



**UNIVERSITY OF CALICUT**

**Abstract**

BSc in Zoology-CUCBCSS UG 2014-Scheme and Syllabus- w.e.f 2014 admission -Approved- Syllabus of Complementary Course incorporated in the syllabus -approved - corrigendum issued

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**G & A - IV - J**

U.O.No. 615/2015/Admn

Dated, Calicut University.P.O, 20.01.2015

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- Read:-*1. U.O. No. 3797/2013/CU, dated 07.09.2013 (CBCSS UG Modified Regulations) (File.ref.no. 13752/GA IV J SO/2013/CU).
2. U.O. No. 5180/2014/Admn, dated 29.05.2014 (CBCSS UG Revised Regulations) (File.ref.no. 13752/GA IV J SO/2013/CU).
3. Item no. 8 of the minutes of the meeting of the Board of Studies in Zoology UG held on 04.03.2014.
- 4.Item no. 2 of the minutes of the meeting of the Faculty of Science held on 27.06.2014.
- 5.U.O.No: U.O.No. 6928/2014/Admn Dt 17.07.14
6. U.O.Note from Pareekshabhavan No: 15714/Ex-1-Asst-3/2014 3/8/14
7. item No: 1&2 of theMinutes of the meeting BOS in Zoology UG held on 18.11.14
8. item No:12 of the meeting of the Minutes of the Faculty of Science held on 22.12.14

**ORDER**

The Modified Regulations of Choice Based Credit Semester System for UG Curriculum w.e.f 2014 was implemented under the University of Calicut vide paper read as (1). The Revised CUCBCSS UG Regulations has been implemented w.e.f 2014 admission, for all UG programme under CUCBCSS in the University, vide paper read as (2).

The Board of Studies in Zoology UG finalized the revised syllabus of BSc Zoology for implementation w.e.f the Academic Year 2014-2015. vide paper read as (3). The Faculty of Science has also approved the minutes of the Board vide paper read as (4).

The Hon'ble Vice Chancellor, considering the exigency, exercising the powers of the Academic Council has approved the items regarding syllbus implementation in the minutes of the

concerned Boards of Studies mentioned in the minutes of the Faculty of Science, subject to ratification by the Academic Council, and orders have been issued vide paper read as (5).

The Pareekshabhavan as per paper read as (6) has reported the following omission in the approved syllabus of BSc Zoology UG 2014.

**The syllabus of complementaty course was not included in the syllabus.**

The BOS in Zoology as per paper read as (7) has corrected the syllabus of BSc Zoology and it has been got approved by the Faculty of Science as per paper read as (8). The chairman has forwarded the Corrected Syllabus and reported that the syllabus of complementary courses will be the same as that of 2013 syllabus.

Therefore the Scheme and Syllabus implemented vide paper read as (5) stands corrected to this effect.

Corrigendum is issued accordingly. (The corrected syllabus is attached herewith and is available in the website: [universityofcalicut.info](http://universityofcalicut.info))

Muhammed S  
Deputy Registrar

To

1. All Affiliated Colleges/SDE/Dept.s/Institutions under University of Calicut.
2. The Controller of Examinations, University of Calicut.
3. The Director SDE, University of Calicut.

Forwarded / By Order

Section Officer

### **BSc Zoology main syllabus 2014 onwards**

- Pattern of the model question paper, scheme of evaluation for internal examination and credit distribution have been included.
- The syllabus of Complementary course 2013 will continue without any change. The pattern of the model question paper, scheme of evaluation for internal examination and credit distribution for the complementary course have also been given.

**UNIVERSITY OF CALICUT**

**B.Sc. ZOOLOGY PROGRAMME**

**SYLLABUS**

**CORE COURSES**

**COMPLEMENTARY COURSES**

**&**

**OPEN AND ELECTIVE COURSES**

*With effect from 2014-15 admission onwards*

## APPENDIX I

**List of the members of Board of Studies in Zoology (U. G.)  
N0.GA 1/F2/302/2012 dated 27.04.2014, Calicut University.P.O**

Sl. No.	Name	Designation	College
1	Sri. Majeed P.P	Associate Professor [Chairman], BOS	MES Mampad College
2	Sri. Mohammed Iqbal	Associate Professor	PSMO College, Tirurangadi
3	Dr. Britto Joseph	Associate Professor	St. Thomas College, Thrissur
4	Sri. M.P. Ishak	Principal	Govt. College, Perinthalmanna.
5	Dr. Sheeba	Associate Professor	Vimala College Thrissur
6	Dr. P.A Sajudeen	Associate Professor (JD, Direcrate of Higher Secondry Education, TVM)	St. Stephan's College, Pathanapuram (On Deputation)
7	Sri. Koshy P.M	Associate Professor	St. Stephan's College, Pathanapuram
8	Dr. Anitha Latha Sadanandan	Associate Professor	Malabar Christian College, Kozhikode
9	Smt. Jayasree V	Associate Professor	Sree Krishna College, Guruvayoor.
10	Dr Shobha T.R	Assistant Professor	Farook College, Kozhikode
11	Dr. N. Ramani	Professor Chairperson Zoology Board of studies (PG), University of calicut	Dept. of Zoology, Calicut University

**SYLLABUS**  
**CORE COURSES 1 TO 24**  
**&**  
**OPEN COURSES 1, 2 & 3**  
**ELECTIVE COURSES 1, 2 & 3**

## COURSE STRUCTURE

### Credit Distribution

Semester	Common course		Core course	Complementary course		Open course	Total
	English	Additional Language		Chemistry	Botany		
I	4+3	4	2	2	2	-	17
II	4+3	4	2	2	2	-	17
III	4	4	3	2	2	-	15
IV	4	4	3+4 <sup>*</sup>	2+4 <sup>*</sup>	2+4 <sup>*</sup>	-	27
V	-	-	3+3+3+3	-	-	2	14
VI	-	-	2+3+3+3+ 3+3 +4 <sup>*</sup> +4 <sup>*</sup> +2 <sup>**</sup> +1 <sup>***</sup> +2 <sup>****</sup>	-	-	-	30
Total	22	16	56	12	12	2	120

\*Practical      \*\*Project      \*\*\*field study/ Study Tour      \*\*\*\* Viva- voce

### Mark Distribution and Indirect Grading System

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 7 point scale is followed. Each course is evaluated by assigning marks with a letter grade (A<sup>+</sup>, A, B, C, D, E or F) to that course by the method of indirect grading.

**Mark Distribution**

<i>Sl. No.</i>	<i>Course</i>	<i>Marks</i>
1	English	600
2	Additional Language	400
3	Core course: Zoology	1750
4	Complementary course: Chemistry	400
5	Complementary course: Botany	400
6	Open Course	50
	<b><i>Total Marks</i></b>	<b>3600</b>

**Seven point Indirect Grading System**

<i>% of Marks</i>	<i>Grade</i>	<i>Interpretation</i>	<i>Grade Point Average</i>	<i>Range of Grade points</i>	<i>Class</i>
90 and above	A <sup>+</sup>	Outstanding	6	5.5 - 6	First Class with distinction
80 to below 90	A	Excellent	5	4.5 – 5.49	
70 to below 80	B	Very good	4	3.5 – 4.49	First Class
60 to below 70	C	Good	3	2.5 – 3.49	
50 to below 60	D	Satisfactory	2	1.5 – 2.49	Second Class
40 to below 50	E	Pass/Adequate	1	0.5 – 1.49	Pass
Below 40	F	Failure	0	0 – 0.49	Fail



## CREDIT AND MARK DISTRIBUTION IN EACH SEMESTERS

**Total Credits: 120; Total Marks: 3600**

<i>Semester</i>	<i>Course</i>	<i>Credit</i>	<i>Marks</i>
<b>I</b>	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course I: Animal Diversity-Nonchordata-Part-I	2	100
	Complementary course: Chemistry	2	80
	Complementary course: Botany	2	80
	<b>Total</b>	<b>17</b>	<b>560</b>
<b>II</b>	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course II: Animal Diversity-Nonchordata-Part-II	2	100
	Complementary course: Chemistry	2	80
	Complementary course: Botany	2	80
	<b>Total</b>	<b>17</b>	<b>560</b>
<b>III</b>	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course III: Animal Diversity-Chordata-Part-I	3	100
	Complementary course: Chemistry	2	80
	Complementary course: Botany	2	80
	<b>Total</b>	<b>15</b>	<b>460</b>
<b>IV</b>	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course IV: Animal Diversity-Chordata-Part-II	3	100

	Core Course V: Practical-I*A, I*B, I*C& I*D	4	100
	Complementary course: Chemistry	2	80
	Complementary course: Botany	2	80
	Complementary course: Chemistry Practical	4	80
	Complementary course: Botany Practical	4	80
	<b>Total</b>	<b>27</b>	<b>720</b>
<b>V</b>	Core Course VI: Environmental Biology, Wild Life Conservation And Toxicology	3	100
	Core Course VII: Ethology, Evolution And Zoogeography	3	100
	Core Course VIII: Cell Biology And Genetics	3	100
	Core Course IX : General Methodology in Science, Biostatistics And Informatics	3	100
	Open Course	2	50
	<b>Total</b>	<b>14</b>	<b>450</b>
<b>VI</b>	Core Course X: Bio chemistry	2	100
	Core Course XI: , Physiology And Endocrinology	3	100
	Core Course XII: Molecular biology And Bio informatics	3	100
	Core Course XIII: Reproductive Biology, Developmental biology And Teratology	3	100
	Core Course XIV: Bio technology, Micro biology And Immunology	3	100
	Core Course-XV: Elective Course : Human Genetics/ 02-Aquaculture, Animal Husbandry And Poultry/ 03-Applied Entomology(Any one)	3	100
	Core Course-XVI: Practical II- II*A, II*B & II*C	4	100
	Core Course-XVII: Practical III-III*A, III*B, III*C & III*D	4	100

	Core Course-XVIII: Project Work	2	50
	Field Study/Study tour	1	
	Viva-voce		
	<b>Total</b>	<b>30</b>	<b>850</b>

### Core Course Structure

**Total Credits: 56 (Internal: 20%; External: 80%)**

<i>Se mes ter</i>	<i>Code No</i>	<i>Course Title</i>	<i>Hrs/ Week</i>	<i>Total Hrs/ Sem</i>	<i>Credits</i>	<i>Marks</i>
<b>I</b>	ZO1B01T	Core Course I: Animal Diversity Nonchordata-I	2	36	2	100
	-	Core Course V : Practical related to ZO1B01T Practical-I*A	2	36	*	-
<b>II</b>	ZO2B02T	Core Course II: Animal Diversity Nonchordata-II	2	36	2	100
	-	Core Course V : Practical related to ZO2BOT-Practical-I*B	2	36	*	-
<b>III</b>	ZO3B03T	Core Course III –Animal diversity- Chordata -I	3	54	3	100
	-	Core Course V : Practical related to ZO3B03T-Practical-I*C	2	36	*	-

<b>IV</b>	ZO4B04T	Core Course IV: Animal diversity Chordata-II	3	54	3	100
	-	Core Course V: Practical related to ZO4B04T- Practical-I*D	2	36	*	-
	ZO4B05P	Practical-I*A, I*B, I*C & I*D	8	144	4	100
<b>V</b>	ZO5B06T	Core Course VI: Environmental Biology, Wild life Conservation & Toxicology	3	54	3	100
	ZO5B07T	Core Course VII: Ethology Evolution & Zoogeography	3	54	3	100
	-	Practical Theory Course related to ZO5B06T & ZO5B07T-Practical II*A	3	54	*	-
	ZO5B08T	Core Course VIII: Cell Biology & Genetics	3	54	3	100
	-	Practical related to Theory Core Course : ZO5B08T-Practical II*B	3	54	*	-
	ZO5B09T	Core Course IX: General Methodology in Science, Bio Statistics & Informatics	3	54	3	100
	-	Practical Related to Theory Core Course ZO5B09T-Practical II*C	2	36	*	-
	-	Project Work	2	36	**	-
	-	Field Study	1	18	***	-
<b>VI</b>	ZO6B10T	Core Course X: Bio Chemistry	2	36	2	100
	ZO6B11T	Core Course XI: Physiology & Endocrinology	3	54	3	100

-	Practical related to Core Course ZO6B10T & ZO6B11T-III*A		2	36	*	-
ZO0612T	Core Course XII: Molecular Biology & Bioinformatics		3	54	3	100
ZO0613T	Core Course XIII: Reproductive Biology, Developmental Biology & Teratology		3	54	3	100
-	Practical related to Theory Core Course ZO0613T-Practical-III*B		2	36	*	-
ZO0614T	Core Course XIV : Bio Technology, Micro biology & immunology		3	54	3	100
-	Practical Related to theory Core Course ZO0614T-Practical III*C		2	36	*	-
ZO0615T (E1) (E2) (E3)	Core Course XV: Elective	1. Human Genetics	3	54	3	100
		2. Aquaculture, Animal husbandry & Poultry				
		3. Applied Entomology(An y One)				
-	Practical Related to Theory Elective Course ZO0615T(E)-Practical III*D		2	36	*	-
ZO0616P	Practical II-II*A, II*B & II*C		8	144	4*	100
ZO0617P	Practical III-III*A, III*B, III*C & III*D		8	144	4*	100

	ZO06 18Pr	Project Work	-	-	2**	50
	ZO06 19F	Field Study		18	1***	-
	ZO06 20V	Viva voce	-	-	2****	-
<b>Total</b>					<b>56</b>	<b>1750</b>

\* Exam will be held at the end of 4<sup>th</sup> semester .

\*\* Exam will be held at the end of 6<sup>th</sup> semester.

- ZO 06 15T An institution can choose any one Elective course among the three courses.
- Includes Field Study also. Marks: 90 (ZO0616P) + 10 (Hand written Field Study Report).
- Includes Viva Voce also. Marks: 85(ZO0617P) + 15(General Viva Voce).
- Practical Examinations are of 4 hrs Duration.

## **CORE COURSE THEORY: EVALUATION SCHEME**

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

### **1. INTERNAL EVALUATION**

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

**Table 1: Components of Evaluation**

<i>Sl. No.</i>	<i>Components</i>	<i>Marks</i>
1	Attendance	5
2	Test papers: I & II	5 + 5
3	Assignment	2
4	Seminar	3
<i>Total Marks</i>		<b>20</b>

**Table 2: Percentage of Attendance and Eligible Marks**

<i>% of attendance</i>	<i>Marks</i>
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

**Table 3: Pattern of Test Papers**

<i>Duration</i>	<i>Pattern</i>	<i>Total number of questions</i>	<i>Number of questions to be answered</i>	<i>Marks for each question</i>	<i>Marks</i>
1.5 Hours	One word	4	4	1	4
	Short answer	5	4	2	8
	Paragraph	5	3	6	18
	Essay	2	1	10	10
<i>Total Marks*</i>					40

\*90% and above = 5, 80 to below 90% = 4.5, 70 to below 80% = 4, 60 to below 70% = 3.5, 50 to below 60% = 3, 40 to below 50% = 2, 35 to below 40% = 1, below 35% = 0.

**Table :4 Scheme for Internal Evaluation of Core Course Practical:1 (ZO4B 05P)**

Attendance	Performance&punctuality	Test paper	Record	Total
5 marks	4 marks	6 marks	5 marks	20 marks

**Record-** *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. Emphasis must be on scientific accuracy and not on beauty of sketches.*

**Record:** 25 marks (20 marks external+5marks internal)

**Attendance:**

90% and above	5 marks
85-89%	4 marks
80-84%	3 marks
76-79%	2 marks
75%	1 marks
Below 75%	Not eligible to attend practical examination

**Performance & Punctuality**

Excellent	4 marks
Very good	3 marks
Good	2 marks
Average	1 marks



### Test Paper

90% & Above	6 marks
80-89%	5 marks
70-79%	4 marks
60-69%	3 marks
50-59%	2 marks
40-49%	1 marks
Below 40%	failure

### Record Evaluation:

Excellent	5 marks
Very good	4 marks
Good	3 marks
Average	2 marks

**Table: 5 Scheme for the Internal Evaluation of Practical: II (ZO0616P)**

Attendance	Performance&Punctuality	Test paper	Field Report	Record
5 marks	2 marks	6 marks	2 marks	5 marks

(5+2+6+2+5=20marks)

**Table: 6 Scheme for the Internal Evaluation of Practical: III (ZO0617P)**

Attendance	Performance&Punctuality	Test paper	Viva-Voce	Record	Total
5 marks	1 marks	6 marks	3 marks	5 marks	<b>20marks</b>

## **2. EXTERNAL EVALUATION**

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

**Table 1: Pattern of Question Papers:**

<i>Duration</i>	<i>Pattern</i>	<i>Total number of questions</i>	<i>Number of questions to be answered</i>	<i>Marks for each question</i>	<i>Marks</i>
3 Hours	One word	10	10	1	10
	Short answer	12	10	2	20
	Paragraph	8	5	6	30
	Essay	4	2	10	20
<i>Total Marks</i>					80

## **CORE COURSE PROJECT: EVALUATION SCHEME**

Project evaluation will be conducted at the end of sixth semester.

**Table 1: Internal Evaluation**

<i>Sl. No</i>	<i>Criteria</i>	<i>Marks</i>
1	Punctuality	2
2	Skill in doing project work	2
3	Project presentation	3
4	Viva-Voce	3
<b><i>Total Marks</i></b>		<b>10</b>

**Table 2: External Evaluation**

<i>Sl. No</i>	<i>Criteria</i>	<i>Marks</i>
1	Content and relevance of the project	10
2	Project report	10
3	Project presentation	10
4	Viva-voce	10
<b><i>Total Marks</i></b>		<b>40</b>

## ZOOLOGY COMPLEMENTARY COURSE STRUCTURE

**Total Credits: 12 (Internal: 20%; External: 80%)**

<i>Semester</i>	<i>Code No</i>	<i>Course Title</i>	<i>Hrs/ Week</i>	<i>Total Hrs</i>	<i>Credi t</i>	<i>Mark s</i>
<b>I</b>	ZO1CO1	Complementary Course I: Zoology-I	2	36	2	80
	-	Complementary Course V: Zoology Practical-I	2	36	*	-
<b>II</b>	ZO2CO2	Complementary Course II: Zoology-II	2	36	2	80
	-	Complementary Course V: Zoology Practical-II	2	36	*	-
<b>III</b>	ZO3CO3	Complementary Course III: Zoology-III	3	54	2	80
	-	Complementary Course V: Zoology Practical-III	2	36	*	-
<b>IV</b>	ZO4CO4	Complementary Course IV: Zoology-IV	3	54	2	80
	-	Complementary Course V: Zoology Practical-IV	2	36	*	-
	ZO4C05(P)	Complementary Course V: Zoology Practical-V	2	36	4*	80
<b>Total</b>					<b>12</b>	<b>400</b>

\* Examination will be held at the end of 4<sup>th</sup> semester.

## **COMPLEMENTARY COURSE THEORY: EVALUATION SCHEME**

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

### **1. INTERNAL EVALUATION**

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

**Table 1: Components of Evaluation**

<i>Sl. No.</i>	<i>Components</i>	<i>Marks</i>
1	Attendance	4
2	Test papers: I & II	4 + 4
3	Assignment	2
4	Viva-Voce	2
<i>Total Marks</i>		<b>16</b>

**Table 2: Percentage of Attendance and Eligible Marks**

<i>% of attendance</i>	<i>Marks</i>
Above 90%	4
85-89%	3.2
80-84%	2.4
76-79%	1.6
75%	0.8

**Table 3: Pattern of Test Papers**

<i>Duration</i>	<i>Pattern</i>	<i>Total number of questions</i>	<i>Number of questions to be answered</i>	<i>Marks for each question</i>	<i>Marks</i>
1.5 Hours	One word	4	4	1	4
	Short answer	4	4	2	8
	Paragraph	3	2	5	10
	Essay	2	1	10	10
<b>Total Marks*</b>					<b>32</b>

\*Marks: 80% and above = 2 , 60 to below 80% = 1.5, 50 to below 60% = 1, 35 to below 50% = 0.5, below 35% = 0.

**Table 4: Scheme for the evaluation of complementary internal practicals**

Attendance	Performance& punctuality	Test Paper	Record	Total
5 marks	3 marks	4 marks	4 marks	16 marks

Record: 20marks (16 external+ 4 internal)

Attendance:

90% & above	5 marks
85-89%	4 marks
80-84%	3 marks
76-79%	2 marks
75%	1marks
Below 75%	Not eligible to attend practicals

Performance& punctuality:

Excellent	3 marks
Good	2 marks
Average	1 marks

Test Paper:

85% & Above	4 marks
70-84%	3 marks
55-69%	2 marks
40-54%	1 marks
Below 40%	Failure

Record:

Excellent	4 marks
Good	3marks
Average	2 marks

## **2. EXTERNAL EVALUATION**

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

**Table 1: Pattern of Question Papers**

<i>Duration</i>	<i>Pattern</i>	<i>Total number of questions</i>	<i>Number of questions to be answered</i>	<i>Marks for each question</i>	<i>Marks</i>
3 Hours	One word	10	10	1	10
	Short answer	10	7	2	14
	Paragraph	6	4	5	20
	Essay	4	2	10	20
	<b><i>Total Marks</i></b>				<b>64</b>

**OPEN COURSE STRUCTURE**  
**(FOR STUDENTS OTHER THAN B.Sc. ZOOLOGY)**

**Total Credits: 2 (Internal 20%; External 80%)**

<i>Semester</i>	<i>Code No</i>	<i>Course Title</i>	<i>Hrs/ Week</i>	<i>Total Hrs</i>	<i>Mark s</i>
<b>V</b>	ZO5D01	Open Course 1: Reproductive Health & Sex Education	2	36	50
	ZO5D02	Open Course 2: Nutrition, Health & Hygiene			
	ZO5D03	Open Course 3: Applied Zoology( Any One)			

**OPEN COURSE: EVALUATION SCHEME**

The evaluation scheme contains two parts: viz., internal evaluation and external evaluation.

**1. INTERNAL EVALUATION**

20% of the total marks are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

**Table 1: Components of Evaluation**

<i>Sl. No.</i>	<i>Components</i>	<i>Marks</i>
1	Attendance	2.5
2	Test papers: I & II	2.5 + 2.5
3	Assignment / Viva	2.5
<b>Total Marks</b>		<b>10</b>

**Table 2: Percentage of Attendance and Eligible Marks**

<i>% of attendance</i>	<i>Marks</i>
Above 90%	2.5
85-89%	2
80-84%	1.5
76-79%	1
75%	0.5

**Table 3: Pattern of Test Papers**

<i>Duration</i>	<i>Pattern</i>	<i>Total number of questions</i>	<i>Number of questions to be answered</i>	<i>Marks for each question</i>	<i>Marks</i>
1 Hour	One word	3	3	1	3
	Short answer	1	1	2	2
	Paragraph	2	1	5	5
	Essay	2	1	10	10
<b>Total Marks</b>					<b>20</b>

\*Marks: 80% and above = 2.5, 60 to below 80% = 2, 50 to below 60% = 1.5, 40 to below 50% = 1, 35 to below 40% = 0.5, below 35% = 0.



## **2. EXTERNAL EVALUATION**

External evaluation carries 80% marks. University examination will be conducted at the end of 5<sup>th</sup> semester.

