ST. JOSEPH'S COLLEGE, DEVAGIRI, CALICUT
(AUTONOMOUS)

B.Sc. ZOOLOGY PROGRAMME

SYLLABUS
for
CORE, COMPLEMENTARY,
OPEN AND ELECTIVE COURSES

With effect from 2015 admission

B.Sc. Zoology Core Syllabus

INTRODUCTION

B.Sc.Degree Programme in Zoology is a Choice Based Credit Semester System of six semesters, offering freedom for the students to choose an open paper in the fifth semester. A Semester will be of 90 days duration including end-semester exam with a total of 450 contact hours for instruction. The total number of credits required for the programme is fixed at 120. The common and complementary courses will be completed by the end of fourth semester. In the fifth semester the students have the freedom to choose one open course from any other stream. The elective course in the sixth semester is from the same stream.

The syllabus for the B. Sc. degree programme with Zoology as core subject of study has provision for both theory and practical components in all the six semesters. In addition to the end-semester examinations to be conducted by the College, a system of continuous evaluation through Internal Assessment by the faculty members of the Department of Zoology must be adopted for Zoology core courses. The assessment of students involves 80% for External Evaluation and 20% for Internal Assessment. Examinations for theory courses will be held at the end of each semester. Examination for the practicals for the first four semesters will be held at the end of the fourth semester and those of fifth and sixth semesters at the end of the sixth semester. Practical courses offered are designed to support the theory topics and also to impart basic skills and techniques required of them.

For developing the learning and understanding skill of students, some pertinent topics are suggested for Seminar / Assignment / Group discussion / Self study. But these topics are not meant for external examinations. In addition to the items for practical, a project work forms an integral part of the curriculum during the fifth and sixth semesters. Field trips / Study tour to places of biological interest, of not less than five days, are also compulsory elements of the curriculum. Students are required to visit different ecological sites for observing animals in their natural habitats. Out of the five days one day must be for tour related to Elective. They shall also visit Institutes / Museums / Zoos, etc. for collecting additional biological information. The Board of Studies in Zoology (UG & PG) approved the revised syllabus of B.Sc. Zoology for implementation with effect from the Academic year 2015- 16.

List of the members of Board of Studies in Zoology

N0.GA/BOS/001/2014 dtd 02/09/2014

Sl. No.	Name	Designation	Institution
1	Dr. George Mathew	Asso. Prof.	St. Joseph's College, Devagiri
2	Dr. Benny T. M.	Asso. Prof.	St. Joseph's College, Devagiri
3	Dr. Boby Jose	Asso. Prof.	St. Joseph's College, Devagiri
4	Dr. Sabu K. Thomas	Asso. Prof.	St. Joseph's College, Devagiri
5	Dr. Vineesh P.J.	Asst. Prof.	St. Joseph's College, Devagiri
6	Dr. Jisha Jacob	Asst. Prof.	St. Joseph's College, Devagiri
7	Dr. Janarthanan S.	Asso. Prof.	Dept. of Zoology, University of Madras
8	Dr. A.J. Solomon Raju	Asso. Prof.	Dept. of Envt. Science, Andhra University
9	Dr. A. John Peter	Chairman & MD	Varsha Bioscience & Biotech
10	Dr. Sureshan P. M.	Officer in Charge	Zoological Survey of India, Calicut
11	Dr. Kannan V.M.	Head & Asso. Prof.	Dept. Of Zoology, University of Calicut

COURSE STRUCTURE

Credit Distribution

Semester	Common Course		Core Course	Complementary Course		Open Course	Total credits
	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*	2+4*	2+4*	--	**27**
V	--	--	3+3+3+3	--	--	2	**14**
VI	--	--	2+3+3+3+3+3+ 4*+4*+2**+ 1*** + 2****	--	--	--	**30**
Total	**22**	**16**	**56**	**12**	**12**	**2**	**120**

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

Mark Distribution

Sl. No.	*Course*	*Marks*
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
	Total Marks	**3600**

CREDIT AND MARK DISTRIBUTION IN EACH SEMESTERS
Total Credits: 120; Total Marks: 3600

Semester	*Course*	*Credit*	*Marks*
I	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
		Total **17**	**560**

	Common course: English	4	100
II	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
		Total **17**	**560**

	Common course: English	4	100
III	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
			460
		Total **15**	

	Common course: English	4	100
IV	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
	Total	**27**	**720**
	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
	Total	**14**	**450**
VI	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	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 Viva-voce	1 2	
	Total	**30**	**850**

Core Course Structure

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

Semester	Code No	Course Title	Hrs/ Week	Total Hrs/ Sem	Credits	Marks
I	**AZOL1B01T**	Core Course I: Animal Diversity Nonchordata-I	2	36	2	100
		Core Course V : Practical related to ZO1B01T Practical-I*A	2	36	*	-
II	**AZOL2B02T**	Core Course II: Animal Diversity Nonchordata-II	2	36	2	100
		Core Course V : Practical related to ZO2BOT-Practical-I*B	2	36	*	-
III	**AZOL3B03T**	Core Course III –Animal diversity- Chordata -I	3	54	3	100
		Core Course V : Practical related to ZO3B03T-Practical-I*C	2	36	*	-

IV	**AZOL4B04T**	Core Course IV: Animal diversity Chordata-II	3	54	3	100
	-	Core Course V: Practical related to ZO4B04T- Practical-I*D	2	36	*	-
	AZOL4B05P	Practical-I*A, I*B, I*C & I*D	8	144	4	100
V	**AZOL5B06T**	Core Course VI: Environmental Biology, Wild life Conservation & Toxicology	3	54	3	100
	AZOL5B07T	Core Course VII: Ethology Evolution & Zoogeography	3	54	3	100
	-	Practical related to theory core course ZO5B06T & ZO5B07T-Practical II*A	3	54	*	-
	AZOL5B08T	Core Course VIII: Cell Biology & Genetics	3	54	3	100
	-	Practical related to Theory Core Course : ZO5B08T-Practical II*B	3	54	*	-
	AZOL5B09T	Core Course IX: General Methodology in Science, Bio Statistics	3	54	3	100

		& Informatics				
	-	Practical Related to Theory Core Course ZO5B09T-Practical II*C	2	36	*	-
	-	Project Work	2	36	**	-
	-	Field Study	1	18	***	-
VI	**AZOL6B10T**	Core Course X: Bio Chemistry	2	36	2	100
	AZOL6B11T	Core Course XI: Physiology & Endocrinology	3	54	3	100
	-	Practical related to Core Course ZO6B10T & ZO6B11T-III*A	2	36	*	-
	AZOL6B12T	Core Course XII: Molecular Biology & Bioinformatics	3	54	3	100
	AZOL6B13T	Core Course XIII: Reproductive Biology, Developmental Biology & Teratology	3	54	3	100
	-	Practical related to Theory Core Course ZO0613T-Practical-III*B	2	36	*	-
	AZOL6B14T	Core Course XIV : Bio Technology, Micro biology & immunology	3	54	3	100
	-	Practical Related to theory Core Course ZO0614T-Practical III*C	2	36	*	-
	AZOL6E01T	Core Course XV: Human	3	54	3	100

		Elective	Genetics				
	-	Practical Related to Theory Elective Course (E)-Practical III*D		2	36	*	-
	AZOL6B15P	Practical II-II*A, II*B & II*C		8	144	4*	100
	AZOL6B16P	Practical III-III*A, III*B, III*C & III*D		8	144	4*	100

	AZOL6B17D	Project Work	-	-	2**	50
	AZOL6B18F	Field study	1	18	1***	-
	AZOL6B19V	Viva voce	-	-	2****	-
Total					**56**	**1750**

* Exam will be held at the end of 4th semester

** Exam will be held at the end of 6th semester.

AZOL6E01T Elective course - Human Genetics

- Includes Field Study also. Marks: 90 + 10 (**Hand written Field Study Report**).
- Includes Viva Voce also. Marks: 85+ 15(General Viva Voce).
- Practical Examinations are of 4 hrs Duration.

- **Project work** extends over the fifth and sixth semesters (two hours per week).
- Topics related to any of the theory courses can be selected
- Not more than 12 students can form a group and undertake a project
- Each individual student should submit a copy of the project report duly attested by the supervising teacher and the Head of the Department.

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.

Table 1: Components of Evaluation

Sl. No.	***Components***	***Marks***
1	Attendance	5
2	Test papers: I & II	5 + 5
3	Assignment	2
4	Seminar	3
	Total Marks	**20**

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	***Marks***
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

Table 3: Pattern of Test Papers

Duration	***Pattern***	***Total number of questions***	***Number of questions to be answered***	***Marks for each question***	***Marks***
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
				*Total Marks**	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.

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

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

CORE COURSE PROJECT: EVALUATION SCHEME

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

Table 1: Internal Evaluation

Sl. No	***Criteria***	***Marks***
1	Punctuality	2
2	Skill in doing project work	2
3	Project presentation	3
4	Viva-Voce	3
	Total Marks	**10**

Table 2: External Evaluation

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

ZOOLOGY COMPLEMENTARY COURSE STRUCTURE

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	**AZOL1C01T**	Complementary Course I: Zoology-I	2	36	2	80
	-	Complementary Course V: Zoology Practical-I	2	36	*	-
II	**AZOL2C02T**	Complementary Course II: Zoology-II	2	36	2	80
	-	Complementary Course V: Zoology Practical-II	2	36	*	-
III	**AZOL3C03T**	Complementary Course III: Zoology-III	3	54	2	80
	-	Complementary Course V: Zoology Practical-III	2	36	*	-
	AZOL4C04T	Complementary Course IV:	3	54	2	80

		Zoology-IV				
IV	-	Complementary Course V: Zoology Practical-IV	2	36	*	-
	AZOL4C05P	Complementary Course V: Zoology Practical-V	2	36	4*	80
				Total	**12**	**400**

* Examination will be held at the end of 4th 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.

