 2019 admission.

Board of Studies in Zoology (U.G.) of Christ College (Autonomous) [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 equipment's 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 5th 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, B (E): 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 5th 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.

Common courses	**:**	**38 credits** (22 for English courses +16 for Additional languages).
Core courses	**:**	**55 credits** (including 2 credits for project work & 1 for field study).
Open course	**:**	**3 credits**
Complementary courses:		**24 credits** (12 credits each for Chemistry and Botany)
Audit courses	**:**	**16 credits** (4 credits per course in first 4 semesters)
Extra credits	**:**	**4 credits** (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

Sl.No.	Semesters	Courses	Credits	Marks	Duration
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
		Total	**16**	**400**	

**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*+ 2**+1**	--	--	--	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
	38 Credits (950 Marks)		**82 Credits (2325 Marks)**				**120 Credits (3275 Marks)**	**#16 Credits (400 Marks)**	**#4 Credits (100 Marks)**

Grand Total: 3775 Marks; 140 Credits (Minimum)

**Practical (12 Credits)* ***Project work – 2 credits; **Field study – 1 credit.*

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. COURSE-WISE MARK DISTRIBUTION OF B.Sc. ZOOLOGY PROGRAMME

Courses			No. of Courses	Marks per Course	Total Marks	Grand Total
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	60+15 = 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

Semester	*Course*	*Credits*	*Marks*
I	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
	Total	**20**	**575**
II	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
	Total	**22**	**625**
III	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
	Total	**19**	**525**
IV	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
	Total	**35**	**925**

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	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

Semester	**Core/Open/ Elective courses**	**Code**	**Course Title**	**Instructional hrs**	**Instructional hrs in a semester**	**Credits**	**External Marks**	**Internal marks**	**Total marks**	**Duration of Exam (hrs)**
	Theory XIII Elective Course##	ZOL6B14(E)01T ZOL6B14(E)02T ZOL6B14(E)03T	• Human Genetics • Aquaculture, Animal Husbandry & Poultry science • Applied Entomology (Any one) ##	3	54	2	60	15	75	2
	Practical III*B	--	Practical related to theory core course ZOL6B12T, 13T & ZOL6B14 (E)01T/ (E)02T/ (E)03T	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 (E)01/(E)02/(E)03)*	8	144	4**	80	20	100	4
		ZOL6B17PF	Project work & Field study	--	--	2+1 ***	60	15	75	
			Total			**58**	**1220**	**305**	**1525**	

Core courses 1450 + Open course 75 = 1525 Marks

Scheme of evaluation: External 80 % +Internal 20 %

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

** Practical examination for 5th and 6th semesters will be held at the end of VI semester.

*** **Project work – 2 credits; Field study – 1 credit.** External evaluation of Project work and Field study report 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 (ZOL6B14(E)01/ ZOL6B14(E)02/ ZOL6B14(E)03) opted by the dept. is for Core course.

Table 6

+++Appendix

B.Sc. ZOOLOGY OPEN COURSE

[For students of other streams]

STRUCTURE OF OPEN COURSE

Course code, Title, Instructional hours, Credits, Marks and Duration of Examination

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	*Open Course 02:* Nutrition, Health and Hygiene							
		ZOL5D03T	*Open Course 03:* Applied Zoology							

	TOTAL	**3**	**54**	**3**	**60**	**15**	**75**	**2**

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)

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 programmme 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.

3. Course Outcomes (COs):

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 1st & 2nd semesters, 3 credits each in 3rd & 4th semesters) with 2 hrs of examination. Four courses each with 4 credits and 2.5 hrs of examination in 5th semester and 5 courses [4 with 3 credits each and one with 2 credits] with 2 hrs examination in 6th semesters of the programme. Towards achieving vocationalisation, 3 core courses are prescribed under Elective course for 6th semester. An institution can choose any one of the following.

Elective courses: 01. Human Genetics (Code: e.g., ZOL6B14(E)01T)

2. Aquaculture, Animal Husbandry and Poultry science

3. 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 5th semester form Practical II [4 credits; Code: ZOL6B15P] and 10 to 14 of 6th 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):

1. Project work

Students are assigned to undertake a project work during 6th 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 3rd practical examination in the sixth semester. The project must contain the following components.

