

UNIVERSITY OF KERALA

First Degree Programme in Zoology

Choice Based Credit and Semester System

Scheme and Syllabus

With effect from 2010 admission

Core Courses
Foundation Course II
and
Open Courses

First Degree Programme in Zoology

Table I. Scheme of Instruction and Evaluation

| Semester | Course Code | Study Component | Instructional hrs/week | | Credit | Duration of Uty. exam | Evaluation | | Total Credit |
|-----------|-----------------------------------|--|------------------------|---|--------|-----------------------|------------|-----|--------------|
| | | | T | P | | | CE | ESE | |
| I | EN1111 | English I | 5 | | 4 | 3hrs | 25% | 75% | 16 |
| | 1111 | Additional Language I | 4 | | 3 | 3hrs | 25% | 75% | |
| | EN1121 | Foundation Course I | 4 | | 2 | 3hrs | 25% | 75% | |
| | CH1131.4 | Complementary Course I | 2 | | 2 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of CH1131.4 | | 2 | – | – | – | – | |
| | BO1131 | Complementary Course II | 2 | | 2 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of BO1131 | | 2 | – | – | – | – | |
| | ZO1141 | Core Course I | 3 | | 3 | 3hrs | 25% | 75% | |
| | Core Course Practical I of ZO1141 | | 1 | – | – | – | – | | |
| II | EN1211 | English II | 4 | | 3 | 3hrs | 25% | 75% | 17 |
| | EN1212 | English III | 5 | | 4 | 3hrs | 25% | 75% | |
| | 1211 | Additional Language II | 4 | | 3 | 3hrs | 25% | 75% | |
| | ZO1221 | Foundation Course II | 3 | 1 | 3 | 3hrs | 25% | 75% | |
| | CH1231.4 | Complementary Course III | 2 | | 2 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of CH1231.4 | | 2 | – | – | – | – | |
| | BO1231 | Complementary Course IV | 2 | | 2 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of BO1231 | | 2 | – | – | – | – | |

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Scheme of Instruction and Evaluation

| Semester | Course Code | Study component | Instructional hrs/week | | Credit | Duration of Uty. Exam | Evaluation | | Total Credit |
|------------|------------------------------------|---|------------------------|---|--------|-----------------------|------------|-----|--------------|
| | | | T | P | | | CE | ESE | |
| III | EN1311 | English IV | 5 | | 4 | 3hrs | 25% | 75% | 17 |
| | 1311 | Additional Language III | 5 | | 4 | 3hrs | 25% | 75% | |
| | CH1331.4 | Complementary Course V | 3 | | 3 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of CH1331.4 | | 2 | – | – | – | – | |
| | BO1331 | Complementary Course VI | 3 | | 3 | 3hrs | 25% | 75% | |
| | | Complementary Course Practical of BO1331 | | 2 | – | – | – | – | |
| | ZO1341 | Core Course II | 3 | | 3 | 3hrs | 25% | 75% | |
| | Core Course Practical I of ZO1341 | | 2 | – | – | – | – | | |
| IV | EN1411 | English V | 5 | | 4 | 3hrs | 25% | 75% | 25 |
| | 1411 | Additional Language IV | 5 | | 4 | 3hrs | 25% | 75% | |
| | CH1431.4 | Complementary Course VII | 3 | | 3 | 3hrs | 25% | 75% | |
| | CH1432.4 | Complementary Course Practical of CH1131.4, CH1231.4, CH1331.4 & CH1431.4 | | 2 | 4 | 3hrs | 25% | 75% | |
| | BO1431 | Complementary Course VIII | 3 | | 3 | 3hrs | 25% | 75% | |
| | BO1432 | Complementary Course Practical of BO1131, BO1231, BO1331 & BO1431 | | 2 | 4 | 3hrs | 25% | 75% | |
| | ZO1441 | Core Course III | 3 | | 3 | 3hrs | 25% | 75% | |
| | Core Course -Practical I of ZO1441 | | 2 | - | - | - | - | | |

First Degree Programme in Zoology
Scheme of Instruction and Evaluation

| Semester | Course Code | Study component | Instructional hrs/week | | Credit | Duration of Uty. Exam | Evaluation | | Total Credit |
|----------|------------------------------------|--|------------------------|---|--------|-----------------------|------------|------|--------------|
| | | | T | P | | | CE | ESE | |
| V | ZO1541 | Core Course IV Practical I of ZO1141, ZO1341& ZO1441 | - | - | 4 | 3hrs | 25% | 75% | 22 |
| | ZO1542 | Core Course V | 5 | | 4 | 3hrs | 25% | 75% | |
| | ZO1543 | Core Course VI | 4 | | 4 | 3hrs | 25% | 75% | |
| | ZO1544 | Core Course VII | 4 | | 4 | 3hrs | 25% | 75% | |
| | ZO1545 | Core Course VIII Practical II of ZO1542,1543&1544 | | 5 | 4 | 3hrs | 25% | 75% | |
| | 1551 | Open Course I | 3 | | 2 | 3hrs | 25% | 75% | |
| | | Project | | 3 | - | - | - | - | |
| | Field Study | | 1 | - | - | - | - | | |
| VI | ZO1641 | Core Course IX | 5 | | 4 | 3hrs | 25% | 75% | 23 |
| | ZO1642 | Core Course X | 4 | | 4 | 3hrs | 25% | 75% | |
| | ZO1643 | Core Course XI | 4 | | 3 | 3hrs | 25% | 75% | |
| | ZO1644 | Core Course XII Practical III of ZO1641 | | 3 | 3 | 3hrs | 25% | 75% | |
| | ZO1645 | Core Course XIII Practical IV of ZO1642 & ZO1643 | | 3 | 3 | 3hrs | 25% | 75% | |
| | ZO1651.1/ ZO1651.2/ ZO1651.3 | Open Course II | 3 | | 2 | 3hrs | 25% | 75% | |
| | ZO1646 | Project and Field Study | | 3 | 4 | Viva-voce | - | 100% | |

T-Theory, P-Practical, CE-Continuous Evaluation, ESE-End Semester Evaluation

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Table II. Scheme of Instruction of Core Courses, Foundation Course II and Open Courses

| Course number | Course Code | Course Title | Semester I | | Semester II | | Semester III | | Semester IV | | Semester V | | Semester VI | | Total | | | |
|---------------|----------------------------|---|---------------|---|-------------|---|---------------|---|-------------|---|---------------|---|-------------|---|---------------|---|--------|--|
| | | | Contact Hours | | Credit | | Contact Hours | | Credit | | Contact Hours | | Credit | | Contact Hours | | Credit | |
| | | | T | P | | | T | P | | | T | P | | | T | P | | |
| C.C. I | ZO1141 | Methodology and Perspectives of Science and Zoology | 3 | | 3 | | | | | | | | | | 3 | 3 | | |
| F.C. II | ZO1221 | General Informatics and Bioinformatics | | | 3 | 1 | 3 | | | | | | | | 4 | 3 | | |
| C.C. II | ZO1341 | Animal Diversity I | | | | | 3 | 3 | | | | | | | 3 | 3 | | |
| C.C. III | ZO1441 | Animal Diversity II | | | | | | 3 | 3 | | | | | | 3 | 3 | | |
| C.C. IV | ZO1541 | Practical I of ZO1141, ZO1341 & ZO1441 | | 1 | | | 2 | | 2 | | | 4 | | | 5 | 4 | | |
| C.C. V | ZO1542 | Cell Biology and Molecular Biology | | | | | | | | 5 | 4 | | | | 5 | 4 | | |
| C.C. VI | ZO1543 | Genetics and Biotechnology | | | | | | | | 4 | 4 | | | | 4 | 4 | | |
| C.C. VII | ZO1544 | Immunology & Microbiology | | | | | | | | 4 | 4 | | | | 4 | 4 | | |
| C.C. VIII | ZO1545 | Practical II of ZO1542, ZO1543 & ZO1544 | | | | | | | | | 5 | 4 | | | 5 | 4 | | |
| O.C. I | 1551 | (Offered by other disciplines) | | | | | | | | 3 | 2 | | | | 3 | 2 | | |
| C.C. IX | ZO1641 | Physiology and Biochemistry | | | | | | | | | | 5 | 4 | 5 | 4 | | | |
| C.C. X | ZO1642 | Developmental Biology & Experimental Embryology | | | | | | | | | | 4 | 4 | 4 | 4 | | | |
| C.C. XI | ZO1643 | Ecology, Ethology, Evolution and Zoogeography | | | | | | | | | | 4 | 3 | 4 | 3 | | | |
| C.C. XII | ZO1644 | Practical III of ZO1641 | | | | | | | | | | | 3 | 3 | 3 | 3 | | |
| C.C. XIII | ZO1645 | Practical IV of ZO1642 & ZO1643 | | | | | | | | | | | 3 | 3 | 3 | 3 | | |
| O.C. II | ZO1651.1/ZO1651.2/ZO1651.3 | (Any one of the courses) | | | | | | | | | | 3 | 2 | 3 | 2 | | | |
| C.C. XIV | ZO1646 | Project | | | | | | | | | 3 | | 3 | | 7 | 4 | | |
| | | Field study | | | | | | | | | 1 | | | | | | | |

C.C.- Core Course, F.C.-Foundation Course, O.P.-Open Course, T-Theory, P-Practical

First Degree Programme
Semester V

Zoology Open Course I
Offered to students of other disciplines

Table III. Scheme of Instruction of Open Course I

| Semester | Course Code | Course Title | Instructional hours/week | Credits |
|----------|-------------|-------------------------------------|--------------------------|---------|
| V | ZO1551.1 | Public Health and Hygiene | 3 | 2 |
| | ZO1551.2 | Human Health and Sex education | | |
| | ZO1551.3 | Human diseases and their management | | |

First Degree Programme in Zoology
Semester VI

Zoology Open Course II
Offered to students of Zoology Programme

Table IV. Scheme of Instruction of Open Course II

| Semester | Course Code | Course Title | Instructional hours/week | Credits |
|----------|-------------|--|--------------------------|---------|
| VI | ZO1651.1 | Economic Zoology : Vermiculture and Apiculture | 3 | 2 |
| | ZO1651.2 | Ornamental Fish Production and management. | | |
| | ZO1651.3 | Dairy farming and Broiler farming | | |

First Degree Programme in Zoology

Table V. Scheme of question paper – Theory Courses

| Type of Questions | Question No. | Nature of questions | Weightage |
|--|--------------|---------------------|-----------|
| I. Objective | 1 – 4 | Fill in the blanks | 1 |
| | 5 – 8 | Match the following | 1 |
| | 9 – 12 | Multiple choice | 1 |
| | 13 – 16 | True or False | 1 |
| II. Short Answer (Answer any eight) | 17 | | 1x8 = 8 |
| | 18 | | |
| | 19 | | |
| | 20 | | |
| | 21 | | |
| | 22 | | |
| | 23 | | |
| | 24 | | |
| | 25 | | |
| | 26 | | |
| 27 | | | |
| III. Short Essay (Answer any 5) | 28 | | 2x5 = 10 |
| | 29 | | |
| | 30 | | |
| | 31 | | |
| | 32 | | |
| | 33 | | |
| | 34 | | |
| | 35 | | |
| IV. Long Essay (Answer any 2) | 36 | | 4x2 = 8 |
| | 37 | | |
| | 38 | | |
| Total | | | 30 |

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Table VI. Scheme of question paper - Practical

| Type of Questions | Weightage |
|-----------------------------------|-----------|
| I. Major Dissection / Experiment | 4 |
| II. Minor Dissection / Experiment | 3 |
| III. Spotters | 10 |
| IV. Record | 3 |
| Total | 20 |

Table VII. Consolidation of Grade of a course

| Evaluation | Grade | Grade points (G) | Weightage (W) | Weighted grade points (GxW) |
|--------------|-------|---------------------|---------------|--------------------------------|
| CE | | | 1 | |
| ESE | | | 3 | |
| Total | | | 4 | |

Grade of Course = Total weighted grade points / Total weightage =

CE - Continuous Evaluation, ESE - End Semester Evaluation

UNIVERSITY OF KERALA

First Degree Programme in Zoology

Choice Based Credit and Semester system

(With effect from 2010 admission)

Scheme of Instruction

First Degree Programme in Zoology is under Choice Based Credit and Semester system (CBCS). The duration of the Programme is three years consisting of six semesters. The duration of each semester is five months (18 weeks) inclusive of the days of examinations. There will be 90 working days and a minimum of 450 hours of instruction in a semester. An academic year will have two semesters. Odd semesters are from June to October and even semesters from December to April and one month each semester break in November and May. The total number of credits of the Programme is 120. The total number of courses is 37.