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

Duration	***Pattern***	***Total number of questions***	***Number of questions to be answered***	***Marks for each question***	***Marks***
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
				Total Marks *	**32**

*Marks: 80% and 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% marks. Examinations will be conducted at the end of each semester.

Table 1: Pattern of Question Papers

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

OPEN COURSE STRUCTURE

(FOR STUDENTS OTHER THAN B.Sc. ZOOLOGY)

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

Semester	Code No	Course Title	Hrs/Week	Total Hrs	Marks
V	AZOL5D01T	Open Course : Human Health & sex Education	2	36	50

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.

Table 1: Components of Evaluation

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

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	2.5
85-89%	2
80-84%	1.5
76-79%	1
75%	0.5

Table 3: Pattern of Test Papers

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

*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. Examination will be conducted at the end of 5th semester.

Table 1: Pattern of Question Paper

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

1. Grade Point (G) = $\frac{Percetage\ \ of\ Marks\ Obtained\ \ in\ a\ course}{10}$

   Grade point is expressed in a 10.0 point scale rounded off to the first decimal place and varies from 0.0 to 10.0

2. Letter Grade: Based on the grade point Letter Grade is awarded as given in the following table

% of Marks (IA + ESE)	Range of Grade Point (G)	Letter Grade	Class
90 - 100	9.0 - 10.0	A^+	First Class With Distinction
80 - 89	8.0 -8.9	A	
70 - 79	7.0 -7.9	B^+	First Class
60 - 69	6.0 -6.9	B	
50 - 59	5.0 - 5.9	C	Second Class
40 - 49	4.0 - 4.9	D	Pass
Course incomplete	0.0- 3.9 = 0.0	F	Fail

3. The minimum Grade Point required for passing a course is 4.0. The grade point for marks in the range 0 to 39 is taken as 0.0.
4. Classification into Distinction, First class, Second class etc will be done for the programme only. This type of classification will not be applicable for individual courses or end semester examinations.
5. Credit Point (P) = Grade Point (G) X Credit of the Course

6. Semester Grade Point Average (SGPA) =
   $\frac{Sum\ of\ credit\ points\ (P) obtained\ \ by\ the\ studentin\ \ in\ the\ various\ \ courses\ \ of\ the\ semest\ er}{Total\ \ Credit\ \ of\ the\ semester}$

   If P_1, P_2 --- P_n are the Credit Points (rounded off to the first decimal place) scored by the student in various courses of the semester and C_1,C_2 --- Cn are the credits of the respective courses, then,

   Semester Grade Point Average (SGPA) = $\frac{P_1 + P_2 + \text{------} + P_n}{C_1 + C_2 + \text{------} + C_n}$

7. Cumulative Grade Point Average (CGPA) =
   $\frac{Sum\ of\ credit\ points\ (P) obtained\ \ by\ the\ studentin\ \ in\ the\ various\ \ courses\ \ of\ the\ Programme}{Total\ \ Credit\ \ of\ the\ Programme}$

   CGPA shall be rounded off to the first decimal place.

Note : In the event a candidate fails to secure E grade (40 % marks) in any Course in a semester, consolidation of SGPA and CGPA will be made only after obtaining E grade (40 % marks) in the failed Course in the subsequent appearance.

FIRST SEMESTER B. Sc. DEGREE PROGRAMME (Theory)

ZOOLOGY CORE COURSE- I
ANIMAL DIVERSITY: NON-CHORDATA PART- I
Code: AZOL1B01T
[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.Hickman & Roberts classification of animal kingdom .
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 brief note on the examples cited]

Phylum Rhizopoda. Eg: *Amoeba*
Phylum. Dinoflagellata. *Noctiluca*
Phylum. Parabasalia. *Trichonympha*
Phylum Apicomplexa [=Sporozoa] eg: *Plasmodium* (life cycle of P.vivax)
Phylum Ciliophora eg: *Vorticella, Ephelota*
Phylum Opalinata. Eg: *Opalina*
Phylum Foraminifera. Eg: *Elphidium* (life history not expected)

General essay : Parasitic protozoans of man (life history not expected) *Trypanosoma, Entamoeba, leishmania.*

Section- C

V. KINGDOM ANIMALIA (**20 hrs**)

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*]

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 (Ascon, Sycon, Leucon, Rhagon); mention amphiblastula, parenchymula and gemmule

VIII. Phylum CNIDARIA [COELENTERATA] (**7 hrs**)

Type: *Obelia* morphology, histology 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, Aurelia*
General essay: Corals & Coral reefs.

IX .Phylum CTENOPHORA [ACNIDARIA] (1 hr)

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

X. ACOELOMATA (3 hrs)

Phylum PLATYHELMINTHES
Classification down to classes; give salient features of the following classes
Class Turbellaria Type: *Dugesia*- morphology, histology & life cycle, Example: *Bipalium.*
Class Cestoda example: *Echinococcus, Fasciola, Taenia solium.*
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 <u>for internal assessments only</u>, and can be subdivided among students)

1) Nutrition in protozoans;
2) Reproduction in protozoans;
3) Locomotion in protists.
4) Polymorphism in cnidarians with special reference to siphonophores
5) Reproduction and development of sponges

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,Opalina, Ephelota* [any 4)
2. Poriferans: *Leucosolenia, Euplectella, 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)

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: AZOL2B02T
[DIVERSITY, ADAPTATIONS AND FUNCTIONAL ANATOMY OF NON-CHORDATE COELOMATES)
[36 hours] [2 hours per week] [2 Credits]

COELOMATA

Phylum **ANNELIDA** (**7hrs**)

Type: ***Nereis***

Morphology, body wall, digestive system, respiratory system, circulatory system, blood vascular system, excretory system, sense organs and reproductive system. Mention heteronereis stage & Trocophore larva.

Classification down to classes; salient features of the following classes

Class Polychaeta example: *Arenicola, Chaetopterus*

Class Oligochaeta example: *Megascolex*

Class Hirudinea example: *Hirudinaria, Hemadipsa, Branchellion*

Phylum **ONYCHOPHORA** **(2 hrs)**

Peripatus: (distribution, peculiarities and affinities)

Phylum **ARTHROPODA** **(11 hrs)**

Type: **Penaeus**

Morphology, digestive system, respiratory system, blood vascular system, excretory system, nervous system, sense organs (statocyst, compound eye in detail), reproductive system, development & life history.

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, Tabanus, stick insect, leaf insect, Belostoma, Luprops* (mupli beetle), Termites, Wasps.

Phylum **MOLLUSCA** **(8 hrs)**

Type: **Pila**

Classification down to classes; salient features of the following classes

Class Aplacophora example: *Neomenia*

Class Monoplacophora example: *Neopalina*

Class Poly placophora example: *Chiton*

Class Bivalvia example: *Perna, Pinctada*

Class Scaphopoda example: *Dentalium*
Class Gastropoda example: *Turbinella*
Class Cephalopoda example: *Sepia, Octopus, Nautilus*

Phylum **ECHINODERMATA (4 hrs)**
Structural peculiarities of **star fish**; digestive system & 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*
Class Echinoidia example: *Salmacis*

Phylum **HEMICHORDATA (1 hr)**
Salient features and example: **Balanoglossus** (mention evolutionary significance)

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*

Topics for Assignment / Seminar
(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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
4. Social organization in insects
5. Economic importance of mollusks
6. Honey bees- different species & economic importance. (Trigona iridipennis-, Apis dorsata, Apis indica, Apis mellifera, Apis florea)
7. Economic importance of crustaceans.
8. Different species of mosquitoes & diseases transmitted by them.
9. Common butterflies & moths of kerala (atleast 10 species- mention southern bird wing & Atlas moth). Southern Birdwing (*Troides minos*), Common Rose,

Common Bluebottle (*Graphium sarpedon),* Paris Pecock, Common Jezebel (*Delias eucharis*), Common evening brown, Common leopard, Common map, Blue tiger, Common crow (*Euploea core),* Common Jezebel (*Delias eucharis*), Malabar Banded Peacock (*Papilio buddha*), Atlas moth

10. Household case bearer (Phereoeca cunea) and Bag worm (Hyphantria cunea)

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

Section A:

1. Annelids : Polychaetes *Aphrodite, Chaetopterus, Arenicola, Tomopteris,* [any 2]
   Common earthworm: *Megascolex / Pheretima,*
   Leech- *Hirudinaria, Heamadipsa, Branchellion*
   [any 2]

2. Arthropods: Items of evolutionary / taxonomic importance -
   Limulus, Trilobite, tadpole shrimp (Triops cancriformis)
   : 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]

3. Molluscs: Inter tidal mollusks – *Chiton, Patella, Haliotis, Onchidium, Aplysia* [any 2]
: Ornamental gastropods –*Cypraea, Murex, Turbinella* [any 2]
: Poisonous gastropod – *Conus*
: Pelecypods of economic importance – *Perna, Pinctada, Teredo, Ostrea* [any 2]
: Scaphopod - *Dentalium*
: Cephalopods of economic or evolutionary importance *Sepia, Loligo, Octopus, Nautilus* [any 2]

4. Echinoderms*: sea lily, star fish, brittle star, sea cucumber, sea urchin, cake urchin, heart urchin* [any 5]

5. Hemichordata: *Balanoglossus*

6. Onychophora: *Peripatus (Evolutionary significance)*

Section B: Histology: TS of 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. *Penaeus* : Appendages [minor)
4. Cockroach : Salivary apparatus [Major)
5. Honeybee/ plant bug: Mouth parts [minor)

Section D: Dissections

1. *Penaeus* : Nervous system [Major)
   Cockroach: Nervous system [Major)

THIRD SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE-III
ANIMAL DIVERSITY – CHORDATA- PART-I
CODE: AZOL3B03T
[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 compare various functional systems (ComparaiveAnatomy) such as Morphology, Integumentary, digestive, respiratory, circulatory, excretory, nervous and reproductive systems also mention the evolutionary significance of each phyla.