1. Introduction with citations of relevant literature
2. Objectives of the study
3. Methodology
2. Field Study
4. Results
5. Discussion
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 3rd 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

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

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 5th and five in 6th 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 externals + 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
Total Marks		**15**	**20**

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
Total marks					**30**

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
Total marks					**40**

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	**Total Marks**	**3**	**4**

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
2	Good	2	3
3	Average	1	1
4	***Total Marks**	**3**	**4**

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

Table 8.d. Split up of internal marks for Classroom Participation (CRP) (Attendance) [20%]

Sl. No.	Range of CRP (Attendence)	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 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]

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

Scheme of Examination (4/5 credit course):

The external question papers are of 80 marks and 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	**Section A:** Short answer	15	15	2	25
	Section B: Paragraph	8	8	5	35
	Section C: Essay	4	2	10	20
Total Marks					**80**

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 4th semester and Practical II & III at 6th 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
Total Marks		**20**

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
	Total Marks	**4**

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 6th 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 No chordate 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*	
	Total Marks			**80**	

***** 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/experime ntal setupetc.;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	
	Total Marks			**80**	

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

PROJECT WORK & FIELD STUDY [2+1 = 3 CREDITS]: EVALUATION SCHEME

a. **Project work (2 credits)**

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 3rd 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 (1 credit)**

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 3rd 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
Total Marks		**60**	**15**	**75**

I. **INTERNAL EVALUATION (12+3=15 Marks)**

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/Organization of Report	4
4	Viva-voce	4
Total Marks		**12**

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

Sl.No.	Components	Marks
1	Content of field study report	2
2	Viva-voce related to field study	1
Total Marks		**3**

I. **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 **10 Marks**	Presentation, quality of analysis/ use of statistical tools, references **10 Marks**	Findings and recommendations **14Marks**	Viva-voce **14 Marks**		Field study related to elective course **2 Marks**	Visit to places of general biological and ecological interest **8 Marks**	Viva-voce related to field study **2 Marks**		

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 courses for students from other streams. The open course is to be taught in 3 hrs per week with a total of 54 instructional hours in the 5th 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 (Classroom Participation)	3
Total Marks		**15**

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
Total marks					**30**

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	**Total Marks**	**3**

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

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

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

Table 19.d. Split up of internal marks for Classroom Participation (CRP) (Attendance) [20%]

Sl. No.	Range of CRP (Attendance)	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

I. **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	**Section A:** Short answer	12	12	2	20
	Section B: Paragraph	7	7	5	30
	Section C: Essay	2	1	10	10
Total Marks					**60**

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 dispatch 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.

SEMESTER I

ZOL1B01T – ANIMAL DIVERSITY: NON-CHORDATA PART- I

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

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

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.Entamoeba
Phylum: Dinoflagellata	e.g.Noctiluca
Phylum:Parabasilia	e.g.Trichonympha

Phylum: Apicomplexa [=Sporozoa] e.g. Plasmodium

Phylum: Ciliophora e.g.Vorticella.

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.Leucosolenia

Class Demospongiae e.g. Spongilla

Class Hexactinellida (=Hyalospongiae) e.g.Euplectella

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.Halistemma, Physalia

Class Scyphozoa e.g.Rhizostoma

Class Anthozoa e.g.Adamsia, Zoanthus, and Madrepora

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 cidippid larva.

[Short answers/Paragraphs/Essays]

MODULE 8

ACOELOMATA (3 hrs)

Phylum PLATYHELMINTHES

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

ClassTurbellaria e.g.*Bipalium*

Class Trematoda e.g.*Fasciola*

Class Cestoda e.g.*Taenia*

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

Gastrotricha e.g.*Chaetonotus*

Phylum **Rotifera** e.g.*Brachionus*

[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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SEMESTER II

ZOL2B02T – ANIMAL DIVERSITY: NON-CHORDATA PART- II

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

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:

1. Class Trilobita	[brief account only]
2. Class Merostomata	e.g. *Limulus*
3. Class Arachnida	e.g. *Heterometrus* (*Palamnaeus*),*Heteropoda* (Huntsman spider, Order *Araneae*). Mention ticks and mites (Subclass *Acari*).
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)

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 **Phoronida** — e.g. *Phoronis*
2. Phylum **Ectoprocta** [**Bryozoa]** — e.g. *Bugula*
3. Phylum **Echiura** — e.g. *Bonellia*

[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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SEMESTER III

ZOL3B03T – ANIMAL DIVERSITY: CHORDATA PART- I

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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 morphologyand 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).