The language courses are distributed over the first four semesters. Foundation course I (English) is in the first semester and Foundation course II in the second semester.

Core courses - Zoology courses – are offered in all the semesters except in the second semester. Hours for Project are distributed over the fifth and sixth semesters and that for the Field study on fifth semester. Students of First Degree Programme in Zoology can choose Open course I offered by any department other than Zoology is in the fifth semester. While Open course II, offered by the Department of Zoology is in the sixth semester. Complementary courses on allied subjects are in the first four semesters.

The scheme of Instruction and Evaluation of study components of First Degree Programme in Zoology is given in the Table I.

Course number, Course Code, Course title and scheme of instruction of Core Courses, Foundation Courses, Open Courses and Project is given in Table II.

Foundation course II (Course Code: ZO1221)

Foundation Course II – General Informatics and Bioinformatics - is in the second semester. It has 72 instructional hours. 54 hours are for theory (3hours/ week) and 18 hours for practical (1hour/ week). Credit is 3. (No ESE for the practical).

Core courses

Core Courses are offered by the parent department. The total number of core courses is fourteen - nine theory courses, four practical courses and one Project and Field Study Course. The Core Course I (Course Code: ZO1141) is prescribed for the first semester and Core Course II (Course Code: ZO1341) for the third semester and Core Course III (Course code: ZOI441) for fourth semester are theory courses, each having 54 hours of instruction (3 hours/ week) and 3 credits. The Core Course IV (Course Code: ZO1541) is Practical I of theory courses ZO1141, ZO1341 and ZOI441. The practical hours are distributed one in the first and two each in the third and fourth semesters. Total credits allotted for Practical I is 4. ESE of Practical I is at the end of V semester. Core Course V

(Course Code: ZO1542) of fifth semester has 90 hours (5hours/ week) and 4credits. Core Course VI (Course Code: ZO1543) and Core Course VII (Course Code: ZO1544) of fifth semester are of 72hours (4 hours/ week) and with 4 credits each. Core Course VIII (Course code: ZO1545) is Practical II of theory Core Courses ZO1542, ZO1543 and ZO1544 has 5 hours in fifth semester. End Semester examination of Practical II is at the end of the fifth semester and 4 credits. Theory Core Course IX (Course Code: Z1641) of sixth semester is of 90 hours (5hours/ week) and 4 credits. Theory Core Courses X (Course Code: ZO1642) and XI (Course Code: ZO1643) of sixth semester are of 72 hours in syllabus (4 hours/ week) with 4 and 3 credits respectively. Core Courses XII (Course Code: ZO1644) is Practical III of Core Course ZO1641 and Core Course XIII (Course Code: ZO1645) is Practical IV of Core Courses ZO1642 and ZO1643. Three hours and three credits are allotted for both courses. Core Course XIV (Course Code ZO1646) is the Project and Field study. In the fifth semester 3 hours are allotted for Project and one hour for the Field study. In the sixth semester also 3 hours are there for the Project. ESE for this course is at the end of the sixth semester and four credits.

Open Courses

Open Course I

Students of First Degree Programme have the freedom to choose Open Course I offered by any disciplines other than the parent department. The students of First Degree Programme in Zoology has to choose Open Course I offered by departments other than Zoology.

Open Course I in the fifth semester offered by the Department of Zoology is for the students of other disciplines. It has 54 hours (3hours/ week) and 2 credits. Three courses are designed for Open Course I. An institution can choose any one of the following courses.

Open Course I

| Course Code | Title of course |
|--------------------|-------------------------------------|
| ZO1551.1 | Public Health and Hygiene |
| ZO1551.2 | Human Health and Sex Education |
| ZO1551.3 | Human diseases and their management |

The scheme of instruction of Open Course I is given in Table III.

Open Course II

Open Course II is for the students of First Degree Programme in Zoology. Instructional hours are in the sixth semester. 54 hours (3hours/ week) and 2credits are allotted for it. Three courses are prepared for Open Course II. An Institution can choose any one of the following courses.

Open Course II

| Course Code | Title of the course |
|--------------------|--|
| ZOI651.1 | Economic Zoology - Vermiculture and Apiculture |
| ZOI651.2 | Ornamental Fish Production and management |
| ZOI651.3 | Dairy farming and Broiler farming |

The scheme of instruction of Open Course II is given in Table IV.

Project and Field study (Course Code: ZO1646)

Core courses include a compulsory Project and Field study. Three hours each are given for project in the fifth and sixth semesters. One hour for the Field study in the fifth semester. The Course Code is ZO1646 and credits 4. There is no Continuous Evaluation for this course.

Scheme of Evaluation

Evaluation of all theory and practical courses involve Continuous Evaluation (CE) and End Semester Evaluation (ESE). The proportion of the grade of CE and ESE 1:3. CE is for 25% and ESE for 75%. All theory courses have ESE at the end of the corresponding semesters. But Practical courses have ESE at the end of fifth semester and at the end of sixth semester only. Both Continuous Evaluation and End Semester Evaluation are carried out with direct grading. The system of five point grade scale adopted is given in Table A

Table A. Five point scale of direct grading

| Grade | Performance | Grade points | Grade Range |
|-------|---------------|--------------|--------------|
| A | Excellent | 4 | 3.50 to 4.00 |
| B | Very Good | 3 | 2.50 to 3.49 |
| C | Good | 2 | 1.50 to 2.49 |
| D | Average | 1 | 0.50 to 1.49 |
| E | Below Average | 0 | 0.00 to 0.49 |

I. Continuous Evaluation (CE)

Continuous Evaluation of each course will be done by the faculty member who is engaging the course. CE is based on the student's attendance, performance in the class tests, seminars / assignments and records of practical. Assignments and answer scripts are to be returned to the students after evaluation. Tabulated statement of CE must be put up on the department notice board prior being dispatched to the University.

The process of Continuous Evaluation must be transparent. Monitoring of the First Degree Programme is done by committees at three levels – Department Level Monitoring Committee (DLMC), College Level Monitoring Committee (CLMC) and University Level Monitoring Committee (ULMC). DLMC consists of the Head of the Department and all teachers of the Department. They monitor the conduct of courses and CE. The Head of the Department be the Chair person and a teacher selected by the DLMC from among the members is the Convener. College Level Monitoring Committee will consider the complaints not redressed by the DLMC.

CE of Theory courses (Weightage 4)

The different components considering for CE of theory courses and corresponding weightage are given in the Table B.

Table B. Components and weightage for CE of theory course

| Sl. No. | Component | Weightage |
|---------|------------------------|-----------|
| 1. | Attendance | 1 |
| 2. | 2 Class tests | 2 |
| 3. | Seminar/ Assignment | 1 |
| Total | | 4 |

1. Attendance (Weightage 1)

The allotment of grades for attendance is given in Table C.

Table C. Grading of attendance

| Attendance | Grade |
|----------------------|---------|
| Above 90% | A grade |
| 86% to 90% | B grade |
| 81% to 85% | C grade |
| 75% to 80 % | D grade |
| Attendance up to 75% | E grade |

A student with attendance below 75% cannot appear for the ESE.

2. Two Class Tests (Weightage 2)

Two class tests shall be conducted for each course during the semester. Average grades of the tests are considered for CE. Weightage for this is 2. Question pattern of ESE can be adopted for test papers. Grading process is similar to that of ESE.

3. Seminar/ Assignment (Weightage 1)

Each student is required to do one seminar or one assignment for each course. Certain topics for seminars/ assignments are given after the syllabus of each course. These topics are denoted for CE only. Seminar is to be graded based on the way of presentation, matter content, etc. These factors can be graded on the five-point scale as given in Table A.

Assignment is to be graded based on timely submission, content, etc. on the five-point scale as given in Table A.

CE of Practical courses: (Weightage 4)

The different components considering for CE of Practical courses and corresponding weightage are given in the Table D.

Table D. Components and weightage for CE of Practical course

| Sl. No. | Component | Weightage |
|---------|----------------|-----------|
| 1. | Attendance | 1 |
| 2. | Performance | 1 |
| 3. | One Class test | 1 |
| 4. | Record | 1 |
| Total | | 4 |

- 1. Attendance:** (Weightage 1) same as given for theory CE in Table C.
- 2. Performance in laboratory :** (Weightage 1) Grade the students in the five-point scale as given for theory (Table A).
- 3. Class test:** (Weightage 1) One class test shall be conducted for a practical course during a semester. Grading process is similar to that of ESE.
For Practical I (Course Code: ZO1541) instead of class test consider the two compulsory assignments given in the syllabus.
- 4. Record:** (Weightage 1) Record is to be assessed taking into account the following points – timely presentation, content, accuracy of diagrams and neatness. Record grading is also on the five-point scale as given for theory (Table A).

Model tabulation sheets for Continuous Evaluation score of theory and practical courses are appended herewith.

First Degree Programme in Zoology**Continuous Evaluation Grade– Theory: Weightage 4**

| Component | Grade | Grade Points (G) | Weightage (W) | Weighted Grade Point (G x W) |
|--------------------|-------|------------------|---------------|------------------------------|
| Attendance | | | 1 | |
| Class test | | | 2 | |
| Seminar/Assignment | | | 1 | |
| Total | | | 4 | |

First Degree Programme in Zoology

Continuous Evaluation Grade– Practical: Weightage 4

| Component | Grade | Grade Point (G) | Weightage (W) | Weighted Grade Point (G x W) |
|-------------|-------|-----------------|---------------|------------------------------|
| Attendance | | | 1 | |
| Performance | | | 1 | |
| Class test | | | 1 | |
| Record | | | 1 | |
| Total | | | 4 | |

II. End Semester Evaluation (ESE) (Conducted by the University)

A. Theory

All theory courses have End Semester Examination at the end of the corresponding semester. The duration of examination is 3 hours per course. Weightage of theory ESE is 30. Grading is according to the five point scale. The question paper for ESE of theory courses will be prepared by the Board of External Examiners appointed by the University.

The Scheme of Instruction and Evaluation of First Degree Programme in Zoology are given in Table I.

The scheme of question paper of Theory Course with weightage is given in Table V.

B. Practical:

End Semester Examination of Practical I (Course Code: ZO1541) and Practical II (Course Code: ZO1545) will be held at the end of the fifth semester. Practical III (Course Code: ZO1644) and Practical IV Course Code: ZO1645) will be held at the end of the sixth semester. The duration of examination is 3 hours. Weightage of Practical ESE is 20. The question papers for the conduct of ESE of Practical will be prepared by the Board of Examiners appointed by the University. Practical examination is to be conducted by a team of two external examiners. A batch may contain a maximum of 15 candidates per session of the exam.

The scheme of question paper of Practical Course with weightage is given in Table VI

C. Record

Each Practical Course has a record book. Candidates must submit the record of the corresponding Practical Course on the day of the end semester examination before the External Examiners for ESE. Candidates without certified record book are not allowed to appear for the examination.

D. Project and Field study

Reports related to project work and Field study are evaluated by the External Examiners on the next day after the End Semester Examination of Practical IV at the end of sixth semester. Total weightage for ESE is 20.

Viva-Voce

Viva-Voce includes presentation of the Project report and testing of the student's knowledge on the project work and general biological topics based on questions asked. Maximum time of ten minutes can be taken for evaluating a candidate. The distribution of weightage is given below.

| | |
|--------------------|-----------|
| Project Report | 7 |
| Viva-voce | 8 |
| Field study Report | 5 |
| Total | <u>20</u> |

Consolidation of Grade of a course having Continuous Evaluation and End Semester Evaluation in 1:3 proportion is given in Table VII.