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**

Ostracoderms: brief note about features and status in classification
Cyclostomata: Characters and examples: Myxine; Petromyzon [mention Ammocoetous larva]

Division 2. **GNATHOSTOMATA**

Super class PISCES [12 hrs]

Type: **Shark**
Classification of Pisces down to orders; salient features of the following groups
Class Placodermi: Brief note about it features and extinction
Class Chondrichthyes [cartilaginous fishes]
Order Selachii examples: Trygon, Stegostoma, Astrapes; Goblin sharks; Elephant sharks (*Callorhinchus milii*).
Order Holocephali example: Chimaera

Class Osteichthyes [bony fishes]

Order Crossopterygii [coelacanths] example: Latimeria (2 species)

Order Dipnoi [lung fishes]: notes on its habits, retrogressive evolution; special features; examples: Neoceratodus, Protopterus, Lepidosiren [add a note on distribution of lung fishes & Accessory respiratory organs in fishes].

Order Acanthopterygii [spiny-rayed fishes] examples: Mugil, Rastrelliger, Polypterus (living fossil), Sardine; Oncorhynchus (Pacific salmon); Note about walking fish (ambulatory fish), Palau Cave Eel

Super class TETRAPODA

Class AMPHIBIA **[14 hrs]**

Type: **Frog** (skeletal systems included).

Classification of Amphibia down to orders with examples

Subclass: **Stegocephali** (brief details without examples)

Order.Laybrinthodontia;

Order.Phyllospondyli;

Order.Lepospondyli

Subclass: **Lissamphibia**

Order Apoda examples: Ichthyophis, Uraeotyphlus

Order Caudata examples: Necturus, Ambystoma with notes on Axolotl, Amphiuma (Congo eel)

Order Anura examples: Bufo, Rhacophorus, *Nasikabatrachus sahyadrensis*

Class REPTILIA **[16 hrs]**

Type: **Calotes** (skull of varanus, pectoral and pelvic girdles, and limbs included)

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

Subclass Anapsida

Order Cotylosauria; Stem reptiles, eg. Limnoscelis, Captorhinus

Order Chelonia: Brief details of shell; MarineTurtles- eg. *Chelone mydas*; Olive ridley turtles (*Lepidochelys olivacea)*; Snapping turtles; Fresh water turtles- eg. Geomyda species; Land tortoises: *Geochelone elegans* (formerly *Testudo elegans*, star tortoise); Trinonyx (freshwater terrapin).

Subclass: Ichtyopterygia

Order Mesosauria: Mesosaurus

Order Ichtyosauria: Ichthyosaurus

Subclass: Synaptosauria

Order Protosauria: Araeoscelis

Order Sauropterygia: Plesiosaurus, Elasmosaurus

Subclass: Lepidosauria

Order Eosuchia: Youngina

Order Rhynchocephalia: Sphenodon

Order Squamata:

Suborder 1. Ophidia (serpentes); Egs: brief notes on common poisonous and non-poisonous snakes of kerala.

Poisonous snakes: King Cobra, Common Indian Cobra; Vipers: Russell's viper (Daboia), saw scaled viper, Bungarus; slender Coral snakes (Callophis), Sea snakes (Enhydrina), Rattle snake (Crotalus)

Non-Poisonous snakes: Zamemis (Ptyas), Typhlops, Eryx conicus, Dryophis, Indian rock python (python molurus), Anaconda (Eunetes murinus), Uropeltis, Natrix.

Suborder 2. Lacertilia (Sauria); examples : Chamaeleon, Draco, Phrynosoma, Varanus monitor, Hemidactylus, Mabuya, Iguana,Varanus komodoensis (Komodo dragon), Heloderma

Suborder 3.Amphisbaenia (worm lizards)

Identification key for poisonous snakes; Brief notes on poison apparatus and biting mechanism, glands and venom teeth; Jacob's organ;

Subclass Archosauria

Orders Thecondontia –Euprarkeria

Orders Pterosauria –Flying reptiles- Pteranodon

Orders Saurichia –Tyrannosaurus, Brontosaurus

Orders Ornithichia- Stegosaurus, Triceratops

Orders Corocodilia: Crocodilia; note about Foramen panniza, secondary palate; examples: Crocodylus,The mugger crocodile (Crocodylus palustris = "crocodile of the marsh"); saltwater crocodile (Crocodylus porosus, saltie, estuarine crocodile), Gavialis (Gavialis gangeticus), Alligator (two livingspecies are the American alligator (A. mississippiensis) and the Chinese alligator (A. sinensis)., Caimans).

Subclass Anapsida: Mammal like reptiles

Order Pelycosauria -Varanosaurus

Order Therapsida -Cynognathus

Order Ictidosauria- Tritylodon

Topics for Assignments / Seminars

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

1) Migration of fishes
2) Lung breathing fishes
3) Accessory respiratory organs in fishes.
4) Parental care in fishes
5) Parental care in amphibians
6) Snake venom: nature; composition; antivenin; polyantivenins; prophylaxis
7) Identification of snakes (practical)
8) Mesozoic era - golden age of reptiles
9) Mammal like reptiles- evolutionary importance
10) Dinosaurs (both bird and reptile like)
11) Brief details of Prehistoric fishes: Alligator Gar .; Sawfish; Arapaima ; arowanal; sturgeon ; Frilled Shark ; Arowana Osteoglossids; lancetfish

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. Urochordata : *Ascidia*, ascidian tadpole, *Salpa, Doliolum* [any 2]

2. Cephalochordata : *Branchiostoma*

3. Agnatha : *Myxine, Petromyzon,* Ammocoetes larva [any 2]

4. Fishes : Common elasmobranchs - *Chiloscyllium, Stegostoma, Sphyrna, Pristis, Trygon, Narcine, Astrape* [any 3]
: Common food fishes - *Sardinella, Rastrelliger, Cynoglossus, Parastromateus, Trichiurus, Cybium, Thunnus, Etroplus, Mugil, Wallagonia, Tilapia, Catla, Cirrhina, Labeo, Cyprinus* [any 4]
: Fishes with special adaptive features - *Hippocampus, Belone, Hemirhampus, Exocoetus, Tetradon, Pterois, Ostracion, Heteropneustes, Clarias, Arius, Anabas, Channa* [*Ophiocephalus*], *Echeneis, Antennarius, Amphisile,* 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*/*Natrix*
: 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. Sardine : [or any other bony fish]: Alimentary canal [Major)

Section E: Osteology
1. Frog: Vertebrae-Typical, 8^{th}, 9^{th}, 10^{th}, Pectoral & pelvic girdle

FOURTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE-IV
ANIMAL DIVERSITY – CHORDATA PART-II
Code: AZOL4B04T

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

(Give an account of various functional systems of the types specified)

Class AVES [27 hrs]

Type: **Columba** (skull and limb bones excluded)
Classification of Aves down to the orders specified; mention one example each

Subclass **Archaeornithes**

Order Archaeopterygiformes example: *Archaeopteryx* – brief account

Subclass **Neornithes**

Super order Odontognathae (toothed jaws)

Order Hesperornithiformes; examples: Hesperornis

Order Icthiornithiformes; Ichthyornis

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 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]

Order Strigiformes [owls] example: *Bubo, Tyto alba.*

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

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

Order Gruiformes [cranes, rails, coots, bustards] example: *Choriotis,* sarus crane (*Grus antigone*)

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*, Brahminy kite (*Haliastur indus*)

Order Ciconiiformes [Herons, Storks, Ibis, Spoon bills] example: *Ardea*

Order Pelecaniformes [Pelicans, Cormorants] example: *Pelecanus*

Order Phoenicopteriformes [Flamingos] example: *Phoenicopterus*

Order Sphenisciformes [Impennae] example: *Aptenodytes* [penguin) *Provide* notes on: extinct birds: Passenger pigeon [*Ectopistes migratorius*), Dodo [*Raphus cucullatus*], Elephant bird [*Aepyornis*] ; Crtically endangered birds: Pink-headed duck [*Rhodonessa caryophyllacea*], Jerdon's courser [*Cursorius bitorquatus*], Forest Owlet (*Athene blewitti*)

Class **MAMMALIA [27 hrs]**

Type*: **Oryctolagus** (Exclude skull and integument system).*

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), phalanger, Koala bear (*Phascolarctos cinereus)*, Wallaby, Wombats; a note about South American and Australian marusupials.