[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, classificationdown 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 [Coelacanths] 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*

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 thefollowing orders (only extant forms):

Subclass I - **Anapsida**

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

SubclassII - **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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SEMESTER IV

ZOL4B04T – ANIMAL DIVERSITY: CHORDATA PART- I

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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]**

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

Subclass **Neornithes[2 hrs]**

Super order **Palaeognathae** [=Ratitae]

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

Super order **Neognathae** [=Carinatae]**[7 hrs]**

6. Order Galliformes [pheasants, quail, turkeys, grouse] e.g. *Pavo cristatus*
7. Order Anseriformes [screamers, water fowls] e.g. *Anas poecilorhyncha*
8. Order Passeriformes [perching birds] e.g. *Passer domesticus*
9. Order Piciformes [woodpeckers, barbets, honeyguides] e.g. *Dinopium*
10. Order Coraciiformes [kingfishers & allies] e.g. *Alcedo atthis*
11. Order Apodiformes [swifts, humming birds] e.g. *Apus nipalensis*
12. Order Strigiformes [owls] e.g. *Bubo*
13. Order Cuculiformes [cuckoos, roadrunners, turacos] e.g. *Eudynamys*
14. Order Psittaciformes [parrots, lories, cockatoos] e.g. *Psittacula krameri*
15. 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, dodoes, sand grouse] e.g. *Columba*
18. Order Falconiformes [diurnal birds of prey – falcons, hawks] e.g. *Mylvus*
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. *Phoenicopterus*

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. *Suncusmurinus, 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.*Cynocephalusvolans* (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.*,

Viverriculaindica (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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SEMESTER I

ZOL4B05P – ZOOLOGY [CORE COURSE] PRACTICAL – I: ANIMAL DIVERSITY: NON-CHORDATA Part - I

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

[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).

1. **Protists**: *Amoeba, Noctiluca, Ceratium, Entamoeba, Trichonympha, Paramecium*

[any 4]

2. **Poriferans**: *Leucosolenia/Scypha* or *Spongilla,* Sponge gemmule, spicules
3. **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]
4. **Platyhelminths**: Free living flat worm: *Bipalium Dugesia*

   Parasitic flat worms: *Fasciola/Taenia solium*
5. **Aschelminths**: Parasitic round worms: *Ascaris*/*Ancylostoma*/*Wuchereria*
6. **Minor Phyla:** *Sipunculus/Bonellia* or any other specimen
7. **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).

SEMESTER II

ZOL4B05P – ZOOLOGY [CORE COURSE] PRACTICAL

ANIMAL DIVERSITY: NON-CHORDATA Part - II

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

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, Heamadipsa, 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*,
3. **Molluscs**: Spider/ tick/mite Inter tidal mollusks – *Chiton, Patella, Haliotis, Onchidium*, [any 2]
   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, hearturchin [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]

SEMESTER III

ZOL4B05P – ZOOLOGY [CORE COURSE] PRACTICAL

ANIMAL DIVERSITY: CHORDATA Part - I

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

[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, Cybium, Thunnus* [any 3]

c. Common edible fishes (Inland) - *Etroplus, 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, Echeneis*, *Antennarius, Amphisile, 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 / Enhydris / 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, 9th Vertebrae,
2. Frog: Pectoral & Pelvic girdles
3. Snake Vertebra [show zygosphene and zygandrum]
4. Carapace and plastron of turtle/tortoise.

SEMESTER IV

ZOL4B05P – ZOOLOGY [CORE COURSE] PRACTICAL

ANIMAL DIVERSITY: CHORDATA Part - II

Number of Contact Hours: 36 hrs

Number of Credits: 2

Course Outline

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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SEMESTER V

ZOL5B06T – ZOOLOGY [CORE COURSE]-V [Theory]

CELL BIOLOGY AND GENETICS

Number of Contact Hours: 54 hrs

Number of Credits: 4

Course Outline

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)**

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)

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: G1, S, G2 and M phases – Check points; G0 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 aneupoloidy) 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)

- De Robertis EMF (2011): *Cell and molecular biology*; 8th Edition, ISBN- 9780781734936 0781734932, Lippincott Williams & Wilkins, 734 pages
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- Gupta, P. K. (2018): *Cell and Molecular Biology*, Revised 5th edition, ISBN, 978-93-5078-154-8, Rastogi Pubs.,1192 pages
- Kleinsmith, L. J. & Kish, V. M. (1995): *Principles of Cell and Molecular Biology*, 2nd Edition, ISBN-10: 0065004043 Harper Collins College Pubs, 809 pages
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Module 6-11 (Genetics)