**Table 1: Pattern of Question Paper**

<i><b>Duration</b></i>	<i><b>Pattern</b></i>	<i><b>Total number of questions</b></i>	<i><b>Number of questions to be answered</b></i>	<i><b>Marks for each question</b></i>	<i><b>Marks</b></i>
2 Hours	One word	10	10	1	10
	Short answer	7	5	2	10
	Paragraph	3	2	5	10
	Essay	2	1	10	10
<i><b>Total Marks</b></i>					<b>40</b>

**FIRST SEMESTER B. Sc. DEGREE PROGRAMME (Theory)**

**ZOOLOGY CORE COURSE- I  
ANIMAL DIVERSITY: NON-CHORDATA PART- I  
Code: ZO1B 01T**

[DIVERSITY, ADAPTATIONS AND FUNCTIONAL ANATOMY OF  
PROTOZOANS AND NONCHORDATES)

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

**Section-A (10 hrs)**

**I. Principles of classification and nomenclature (5 hrs)**

Systematics; Natural and classical. Nomenclature: Binomial and Trinomial nomenclature; International rules of Zoological nomenclature (brief account); Mention new trends in systematics like Chemotaxonomy and Serotaxonomy, Cytotaxonomy, Numerical taxonomy (Phenetics), Cladistics (Phylogenetic systematics), Molecular systematics.

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

Mention Cavaller-smith's eight kingdom classification also.

**III. Concepts of classification of animals (brief account) (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 in the somite, homology and analogy of organs and their origin, development of mouth and digestive tract.

**Section-B**

**IV KINGDOM PROTISTA (6 hrs)**

(Give a comparative account of various functional systems of the types specified to get an idea on the evolutionary trends of diversity.)

Type: *Paramecium*: morphology and structural organization [as revealed by compound microscopy]; locomotion, nutrition, excretion, osmoregulation and reproduction; conjugation in detail. Characteristic features and classification of Kingdom Protista down to phyla [Salient features of the following phyla with note on the examples cited]

Phylum Rhizopoda. Eg: *Amoeba*

Phylum. Dinoflagellata. *Noctiluca*

Phylum. Parabasalia. *Trichonympha*

Phylum Apicomplexa [=Sporozoa] eg: *Plasmodium*

Phylum Ciliophora eg: *Vorticella*, *Ephelota*

## Section- C

### V. KINGDOM ANIMALIA

(20 hours)

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.*]

**Compare the various systems based on a specific example from each phylum**

### VI. MESOZOA

(1hr)

A brief account of dicyemid and orthonectid mesozoans with examples: *Dicyema*, *Rhopalura*

### VII. METAZOA

(3 hrs)

Phylum PORIFERA

Classification down to classes; salient features of the classes

Class Calcispongiae example: *Leucosolenia*

Class Demospongiae example: *Spongilla*

Class Hyalospongiae example: *Euplectella*

Give an account of canal system; mention amphiblastula, parenchymula and gemmule

### VIII. Phylum CNIDARIA [=COELENTERATA]

(7 hrs)

Type: *Obelia* morphology and life cycle

Classification down to classes; salient features of the classes

Class Anthozoa example: *Adamsia*, *Zoanthus*, and *Madrepora*

Class Hydrozoa example: *Halistemma*, *Physalia*

Class Scyphozoa example: *Rhizostoma*

### IX .Phylum CTENOPHORA [=ACNIDARIA]

(1 hr)

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

### X. ACOELOMATA

(3 hrs)

Phylum PLATYHELMINTHES

Classification down to classes; give salient features of the following classes

Class Turbellaria Type: *Dugesia*

Class Cestoda example: *Echinococcus*, *Fasciola*

Class Trematoda example: *Schistosoma*,

### XI. PSEUDOCOELOMATA

(3 hrs)

Super phylum ASCHELMINTHES

Highlight the heterogeneous nature of animals of this group, Classification down to phyla

**Phylum Nematoda**

Characteristic features of *Ascaris*

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

**Minor Phyla** (Salient features of the following)  
(2hrs)

Phylum **Gastrotricha** mention example: *Chaetonotus*

Phylum **Rotifera** example: *Brachionus*

## **XII. Topics for Assignment / Seminar**

**(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] Polymorphism in cnidarians with special reference to siphonophores
- 5] Reef building corals and coral reefs

**CORE COURSE I: PRACTICAL- I\* A**  
**ANIMAL DIVERSITY NON-CHORDATA Part- I**  
**(36 hours) (2 hrs per week)**

*[Students are expected to make sketches with notes, while they study the specimens in the laboratory / 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.]*

**Section A: Study of the following 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*,  
*Ephelota*  
[any 4)
2. Poriferans: *Leucosolenia*, *Scypha*, *Spongilla*, sponge gemmule, spicules [any 2)
3. Cnidarians: Sedentary hydrozoans: *Hydra*, *Obelia*  
[any 1)  
*Obelia* medusa  
Pelagic hydrozoans: *Physalia*, *Velella*  
[any 1)  
Pelagic scyphozoan: *Aurelia* / *Rhizostoma*  
Common anthozoans: *Adamsia*, *Edwardsia*, *Madrepora*,  
*Fungia*, *Tubipora*, *Gorgonia*  
[any 2)
4. Platyhelminths: Free living flat worm: *Bipalium* / *Dugesia*  
Parasitic flat worms: *Fasciola*, *Taenia solium*  
[any 1)
5. Aschelminths: Parasitic round worms: *Ascaris*, *Ancylostoma*, *Wuchereria*  
[any 1)
6. Minor Phyla : *Sipunculus* / *Bonellia* or any other specimen

**Section B: Histology**

Transverse sections of a coelenterate, a platyhelminth, a nematode (*Ascaris* male/female)

**SECOND SEMESTER B. Sc. DEGREE PROGRAMME (Theory)**  
**ZOOLOGY CORE COURSE- II**  
**ANIMAL DIVERSITY: NON-CHORDATA– PART- II**  
**Code: ZO2B 02T**  
[DIVERSITY, ADAPTATIONS AND FUNCTIONAL ANATOMY OF  
NON-CHORDATE COELOMATES)  
[36 hours] [2 hours per week] [2 Credits]

**COELOMATA**

Phylum **ANNELIDA**  
(7hrs)

**Type:** *Neanthes* or *Nereis*

Classification down to classes; salient features of the following classes

Class Polychaeta example: *Arenicola*

Class Oligochaeta example: *Megascolex*

Class Hirudinea example: *Hirudinaria*

Phylum **ARTHROPODA**

(11 hrs)

Type: *Penaeus* [details of larval stages not expected]

Classification down to classes; salient features of the following classes

Class Trilobita [brief account only]

Class Merostomata example: *Limulus*

Class Arachnida example: *Palamnaeus*, spider, mention ticks and mites

Class Myriapoda examples: *Scolopendra*, *Spirostreptus*

Class Crustacea example: *Sacculina*, *Eupagurus*

Class Insecta examples: *Lepisma*, *Mantis*, and *Tabanus* Southern bird  
wing butterfly

Phylum **MOLLUSCA**

(8 hrs)

Type: *Pila*

Classification down to classes; salient features of the following classes

Class Placophora example: *Chiton*

Class Bivalvia example: *Perna*

Class Scaphopoda example: *Dentalium*

Class Gastropoda example: *Turbinella*

Class Cephalopoda example: *Sepia*

Phylum **ECHINODERMATA**

(4 hrs)

Structural peculiarities of star fish; water vascular system in detail

Classification down to classes [of extant forms only]; salient features of the following

Classes and very brief account of examples

Class Crinoidea example: *Antedon*

Class Asteroidea example: *Astropecten*

Class Ophiuroidea example: *Ophiothrix*

Class Holothuroidea example: *Holothuria*

Phylum **HEMICHORDATA** (1 hr)

Salient features and example: *Balanoglossus*

**Coelomate Minor Phyla:** (3 hrs)

Salient features of the following Minor Phyla; mention examples specified [structure and life history not required]

Phylum **Phoronida** example: *Phoronis*

Phylum **Ectoprocta** [=Bryozoa] example: *Bugula*

Phylum **Echiura** example: *Bonellia*

Phylum **Onychophora** [2 hrs]

*Peripatus*: [distribution, peculiarities and affinities]

### Topics for Assignment / Seminar

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

- 1] Ecological importance of earthworm and vermiculture
- 2] Larval forms in Crustacea and their significance
- 3] Metamorphosis in insects; Social organization in insects
- 4] Economic importance of mollusks
5. Useful and harmful insects.
6. Economic importance of crustaceans.

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**CORE COURSE II: PRACTICAL- I\* B**  
**ANIMAL DIVERSITY NONCHORDATA Part- II**  
**(36 hours) (2 hrs per week)**

1. **Annelids** : Polychaetes *Aphrodite*, *Chaetopterus*, *Arenicola*, *Tomopteris* [any 2]  
Common earthworm: *Megascolex* / *Pheretima*  
: Leech: *Hirudinaria*, *Haemadipsa*, *Branchellion*  
[any 2]
2. **Arthropods**: Items of evolutionary / taxonomic importance -  
*Limulus*, *Streptocephalus*  
[any 2]  
: Common fouling barnacle – *Lepas* / *Balanus*  
  
: Parasitic crustaceans– *Sacculina*, *Cymathoa*, *Argulus*  
[any 2]  
: Crustacean of the sandy shore– *Emerita* / *Albunea*  
: Symbiotic crustacean - *Eupagurus*  
: Economically important crustacean– prawn, crab  
[any 1]  
: Vectors – *Cyclops*, mosquito, housefly, rat flea  
[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 1]  
: Predatory insect - dragonfly, ant lion, *Mantis*  
[any 1]  
: Insect which camouflages - stick insect / *Phyllium*  
: Common myriapods – *Scolopendra*/ *Scutigera*, *Julus*/ *Spirostreptus* / *Jonespeltis*  
[any 2]  
: Common arachnids – *Palamnaeus* / *Buthus*, spider/ tick / mite  
[any 2]
9. **Mollusks** : Inter tidal mollusks – *Chiton*, *Patella*, *Haliotis*, *Onchidium*, *Aplysia*  
[any 2]  
: Ornamental gastropods – *Cypraea*, *Murex*, *Turbinella*  
[any 2]  
: Poisonous gastropod – *Conus*  
: Pelecypods of economic importance – *Perna*, *Pinctada*,



*Teredo, Ostrea*

[any 2]

: Scaphopod - *Dentalium*

: Cephalopods of economic or evolutionary importance

*Sepia, Loligo, Octopus, Nautilus*

[any 2]

10. Echinoderms: *sea lily, star fish, brittle star, sea cucumber, sea urchin, cake urchin, heart urchin*

[any 3]

11. Hemichordata: *Balanoglossus*

12. Onychophora: *Peripatus* (Evolutionary significance)

**Section B: Histology:** Compare TS of an annelid [*Neanthes* / Earth worm / leech]

**Section C: Mountings**

1. Earthworm : Setae [a few loose setae] (minor)

2. *Neanthes* or any other polychaete: Parapodium [minor]

3. *Panaeus* : Appendages [minor]

4. Cockroach : Salivary apparatus [Major]

5. Honeybee/ plant bug: Mouth parts [minor]

**Section D: Dissections**

1. *Panaeus* : Nervous system [Major]

2. Cockroach : Nervous system [Major]

**THIRD SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY CORE COURSE-III**  
**ANIMAL DIVERSITY – CHORDATA- PART-I**  
**CODE: ZO3B 03T**

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

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

**Introduction** **[3 hrs]**

Chordate characters [fundamental, general and advanced]; chordates versus nonchordates; diversity of chordates; classification down to subphyla; salient features of each subphylum. Type study with special emphasis to comparing various functional systems (Comparative Anatomy) such as Morphology, Integumentary, digestive, respiratory, circulatory, excretory, nervous and reproductive systems. Also mention the evolutionary significance.

**Subphylum 1. UROCHORDATA** [Tunicata] **[5 hrs]**

Affinities; add a note on neoteny [paedogenesis]

Classification down to classes

Class: Ascidiacea Type: *Ascidia* [morphology and retrogressive metamorphosis]

Class Larvacea example: *Oikopleura*

Class Thaliacea example: *Doliolum*

**Subphylum 2. CEPHALOCHORDATA** **[4 hrs]**

Example: *Branchiostoma* [= *Amphioxus*] morphology, primitive, degenerate and specialized features [affinities and systematic position to be emphasized]

**Subphylum 3. VERTEBRATA** **[3 hrs]**

**Division 1. AGNATHA**

Characters and examples: *Myxine*; *Petromyzon* [mention Ammocoetous larva]

**Division 2. GNATHOSTOMATA**

**Super class PISCES** **[12 hrs]**

**Type: Mullet**

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

Class Chondrichthyes [cartilaginous fishes]

Order Selachii examples: *Scoliodon*, *Trygon*

Order Holocephali example: *Chimaera*

Class Osteichthyes [bony fishes]

Order Crossopterygii [coelacanths] example: *Latimeria*

Order Dipnoi [lung fishes] examples: *Neoceratodus*, *Protopterus*, *Lepidosiren* [Add a note on distribution of lung fishes]

Order Acanthopterygii [spiny-rayed fishes] examples: *Mugil*, *Rastrelliger*

Super class **TETRAPODA**

Class **AMPHIBIA**

[14 hrs]

**Type: Frog**

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

Order Apoda examples: *Ichthyophis*, *Uraeotyphlus*

Order Caudata examples: *Necturus*, *Ambystoma*, mention Axolotl

Order Anura examples: *Bufo*, *Rhacophorus*

Mention discovery of *Nasikabatrachus sahyadrensis*

Class **REPTILIA**

[16 hrs]

**Type: Calotes**

Classification of Reptilia down to subclasses; salient features of the following subclasses; mention the given orders with examples

Subclass Anapsida

Order Cotylosauria [stem reptiles] example: *Hylonomus*

Order Chelonia [common turtles, tortoises etc.] example: *Chelone*

Subclass Lepidosauria [= Super order 1. Lepidosauria under Subclass Diapsida]

Order Rhynchocephalia example: *Sphenodon*

Order Squamata examples: *Chamaeleon*, *Ophidia*: *Common poisonous and non-poisonous snakes of kerala. Ptyas, Typhlops, Naja, Daboia, Bungarus*; identification key for poisonous snakes

Subclass Archosauria [= Super order 2. Archosauria under Subclass Diapsida]

Order Crocodilia examples: *Crocodylus*, *Gavialis*, *Alligator*

Subclass Euryapsida and Subclass Synapsida

### **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; polyantivenins; prophylaxis
5. Accessory respiratory organs in fishes.
6. Economic importance of fishes.

## **CORE COURSE III: PRACTICAL- I\* C ANIMAL DIVERSITY –CHORDATA-PART I (36 hours) (2 hours per week)**

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

### **Section A: Study of the following 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. Cephalochordate : *Branchiostoma*
3. Agnathans : *Myxine*, *Petromyzon*, Ammocoetes larva [any 1]
4. Fishes : Common elasmobranchs - *Chiloscyllium*, *Stegostoma*, *Sphyrna*, *Pristis*, *Trygon*, *Narcine*, *Astrapes* [any 2]  
: Common food fishes - *Sardinella*, *Rastrelliger*, *Cynoglossus*, *Parastromateus*, *Trichiurus*, *Cybbium*, *Thunnus*, *Etroplus*, *Mugil*, *Wallagonia*, *Tilapia*, *Catla*, *Cirrhina*, *Labeo*, *Cyprinus* [any 3]  
: Fishes with special adaptive features - *Hippocampus*, *Belone*, *Hemirhamphus*, *Exocoetus*, *Tetradon*, *Pterois*, *Ostracion*, *Heteropneustes*, *Clarias*, *Arius*, *Anabas*, *Channa* [= *Ophiocephalus*], *Echeneis*, *Antennarius*, *Amphisila*, eel [*Anguilla* / *Muraena*] [any 5]
5. Amphibians : Common amphibians- *Bufo*, *Hyla*, *Rana*, *Rhacophorus* *Ambystoma*/ Axolotl larva, an apodan [any 3]
6. Reptiles : Common lizard- *Hemidactylus*, *Calotes*, *Mabuya* [any 1]  
: Lizards with special adaptations - *Draco*, *Chamaeleon*, *Phrynosoma*, *Uromastix* [any 2]  
: Non poisonous snakes: *Ptyas*, *Natrix*, *Eryx*, *Lycodon*, *Typhlops* [any 2]  
: Poisonous snakes - *Naja*, *Daboia* [*Vipera*], *Bungarus*, *Echis* [any 2]  
: Water snake – *Hydrophis* / *Enhydrina*  
: Arboreal snake – *Dryophis* / *Python*

### **Section B: Histology**

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

### **Section C: Mountings**

1. *Sardinella* : Cycloid scale [minor]
2. Shark/*Calotes* : Brain (minor)-Demonstration only.

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

1. Shark/*Calotes*/Frog : IX and X cranial nerves on one side (Major)
2. Shark/*Calotes* /Frog: Heart and ventral aorta with branches on both sides (Major)
3. Mullet : [or any other bony fish]: Alimentary canal [Major]

### **Section E: Osteology**

1. **Frog** : Vertebrae-Typical, 8th, 9th, 10th, Pectoral & pelvic girdle

**FOURTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)**  
**ZOOLOGY CORE COURSE-IV**  
**ANIMAL DIVERSITY – CHORDATA PART-II**  
**Code: ZO4B 04T**

[TAXONOMY, DIVERSITY, STRUCTURAL ANATOMY AND  
ADAPTATIONS OF CHORDATES – AVES AND MAMMALS]  
[54 hours] [3 hours per week] [3 credits]

(Give a comparative account of various functional systems of the types specified)

Class **AVES**

[27 hrs]

**Type: Columba**

Classification of Aves down to the orders specified; mention one example each

Subclass Archaeornithes

Order Archaeopterygiformes example: *Archaeopteryx* – brief account

Subclass Neornithes

Super order Palaeognathae [=Ratitae]

Order Casuariiformes example: *Casuarius* [cassowary]

Order Dinornithiformes [=Apterygiformes] example: *Apteryx* [kiwi]

Order Rheiformes example: *Rhea*

Order Struthiorniformes example: *Struthio* [ostrich]

Super order Neognathae [=Carinatae]

Order Galliformes [pheasants, quail, turkeys, grouse] example: *Pavo cristatus*

Order Anseriformes [screamers, water fowls] example: *Anas*

Order Passeriformes [perching birds] example: *Passer domesticus*

Order Piciformes [wood peckers, barbets, honey guides] example: *Dinopium*

Order Coraciiformes [kingfishers & allies] example: *Alcedo*

Order Apodiformes [swifts, humming birds] example: *Micropodus*

Order Strigiformes [owls] example: *Bubo*

Order Cuculiformes [cuckoos, roadrunners, turacos] example: *Eudynamys*

Order Psittaciformes [parrots, lorries, cockatoos] example: *Psittacula krameri*

Order Gruiformes [cranes, rails, coots, bustards] example: *Choriotis*

Order Charadriiformes [plovers, gulls, terns, auks, sand pipers] example: *Tringa*

Order Columbiformes [pigeons, doves, dodoes, sand grouse] example: *Columba*

Order Falconiformes [diurnal birds of prey – falcons, hawks] example: *Mylvus*

Order Ciconiiformes [herons, storks, ibis, spoon bills] example: *Ardea*

Order Pelecaniformes [pelicans, cormorants] example: *Pelecanus*

Order Sphenisciformes [Impennae] example: *Aptenodytes* [penguin]

Order Phoenicopteriformes [flamingos] example: *Phoenicopterus*

Add a note on extinct birds: passenger pigeon [*Ectopistes migratorius*], dodo

[*Raphus cucullatus*], pink-headed duck [*Rhodonessa caryophyllacea*], elephant bird

[*Aepyornis*] rediscovery of Jerdon's courser [*Cursorius bitorquatus*]

## Class MAMMALIA

[27 hrs]

Type: *Oryctolagus*

Classification of Mammalia down to the orders cited with examples specified

Subclass Prototheria Infraclass Ornithodelphia [egg-laying mammals]

Order Monotremata examples: *Ornithorhynchus* [platypus], *Tachyglossus* [= *Echidna*]

Subclass Theria Infraclass Metatheria [marsupials]

Order Marsupialia examples: *Didelphis* [opossum], *Macropus* [kangaroo]

Infraclass Eutheria [true placental mammals]

Order Edentata examples: *Bradypus* (sloth), *Dasypus* (armadillo) *Myrmecophaga* (spiny ant eater)

Order Pholidota example: *Manis* (pangolin / scaly ant eater)

Order Lagomorpha [rabbits and hares]

Order Rodentia examples: *Funambulus*, *Ratufa*

Order Insectivora examples: *Paraechinus* (hedgehog), *Suncus* (= *Crocidura*)

Order Dermoptera examples: *Cynocephalus* (*Galeopterus* - flying lemur)

Order Chiroptera examples: *Pteropus*, *Pipistrellus*

Order Primates examples: *Loris*, *Macaca*, *Gorilla*, *Pongo*, *Hylobates*, *Homo*

Order Carnivora examples: *Phoca* (seal), *Odobenus* (walrus), *Panthera* sps, *Viverricula indica* [civet]

Order Cetacea examples: *Physeter* (sperm whale) *Delphinus* (dolphins), *Phocaena* (porpoise) *Balaenoptera* (baleen whale)

Order Artiodactyla examples: *Sus scrofa cristatus*, *Gaur*, *Giraffa*, *Hemitragus* [tahr], *Cervus*, *Axis axis* (spotted deer), *Antelope cervicapra* [antelope, black buck]

Order Perissodactyla examples: *Equus caballus* (horse), *Rhinoceros*

Order Sirenia examples: *Trichechus* (manatee), *Dugong*

Order Proboscidea examples: *Elephas maximus indicus* [Indian elephant] and *Loxodont a africana* [African savanna elephant] *Loxodonta cyclotis* [African forest elephant]

### Topics for seminar:

(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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**CORE COURSE IV: PRACTICAL- I\* D**  
**ANIMAL DIVERSITY –CHORDATA-PART II**  
**(36 ours) (2 hours per week)**

**1.Birds-**

- 1.Fossil . Archaeopteryx
  - 2.Flightless bird.Rhea,Struthio [any 1]
  - 3.Aquatic birds.Jacana,duck,teal [any 1]
  - 4.Wet land birds.heron,ibis,stroks,pelicans [any 2]
  - 5.Migratory birds.pelicans,cranes,flamingos [any 1]
  - 6: Features and adaptations of: duck, parrot, king fisher, owl, kite and wood pecker [draw sketches of the beaks and feet of 3 birds)
- [Watch birds in their natural habitat and prepare a field note]**

- 2. Mammals :** Common insectivore – *Suncus*, *Hedgshog* [any 1]  
: Common rodent – rat/ bandicoot/ squirrel [any 1]  
: Common bat of Kerala [any 1]  
: A primate – *Loris* or any other item

**3.Osteology:**

Rabbit or any other mammal: skull [details of dentition], Atlas, axis, typical vertebra, scapula and pelvic girdle



**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)**  
**ZOOLOGY CORE COURSE –VI**  
**Code: ZO5B 06T**  
**ENVIRONMENTAL BIOLOGY, WILDLIFE CONSERVATION AND**  
**TOXICOLOGY,**  
**[54 hours] [3 hours per week] [3 credits]**

**Section A: ENVIRONMENTAL BIOLOGY (32 hrs)**

**1. Ecological tools and Techniques (4 hrs)**

1. Sampling of animal populations
  - (i) Trapping and collecting various groups of flying insects (aquatic organisms, soil organisms, birds and mammals).
  - (ii) Marking of animals
  - (iv) Determination of home range and territory
  - (v) Estimation of number of animals in population
  - (vii) Indirect method of estimating wild animals by their signs and symptoms.