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, Castor (Beaver), Lemming, Porcupine*
Order Soricimorpha (Shrews, Moles: *Suncus, Crocidura)*
Order Erinaceomorpha (*Paraechinus,* Hedgehog),
Order Chrysochloridea (Golden mole of South Africa, Tenerec of Madagascar/Africa)
Order Dermoptera examples: *Cynocephalus* (*Galeopterus* - flying lemur)
Order Chiroptera examples: *Pteropus, Pipistrellus; notes on adapatations for aerial life and sonar sense*
Order Primates
Suborder Haplorhini: examples: *Loris, Lemur,* ring-tailed lemur (*Lemur catta*)
Suborder Strepsirhini: examples: *Tarsiers*, *Platyrrhines (*New World Monkeys*)* - *Marmoset, Howler monkey; Catarrhines (*Old World Monkeys*)* - *Macaca radiata, Macaca silenus, Presbytis entellus (*Hanuman langur, Grey langur*), Presbytis johni (*Nilgiri langur- black langur*); Apes: Hylobates (*gibbons*), Pongo (*Orangutan*), Chimpanzee, Gorilla, Homo*
Order Carnivora examples: Dog, Wolf (*Canis lupus*), Jackal, Fox (*Vulpes bengalensis*), Bear, Otter, Herpestes (Mongoose), Lesser Panda, Giant Panda, *Phoca* (Seal), *Odobenus* (Walrus), Sea lion (Eumetopias), *Panthera* sps (Lion, Tiger, Leopard), *Viverricula indica* [civet], Malabar Civet (viverra megaspila); Meerkat or Suricate (*Suricata suricatta)*

Order Cetacea *exa*mples: *Physeter (*Sperm whale*), Delphinus* (*dolphins), Phocaena* (p*orpois*e) *Balaenoptera (*baleen wha*le).*

Order Artiodactyla *examples: Sus scrofa cristatus, Gaur, Giraffa, Hemitragus* [tahr], *Cervus, Axis axis* (Spotted deer), *Antelope cervicapra* (Black Buck), *Musk deer (Moschus moschiferous),* Indian Spotted Chevrotain/ mouse deer (*Moschiola indica*), *Camelus (Camel), Llama glama (Ilama), Wild beest (Gnu).*

Order Perissodactyla *exam*ples: *Equus caballus (horse), Rhinoceros, Zebra, Tapir*

Order Sirenia examples: *Trichechus* (manatee), *Dugong, note about* Steller's Sea Cow (*Hydrodamalis gigas*)

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

Order Hyracoidea: Hyrax (coneys),

Order Tubulidentata: Aardvarrk

Topics for seminar:

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

1. Aquatic mammals and their adaptations
2. Dentition in mammals [adaptations related to food)
3. Flying mammals
4. Migration in birds
5. Flight adaptations
6. Common goat breeds (Beetal, Sirohi, Malabari, Jamunaparri, Boer)
7. Brief account of Common cow breeds (Vechur, Gir, Sahiwal, Sindhi, Ongole, Brown Swiss, Holstein Friestian and Jersey)
8. Common fowl breeds (Naked neck, Leghorn, Asil, Brahma, Bantam, Silkie, Rhod island red and white, Astralorp, Giriraja and Gramapriya)
9. Common Indian dog breeds (Rajapalayam, Alangu Mastiff, Kombai, Chippiparai, Kanni and Caravan Hound)
10. Major dog breeds of the world (German Shepherd, Rottweiler, Pug, Great Dane, Doberman, Dachshund, Bulldog, Dalmatian, Labrador retriever, Spitz)

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

I.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, Open Billed Strok, Common Sand Piper[any 2]

5. Migratory birds: Pelicans, Cranes, Flamingos, Grey Wagtail [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)
7. Classify the feathers of birds.

[Watch birds in their natural habitat and prepare a field note]

II. 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

III. Osteology:

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

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FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE –VI
Code: AZOL5B06T
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)

(a) Sampling of animal populations
- (i) Trapping and collecting various groups of insects, aquatic organisms, soil organisms, birds and mammals- pit fall trap, berlese funnel, light trap, pheromone trap, pooter.
- (ii) Marking of animals
- (iii) Determination of home range and territory
- (iv) Estimation of number of animals in population
- (v) Indirect method of estimating wild animals by their signs and symptoms.

(b) 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- phosphorus 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(structure, stratification, dominance, succession- primary, secondary, teritiary successions with pond as an example) and classification, species diversity, fluctuations, stratification, succession, ecotone and edge effect

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

Intraspecific and interspecific associations - Positive and negative interactions: Mutalism, Protoco- operation, 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,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-Strategies of conservation, Natural Reserves, Classification of natural resourses.

(f) Wild life conservation, Wild life (protection Act) 1972, Conservation projects. Project Tiger, Project Elephant, Gir Lion project, Crocodile breeding project, Dolphins, Swamp deer, Project Sangai, Operation Rhino.

(g) Endangered fauna and flora.

Conservation of biodiversity - ex situ conservation (Zoo, Gene Bank, Pollen Bank, Aquarium, Botanical Gardens etc.); Mention conservation of germplasm.

(h) In situ conservation: Sanctuaries-Thattekkad bird sanctuary, Parambikulam wild life sanctuary, Periyar wildlife sanctuary, Malabar wildlife sanctuary; National parks – Eravikulam NP &Silent valley NP and Biosphere Reserves-Nilgiri BR &Agasthyamalai BR

Kadalundi Vallikunnu Community reserve.

(i) Mention IUCN categories and Red data book.

2. Global Strategy for Conservation (6 hrs)

(a) Stockholm Conference / Declaration (1972)

(b) Rio Declaration (Earth Summit, 1992)

(c) CITES

(d) Biodiversity Convention of UNCED

(e) Kyoto Agreement (1997)

(f) Ramsar Convention- mention Ramsar sites in Kerala

(g) World Summit on Sustainable Development

(h)UNEP and its major strategies

(i) Protection of plant varieties and farmer's right Act (2001)

(j) Biodiversity Act 2002

(k) Wildlife Act 1972 and its Amendments

(l) WWF

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
(f) Biocoides – classification (brief mention)

Topics for Assignment/Seminar

(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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. Environmental pollution-land, water, sound and radiation
4. Critically endangered birds of India (Jerdons courser,Forest owlet,White bellied heron,White backed vulture, Slender billed vulture, Redheaded vulture, Lonf billed vulture, Himalayan Quail, Pink headed duck, Bengal Florican, Spoon billed sandpiper, Siberian crane, Sociable lapwing)
5. Critically endangered invertebrates of India- (Rameshwaram Ornamental spider, Peacock Tarantula spider, Fire coral (Millepora boschmai) and the Pigmyhog sucking louse)
6. Critically endangerd mammals of India (Pygmy Hog,Andaman White toothed shrew, Jenkins Andaman Spiny Shrew, Nicobar White tailed Shrew, Elvira rat, Kondana rat, Namdapha Flying Squirrel, Sumatran Rhinoceros, Javan Rhinoceros, and the Malabar Civet)
7. Diversity Indices

References:

Environmental Biology, Conservation Biology & Toxicology

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19. Ramakrishnan, P.S- *Ecology and Sustainable Development* 2nd edition – National Book Trust India

FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE –VII
Code: AZOL5B07T

EHOLOGY, 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 fleged 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- Peripatus, Limulus, Latmeria, Sphenodon

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 Lamark'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 allogenous 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 horse

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): Palaeartic region, Oriental region, Australian region, Ethiopean region, Nearctic region and Neotropical region; insular fauna; Mention continental and oceanic islands-Madagascar, Mauritius, New Zealand, St. Helen, Galapagos 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 <u>for internal assessments only</u>, and can be subdivided among students)

1. Historical aspects of evolution - Inorganic and Organic
2. Fossils and fossilisation
3. Evolution of vertebrate groups- Agnathans, fishes, amphibians, reptiles, birds, Mammals.
4. Polypliody and Evolution

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

[54 hours] [3hours 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. Evironmental Biology, Conservation Biology & Toxicology
1. Estimation of dissolved O2 using Winkler method (in pond and tap water)
2. Estimation of dissolved CO2 in pond and tap wate
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.
7. Estimation of water hardness
8. Light penetration of pond water- Secchi disc.

FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE- VIII
Code: AZOL5B08T
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) 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
- (e) Phase contrast microscope,
- (f) Fluorescence microscope,
- (g) Confocal Laser Scanning microscope

(ii) Micrometry: Use of ocular micrometer and stage micrometer for microscopic calibration
Use of camera lucida, principle and uses.

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

1. Plasma membrane –Unit membrane concept. **(2 hrs)**
Structure (fluid-mosaic model) and Chemical organization; Functions – Transmembrane transportation –diffusion, osmosis, active transport, pinocytosis, phagocytosis, secondary active transport. Modifications of plasma membrane-microvilli, desmosomes, gap junction, tight junction

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.
Microbodies- peroxisomes, glyoxisomes

5. Centrioles and basal bodies: (1hr)

Structure, chemical composition and functions.
Cytoskeleton- microtubules, microfilaments & intermediate filaments

6. Golgi bodies:

Morphology, chemical components, secretory and endocytic path ways, 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.

9. Cell Divisons (3hrs)

a. 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.

b. Cytogenetics of cancer **(2 hrs)**

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

c. Cell aging: **(1 hr)**

Apoptosis – Cell death

Section-B: GENETICS (27 hrs)

1. Gregor Mendel & his work: **(2 hrs)**

Monohybrid cross, dihybrid cross, back cross, Variations from Mendelian ratios 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, eg: 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 bloodgroup 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 influence of sex determination (eg: crocodile, Bonellia), sex reversal- free martins; sex determination in honey-bees; 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 mtuations – substituton mutations and frame shift mutations – mechanisms – factors influencing mutations – induced mutations – mutagens – Detection ofmutations (ClB Method) Chromosome mutations – numerical and structural changes

Numerical changes: euploidy and aneupoloidy with subdivisions

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

Mention significance of mutations in speciation and breeding

8. Cytoplasmic or extra nuclear inheritance: Shell coiling in Limnaea (1 hr)

Cytoplasmic organelles, DNA in chloroplast and mitochondria and endo-symbionts like kappa particles.

9. Chromosomal anomalies and disorders: (3 hrs)

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, alkaptonuria, galactosemia, Tay-Sach's syndrome, Gaucher's disease, Sickle cell anaemia, thalassemia, Brachydactyli, sex chromosomal mutations: Haemophilia, Lesch–Nyhan syndrome, dermal hypoplasia, Polygenic traits: cleft palate / lip, club foot, Hydrocephaly Gene therapy.

10. Genetic councelling: (1 hr)

Eugenics, Euthenics and Euphenics.