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- John Ringo (2004): *Fundamental Genetics*- Online ISBN 9780511807022 Cambridge University Press, 462 pages
- Peter Snustad & Michael J. Simons (2011): *Principles of Genetics*;6th Edition, ISBN 1118129210, JW & S, 784 pages
- Read Andrew and Dian Donnai (2015): *New Clinical Genetics*, 3rd Edition, ISBN- 10: 0073525308, McGraw Hill, 480 pages
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- Robert H. Tamarin (1998): *Principles of Genetics*, 6th Edition, ISBN-10: 0697354628 William C Brown Pub, 680 pages
- Tom Strachan and Andrew Read (2018): *Human Molecular Genetics*,5th Edition, ISBN 9780815345893 JW & S, 770 pages

SEMESTER V

ZOL5B07T – ZOOLOGY [CORE COURSE]-VI [Theory]

BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY

Number of Contact Hours: 54 hrs

Number of Credits: 4

Course Outline

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

[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: Archaebacteria, 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)

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 – κ and λ 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 Immuno deficiency diseases, Tumorand transplantation immunology (9 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

References

Module 1-3 (Biotechnology)

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Module 4-6 (Microbiology)

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Module 7-9 (Immunology)

- Abul K. Abbas, Andrew H. Lichtman & Shiv Pillai (2017) *Cellular & Molecular Immunology* 8th Edition, Paperback ISBN: 9780323479783, Elsevier, 608 pages
- Andrew E Williams (2011) *Immunology Mucosal and Body Surface Defenses*, Ist Edition, ISBN: 0470090049, Wiley and Blackwell, 398 pages
- David Male, Jonathan Brostoff, David Roth and Ivan Roitt (2013) *Immunology*, 8th Edition, ISBN: 9780323080583, Elsevier, 482 pages
- Helen Chapel, Mansel Haeney, Siraj Misbah & Neil Snowden (2014) *Essentials of Clinical Immunology* 6th Edition, ISBN: 978-1-118-47295-8, Wiley Blackwell, 376 pages
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SEMESTER V

ZOL5B08T – ZOOLOGY [CORE COURSE]-VII [Theory]

BIOCHEMISTRY AND MOLECULAR BIOLOGY

Number of Contact Hours: 72 hrs

Number of Credits: 4

Course Outline

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. β-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)

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 hrs)

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

References

Module 1-6 (Biochemistry)

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- James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick (2017): *Molecular Biology of the Gene* 7th Edition, ISBN-10: 9332585474, Pearson Publication, 912 pages
- 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
- Kleinsmith, L. J. & Kish V. M (1995): *Principles of Cell and Molecular Biology*.2nd Edition, ISBN-10: 0065004043, Harper Collins College Pubs, 809 pages
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- Lynn Jorde John Carey Michael Bamshad (2015): *Medical Genetics* 5th 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* 2nd Edition, ISBN- 10: 0198705972, Oxford, 936 pages.
- Robert J Brooker (2011): *Genetics-Analysis & Principles* 4th Edition, ISBN-10: 0073525286, Mc Graw Hill, 864 pages

SEMESTER V

ZOL5B09T – ZOOLOGY [CORE COURSE]-VII [Theory]

METHODOLOGY IN SCIENCE, BIOSTATISTICS AND BIOINFORMATICS

Number of Contact Hours: 54 hrs

Number of Credits: 4

Course Outline

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)

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

Module 1-3 (Methodology in Science)

- 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*, 4th Edition, ISBN 9780198717355, Oxford University Press, 224 pages
- Victoria, E. McMillan. (2006)*Writing Papers in the Biological Sciences*, 4th 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*, 3rd Edition, CUP, 272 pages
- Green, R. H. (1979) *Sampling design and Statistical Methods for Environmental Biologists.* ISBN 978-0-471-03901-3, J.W. & S. 272 pages
- Gupta, S. P. (2018) *Statistical Methods.* 45th Revised Edition, ISBN 978-93-5161-112-7 (506), Sultan Chand & Co.1440 pages
- Wayne W. Daniel and Chad L. Cross (2014) *Biostatistics: Basic Concepts and Methodology for the Health Sciences,* 10th 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* 2nd 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,* 2nd 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* 3rd Edition, ISBN 978-1-4471- 6701-3, Springer, 308 pages
- Jonathan Pevsner (2015): *Bioinformatics and Functional Genomics* 3rd Edition, ISBN: 978-1- 118-58178-0, Wiley, 1160 pages
- Malcom Campbell and Laurie J. Heyer (2006): *Discovering Genomics, Proteomics and Bioinformatics,* 2nd Edition, ISBN 10: 9780805382198, Pearson, 464 pages