**2. Remote sensing.**

**2. Ecosystem and Energetics (6hrs)**

- (a) Definition, scope and branches of ecology, Habitat, Niche, Community, Autecology and Synecology.
- (b) Energy flow and energetics of ecosystem
- (c) Solar energy and photosynthetic and chemosynthetic production
- (d) Energy transformations and energy transfer
- (e) Laws of thermodynamics

**3. Biogeochemical cycles (3 hrs)**

Basic types of biogeochemical cycles - Gaseous cycle - carbon and nitrogen cycles; sedimentary cycle

**4. Limiting factors (2 hrs)**

Basic concepts - Leibig's law of minimum - Shelford's law of tolerance, combined concept of limiting factors

**5. Population Ecology (5 hrs)**

Properties of population - density, natality, mortality, age distribution, biotic potential, environmental resistance and carrying capacity, population growth forms, J and S shaped curves, migration, emigration and immigration

**6. Community Ecology (5 hrs)**

Biotic community - definition, characteristics and classification, species diversity, fluctuations, stratification, succession, ecotone and edge effect

**7. Population interactions (3 hrs)**

Intraspecific and interspecific associations - Positive and negative interactions: Mutualism, Commensalism, Parasitism, Predation, Competition

**8. Man and Environment (4 hrs)**

- (a) Sustainable development (in brief)
- (b) Destruction of habitat and its consequences - wetland, paddy fields, mangrove, river encroachment, sand and clay mining, ecological impacts of tourism

## **Section B: WILDLIFE CONSERVATION (18 hrs)**

### **1. Biodiversity**

**(12 hrs)**

- (a) Introduction: alpha, beta and gamma diversities. Mention Shannon diversity index and Simpson's dominance index.
- (b) Hot spots of biodiversity. Mention hotspots in Indian region (Western ghats and Sreelanka, Eastern Himalayas and Indo Burma)
- (c) Threats to biodiversity (Habitat modification, pollution, poaching, etc.)
- (d) Role of systematics in biodiversity, Extinction of species.
- (e) Natural resources and conservation-Strategeies of conservation, Natural Reserves, Classification of natural resourses.
- (f) Wild life conservation, Wild life (protection Act)1972,Conservation projects. Project Tiger,Elephant,Lion,Crocodile,Dolphins, Swamp deer,Blackbuck and Turtle.
- (g) Endangered fauna and flora.
- (h) Sanctuaries-Thattekkad bird sanctuary&Parambikulam wild life sanctuary, National parks –Eravikulam NP &Silent valley NP and Biosphere Reserves-Nilgiri BR &Agasthyamalai BR .
- (i) Mention IUCN categories and Red data book.
- (j) Conservation of biodiversity - in situ and ex situ conservations. Mention conservation of germplasm.

### **2. Global Strategy for Conservation**

**(6 hrs)**

- (a) Stockholm Conference / Declaration (1972)
- (b) Nairobi Conference / Declaration
- (c) Rio Declaration (Earth Summit, 1992)
- (d) CITES
- (e) Biodiversity Convention of UNCED
- (f) Kyoto Agreement (1997)
- (g) Johannesburg Conference (2002)
- (h) World Summit on Sustainable Development
- (i) UNEP and its major strategies
- (j) Protection of plant varieties and farmer's right Act (2001)
- (k) Biodiversity Act 2002
- (l) Seed Bill 2005
- (m) Wildlife Act 1972 and its Amendments

## Section C: TOXICOLOGY (4 hrs)

### 1. Toxicants and public health hazards

- (a) Toxic chemicals (pesticides, automobile emissions, heavy metals, fertilizers, food additives, xenobiotics, radioactive wastes).
- (b) Indian law of drug and poisons
- (c) Levels of toxicity- Acute, sub acute, chronic, LD 50, LC 50
- (d) Common bacterial poisoning (botulism)
- (e) Behavioural Toxicology

### Topics for Assignment/Seminar

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

- 1. Environmental ethics and legislation
- 2. Individual responsibilities – Role of Governmental and Non Governmental Organisations in biodiversity conservation
- 3. Survey of animal poisons
- 4. Environmental pollution-land, water, sound and radiation

### References:

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Ramakrishnan, P.S- *Ecology and Sustainable Development* 2nd edition – National Book  
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**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY CORE COURSE –VII**  
**Code: ZO 5B 07T**  
**ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY**  
**[54 hours] [3 hours per week] [3 credits]**

**Section A: ETHOLOGY (14 hrs)**

- 1. Brief history, scope and branches of ethology.** (2 hrs)
- 2. Patterns of behaviour** (5 hrs)
- (a) Innate behaviour (orientation taxes/ kinesis), simple reflexes and instincts, motivation and categories of behavior.
- (b) Learned behaviour - habituation, conditioned reflex, trial and error learning; latent learning, imprinting, insight learning, memory and learning
- 3. Biological clocks / rhythms** (4 hrs)
- Photoperiod, circadian rhythm; migration, navigation and homing instinct; diapause, hibernation and aestivation (in brief)
- 4. Sociobiology** (3 hrs)
- Social group in termites and elephants, pheromones and social behavior. (mention human pheromones also)

**Section B: EVOLUTION (32 hrs)**

- 1. Introduction:** (2 hrs)
- Concepts of inorganic and organic evolution, History of evolutionary thought: Ideas of evolution during Pre-Darwinian, Darwinian and Post-Darwinian periods. (brief account).
- 2. Course of Evolution:** (6 hrs)
- (a) **Origin of life:** i) Theory of abiogenesis ii) Theory of biogenesis iii) Theory of special creation iv) Theory of Panspermia and v) Biochemical origin of life - Modern hypothesis – Oparin-Haldane Theory . Major steps in the biochemical evolution of the life (brief account): Origin of Earth and the primordial atmosphere, formation of organic molecules, formation of macromolecules or polymers, and formation of coacervates, microspheres, protocells and full fledged living cells. Experimental evidence for biochemical origin of life: Urey- Miller experiment. Other experiments , Modern ideas on the origin of life.
- (b) **History of Life on Earth:** Geological time scale (simple chart), mention Cambrian explosion.
- (c) **Fossils, Fossilization and Dating of fossils** (brief account).
- (d) **Living fossils:** mention common features and examples.
- 3. Evidences of Organic Evolution:** (5 hrs)
- i) Morphological and anatomical evidences: Homologous, analogous and vestigial structures and their evolution. ii) Physiological and biochemical evidences: examples. iii) Embryological evidences: examples, Biogenetic Law. iv) Palaeontological evidences: Kinds of fossilization, formation of sedimentary rocks, determination age of rocks and fossils, conclusion drawn from fossil records (brief account). v) Taxonomical evidences: evolution based principles of classification, mention phylogenetic tree.

#### **4. Theories of Evolution:** (5 hrs)

**Lamarckism:** Explanation of the major postulates of the Lamarck's theory with examples, Criticism against Lamarckism, Neo-Lamarckism, Present status of Lamarckism. **Darwinism:** Explanation of important postulates of Darwin's theory, Examples for natural selection, Criticism against Darwinism, Neo-Darwinism (Synthetic theory of evolution).

#### **5. Modern Concepts of Evolutionary Process:** (3 hrs)

Genetic basis of evolution: i) Mutations (gene and chromosomal mutations brief account), ii) Variations: somatic or environmental variations and genetic or hereditary variations, iii) Hardy-Weinberg Principle: Hardy-Weinberg Equilibrium, Factors that upset Hardy-Weinberg Equilibrium, iv) Genetic drift: effects on population, Bottleneck effect and Founder effect, genetic drift and natural selection, importance of genetic drift in evolution; Theory of Punctuated equilibrium and its relevance.

#### **6. Nature of Evolution:** (3 hrs)

**Species and Speciation:** Species concept: Morphological and biological species concepts, General characteristics and subdivisions (sub species, semispecies, sibling species, cline and deme) of species; Speciation: Types of speciation-i) Phyletic speciation (autogenous and alloigenous transformations) ii) True speciation (Instantaneous and gradual speciation [allopatric and sympatric speciation]).

#### **7 Isolation and Isolating Mechanisms:** (3hrs)

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.).

**8.Adaptive Radiation (Divergent Evolution):** cause and significance, adaptive radiation in Darwin's finches.

**Convergent Evolution:** mention examples.

**Pre-adaptation:** mention examples.

#### **9. Evolution of Vertebrate Groups:** (2 hrs)

Evolution of agnathans, fishes, amphibians, reptiles, birds and mammals (brief account).

#### **10. Evolution of Modern Man:** (3 hrs)

Evolutionary trends in humans, Ancestors of Primates, Apes-the closest relatives of man, Fossil ancestors of man: *Dryopithecus*, *Australopithecus* (The Man-Ape of Africa), *Homo habilis* (The Handy Man), *H. erectus*, *H. neanderthalensis* (Neanderthal man), The Cro-magnon, *Homo sapiens* (Modern man); Socio-cultural evolution (brief account).

## Section C: ZOOGEOGRAPHY (8 hrs)

### 1. Animal Distribution

(4 hrs)

- (a) Geographic distribution of animals - cosmopolitan distribution, discontinuous distribution, bipolar distribution and isolated distribution  
(b) Factors affecting animal distribution; Barriers to animal distribution - Physical barriers (topographical and climatic); biological barriers.

### 2. Zoogeographical realms

(2 hrs)

Zoogeographical regions with specific fauna (fauna regions): Palaearctic region, Oriental region, Australian region, Ethiopian region, Nearctic region and Neotropical region; insular fauna; Mention continental and oceanic islands.

### 3. Biogeography of India

(2 hrs)

Biogeographical zones of India

Trans Himalayan zone; Himalayan zone; Desert zone; semiarid zone; Western Ghats zone; Deccan plateau zone; Gangetic plain zone; North east zone. Coastal zone; Islands present near the shore line.

### Topics for Assignments / Seminars

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

1. Historical aspects of evolution - Inorganic and Organic
2. Fossils and fossilisation
3. Evolution of horse
4. Polyploidy and Evolution

## REFERENCES

### *For Ethology & Evolution*

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**CORE COURSE XVI: PRACTICAL II\*-A**  
**ENVIRONMENTAL BIOLOGY, WILDLIFE CONSERVATION,**  
**TOXICOLOGY, ETHOLOGY, EVOLUTION & ZOOGEOGRAPHY**

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

**I. Ethology (Any 1)**

1. Demonstration of the effect of alarm pheromones in ants
2. Demonstration of phototaxis using earth worm

**II. Evolution**

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 evolution of man based on three hominid fossils
4. Study of connecting links (*Archeopteryx* and *Peripatus*)
5. Study of any four vestigial organs in humans
6. Study of adaptive radiation in feet of birds / mouth parts of insects

**III. Zoogeography**

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

**IV. Environmental Biology, Conservation Biology & Toxicology**

1. Estimation of dissolved O<sub>2</sub> using Winkler method (in pond and tap water)
2. Estimation of dissolved CO<sub>2</sub> in pond and tap water
3. Determination of pH using pH paper / digital pH meter
4. Extraction of soil organism by hand picking, floatation and Berlese funnel method
5. Study of marine planktons (any five items up to genus level)
6. Study of food chain and food web.



**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)**

**ZOOLOGY CORE COURSE- VIII**

**Code: ZO 5B 08T**

**CELL BIOLOGY AND GENETICS**

**(54 hours) (3 hours per week) (3 credits)**

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

**I. Scientific instruments and techniques in Cell Biology**

**1. Microscopy:**

**(5 hrs)**

(i) Light microscopy: (a) Simple microscope (b) Compound microscope: Principles and uses; Use of oil immersion objectives; Use of ocular micrometer and stage micrometer for microscopic calibration (Micrometry); Use of cameralucida, principle and uses. Mention phase contrast microscope, Fluorescence microscope  
(ii) Electron microscopy: Principle, applications, advantages and disadvantages. Mention (a) Transmission Electron Microscope (TEM), (b) Scanning Electron Microscope (SEM). (c) Scanning-tunnelling microscope  
(d) Atomic force microscope.

**2. Histological Techniques:**

**(3 hrs)**

(i) Microtomy: Rotatory microtome (brief description), uses  
(ii) Preparation of materials for light microscopy (for temporary and permanent), fixation: Common fixatives, such as buffered formalin, ethanol, Bouin's solution and Carnoy's fluid; Common histological stains: Haematoxylin, Eosin and Leishman's). Vital stains: Neutral red and Janus green; Mounting medium: DPX, Canada Balsum

**3. Histochemicals**

**(1hr)**

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

**II. Structure of eukaryotic cell (2 hrs)**

**1. Plasma membrane** –Unit membrane concept. Structure (fluid-mosaic model) and Chemical organization; Functions – Transmembrane transportation –diffusion, osmosis, active transport, pinocytosis, phagocytosis. Glycocalyx – Modifications of plasma membrane

**2. Ribosomes:**

**(2hrs)**

Types of ribosomes in prokaryotes, eukaryotes and mitochondria; Structure and chemical composition of subunits; free and attached ribosomes, monosomes, polysomes; functions of ribosomes; biogenesis of ribosomes.

**3. Mitochondria:**

**(2 hr)**

Structure and Functions of mitochondria, mitochondriogenesis

**4. Lysosomes:**

**(1 hr)**

Structure and chemistry, kinds of lysosomes, polymorphisms, enzymes in Lysosomes, concept of GERL (Golgi body – Endoplasmic Reticulum – Lysosome complex), functions of lysosomes.

### **5. Centrioles and basal bodies:**

**(1hr)**

Structure, chemical composition and functions.

### **6. Golgi complex:**

Morphology, chemical components, secretory and endocytic pathways, functions, golgiogenesis.

### **7. Interphase nucleus:**

**(3hrs)**

General structure and functions, and nucleo-cytoplasmic index, Nuclear envelope : Structure , nuclear pores and pore complex formation, Functions, Nucleoplasm, Nucleolus: Structure, composition, nuclear cycle, nucleolar organizer, functions; Chromosomes: Chromatin, euchromatin, heterochromatin; Nucleosomes : chemical composition, Nucleosome packing , organization of chromatin.

### **8. Giant chromosomes:**

**(1hr)**

Polytene chromosomes: occurrence, structure, puffs and bands, endomitosis, significance in cytological studies.

Lamp brush chromosomes: occurrence, structure, loops, significance.

## **Cell Divisions**

**(3hrs)**

**1. Cell division** – Cell cycle; G1, S, G2 and M phases – Check points.

Amitosis: brief account only.

Mitosis: description of all stages, cytokinesis and significance.

Meiosis: description of all stages, nature of chromosomes during different stages and significance; mention stage G0 as an elevated part of cell cycle.

### **2. Cytogenetics of cancer**

**(2 hrs)**

Types of cancer, characteristics of cancer cells, Carcinogenesis (theories: brief account).

### **3. Cell aging:**

**(1 hr)**

Apoptosis – Cell death

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

### **1. Variations from Mendelian ratios:**

**(2 hrs)**

Incomplete dominance and co-dominance, lethal genes, Pleiotropism

### **2. Interaction of genes:**

**(3 hrs)**

Allelic and non allelic interactions, factor hypothesis, inheritance of comb pattern in Poultry, supplementary genes, complementary genes, epistasis, duplicate genes, polymeric genes, modifying genes, atavism, penetrance, expressivity, polygenic (quantitative) inheritance, skin colour in man

### **3. Multiple alleles:**

**(3 hrs)**

Definition, characteristics and examples: coat colour in rabbits, mention isoalleles, blood group alleles, genetics of ABO blood group system, mention other systems of blood grouping; MN blood group, Levin, and Bombay phenotype; Rh factor and erythroblastosis foetalis; (problems related to blood group inheritance are to be worked out)

**4. Linkage, crossing over and recombination:** (4 hrs)

Morgan's work on *Drosophila*, define chromosome theory of linkage; linkage types with examples: complete and incomplete linkage, linkage groups, crossing over; factors influencing linkage and crossing over; recombination; linkage map [Definition and principle]

**5. Sex determination:** (3 hrs)

Sex determination and sex differentiation, sex chromosomes; X and Y male heterogametic and female heterogametic chromosome mechanism of sex determinations [XX-XO, XX-XY, ZZ-ZW types]; Genic balance (ratio) theory of Bridges, environmental and hormonal influence of sex determination: sex in honey-bees and *Bonellia*; short notes on intersexes; gynadromorphism

**6. Sex-linked, sex-influenced and sex-limited characters:** (4 hrs)

Types of sex-linkage – sex linkage in man [colour blindness as an example] holandric genes [hypertrichosis as an example]; sex-influenced traits and sex-limited traits [definition and examples] – Pedigree analysis – importance of Y; dosage compensation – Barr body – Lyon hypothesis

**7. Mutation:** (3 hrs)

Definition – kinds of mutations – gene mutations – molecular basis of gene mutations – substitution mutations and frame shift mutations – mechanisms – factors influencing mutations – induced mutations – mutagens – Detection of mutations (CIB Method)

Chromosome mutations – numerical and structural changes

Numerical changes: euploidy and aneuploidy with subdivisions

Structural changes: deletion, duplication, insertion, inversion, translocation

Mention significance of mutations in speciation and breeding

**8. Human Genetics:** (4 hrs)

Normal chromosome complement in human beings, classification and grouping of human chromosomes (Patau's scheme), Gene therapy.

Chromosomal anomalies and disorders: Down's, Patau's, Edward's and Cri-du-chat syndromes, sex chromosomal anomalies like Turner's and

Klinefelter's syndromes), Gene mutations: autosomal mutations like

albinism, PKU, alcaptonuria, galactosemia, Tay-Sach's syndrome, Gaucher's disease, sickle cell anaemia, thalassemia, brachydactyly, sex chromosomal

mutations: haemophilia, Lesch-Nyhan syndrome, dermal hypoplasia

Polygenic traits: cleft palate / lip, club foot, hydrocephaly

**9. Genetic counselling:** (1 hr)

Eugenics, Euthenics and eugenics.

**Topics for assignments/seminars**

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

1. History of genetics
2. Human cloning – pros and cons.
3. Cytoplasmic or extra nuclear inheritance: Shell coiling in *Limnaea*, cytoplasmic organelles, DNA in chloroplast and mitochondria and endo-symbionts like kappa particles and sigma .
4. Microbodies : Peroxisomes and glyoxysomes, Structure, functions and origin of microbodies.
5. Human genome project
6. Cytogenetics of cancer

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- Weaver, H.: *Genetics*. 1997, W.C. Brow

**CORE COURSE XVI: PRACTICAL- II\*B**  
**CELLBIOLOGY AND GENETICS**  
**(54hours) (3 hours per week)**

**Section A: Cell Biology**

1. Staining of eukaryotic cells: Temporary mount of buccal epithelial cells to study their structure and observe Barr body.(Major)
2. Mitosis: stages in onion (*Allium cepa*) root meristem (squash preparation)
3. Calculation of mitotic index and metaphase index in root meristem of *Allium cepa*
4. Meiosis: stages in testis of grass hopper (demonstration only)
5. Giant chromosomes in Diptera: (*Drosophila* / *Chironomus* larvae) salivary gland cells (demonstration only).
6. Study of the parts of a compound microscope, its proper use and maintenance (Minor)
7. Measurement of size of microscopic objects using ocular and stage micrometers (Major)
8. Study of the applications of centrifuge. Demonstration of cell fractionation and centrifugation using fish liver (or any other specimen)

**Section B: Genetics**

1. Scheme of Pedigree chart
2. Study of sex-linked inheritance (haemophilia and colour blindness)
3. Study of inheritance of human traits: (use Pedigree charts). Blood groups, widow's peak, eye colour
4. Genetic problems on Monohybrid, dihybrid crosses, blood groups, incomplete dominance and sex-linked inheritance (minimum ten problems to be worked out)
5. Study of normal male and female human karyotype (use photographs or xerox copies) and abnormal human karyotypes (any two)
6. Study of genetic syndromes: Down's, Klinefelter's, Turner's and Edward's
- 7 Study of phenotypic characters in male and female *Drosophila*

**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY CORE COURSE- IX**  
**Code: ZO5B 09 T**  
**GENERAL METHODOLOGY IN SCIENCE, BIOSTATISTICS**  
**AND INFORMATICS**  
**(54 hours) (3 hrs per week) (3 credits)**

**Section A: GENERAL METHODOLOGY IN SCIENCE (20 hrs)**

**I. Science and Scientific Studies**

**(1hrs)**

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

**II. Scientific Methods**

**(7 hrs)**

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; Scientific evidences and Proofs; Peer reviews.

Importance of Models, Simulations and Virtual Testing.

**III. Experimentation**

**(6hrs)**

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.

**IV. Ethics in Science and Animal Ethics**

**(6hrs)**

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

Reporting of observational and experimental data, Influence of observer on observations. Publications, Patents, Plagiarism

Section 51A(G), Section 17.1(d) of the prevention of cruelty to animals. (Act of 1960)

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

I- Biostatistics: Definition, Scope, Role of statistics in Life Sciences, Terminology and variables .

Sample and Sampling: Sample size, Sampling errors, Methods of sampling Specific aspects of statistical data

i) Collection / documentation of data of the experiments:

Classification and tabulation of data

ii) Presentation of data: a) Graphic representation: Histogram, Frequency Polygon and Frequency Curve

b) Diagrammatic representation: Line diagram, Bar diagram and Pie diagram

iii) Analysis of data:

(a) Measures of central tendency: Mean, Median and Mode Standard error

iv) Interpretation:

Significance of statistical tools in data interpretation(mention t test, f test and chisquare)  
Statistics-based acceptance or rejection of hypothesis

## **SECTION-C: INFORAMTICS (19 hours)**

### **I. KNOWLEDGE SKILLS FOR HIGHER EDUCATION (8 hrs)**

Data, information and knowledge, knowledge management - Internet access methods - Dial-up, DSL, Cable, ISDN, Wi-Fi - Internet as a knowledge repository, academic search techniques, creating cyber presence, case study of academic websites, open access initiatives, open access publishing models. Basic concepts of IPR, copyrights and patents, plagiarism, introduction to use of IT in teaching and learning, case study of educational software, academic services - INFLIBNET, NICNET, BRNET

### **II. SOCIAL INFORMATICS (6 hrs)**

IT & society - issues and concerns - digital divide, IT & development, the free software movement, IT industry: new opportunities and new threats, software piracy, cyber ethics, cyber crime, cyber threats, cyber security, privacy issues, cyber laws, cyber addictions, information overload, health issues-guide lines for proper usage of computers, internet and mobile phones. E-wastes and green computing, impact of IT on language and culture - localization issues - Unicode - IT and regional languages.

### **III. IT APPLICATIONS (very brief account of the following) (5 hrs)**

e-Governance applications at national and state level, IT for national integration, overview of IT application in medicine, healthcare, law, crime detection, publishing, communication, resources disabled management, weather forecasting, education. IT in service of, futuristic IT - Artificial Intelligence, Virtual Reality, Bio-Computing.