Topics for assignments/seminars

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

1. Light microscopy: (a) Simple microscope (b) Compound microscope: Principles and uses; Use of oil immersion objectives;
2. History of genetics
3. Human cloning – pros and cones.
4. Chromosome structure, metaphase chromosomes, number, classification and morphological variations
5. Microbodies: Peroxisomes and glyoxysomes, Structure, functions and origin of microbodies.
6. Human genome project
7. Cytogenetics of cancer

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22. Butterworth Sharma, A., Chromosomes. 1992, Oxford & IBH
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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)
6. Study of genetic syndromes: Down's, Klinefelter's, Turner's, Edward's, Patau's, Cri-du chat syndromes
7. Maintenance of Drosphila culture and study of phenotypic charcters in male and female *Drosophila*
8. Vital staining of mitochondria

FIFTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)
ZOOLOGY CORE COURSE- IX
Code: AZOL5B09T
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, and education. Futuristic IT - Artificial Intelligence, Virtual Reality, Bio-Computing.

Topics for Assignments / Seminars.

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

1. Findings that changed the course of science.
2. Prepare a table showing the height of 20 students in a class. Calculate the mean height.
3. What are the mathematical properties of SD? How is it a better measure of Dispersion than range? Calculate the arithmetic mean and the SD of the frequency distribution obtained from a sample of data.
4. Report an experimental data in tabular / graphical form.

References – GENERAL METHODOLOGY &BIOSTATISTICS

1. Bailey, N. T. J. (1994/'95). Statistical Methods in Biology, 3e, CUP/ LPE.
2. Collins, H. and Pinch, T. (1993). The Golem: What Every one Should Know About Science, Cambridge University Press.
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11. Sokal, R. R. and Rohlf, F. I. Introduction to Biostatistics, W.H. Freeman.
12. Steel, R.G.D. and Torrie, J.H. Principles and Practice of Statistics with special reference to Biological Science.
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14. Victoria, E. McMillan. (1997). Writing Papers in the Biological Sciences, Bedford Books, Boston.
15. 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.
Writing Papers : www.ruf.rice.edu/~bioslabs/tools/report/reportform.html

References on INFORMATICS

1. Technology in Action, Pearson.
2. V. Rajaraman, Introduction to Information Technology, Prentice Hall. Alexis Leon & Mathews Leon, Computers Today, Leon Vikas,
3. Peter Norton, Introduction to Computers, 6e, (Indian Adapted Edition), Additional References.
4. Greg Perry, SAMS Teach Yourself Open Office.org, SAMS.
5. Alexis & Mathews Leon, Fundamentals of Information Technology, Leon Vikas George Beekman, Eugene Rathswohl, Computer Confluence, Pearson Education. Barbara Wilson,
6. Information Technology: The Basics, Thomson Learning
7. John Ray, 10 Minute Guide to Linux, PHI, ISBN 81-203-1549-9.
8. Ramesh Bangia, Learning Computer Fundamentals, Khanna Book Publisher
9. Web Resources www.fgcuedu/support/office2000.
10. www.openoffice.org Open Office Official web site.
11. www.microsoft.com/office MS Office web site.
12. www.Igta.org Office on-line lessons.

13. www.learnthenet.com Web Primer.
14. www.computer.org/history/timeline.
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16. http://computer.howstuffworks.com.
17. wwwkeralaitmission.org.
18. http://ezinearticles.com/?Understanding-The-Operation-Of-Mobile-Phone-Networks&id=68259.
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20. http://www.studentworkzone.com/question.php?ID=96.
21. 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.

SIXTH SEMESTER B.Sc .DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE- X
Code: AZOL6B10T
(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 quantitave) and clinical significance of these tests- Benedict's, Fehling's, Barfoed's, Selivanof's, Mollish's

test. Mention the clinical significance of Lugol's iodine and glucose estimation. Mention the principles and applications of (i) Colorimeter (ii) Ultraviolet - visible spectrophotometer. Mention diabetes Type I & II.

3. Amino acids and Proteins (6hrs)

Structure and classification of aminoacids. Properties of aminoacids. Isoelectric point, Zwitter- ion. Peptide linkages.

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

Principles of analytical techniques such as Biuret reaction, Xanthoproteic test, Ninhydrin reaction.

Seperation techniques. Mention clinical significance of serum-protein estimation. Brief introduction to

(1)Chromatography:

(a) Paper chromatography

(b) Column chromatography,

(2)Electrophoresis:

(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. Mention the clinical significance of lipid profile estimation.

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, allosteric enzymes.

6. Nucleic acids (4 hrs)

Chemistry and structure of purines and pyrimidines, chemistry and structure of nucleotides

(ATP, cAMP, NAD^+, FAD), molecular structure of B-DNA, A-DNA, Z-DNA, 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, HMP pathway, role of cytochromes,

release and storage of energy, high energy compounds, proton gradient and principles of chemiosmotic synthesis of ATP. Deamination, transamination and decarboxylation of amino acids. β-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. pH, pKa, amphoteric properties
3. Mucopolysaccharides
4. Polyunsaturated fatty acids.
5. Importance of Nucleic acids
6. Structure of DNA
7. Specificity of Enzymes
8. 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, 3rd edn., Tata McGraw Hill Pub. Comp., New Delhi.
12. Wilson and Walker – Principles and Techniques of Biochemistry and Molecular Biology, 6th edition – Cambridge Low Price edition.

SIXTH SEMESTER B.Sc. ZOOLOGY CORE COURSE- XI
Code: AZOL6B11T
(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)

Gaseous exchange and transport of respiratory gases, Respiratory pigments, structure and properties of Hb, Oxygen-Hb dissociation curve and factors affecting O_2-Hb curve, Neurophysiological control of respiration; physiological problems in diving mammals, newborn and aged individuals. CO poisoning , Respiratory problem- hypoxia, asphyxia

3. Body fluids & 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 hemorrhage and stroke, ECG.

Lymphatic system- Formation of Lymph, composition, structure, Function and importance of lymphatic circulation

4. Osmoregulation and Excretion(6 hrs)

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

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, summation, fatigue, rigor mortis.

6. Nerve Physiology(5 hrs)

Different types of nerve cells, glial cells, regeneration of medullary fibres, neurotrophins, nerve impulse transmission, synapses and neuro- muscular junctions, synaptic transmission (electrical & chemical), neurotransmitters

Neural disorders- dementia, alzhimers disease, dyslexia, epilepsy, EEG

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 (1hrs)

Neuro endocrine organs and hormones in insects and crustaceans.

2. Vertebrate endocrinology(5hrs)

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.

3. Concepts of neurosecretion (4hrs)

Hypothalamus- Hypophysial interactions, Hypothalamus releasing and inhibiting hormones. Roles of hypothalamic and pituitary hormones: Antidiuretic hormone, Oxytocin, growth hormone, Adrenocorticotrophic hormone, TSH, Gonadotrophins.

4. Reproduction (4hrs)

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

5. **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

Topics for assignments/seminars

(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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. Common renal problems - Renal hypertension, nephritis, renal failure, oedema, acidosis, uraemia, haematuria and calculi.
6. Brief notes on: Intelligence, memory, sleep, EEG, hunger, thirst and emotion
7. Emergency hormones, Epinephrine and norepinephrine.
8. Normal and abnormal constituents of blood serum

REFERENCES

1. Chatterjee, C.C., Human Physiology, Medical Allied Agency.
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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 – Cambridige 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

Photoelectric colorimeter (demonstration)

References:

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

SIXTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)
ZOOLOGY Core Course-XII
Code: AZOL6B12T
MOLECULAR BIOLOGY & BIO INFORMATICS [54 hours] [3 hours per week] [3credits]

Section- A: MOLECULAR BIOLOGY (27 hours)

MOLECULAR BIOLOGY (27 hours)

1. Introduction (4Hrs)

DNA as genetic material – experiments of Frederick Griffith and Hershey & Chase. Gene concept – Classical and modern concepts.

Gene action/expression – one gene one enzyme hypothesis, one gene one polypeptide hypothesis

Central dogma - Central dogma of Molecular Biology, Reverse transcription, modified central dogma.

2. DNA Replication (3Hrs)

DNA polymerases, Semi conservative & semi discontinuous, priming of Okazaki fragments, mechanism of primer removal, joining of Okazaki fragments.

3. Transcription (5 Hrs)

RNA polymerases of eukaryotes and prokaryotes, promoters, terminators, enhancers, silencers & insulators, mono & poly cistronic transcription units.

Initiation, elongation and termination of transcription (brief account). Post transcriptional modification of the primary transcript - hnRNA; capping, poly (A) tailing & splicing (brief account), spliceosomes. Mention Trans splicing & RNA

editing.

4. Genetic code (3Hrs)

Deciphering of genetic code, experiments of Nirenberg & Khorana, codon assignments, properties of the genetic code & Wobble hypothesis.

5. Translation (6Hrs)

Activation of amino acids & aminoacyl tRNA synthetases
Role of ribosomes & active centres of ribosomes
Role of tRNA in translation
Initiation, elongation & termination of translation
Post translational modification of the peptide chain – cleavage, formation of disulfide bridges, acetylation, glycosylation, myristoylation, sulphation, hydroxylation, prenylation, ubiquitination, SUMOylation etc.
Protein folding & role of molecular chaperones
Protein targeting (brief account)

6. Regulation of gene action (3Hrs)

Operon concept, lac operon and its regulation
Short interfering RNA (siRNA) and RNA interference (RNAi), gene modulation
House keeping and luxury genes

7. Organization of genome (3hrs)

C-value, C-value paradox, non repetitive, moderately repetitive and highly repetitive DNA, satellite DNA, selfish DNA
Split genes, overlapping genes, pseudogenes, transposons, cryptic genes
Cistron, muton, recon & complicon.
Human genome & human genome project
Mitochondrial & chloroplast genome (brief account)

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. Endosymbiotic origin of mitochondria and chloroplast
6. Types of RNA
7. Human genome
8. Structure of tRNA

Section- B: BIO INFORMATICS (27 hours)

I. Overview of Bioinformatics(2hrs)

Introduction, Bioinformatics and the Internet, Useful bioinformatics site on the www, Scope and Research areas of Bioinformatics.