SEMESTER V

ZOL6B15P – ZOOLOGY [CORE COURSE] PRACTICAL – II

PRACTICAL II*A: CELL BIOLOGY, GENETICS, BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY

Number of Contact Hours: 72 hrs

Number of Credits: 4

Course Outline

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 3rd 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/cheek 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 (*Lactobacilius* 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 detectionof specific proteins using flowcharts/diagrams/by visiting a diagnostic Lab)

References

- Godkar P.B. (2005) *Textbook of Medical Laboratory Technology Vol 1&2, 3rd Edition, ISBN*- 10: 9789381496190, Bhalani Publishers, 1648 pages
- Margaret J. Barch, Turid Knutsen and Jack L. Spurbeck (1997) *The AGT Cytogenetics Laboratory Manual*; ISBN-10: 0397516517, Lippincott
- Mukesh Kumar (2018) Practical Microbiology for Undergraduates, 3rd Edition, ISBN- 10: 8183602363, Jain Brothers
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- 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*;1st Edition, ISBN-10: 9781119069744, Wiley-Blackwell, 840 pages

SEMESTER V

ZOL6B15P – ZOOLOGY [CORE COURSE] PRACTICAL – II

PRACTICAL II*B: BIOCHEMISTRY, MOLECULAR BIOLOGY, METHODOLOGY IN SCIENCE, BIOSTATISTICS & BIOINFORMATICS

Number of Contact Hours: 72 hrs

Number of Credits: 4

Course Outline

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 Bionformatics

(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 ± SD using suitable data. Draw the same in Excel or using any free software and record it.
7. Prepare a frequency polygon with mean ± SD utilizing appropriate data.
8. Draw a bar diagram with mean ± SD employing suitable data.
9. Construct a histogram with mean ± 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*, 2nd Edition, ISBN-10: 9780805382198, Benjamin Cummings, 464 pages
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- Roy R. N. (2001) *A Text Book of Biophysics*, 2nd Revised Edition, ISBN 10: 8173811458, New Central Book Agency, 992 pages
- Sawbney S. K. and Singh R. (2001) *Introductory Practical Biochemistry*, ISBN- 10: 8173193029, Narosa Publ, 470 pages

SEMESTER V

ZOL5D01T-ZOOLOGY OPEN COURSE- I (Theory)

REPRODUCTIVE HEALTH AND SEX EDUCATION

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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. Ogenesis.

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)

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-foetoprotein 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, cybersex, 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

- Brian Walker Nicki R Colledge Stuart Ralston and Ian Penman (2014): *Davidson's Principles and Practice of Medicine*, 22nd edition; eBook ISBN: 9780702052248, Elsevier
- John Hall (2015): *Textbook of Medical Physiology; 13th Edition,* ISBN: 9781455770052, Elsevier Health, 1168 pages
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- Reisman, Judith A, Eichel, Edward W, Muir, J Gordon and Court, J H (John Hugh) (2001): *Kinsey, sex, and fraud: the indoctrination of a people: an investigation into the human sexuality research,* ISBN 10: 091031120X, Lochinvar-Huntington House
- Robert T. Francoeur (1982): *Becoming a sexual person*, ISBN-10: 0471078484, John Wiley and Sons, 836 pages

- Vander, Sherman and Luciano (2003): *Human Physiology*, 9th Edition, ISBN- 10: 9780072437935, McGraw Hill, 864 pages

  http://www.biologydiscussion.com/essay/reproductive-health-in-human-problems- and-strategies/5167 http://stayteen.org/sex-ed/article/why-sex-education-important http://www.onlymyhealth.com/importance-sex-education-among-youth-1301382451 http://www.livestrong.com/article/246343-how-to-make-friends-with-the-opposite- sex/
- http://stories.plancanada.ca/gender-discrimination-starts-at-home/

SEMESTER V

ZOL5D02T -ZOOLOGY OPEN COURSE- II (Theory)

NUTRITION, HEALTH AND HYGIENE

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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 (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)

Dog bite; Insect sting: scorpion, Bee and wasp; Snake bite: venomous and Non- nenomous 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.