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

**(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 for

#### **References – GENERAL METHODOLOGY &BIOSTATISTICS**

Bailey, N. T. J. (1994/'95). Statistical Methods in Biology, 3e, CUP/ LPE.  
Collins, H. and Pinch, T. (1993). The Golem: What Every one Should Know About Science, Cambridge University Press.  
Gieryn, T. F. (1999). Cultural Boundaries of Science, Univ. Chicago Press.



Green, R. H. Sampling design and Statistical Methods for Environmental Biologists. J.W. & S.

Gupta, S. P. (2002). Statistical Methods. 31e, Sultan Chand & Co.

Holmes, D., Moody, P. and Dine, D. (2006). Research Methods for the Biosciences, Oxford University Press.

Pechenik, J. A. (1987). A Short Guide to Writing About Biology, Boston. Little Brown.

Prasad, S. (2004 / '05). Elements of Biostatistics, Rastogi Publs., Meerut.

Ruxton, G. D. and Colegrave, N. (2006). Experimental Design for Life Sciences, 2e, Oxford University Press.

Rastogi, V. Fundamentals of Biostatistics 2nd edition – Ane's student edition

Snedcor, G. W. and Cochran, W. G. Statistical Methods. Allied East-West Press, ND.

Sokal, R. R. and Rohlf, F. I. Introduction to Biostatistics, W.H. Freeman.

Steel, R.G.D. and Torrie, J.H. Principles and Practice of Statistics with special reference to Biological Science.

Verma, B. L. *et al.* (1993). Biostatistics, OBS, ND.

Victoria, E. McMillan. (1997). Writing Papers in the Biological Sciences, Bedford Books, Boston.

Yadav, K. (1993). Teaching of Life Sciences, Anmol Pubns., New Delhi.

### **Useful webs**

Biological methods: [www.cfkeep.org/html/stitch.php?s=98965698293378 & id = 44650773279975](http://www.cfkeep.org/html/stitch.php?s=98965698293378&id=44650773279975).

Writing Papers : [www.ruf.rice.edu/~bioslabs/tools/report/reportform.html](http://www.ruf.rice.edu/~bioslabs/tools/report/reportform.html)

### **References on INFORMATICS**

Technology in Action, Pearson.

V. Rajaraman, Introduction to Information Technology, Prentice Hall.

Alexis Leon & Mathews Leon, Computers Today, Leon Vikas, Rs. 180.

Peter Norton, Introduction to Computers, 6e, (Indian Adapted Edition), Additional References.

Greg Perry, SAMS Teach Yourself Open Office.org, SAMS.

Alexis & Mathews Leon, Fundamentals of Information Technology, Leon Vikas

George Beekman, Eugene Rathswohl, Computer Confluence, Pearson Education.

Barbara Wilson, Information Technology: The Basics, Thomson Learning

John Ray, 10 Minute Guide to Linux, PHI, ISBN 81-203-1549-9.

Ramesh Bangia, Learning Computer Fundamentals, Khanna Book Publisher

### **Web Resources**

[www.fgcu.edu/support/office2000](http://www.fgcu.edu/support/office2000).

[www.openoffice.org](http://www.openoffice.org) Open Office Official web site.

[www.microsoft.com/office](http://www.microsoft.com/office) MS Office web site.

[www.Igta.org](http://www.Igta.org) Office on-line lessons.

[www.learnthenet.com](http://www.learnthenet.com) Web Primer.

[www.computer.org/history/timeline](http://www.computer.org/history/timeline).

[www.computerhistory.org](http://www.computerhistory.org).

<http://computer.howstuffworks.com>.

[www.keralaitmission.org](http://www.keralaitmission.org).

<http://ezinearticles.com/?Understanding-The-Operation-Of-Mobile-Phone-Networks&id=68259>.

<http://www.scribd.com/doc/259538/All-about-mobile-phones>.

<http://www.studentworkzone.com/question.php?ID=96>.

<http://www.oftc.usyd.edu.au/edweb/revolution/history/mobile2.html>

**CORE COURSE XVI : PRACTICAL- II\* C**  
**GENERAL METHODOLOGY IN SCIENCE, BIOSTATISTICS**  
**AND GENERALINFORMATICS**  
**[36 hours] [2 hours per week]**

**Any 4 items of the following (1-7)**

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.
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.
5. Censusing of the avian fauna / any fauna of an area and present the data in a suitable graphical form.
6. Construct frequency curve, frequency polygon, bar diagram, histogram and pie diagram using suitable data.
7. Formulate a hypothesis of any scientific observation made by you.
  - ☐ ☐ Feeding rate and BMI in an insect larva.
  - ☐ ☐ Phototaxis in Earth worms.
  - ☐ ☐ Mortality of mosquito larvae on application of oil / kerosene.

**SIXTH SEMESTER B.Sc .DEGREE PROGRAMME(Theory)**  
**ZOOLOGY CORE COURSE- X**  
**Code: ZO6B 10T**  
**(36) (2hours/ week) (2 credits)**

**BIOCHEMISTRY (36 hrs)**

**1. Introduction (2hrs)**

History and scope, Stabilising forces in biomolecules (micro and macro molecules) and elements of biological importance; Electrostatic bonds, Hydrogen bonds, hydrophobic interactions,

**2. Carbohydrates (6hrs)**

Structure and classification. Monosaccharides, Glucose, Fructose, Mannose, Galactose, Disaccharides, Sucrose, Maltose, Polysaccharides, Starch and Glycogen. Mention the biological functions.

Principles of analytical techniques (qualitative and quantitative) and clinical significance of these tests; (Benedict's, Fehling's, Barford's, Selivanof's etc.) Mention (i) Colorimeter (ii) Ultraviolet - visible spectrophotometer,

**3. Amino acids and Proteins (6hrs)**

Structure and classification of amino acids. Properties of amino acids. Isoelectric point, Zwitterion. Peptide linkages.

Primary, Secondary and Tertiary structure of proteins, physical and chemical properties. Denaturation of proteins.

Principles of analytical techniques such as Biuret reaction, Xanthoprotein test, Ninhydrin reaction. Separation techniques. Brief introduction to (1)Chromatography:(a) Paper chromatography (b) Column chromatography, 2.Electrophoresis: Mention (a) Polyacrylamide Gel Electrophoresis (PAGE) b) Agarose Gel Electrophoresis

**4. Lipids (4 hr)**

Classification and functions (simple and compound lipids), Triglycerides Mention phospholipids, lecithins, cephalins, prostaglandins and cholesterol.

**5. Enzymes and co-enzymes (4 hrs)**

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

**6. Nucleic acids (4 hrs)**

Chemistry and structure of purines and pyrimidines, chemistry and structure of nucleotides (ATP, cAMP, NAD<sup>+</sup>, FAD), molecular structure of B-DNA, molecular structure of tRNA.

**7. Metabolism of carbohydrates, proteins and lipids (10 hrs)**

Glycogenesis, glycogenolysis, gluconeogenesis, glycolysis, mention Kreb's cycle, Oxidation and reduction reactions, redox potentials, electrochemical gradients, electron transport chain, oxidative phosphorylation, role of cytochromes, release and storage of energy, high energy compounds, proton gradient and principles and chemiosmotic synthesis of ATP. Deamination, transamination and decarboxylation of amino acids.  $\beta$ -oxidation of fatty acids.

**Topics for assignments/seminars**

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

1. Biological roles of water
2. Mucopolysaccharides
3. Polyunsaturated fatty acids.
4. Importance of Nucleic acids
5. Structure of DNA
6. Specificity of Enzymes
7. Significance of TCA cycle.

## REFERENCES

1. Nelson, D.L. & Cox, M.M., Lehninger Principles of Biochemistry, 4e, Palgrave MC, WHF.
2. Oser, B., Hawk's Physiological Chemistry, 14e, 1971, TMH
3. D.M. Vasudevan and Sreekumari Text book of Biochemistry, Jaypee.
4. .Arora, M. P. (2004). Biophysics, 1e, Himalaya Publications
5. Asha Bhate (2005). Modern Tools and Techniques. Sarup & Sons.
6. Bajpai, P. K. (2006). Biological Instrumentation and Methodology, 1e, S. Chand & Company Ltd.
7. Boyer, R. (2004). Modern Experimental Biochemistry, 3e, Pearson Edn.
8. Conn, E.E. *et al.* Outlines of Biochemistry, 5e, 2001, John Wiley & Sons.
9. Mathews, C.K. *et al.*, Biochemistry, 3e, 2003, Pearson Edn. (Indian Edn.).
10. Voet, D. & Voet, J.G., Biochemistry, JW & S.
11. David P. Plummer - Introduction to Practical Biochemistry, 3<sup>rd</sup> edn., Tata McGraw Hill Pub. Comp., New Delhi.
12. Wilson and Walker – Principles and Techniques of Biochemistry and Molecular Biology, 6<sup>th</sup> edition – Cambridge Low Price edition.

## **ZOOLOGY CORE COURSE- XI**

**Code: ZO6B 11T**

**(54) (3hours/ week) (3 credits)**

### **PHYSIOLOGY AND ENDOCRINOLOGY- (54 hours)**

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

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

Balanced diet, nutrition in pregnancy, infant nutrition, breast feeding. Importance of dietary fibres, nervous and hormonal control of digestion, ruminant digestion. Nutritional disorders –anorexia, acidity, ulcer, flatulence, starvation, fasting and its significance. Obesity causes and consequences, Role of vitamins and minerals.

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

Brief account of gaseous exchange and transport of respiratory gases, respiratory pigments, structure and properties of Hb, Oxygen dissociation curve, Neurophysiological control of respiration; physiological problems in diving mammals, newborn and aged individuals.

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

Blood functions and composition, agglutination and coagulation of blood (enzyme cascade theory), clinical analysis of blood, haemostasis, haemolysis and jaundice, haemoglobinopathies, ESR, blood transfusion, aphaeresis,

Types of heart, haemodynamics. Common cardio-vascular problems: abnormal variations in BP, tachycardia, Bradycardia, Myocardial infarction, heart failure, cerebral haemorrhage and stroke, ECG.

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

Osmotic and ionic regulation in terrestrial, fresh water and Marine animals; Osmoconformers, osmoregulators, water retention and conservation in desert forms, types of excretion, urea cycle. Human kidney- urine formation with countercurrent mechanism and hormonal regulation. Abnormal constituents of urine.

##### **5. Muscle Physiology (6 hrs)**

Structure of vertebrate skeletal muscle, EM structure of Myofibrils and Myofilaments; contractile proteins, ultra structural changes, physiology and chemistry of muscle contraction, energy sources, role of creatine phosphate, coricycle, muscle twitch, fatigue, rigor mortis.

**6. Nerve Physiology (5 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 & chemical), neurotransmitters

**7. Bioluminescence and Bioelectricity (2 hr)**

Classification -symbiotic, extra cellular and intracellular. Physiology and significance of light production. Structure and functions of electric organs.

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

**1. Invertebrate endocrinology**

Neuro endocrine organs and hormones in insects and crustaceans. (1hrs)

**2. Vertebrate endocrinology**

Classification of hormones, steroid and peptide hormones, Endocrine glands in man (Pituitary, Adrenal, Pineal, Thyroid, Parathyroid, Gastro- intestinal, and Pancreas) and their hormones(brief account). Hormonal disorders. (5hrs)

**3. Concepts of neurosecretion**

Hypothalamus Hypophyseal interactions, Hypothalamus releasing and inhibiting hormones. Roles of hypothalamic and pituitary hormones: Antidiuretic hormone, Oxytocin, growth hormone, Adrenocorticotrophic hormone, TSH, Gonadotrophins. (4hrs)

**3. Reproduction**

Hormonal control of Testes, Functions of Testosterone. Role of Hormones in Female Sexual cycle, Placental Hormones, Female & Male sexual dysfunctions- Hormone related only.

**4. Hormonal action (4hrs)**

Mechanism of hormone action at the level of cell membrane (insulin), at the level of enzyme located in cell membrane (adrenaline and peptide hormones), at the level of organelles (thyroxine), at the level of genes (steroids), positive and negative feedback regulation; Hormone receptors (4hrs)

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

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

1. Role of enzymes in digestion of Carbohydrates, proteins and lipids.
2. Absorption of carbohydrates, proteins, and lipids.
3. Respiratory problems and health hazards caused by smoking.
4. Medical aids for respiration - aspirators, artificial respiration and ventilation, heart lung machine
5. Composition and functions of lymph.
6. Common renal problems - Renal hypertension, nephritis, renal failure, oedema, acidosis, uraemia, haematuria and calculi.
7. Brief notes on: Intelligence, memory, sleep, EEG, hunger, thirst and emotion
8. Emergency hormones, Epinephrine and norepinephrine.

### **REFERENCES**

1. Chatterjee, C.C., Human Physiology, Medical Allied Agency.
2. Ganong, W.F., Lange Review of Medical Physiology, 20, Indian Edn., 2002, MGH. .
3. Guyton, A.C., Hall, J.E.: Text book of Medical Physiology, IOC, Harcourt.
4. Vander, A.J. *et al.* Human Physiology, 1998, MGH.
5. Bentley, P. J. Comparative vertebrate endocrinology, CUP.
6. Berry, A.K., A Text book of Animal Physiology, 6e, Emkay Publications, Delhi-51.
7. Gorbman, A. *et al.* Comparative Endocrinology, JW & S.
8. Hoar, W.S.: General and Comparative Animal Physiology. 1975, PHI.
9. Vijayakumaran Nair and Paul, Animal physiology and Biochemistry, Academia.
10. Hadley, M.E., Endocrinology, 5e, 200, Pearson Edn. (Singapore), ND
11. Highnam & Hill: Invertebrate Endocrinology.
12. Turner, C.D. General and Comparative Endocrinology.
13. Williams, R.H., Text book of Endocrinology, W.B. Saunders.
14. Nielsen – Animal Physiology – Cambridge University Press.



**CORE COURSE XVII: PRACTICAL III\*-A**  
**BIOCHEMISTRY, PHYSIOLOGY AND ENDOCRINOLOGY**  
**(36 hours) (2 hours per week)**

1. Qualitative Tests for mono, di and polysaccharides (reducing and nonreducing) (major)
2. Qualitative Tests for protein
3. Qualitative Tests for lipids
4. Abnormal constituents of urine (glucose and albumin ) (major)
5. Determination blood clotting time (Demo)
6. Determination of blood pressure (Demo)
7. Determination of Hb content in man using Haemoglobinometer (Demo)
8. Determination of body mass index (individuals)
9. Separation of amino acids (or any other compounds) from a mixture by using paper chromatography (demonstration)
10. Determination of concentration of unknown solutions using Photo colorimeter (demonstration)

**References:**

- Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Patki, L. R., Balchandra, B. L. and Jeevaji, I. H. (1983). An Introduction to Microtechnique, S. Chand & Co. Ltd.
- Piramal, V. (2005). Biophysics. Dominant Publs. and Distributors.
- Plummer, D. T. (1995). An Introduction to Practical Biochemistry, 3e, Tata Mc Graw-Hill Publ. Co. Ltd., New Delhi.
- Roy, R. N. (2005). A Text Book of Biophysics. New Central Book Agency, Pvt. Ltd.
- Sawbney, S. K. and Singh, R. (eds.) (2001). Introductory Practical Biochemistry, Narosa.
- Verma, P. S. and Agarwal, V. K. (1985). Principles of Ecology. S. Chand & Co. Ltd., New Delhi.

**Code: ZO6B 12T**  
**MOLECULARBIOLOGY & BIO INFORMATICS**  
**[54 hours] [3 hours per week] [3credits]**

**Section- A: MOLECULAR BIOLOGY (27 hours)**

**1. Introduction**

**(5 hrs)**

DNA as the genetic material. Griffith's experiments-Bacterial transformations-Experiments by Hershey and Chase. Concept of gene-Gene action / gene expression: one gene – one enzyme hypothesis, one gene – one polypeptide hypothesis; central dogma of molecular biology and central dogma reverse; retroviruses.

**2. Repetitive and unique DNA sequences**

**(3 hrs)**

Chromosome content – C-value and C-value paradox, unique, moderately repetitive and highly repetitive DNA sequences – Satellite DNA – selfish DNA

**3. Genetic code**

**(4hrs)**

Gene and genetic code, deciphering / cracking of genetic code; contributions of 1) Nirenberg and associates, 2) Khorana; properties of genetic codes, codon assignments, wobble hypothesis

**4. Protein synthesis:**

**(5 hrs)**

Regulation of Protein synthesis – Role of RNAs  
synthesis of mRNA – promoter, enhancer and silencer sites – post transcriptional modifications – cis-trans splicing – spliceosomes – hn RNAs – activation of Amino acids – Polypeptide chain initiation, elongation and termination – release – Ribozymes – post translational modifications – coupled transcription and translation – poly cystronic mRNA – role of molecular chaperons – cell targeting proteins (brief account only).

**5. Regulation of gene action:**

**(4hrs)**

In prokaryotes [operon concept, Lac operon in detail], lytic cycle and lysogeny of phages [brief account] siRNA and RNAi, House keeping genes, gene modulation.

**6. Organization of genome**

**(5 hrs)**

Classical concepts of genes. Modern concept of genes – cistron, muton, recon, complicon, transcripton; split genes, overlapping genes, pseudo genes, jumping genes, cryptic genes [brief accounts only]

## **Topics for assignments / seminar**

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

- 1. Human genome project**
- 2. Structure of DNA**
- 3. Types of DNA**
- 4. Milestone of molecular biology**
- 5. Mitochondrial genome**
- 6. Types of RNA**

## **Section- B: BIO INFORMATICS (27 hours)**

### **I. Overview of Bioinformatics**

**(2hrs)**

Introduction: Definition, history, development and scope, tasks

### **II. Major databases in Bioinformatics**

**(5 hrs)**

a)Primary databases:

Nucleotide sequence databases – Mention EMBL, DDBJ, Genbank

Protein sequence databases – Mention Swiss Prot, PIR, MIPS

Metabolite databases – Mention KEGG, EcoCyc

b)Secondary databases: Mention PROSITE, PRINTS, Blocks

### **III. Database Search Engines**

**(4hrs)**

Mention Entrez at NCBI of USA, SRS at EBI of England, STAG at DDBJ of Japan

### **IV. Sequence Similarity Search**

**(3hrs)**

Pairwise sequence alignment: Mention BLAST, FASTA, Multiple

sequence alignment: Mention CLUSTAL W, CLUSTAL X

### **V. Micro arrays**

**(2hrs)**

Data analysis tools and methods

### **VI. Genomics**

**(3 hrs)**

DNA sequencing, applications (Brief account)

### **VII. Proteomics**

**(2 hrs)**

Tools and applications (Brief account)

### **VIII. Metabolomics**

**(2hrs)**

Tools and applications (Brief account)

## **IX. Applications of Bioinformatics (2hrs)**

## **X. Ethical issues in Bioinformatics (2hrs)**

Accuracy and error

a. Appropriate uses and users

b. Privacy and confidentiality

### **References:-Molecular biology:**

Alberts, B. *et al.* *Molecular Biology of the Cell*.

Garland Pubg. Inc., New York.

Bhaskaran, K.K. & Biju Kumar, A.: *Cell Biology, Genetics & Molecular Biology*.  
Manjusha.

Brooks, R. J.: *Genetics: Analysis and Principles*. 1999, Addison Wesley

Burns, G. W. & Bottino, P. J.: *The Science of Genetics*. 6/7e, Maxwell McMillan

Darnell, J. *et al.*: *Molecular Cell Biology*. Scientific American Book

De Roberties, E. D. P. *et al.*: *Cell and Molecular Biology* TMH

Dobzhansky, Th.: *The Genetics and Origin of Species*. Columbia Uty. Press

Freifelder: *Molecular Biology*. Narosa Pubg. House, N. D.

Gangane, S. D.: *Human Genetics*. 2e, 2000, B. I. Churchill Livingstone, N D.

Gerlad Karp: *Cell and Molecular Biology*.

Good Enough, U.: *Genetics*. Halt, Reinharts & Winston

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John Ringo: *Fundamental Genetics*- Cambridge University Press.

Kleinsmith, L. J. & Kish, V. M.: *Principles of Cell and Molecular Biology*. 2e,  
1995, Harper Collins College Pubs

Lewin, B. *Genes IX edition*. OUP

Mange, E. J. & Mange, A. P.: *Basic Human Geneics*. 1999. Indian edn. Rastogi

McCusik, V. A.: *Human Genetics*. PHI.

Micklos, D. A. & Freyer, G. A.: *DNA Science*. 1990, Cold-Spring Harbour Lab Pre

Primrose, S. B. *et al.*: *Principles of Gene Manipulation*, 6e, 2000, Blackwell Science.

Ricki, L.: *Human Genetics: Concepts and Applications*. WCB MGH

Red: *New Clinical Genetics*.

Robert H. Tamarin, *Principles of Genetics*.

Roy, R. N.: *Medical Biophysics*, 1e, 2001, Books & Allied, Calcutta

Sharma, A. K. & Sharma, A.: *Chromosome Techniques*. 1990, Butterworth

Sharma, A., *Chromosomes*. 1992, Oxford & IBH

Sharma, B. K.: *Instrumental Methods of Chemical Anlasis*. Goel Pub House

Sinnott, E. M. *et al.* *Principles of Genetics*, 1958, MGH

Snustad & Simons: *Principles of Genetics*. 1997, JW & S

Stine, C. J.: *The New Human Genetics*, W.C. Brown

Strachan, I. & Read, A.P.: *Human Molecular Genetics*. 1999, JW & S

Strickberger: *Genetics*, 4e, W.C. Brown Pub., Maxwell Macmillan.

Vijayakumaran Nair, K. & Jayaprakash, M.: *Cell Biology, Genetics, Molecular  
Biology*. Academica, TVM.

Watson, Baker, Bell, Gann and Levin, *Molecular Biology of Genes*.

Watson, J.D. *et al.*, *Molecular Biology of the Gene*, 4e, Benjamin Cummings

Weaver, H.: *Genetics*. 1997, W.C. Brown

Winchester, A.M.: *Genetics*, 3e, 1966/6790, Oxford & IBH.