**First Degree Programme
Semester I
Zoology Core Course I
Methodology and Perspectives of Science and Zoology**

Course code – ZO1141

No. of Credits – 3

Total hours 54

Aim of the course

To introduce the methodology and perspectives of Science in general so as to enable the students to systematically pursue Zoology in relation to other disciplines that come under the rubric of science.

Objectives of the course

- To learn the fundamental characteristics of science as a human enterprise
- To understand how science works
- To study to apply scientific methods independently

Methodology of Science

35hrs

Module I

3hrs

Introduction to scientific studies: scientific knowledge – laws, disciplines and revolutions

Module II

8hrs

Methods, Tools and Experimentation: hypothesis, theories and laws in science, Hypothetico-deductive and inductive models, simulations and virtual testing, observations, evidences and proofs.

Module III

10hrs

Scientific instruments and techniques: microscopes-light microscopes, dark-field, fluorescent microscope and centrifuges (self study), phase-contrast microscope, electron microscopes-TEM and SEM, colorimeter, spectrophotometer, pH meter, chromatography, electrophoresis; Microtome and histological staining techniques, Robotics.

Module IV

14hrs

Data handling in Science: design of experiments-observation, data collection, nature and types of data (typical examples), treatment of data, data interpretation, significance of statistical tools in data interpretation, errors and inaccuracies, instrumental errors and variables, human errors.

Data presentation: tables, graphs (line graphs, frequencies polygon, frequency curve and ogives) and diagrams(bar and pie); statistical testing- null hypothesis, test of significance (t-test), statistics based acceptance or rejection of a hypothesis (chi-square); deduction of scientific correlation, patterns and trends.

Ethics in science: (brief account only), scientific information-depositories of scientific information- primary, secondary and digital sources; sharing of knowledge, transparency and honesty; danger or preconceived ideas. Reporting of observational and experimental data, human bias, biased observations, influence of observer on observations, publications and patents, Plagiarism

Methodology of Zoology

19hrs

Module V

6hrs

Nature and scope of Zoology: branches of Zoology, opportunities for further studies in zoology, websites for zoology studies

Module VI

13hrs

Introduction to Zoology, taxonomy-definition, history, new trends and importance, mention molecular taxonomy. Components of classification, Taxonomic hierarchy- taxon, category and rank. Linnaean hierarchy, nomenclature, principles of nomenclature. International Code of Zoological Nomenclature (ICZN), rules of nomenclature, requisites – uni, bi and trinominalism. Species, species concept and approach, taxonomic aids.

Suggested topics for assignments / seminars

1. Different types of microscopes,
2. Different types of centrifuges,
3. Collection of different local fauna and analysis of data,
4. Designing of an experiment of own interest
5. Construction of bar diagram, histogram, pie diagram, frequency curve, frequency polygon
6. Collect and identify five local fauna with systematic position.

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First Degree Programme
Semester II
Zoology Foundation course II
General Informatics and Bioinformatics

Course code – ZO1221

No. of Credits - 3

Total hours 54

Aim of the course

To expand basic informatics skill and attitudes relevant to the emerging society and also to equip the student to effectively utilize the digital knowledge resources for the study of Zoology

Objectives of the course

- To review the basic concepts and functional knowledge in the field of informatics
- To create awareness about nature of the emerging digital knowledge society
- To create awareness about social issues and concerns in the use of digital technology
- To learn the nature, application and scope of Bioinformatics

General Informatics

36hrs

Module I

6hrs

Overview of Information Technology: features of the modern Personal Computer and Peripherals, computer networks and internet, introduction to mobile phone technology, purchase of technology, license, guarantee, warranty, overview of operating system and major application softwares.

Module II

12hrs

Knowledge skills for Higher Education : data information and knowledge, knowledge management – Internet as a knowledge repository, academic search techniques, creating your cyber presence, 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 softwares. Academic services – INFLIBNET, NICNET, BRNET

Module III

10hrs

Social Informatics : IT and society – Issues and Concerns – digital divide, IT and development, new opportunities and new threats, cyber ethics, cyber crime, security, privacy issues, cyber addictions, information overload; health issues – guide lines for proper usage of computers, internet and mobile phones. Localization issues – IT and regional languages – IT for the disabled, the free software debate.

Module IV

8hrs

IT @ Service of society: e-governance application and state level, overview of IT application in medicine, healthcare, business, commerce, industry, defense, law, crime detection, publishing, communication, resource management, weather forecasting, education, film and media, futuristic IT – artificial Intelligence, virtual Reality

Bioinformatics

18hrs

Module V

9hrs

Definition, Nature & Scope of Bioinformatics - Contrast between Bioinformatics and Computational Biology; Key Bio-sequences in Molecular Biology - DNA, RNA and Amino-acid sequences - Popular Databases in Bioinformatics - NCBI, DDJB, PDB, OMIM; BLAST & FASTA sequence file formats, Approach of Comparative Biology based on sequence comparison - The basic idea of sequence comparison (algorithms not required) - idea of scoring matrices

Module VI

9hrs

The Blast search engine - important features - Idea of Multiple sequence alignment - Proteomics: Basic ideas of Protein Structure prediction- Concept of Homology Modeling- Idea of Molecular Phylogenetics - advantages and computational procedure (only description of use of a package such as Phylip)- Basic concepts of computer Aided Drug Discovery- General description of drug discovery pipeline- concept of Personalized medicine; Bioinformatics tools: (i)Molecular Visualization Software - Rasmol (Basic features only) - (ii) ORF finding (iii) gene finding, (iii) BLAST (iv) Hydrophobicity Prediction (v) Single Nucleotide Polymorphism (SNP) prediction using GENSNIIP

Practical

Total hours 18

(No ESE for practical)

- a) Download a specified sequence from NCBI and search with it in BLAST and report results with comments.
- b) Download molecular structure data files of DNA, Sugar, Water etc and inspect them through Rasmol. Make one measurement each on these molecules (distance, angles etc).
- c) Download a specified DNA sequence from NCBI and identify ORF & genes, if any, in it.
- (d) Download a specified AA sequence from NCBI and plot its hydrophobicity profile.
- (e) Demonstrate SNP prediction using GENSNIIP.

Suggested topics for assignments/ seminars

1. Conduct of an experiment to demonstrate the use of BLAST
2. Visit KEGG data base and retrieve the list of completed genome project
3. Compare the traditional Phylogenetic methods with the Molecular Phylogenetics
4. Visit NCBI, EMBL, DDBJ, PDB. List out the salient features of them.
5. Write a report on various phases of Computer Aided Drug Discovery.
6. From internet locate some success stories of Computer Aided Drug Discovery
7. Write brief note on recent development of System Biology and Synthetic Biology.
8. Down load the human chromosome I in fasta format and cut a portion of the

sequence, using gene finding tool predict the gene present.

9. Write a brief note on different Phylogenetic tree building methods.

References

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- Web Resources
 - www.fgcu.edu/support/office2000
 - www.openoffice.org *Open Office Official* web site
 - www.microsoft.com/office *MS Office* web site
 - www.lgta.org *Office* on-line lessons
 - www.learnthenet.com *Web Primer*
 - www.computer.org/history/timeline
 - www.computerhistory.org
 - www.keralaitmisson.org *Kerala Govt. IT Dept.*
 - www.technopark.org
 - <http://ezinearticles.com/?Understanding-The-IOperation-Of-Mobile-Phone-Networks&id=68259>
 - <http://www.scribd.com/doc/259538/All-about-mobile-phones>
 - <http://www.studentworkzone.com/question.php?ID=96>
 - <http://www.ofc.usyd.edu.au/edweb/revolution/history/mobile2.html>

**First Degree Programme
Semester III
Zoology Core Course II
Animal Diversity I**

Course code – ZO1341

No. of Credits – 3

Total hours 54

Aim of the course

To provide the students with an in-depth knowledge of the diversity in form, structure and habits of invertebrates.

Objectives of the course

- To learn the basics of systematics and understand the hierarchy of different categories.
- To learn the diagnostic characters of each phyla through brief studies of typical examples.
- To obtain an overview of economically important invertebrate fauna

Module I

Introduction, Two kingdom classification and Whittaker's five kingdom classification. Advantages and disadvantages of five kingdom classification. (self study)

Module II

10hrs

Kingdom Protista: general characters, structure and zoological importance and systematic position of *Actinophrys*, *Noctiluca*, *Paramecium* and *Opalina*. Parasitic protozoans- morphology, life history, pathogenicity and prophylaxis of *Entamoeba histolytica*, *Trypanosoma gambiense* and *Plasmodium vivax*.

Module III

8hrs

Kingdom Animalia: Outlines of classification – Subkingdom Mesozoa, Subkingdom Parazoa, Subkingdom Eumetazoa. Levels of organization– cellular, tissue, organ. Divisions of Eumetazoa- Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia. Sub kingdom Mesozoa- general characters, eg. *Rhopalura*. Sub kingdom Parazoa- general characters and mention the classes of Porifera- Calcispongia, eg. *Sycon*; Hydrosporgia, eg. *Euplectella*; Desmospongia, eg. *Spongilla*.

Module IV

4hrs

Phylum Coelenterata: General characters (self study). Classes- Hydrozoa eg. *Obelia*, *Physalia*; Scyphozoa eg. *Aurelia*, *Rhizostoma*; Anthozoa eg. sea anemone, *Madrepora*. General topic- Polymorphism in coelenterate s.

Module V

7hrs

Phylum Platyhelminthes: General characters (self study). Classes- Turbellaria eg. *Bipalium*, Trematoda eg. *Fasciola*; Cestoda, eg. *Teania solium*.

Phylum Nematoda: general characters (self study), eg. *Ascaris*, *Ancylostoma*, *Enterobius*, *Wuchereria*.

Phylum Annelida: General characters (self study). Type- Earthworm (self study). Classes-

Polychaeta eg. *Aphrodite*, *Arenicola*; Oligochaeta eg. *Nereis*, Heteroneries; Hirudinaria eg. leech. General topic - Vermiculture (brief account)

Module VI

16hrs

Phylum Arthropoda: General characters (self study), Type- *Penaeus*. Mention the classes. eg. cockroach, *Limulus*, *Eeupagurus*, *Sacculina*, termite, honey bee, scorpion.

Phylum Onychophora: general characters, eg. *Peripatus*. General topic: Apiculture, sericulture.

Module VII

9hrs

Phylum Mollusca: General characters (self study), Classes- Monoplacophora, eg. *Neopilina*; Amphineura, eg. *Chiton*; Aplecophora, eg. *Neomenia*, Gastropoda eg. *Pila*; Scaphopoda, eg. *Dentalium*; Pelicypoda eg. *Perna*, *Terido*; Cephalopoda, eg. *Sepia*, *Octopus*. General topic- Economic importance of mollusca - emphasis on pearl culture.

Phylum Echinodermata: General characters (self study) Classes- Asteroidea, eg. *Asterias*; Ophiuroidea, eg. *Ophiothrix*; Echinoidea, eg. *Echinus*; Holothuroidea, eg. Sea cucumber, Crinoidea, eg. Sea lily.

Suggested topics for assignments / seminars

1. Parasitic Protozoa
2. Corals and coral reefs
3. Polymorphism in Cnidaria
4. Life history of *Fasciola*
5. Nematode parasites (any three)
6. Economic importance of earthworm and vermiculture
7. Economic importance of molluscs
8. Mussel culture
9. Pearl culture
10. Economic importance of insects
11. Insect pests of crop plants
12. Social insects
13. Mosquitoes- morphological differences and diseases
14. Crustacean larvae.

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**First Degree Programme
Semester IV
Zoology Core Course III
Animal Diversity II**

Course Code – ZO1441
No. of credits – 3

Total hours 54

Aim of the course

To provide the students with an in-depth knowledge of the diversity in form, structure and habits of invertebrates.