References

- Martin Eastwood (2003): Principles of Human Nutrition, Second edition. ISBN: 978-0-632- 05811-2. Blackwell Science Ltd, 680 pages.
- Brian Walker, Nicki R Colledge, Stuart Ralston and Ian Penman (2014): *Davidson's Principles of Practice of Medicine*. 22nd Edition; eBook ISBN: 9780702057199, Elsevier, 1392 pages
- Harvey Washington Wiley: Wiley's Health Series, Vol. 1: *Nutrition Hygiene Physiology*; Wiley
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- Michael J. Gibney (2012): *Public Health Nutrition*, ISBN: 978-1-444-34204-8, Blackwell, 392 pages
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Singh, H.D., Sarada Subramanyam, and K. Madhavankutty (2014): *Textbook of HumanPhysiology;* ISBN 10: 8121902169, S. Chand & Co.

SEMESTER V

ZOL5D03T -ZOOLOGY OPEN COURSE- III (Theory)

APPLIED ZOOLGY

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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, Artifical 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 hystolytica, 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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SEMESTER VI

ZOL6B10T - ZOOLOGY CORE COURSE – IX [Theory]

PHYSIOLOGY AND ENDOCRINOLOGY

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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.

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)

Hypothalamus-hypophysial 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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SEMESTER VI

ZOL6B11T - ZOOLOGY CORE COURSE – X [Theory]

REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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

[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)

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, dedifferentiaton 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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SEMESTER VI

ZOL6B12T - ZOOLOGY CORE COURSE – XI [Theory]

ENVIRONMENTAL AND CONSERVATION BIOLOGY

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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

e) Determination of home range and territory

f) Estimation of number of animals in a population

g) Indirect method of estimating wild animal populations

h) Recent trends- Camera trapping, Radio collaring and Remote sensing

[Short answer/Paragraphs]

Section B: CONSERVATION BIOLOGY (14 hrs)

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: LD50 and LC50.

[Short answer/Paragraps]

Topics for Assignments/Seminars

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

Environmental factors (Temperature, water, light, soil) and their influence on organisms.

1. Concept of habitat and niche.
2. Food chains and food web.
3. Major biomes of the world.
4. Ecological pyramids.
5. Ecological succession, basic types and processes in succession.
6. Environmental pollution-Land, water, air, sound and radiation.
7. Global warming and Ozone depletion.
8. Individual responsibilities – Role of Governmental and Non-Governmental Organizations in biodiversity conservation – Chipko, Green peace WWF
9. Food additives.

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SEMESTER VI

ZOL6B13T - ZOOLOGY CORE COURSE – XII [Theory]

ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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)

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)

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* (Pithecanthropines), *H.sapiens neanderthalensis* (Neanderthal man), *Homo sapiens fossilis* (The Cro-magnon), *Homo sapiens sapiens* (Modern man), mention Denizoans and Malapan 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): Palaeartic region, Nearctic region, Neotropical

region, Ethiopean region, Oriental region and Australian region; brief description on Wallace line, Weber line and Wallacea.

Insular fauna (1 hr)

Faunal characteristics of continental (Madagaskar 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

References

Module 1-2 (Ethology)

- Jerry A. Hogan. 2017. *The Study of Behavior: Organization, Methods, and Principles*. ISBN: 9781107191976. Cambridge University Press. 380 pages.
- John Alcock & Dustin R Rubenstein. 2019. *Animal Behaviour*, 11th edition. Published by Sunderland, Massachusetts Sinauer Associates, Oxford University Press. 672 pages.
- Lee Alan Dugatkin. 2013. *Principles of Animal Behavior*, 4th Edition. ISBN-13: 978- 0393920451. ISBN-10: 0393920453. W. W. Norton & Company. 576 pages.
- Michael Breed & Janice Moore. 2015. *Animal Behaviour*. Second Edition. ISBN: 9780128015322. Academic Press. 552 pages.
- V. K. Agarwal. 2010. *Animal Behaviour (Ethology)*. ISBN: 9788121932103, 8121932106. S.Chand Publishers. 400p.