II. Major databases in Bioinformatics(3 hrs)

Biological databases

a)Primary databases:

Nucleotide sequence databases – Mention EMBL, DDBJ, Genbank

Protein sequence databases – Mention Swiss Prot, PIR, MIPS

Composite protein sequence databases-Mention NRDB, OWL, MIPSX

Metabolite databases – Mention KEGG, EcoCye

b)Secondary databases: Mention PROSITE, PRINTS, Blocks

Why create secondary databases?

Web addresses

III. Database Search Engines(4hrs)

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

Data retrieval with Entrez and SRS.

IV. Sequence Similarity Search(3hrs)

Pairwise sequence alignment: Mention BLAST, FASTA, Multiple sequence alignment: Mention CLUSTAL W, CLUSTAL X

V. Phylogenetics(2hrs)

Phylogenetics, cladistics and ontology

Building phylogenetic trees

Evolution of macromolecular sequences

V. Micro arrays(2hrs)

Introduction, Applications and Types of DNA microarrays, Experimental process. Expression profile with DNA microarrays, Analysis of microarray data.

VI. Genomics(3 hrs)

Bioinformatic tools used for the Identification of Protein coding genes, Identification of Regulatory DNA Sequences (Specialised alignment tools) and Identification of Enhancers (CHIP- chip assay method). **(Brief)**

Deep Sequencing used for exploring Human Origin. (Ref: Watson, *Molecular Biology of Gene*, Pearson International Publishers)

VII. Proteomics (2 hrs)

Aims, strategies and challenges in proteomics. Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-protein interactions: experimental and computational methods, databases

VIII. Metabolomics(*2*hrs)

Data acquisition, pre-processing and quality control

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:**

1. Alberts, B. *et al*. *Molecular Biology of the Cell*.
2. Garland Pubg. Inc., New York.
3. Bhaskaran, K.K. & Biju Kumar, A.: *Cell Biology, Genetics & Molecular Biology*.
4. Brooks, R. J.: *Genetics: Analysis and Principles*. 1999, Addison Wesley
5. Burns, G. W. & Bottino, P. J.: *The Science of Genetics*. 6/7e, Maxwell McMillan
6. Darnell, J. *et al*.: *Molecular Cell Biology*. Scientific American Book
7. De Roberties, E. D. P. *et al*.: *Cell and Molecular Biology* TMH
8. Dobzhansky, Th.: *The Genetics and Origin of Species*. Columbia Uty. Press
9. Freifelder: *Molecular Biology*. Narosa Pubg. House, N. D.

References:-**Bioinformatics:**

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Westhead, D.R et al: Instant notes BioinformaticsUniversity f Leeds, UK
3. Attwood, T.K et al: An Introduction to Bioinformatics, Dorling Kindersely Pvt. Ltd
4. Gangane, S. D.: Human Genetics. 2e, 2000,
5. B. I. Churchill Livingstone, N D. Gerlad Karp: Cell and Molecular Biology.
6. Good Enough, U.: Genetics. Halt, Reinharts & Winston
7. Gupta, P. K.: Cell and Molecular Biology, 2e, 2002, Rastogi Pubs.,
8. Meerut. John Ringo: Fundamental Genetics- Cambridge University Press.
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10. Lewin, B. Genes IX edition. OUP
11. Mange, E. J. & Mange, A. P.: Basic Human Geneics. 1999. Indian edn.
12. Rastogi McCusik, V. A.: Human Genetics. PHI.
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15. Robert H. Tamarin, Principles of Genetics.
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17. Calcutta Sharma, A. K. & Sharma, A.: Chromosome Techniques. 1990, Butterworth Sharma, A., Chromosomes. 1992, Oxford & IBH

18. Sharma, B. K.: Instrumental Methods of Chemical Anlasis.
19. Goel Pub House Sinnott, E. M. et al. Principles of Genetics, 1958, MGH
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22. Strachan, I. & Read, A.P.: Human Molecular Genetics. 1999,
23. JW & S Strickberger: Genetics, 4e, W.C. Brown Pub.,
24. Maxwell Macmillan. Vijayakumaran Nair, K. & Jayaprakash, M.: Cell Biology, Genetics, Molecular Biology. Academica, TVM.
25. Watson, Baker, Bell, Gann and Levin, Molecular Biology of Genes.
26. Watson, J.D. et al., Molecular Biology of the Gene, 4e,
27. Benjamin Cummings Weaver, H.: Genetics. 1997, W.C. Brown
28. Winchester, A.M.: Genetics, 3e, 1966/6790,
29. Oxford & IBH. Vides, Integrative Approach to Molecular Biology, MIT Press Vides, Gene Regulation and Metabolism, MIT Press Potchard, Medical Genetics at a Glance, Blackwell
30. Jan Vijg, Aging of the Genome, Oxford University Press
31. Frank H. Stephenson, Calculations for Molecular Biology and Biotechnology: A guide to Mathematics in the Laboratory, Academic Press, Elsevier
32. Atwood and Parry-Smith. 2001. Introduction to Bioinformatics. Pearson Education Asia, New Delhi.
33. Baxevanis & Ouellette. 2001. Bioinformatics - A practical guide to the Analysis of Gdnes and Proteins, Wiley, New York.
34. Mount, 2001. Bioinformatics: Sequence and Genome Analysis. Cold Sprint Harbour laboratory Press, New York.
35. S.C. Rastogi, Mendiratta, P. Rastogi. 2005. Bioinformatics: Method & Applications. Genomics, Proteomiocs & Drug Discovery. Prentice Hall of India, New Delhi.
36. Mani & Vijayaraj. 2004. Bioinformatics: A Practical Approach. Aparna Publications, India.
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SIXTH SEMESTER B. Sc. DEGREE PROGRAMME(Theory)
ZOOLOGY Core Course XIII
Code: AZOL6B13T
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, 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 (spermatogenesis and oogenesis).

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

Classification of placenta based on foetal membranes, mode of implantation, nature of contact, Distribution of chorionic villi and histological intimacy- Add a note on human placenta

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. Fertilization. (3 hrs)

Mechanism of fertilization(Approach of sperms to ovum,Capacitation of (the sperm, Attachment and agglutination of sperm on the egg surface, Penetration of sperm into ovum, Acrosomal reaction and cortical reaction, Reorganization of sperm, Reaction of egg to sperm entry, Block to polyspermy, Activation of egg to initiate development, Syngamy),Significance of fertilization.

4. 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.

5. Early development of Amphioxus (3 hrs)

Cleavage, Blastulation, Gastrulation & Neurulation.

6. Development of Frog (6 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.

7. Development of Chick (6 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.

8. Development of Man (3 hrs)

Cleavage and formation of morula, development of blastocyst, implantation, gastrulation up to the formation of germ layers.

9. Cell Differentiation and Gene action during development (4 hrs)

Cell differentiation, totipotency, pluripotency, Dedifferentiaton and Redifferentiation; controlled gene expression during development, Homeotic genes, Mention Hoxgenes; Stem cells, their significance and applications.

10. Parthenogenesis (2 hrs)

Definition, Types: i).Natural parthenogenesis: Arrhenotoky, Thelytoky, Obligatory and Facultative, ii). Artificial parthenogenesis and significance

11. 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 <u>for internal assessments only</u>, and can be subdivided among students)

1. Structure of human sperm
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,Human)
7. Corpus luteum, corpus albicans and corpus haemorhagicum
8. Sperm bank
9. Ovum bank
10. IVF

References

1. Agarwal, P., *Chordate Embryology and Histology*, 1e, 2001,
2. Balinsky, B.I. *Embryology*, Saunders & Company
3. Berril, N.J. & Karp, G. Development TMH.
4. Boby Jose. Reproductive Biology, Developmental Biology and Teratology. Manjusha Pub.
5. Gilbert, S.C., *Developmental Biology*, 5e, Sinauer Associations.
6. Muller, Developmental Biology, Springer Publishers.
7. Jayaprakash, M. *A Manual of Developmental Biology*, 2e, Academia, Trivandrum. Patten, B.M.: *Early Embryology of the Chick*, 1973, TMH.
8. Patten, B.M.: Foundations of Embryology, 1958, McGraw Hill. Rugh, R.: Frog Reproduction and Development.
9. Sastry & Shukal: Developmental Biology – Sinaur Associates. Verma, P.S.

& Agarwal V.K.: Chordate Embryology.
10. Vijayakumaran Nair, K. & George P.V. A Manual of Developmental Biology, 3e, 2002.
11. Wolpert, L.: Principles of Development, 1994, OUP.

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: AZOL6B14T
BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY
(54 hours) (3 hours per week) (3 credits)

Section- A: BIOTECHNOLOGY (18 hrs)

1. Definition and brief introduction of Biotechnology (2 hrs)

Mention branches of Biotechnology (brief).

2. Fundamentals of animal cell culture and hybridoma technology(3 hrs)

Primary cell culture, secondary culture, types of cell lines, valuable products from cell culture, hybridoma technology, monoclonal antibodies and their uses.

3. Gene cloning and DNA sequencing (4 hrs)

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 Recombinant DNA, DNA sequencing- Maxam & Gilbert and Sangers method. **(brief)**

4. Transgenic organisms (3 hrs)

(a) Transfection methods: Calcium phosphate precipitation, Dextran mediated, Lepofection, Electroporation, Retroviral infection, micro injection, Shotgun method **(brief)**
(b) Transgenic animals: Fish, sheep, rabbit, mice, and goat. **One example** from each
(c) Molecular pharming and bioreactors
(d) Mention knock out mice, Bt cotton

5. Molecular markers (3 hrs)

RFLP, RAPD, VNTR Micro satellites or STR, and their uses.
Chromosome walking, Fluorescence in situ hybridization (FISH) and DNA Finger printing (Profiling) techniques.