Vides, *Integrative Approach to Molecular Biology*, MIT Press  
 Vides, *Gene Regulation and Metabolism*, MIT Press  
 Potchard, *Medical Genetics at a Glance*, Blackwell  
 Jan Vijg, *Aging of the Genome*, Oxford University Press  
 Frank H. Stephenson, *Calculations for Molecular Biology and Biotechnology: A guide to Mathematics in the Laboratory*, Academic Press, Elsevier

## References:Bioinformatics

Atwood and Parry-Smith. 2001. Introduction to Bioinformatics. Pearson Education Asia, New Delhi.  
 Baxeavanis & Ouellette. 2001. Bioinformatics - A practical guide to the Analysis of Gdnes and Proteins, Wiley, New York.  
 Mount, 2001. Bioinformatics: Sequence and Genome Analysis. Cold Sprint Harbour laboratory Press, New York.  
 S.C. Rastogi, Mendiratta, P. Rastogi. 2005. Bioinformatics: Method & Applications. Genomics, Proteomiocs & Drug Discovery. Prentice Hall of India, New Delhi.  
 Mani & Vijayaraj. 2004. Bioinformatics: A Practical Approach. Aparna Publications, India.  
 Higgins and Taylor. 2000. Bioinformatics: Sequence, Structure and Databanks. Oxford University Press, Oxford.  
 Jin Xiong. 2006. Essential Bioinformatics. Cambridge University Press, India Pvt. Ltd.  
 Rex A. Dwyer - Genomic Peril - From Bioinformatics Basics to Working Code (with CD) - Cambridge University Press.  
 Atwood and Parry-Smith. 2001. Introduction to Bioinformatics. Pearson Education Asia, New Delhi.  
[www.fgcuedu/supp](http://www.fgcuedu/supp)

### SIXTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)

#### ZOOLOGY Core Course XIII

Code: ZO6B 13 T

#### REPRODUCTIVE BIOLOGY, DEVELOPMENTAL BIOLOGY AND TERATOLOGY

(54 Hours) (3 hours per week, 3 credits)

#### Section A: REPRODUCTIVE BIOLOGY (14 hrs)

##### 1. Introduction

(1 hr)

Scope, reproductive strategies in invertebrates and vertebrates: semiparity and iteroparity, sexpatterns: unisexual, reversal of sex, examples.

##### 2. Reproductive system in human beings

(3 hrs)

Male reproductive system: Structure of testis, Semen production and composition, Ejaculation; Female reproductive system: Structure ovary and

Graafian follicle, ovulation, mention corpus haemorrhagicum, corpus luteum and corpus albicans; Accessory reproductive organs ; secondary sexual characteristics. Gametogenesis male and female

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

**4. Reproductive cycles in Mammals (2 hrs)**

Oestrous and menstrual cycles and their hormonal control

**5. Reproductive technologies (1 hr)**

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

**6. Cryopreservation and embryo transfer (1 hr)**

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

**7. Assisted Reproductive Techniques (ART) (1hr)**

GIFT, ZIFT, ICSI, oocyte donation and embryo donation

**8. Prenatal Diagnosis (1 hr)**

Different methods (invasive and non invasive). Female foeticide: ethical issues and law. (Mention Prenatal Diagnostic techniques – Prevention of misuse act – PNDT Act

**9. Fertility Control (2 hr)**

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

**Section B: DEVELOPMENTAL BIOLOGY (37hrs)**

**1. Introduction (1 hr)**

Historical Perspective, Theories of Preformation, Epigenesis, Recapitulation and Germplasm, Determinate and Indeterminate types of development, Germ layers and Derivatives.

**2. Types of eggs (2 hrs)**

Classification of eggs based on: the amount of yolk (micro, meso & macrolecithal), the distribution (iso, centro & telo lecithal), presence or absence of shell (cleidoic & non cleidoic), the development (determinate & indeterminate) with examples; egg membranes (primary, secondary and tertiary)

**3. Cleavage and cell lineage (3 hrs)**

Types of cleavage with examples: based on planes (Meridional, Vertical, Equatorial and Latitudinal); based on amount of yolk (Holoblastic & Meroblastic); based on development (Determinate & Indeterminate); based on Pattern (Radial & Spiral); Cell lineage studies in Planocera; Different types of blastulae.

**4. Early development of Amphioxus** (3 hrs)  
Cleavage, Blastulation, Gastrulation & Neurulation.

**5. Development of Frog** (8 hrs)  
Fertilization, Cleavage, Blastulation & fate map, Gastrulation (Morphogenetic movements) and formation of germ layers, neurulation & notochord formation, mesoderm and coelom formation; organogeny of brain and eye; hormonal control of amphibian metamorphosis.

**6. Development of Chick** (7 hrs)  
Fertilization, Structure of egg; cleavage, blastulation, gastrulation and formation of germ layers; Salient features of chick embryo at primitive streak stage, 24 & 33, 48 hours stage; Development and functions of extra embryonic membranes.

**7. Development of Man** (3 hrs)  
Cleavage and formation of morula, development of blastocyst, implantation, gastrulation up to the formation of germ layers.

**8. Cell Differentiation and Gene action during development** (4 hrs)  
Cell differentiation, totipotency, pluripotency, Dedifferentiation and Redifferentiation; controlled gene expression during development, Homeotic genes, Mention Hoxgenes; Stem cells, their significance and applications .

**9. Parthenogenesis** (2 hrs)  
Definition, Types: i). Natural parthenogenesis: Arrhenotoky, Thelytoky, Obligatory and Facultative, ii). Artificial parthenogenesis, and significance

**10. Experimental Embryology** (4 hrs)  
Construction of fate map, Vital staining, Marking with carbon particles & radio active tracing; Spemann's constriction experiments on amphibian embryos (Potency of nuclei and grey crescent), Importance of Grey crescent; Organizers in amphibian development (primary, secondary & tertiary organizers); Gradient experiments in sea urchin eggs).

### **Section C: TERATOLOGY (3 hrs)**

Environmental disruption of animal development (alcohol, drugs, Nicotine and chemicals- brief account) [Refer Developmental Biology, Scott F.Gilbert].

### **Topics for Seminar / Assignment/Discussion**

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

1. Placenta: different types and functions
2. Development of foetal membranes in man.
3. Regeneration in animals.
4. Factors affecting regeneration
5. Factors inducing parthenogenesis.
6. Structure of different types of eggs (amphioxus, frog, insect)
7. Corpus luteum, corpus albicans and corpus haemorrhagicum

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- Agarwal, P., *Chordate Embryology and Histology*, 1e, 2001, Krishna Prakashan
- Balinsky, B.I. *Embryology*, Saunders & Topan
- Bejley, D.J. *et al.*, *Human Reproduction & Developmental Biology*, 1980, McMillan
- Berril, N.J. & Karp, G. *Development* TMH.
- Gilbert, S.C., *Developmental Biology*, 5e, Sinauer Associates.
- Jayaprakash, M. *A Manual of Developmental Biology*, 2e, Academia, Trivandrum.
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- Patten, B.M.: *Foundations of Embryology*, 1958, McGraw Hill.
- Rugh, R.: *Frog Reproduction and Development*.
- Sastry & Shukal: *Developmental Biology*, 2003, 1e, Rastogi Pub.
- Scott, F., Gilbert: *Developmental Biology* – Sinaur Associates.
- Verma, P.S. & Agarwal V.K.: *Chordate Embryology*.
- Vijayakumaran Nair, K. & George P.V. *A Manual of Developmental Biology*, 3e, 2002.
- Wolpert, L.: *Principles of Development*, 1994, OUP.
- Muller, *Developmental Biology*, Springer Publishers.



**CORE COURSE XVII: PRACTICAL III\*B**  
**REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY**  
**(36 hours) (2 hours per week)**

1. Demonstration of chick blastoderm
2. Induced ovulation in fish
3. Study of life cycle in *Drosophila*

**Spotters**

Types of eggs (Insect, amphioxus, frog, chick, and human)  
Cleavage in frog (use slides / diagrams/models)  
Shark - Yolk sac placenta  
Frog- Blastula, gastrula, neurula  
Chick – 18, 24, 32, 48 hours of incubation  
Mammal - Any two mammalian embryos  
Larval forms of invertebrates (any five) and vertebrates (any two)

**SIXTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY Core Course XIV**  
**Code: ZO6B 14T**  
**BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY**  
**(54 hours) (3 hours per week) (3 credits)**

**Section- A: BIOTECHNOLOGY (18 hrs)**

1. **Definition and brief introduction of Biotechnology** – Mention branches of Biotechnology (brief). **(2 hrs)**
2. **Fundamentals of animal cell culture and hybridoma technology:** Primary cell culture, secondary culture, types of cell lines, valuable products from cell culture, hybridoma technology, monoclonal antibodies and their uses . **(3 hrs)**
3. **Gene cloning and DNA sequencing:** Introduction, cloning vectors (plasmid, pBR322, phages, cosmids, virus, YAC), Enzymes of rDNA technology (Exonuclease, Endonuclease, Restriction enzyme, DNA ligase, DNA polymerase, Reverse transcriptase)  
Use of Linkers  
Construction of Recombinant DNA, DNA sequencing (brief) **(4 hrs)**
4. **Transgenic organisms:**  
(a) Transfection methods: Calcium phosphate precipitation, Dextran mediated, Lipofection, Electroporation, Retroviral infection, micro injection, Shotgun method (brief)  
(b) Transgenic animals: Fish, sheep, rabbit, mice, and goat. 1 example from each  
(c) Molecular pharming and bioreactors  
(d) Mention knock out mice, Bt cotton **(3 hrs)**

**5. Molecular markers** – RFLP, RAPD, VNTR Micro satellites or STR, and their uses. Chromosome walking, Fluorescence in situ hybridization (FISH) and DNA Finger printing (Profiling) techniques. **(3 hrs)**

**6. Biotechnology and Environment:**

Biosensors, Bioremediation – Ex situ and in situ

Biofiltration , Bioleaching (microbial mining)

**(2hrs)**

**7. The ethical and social implications of genetic engineering.** **(1 hr)**

**Section-B: MICROBIOLOGY (18 hrs)**

**1. Introduction and scope of microbiology.** **(1 hr)**

**2. Survey of Microorganisms** (outline only)

**(3 hrs)**

Prions, Viroids, Viruses, Rickettsias, Mycoplasmas, Bacteria,

Cyanobacteria, Prochlorophyta, Protozoa, Algae, Fungi and Slime moulds

**3. Structure of a typical bacterium:** **(3 hrs)**

Characteristics and major groups of bacteria, growth phases, measurement of growth

**4. Viruses:** Structure and shape **(2 hrs)**

**5. Basic methods in Microbiology:** **(4 hrs)**

Microscopic methods, Techniques of sterilization, Media preparation, Isolation and inoculation, Direct observation and Staining techniques, Maintenance and preservation of cultures

**6. Microorganisms in Industry:** **(2 hrs)**

Products of industrial fermentations, Citric acid, Lactic acid, Amino acids, Enzymes, Vitamins, Antibiotics, Single cell protein, Steroids etc.). Effects of environment on microbial growth (Temperature, Atmosphere, pH and Osmotic factors

**7. Microorganisms in Human Diseases:** **(3 hrs)**

Normal micro flora of the human body, Diseases caused by Bacteria, Protozoa, Virus (brief). Epidemiology and control of diseases, chemotherapy

## **Section-C IMMUNOLOGY ( 18 hrs )**

### **1. Introduction and History**

Immunity – Natural and Acquired, Active and Passive, Immunisation, Vaccines Principles of vaccination, Attenuated bacterial or viral vaccines, inactivated viral or bacterial vaccines, Toxoid vaccines.(brief).

(2hrs)

### **2. Immune System**

Cells and organs of the immune system.(B- lymphocytes,T-lymphocytes,NK cells, monocytes,macrophages,Neutrophils,Basophils,Eosinophils, Mastcell & Dendriticcells. Organs-Spleen,Thymus .Bonemarrow and Lymphnodes

(3hrs)

### **3. Structure and classes of immunoglobins, their biological functions. (2 hrs)**

### **4. Antigens:**

Exogenous antigens, Endogenous antigens, adjuvants, haptens, Epitopes, Antigen-antibody reaction - Precipitation reaction, Agglutination reaction, Agglutination inhibition reaction.

(3hrs)

### **5. Autoimmune diseases:**

Systemic-Examples (a).SLE,(b) Multiple sclerosis and(c) Rheumatoid arthritis - Organ specific-Examples (a) Hashimoto's thyroiditis (b) Grave's disease and (c) Myasthenia gravis.

### **6. Techniques in Immunology :**

**(2hrs)**

(Principles and Applications of)

(i) Immuno assays: RIA, ELISA and Flow cytometry

(ii) PCR

(iii) Blotting techniques: (a) Southern blotting (b) Northern blotting

(c) Western blotting; Mention dot blots and slot blots.

(3hrs)

### **7. Tumour immunology:**

Malignant transformation of cells, tumour antigens, immune response to Tumour effector mechanisms in antitumor immunity. (a) Antibodies b) T-lymphocytes c) NK cells d) Macrophages (e) Immunotherapy.

(3hrs)

## **Topics for Assignment / Seminar**

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

1. Gene therapy.

2. Biofertilizers and Biopesticides.

3. Organ transplantation.

4. Genetically engineered microorganisms and their applications.
5. Hyper sensitivity reactions.
6. Genetically engineered food crops and concerns.
- 7. Cellular immunity.**
- 8. Humoral immunity.**

## References

- R. C. Dubey, A text book of Biotechnology, S. Chand & Co.  
 Benjamin Lewin – Genes, Vol. IX.  
 Old and Primrose – Molecular Cloning.  
 L.P. Rema – Applied Biotechnology – MJP Publishes.  
 R.C. Sobti and S. Pachauri – Essentials of Biotechnology – Ane books Pvt. Ltd.  
 B.D. Singh – A text book of Biotechnology, Kalyani Publishers.  
 Peleazar, M.J., Reid, R.D. and Chan, E.C.S., Microbiology, TMH.  
 Kuby, J., Immunology, W.H. Freeman.  
 Joshy K.R. Immunology – Agro Bios.  
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 A.S. Rao, Introduction to Microbiology, Prentice Hall of India.  
 Hans G. Schiegl – General Microbiology, Cambridge University Press.  
 Heritage, Evans and Killington – Introductory Microbiology – Cambridge University Press.  
 Kanika Sharma – Manual of Microbiology tools and techniques – Ane Books Pvt. Ltd.  
 Dominic W.C. Wong – The ABCS of gene cloning – Springer International Edn.  
 Veerbala Rastogi – Fundamentals of Molecular Biology, Ane Books Pvt. Ltd.  
 Colin Ratledge and Bjorn Kristiansen – Basic Biotechnology, Cambridge University Press.  
 John Smith – Biotechnology, Cambridge University Press.  
 Wise – Immunology – Blackwell Publishers.  
 Todd – Lecture notes on Immunology – Blackwell Publishing.  
 Monica Cheesbrough, District Laboratory Practice in Tropical Countries, Part I and II, Cambridge Low Price Editions.  
 Nicholl – An Introduction to Genetic Engineering – Cambridge University Press.  
 Wise – Immunology a Comprehensive Review – Ane Books.  
 Alphey – DNA Sequencing – Bios Scientific Publishers.  
 Hardin – Cloning, gene expression, and protein purification – Oxford University Press.  
 Gandhi – Microbiology and Immunology notes and cases – Blackwell Publishing.  
 N. Ahmed, Qureshi and Khan – Industrial and Environmental Biotechnology, Horizon Press.  
 Mansi – Fermentation, Microbiology and Biotechnology, Second Edition.- Taylor and Francis  
 Wise,- Bioinstrumentation and Biosensors - Taylor and Francis.

**CORE COURSE XVII: PRACTICAL III\*C**  
**BIOTECHNOLOGY, MICROBIOLOGY, IMMUNOLOGY , MOLECULAR**  
**BIOLOGY & BIOINFORMATICS**  
**(36 hours ) 2hours per week**

1. Staining of bacterial cell using appropriate bacterial stain. *Lacto bacilli*
2. Staining of root nodule Nitrogen fixing bacteria. *Rhizobium*.
3. Identification of motile bacteria by hanging-drop method. (Demonstration only).
4. Preparation of culture media for bacteria. (Synthetic Media, Natural Media, Simple Media, Differential Media, Selective Media,
5. Study of microbial byproducts. (Antibiotics, Milk products)
6. Identification of human blood group (A B O and Rh )
7. Prepare human blood smear to study the immunologically significant cells.
8. Study of transgenic animals.
9. Study of the principle and applications of Electrophoretic apparatus.
10. Study of the principle and applications of DNA finger printing.
11. PCR-Principle and applications.
12. ELISA-Demonstration.
13. Sequence Similarity Search using BLAST (Demonstration only)

**PROJECT WORK Code No: [ZO06 18(Pr)] – Vth SEMESTER**

(36 hrs 2 hrs/week, 2-credits)

Internal Mark-10

External Mark-40

Students are required to undertake project work on problems pertaining to biological science of 36hrs duration in Vth Semester. 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 9 students can undertake a particular 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 the Department must be submitted by *each candidate* for evaluation separately on the day of practical examination during VIth semester. The project must contain the following sections.

1. Introduction and objectives of study. (This part may contain citations of relevant literature in the field, if available)
2. Methodology
3. Interpretation of results
4. Reference

**Field Study / Study Tour (One credit, 10 Marks)**

A field study/study tour of 5 days is compulsory during the tenure of the programme. A total of atleast 3 days should be kept apart for visiting places of biological interest. One day trip should be associated with a site of ecological importance and one day trip should be associated with Elective course chosen. A detailed tour report certified by the teacher in charge of study tour and also by the Head of the Department regarding the field study/study tours specifying the places and institutions visited, date and time of visit, details of observations made etc. must be submitted by each student for evaluation during the day of practical examination of VIth semester. The study tour report is compulsory for each student appearing for practical examination.

**Viva-Voce (Two credit, 15 Marks)**

At the end of VIth semester each student shall appear for a viva-voce before a team of two external examiners. It will be conducted on a separate day for all candidates of the centre concerned. The questions will be based on basic biological concepts and field study. It shall not normally exceed 10 mts per candidate. Marks shall be given according to their performance.

There shall be an internal viva-voice for 3 Marks.

**SYLLABUS**  
**OPEN COURSES**  
**ZO5 D 01 , 02 & 03**  
**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY OPEN COURSE- I**  
**Code: ZO5-D 01**  
**REPRODUCTIVE HEALTH AND SEX EDUCATION**  
**(36 hours) (2 hours per week) (2 credits)**

**1.Introduction**

**(1 hrs)**

Reproductive rights, Need for sex education

**2.Sex determination and Chromosomal anomalies**

**(5hrs)**

Chromosomal mechanism of sex determination, Environmental control of sex determination, Hormonal control of sex determination, Barr body, Twin studies, Sex reversal, Sex chromosomal anomalies: Turner's syndrome and Klinefelter's syndrome.

**3.Sexual abuses and myths**

**(4hrs)**

Premarital and extramarital sex, Sexual abuse and rape, Sexual perversions, Alternate orientations (Homosexuality, Lesbianism, Bisexuality Paraphilias), Oral sex, Animal sex, Cyber sex, Child abuse, Prostitution, Sexual myths, Sexual hygiene.

**4.Prenatal Diagnosis**

**(3hrs)**

Different methods (invasive and non invasive). Female foeticide: Ethical issues and laws. (Mention Prenatal Diagnostic techniques – Prevention of misuse act – PNDT Act)

**5.Fertility Control**

**(4 hrs)**

Natural methods, Artificial methods, Contraceptive devices and medications, Abortion, Legal termination of pregnancy, Vasectomy, Tubectomy, Vaccines and hormones in fertility control.

**6.Infertility and assisted reproductive technologie**

**(5hrs)**

Physiological infertility, pathological infertility, causes and problems in male and female infertility. Assisted Reproductive Technologies (ART) – IVF, ET, AI, GIFT, ZIFT, ICSI, Embryo or oocyte donation, health hazards in ART, cryopreservation of blastocysts and ethics, designer baby and ethics.

**7.Sexually transmitted infectious diseases**

**(6hrs)**

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.

### **8. Ethical aspects of sex**

**(2 hrs)**

Introduction, Healthy relationship with opposite sex, Role of counseling, Gender discrimination in family and society, Sperm bank, Ovum bank,

### **9. Common diagnostic techniques**

**(6 hrs)**

Imaging techniques and purpose of imaging – Angiography, CT scanning, MRI, PET, and Ultra sound scanning.

Techniques to monitor body vital functions – EEG, ECG, LFT.

Laboratory diagnostic methods – ELISA, WESTERN BLOT.

Therapeutic methods – Endoscopies, Laser microscopy, haemodialysis, bypass surgery, angioplasty.

### **. Topics for Assignments and 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**

1. Prakash Kothari : *Common sexual problems and solutions*, UBS Publishers and Distributors Ltd.
2. Kinsey, sex and fraud, Judith, Edward W. Eichel, John H. Court and J. Gordon, Editors Lochinvar : Huntington House Publications.
3. Lynn L. Long, Judith A. Burnett, R. Valorie Thomas: *Sexuality counseling An integrated approach* , Pearson, Merrill Prentice Hall.
4. Robert T. Francoeur: *Becoming a sexual person*, John Wiley and Sons.
5. Guyton & Hall: *Textbook of Medical Physiology*
6. Churchill Livingstone : *Davidson's Principles and Practice of Medicine*.
7. Vander, Sherman and Luciano : *Human Physiology*, McGraw Hill.
8. Vijayakumaran Nair, K. and Paul, P.I: *Animal Physiology and Biochemistry*,



**FIFTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)**

**ZOOLOGY OPEN COURSE II**

**Code: ZO5D 02**

**NUTRITION, HEALTH AND HYGIENE**

**(36 hours) (2 hours per week) (2 credits)**

**Section-A: NUTRITION (18 Hours)**

1. Introduction
2. Components of food, classification of foodstuffs, Balanced diet.
3. Dietary recommendations to a normal adult, infant, pregnant woman and aged.
4. Malnutrition disorders.
5. Significance of breast feeding.
6. Importance of fibers in food.
7. Food toxins, food adulteration, food processing and preservation.
8. Defects of modern food habits, mention food additives
9. Nausea, Vomiting, diarrhea, Constipation, piles, anorexia, starvation, acidity, flatulence, ulcer
10. Fasting and its significance.
11. BMI and its significance.
12. Different feeding habits: vegetarians, non-vegetarians and vegans
13. Human digestive system.

**Section-B: HEALTH and HYGIENE (18 Hours)**

1. Physical health, psychological health, sociological health, Genetic influence on health. Three elements of health programmes: environment-education-surveillance.(1 hrs)
2. Fitness-body conditioning, principles of exercise programmes, sports, use of leisure time. (1 hr)
3. Alcoholism: Alcoholic beverages, physiological effects of alcohol, abuse of alcohol, treatment of chronic abuse of alcohol; Smoking: rights of non smokers, composition and effects of tobacco smoke, the smoking habits (active and passive smoking). (2 hrs)
4. Familiarization of various diseases and disorders of human body.
  - a. Communicable and non-communicable diseases (brief account): Bacterial, viral, fungal and protozoan, helminth. (2 hrs)
  - b. Parasites and their diseases (life cycle not expected): Mode of infection, pathogenecity, diagnosis, treatment and prophylaxis of *Entamoeba histolytica* & *Taenia solium* (2hrs)
  - c. Vector borne diseases and their control: *Anopheles*, *Culex* & *Aedes*.(1 hrs)
  - d. Disorders of blood vascular system: Hypotension and hypertension, coronary thrombosis, stroke. (2 hrs)
  - e. Cancer, hepatitis, jaundice, diabetes type I and II, insulinoma, Hyperinsulinism,Aids(briefaccount) ( 2 hrs)
  - f. Early intervention in autism, dyslexia and mental retardation. (1 hr)

5 .First aid-Snake bite (add a note on identification of poisonous and non poisonous snakes from the bite mark and observing the snake, mention Haemotoxic and neurotoxic venom, anti venom, poly venom (preparation); dog bite; Scorpion/ bee/ wasp sting; burns, road accidents, drowning.  
(2 hrs)

6 .Proper use of drugs-ill-effects of self medication. (1 hr)

7. Hygiene: Hygiene and health factors at home, personal hygiene, Oral hygiene and sexhygiene.  
(1 hr)

### **Topics for Assignments and Seminars;**

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

1. Vitamins, hypovitaminosis, hypervitaminosis
2. Substance abuse (alcohol, tobacco, resins, solvents, narcotics)
3. Blood pathology: anaemia, polycythemia, leucocytosis, leucopaenia, leukemia.
4. Genetic disorders, mental illness, rehabilitation.
5. Drug abuse in sports and athletics.