Objectives of the course

- To learn the general characteristics and classification of different classes of vertebrates
- To get an understanding of the vertebrate evolutionary tree
- To understand general aspects of applied interest

Module I

6hrs

Introduction, Phylum Chordata: general characters and their classification into three subphyla (self study). Subphylum Urochordata- general characters, Class Larvacea eg. *Oikopleura*; Class Ascidiacea eg. *Ascidia* (Mention retrogressive metamorphosis) and Class Thaliacea eg. *Salpa*. Subphylum Cephalochordata-general characters, eg. *Amphioxus*

Module II

10hrs

Subphylum Vertebrata: general characters, Division 1 Agnatha -general characters, Class Cyclostomata eg. *Petromyzon*, Class Ostracodermi; Division 2 Gnathostomata-general characters, Classification into Super class Pisces and Tetrapoda. Super class Pisces- general characters and classification, Class Placodermi, Class Chondrichthyes, Sub class Elasmobranchii eg. *Narcine*, Sub class Holocephali eg. *Chimaera*; Class Osteichthyes- Sub class Choanichthyes- Order1 Crossoptergii eg *Latimeria*, Order 2 Dipnoi eg.

Protopterus, Subclass Actinopterygii-Super order Chondrostei eg *Acipenser*.
Super order Holostei eg *Lepidosteus*, Super order Teleostei eg *Anabas*, *Clarius*,
Saccobranchus, *Ophiocephalus*, *Echeneis*. General topic: Accessory respiratory
organs in fishes.

Module III

5hrs

Super class Tetrapoda: Salient features, Class Amphibia - general characters (self study). Classification- Order Urodela eg *Amblystoma*, Order Anura eg *Hyla*, *Bufo*, *Rana*

Order Apoda eg. *Ichthyophis*. General topic: Parental care in amphibia.

Module IV

9hrs

Class Reptilia - general characters (self study). Classification - Subclass Anapsida - Order Chelonia eg. *Chelone*; Subclass Parapsida eg *Ichthyosaurus*; Subclass Diapsida- Order Rhynchocephalia eg. *Sphenodon*, Order Squamata- Suborder Lacertilia eg *Calotes*, *Chamaeleon*, *Draco*, *Hemidactylus*, Suborder Ophidia eg. *Naja naja*, *Vipera*, *Bungarus*, *Enhydrina*, *Ptyas*, *Lycodon*, *Tropidonotus*, *Dryophis*, *Typhlops* and *Eryx johni*, Suborder Crocodilia eg. *Crocodylus*, *Alligator*; Subclass Synapsida eg *Cynognathus*. General topic: Identification of poisonous and non-poisonous snakes.

Module V

5hrs

Class Aves- general characters (self study). Classification- Subclass Archeornithes eg *Archeopteryx*; Subclass Neornithes- Super order Paleognathae eg. *Sruthio* and *Emu*, Super order Neognathae eg. Grey heron, Vulture, Kite, *Pavo*, Koel, Owl, Woodpecker, Crow. General topic: Migration in birds.

Module VI

19hrs

Class Mammalia – Detailed study: Anatomy of *Homo sapiens*. General characters and classification of Class Mammalia- Subclass Prototheria eg. *Tachyglossus*; Subclass Metatheria eg. *Macropus*; Subclass Eutheria- Order Insectivora eg. *Paraechinus*, Order Dermoptera eg. *Galeopithecus*, Order Chiroptera eg. *Pteropus*, Order Primates eg. *Loris*, Orangutan, Order Carnivora eg. *Leo* sps, *Felis domesticus*, *Canis familiaris*, *Herpestus*, Order Cetacea eg. *Delphinus*, Order Perissodactyla eg. *Equus*, Order Artiodactyla eg. *Camelus*, *Hippopotamus*, Order Proboscidea eg. *Elephas*. Order Sirenia eg. *Dugong*, Order Hyracoidea eg. *Procavia*, Order Rodentia eg. *Rattus*, Order Lagomorpha eg. *Oryctolagus*, Order Edentata eg. *Dasybus novemcinctus* (Armadillo), Order Pholidota eg. *Manis*, Order Tubilidentata eg. *Orycteropus*.
General topic: Dentition in mammals

Topics for assignments / seminars

1. Migration in fishes.
2. Parental care in fishes.
3. Caudal fin in fishes
4. Snake venom and its uses.
5. Volant adaptations of birds.
6. Adaptations of feet and beak of birds.
7. Economic importance of mammals.
8. Mammalian resources of the forests of Kerala.

9. Flying mammals.
10. Endangered mammals.

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First Degree Programme Zoology Core Course IV

Practical I - Methodology and Perspectives of Science and Zoology, Animal Diversity I and Animal Diversity II

Course Code – ZO1541

No. of credits – 4

Aim of the course

To provide a hands on training experience in anatomy through simple dissection and mountings

Objectives of the course

- To familiarize students with conventional organ system in common, easily available animals.
- To emphasize the adage that 'seeing is believing' typical examples and economically important specimen (preserved) to be studied.
- To study and carry out routine clinical analysis of blood and urine.

Methodology and Perspectives of Zoology

Study of the following instruments

1. Compound microscope

2. Centrifuge
3. Colorimeter
4. Microtome
5. pH Meter

Biostatistics

Graphs, Tables, Histogram, Pie diagram
 mean, median, mode, standard deviation and standard error
 students' t- test and chi- square test

Animal Diversity I

Minor Practicals - any four.

1. Nereis – parapodium
2. Earthworm – body setae
3. Cockroach – salivary apparatus in situ
4. Cockroach – mouth parts
5. Honey bee – mouth parts / mosquito - mouth parts
6. Prawn – appendages

Major Practical – any two

1. Earthworm – nervous system
2. Cockroach – nervous system
3. Prawn – nervous system

Taxonomy

Identification and classification of the following specimens

1. Protista – *Actinophrys*, *Noctiluca*, *Pramecium*, *Opalina* – any 2
2. Phylum Porifera – *Euplectella*, *Spongilla* - any 1
3. Phylum Cnidaria – *Hydra*, *Obelia*, *Physalia*, *Aurelia*, Sea anemone, Madrepora – any 3
4. Phylum Nematoda – *Ascaris* male and female (entire)
5. Phylum Platyhelminthes – *Bipalium*, *Fasciola*, *Teania solium* – any 1
6. Phylum Annelida – Earthworm, *Nereis*, Leech, *Aphrodite*, *Arenicola* – any 1
7. Phylum Onychophora – *Peripatus*
8. Phylum Arthropoda – Cockroach, *Limulus*, *Eupagurus*, *Sacculina*, Honey bee, *Lepisma*, Scorpion – any 3
9. Phylum Mollusca – Chiton, *Pila*, *Xancus*, *Dentalium*, *Perna*, *Mytilus*, *Teredo*, *Sepia*, *Octopus*. – any 2
10. Phylum Echinodermata – Starfish, Brittle star, Sea urchin, Sea cucumber, Sea lily – any 2

Animal Diversity II

Minor practical

Fishes - placoid scales of *Scoliodon* and cycloid and ctenoid scales of *Anabas*

Osteology

Human limb bones, girdles, typical vertebra, atlas, axis, thoracic and lumbar vertebrae and lower jaw.

Turtle - carapace and plastron.

Taxonomy

Prochordates – *Amphioxus (entire)*

Pisces - 2 cartilaginous fishes, 2 fishes with accessory respiratory organs, 2 edible fishes and 2 culture fishes.

Amphibia - any 3 (representing the three orders).

Reptilia - 2 poisonous and 2 non -poisonous snakes, *Draco, Chamaelon*

Aves - Different feathers, Pigeon.

Mammals - Bat

Compulsory assignment for practical

Animal Diversity I (5% of practical CE)

Students shall collect any 2 invertebrates/parasites/pests specimens and prepare a brief note including taxonomy and submit for evaluation.

Animal Diversity II (5% of practical CE)

Students shall collect any two local fish and prepare a brief note including taxonomy and submit for evaluation.

First Degree Programme Semester V Zoology Core course V Cell Biology and Molecular Biology

Course code – ZO1542

No. of credits – 4

Total hours 90

Aim of the course

To educate the student on the fundamental structure, biochemistry and function of the cell and the principles of molecular biology and gene manipulation

Objectives of the course

- To study the ultra-structure of prokaryotic and eukaryotic cells
- To study the nature, replication and modification of the genetic material of eukaryotes
- To obtain a broad concept of gene expression and regulation

Cell Biology

50 hrs

Module I

38hrs

History, development and scope of cell biology, discovery of cells; cell theory and its modern version (self study).

Cell and its components: basic types of cells- prokaryotic and eukaryotic,

nature and comparison (self study)

Ultra structural organization and functions: Plasma membrane- ultra structure- fluid mosaic model , functions of plasma membrane, trans-membrane transport. Cell communication- cell signaling and signal transduction, basic elements involved.

Mitochondria- structure, functions, mention oxidative phosphorylation and electro transport chain.

Endoplasmic reticulum - morphology, types, functions and formation.

Golgi bodies - morphology, types, functions (role in secretion) and formation.

Lysosomes- morphology, mention major groups of enzymes, classification, polymorphism and functions.

Microbodies - morphology, major enzymes, peroxisomes and glyoxisomes functions.

Ribosomes - different types, subunits, functions.

Proteosomes - structure, ubiquitin - tagged protein degradation.

Centrioles and basal bodies- structure and functions.

Cytoskeleton- microtubules, microfilaments and intermediate filaments- examples and functions.

Interphase nucleus - gross structure and functions; nuclear envelope- pores and pore complexes; nuclear lamina, formation of NE; nucleoplasm- nature and importance.

Nucleolus - structure, nucleolar cycle, nucleolar organizer and functions.

Chromatin - euchromatin and heterochromatin, nucleosomes, unit fibre, solenoid fibre, and higher order of organization, condensation and coiling.

Chromosome - structure of a typical metaphase chromosome; giant chromosomes- polytene chromosomes, lamp brush chromosomes; endomitosis.

Module II

8hrs

Cell Division: cell cycle- G₁, S, G₂, and M phases (mention G₀, and D₀ stages and their significances); amitosis (brief account only). Mitosis (self study). Meiosis: description of all stages, synaptonemal complex, significance

Module III

2hrs

Biology of cancer: characteristics of cancer cells, dedifferentiation of cancer cells, theories of cancer, carcinogenesis, oncogenes and tumor suppressor genes

Module IV

2hrs

Aging: cellular and other changes, apoptosis, causes of aging, mention free radicals and superoxide dismutase (SOD), theories of aging.

Module V

40 hrs

Module V

16hrs

Introduction: history, development and scope.

Nature of genetic material: search for the genetic material, Griffith's experiment, transformation, contributions of Avery, MacLeod and McCarty, Conrat & Stern's experiment with TMV, Hershey & Chase's experiment, transduction.

Composition and structure of nucleic acids - Watson - Crick model of DNA, clover leaf model of tRNA, different types of DNA and RNA; DNA replication in prokaryotes and eukaryotes - Semi-conservative method, Messelson & Stahl experiment, replication machinery and mechanism; modification and repair of DNA.

Module VI

15hrs

Gene Expression: contributions of Garrod, one gene – one enzyme hypothesis, one gene one polypeptide hypothesis, central dogma of Molecular Biology, central dogma reverse, co-linearity of genes and gene products.

Genetic code - deciphering / cracking the GC, characteristics of GC, codon assignment and wobble hypothesis.

Mention contributions of Nirenberg and his associates, Khorana and his associates. Transcription of RNAs - RNA polymerases, transcription factors, mechanism of transcription, post-transcriptional modifications of mRNA, rRNA and tRNA, reverse transcription, translation – machinery and mechanism; post translational modification of proteins; role of chaperones in protein normal folding and protection

Module VII

5hrs

Gene regulation: in prokaryotes (inducible and repressive systems); operon concept – Lac operon and Trp operon

Module VIII

4hrs

Bacterial Recombination: transformation, conjugation and transduction (general and specialized transduction)

Suggested topics for assignments / seminars

1. Basic properties of cells
2. A brief history of studies on plasma membrane structure
3. Role of Ca⁺⁺ in signal transduction
4. Chemical components of: a) Endoplasmic reticulum b) Golgi bodies c) Lysosomes
d) Ribosomes
5. Models of ribosome structure
6. Lysosomes and storage diseases
7. Phenylketonuria
8. Alkaptonuria
9. Albinism

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**First Degree Programme
Semester V
Zoology Core Course VI
Genetics and Biotechnology**

Course Code – ZO1543

No. of credits – 4

Total hours 72

Aim of the course

To educate the students on the underlying genetic mechanism operating in man and state of the art bio-techniques

Objectives of the course

- To learn the mechanism of crossing over and inheritance patterns in man.
- To understand the principles and techniques involved in DNA technology and get an overview of modern techniques like PCR, Hybridoma technology, gene therapy and human cloning

Genetics

37hrs

Module 1

8hrs

Introduction, Mendel and his experiments, relevance of Mendel's principles in modern genetics (self study); genetic terminology-gene, allele, genotype, phenotype, genome; wild type and mutant type, test cross, back cross and reciprocal cross.