Module 3-8 (Evolution)

- Brian K. Hall & Benedikt Hallgrimsson. 2014. *Strickberger's Evolution.* 5th Edition. ISBN: 9789380853789, 9380853785. Publisher: Viva. 672 pages.
- Darlington P J 1966. Zoogeography: The Geographical Distribution of Animals. Fourth Edition. John Wiley & Sons, Inc. 675 pages.
- Jain P C & M.S. Anantharaman. *Palaeontology (Palaeobiology): Evolution and Animal distribution*. 9th Edition. ISBN-10: 9382956441; Vishal Publishing Co.
- James H. Brown. 1996. *Biogeography*. ISBN-10: 0697243591; ISBN-13: 978-0697243591. William C Brown Pub., 643 pages.
- James T. Costa. 2009. *The Annotated Origin – A Facsimile of the First Edition of On the Origin of Species*. ISBN-10: 0674032810; University Press; Annotated edition. 546 pages.
- Niles Eldredge. 1985. *Time Frames*: *The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria*. ISBN-10: 0671495550; Simon & Schuster. 240 pages.
- Niles Eldredge. 1998. *Pattern of Evolution*. ISBN-10: 0716730464; ISBN-13: 978- 0716730460. W H Freeman & Co. 219 pages.
- Richard Dawkins. 2006. *The Blind Watchmaker – Why the Evidence of Evolution Reveals a Universe without Design*. ISBN-10: 0393315703; W. W. Norton & Company. 496 pages.
- Robert Andrew Foley & Roger Lewin. 2003. *Principles of Human Evolution 2nd Edition*. ISBN-10: 0632047046; ISBN-13: 978-0632047048. Wiley-Blackwell. 568 pages.
- Solomon Stevens. 2017. *Evolutionary Biology*. ISBN-10: 1635491169. ISBN-13: 978- 1635491166. Larsen and Keller Education. 190 pages.

Module 9 (Zoogeography)

- Andrews, M.I. & Joy, K.P. *Ecology, Evolution & Zoogeography*. S.M. Book Depot, Changanassery
- Rastogi V. B. & Jayaraj.1998. *Animal Ecology and Distribution of Animals*. Kedar Nath and Ram Nath. ISBN: 5551234001809.
- Tiwari, S. K. 1985. *Zoogeography of India and South East Asia.* CBS Pubs, New Delhi

SEMESTER VI

ZOL6B14(E)02T - ZOOLOGY ELECTIVE CORE COURSE- II (Theory)

AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY SCIENCE

Number of Contact Hours: 54 hrs

Number of Credits: 3

Course Outline

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 nutterei*)

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)

i. Fishing crafts – Mention Catamaran, Canoes and dug-out-canoes.

ii. Fishing gears – Gillnet/drift gillnet, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing.

iii. Fish Spoilage and Preservation: Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting and smoking.

iv. Fish utilisation: Nutritive value, bye products, liver oil, body oil, fish meal, fish flour, Isinglass, glue, skin, fin soup, lime, chitin and chitosan.

v. Diseases and parasites of Fish: Fungal infection – Epizootic Ulcerative Syndrome (EUS), Saprolegnia, Fin and tail rot disease, Dropsy.

vi. Mud banks of Kerala coast.

[Short answers/Paragraphs/Essays]

MODULE 4

Poultry science (7 hrs)

i. Egg production, cable bird production, nutritive value and bye products.

ii. Breeds of fowl – Exotic –Rhode Island Reds, Plymouth Rock, Naked Neck and Leghorn; Indigenous – Gramapriya, Giriraja and Kalinga Brown.

iii. Poultry rearing: Selection of eggs, hatching, incubation, brooding, sexing and vaccination.

iv. Poultry housing: Free range system, Semi-intensive system (deep litter system and individual cage system).

v. Equipments for feeding: Nutrients for starting, growing, laying hen.

vi. Common poultry feeds, food rations and feed formulation.

vii. 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/Paragraghs]

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.

References

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- Ashok Kumar Rathoure, Dinesh Kumar, Nazneen Z. and Deshmukh (2015): *Applied and Economic Zoology*; Daya Publishing House. 326 pages.
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- Banerji, G.C. (1998): *A text book of Animal husbandry* 8^{th} *Edn.*, Oxford & IBH.1096 pages.
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- Jawid Ahsan and Subhas Prasad Sinha (2010): *A hand Book on Economic Zoology*; S. Chand, ISBN. 9788121908764, 314 pages
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- P.R. Venkitaraman (1983): *Text Book of Economic Zoology*, Sudarsana Publications
- Ram Prabhu Jayasurya and N Arumugam (2013): *Economic Zoology*; Saras Publications. ISBN-10: 938245926X, 560 pages

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SEMESTER VI

ZOL6B16P - ZOOLOGY [CORE COURSE] PRACTICAL – III*A PHYSIOLOGY, ENDOCRINOLOGY, REPRODUCTIVE AND DEVELPOMENTAL BIOLOGY

Number of Contact Hours: 72 hrs

Number of Credits: 4

Course Outline

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.
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).