### **References**

1. Gibney, *Public Health Nutrition*, Blackwell.
2. Gibney, *Clinical Nutrition*, Blackwell.
- 99
3. Sarada Subramanyam and K. Madhavankutty, *Textbook of Human Physiology*.
4. Churchill Livingstone, *Davidson's Principles of Practice of Medicine*.
5. Guyton & Hall, *Textbook of Medical Physiology*.

**FIFTH SEMESTER B.Sc. DEGREE PROGRAMME (Theory)**

**ZOOLOGY OPEN COURSE- I**

**Code: ZO5D 03**

**APPLIED ZOOLOGY**

**(36 ours) (2 hours per week) (2 credits)**

**Section- A: ENTOMOLOGY**

**1. Introduction: ( 1hr)**

Mention Agricultural entomology, Forest entomology, Veterinary entomology Medical entomology , Forensic entomology, Industrial entomology, Nutritional entomology, Cultural entomology.

**2. Agricultural Pests (6 hrs)**

Definition of pest, Kinds of insect pests , Nature of damage caused and control measures of the following pests:

(a). Pests of paddy

1. *Spodoptera mauritia* (Rice swarming caterpillar)

2. *Leptocorisa acuta* (Rice bug)

(b). Pests of coconut

1. *Oryctes rhinoceros* (Rhinoceros beetle)

2. *Rhynchophorus ferrugineus* (Red palm weevil)

(c). Pests of stored products

1. *Sitophilus oryzae* (Rice weevil)

2. *Callasobruchus chinensis* (Pulse beetle)

**3. Productive Insects (6 hrs)**

**(a). Apiculture**

1. Brief description of common species of *Apis*

2. Honey bee products : bee wax and its uses, chemical composition of honey and uses

**(b). Sericulture**

1. Brief description of *Bombyx mori* (Mulberry silk moth), *Antheraea paphia* (tassar silkworm)

2. Sericulture and extraction of silk

3. Types of silk: Tasar, Muga and Eri Silk

**4. Insect Pest Management (5 hrs)**

1. Cultural control

2 Mechanical controls

3. Biological control

4. Chemical control

5. Integrated pest management (IPM)

### **Section- B: AQUACULTURE (4hrs)**

1. Brief account on Pisciculture, Prawn culture, Mussel culture and Pearl Culture (with examples).

### **Section- C: POULTRY SCIENCE (4hrs)**

1. Introduction, Importance of egg production, Nutritive value of eggs.
2. Breeds of fowl:
  - a) Exotic breeds: Rhode Island Red, Plymouth Rock, New Hampshire.
  - b) Indigenous breeds: Chittagong, Gangus

### **Section –D: ANIMAL HUSBANDRY (6 hrs)**

1. Introduction.
2. Breeds of cattle
3. Artificial insemination
4. Storage of semen
5. Embryo transfer technology
6. Common diseases : (a) Anthrax (b) Foot and mouth diseases (c) Rinderpest

### **Section –E: PARASITOLOGY (4hrs)**

1. Introduction
2. Human Parasites:

Mention the habits, habitat, life cycle, mode of infection, control measures of the following parasites: *Entamoeba histolytica*, *Plasmodium vivax* & *Taenia solium*.
3. Insect Vectors of human diseases:

*Anopheles*, *Culex* & *Aedes* (Mention habits, structure, disease caused and control).

### **References**

- Nayar, M.R.G.K. A *Monograph on Crop pests of Kerala and their control*. 1989 , Published KAU, Vellanikkara.
- Sobti *Medical Zoology* Shoban Lal & Co.
- Boraiah, G., *Lecturers on Sericulture* 2e. 1994, SBS Pub. Bangalore.
- Cherian & Ramachandran Bee keeping in *South Indian* Govt. Press, Madras.
- Dileep de Sarkar: *The Silkworm Biology* Genetics and breeding.
- FAO. manual of silkworm rearing. A manual of mulberry cultivation. A manual

of silk Reeling.

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Sarda Singh: *Bee Keeping in India*, ICAR.

Sreerama Reddy G. *Silkworm Breeding*

Sulochana Chetty & Ganga: Sericulture.

Tamaki. Y.: Sericology: Central Silk Board, 95-B, Marine Drive, Bombay-2.

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Lasley, J.F.: *Genetics of Livestock Improvement*. 1987, Prentice Hall Eaglewood.

Linter & Sunk: *Poultry Science*, Lippincot & Co. N.Y.

Sastry, N.S.R. Thomas, C.K. & Singh R.A.: *Poultry Production*.

Sastry, N.S.R. *Farm Animal Management & Poultry Prodcution*.

Sastry N.S.R.: *Farm Animal Management & Poultry Production*. Vikas.

Singh H & Mossa: *Livestock & Poultry Production*, PHI.

Thomas, C.K. & Sastry, N.S.R.: *Dairy Bovine Production*, 1991, Kalyani.

**SYLLABUS**  
**ELECTIVE COURSES**  
**ZO6B 15(E) 01,02&03**  
**SIXTH SEMESTER B.Sc. DEGREE PROGRAMME-(Theory)**  
**ZOOLOGY ELECTIVE COURSE- III**  
**Code: ZO6B 15(E) 01T**  
**HUMAN GENETICS**  
**(54 hours) (3 hours per week) (3 Credits)**

**1. Introduction: Scope and Significance** **(1 hr)**

**2. Identification of human chromosomes**

(a) History and nomenclature of human chromosomes – various conferences and their contributions: Denver, Chicago, Paris and Stockholm Conferences.

(3 hr)

(b) Characteristics of human chromosomes by non-banding techniques: A to G groups, various banding techniques, G-banding, Q-banding, R-banding, C-banding, Y-banding, NOR banding and fluorescent in-situ hybridization (FISH).

(4hr)

(c) Non-disjunction of chromosomes- Meiotic non-disjunction, mitotic non-disjunction, non-disjunction of autosomes, non-disjunction of sex chromosomes and mosaicism

(3 hr)

**3. Human Pedigrees**

Pedigree construction, data collection, analysis and pedigree charts of autosomal dominant, autosomal recessive, X-linked dominant and recessive gene mutation disorders.

(4hr)

**4. Autosomal dominant inheritance**

Familial hypercholesterolemia, metabolic and genetic control of cholesterol, Huntington's disease, Marfan's syndrome (Arachnodactyly), osteogenesis-imperfecta (brittle bone disease), Ehlers-Danlos Syndrome (Rubber man or the Elastic Woman)

(4hr)

**5. Autosomal recessive inheritance**, cystic fibrosis, CF gene and protein, Detection of CF homozygotes and carriers, hereditary microphaly, retinoblastoma, craniodiaphyseal dysplasia, Hutchinson-Gilford syndrome (progeria), Thalassemia and Hereditary hemolytic anemia.

(4hr)

**6. X-linked dominant and recessive inheritance:**

Duchene's muscular dystrophy, identification of the DMD gene, carriers and hemizygotes, Hypophosphatemia, Von willebrand's disease, SCID & Albright's hereditary osteodystrophy  
(4hr)

**7. Multifactorial inheritance**

Congenital heart diseases(ASD&VSD), Alzheimer's disease, Schizophrenia, intelligence, stature, blood pressure, refractive index of the Eye & dermatoglyphic ridge count.  
(4hr)

**8. Chromosome structural modification and the human phenotype**

Ring chromosome, Iso chromosomes, Philadelphia chromosome, cri-du-chat syndrome (5p<sup>-</sup> syndrome) Prader willi syndrome, Fragile X- Syndrome(Martin Bell syndrome), Burkitt's lymphoma (14q<sup>+</sup> syndrome)  
(4hr)

**9. Reproduction and Development**

(a) Prenatal development: genes and hormones.

Errors in sexual development: Defects of androgen target cells – deficiency

Of 5 alpha reductase, congenital adrenal hyperplasia, and sex reversal.

(b) Genetics of embryonic development

Maternal effect genes, segmentation and pattern formation genes, adhesion molecules and genes: programmed cell death (apoptosis).

(5hr)

**10. Genomic imprinting**, inbreeding in isolates, consanguineous marriages, twin studies, biology of twinning, analysis of twin data.

(4hr)

**11. Prenatal diagnosis and genetic services**

Amniocentesis, chorionic villi biopsy, foetoscopy, ultrasound sonography, Alpha foeto protein screening, Prenatal sexing, test tube babies, Karyotyping.

(4hr)

**12. Genetic counselling:**

Procedures and ethical concern, history of counselling, methods of genetic counselling, marriage counselling, directive and non directive reason for seeking counselling, psychodynamics of genetic counselling.

(5 hrs)

**13. Pharmacogenetics**, Ecogenetics and the Phenocopy.

(3hr)

### **Topics for Seminars / Assignment / Discussion**

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

1. Human genome project: Pros and cons in new era.
2. Role of genetics in modern reproductive techniques.
3. Gene therapy
4. Inborn errors of metabolism
5. Y-linked genes
6. XYY syndrome &XXX Females.
7. Triplet repeat disorders ( syndromes)
8. The effect of chromosome aneuploidy on the human phenotype

### **Books for Reference**

1. Basic Human Genetics: Elaine Johansen Mange & Arthur P. Mange, Rastogi Publications, Shivaji Road, Meerut.
2. Fundamentals of Genetics, John Ringo; - Cambridge University press
3. Genetics in Medicine: Thomson & Thomson, W.B. Saunders
4. Human Genetics: Gangane S.D., Bichurlev, New Delhi.
5. Human Genetics: Mc: Kursick, V.A.
6. Principles of Human Genetics: Curtstein Euresia Publishing House.
7. The New Human Genetics-Jerald.J. Stine (University North Florida) Wm. C. Brown Publishers, Dubuque. Iowa.

## **CORE COURSE XVII: ELECTIVE COURSE PRACTICALS III\*D**

### **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. Ishihara 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. Examination of Barr bodies.
7. Pedigree studies and identification of the nature of inheritance from pedigree chart (any one trait).
8. Identification of human karyotypes (Down's, Turner's, Klinefelter's) from idiogram.



**SIXTH SEMESTER B.Sc. DEGREE PROGRAMME (Theory)**  
**ZOOLOGY ELECTIVE COURSE**  
**Code: ZO6B 15(E)02T**  
**AQUACULTURE, ANIMAL HUSBANDRY & POULTRY SCIENCE**  
**(54 hours) (2 hours per week) (3 credits)**

**A. AQUACULTURE**

1. Introduction, its scope in India and Kerala, Export potential, Different types of cultures. (2 hrs)
2. Mariculture (3 hrs)
  - (a) Prawn culture: Important culture varieties, Pokkali culture, breeding spawning, control breeding, induced maturation, eye stalk ablation, culture methods, freezing, curing and canning.
  - (b) Mussel culture: *Perna indica*, *Perna viridis*, Seed collection, artificial seed production, induced spawning, rearing, raft culture, harvesting.
3. Pisci culture
  - (a) Egg collection, induced spawning, construction, preparation and maintenance of ponds, manuring, feeding and harvesting, cryo preservation of fish germplasm, semen bank and preservation media. (4 hrs)
  - (b) Biology and culture of Indian major carps – *Catla catla*, *Labeo rohita*, *Cirrhina mrigala*. (2 hrs)
  - (c) Biology and culture of Exotic carps. Eg: *Hypophthalmichthys molitris* – (Silver carp). (1 hr)
  - (d) Inland fishes and Fisheries – eg: *Channa*, *Clarius* - Rivers, Paddy fields, Utilisation of sewage in fish culture.
  - (e) General account and fishery aspect of sardine, shark, tuna. (3 hrs)
  - (f) Ornamental fisheries – common aquarium fishes, aquarium management and identification of sex. eg: *Carassius auratus* (Gold fish), *Pterophyllum* sps., *Astronotus ocellatus* (Guppy) – *Lebistes reticulatus*. (2 hrs)
4. Plankton and Fishery production – Zoo and Phytoplankton – Vertical migration – Plankton and Productivity. (2 hrs)
5. Fishing Gears: Gill net / drift gill net, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing. (3 hrs)
6. Fish Spoilage and Preservation – Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting, smoking. (4 hrs)
7. Fish utilisation (4 hrs)

Nutritive value, by products, liver oil, body oil, fish meal, fish flour, Isin glass, glue, skin, fin soup, lime, chitin, chitosan.
8. Diseases and parasites of Fish – Fungal infection – by – Saproleginia – Bacterial – Fin & tail rot disease, Dropsy. (2 hrs)
9. Mud banks of Kerala coast (1 hr)

## **B. POULTRY SCIENCE:**

### **Introduction and Scope**

- (a) Egg production, cable bird production, nutritive value, bye products. **(6 hrs)**  
(b) Different breeds – Exotic – 3 examples.  
Indigenous – 2 examples.  
(c) Poultry rearing : Selection of eggs, hatching, incubation, brooding, sexing, vaccination.  
Poultry housing: Free range system, Semi-intensive system (deep litter system and individual cage system).  
Equipments for feeding: Nutrients for starting, growing, laying hen.  
Common poultry feeds, food rations, and feed formulation.  
Common diseases of poultry (Ranikket, Pullorum, Fowl pox).

## **C. ANIMAL HUSBANDARY**

**(6 hrs)**

Introductin: history, origin, domestication.  
Breeds of cattle:  
Milk type : Sindhi, Gir  
Draft breed: Nagori & Kangayam  
Duel purpose: Ongole, Hariana  
Exotic breed : Jersey, Holstein – Friesian  
Native breeds: Conservation programmes, Vechur cow.  
Feeding: Common cattle feeds, fodder  
Common diseases : Anthrax, Foot & Mouth disease. Parasites.  
Meat hygiene: Slaughter and clean meat production – Zoonotic diseases.

## **D. DAIRY SCIENCE**

**(4 hrs)**

Role of dairy development in rural economy employment opportunities, white revolution.  
Dairy processes: Staining, Filtration, Cooling, Chilling, Clarification, Pasteurisation, Freezing, Recombined milk, Soft curd milk, Skimmed and toned milk.  
Artificial milk, Milk – adulteration.

### **Topics for Seminar / Assignment / Discussion**

1. Role of physical and chemical factors in aquaculture.
2. Fish weed organism: Sea weed culture. eg: Grassilaria, Sargassum.
3. Dairy products, manufacture and nutritive value.

### **References:**

1. Banerji, G.C. : A text book of Animal husbandry, 1998. Oxford & IBH.
2. Banerji, G.C. Poultry, Oxford & IBH.
3. P.R. Venkitaraman: Economic Zoology.
4. V. Sudheeran: Economic Zoology.
5. Kurian C.V., Sebastian C.V. : Prawn and Prawn fisheries in India, Hindustan Publication Corporation of India.
6. Alikunhi, K.R. : Fish culture in India, KAV, ICAR.

## **ELECTIVE COURSE PRACTICALS- XVII**

### **ELECTIVE COURSE PRACTICAL- III\*D**

**36 Hours 2 Hours per week**

#### **Aquaculture, Animal husbandary 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).
4. Study of different crafts and gears.
5. Study of aquarium and aquarium fishes / ornamental fishes.
6. Breeding techniques: preparation of hormone extracts and injection of hormones to fishes; eyestalk ablation in prawns.
7. Study of fish products and byproducts.
8. Identification of larval forms of prawn, pearl oyster, mussel, lobster and crab.
9. Identification of major edible crustaceans and mollusks.
10. Identification of edible sea weeds.

**SIXTH SEMESTER B.Sc. DEGREE PROGRAMME(Theory)**  
**ZOOLOGY ELECTIVE COURSE- I**  
**Code: ZO6B 15(E) 03T**  
**APPLIED ENTOMOLOGY**  
**(54 hours) (3 hours per week) (3 credits)**

**A. Agricultural Entomology**

**1. Introduction to Entomology** (5 Hrs)

Mention Agricultural entomology, Forest entomology, Veterinary entomology, Medical entomology, Forensic entomology, Industrial entomology, Nutritional entomology, Cultural entomology. Classification of Class Insecta down to orders, General organization of an insect.

**2. Insects in Service of Man** (2 hrs)

Useful products, Useful body, Galls, Pollinators, Destroyers of insect pests, Serve as food for animals and even man, Destroyers of weeds, Improve soil fertility, Act as scavengers, Aid in scientific research, Aesthetic and entertainment value, Use in medicine, Pollution indicators, Arrow poisons, Cold light, Insects in forensic science, Utility of insect pheromones and hormones (very brief account).

**3. Insects as enemies of Man:** (23 hrs)

Definition of pests, kinds of insect pests, causes of pest outbreak, pests injurious to plants and animals, pests as vectors of diseases,

**(a) Pests of Paddy:** (Life history, damage and control measures)

1. *Spodoptera mauritia* (Rice swarming caterpillar)

2. *Leptocorisa acuta* (Rice bug)

3. *Diuraphis armigera* (Rice hispa)

**(b) Pests of coconut:** (Life history, damage and control measures)

1. *Oryctes rhinoceros* (Rhinoceros beetle)

2. *Opisina arenosella* (Black headed caterpillar)

3. *Aceria guerreronis* (Coconut mite)

**(c) Pests of sugar cane** (damage and control measures)

1. *Chilo infuscatellus* (Sugarcane shoot borer)

2. *Scirpophaga nivella* (Sugarcane top shoot borer)

3. *Saccharicoccocus sacchari* (Cane mealy bug)

**(d) Pests of plantation crops:** Coffee, rubber, tea, pepper and cardamom. (Two examples for each, Damage, control measures)

Coffee: 1. *Xylotrechus quadripes* (Coffee white stem borer)

2. *Coccus viridis* (Coffee green bug)

Tea: 1. *Helopeltis antonii* (Tea mosquito bug)

2. *Toxoptera aurantii* (Tea aphid)

Rubber: 1. *Aspidiotus destructor* (Scale insect)

2. *Comocrits pieria* (Bark caterpillar)

Pepper: 1. *Longitarsus nigripennis* (Pollu beetle)

2. *Laspeyresia hemidoxa* (Shoot borer) Cardamom: 1. *Sciothrips cardamomi* (Cardamom thrips)  
2. *Eupterote canarica* (Cardamom hairy caterpillar)

(c) **Pests of fruits and vegetables** (Banana, mango, cashew, lady's finger, chilly, pulses, etc.) Two examples for each, Damage and control measures.

**Pests of fruit plants:**

- Banana : 1. *Cosmopolites sordidus* (Banana weevil)  
2. *Pentalonia nigronervosa* (Banana aphid)  
Mango : 1. *Batocera rufomaculata* (Mango stem borer)  
2. *Dacus dorsalis* (Fruit fly)  
Cashew : 1. *Plocoederus ferrugineus* (Cashew stem borer).  
2. *Helopeltis antonii* (Cashew mirid).

**Pests of vegetables:**

- Lady's finger: 1. *Platyedra gossypiella* (Pink ball worm)  
2. *Earias vitella* (Spotted ball worm)  
Brinjal : 1. *Leucinodes orbonalis* (Shoot and fruit borer)  
2. *Epilachna vigintioctopunctata* (Epilachna beetle)  
Cucurbits : 1. *Dacus cucurbitae* (Melon fly)  
2 *Raphidopalpa foveicollis* (Pumpkin beetle)

(d) **Pests of stored products.** ( damage and control measures).

1. *Tribolium castaneum* (Rust red flour beetle)  
2. *Callasobruchus chinensis* (Pulse beetle)

(e) **Pests of domestic animals:** 3 examples.

1. Domestic fowl: *Menopon gallinae* (Shaft louse)  
2. Goat : *Oestrus ovis*  
3. Cattle : *Tabanus striatus* (Horse fly)

**4. Insect Pest Control:**

(12 hrs)

(a) **Natural control** (b) **Applied control or Artificial control:**

Prophylactic and Curative methods [cultural, mechanical, legal methods (brief account), biological and chemical methods].

**Biological control** : History; Ecological, biological and economic dimensions of

biological pest control methods , Mention any 3 important biological control project undertaken in India. Merits and demerits.

**Chemical control:** Classification, Insecticides of plant origin; Insecticides, Mention insecticide residue, resistance and resurgence of insect pests; Pesticide appliances (Hand compression sprayer, Knapsack sprayer and Rocker sprayer); Precautions in handling insecticides (brief account).

**Modern methods of Pest control:** Autocidal and Pheromonal control (brief account)

**Integrated Pest Management (IPM):** Features, advantages (brief account).

## **B. Industrial Entomology**

**(12 hrs)**

### **Productive Insects**

**(a) Honey bee:** Apiculture and its scope; Different species, Social organization, structure of worker bee, life history (brief account) and communication; Bee products: Honey and Bee wax, Composition and Uses, Bee diseases.

**(b) Silk moth:** Different types of silkworms, life cycle (brief account); Sericulture (brief account), moriculture, Processing and extraction of silk (brief account), Diseases of silk worms, composition and uses of silk.

**(c) Lac insect:** Different strains of Lac insects; cultivation, inoculation and harvesting, propagation of lac ; composition and uses of lac, enemies of lac insects.

### **Seminars / Assignment / Discussion**

1. Biology of major insect vectors of human diseases, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla*, *Pediculus*, *Cimex*, *Phthirus*.
2. Diseases and its control measures of Filariasis, Yellow fever, Dengue, Typhus fever, Plague and Kala-azar.
3. Collection and Preservation of Insects.
4. Insects as human food for the future.
5. Causes of success of insects.

### **References**

1. Atwal, A.S and Dhaliwa, G.S.(2008) *Agricultural Pests of south Asia and their Management*, 6 e, Kalyani Publishers
2. Bhaskaran, K.K and Francy, C. F (2010) *Elements of Applied Entomology*, Manjusha Publications.
3. Dhaliwal, G.S. *et al* (2008) *Essentials of Agricultural Entomology*, Kalyani Publishers
4. Hill D.S. *Agricultural Entomology*
5. Metcalf, C.L. & Flint, W.P. (1973) *Destructive and Useful Insects*, USTMH,
- 6 Nalina Sundari, M.S and Santhi,R. *Entomology*, MJP Publishers
7. Nayar, K.K. *et al*. *General and Applied Entomology*, TMH
8. Nair, M.R.G.K. *A Monograph on Crop pests of Kerala and their control*. 3e. 1989 KAU Publ., Vellanikkara.
9. Nair. M.R.G.K. *Insect & Mite Crops in India*
10. Pedigo .*Entomology & Pest Management*
11. Ramakrishna Ayyar, T.V. Maras, 1963.*Handbook of Economic Entomology for South India*,
- 12 Srivastava,K. P. *A Text book of Applied Entomology* , Vol. I & Vol. II, Kalyani Publishers, Ludhiana, New Delhi, Noida (U.P.).