Interaction of genes: Allelic, incomplete dominance, lethal and co-dominance, non-allelic, complementary gene action (self study); Co-epistasis, dominant (feather coat) and recessive (coat colour), polygenic action (skin colour), pleiotropism (one example). Multiple alleles- ABO Blood group system, Rh group and its inheritance.

Module II

8hrs

Linkage, crossing over and recombination: Linked genes, linkage groups, chromosome theory of linkage, factors affecting linkage, crossing over and recombination, mechanism, kinds and factors affecting crossing over and its significance. Chromosome mapping (brief account only).

Sex Linkage: Characteristics of sex linked inheritance, sex linked inheritance of man (colour blindness and haemophilia), incompletely sex linked genes, holandric genes, sex limited genes and sex influenced genes.

Module III

8hrs

Sex Determination: Environmental factors on sex determination, mention genetic balance theory, chromosome theory of sex determination, chromosomal mechanism of sex determination, (XX-XY, XX-XO, ZZ-ZW), sex determination in man, role of Y chromosome, Barr bodies, dosage compensation and Lyon hypothesis. Chromosome mosaicism. Mention inter sex, gynandromorph and hermaphrodite.

Module IV

6hrs

Mutation: Types of mutations - somatic, germinal, spontaneous, induced, autosomal and allosomal, euploidy and aneuploidy. Gene mutation, molecular basis of mutation, induced mutation- chemical, ionizing and non ionizing.

Module V

3hrs

Cytoplasmic inheritance: Mitochondrial DNA, kappa particles in paramecium, maternal effects in Drosophila.

Module VI

4hrs

Human Genetics: Karyotyping, normal chromosome complement, pedigree analysis, chromosomal anomalies in man, autosomal (eg. Down syndrome, Edwards syndrome), allosomal (eg. Klinefelters syndrome, Turner's syndrome)

Biochemical genetics: Human biochemical genetics, biochemical pathway of phenyl alanine, tyrosine metabolism in normal man. Disorders- Phenylketonuria, Alkaptonuria, Tyrosinosis and Albinism.

Biotechnology

35 hrs

Module VII

9hrs

Introduction- Scope of biotechnology, emerging branches of biotechnology.

Genetic engineering and recombinant DNA technology, techniques in gene cloning, restriction endonucleases, ligases, major steps in cutting and joining of DNA, tools used in recombinant DNA technology, vectors, plasmids, probes, linkers, host cells, transformation and detection of recombinant molecules.

Module VIII**6hrs**

Genomic library, construction of genomic library and cDNA library, Polymerase Chain Reaction-basic steps and applications of PCR ,DNA sequencing (Sanger method, Automated sequencing), patenting DNA sequences.

Module IX**5hrs**

Blotting Techniques: Southern, Northern and Western blotting, DNA fingerprinting.

Module X**6hrs**

Human Genome Project, hybridoma technology and monoclonal antibodies;gene transfer techniques (chemical treatment, electroporation, lipofection, microinjection, retro viral vector method, embryonic stem cell method and shot gun method); transgenic microbes, plants and animals.

Module XI**4hrs**

Gene therapy: somatic gene therapy and germ line gene therapy; gene doping and its implications; DNA vaccines; Human cloning –therapeutic and reproductive cloning.

Module XII**5hrs**

Practical applications of biotechnology-in medicine, agriculture, industry, pollution control, forensics and judiciary. Potential hazards of biotechnology.

Bio-ethics - problems and solutions. Biotechnology in future.

Suggested topics for assignments / seminars

1. Mendel's laws.
2. Blood groups.
3. Intersexes, hermaphrodites, and gynandromorphs.
4. Genetic counseling
5. Human Genome Project.
6. Applications of DNA fingerprinting.
7. Ethical and social issues of Biotechnology.
8. Complimentary gene action.
9. Incomplete dominance.
10. Chemical mutagens in food.

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**First Degree Programme
Semester V
Zoology Core course VII
Immunology and Microbiology**

Course code – ZO1544

No. of credits – 4

Total hours 72

Aim of the course

To update the student on the scope and importance of clinical immunology and create an awareness about the inherent dangers of microbes

Objectives of the course

- To enable the student to understand the principles and mechanisms of immunology
- To learn the malfunctioning and disorders of the immune system
- To get a broad understanding of microbes and their economic importance with special reference to pathogenic forms.

Immunology

37 hrs

Module I

2hrs

Introduction, history, development and scope.

Module II

3hrs

Immunity: definition, classification of immunity. Innate (non-specific)– species, racial and individual IM with examples, acquired (specific)– active IM (natural and artificial) with examples, passive IM (natural and artificial) examples.

Module III

6hrs

Immune system: organs and tissues of the immune system. Primary (central) - thymus, bone marrow, bursa of Fabricii; secondary (peripheral)- spleen, lymph nodes, MALT etc. Cells- lymphocytes – T cells and B cells – formation, development and maturation; plasma cells and null cells – natural killer cells, killer cells, lymphokine - activated killer cells; phagocytes / macrophages; antigen presenting cells – macrophages, B-lymphocytes, dendrite cells, Langerhans cells; follicular dendrite cells, neutrophils, eosinophils, basophils, mast cells. Mitogens – mention only

Module IV

14hrs

Antigens (immunogens) (Ag): definition, complete antigens, haptens, antigenic determinants or epitopes; antibodies (Immoglobulins)- definition, general structure of Ig, Ig determinants, physico-chemical properties of Ig, classes of Ig- G, M, A, D, E; mention abnormal Igs; antigen – antibody reactions- mechanism (mention zone phenomenon), precipitation reactions, agglutination reactions, complement fixation, neutralization, opsonisation (brief accounts only)

Complement system: definition, general features, major histocompatibility complex (MHC) (brief account only). Immune response- definition, types of immune responses- humoral immune response (antigen mediated immunity - AMI) and cellular immune response (cell

mediated immunity - CMI) in detail, induction of CMI, mention cytokines, define immunological memory, immunological tolerance and immune suppression

Module V

12hrs

Hyper sensitivity / allergy: definitions, classification- types I, II and III (Brief accounts only); immuno deficiency diseases (ID)- definition, primary IDs, disorders of immune mechanism (humoral, cellular and combined IDs), disorders of complements, disorders of phagocytosis, mention one example each, secondary IDs - mention example, an account of Acquired Immune Deficiency Syndrome (AIDS); Auto immunity-definition, mechanism, mention AI diseases; transplantation immunity-definition, classification of transplants, graft versus host reactions; graft rejection, mechanism of graft rejection, factors affecting graft survival; Immunisation and vaccination- definitions, vaccines; types of immunization- active immunization- killed and live attenuated vaccines, microbial extracts, vaccine conjugates, toxoids, recombinant vaccines, DNA vaccines; passive immunization- pooled normal human Igs, specific Igs (hyper antisera); combined immunization

Microbiology

35hrs

Module VI

14hrs

Introduction: history, development and scope Importance of microbes in various ways- beneficial, harmful, ecological and others.

Classification of microbes/ particles: broad classification- viruses- different groups, examples; mention viroids and prions, *Mycoplasmas*, *Rickettsiae* and *Chlamydiae*; Bacteria: 1. Archaea – significance of extreme life forms (*Methanoarchaea*, extreme halophiles and thermophiles); Eubacteria (=Bacteria) Major groups of Eubacteria: Bergey's system of classification; modern methods classification of Eubacteria (outline only with familiar examples)- Nonphotosynthetic proteobacteria:- (Fermentative Rods and Vibrios) ex. *Vibrio*, *Pasteurella* (oxidative rods and cocci) eg. *Pseudomonas*, *Azotobacter*, *Rhizobium*;

Chemo-lithotrophic bacteria:- eg. nitrifying, sulphur and iron bacteria;

Firmicutes (eg. *Staphylococcus*) and Actinobacteria (*Coryneform* bacteria);

Phototrophic bacteria (Cyanobacteria); Algae- (details not expected)

Protista- different groups- examples: *Plasmodium*, *Giardia*; Fungi- Mention different groups – example *Candida*. Structure of a bacteriophage and a typical bacterium

Module VII

9hrs

Applied microbiology: various fields: emphasis on environmental, agricultural, medical, biotechnological, industrial and strategic fields

Module VIII

12hrs

Symbiotic microbes: microbes with other microbes, microbes with plants

microbes with animals; microbe – human host interactions, normal human microbiota of various organs- mention any 3 examples, pathogenic microbes – mention any 3 examples, microbial toxins – mention any 2 examples.

Microbial diseases in man (of skin, respiratory system etc.)- viral – chicken pox, measles, cold, herpes, hepatitis, poliomyelitis; bacterial – diphtheria, pneumonia, leprosy, ornithosis; fungal – aspergillosis, candidiasis and others – malaria

Suggested topics for assignments / seminars

1. Factors affecting innate immunity
2. Defense mechanisms of the body against infections
3. Factors affecting antibody production
4. Theories of antibody production
5. Organ transplantation
6. Immunisation and vaccination
7. Antiseptics and antibiotics
8. Sterilisation and disinfection

9. Anaphylaxis

10. Inflammation and fever

11. Blood transfusion and safety

12. Timing of vaccination: National Immunization Schedule

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First Degree Programme
Zoology Core course VIII
Practical II - Cell Biology and Molecular Biology, Genetics and
Biotechnology and Immunology and Microbiology

Course Code – ZO1545

No. of credits – 4

Aim of the course

To expertise the student to carry out routine hematological and microbiological techniques

Objectives of the course

- 1) To prepare and observe chromosomal arrangements during cell division
- 2) To study chromosomal aberrations in man
- 3) To gain of broad knowledge of conventional biotechnological procedures
- 4) To perform routine blood analysis.

Cell Biology and Molecular Biology

1. Staining of prokaryotic cells: (a) *Lactobacillus* from curd (b) Nitrogen fixing bacteria (*Rhizobium*) from root nodules of legumes
2. Staining of eukaryotic cells: buccal epithelial cells (observe Barr body)
3. Study of cell organelles
4. Mitosis: stages in onion (*Allium cepa*) root meristem (squash preparation)
5. Calculation of mitotic index and metaphase index in root meristem of *Allium cepa*
6. Meiosis: stages in testis of grass hopper (demonstration only)
7. Giant chromosomes in Diptera: (*Drosophila Chironomus* larvae) salivary gland cells (demonstration only)

Genetics

1. Study of monohybrid cross using coloured beads.
2. Study of normal chromosome complement and karyotype of man.
3. Study of genetic syndromes and abnormal karyotypes of man
(Klinefelter's syndrome, Turner's syndrome, Down syndrome and Edward syndrome).
4. Study of Barr body and its significance (in stained buccal epithelial cells).
5. Construction of Pedigree chart.
6. Study of phenotypic characters of male and female *Drosophila*.