6. Biotechnology and Environment (2hrs)

Biosensors, Bioremediation – Ex situ and in situ
Biofiltration , Bioleaching (microbial mining)

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

Section-B: MICROBIOLOG Y (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, shape and classification (2 hrs)

5. Basic methods in Microbiology (4 hrs)

Microscopic methods, Techniques of sterilization, Media- different media (McConky's broth, Nutrient agar), preparation, Isolation and inoculation, Direct observation and Staining
Techniques- Gram staining, Maintenance and preservation of cultures

6. Microorganisms in Industry (2 hrs)

Products of industrial fermentations, Citric acid, Lactic acid, Amino acids, Enzymes, Vitamins, Antibiotics (pencillin, amphicillin, cephalosporin, aminoglycosides. Chloramphenicol, streptomycin), 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, Brief note on Diseases caused by Bacteria (Diphtheria, tuberculosis, whooping cough, Typhoid, Cholera, Tetanus, Anthrax, Leprosy, Botulism), Virus (Poliomyelitis, Cancer, Mumps, Measles, Rubella, SARS, Bird flu, Swine flu, Herpes, Dengue, Rabies) Epidemiology and control of diseases

Section-C IMMUNOLOGY (18 hrs)

1. Introduction and History (2hrs)

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).

2. Immune System (3hrs)

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

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

4. Antigens (2hrs)

Types, Factors for Immunogenecity, Exogenous antigens, Endogenous antigens, adjuvants, haptens, Epitopes, Antigen-antibody reaction - Precipitation reaction, Agglutination reaction, Agglutination inhibition reaction.

5. Humoral and cellular Immunity (2hrs)

Primary and secondary response, Generation of CTLs, NK cell mediated cytotoxicity, ADCC, cytokines (brief).

6. Major Histocompatability complex (1 hrs)

MHC, HLA, Class I MHC, Class II MHC molecules and structure

7. Immunodeficiency diseases (2 hrs)

AIDS- structure of HIV virus, Clinical course of HIV- Acute infection, seroconversion, Window period, Chronic latent phase- Lymoh adenopathy, Crisis phase, Antiretro viral therapy.

8. Autoimmune diseases:(1 hrs)

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.

9.Techniques in Immunology (1hrs)

Principles and Applications of- Immuno assays: RIA, ELISA and Flow cytometry

10.Tumour immunology (2hrs)
Malignant transformation of cells, tumour antigens, immune response to Tumour antigens, Tumour effector mechanisms in antitumor immunity-a) Antibodies b) T-lymphocytes c) NK cells d) Macrophages (e) Immunothreapy.

Topics for Assignment / Seminar
(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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. Primary Immunodeficiency syndromes.

References

1. A. T Thomas, P. Cyril & Boby Jose. Biotechnology, Microbiology and Immunology. Manjusha Pub.
2. R. C. Dubey, A text book of Biotechnology, S. Chand & Co. Benjamin Lewin – Genes, Vol. IX.
3. Old and Primrose – Molecular Cloning.
4. L.P. Rema – Applied Biotechnology – MJP Publishes.
5. R.C. Sobti and S. Pachauri – Essentials of Biotechnology – Ane books Pvt. Ltd. B.D. Singh – A text book of Biotechnology, Kalyani Publishers.
6. Pelezar, M.J., Reid, R.D. and Chan, E.C.S., Microbiology, TMH. Kuby, J., Immunology, W.H. Freeman.
7. Joshy K.R. Immunology – Agro Bios.
8. Ananthanarayan & Paniker, J. Microbiology Orient Longman. A.S. Rao, Introduction to Microbiology, Prentice Hall of India.
9. Hans G. Schiegel – General Microbiology, Cambridge University Press. Heritage, Evans and Killington – Introductory Microbiology – Cambridge University Press.
10. Kanika Sharma – Manual of Microbiology tools and techniques – Ane Books Pvt. Ltd.
11. Dominic W.C. Wong – The ABCS of gene cloning – Springer International Edn.
12. Veerbala Rastogi – Fundamentals of Molecular Biology, Ane Books Pvt. Ltd.
13. Colin Ratledge and Bjorn Kristiansen – Basic Biotechnology, Cambridge University Press. John Smith – Biotechnology, Cambridge University Press.
14. Wise – Immunology – Blackwell Publishers.
15. Todd – Lecture notes on Immunology – Blackwell Publishing.

16. Monica Cheesbrough, District Laboratory Practice in Tropical Countries, Part I and II, Cambridge Low Price Editions.
17. Nicholl – An Introduction to Genetic Engineering – Cambridge University Press. Wise – Immunology a Comprehenive Review – Ane Books.
18. Alphey – DNA Sequencing – Bios Scientific Publishers.
19. Hardin – Cloning, gene expression, and protein purificaiton – Oxford University Press. Gandhi – Microbiology and Immunology notes and cases – Blackwell Publishing.
20. N. Ahmed, Qureshi and Khan – Industrial and Environmental Biotechnology, Horizon Press.
21. 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. Identifiation of motile bacteria by hanging-drop method.(Demonstration only).

4.Preparation of culture media for bacteria.(Synthetic Media,NaturaMedia,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)

SIXTH SEMESTER B.Sc. DEGREE PROGRAMME-(Theory)
ZOOLOGY ELECTIVE COURSE- III
Code: AZOL6E01T
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 (4hr)
Pedigree construction, data collection, analysis and pedigree charts of autosomal dominant, autosomal recessive, X-linked dominant and recessive gene mutation disorders.

4. Autosomal dominant inheritance (4hr)
Familial hyper cholesterolemia, 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)

5. Autosomal recessive inheritance (4hr)
Cystic fibrosis, CF gene and protein, Detection of CF homozygotes and carriers, Hereditary Microphaly, Retinoblastoma, Craniodiaphyseal dysplasia, Hutchinson-Gilford syndrome (progeria), Thalasemia and Hereditary hemolytic anemia.

6. X-linked dominant and recessive inheritance: (4hr)
Duchene's muscular dystrophy, identification of the DMD gene, carriers and hemizygotes,
Hypophosphatemia, Von willebrand's disease, SCID & Albright's heridictory Osteodystrophy

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

8. Chromosomosome structural modification and the human phenotype (4hr)

Ring chromosome, Iso chromosomes, Philadelphia chromosome, Cri-du-chat syndrome (5p-syndrome) Prader willi syndrome, Fragile X- Syndrome (Martin Bell syndrome), Burkitt's lymphoma (14q+ syndrome)

9. Reproduction and Development (5hr)

(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).

10. Genomic imprinting, inbreeding in isolates, consanguinous marriages, twin studies, biology of twinning, analysis of twin data. **(4hr)**

11. Prenatal diagnosis and genetic services (3hr)

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

12. Genetic counselling: (4hrs)

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

13. Pharmacogenetics , Ecogenetics and the Phenocopy. (2hrs)

14. Evolutonary genetics: (3hrs)

Human genetic variation; - haplogroups; Human races, human variability messages from mitochondrial DNA. Archaeogenetics: Genetics and archaeogenetics of South Asia- -0ut of Africa theory; genetic origin of Indian populations - Indian Genome Variation initiative

Topics for Seminars / Assignment / Discussion

(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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. Lowa.

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

(36 hrs 2 hrs/week, 2-credits) Internal Mark-10
External Mark-40 (Project- 30; Viva- 10)

Students are required to undertake project work on problems pertaining to biological science. Scientific study on the topic selected is required to be carried out under the supervision and guidance of faculty members. A group consisting of not more than 12 students can undertake 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- Tour report- 7; Viva- 3)

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 credits, 15 Marks)

At the end of VIth semester each student shall appear for a viva-voce before a team of one external and one internal examiner. 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 and project. It shall not normally exceed 10 minutes per candidate. Marks shall be given according to their performance.
There shall be an internal viva-voice for 3 Marks.

OPEN COURSE

FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY OPEN COURSE
Code: AZOL5D01T
HUMAN HEALTH AND SEX EDUCATION
(36 hours) (2 hours per week) (2 credits)

1. Introduction (3 hrs)

Reproductive rights, Need for sex education, Human Reproductive system- Male and Female (Brief), Menstrual and Oestrous cycle, Puberty, Menopause, Andropause.

2.Gestation,Placentation,Parturition,Lactation (2hr)

3.Sexdetermination 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 Klinefilter's syndrome.

4. Sexual abuses and myths(3hrs)

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.

5. Prenatal Diagnosis(2hrs)

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

6.FertilityControl(4 hrs)

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

7. Infertility and assisted reproductive technologies(4hrs)

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.

8.Sexually transmitted infectious diseases(5hrs)

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.

9. 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

10.Common diagnostic techniques (Brief notes on)(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, mammogram, Pap smear.

Topics for Assignments and Seminars

(Topics allotted for assignments/ seminars should be considered <u>for internal assessments only</u>, 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

6. Ovulation prediction kit, Pregnancy detection kit.
7. Autism, Dyslexia, Common problems of Adolescence.

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, Merril 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*,

UNIVERSITY OF CALICUT

B.Sc. Degree Course

Complementary Course - Zoology

Semester B. Sc. Degree Programme

Complementary Course I - Theory

ANIMAL DIVERSITY & WILD LIFE

Code: AZOL1C01T

(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 Organization and classification down to classes with examples.

I. Type for detailed study **18 hrs**

1. *Penaeus* (6 hrs) (Exclude details of larval stages).