**ZOOLOGY ELECTIVE COURSE: XVII (PRACTICAL III\* – D)**  
**APPLIED ENTOMOLOGY**  
**(36 hours) (2hours per week)**

1. Identification and brief notes on the following pests:  
Any 2 pests each of paddy, coconut, banana, mango, cashew, coffee, tea, rubber, pepper, cardamom, and pests of vegetables.  
Pests of stored products (any 3)
2. Study of damage caused by pests: (damaged parts of plants, fruits and seeds, wood, pepper, 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 bees 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).

# MODEL QUESTION PAPETR

## FIRST SEMESTER B.Sc DEGREE EXAMINATION

### Part III Zoology (Core)

#### ZO1B01T – Core course I - Animal Diversity – Nonchordata – I

**Time: 3 Hour**

**Maximum Marks: 80**

#### **I. One Word Questions (Answer all the questions)**

1. Portuguese man of war.
2. Scientific name of Round worm.
3. Pathogen responsible for malaria.
4. Name the class to which *Dugesia* belongs.
5. The structure concerned with offense and defense in *Physalia*.
6. Name the organism commonly known as wheel animalcule.
7. Name an endoparasite seen in the gut of termite.
8. Name the scientist who proposed five kingdom classification.
9. Name the button polyp.
10. The scientific name of 'venus flower basket'.

**(10 x 1 = 10 Marks)**

#### **II. Paragraph Questions (Answer any ten questions)**

11. Give a brief account on the International Rules of Zoological Nomenclature.
12. What are corona and cement glands. Explain its functions.
13. Give an account of metagenesis.
14. Differentiate between radial and bilateral symmetry.
15. Write down the pathogenicity of *Enterobius*.
16. Explain the unique features of *Pleurobrachia*.
17. Comment on the polymorphism in *Physalia*
18. What are flame cells? What is its function.
19. Differentiate between polyp and medusa.
20. What are choanocytes?



21. Give the features of the class Calcispongiae.

22. Explain the locomotion in *Paramecium*.

**(10 x 2 = 20 Marks)**

**III. Short Answer Questions (Answer any five questions)**

23. Enlist the salient features of the Phylum Gastrotricha.

24. Write down the parasitic adaptations of Phylum Platyhelminthes.

25. Explain the life cycle and pathogenicity of *Wuchereria*.

26. Give an account on the salient features of the Kingdom Protista.

27. Write notes on a) Chemotaxonomy b) Serotaxonomy c) Cytotaxonomy.

28. With suitable diagram explain the structure of sponge gemmule. What is its significance?

29. With suitable sketch explain the structure of a cnidoblast.

30. Write notes on *Adamsia* and comment on its ecological association.

**(5 x 6 = 30 Marks)**

**IV. Essay Questions (Answer any two questions)**

31. With the help of suitable diagram explain the conjugation in *Paramecium*. Add a note on its biological significance.

32. Explain the five kingdom classification. Give its merits and demerits.

33. Classify the phylum coelenterate down to classes giving salient features. Give examples for each class

34. Give an account on the canal system in sponges

**(2 x 10 = 20 Marks)**

# MODEL QUESTION PAPETR

SECOND SEMESTER B.Sc DEGREE EXAMINATION  
Part III Zoology (Core)  
ZO2B02T – Core course II - Animal Diversity – Nonchordata – II

Time: 3 Hour

Maximum Marks: 80

**I. One Word Questions (Answer all the questions)**

1. Give the Scientific name of 'tusk shell'.
2. Name a living fossil.
3. The respiratory structure in *Asterias*.
4. The scientific name of Indian Cattle leach.
5. Name the class to which *Scolopendra* belongs.
6. Chemoreceptor in *Pila*.
7. The smallest appendage in *Penaeus*.
8. Name a tube dwelling polychaete.
9. Name the phylum to which *Bugula* belongs.
10. The sexual part of heteronereis.

(10 x 1 = 10 Marks)

**II. Paragraph Questions (Answer any ten questions)**

11. With suitable diagram explain the structure of a parapodium.
12. What are Pedicellaria. What is its function?
13. Explain heteronereis Stage.
14. Explain the structure and function of radula.
15. Explain the evolutionary significance of *Limulus*.
16. What is petasma and what is its function?
17. Write notes on *Arenicola* and comment on its ecological adaptations.
18. What is meant by parasitic castration?
19. Explain the parasitic adaptations of leech.
20. What are green glands? What is its function?

21. What is the importance of clitellum?
22. Explain the respiratory structures in *Penaeus*.

**(10 x 2 = 20 Marks)**

**III. Short Answer Questions (Answer any five questions)**

23. Explain the mechanism of branchial and pulmonary respiration in *Pila*.
24. Enlist the salient features of the class Trilobita.
25. Explain the affinities of *Peripatus*.
26. Explain the structure of a compound eye in *Penaeus*.
27. Explain the salient features of the phylum Arthropoda. Name the major classes of Arthropoda.
28. Give an account of *Balanoglossus*.
29. Enumerate the salient features of the phylum Ectoprocta. Give example.
30. Explain the excretory system of *Nereis*. Comment on its osmoregulation.

**(5 x 6 = 30 Marks)**

**IV. Essay Questions (Answer any two questions)**

31. With suitable diagrams describe the appendages in *Penaeus*.
32. Explain the water vascular system in starfish.
33. Classify the phylum Mollusca down to classes giving the salient features and examples of each class.
34. With the help of a suitable diagram explain the digestive system of *Nereis*.

**(2 x 10 = 20 Marks)**

# MODEL QUESTION PAPETR

**THIRD SEMESTER B.Sc DEGREE EXAMINATION**  
**Part III Zoology (Core)**  
**ZO3B03T – Core course III - Animal Diversity – Chordata – I**

**Time: 3 Hour**

**Maximum Marks: 80**

**I. One Word Questions (Answer all the questions)**

1. Name a fish with brood pouch.
2. Name a flying amphibian.
3. Name the order to which *Hylonomous* belongs.
4. Name the animal which exhibit neoteny.
5. Name the class to which *Oikopleura* belongs.
6. Write the scientific name of any two non-poisonous snakes.
7. Name the types of gills in osteichthyes
8. Name a poisonous euselachii fish with sting.
9. Name the connection between third and fourth ventricle of brain
10. Name the order to which *Rastrelliger* belongs.

**(10 x 1 = 10 Marks)**

**II. Paragraph Questions (Answer any ten questions)**

11. What is plastron?
12. Comment on the significance of *Latimeria*.
13. What is meant by neoteny?
14. Enlist the salient features of the order Apoda.
15. What are stem reptiles?
16. Write notes on *Chimaera*.
17. Differentiate between *Crocodylus* and *Alligator*.
18. Give an account on Ammocoetes larva.
19. Explain the morphological features of *Myxine* and *Petromyzon*.
20. Enlist the salient features of the order Rhynchocephalia.

21. Give an account on *Doliolum*.
22. Give an account on the primitive features of *Branchiostoma*.

**(10 x 2 = 20 Marks)**

**III. Short Answer Questions (Answer any five questions)**

23. Classify living amphibians down to classes. Give example for each class.
24. Give an account of Ascidia.
25. Explain retrogressive metamorphosis with suitable example.
26. Explain the peculiarities and distribution of Dipnoi.
27. Explain the respiratory structure and mechanism of respiration in frog.
28. Differentiate between chondrichthyes and osteichthyes.
29. Describe the salient features of the class Thaliacea. Give examples.
30. Explain the affinities of *Sphenodon*.

**(5 x 6 = 30 Marks)**

**IV. Essay Questions (Answer any two questions)**

31. Explain the identification key for poisonous and non-poisonous snakes
32. Classify Reptilia down to subclasses with salient features and examples.
33. With neat labeled diagram explain the structure of brain in Mullet.
34. With suitable diagram explain the venous system of frog.

**(2 x 10 = 20 Marks)**

# **MODEL QUESTION PAPETR**

**FOURTH SEMESTER B.Sc DEGREE EXAMINATION**  
**Part III Zoology (Core)**  
**ZO4B04T – Core course IV - Animal Diversity – Chordata – II**

**Time: 3 Hour**

**Maximum Marks: 80**

**I. One Word Questions (Answer all the questions)**

1. Name the three meninges in Rabbit.
2. Give the scientific name of any one egg laying mammal.
3. Write down the dental formula of rabbit.
4. Give the scientific name of ostrich.
5. Name a poisonous mammal.
6. Name an ape found in India.
7. Give the scientific name of Peacock.
8. Name a carnivorous mammal which gives ivory.
9. Name the order to which Rhinoceros belongs.
10. Name the ear ossicles.

**(10 x 1 = 10 Marks)**

**II. Paragraph Questions (Answer any ten questions)**

11. What are pouched mammals? Give an example
12. Explain the desert adaptations of Ostrich
13. Explain the functions of pancreas in Rabbit
14. What is the stato-acoustic organ of Rabbit? What is its function?
15. Give the features of Perissodactyla.
16. What is meant by coprophagy?
17. What is meant by complete double circulation?
18. What are pace makers? What is its function?
19. What is pecten? What is its function?
20. What is iter?

21. Give an account on the salient features of Ratite.
22. Comment on the dentition in rabbit.

**(10 x 2 = 20 Marks)**

**III. Short Answer Questions (Answer any five questions)**

23. Briefly explain the affinities of *Archeopteryx*.
24. Enlist the salient features of Lagomorpha and Rodentia.
25. Explain the adaptive features of Cetacea and Sirenia.
26. Briefly explain the structure of heart in Rabbit.
27. Explain the structure of a typical feather in birds.
28. Briefly explain the characters of the Order Marsupialia.
29. Give the salient features of Psittaciformes. Give examples.
30. Explain the structure of eye in Rabbit.

**(5 x 6 = 30 Marks)**

**IV. Essay Questions (Answer any two questions)**

31. With suitable diagrams explain the respiratory system of Rabbit.
32. With suitable sketches explain the venous system of Rabbit.
33. Explain the respiratory system and mechanism of respiration in *Columba*.
34. Compare and contrast the arterial system of *Columba* and *Oryctolagus*.

**(2 x 10 = 20 Marks)**

**SYLLABUS**

**UNIVERSITY OF CALICUT**  
**B.SC. DEGREE COURSE**  
**COMPLEMENTARY COURSE – ZOOLOGY**

*With effect from 2014-15 admission onwards*

**MARK DISTRIBUTION AND INDIRECT GRADING SYSTEM**

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 7 point scale is followed. Each course is evaluated by assigning marks with a letter grade (A+, A, B, C, D, E or F) to that course by the method of indirect grading.

**SEVEN POINT INDIRECT GRADING SYSTEM**

<i>% of Marks Grade</i>	<i>Grade</i>	<i>Interpretation</i>	<i>Grade Point Average</i>	<i>Range of Grade points</i>	<i>Class</i>
90 and above	A+	Outstanding	6	5.5 - 6	First Class with distinction
80 to below 90	A	Excellent	5	4.5 – 5.49	
70 to below 80	B	Very good	4	3.5 – 4.49	First Class
60 to below 70	C	Good	3	2.5 – 3.49	
50 to below 60	D	Satisfactory	2	1.5 – 2.49	Second Class
40 to below 50	E	Pass/Adequate	1	0.5 – 1.49	Pass
Below 40	F	Failure	0	0 – 0.49	Fail



## SCHEME OF INSTRUCTION

Zoology forms one of the Complementary courses of the B.Sc. Degree programme. It is to be taught during the first four semesters of the programme. The syllabus includes Theory as well as Practical components

### B.SC. ZOOLOGY COMPLEMENTARY COURSE STRUCTURE

**Total Credits 12 (Internal 20% & External 80%)**

Semester	Code No	Course Title	Hours/ Week	Total Hours/ Semester	Credits	Marks
I	ZO1C01	Complementary Course I: Zoology-I	2	36	2	80
		Complementary Course V: Zoology Practical-I	2	36	*	--
II	ZO2C02	Complementary Course II: Zoology-II	2	36	2	80
		Complementary Course V: Zoology Practical-II	2	36	*	--
III	ZO3C03	Complementary Course III: Zoology-III	3	54	2	80
		Complementary Course V: Zoology Practical-III	2	36	*	--
IV	ZO4C04	Complementary Course IV: Zoology-IV	3	54	2	80
		Complementary Course V: Zoology Practical-IV	2	36	*	--
	ZO4C05(P)	Complementary Course V: Zoology Practical-V	2	36	4*	80
<b>Total</b>					12	400

\* Examination will be held at the end of 4<sup>th</sup> semester

## SCHEME OF EVALUATION

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

### THEORY

#### 1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

**Table 1:- Components of Evaluation**

Sl. No.	Components	Marks
1	Attendance	4
2	Test Papers: I & II	4 + 4
3	Assignment	2
4	Seminar	2
Total Marks		16

**Table 2:- Percentage of Attendance and Eligible Marks**

% of attendance	Marks
Above 90%	4
85-89%	3.2
80-84%	2.4
76-79%	1.6
75%	0.8

**Table 3:- Pattern of Test Papers**

<b>Duration</b>	<b>Pattern</b>	<b>Total number of questions</b>	<b>Number of questions to be answered</b>	<b>Marks for each question</b>	<b>Marks</b>
1.5 Hours	One word	4	4	1	4
	Short answer	4	4	2	8
	Paragraph	3	2	5	10
	Essay	2	1	10	10
<b>Total Marks*</b>					<b>32</b>

\*Marks: 80% & above = 4, 60 to below 80% = 3, 50 to below 60% = 2  
 35 to below 50% = 1 below 35% = 0

## 2. EXTERNAL EVALUATION

External Evaluation carries 80% of the total marks. University Examination will be conducted at the end of each semester.

**Table 1:- Pattern of Question Paper**

<b>Duration</b>	<b>Pattern</b>	<b>Total number of questions</b>	<b>Number of questions to be answered</b>	<b>Marks for each question</b>	<b>Marks</b>
3 Hours	One word	10	10	1	10
	Short answer	10	7	2	14
	Paragraph	6	4	5	20
	Essay	4	2	10	20
<b>Total Marks*</b>					<b>64</b>

## **PRACTICAL**

### **1. INTERNAL EVALUATION**

**Table 1:- Components of Evaluation**

<b>Sl. No.</b>	<b>Components</b>	<b>Marks</b>
1	Attendance	5
2	Performance & Punctuality	3
3	Test Papers	4
4	Record	4
<b>Total Marks</b>		<b>16</b>

**Table 2:- Percentage of Attendance and Eligible Marks**

<b>% of attendance</b>	<b>Marks</b>
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

**Table 3:- Percentage of Eligible Marks for Performance & Punctuality**

<b>Criteria</b>	<b>Marks</b>
Excellent	3
Good	2
Moderate	1

**Table 4:- Percentage of Eligible Marks for Test Papers**

<b>Criteria</b>	<b>Marks</b>
85% and above	4
70 - 84%	3
55 - 69%	2
40-54%	1

**Table 5:- Percentage of Eligible Marks for Record**

<b>Criteria</b>	<b>Marks</b>
Excellent	4
Good	3
Average	2
Below average	1

## **2. EXTERNAL EVALUATION**

The Practical Examination will be held at the end of fourth semester. External Evaluation carries 80% of the total marks. The question paper for the conduct of practical examination shall be prepared by the Board of External Examiners appointed by the university. The duration for the conduct of examination is **4 hours**

## SYLLABUS

First Semester B. Sc. Degree Programme

Complementary Course I: Zoology-I

ANIMAL DIVERSITY & WILD LIFE

Code: ZO1C01

(36 hours) (2 hours per week) (Credits - 2)

### A. Animal Diversity

30 hrs

The study of animal diversity is based on types with emphasis on structural organisation and classification down to classes with examples.

#### I. Type for detailed study -- 18 hrs

##### 1. *Penaeus* (6 hrs)

Morphological features, Appendages, Digestive system & feeding and digestion, Respiratory system and mechanism of respiration, Blood vascular system, Excretory system, Nervous system, Sense organs (statocyst, compound eye), Reproductive system

##### 2. *Oryctolagus* (12 hrs)

Morphology, Vertebral column (typical vertebra, Atlas, Axis, Thoracic vertebra, Fore limb, Pectoral girdle, Hind limb, Pelvic girdle), Digestive system and mechanism of digestion (mention about dentition, digestive glands & coprophagy), Respiratory system and mechanism of respiration, Structure of Heart and its working and regulation of heart beats, Brain, Eye, Ear, Urinogenital system)

#### II. Classification --- 12 hrs

An outline of 5 kingdom classification.

Kingdom: *Protista*: Salient features, classification including sub kingdom. Names only. Special reference on sub kingdom with salient features Eg:- *Noctiluca* & *Vorticella*.

Kingdom Animalia (Only salient features, mention classes)

Phylum Porifera Eg: *Leucosolenia*

Phylum Coelenterata Eg: *Obelia*

Phylum Platyhelminthes Eg: *Fasciola*, *Schistosoma*

Phylum Aschelminthes Eg: *Ascaris*

Phylum Annelida Eg: *Arenicola*, *Hirudinaria*

Phylum Arthropoda Eg: *Limulus*, *Peripatus*, *Sacculina*, *Eupagurus* & *Belostoma*

Phylum -Mollusca Eg: *Chiton*, *Perna*, *Teredo* & *Sepia*

Phylum Echinodermata Eg: *Asterias* & *Holothuria*

Sub phylum Urochordata Eg: *Ascidia*

Subphylum Cephalochordata Eg: *Branchiostoma*

Subphylum Vertebrata :

Agnatha Eg: *Petromyzon*

Super class Pisces

Class: Chondrichthyes Eg: *Narcine*

Class: Osteichthyes Eg: *Echeneis*, *Hippocampus* and *Heteropneustes*

Super class Tetrapoda

Class Amphibia Eg: *Ichthyophis*, *Salamandra* and *Rhacophorus*

Class Reptilia Eg: *Chamaeleo*, *Daboia* & Tortoise

Class Aves Eg: *Columba*

Class Mammalia Eg: *Pteropus*

## **B. Wild life**

**6 hrs**

I. Threats to Biodiversity

II. Wild life management and conservation Mention Protection Acts.

III. Sustainable development

IV. Red data Book & IUCN

## Assignments

Teachers can suggest topics of Assignments / Seminars (**For internal evaluation only**).

## References

1. Jordan E.L. & Verma, P.S. *Invertebrate Zoology* S. Chand & Co.
2. Jordan E.L. & Verma, P.S. *Vertebrate Zoology* s. chand & Co.
3. Kotpal, R.L. *Modern Text Book of Zoology* Rastogi Publi. *Vertebrate & Invertebrates*
4. Soper, R. *et al. Biological Sciences*, Cambridge University Press.
5. Rajesh Gopal. *Wild life Biology*.
6. Ekambraanatha Ayyar, M. & Ananthakrishnan, T.N. *Manual of Zoology*, Vol. I (Part I & II),  
S. Viswanathan, Madras.
7. Encarta: 2004 Edn or earlier versions (CDs), Microsoft.
8. Encyclopedia Britannica: 2004 Edn. or earlier versions (CDs), Britannica.com.India.
9. Ahluwalia, V.K. and Sunitha Malhotra-Environmental Science, Ane Books Pvt.Ltd.  
<http://www.ucomp.berkeley.edu>.  
<http://www.mbl.edu>.  
<http://phylogeny.cornell.edu>  
<http://www.ent.castate.edu>.



**COMPLEMENTARY COURSE V: ZOOLOGY PRACTICAL - I**  
**(36 hours) (2 hours per week)**

*(Students are expected to make sketches with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches with notes of all specimens, mountings and dissections. The record should contain the scientific name, phylum and class (for vertebrates order also). Emphasis must be on scientific accuracy and not on beauty of sketches)*

**A. Animal Diversity**

Phylum Protozoa : *Noctiluca, Vorticella*

Phylum Porifera : *Leucosolenia*

Phylum Coelenterata : *Obelia, Physalia, Rhizostoma* (Any 2).

Phylum Platyhelminthes : *Fasciola*

Aschelminthes : *Ascaris*

Annelida : *Chaetopterus / Arenicola, Hirudinaria*.

Arthropoda : *Peripatus, Eupagarus, Belostoma, Limulus, Sacculina* (Any 3).

Mollusca : *Chilon, Sepia/ Loligo, Octopus* (Any 2)

Echinodermata : *Asterias, Holothuria*.

Phylum Chordata :

Prochordates: *Ascidia/ Branchiostoma*.

Cyclostomata: *Petromyzon*.

Suuperclass Pisces: *Narcine, Echeneis, Hippocampus, Heteropneustes, Anguilla* (Any 3)

Class Amphibia : eg. *Ichthyophis, Axolotl larva, Rhacophorus* (Any 2)

Class Reptilia : eg. *Chamaeleon, Daboia/ Bungarus*

Class Aves. eg: *Columba*

Class Mammalia: *Pteropus* or any other Bat.

**B. Histology** : Study of the T.S. of *Hydra, Ascaris*, Earth worm (through typhlosolic region).

**C. Osteology** : Dentition (Rabbit), Pectoral and Pelvic girdles.

**SYLLABUS**  
**Second Semester B.Sc. Degree Programme**  
**Complementary Course II: Zoology-II**  
**ECONOMIC ZOOLOGY**  
**Code: ZO2C02**  
**(36 hours) (2 hours per week) (Credits - 2)**

**I. Parasitism in relation to man** **12 hrs**

1. Introduction, classification of parasites and hosts (3 hrs)  
(Obligatory, facultative, permanent, temporary, external, internal, and hyper parasites and parasitoid; definitive, intermediate, carrier and reserve hosts).
2. Infection and infestation (1 hrs).  
Mention Hyperinfection and Auto infection.
3. Modes of infection (2 hrs)  
Inoculative, contaminative direct and retroinfection.
4. Human Parasites (7 hrs)  
*Entamoeba histolytica*, *Taenia solium*, *Schistosoma haematobium*,  
*Ancylostoma duodenale*, *Wuchereria bancrofti* and *Enterobius vermicularis*

**II. Insects in relation to man** **12 hrs**

**Insect Pests (4 hrs)**

1. Introduction, Definition of Pests, Kinds of Pests, Causes of pest outbreak.  
Nature of damage to host plants and control measures of the following pests  
(Exclude structure and Life history of Pests).
  - a) *Spodoptera* sp. (rice swarming caterpillar)
  - b) *Leptocorisa* sp. (rice bug)
  - c) *Rhynchophorus* sp. (red palm weevil)
  - d) *Opisina* sp. (Black headed caterpillar, mention biological control)
  - e) *Aceria* sp. (Coconut mite)
  - f) *Helopeltis* sp. (tea bug)
  - g) *Cosmopolites* sp. (Banana rhizome weevil)
  - h) *Dacus* sp. (Fruit fly)
  - i) *Batocera* sp. (Mango stem borer)
  - j) *Sitophilus* sp. (rice weevil)
  - h) *Callosobruchus* sp. (pulse beetle)
  - i) *Chilo infuscatellus* (Sugarcane shoot borer).
  - j) *Platyedra gossypiella* (Pink Ball Worm).
  - k) *Etiella zinckenella* (Grampod Borer).