Biotechnology

1. DNA extraction
 2. Polymerase Chain Reaction
 3. Southern blotting and Northern blotting
 4. Gene cloning
- (Demonstration in the Department / Visit to research institute / CD display)

Immunology and Microbiology

1. Collection of blood, and study of the effect of anticoagulant.
2. Total and differential count of blood cells.
3. ABO and Rh systems of blood grouping.
4. Microscopic observation and study of stained preparations of any two microbes

First Degree Programme
Semester VI
Zoology Core Course IX
Physiology and Biochemistry

Course Code – ZO1641

No. of credits – 4

Total hours 90

Aim of the course

To improve the student's perspective of health and biology through in-depth study of human physiology

Objectives of the course

- To study the different system and the inherent disorders/ deficiencies involved therein.
- To learn the structure and functions of bio-molecules and their role in metabolism

Physiology

60 hrs

Module I

6hrs

Nutritional Physiology: general introduction, types of nutrition, mechanical and chemical changes of food in the alimentary canal, balanced diet, nutritional disorders – PEM, vitamin deficiency, deficiency of iron, iodine and calcium, lifestyle diseases, role of fibres, nervous and hormonal control of digestion

Module II

8 hrs

Circulatory Physiology: Blood- Composition and functions of blood plasma and formed elements, blood groups, mechanism of blood clotting, intrinsic and extrinsic pathways, disorders of blood clotting, anticoagulants, heartbeat, conducting system and pace maker, pulse and blood pressure, clinical significance, control of cardiac activity, common cardio

vascular diseases – arteriosclerosis, atherosclerosis, Myocardial infarction, electrocardiogram, angiogram, angioplasty. Lymph and lymphatic system (brief account)

Module III

8 hrs

Respiratory Physiology: Gas exchange, respiratory pigments- structure of haemoglobin, transport of O₂- Oxyhaemoglobin curve, Bohr effect, transport of CO₂ -carbonic acid, carbamino haemoglobin, bicarbonate and chloride shift, regulation of respiration – neural and chemical; respiratory disturbances – apnoea, dyspnoea, hypoxia, hypo and hyper capnia, asphyxia, carbon monoxide poisoning, bronchitis, asthma. Physiological effects of smoking

Module IV

8hrs

Renal Physiology: Nephron – structure, urine formation, counter-current multiplier system,

role of kidney in osmoregulation, composition of urine, abnormal constituents of urine, regulation of kidney functions, renal disorders – nephritis, haematuria, renal calculi, acidosis and alkalosis – Dialysis and kidney transplantation.

Module V

8 hrs

Muscle Physiology: Brief account of types of muscles, fast and slow twitch muscles, red and white muscles. Ultra structure of striated muscle fibre, muscle proteins, simple muscle twitch, summation, tetanus, tonus, All or None law, fatigue, oxygen debt, rigor mortis. Physiological and biochemical events in muscle contraction.

Module VI

6 hrs

Nerve Physiology: Neurons – structure, types of neuron (self study). Synapse and types of synapse, nerve impulse propagation, synaptic transmission. Reflex action, refractory period, neuro transmitters, electro encephalo gram. Nerve disorders – epilepsy, Alzheimer's disease, Parkinson's disease.

Module VII

5 hrs

Sensory Physiology: Structure of eye and ear (self study). Physiology of vision, visual elements and pigments, photo chemistry of vision. Eye defects – myopia, hyperopia, presbyopia, astigmatism, cataract. Structure of ear and mechanism of hearing, hearing impairments – deafness, labyrinthine disease. Olfactory, gustatory and tactile sense organs

Module VIII

3hrs

Reproductive physiology: Male and female reproductive organs (self study). Reproductive cycles, puberty, adolescence, pregnancy, parturition, lactation and birth control.

Module IX

8hrs

Endocrinology: Endocrine glands in man, hormones and disorders, feed-back mechanism, mechanism of hormonal activity.

Biochemistry

30hrs

Module X

8hrs

Biomolecules: micromolecules, macromolecules, water, buffer systems and importance; Carbohydrates-structure, classification- monosaccharides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), disaccharides and polysaccharides (homo and hetero polysaccharides); biological functions of carbohydrates.

Lipids- classification- simple lipids, (neutral fats and waxes), conjugated lipids (phospho lipids, sphingo lipids, glyco lipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins), biological functions of lipids.

Proteins - classification of proteins, amino acids- basic structure, structure of protein- primary, secondary tertiary and quaternary structures, haemoglobin as atypical protein, biological functions of proteins.

Module XI

16hrs

Metabolism: Carbohydrate metabolism – glycogenesis, glycogenolysis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Kreb's cycle, electron transport series, chemi-osmotic theory, energetic; hormonal control of carbohydrate metabolism.

Lipid metabolism – hydrolysis of lipid, beta oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism, hormonal control of lipid metabolism.

Protein metabolism – deamination, transamination, formation of urea, hormonal control of protein metabolism.

Module XII

6hrs

Enzymes: Chemical nature, mechanism of enzyme action, factors affecting enzyme activity, kinetics of enzyme action, Michaelis – Menten equation, iso enzymes, co-enzyme, co-factors, enzyme activation and inhibition.

Topics for assignments / seminars

1. Amino Acids
2. Nucleic Acids
3. Enzymes and their Classification
4. Nutrients
5. Vitamin deficiency diseases – symptoms and diagnosis
6. Hormone deficiency diseases – symptoms and diagnosis
7. Body temperature and its osmoregulation.
8. Human brain
9. Instruments used for the diagnosis of circulatory disorders.
10. Kidney related diseases and their diagnostic instruments.
11. Brain related diseases and their diagnostic tools.
12. Submission of endocrine glands of mammals (goat, cow, buffalo, pig) description.
13. Submission of models of diagnostic instruments with description.

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Physiology

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**First Degree Programme
Semester VI
Zoology Core Course X
Developmental Biology and Experimental Embryology**

Course code – ZO1642

No. of credits – 4

Total hours 72

Aim of the course

To familiarize the student with the principle of developmental biology and provide him a bird's eye view of sophisticated embryological techniques

Objectives of the course

- To study the various stages involved in the developing embryo
- To study the initial developmental procedures involved in *Amphioxus*, Frog and chick
- To procure information on state- of- the art experimental procedures in embryology.

Developmental biology

57hrs

Module I

4 hrs

Introduction, historical perspective (brief account), theories- Preformation, Epigenesis, Recapitulation and Germplasm. Subdivisions of Developmental biology.

Spermatogenesis and oogenesis, structure of Graafian follicle, typical egg and sperm. Polarity of egg, egg envelopes; classification of eggs based on different criteria.

Module II

8hrs

Fertilization: Agglutination, sperm penetration, activation of egg, amphimixis; physiological and biochemical changes during and after fertilization. Parthenogenesis- introduction, natural and artificial parthenogenesis, arrhenotoky and thelytoky, obligatory and facultative, significance of parthenogenesis.

Module III

9hrs

Cleavage: types of cleavage - holoblastic and meroblastic; patterns of cleavage – radial, bilateral, spiral, rotational; cell lineage in Planocera (brief account only). Morula formation in microlecithal, mesolecithal, macrolecithal eggs; blastulation - introduction, different types of blastula – stereo blastula, coeloblastula, discoblastula, periblastula, blastocyst. Presumptive organ forming areas and fate maps, eg. amphioxus, frog, construction of fate maps.

Module IV

3hrs

Gastrulation: introduction, brief account of morphogenetic movements – epiboly and emboly (invagination, involution, infiltration, ingression, delamination, convergence, divergence) concept of germ layers, derivatives of germ layers.

Module V

5 hrs

Cell differentiation : totipotency, pluripotency and unipotency of embryonic cells. Determination and differentiation in embryonic development. Gene action, drosophila as a model organism (brief account only), Homeotic genes and Hox genes.

ModuleVI

25hrs

Development: Amphioxus - cleavage, blastulation, gastrulation, neurogenesis, notogenesis, mesoderm and coelom formation.

Frog -cleavage, blastulation, gastrulation, organogeny – development of brain, eye, heart; metamorphosis - ecological, morphological and physiological changes and hormonal control.

Chick - cleavage, blastulation, gastrulation, study of 24 hrs chick embryo; development of extra- embryonic membranes in chick.

Man - implantation, pregnancy, parturition. Placentation in mammals – different types of placenta, functions.

Module VII

3hrs

Teratology: definition, causes, infections, drugs and chemicals, metabolic imbalance, ionizing radiation, malnutrition, autoimmunization.

Experimental embryology

Module VIII

15hrs

Spemann's constriction experiments, organizers and embryonic induction, transplantation experiments involving optic cup, nuclear transplantation experiments in amphibians. In vitro fertilization and embryo transfer experiments in farm animals, In vitro fertilization and embryo transfer experiments in man and test tube babies; cloning experiments in animals-mammals; prenatal diagnosis and sex determination methods – amniocentesis chorionic villus sampling, ultra sound scanning. Embryonic and adult stem cell research and stem cell therapy.

Suggested topics for assignments / seminars

1. Human male and female reproductive organs.
2. Larval forms of invertebrates.
3. Metamorphosis in insects.
4. Regeneration in animals
5. Cloning experiments in animals.
6. Transgenic animals.
7. Stem cell research.
8. Comparative account on cleavage, blastulation, gastrulation in different animals.
9. Embryonic development of an invertebrate.

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**First Degree Programme
Semester VI
Zoology Core Course XI
Ecology, Ethology, Evolution and Zoogeography**

Course Code – ZO1643

No. of credits – 3

Total hours 72

Aim of the course

To enhance the student's concept of nature and her resources and appreciating the process and product of organic evolution

Objectives of the course

- To learn the principles, applications and management of environmental science.
- To study the inherent morphological and physiological bases of behavioural pattern exhibited by vertebrates.
- To get an exhaustive knowledge of organic evolution with special reference to man.

Ecology

24hrs

Module I

Components of ecosystem: Environmental factors - abiotic factors, light, temperature, soil, water, air; biotic factors- autotrophs, phagotrophs and saprotrophs; ecosystem interaction and inter-relationship between biotic and abiotic factors, the cybernetic nature and the stability of the ecosystem.

Pond as an ecosystem (self study)

Module II

5 hrs

Biogeochemical cycles: Basic types of biogeochemical cycles - gaseous cycle-carbon and nitrogen cycles, mention sedimentary cycles (P and S), recycling pathways and recycle index.

Limiting Factors- basic concepts- Leibig's law of minimum, Shelford's law of tolerance, combined concept of limiting factors, Light and temperature as limiting factors.

Module III

5 hrs

Habitat Ecology: Biosphere classification- lithosphere, hydrosphere and atmosphere- physical features, fauna and their adaptations of aquatic, terrestrial and marine habitats (self study)

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

Community ecology: Definition and characters, species diversity; stratification; dominance; ecotone and edge effect; ecological indicators; community periodicity, succession (self study)

Module IV

5 hrs

Anthropogenic impact on ecosystem: Ionizing radiation and radioisotopes, ionizing radiation and human health, radiation accidents and other exposures, disposal of radioactive wastes, pesticides like DDT, endosulphan, furadan, insect repellants, e-wastes. Monitoring of pollutants – physical, chemical and biological.

Module V

Wild life conservation and management: Significance, causes of extinction, concepts of threatened species, red data book, IUCN, WWF, CITES, Green Environment and Green peace; protected areas, biosphere reserves, national parks and sanctuaries in India, forests in India, desertification, deforestation, carbon trading; importance of mangroves in coastal ecosystems- conservation and management (self study)

Module VI

9 hrs

Environmental biotechnology: Biotechnological methods of pollution detection, biotechnological methods in pollution abatement, bioremediation, biotechnology and biodegradation, genetically engineered microbes in bio-treatment of waste, eco-friendly bio-products for environmental health, bio-piracy, bio-pesticides and bio-fertilizers, organic farming and its merits. Green chemistry – designing a Green synthesis, basic principles of Green chemistry.

Ethology

12 hrs

Module VII

12 hrs

History and scope of ethology: Motivation- models of motivation (Lorenz's psycho-hydraulic model and Deutsch's model); learning- types of learning (imprinting, habituation, conditioned reflex, unconditioned reflex, latent learning); neural mechanisms in behavior- role of hypothalamus and other brain centers, hormones and behavior; sociobiology- social groups – merits and demerits, properties of organized societies, social groups in mammals,

social stress. Pheromones and chemical communications, human pheromones.

Evolution

26hrs

Module VIII

Theories of organic evolution: Lamarck's theory, its criticism (Weisman's germplasm theory) Darwin's theory of natural selection (mention the contributions of Wallace). Mutation theory (self study)

Module IX

4hrs

Geological timescale, fossils, fossilization, paleontological evidences of evolution, fossil dating and significance of fossils.