References

- F. S. Billet and A. E. Wild: Practical studies of animal development, ISBN: 9789401168861, Springer
- George Van Ness Dearborn (2016): A Text-Book of Human Physiology, Theoretic and Practical, ISBN-10: 1373146265, Wentworth Press, 572 pages
- G.K. Pal and Parvathy Pal (2016): Text book of practical physiology, 4th Edition, ISBN- 10: 8173719969, Orient blackswan
- V.P. Varshney, Mona Bedi (2018): Ghai's Textbook of Practical Physiology, 9th Edition, ISBN-10: 9352705327, Jaypee Brothers, 376 pages

SEMESTER VI

ZOL6B16P - ZOOLOGY [CORE COURSE] PRACTICAL – III*B

ENVIRONMENTAL AND CONSERVATION BIOLOGY, ETHOLOGY, EVOLUTION, ZOOGEOGRAPHY & ELECTIVE

[HUMAN GENETICS/AQUACULTURE, ANIMAL HUSBANDRY & POULTRY SCIENCE/APPLIED ENTOMOLOGY]

Number of Contact Hours: 72 hrs

Number of Credits: 4

Course Outline

Section A: ENVIRONMENTAL AND CONSERVATION BIOLOGY (28 hrs)

1. Estimation of dissolved O_2 in water sample using Winkler's method (Major).
2. Estimation of dissolved CO_2 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)

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 Chaemotaxis 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)

References

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- Rastogi & Jayaraj (1998): *Animal Ecology and Distribution of Animals*, ISBN-13 5551234001809, K Nath & R Nath
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- Thomas Mertens and Robert and L Hammersmith (2014): *Genetics, Laboratory Investigations*, 14th Edition, ISBN-10: 0321814177, Pearson Education, 320 pages
- Eiri Board (2008): Hand *Book of Milk Processing Dairy Products and Packaging Technology*, ISBN-10: 8186732969, Engineer's India Research Institute
- D.K. Thompkinson and Latha Sabiki (20120: *Quality Milk Production and Processing Technology*, ISBN 9789380235899, New India Publishing Agency, 302 pages
- Francis Day: *The Fishes of India* (2-volume set), (Reprint of a work published in 1875), ISBN 9788180941559, MJP Pblishers
- Leonel Pereira (2016)*: Edible Seaweeds of the World* 1st Edition, ISBN 9781498730471, CRC Press
- N. V. Jadhav and M.F. Siddiqui (2010): *Handbook of Poultry Production and Management*, 2nd Edition, ISBN-13-9788180619250, Jaypee Brothers
- Peter Henderson and J. Robin Somes: *Identification Guide to the Inshore Fish of the British Isles*, ISBN 9781904690634, NHBS, 321 pages
- S.N. Sinha (2016): Cow Keeping in India: *A Simple & Practical Book on their Care & Treatment Their Various Breeds*, 5th Edition, ISBN-10: 8176220981, Daya Publishing House
- Alka Prakash (2009): *Laboratory Manual of Entomology*; 1St Edition, ISBN-10: 8122412920, New age international, 148 pages
- Ashok kumar and Prem Mohan Nigam (2000): *Economic & Applied Entomology*; ISBN 5551234018938, Emkay Publications,
- D.S. Reddy: *Applied Entomology*; New Vishal Publications
- Henry Torsey Fernald (2018): *Applied Entomology: An Introductory Text-Book of Insects in Their Relations to Man;* ISBN-10: 0666528853. Forgotten books, 406 pages
- K.N. Ragumoorthi, M.R. Srinivasan and V. Balasubramani (2016): *Principles of Applied Entomology*; ISBN-10: 978819025582, A. E Publications
- K. P. Srivastava & G. S. Dhaliwal (2010): *A text book of applied Entomology*; ISBN- 10: 8127261645, Kalyani Publishers
- Mark Curtis Wilson (1984): *Fundamentals of Applied Entomology* (Practical Insect Pest Management, 1);2nd Edition, ISBN-10: 0881330310, Waveland Pr Inc; 216 pages
- M.M. Trigunayat (2016): *A manual of Practical Entomology* (Field and laboratory guide); 3rd Edition, ISBN: 9788172339838, Scientific Publisher, 358 pages