- l) *Menopon gallinae* (Shaft louse).
  - m) *Eomenacanthus stramineus* (Chicken louse).
  - n) *Hippobosca maculata* (house fly).
  - o) *Tabanus striatus* (horse fly).
2. Vectors of human diseases (3 hrs)  
Insect vectors of human diseases and their control. *Anophales*, *Culex*, *Aedes*, *Xenopsylla*, *Cimex*, *Pediculus* and *Phthirus* (Diseases like malaria, filariasis, yellow fever, typhus fever, dengue, plague, chikun gunea; kala azar).
  3. Insect control (3 hrs)  
Basic principles of chemical control and biological control. Integrated Pest Management (IPM) (Brief notes).
  4. Useful Insects (2 hrs)  
Honey bee : social organization, importance of apiculture, bee products.  
Silk worm and lac insect: Economic importance.

### **III. Aquaculture and Fishery Biology**

**12 hrs**

1. Brief Introduction mentioning its scope in Kerala. (2 hrs)
2. Pisciculture: Egg collection and hatching, induced spawning (4 hrs)  
Nursery ponds, manuring, feeding and harvesting,  
Ornamental fish farming (Brief account). Mention common species.
3. Prawn culture: Breeding and spawning of prawns, seed collection and culture, types of prawn farms, mention common species (2 hrs).
4. Mussel farming: seed collection, artificial collection of seeds, induced spawning, rearing of larvae, farming methods, harvesting (2 hrs) (brief account).
5. Pearl Culture: Preparation of nuclei, preparation of host and graft tissue, implantation, nursing (brief account). (1 hrs)
6. Fish utilization: Nutrition value, byproducts. (1 hrs)

### **Assignment**

Teachers can suggest topics for Assignments / Seminar (**For internal evaluation only**).

### **References**

1. Baskaran, K.K. & Biju Kumar, A. Economic Zoology, Manjusha Publication.
2. Borajah, G., Lecturers on Sericulture, 2e, 1994, SBS Pub., Banglaore.

3. Nayar, K.K. *et al.* : General & Applied Entomology, TMH.
4. Shukla, G.S. & Upadhyay, V.B. : Economic Zoology, 4e, 2002, Rastogi.
5. Singh, S. : Bee keeping in India, ICAR.
6. Singh, V.R.P. & Ramachandran, V. : Frshwater Fish culture (1985) ICAR.
7. Srivastava, C.B.L. : Fishery Science and Indian Fisheries, 2002, Kitab Mahal.
8. Nayar, K.K. *et al.*: General & Applied Entomology, TMH.
9. Shukla, G.S. & Upadhyay, V.B. : Economic Zoology, 4e, 2002, Rastogi.
10. Singh, S. : Bee keeping in India, ICAR.

## **COMPLEMENTARY COURSE V: ZOOLOGY PRACTICAL-II**

**(36 hours) (2 hours per week)**

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

### **Study of the following parasites**

*Entamoeba, Trypanosoma, Plasmodium, Schistosoma, Taenia, Ancylostoma, Enterobius, Wuchereria, Hirudinaria, Cimex (Any 5).*

### **Study of the following vectors**

*Anopheles, Culex, Cimex, Pediculus (Any 2)*

### **Study of the following pests**

*Spodoptera, Leptocorisa, Oryctes, Rhynchophorus, Opisina; Batocera, Termite Queen, Sitophilus (Any 5).*

### **Study of following useful insects**

*Apis (worker) Bombyx female (Any 1)*

### **Study of following item of Economic Importance**

*Perna, Pinctada, Teredo, Loligo, Penaeus, Scoliodon, Catla, Sardinella, Rastrelliger, Cybium (Any 5).*

**SYLLABUS**  
**Third Semester B.Sc. Degree Programme**  
**Complementary Course III: Zoology-III**  
**PHYSIOLOGY, TOXICOLOGY & ETHOLOGY**  
**Code: ZO3C03**  
**(54 hours) (3 hours per week) (Credits - 2)**

**A. Physiology**

**36 hrs**

- I. Trans membrane transport mechanism (4 hrs)  
Structure of Plasma membrane, Fluid mosaic model, Passive & Active mechanisms, vesicular transport.
- II. Nutrition (3 hrs)  
Absorption of nutrients, nervous and hormonal control of digestion, importance of fibre in the food, Anorexia, ulcer, obesity starvation and fasting (In brief).
- III. Respiration (4 hrs)  
Gaseous exchange, Respiratory pigments, structure and properties of haemoglobin, gas transport, control of respiration, respiratory problem, Hypoxia, Asphyxia, CO<sub>2</sub> poisoning or Cyanide poisoning, respiratory problem of high altitudes, problem of diving mammals, aspirators, artificial ventilation, heart lung machine, smoking and its ill effects.
- IV. Body fluid and circulation (6 hrs)  
Blood constituents, Mention agglutination and coagulation of blood, Haemostasis, Haemolysis and Jaundice, Blood transfusion (short notes). Structure and working of heart (in Brief). Electrical and Mechanical properties of Cardiac muscle, Pacemaker and Conducting system of heart. Cardiac cycle and regulation of heart beat. Blood pressure, pulse, cardiovascular problems (brief description). Arterio sclerosis and athero sclerosis, myocardial infarction, hypertension and thrombosis.
- V. Osmoregulation & Excretion (6 hrs)  
Osmoconformers, Osmoregulators, Water retention and Conservation in desert forms. Classification of animals based on nitrogen compounds excreted, Ammonotelism, Ureotelism, Uricotelism, Urea cycle. Hormonal control of kidney function, Kidney disorders, renal Hyper tension, Nephritis, Renal failure, dialysis and kidney transplantation (short notes).
- VI. Muscle Physiology (6 hrs)  
EM structure of myofibrils and myofilament, contractile proteins different types. Chemistry and mechanism of muscle contraction, Energy supply, muscle twitch tetanus, isometric and isotonic contraction, summation of stimuli, all or none law - fatigue rigour mortis.
- VII. Nerve physiology (7 hrs)

Mention different types of nerve cells, glial cell, giant nerve fibre; neurotrophins excitation, impulse generation and transmission, electrochemical changes. Maintenance of resting potential, Action potential, threshold of stimulus, all or none response, synapsis, and myo neural junctions. Synaptic transmission, neuro transmitters. Scanning - MRI, CT etc.

## **B. Toxicology**

**6 hrs**

- I. Toxicants and Public health hazards.
- II. Toxic chemicals, Pesticides, Automobile emission, Heavy metals, fertilizers, food additives, xenobiotics, and radioactive wastes.

## **C. Ethology**

**12 hrs**

Brief accounts of the following topics.

### **Introduction**

- I. History, Scope and Branches of ethology (1 hr)
- II. Innate behaviour (1 hr)  
Orientation, taxes and kinesis, simple reflexes and instincts, drive and motivation.
- III. Learned behaviour (2 hr)  
Habituation, conditioned reflex, trial and error learning, latent learning, imprinting, insight learning
- IV. Patterns of behaviour (2 hrs)  
Habitat selection, sexual selection, co-operation, protection, territoriality, aggression, courtship and agonistic behaviour.
- V. Biological clocks/rhythm (1 hr)  
Photoperiod, circadian rhythm, migration, navigation and homing instinct, diapause, hibernation, aestivation.
- VI. Communication in animals (1 hr)
- VII. Social organization in mammals. (2 hrs)
- VIII. Proximate factors (2 hrs)  
Neurological basis of behaviour, mention hormonal, biochemical, environmental and genetic factors that influence behaviour.

### **Assignments**

Teacher can suggest topics for Assignment / Seminar (**For internal evaluation only**).

## **Reference**

1. Berry, A.K. A Text Book of Animal Physiology. Emkay Publications, Delhi, 51.
2. Chatterjee, C.C. Human Physiology. Medical Allied Agency.
3. Guyton. A.C & Hall. TB of Medical Physiology, Harcourt.
4. Goyal, K.A. & Sastry, K.V. Animal Physiology. Rastogi. Pub.
5. Rastogi, S.C. Essentials of Animal Physiology, Wiley Eastern.
6. Boinlanger, E.G. Animal Behaviour, 1994. ----- Pub.
7. Reena Mather. Animal Behaviour, 1994. Rosthogi Pub.
8. Sharma, P.D. Tolxicology.
9. Purohit, S.S. Ecology, Environment and Pollution, 2003, Agro.



## **COMPLEMENTARY COURSE V: ZOOLOGY PRACTICAL-III**

**(36 hours) (2 hours per week)**

### **Section A : Physiology**

1. Blood smear preparation and study of RBCs and different types of WBCs.
2. Human blood grouping – ABO and Rh systems.
3. Detection of monosaccharides, lipids and proteins.

### **Section B : Mounting**

1. Earth worm : Setae in situ (minor), Spermatheca (minor)
2. *Penaeus* : Appendages (minor)
3. Cockroach : Salivary apparatus (major).
4. Honeybee/Plant bug : Mouth parts (minor).
5. *Sardinella* : Cycloid Scales (minor).

## **SYLLABUS**

**Fourth Semester B.Sc. Degree Programme**

**Complementary Course IV: Zoology-IV**

**GENETICS AND IMMUNOLOGY**

**Code: ZO4C04**

**(54 hours) (3 hours per week) (Credits-2)**

**1. Human Genetics 12 hrs**

Normal human karyotype: Classification and grouping of human chromosomes (Patau & Denver schemes) Chromosomal anomalies and disorders (short note only) Autosomal anomalies : Phenyl ketonuria, Sickle cell anemia X-linked – Haemophilia and Color blindness Y-linked – Multiple sclerosis, Ichthyosis, Polygenic inheritance, Cleft palate or Cleft lip and diabetes mellitus. Prenatal diagnosis Genetic counselling.

**2. Genetic Control of Sex 6 hrs**

Autosomes and sex chromosomes: Mention Barr body and its significance – Chromosomal mechanism of sex determination: genic balance theory; Environmental Control of sex; hormonal influence of sex determination; sex mosaics; gynandromorphism.

**3. Genes and gene action 8 hrs**

Modern concept of genes, split genes, pseudogenes, overlapping and jumping genes, DNA as genetic material, Griffith experiment, Hershey and Chase experiment. One gene one enzyme hypothesis, One gene – one polypeptide hypothesis, Gene action: outline of protein synthesis.

**4. Genetic Engineering 8 hrs**

Definition and scope. Methodology: Brief account of recombinant DNA technology – Brief account of enzyme involved; polymerases, nucleases, ligases. Identification, slicing and splicing of desired genes; transfer of desired genes; direct and vector mediated plasmids, phages and bacterial genes. Practical application, advantages and potential hazards.

**5. Cytogenetics of Cancer 6 hrs**

Types of cancer: brief account of sarcomas, carcinomas, melanomas, leukemia, lymphomas, blastoma, etc.

Characteristics of cancer cell: uncontrolled multiplication, loss of contact inhibition, metastasis, reduced cellular adhesion, metaplasia, invasiveness, etc.

Origin of Cancer: mutational and viral theories, polygenic basis, hereditary dispositions.

6. **Brief notes on:** Protoplast fusion, hybridoma technology, monoclonal antibodies.
7. **Genetics of** assisted or infertility reproduction.
8. **Eugenics, Euthenics and Ephenics.**

## **IMMUNOLOGY (14 hrs)**

(Brief account of the following topics)

1. **Introduction:** definition, antigens, natural ways of avoiding pathogens. (1 hr)
2. **Immunity:** Natural and acquired (active and passive) (1 hr)
3. **Immune system:** Organs and cells: major histocompatibility complex (2 hrs)
4. **Antigen – antibody reaction:** agglutination and precipitation (1 hr)
5. **Immune response:** Humoral and cellular immune effector mechanisms, antibodies, structure of immunoglobulin G: cytokines (2 hrs)
6. **Immunodeficiency diseases:** Primary and secondary types: AIDS (2 hrs)
7. **Vaccines and interferons** (1 hr)
8. **Advanced Biological Techniques:** (short not only) (4 hrs)

Southern Blotting Techniques, Northern blotting techniques, Western blotting techniques, DNA Finger printing, ELISA test.

## **Assignments**

Teacher can suggest topics for Assignment / Seminar **(For internal assessment only).**

## **REFERENCES**

1. Gangane, S.D.: Human Genetics, 2e, 2000, B.T. Churchill Livingstone, New Delhi.
2. Gordner *et al.* : Principles of Genetics, 8e, John Wiley.
3. Gilbert, S.C.: Developmental Biology, 5e, Sinauer Associates.
4. Jogchand, S.N. : Gene Biotechnology, Himalaya Publishing House.
5. Joshi, K.R. : Immunology 5e, 2003, Agro.
6. Kuby, J. : Immunology, 2e, 1994, W.H. Freeman & Co.
7. Mange, E.J. & Mange, A.P. Basic Human Genetics, 1999, Rastogi Pubs.

8. McEwen, R.S. : Vertebrate Embryology, Oxford & IBH.
9. Playfair, J. : Infectin and Immunity, 1995, OUP.
- 10 Ricki, L. : Human Genetics: Concepts and Application, WCB MGH.
- 11 Roitt, I.M.: Essential Immunology, 8e, 1994, Blackwell Science.
12. Snustand & Simmons: Principles of Genetics, 3e / 4e, Cambridge Uty. Press (LPE).
13. Stine, C.J. : The New Human Genetics: W.C. Brown.
14. Twyman : Instant notes in Developmental Biology, 2001, Viva Books.
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## **COMPLEMENTARY COURSE V: ZOOLOGY PRACTICAL-IV**

**(36 hours) (2 hours per week)**

### **Section A : Dissections (Digital versions to be downloaded or procured as per UGC Guidelines)**

Earth worm : Alimentary canal upto 25<sup>th</sup> segment (minor)

*Penaeus* : Nervous system (major)

Mullet : Alimentary canal (major)

### **Section B : Genetics**

Study of the following (use slides / models / charts / photographs)

1. Study of sex linked inheritance (Haemophilia, Sickle cell anaemia, Color blindness).
2. Study of normal human karyotype and abnormal karyotype (Any 2).

**MODEL QUESTION PAPER**

**FIRST SEMESTER B Sc DEGREE EXAMINATION**

**Part III- ZOOLOGY**

**COMPLIMENTARY COURSE - I ANIMAL DIVERSITY AND WILD LIFE CONSERVATION**

**Code:ZO1CO1**

**Time: 3 Hours**

**Maximum marks: 64**

**( Give illustrations and figures where ever necessary)**

**I .One word questions (Each question carries 1 mark) Answer all questions.**

1. Write down the dental formula of Rabbit.
2. The gills in which gill lamellae are arranged in tree like fashion.
3. The peculiar mode of feeding and digestion in Rabbit.
4. Which is the center that initiates heart beat in Rabbit?
5. Name the process of regular and alternate asexual and sexual generation in the life history of an organism.
6. Name the parasitic effect caused by *sacculina* on crab.
7. Name the term of unique habit of self defense exhibited by sea cucumbers.
8. The condition in which Ascidian tadpole undergo less advanced sedentary adult
9. Which is the free swimming larva of *Leucosolenia*?
10. Name the book published by IUCN. (10X1=10)

**II.Short answer question(Answer any 7. Each question carries 2 marks)**

11. What is polymorphism? Comment on with special reference to *Physalia*
12. Write notes on *Noctiluca*.
13. Describe the parasitic adaptations of Leech.
14. Comment on sexual dimorphism with special reference to *Ascaris*.
15. Describe the evolutionary significance of *Peripatus*.
16. With suitable diagram describe the typical vertebra of Rabbit.
17. Define polymorphism with special reference to *Physalia*.

18. Describe any four salient features of phylum mollusca.

19. Comment on the arboreal adaptations of *Chamaeleon*.

20. Briefly explain the dermal layers of sponges. (7x2=14 marks)

**III. paragraph question (Answer any 4, Each question carries 5marks)**

21. Briefly describe the causes of loss of biodiversity.

22. Write an account on the thoracic appendages of *Paenus* with the help of suitable diagram

23. Describe the digestive system of Rabbit.

24. Draw a neat labelled diagram of ventral view of brain of Rabbit.

25. Classify phylum Echinodermata up to classes with diagnostic features of each class with suitable examples.

26. Write an account of *Ascaris lumbricoides*. Add a note on its mode of transmission and pathogenic effects. (4x5=20 marks)

**IV. Essay question (Answer any 2, Each question carries 10 marks)**

27. Briefly describe five kingdom classification. Add a note on its merits and demerits.

28. Briefly describe the structure and working of heart of Rabbit.

29. Give an account of larval forms of *Penaeus* with suitable sketches. (2x10=20 marks)

**MODEL QUESTION PAPER**  
**SECOND SEMESTER B Sc DEGREE EXAMINATION**  
**Part III- ZOOLOGY**  
**COMPLIMENTARY COURSE II-ECONOMIC ZOOLOGY**  
**Code:ZO2CO2**

**Time: 3 Hours**

**Maximum marks: 64**

**( Give illustrations and figures where ever necessary)**

**I One word questions (Each question carries 1 mark) Answer all questions.**

1. The diseases transmitted from vertebrate animals to man.
2. The pest which acquire pest status accidentally or unexpectedly in isolated areas.
3. Name a Coconut pest.
4. Cultivation of organisms in marine environment.
5. Organisms which are alternately parasitic and free living.
6. Name the high grade collagen produced from gas bladder of certain fishes.
7. The enzyme present in the saliva of leech.
8. The re infection in which host itself act as a source and agent of infection.
9. The organism which can live only as parasites depending exclusively upon the hosts.
10. Name the variety of Rice capable of growing tall in flooded waters. (10X1=10)

**II. Short answer questions (Answer any 7. Each question carries 2 marks)**

11. Mention the economic importance of honey.
12. Explain raft culture.
13. Describe the pathogenic effect of *Wuchereria bancrofti*.
14. Comment on eye stalk eblation in crustaceans.
15. Explain the importance of sericulture.
16. Briefly explain the mode of transmission of *Enterobius vermicularis*
17. Give an account of ornamental fish farming



18. Comment on the adaptations of worker bee.

19. Describe the harmful effects of *Leptocoroza*.

20. Write notes on the control methods of *Pediculus humanus*. (7x2=14 marks)

**III. paragraph questions (Answer any 4, Each question carries 5 marks)**

21. Give an account of integrated pest management.

22. What is aquaculture? Add a note on different types of aquaculture.

23. Comment on lac insect and its economic importance.

24. Write notes on mosquitoes and its control measures..

25. What is a parasite? Add a note on its characteristic features and adaptations.

26. Give an account of Coconut pests. Write notes on nature of damage and control measures of each parasite. (4x5=20 marks)

**IV. Essay questions (Answer any 2, Each question carries 10 marks)**

27. Explain briefly about the social organization in honey bee.

28. What is pest control. Describe different types of pest control methods in detail.

29. Give an account of life cycle, pathogenic effects and control measures of Tape worm.

30. Write an essay on pearl culture. Add a note on its economic importance. . (2x10=20 marks)

**MODEL QUESTION PAPER**

**THIRD SEMESTER B Sc DEGREE EXAMINATION**

**Part III- ZOOLOGY**

**COMPLIMENTARY COURSE III-PHYSIOLOGY, TOXICOLOGY AND ETHOLOGY**

**Code: ZO3CO3**

**Time: 3 Hours**

**Maximum marks: 64**

**( Give illustrations and figures where ever necessary)**

**I .One word questions (Each question carries 1 mark) Answer all questions.**

- 1.The pigment present in neuron related with aging.
- 2.The bulk intake of large sized solid substances.
- 3.Name the blue colored respiratory pigment present in Arthropods and Molluscs.
- 4.What is the term used for abnormal rate of heart beat?
- 5.Which is an inhibitory neurotransmitter?
- 6.The inflammatory disorder of kidney is called.
- 7.The toxicants which causes abnormal development and inborn defects.
- 8.Name the pattern of behavior of defense of food source ,home sites and other resources against the members of same species.
- 9.The self sacrificing behavior rendered by animal to increase the evolutionary fitness and survival value of others.
10. Name an allergic disorder caused by food additives. (10X1=10)

**II.Short answer question(Answer any 7. Each question carries 2 marks)**

- 11.Explain different types of reflexes
- 12.Anorexia nervosa.
- 13.Comment on effects of smoking.
- 14.Explain heart lung machine.
- 15.Differentiate isotonic and isometric contraction.

16. Give an account of various types of toxicants.
17. Explain Muscle twitch, Muscle tone, Summation and Muscle fatigue.
18. Briefly explain different types of reflexes.
19. Comment on properties of cardiac muscles.
20. What is imprinting? Explain with suitable example. (7x2=14 marks)

**III. paragraph questions (Answer any 4, Each question carries 5marks)**

21. Briefly describe different types of communication..
22. What is synapses? Describe the process of synaptic transmission.
23. Explain the biochemical process of energy requirement during muscular contraction.
24. Give an account of gastro intestinal hormones.
25. Briefly explain the cardiovascular problems.
26. Explain the role of hormones in urine production. (4x5=20 marks)

**IV. Essay questions (Answer any 2, Each question carries 10 marks)**

27. Write an essay on structure of plasma membrane. Add a note on its function.
28. Briefly describe the composition and functions of blood.
29. Give an account of patterns of behavior.
30. Describe Carbon dioxide transport during respiration. (2x10=20 marks)

**MODEL QUESTION PAPER**

**FOURTH SEMESTER B Sc DEGREE EXAMINATION**

**Part III- ZOOLOGY**

**COMPLIMENTARY COURSE IV-GENETICS AND IMMUNOLOGY**

**Code : ZO4CO4**

**Time: 3 Hours**

**Maximum marks : 64**

**(Give illustrations and figures where ever necessary)**

**I . One word questions (Each question carries 1 mark) Answer all questions.**

- 1.From which cells carcinoma originates?
- 2.The metabolic error in which Phenyl alanine accumulates.
- 3.Who coined the term Gene?
- 4.Which is the initiation codon?
5. The small organic molecule which are antigenic but not immunogenic.
- 6.Name the sterile female cattle with some male features.
- 7.Name the mutant, imperfect and non functional genes.
- 8.Which is the substance that enhances immunogenicity?
- 9.The branch of genetics which deals with science of better living.
- 10.Name any one auto immune disorder. (10X1=10)

**II. Short answer question (Answer any 7. Each question carries 2 marks)**

- 11.What is protoplast fusion? Explain.
- 12.Explain different types of enzymes and their role of in r DNA technology.
- 13.Enlist the characteristics of antigens.
- 14.Comment on the role of T- cells.
- 15.Write notes on lymphocytes.
- 16.Give an account of Southern blotting.
- 17.Explain major types of Antigen-Antibody interactions.

18. Briefly explain the theories of origin of cancer.

19. Explain X-linked inheritance with suitable examples.

20. What is gynandromorphism? Mention different types. (7x2=14 marks)

**III. paragraph questions (Answer any 4, Each question carries 5 marks)**

21. Write an account of gene transfer techniques.

22. What is prenatal diagnosis? Explain different methods of prenatal diagnosis.

23. Describe the practical applications of genetic engineering.

24. Give an account of vaccines and interferons.

25. What is a vector? Write an account of various vectors used in genetic engineering.

26. What is immunity? Explain different types of immunological organs. (4x5=20 marks)

**IV. Essay question (Answer any 2, Each question carries 10 marks)**

27. "DNA as the genetic material". Illustrate with experimental evidence.

28. What is cancer? Explain the characteristics of cancer cells.

29. Differentiate karyotype from karyogram. Write an essay on different schemes of chromosome grouping.

30. What are immunoglobulins? Explain the structure and add a note on its role. (2x10=20 marks)