Module X

12hrs

Modern concept of organic evolution: (Neo Darwinism) - genetic basis of evolution- gene pool, gene frequency, mutation, role of mutation in evolution, neutral mutation (Kimura), genetic drift, genetic equilibrium; factors affecting genetic equilibrium and Hardy –Weinberg law.

Natural selection: types of selection (brief account of the observation in *Biston betularia*), isolation and isolating mechanisms; speciation- sympatric speciation and allopatric speciation. Hybridization- adaptive radiation with special reference to Darwin's finches.

Module XI

10hrs

Tempo of Evolution: Gradualism vs Punctuated equilibrium, rates of evolution- Bradytely and Tachytely, Gould's and Eldridge's contributions, orthogenesis and orthoselection, anagenesis and cladogenesis.

Evolution of man Organic and cultural, examples of trends in human evolution, fossil men- brief accounts of Parapithecus, Propliopithecus, Dryopithecus, Ramapithecus, Australopithecus, Neanderthal, Cromagnon and Modern man.

Zoogeography

10 hrs

Module XII

4hrs

Animal Distribution: Geographic distribution of animals-cosmopolitan distribution, discontinuous distribution, bipolar distribution and isolated distribution, factors affecting animal distribution, barriers to animal distribution- physical and biological barriers.

Module XIII

6hrs

Zoogeographical Realms: (brief account of each realm mention the areas included, physical features and fauna) Palaearctic region, Australian region, Ethiopian region, Nearctic region, Oriental region and Neotropical region. Biogeographical classification of India- Western Ghats, Eastern Ghats and Himalayas. Insular Fauna: Brief account of oceanic islands and continental islands (with one example each)

Suggested topics for assignments / seminar

1. Biodiversity of sacred groves of Kerala.
2. Mangroves of Kerala and their importance.
3. Wild life sanctuaries of Kerala.
4. Depleting water resources of Kerala
5. Sand mining and related problems.
6. Threatened animals of India.
7. Pheromones and behaviour.
8. Origin of life.
9. Mesozoic reptiles.

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First Degree Programme
Zoology Core Course XII
Practical III - Physiology and Biochemistry

Course Code - ZO1644

No. of credits – 3

Aim of the course

To demonstrate basic principles in physiology

Objectives of the course

- To learn clinical procedures for blood & urine analysis
 - To make the student skillful in simple biochemical laboratory procedures.
1. Preparation of blood smear and study of blood cells of man.
 2. Kymograph apparatus and explanation of simple muscle twitch.

3. Measurement of oxygen consumption of cockroach using Fen's respirometer.
4. Study of tonicity of blood cells
5. Urine analysis for the detection of abnormal constituents – glucose, albumin
6. Detection of excretory products – ammonia (Nessler's test), urea (Ammonia generation/ Biuret test) and uric acid (Phosphotungstic acid test)
7. Paper chromatographic separation of amino acids
8. Estimation of haemoglobin of blood using Haemoglobinometer.
9. Effect of temperature / pH on salivary amylase activity
10. Isolation of casein from milk.
11. Digestion of starch and separation of maltose by dialysis.

First Degree Programme
Zoology Core Course XIII
Practical IV - Developmental Biology and Experimental Embryology and
Ecology, Ethology, Evolution and Zoogeography

Course Code – ZO1645

No. of credits - 3

Developmental Biology and Experimental Embryology

1. Study of different types of eggs -Amphioxus, frog, chick, man- based on models/charts.
2. Study of blastula- Amphioxus, frog- slide / model
3. Study of gastrula – frog-yolk plug stage - slide / model.
4. Mounting of 24hrs/48hrs chick blastoderm.
5. Study of placenta – any two types.
6. Sperm motility in fish (zebra fish)
7. Embryonic development of the egg of zebra fish (demonstration only)

Ecology, Ethology, Evolution and Zoogeography

1. Estimation of dissolved oxygen
2. Estimation of CO₂
3. Primary productivity using dark and light bottle
4. Turbidity using Secchi disc
5. Estimation of hardness of three different water samples.
6. Extraction of soil organisms- Berlese funnel, Baerman's funnel
7. Construction of food web
8. Study of ecological adaptations – any three
9. Study of marine plankton – any three
10. Measurement of pH of different water samples using pH meter, pH paper and indicator solution.
11. Alarm pheromones in ants.
12. Mention the contribution of Darwin and Lamark.
13. Study different zoogeographical realms with fauna.

First Degree Programme

Semester V

Zoology Open Course I

Public Health and Hygiene

Course Code – ZO1551.1

No. of credits – 2

Total hours 54

Aim of the course

To make the student aware of the essentials of public health and sanitation thereby warding off diseases and uplifting the living standards of the community

Objectives of the course

- To learn the principles of nutrition and dietetics
- To understand the ill effects of modern lifestyle
- To study the advantages of being hygienic

Module I

6hrs

Introduction: Scope and importance of the study; balanced diet, diet control for diabetics, cholesterol etc., concept of energy, calories, daily food intake as per occupation, pregnancy and lactation, probiotics and nutraceuticals. Dietary requirements of infants, pre-school children, school children, adults and geriatric care. Malnutrition and over nutrition – obesity

and weight control; defects of modern food habits – fast food, soft drinks, ice-creams and broiler chicken.

Module II

4hrs

Adulteration of food: food hygiene – hygiene of milk, meat, fish, eggs, fruits and vegetables, common food adulterants – harmful effects and their detection, food additives, fortification of food; Food Adulteration Act and its stringent implementation

Module III

18hrs

Health Hazards: Health dynamicity – definition, spectrum, factors influencing health, health as a medium of socio-economic development. Diseases – concept, terminologies, disease cycle, mode of transmission. Preventive methods including vaccination and its schedule. Common food borne and water borne diseases (gastroenteritis, jaundice, cholera, salmonellosis, travellers' diarrhoea and *Escherichia coli* infection, typhoid) – causative agents, symptoms, prevention and control. Emerging diseases, sexually transmitted infections – AIDS, genital herpes, hepatitis B, syphilis, gonorrhoea – causative agents, symptoms, modes of transmission and prevention. Dengue, chikunguniya, rat fever (general methods of mosquito control and the need to prevent mosquito breeding in and around our homes). Lifestyle habits – excessive usage of T.V., computer, mobile phones, two wheelers, and their impacts on health. Lack of physical exercise and its deleterious effects on the body and mind

Module IV

6hrs

Health Education: Definition, objectives, principles and methods of health education, ill-effects of smoking, alcoholism and drug abuse (emphasis should be given to pan masala, amphetamines, hashish, opium, brown sugar, pethedine). Population control and family welfare, use of contraceptives. Blood donation –basics of ABO, blood grouping including Rh factor. Genetic incompatibility and consanguineous marriages.

Module V

12hrs

Mental Health: Definition by WHO and necessity of mental well being, major depressive disorders, substance abuse, schizophrenia, obsessive compulsive disorders, domestic violence, causes for lost years of healthy life, strategies for prevention and possible interventions, childhood mental disorders and illnesses, gulf widow syndrome, stress reduction and management (importance of yoga)

Module VI

8hrs

Hygiene: Definition, personal hygiene- body odour, oral hygiene, grooming, feminine hygiene, sleep hygiene, hand washing, toiletry. Social hygiene – clean living movements, occupational hygiene, food and cooking hygiene, medical hygiene, excessive hygiene.

Suggested topics for assignments / seminars

1. Medical camps maybe conducted in colleges and students can have routine blood tests and grouping done.
2. Extension activities – Community programmes may be arranged for alcoholics and students may form self-help groups for extending social support.
3. Awareness programmes – Drinking water sources may be tested for possible contamination and classes on sanitation may be arranged for the local people.
4. Case studies based on public hygiene.
5. Survey of mental illness and symptoms among children of mentally retarded schools.
6. Effect of alcoholism on the social life in a community
7. Impact of tobacco addiction on the life of farmers

References

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- Swaminathan S. Principles of Nutrition and Dietetics.

First Degree Programme
Semester V
Zoology Open Course I
Human Health and Sex Education

Course Code – ZO1551.2

No. of credits – 2

Total hours 54

Aim of the course

To redress problem associated with health and sex thereby promoting fitness and well being.

Objectives of the course

- To make the student understand the importance of good health.
- To educate the student on clean sexual habits thereby warding off sexually transmitted diseases.

Module I

14hrs

Introduction to health, health as a state of wellbeing, health awareness, Immunity-immunization and vaccination, factors affecting health- food, balanced diet, food supplements, pathogens, pollution, sleep, exercise and stress. Physical health, reproductive health, adolescence, senescence. Mental health- mental illness and disabilities, symptoms and prevention of mental illness; alcoholism, tobacco addiction, de-addiction, lifestyle diseases. Community health- health centres, role of health centres. Spiritual health, yoga and meditation.

Module II

8hrs

Human reproductive system: Male reproductive system- structural details of testis and accessory structures, functions of testis, semen, hormonal control. Female reproductive system- structure of ovary, accessory structures, puberty, reproductive cycles and hormonal control, menstrual cycle, gestation period, hysterectomy, menopause.

Module III

7hrs

Events of human reproduction: Gametogenesis- spermatogenesis and oogenesis, ovulation, fertilization, embryonic development, parturition

Module IV

12hrs

Human intervention in reproduction: Contraception and birth control-barrier method, hormonal methods, natural methods, sterilization, termination of pregnancy. Infertility-male and female infertility, causes and treatment for infertility. Assisted Reproductive Techniques- IVF, GIFT, ZIFT, Donor Insemination (DI). Artificial Insemination by Donor (AID), Artificial Insemination by Husband or partner (AIH). Surrogacy, SUZI (sub-zonal insemination), MIST (micro insemination sperm transfer)

Module V

6hrs

Sexually transmitted diseases: Syphilis, genital warts, chlamydia, chancroid, trichomoniasis, gonorrhoea, genital herpes, AIDS

Module VI

7hrs

Sex education: Adolescent sexual activity, teenage pregnancy, sexual harassment, sexual awareness and policies (legal aspects), lesbian and gay sex, bisexual, transgender youth, adolescent stress management

Suggested topics for assignments / seminars

1. A survey of lifestyle diseases in a locality
2. A study on sexually transmitted diseases registered in a hospital

3. A survey of vaccination in village, town and city
4. Impact of yoga and meditation on health
5. A survey of contraceptive methods prevalent among village and city people.
6. A comparison of the affects of sexual harassment among school and college students.
7. A survey of adolescent sexual activities in a city or town.

References

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- The Complete Manual of Fitness and Well-being. The Reader's Digest Association, Inc. Pleasantville, New York / Montreal.
- Guyton & Hall. Textbook of Medical Physiology.

First Degree Programme
Semester V
Zoology Open Course I
Human diseases and their management

Course Code – ZO1551.3

No. of credits – 2

Total hours 54

Aim of the course

To instill in the students the need to manage communicable diseases thereby creating a healthy society

Objectives of the course

- To learn the various modes and agents of disease transmission

- To learn the causative factors of non communicable diseases

Module I

4hrs

Introduction: Health-WHO definition, individual and community health, importance of individual health, history of human diseases, human diseases, cultural and social factors in health and diseases, differences in health and diseases.

Module II

6hrs

Environment and health: Basic health requirements in the environment.

Water – sources and uses of water, water pollution, water-borne diseases and purification of water. Housing- basic human requirement- sanitation- nature and methods of purification of water. Air- composition and cause of discomfort- need for proper ventilation, removal of refuse- disposal and utilization of excreta (biogas).

Module III

4hrs

Lifestyle choice for healthier life: Diet and health, exercise and health, alcohol, tobacco and drugs, sex and health, computers and health, mobile phone and health, psychological health

Module IV

3hrs

Communicable diseases: Classification of communicable diseases. Defense mechanism – immunity (natural, acquired)

Module V

4hrs

Viral Infections: Brief account of virus, chickenpox, poliomyelitis, rabies, yellow fever, dengue fever, mumps, influenza, measles, encephalitis, hepatitis ,HIV infection and AIDS – causes ,symptoms, prevention and cure.