2. *Oryctolagus* (12 hrs) [Exclude skin, skull bones, arterial system, venous

system, lymphatic system, autonomous nervous system and endocrine 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,Aurelia, Sea Anemon*
Phylum Plalyhelminthes	Eg: *Fasciola, Schistosoma*
Phylum Aschelminthes	Eg: *Ascaris, Enterobius*
Phylum Annelida	Eg: *Arenicola, Hirudinaria, Megascolex*
Phylum Arthropoda	Eg: *Limulus, Sacculina, Eupagurus, Belostoma*
Phylum Onycophora	Eg: Peripatus
Phylum Mollusca	Eg: *Chiton, Perna, Teredo, Sepia, Pinctada, Loligo*
Phylum Echinodermata	Eg: *Asterias , Holothuria, Sea urchin*
Sub phylum Urochordata	Eg: *Ascidia*

Subphylum Cephalochordata Eg: *Branchiostoma*

Subphylum Vertebrata :

Agnatha Eg: *Petromyzon, Myxine*

Super class Pisces :

Class: Chondrichthyes Eg: *Narcine, Shark*

Class: Osteichthyes Eg: *Echeneis, Hippocampus, Heteropneustes, Scomberomorus,* Pomfret

Super class Tetrapoda

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

Mention- Nasikabatrachus sahyadrensis

Class Reptilia Eg: *Chamaeleo, Daboia*, Tortoise, *Cobra, Bungarus, Enhydrina*

Class Aves Eg: *Columba*

Class Mammalia Eg: *Pteropus*

B. Wild life (6 hrs)

I. Biodiversity, Levels of biodiversity (brief), significance and uses of biodiversity, Threats to Biodiversity- (fragmentation, exotic species, over exploitation, indiscriminate killing, climate change, unplanned development), extinction of species, concept of threatened species

II. Wild life management and conservation- Importance of wild life, Strategies of conservation (*Ex situ* and *In situ*), Mention Protection Acts- The Wildlife Act, 1972; Forest Act, 1980; National Biological Diversity Act, 2002; Biological Diversity Bill, 2002.

III. Sustainable development

IV. Red Data Book, IUCN, WWF

Assignments (for Internal Assesment only)

1. Project Tiger
2. Project Elephant
3. Operation Rhino
4. Ramsar site

References

1. Jordan E.L. & Verma, P.S. *Invertebrte 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.
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COMPLEMENTARY COURSE I: PRACTICAL I

A. Animal Diversity **(36 hrs)**

Phylum Dinoflagellata : *Noctiluca*

Phylum Ciliophora : *Vorticella*

Phylum Porifera : *Leucosolenia*

Phylum Coelenterata : *Obelia, Physalia, Rhizostoma* (Any 2).

Phylum Platyhelminthes : *Fasciola*

Aschelminthes : *Ascaris*

Annelida : *Chaetopterus / Arenicola, Hirudinaria.*

Arthropoda : *Eupagarus, Belostoma, Limulus, Sacculina* (Any 3).

Onycaphora : *Peripatus*

Mollusca : *Chilon, Sepia/ Loligo, Octopus* (Any 2)

Echinodermata : *Asterias, Holothuria.*

Phylum Chordata

Prochordates : *Ascidia/ Branchiostoma.*

Cyclostomata : *Petromyzon.*

Suuperclass Pisces : *Narcine, Echeneis, Hippocampus, Heteropneustes, Anguilla, Pomfret* (Any3)

Class Amphibia :*Ichthyophis, Axolotl* larva, *Rhacophorus* (Any 2)

Class Reptilia :*Chamaeleon, Daboia, Bungarus*

Class Aves : *Columba*

Class Mammalia : *Pteropus* or any other Bat.

B. Histology : Study of the T.S. of *Hydra*, *Ascaris*, Earth worm (through typhlosolic region).

C. Osteology : Dentition (Rabbit), Pectoral, Pelvic girdles, typical vertebra

Second Semester B.Sc. Degree Programme
Complementary Course II - Theory
ECONOMIC ZOOLOGY
Code: AZOL2C02T
(36 hours) (2 hours per week) (Credits - 2)

I. Parasitism in relation to man **(12 hrs)**

1. Introduction, classification of parasites and hosts **(3 hr s)**

Obligatory, facultative, permanent, temporary, external, internal, and hyper parasites and parasitoid; definitive, intermediate, carrier and reserve hosts.

2. Infection and infestation **(1 hr)**

Mention Hyper infection and Auto infection.

3. Modes of infection **(2 hrs)**

Inoculative, contaminative direct and retroinfection.

4. Human Parasites **(7 hr s)**

Entamoeba histolytica, Taenia solium, Schistosoma haematobium, Ancylostoma duodenale, Wuchereria bancrofti and Enterobius vermicularis

II. Insect Pests **(4hrs)**

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)

k) *Callosobruchus* sp. (pulse beetle)

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 (3hrs)

Basic principles of chemical control and biological control. Integrated Pest Management (IPM) (Brief notes).

4. Useful Insects (2hrs)

Honey bee: social organization, importance of apiculture, bee products. Silk worm and lac insect: Economic importance.

Predatory insects, insect parasitoids

III. Aquaculture and Fishery Biology (12 hrs)

1. **Brief Introduction mentioning its scope in Kerala. (2hrs)**
2. **Pisciculture: Egg collection and hatching, induced spawning (4hrs)**

   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)**
5. **Pearl Culture:** Preparation of nuclei, preparation of host and graft tissue, implantation, nursing (brief account). **(1 hr)**
6. **Fish utilization:** Nutrition value, byproducts. **(1hr)**

Assignment (for Internal Assesment only)

1. *Chilo infuscatellus* (Sugarcane shoot borer).
2. *Platyedra gossypiella* (Pink Ball Worm).
3. *Etiella zinckenella* (Grampod Borer).
4. *Callosobruchus chinensis* (Pulse beetle).
5. *Menopon gallinae* (Shaft louse).
6. *Eomenacanthus stramineus* (Chicken louse).
7. *Hippobosca maculata* (house fly).
8. *Tabanus striatus* (horse fly).
9. *Pediculus humanus* (head louse)

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COMPLEMENTARY COURSE II: PRACTICAL I

Study of the following parasites **(36 hrs)**

Entamoeba, Trypansoma, Plasmodium, Schistosoma, Taenia, Ancylostoma, Enterobius, Wuchereria, Hirudinaria, Cimex (Any 5).

Study of the following vectors 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 one)

Study of following item of Economic Importance

Perna, Pinctada, Teredo, Loligo, Penaeus, Scoliodon, Catla, Sardinella, Rastrelliger, Cybium (Any 5) .

Third Semester B.Sc. Degree Programme
Complementary Course III (Theory)
PHYSIOLOGY, TOXICOLOGY & ETHOLOGY
Code: AZOL3C03T
(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 fiber 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_2 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 (6hrs)
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 rigor mortis.

VII. Nerve physiology (7 hrs)
Mention different types of nerve cells, glial cell, giant nerve fiber; 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)

Introduction (Brief accounts of the following topics)

I. History, Scope and Branches of ethology **(1 hr)**

II. Innate behaviour **(1 hr)**
Orientation, taxes and kineses, 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**).

1. Role of enzymes in digestion of Carbohydrates, proteins and lipids.
2. Absorption of carbohydrates, proteins, and lipids.
   Respiratory problems and health hazards caused by smoking.
3. Problems of Alcoholism
4. Medical aids for respiration - aspirators, artificial respiration and ventilation, heart lung machine
9. Common renal problems - Renal hypertension, nephritis, renal failure, edema, acidosis, uremia, haematuria and calculi.
10. Camouflage, mimicry- Mullerian, Batesian.

11. Brief notes on: Intelligence, memory, sleep, EEG, hunger, thirst and emotion

12. Emergency hormones, Epinephrine and norepinephrine.
13. Human lymphatic system

14. Minamata disease
15. Positive and Negative aspects *Endosulfan*

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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 III: PRACTICAL I

Section A : Physiology (36 hrs)

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 : Mouth parts (minor).
5. Shark : Placoid scales (minor).

Fourth Semester B.Sc. Degree Programme
Complementary Course IV (Theory)
GENETICS AND IMMUNOLOGY
Code: AZOL4C04T

(54 hours) (3 hours per week) (Credits-2)

1. Human Genetics (12hrs)

Normal human karyotype: Classification and grouping of human chromosomes (Pataus & 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 counseling.

2. Genetic Control of Sex **(06 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 **(08 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 **(08 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 **(05 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. Genetics of assisted or infertility reproduction.

7. Eugenics, Euthenics and Euphenics.

IMMUNOLOGY (15 hrs)

(Brief account of the following topics)

1. Introduction: **(03 hrs)**

1.1.Innate and adaptive immunity
1.2. Cells and organs of the immune system
1.3. Antigens, Antigenicity, Immunogenicity and Haptens
1.4. Factors influencing immunogenicity

2. Antibodies: **(02 hr)**

2.1.Structure and Function
2.2. Monoclonal antibodies-Hybridoma technology and applications

3. Antigen-Antibody interaction: **(05 hrs)**

3.1. Strength of Antigen-Antibody interaction
3.2. Cross reactivity, Precipitation reactions, and Agglutination reactions.

3.3. Immunotechniques – Detection of molecules using ELISA, RIA, Western blot, Southern blot, Northern blot, DNA Fingerprinting.

4. Generation of B cell and T-cell response: **(02 hrs)**

4.1. Humoral and cell-mediated response
4.2. Properties of B-cell and T-cell- epitopes
4.3. Activation and differentiation of B and T cells
4.4. Cytokines

5. Immunodeficiency diseases: **(02 hrs)**

5.1. Primary (Bruton's disease, Di-george syndrome & SCID) and secondary types: AIDS

6. Vaccines and interferons **(01 hr)**

Assignments

(1) **Major Epidemics of Human Infectious**
(2) Human immune system and mechanisms of immunity
(3) Immune responses during bacterial, parasitic and viral infections.
(4) Autoimmune diseases

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