Module VI

4hrs

Bacterial Infections: Brief account of bacteria, dysentery, cholera, tuberculosis, tetanus, diphtheria, septicemia, scarlet fever, typhoid, plague; STD and leprosy – causes, symptoms, prevention and cure.

Module VII

4hrs

Protozoan Infections: Brief account of protozoans - amoebiasis, leishmaniasis, trichomoniasis, malaria - causes, symptoms, prevention and cure.

Module VIII

4hrs

Worm Infections: Brief account of platyhelminthes and nematods, cysticercosis, taeniasis, ascariasis, ancylostomiasis, ercephalitis, enterobiasis and dracunculosis – causes, symptoms, prevention and cure.

Module IX

3hrs

Vector borne diseases: Vector – identification of vectors – dengue, filaria, kala azar, Japanese encephalitis, chikungunya- causes, symptoms, prevention and cure.

Module X

4hrs

Non-communicable diseases: Hereditary and congenital diseases – haemophilia, diabetes mellitus, hypertension, muscular dystrophia, some types of cancer. Immunological diseases – allergy, autoimmune diseases. Deficiency diseases – scurvy, pellagra, beriberi,

xerophthalmia, rickets. Cardiovascular diseases-causes, symptoms, prevention and treatment.

Module XI

4hrs

Mental health: Meaning, definition, history, characteristics of a mentally healthy person. Types of mental illness – causes, symptoms and prevention – major mental illness (schizophrenia, paranoia), minor mental illnesses (anxiety, phobia, obsessive compulsive neuroses)

Module XII

8hrs

Basic viewing techniques- endoscopy examination techniques: Blood- total count, differential count, ESR, immune function tests, blood clotting test, routine blood chemistry, blood cholesterol test, hormone tests; urine- routine urine chemistry; cell and tissue test- pap test, sputum test, biopsy, histopathology; genetic tests- amniocentosis, chorionic villi sampling; imaging techniques- X – ray, ultrasound scanning, CT scan, MRI scan, SPECT scanning, PET scanning;

Module XIII

2hrs

Role of yoga in management of common diseases.

Suggested topics for assignments/ seminars

Epidemiological study of the above diseases.

Questionnaire has to be prepared . Students has to be grouped in 10. Each student will have to visit 25 houses and record the observations. The data of 10 students (250 Houses) has to be tabulated, studied and interpreted.

Every year the study, if possible, has to carry out in the same houses or to the same locality. This follow up survey will be very useful

References

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- Swami Styananda Saraswathi, Swami Karam: Yogic Management of Common Diseases.

**First Degree Programme
Semester VI
Zoology Open Course II
Economic Zoology - Vermiculture and Apiculture**

Course Code – ZOI651.1
No. of credit – 2

Total hours 54

Aim of the course

To promote self employment and self reliance among educated youth

Objectives of the course

- To learn the basic procedure and methodology of vermiculture
- To learn the scope and methodology of apiculture.

Vermiculture

24hrs

Module I

6hrs

Introduction: definition and scope of vermiculture. Nature and species of earthworms: habit categories – epigeic, endogeic and anecic, indigenous and exotic species (*Eudrillus eugeniae*/*Eisenia foetidae*/*Perionyx excavatus*/ *Lampito mauritii*), identification of the above four species based on morphological characters.

Module II

10hrs

Methodology of vermicomposting: step by step methodology – containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting, and storage of vermicompost. Advantages of composting, precautions to be taken to prevent attack by pests and pathogens.

Module III

8hrs

Vermicompost profile and applied aspects: physical, chemical and biological parameters of

vermicast, vermin enrichment, economic uses of vermiculture (biofertilizer, waste disposal, vermiwash, poultry feed, vermi-remediation etc.

Apiculture

30hrs

Module IV

8hrs

Introduction and Scope: Definition and significance of the study. Caste system and Social behavior; common species of honeybees used, organization of bee colony, social life and adaptations of honeybees.

Module V

12hrs

Bee keeping methods and equipments: indigenous methods, extraction appliances, extraction of honey from the comb and processing, management and maintenance of an apiary, bee pastures

Module VI

10hrs

Diseases and economics: diseases (bacterial, fungal, protozoan, acarine, brood diseases), preventive and curative measures. Use of honey, bees wax, bee venom, nutrient profile of honey, marketing strategies.

Suggested topics for assignments / seminars

Vermiculture

1. Report of field visits to commercial/professional units
2. Feasibility of maintaining a vermicomposting plant in the College maybe worked out
3. Awareness programmes on waste management through vermicomposting may be conducted for the local residence associations

Apiculture

1. Report of field visits

References

1. Cherian & Ramachandran Bee keeping in *South Indian* Govt. Press, Madras.
2. Gupta, K.C. Romance of bee keeping. Khadi Paristhan, Calicut.
3. Mary Appelhof. Worms eat my Garbage.
4. Mishra R.C. Perspectives in Indian Apiculture
5. Sathe, T.V. Vermiculture and Organic farming.

First Degree Programme
Semester VI
Zoology Open Course II
Ornamental fish production and management

Course Code – ZO1651.2

No. of credits - 2

Total hours 54

Aim of the course

To make the student aware of the vast potentials involved in ornamental fish farming and trading

Objectives of the course

- To learn the scientific method of setting an aquarium
- To learn the culture breeding and marketing techniques of common indigenous ornamental fishes

Module 1

6hrs

Importance and history of aquarium fish keeping. Design and construction of aquaria: aquarium fabrication- shape, size, volume, type of glass tank, cutting of glass, preparation of glass tank, strengthening and supporting of tank, fitting of tanks into room settings; aquarium floor setting – type and size of pebbles, gravels, granites used for bed setting and its advantages. Filters- biological, chemical and mechanical. Aquarium accessories like aerators, decorative, lighting, heating and feeding trays.

Module II

3hrs

Water quality management in aquarium systems – sources of water, containers, storage, temperature, pH, dissolved carbon dioxide, ammonia, hardness, turbidity and ozone in aquarium.

Module III

5hrs

Aquarium plants: Uses of aquarium plants, different varieties of plants like submerged plants (tubers, rooted plants, cutting plants) and emerged plants, indoor plants and outdoor plants, selection of plants, planting techniques, propagation and maintenance of aquarium plants. Advantages of natural plants over artificial plants.

Module IV

9hrs

Fresh water ornamental fishes : Common ornamental fishes- indigenous and exotic species; Identification and biology of the common ornamental fishes. *Cyprinus carpio* (koi carp), *Molliesia sphenops* (black molly lyre tail), *Poecilia reticulata* (guppy), *Poecilia latipinna*, *Xiphophorus helleri* (red sword tail) *Xiphophorus maculatus* (red platy) *Pterophyllum scalare altum* (angel fish) *Carassius auratus* (red oranda) *Betta splendens* (Siamese fighting fish) *Trichogaster leeri* (pearl gourami). Live bearers and egg layers. Sexual dimorphism in ornamental fishes.

Module V

6hrs

Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio. Brood stock management- selection of brooders, maintenance and management of brood stocks. Selective breeding and hybridization techniques. Induced breeding. Colour enhancement techniques.

Module VI

6hrs

Aquarium maintenance- Setting up of a freshwater community tank and its maintenance. Food and feeding - live feed and formulated feed. Preparation and culture of live feed (Artemia, Infusoria, Spirulina). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes - their causative agents - virus, bacteria, fungi, protozoa and nematode; symptoms, treatment and prophylactic measures.

Module VII

10hrs

Indigenous ornamental fishes - Common indigenous ornamental fishes. Identification and biology of the common ornamental fishes. Cyprinids *Puntius denisonii* (red line torpedo fish), *Puntius fasciatus* (melan barb), *Puntius filamentosus* (Indian tiger barb), *Puntius curmuca* (red tailed silver shark), *Danio malabaricus* (Malabar danio); Loaches (*Nemacheilus triangularis* (Zodiac loach), *Lepidocephalus thermalis* (Malabar loach)); Cichlids: *Etoplus maculatus* (yellow and orange chromides), *E. suratensis* (pearl spot), Anabantids: *Anabas testudineus* (climbing perch) and Catfishes : *Horabagrus brachysoma* (Yellowish catfish), *H. nigricollaris* (White collared imperial catfish).

Module VIII

4hrs

Marine aquarium: preparation and maintenance of common marine ornamentals (Fishes, Crustaceans, Mollusks and Echinoderms). Collection, packing and transportation and marketing of indigenous ornamental fishes. Post harvest

technology

Module IX

5hrs

Constraints of farming and export of ornamental fishes: Convention on biodiversity; procedures for starting an export firm; training methods and entrepreneurship; funding agencies.

Suggested topics for assignments / seminars

1. Indigenous fishes of Kerala
2. Indigenous ornamental fishes of India
3. Feeding habits of fishes
4. Nutritional requirement in fishes
5. Aquarium plants
6. Preparation of Community tank.
7. Fish diseases
8. Predators in a fish pond.
9. Environmentally and genetically induced abnormalities in ornamental fishes.
10. Economic importance of ornamental fishes.

References

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- Talwar.P.K., and Jhingran.A.G.,(1991). Inland fishes Oxford and IBH Publishing Co. PVT LTD, New Delhi.
- Web site: [www. Ornamentalfish.org](http://www.Ornamentalfish.org)

First Degree Programme

Semester VI

Zoology Open Course II

Dairy farming and Broiler farming

Course Code – ZO1651.3

No. of credits – 2

Total hours 54

Aim of the course

To promote and encourage the students to take up animal husbandry instead of craving for white collar jobs

Objectives of the course

- To aid white revolution by improving the breeds of cattle
- To learn the proper and scientific methodology behind poultry farming

Dairy farming

27hrs

Module I

7hrs

Breeds of livestock and dairy farm: Breeds of Taurus (exotic) dairy cattle, breeds of zebu (Indian) cattle, breeds of dairy buffaloes; present status of dairy farming; planning to establish dairy farm, location of farm, different housing systems, dairy buildings, space requirements, economically setting a small farm.

Module II

5hrs

Nutritive values of common feeds, commercial and mixed feeds: Feeding and providing feed - feeds rich in minerals , feeds rich in protein , live stock tonics - hormones , thyroprotein , stilbestrol , urea for dairy cattle, toxic feeds, food-poisoning - Balancing the dairy ration - general rule for feeding dairy herd.

Module III

4hrs

Mechanism of reproduction: Male reproductive organs, female reproductive organs, role of hormones in male reproduction, role of hormones in female reproduction; care and management of newborn animals.

Module IV

6hrs

Artificial insemination: Advantages of artificial insemination over natural breeding, limitation of A.I, problems under Indian conditions; collection of semen - electro ejaculation, dilution of semen and cryopreservation, insemination , cleaning and sterilization of apparatus. Common parasites in India and cure methods - External parasites and pest, reproductive diseases, milk borne diseases.

Module V

5hrs

Preparation and marketing of dairy products: Determining quality of milk, choosing market outlet, assembling dairy products from farms, co-operative action among creameries, hauling milk to city markets; Marketing fluid milk (i) Specific gravity of milk (ii) determination of specific gravity with a lactometer (iii) pasteurization of milk (iv) advantages of pasteurization; determining cost of distribution.

Broiler farming

27hrs

Module VI

5hrs

History, contribution to remove protein deficiency, role of broiler farm in urban and rural areas, employment potential, export potential. Poultry breeds, broiler strains available in India, day old chicks and their maintenance, hatchery potential; parental stocks and their maintenance

Module VII

5hrs

Poultry house, site, space requirement, types of houses-cage and deep-litter system, equipment for feeding and watering, lighting for poultry houses, ventilation.

Module VIII

5hrs

Nutrition of poultry birds, nutritional requirements according to age, starter feed, finisher feed, feed formulation. Availability of raw material for feed; use of antibiotics, aminoacids and minerals.

Module IX

5hrs

Brooding and rearing baby chicks, types of brooders, vaccination, summer management and monsoon management.

Module X

7hrs

Diseases and health management, common diseases caused by viruses, bacteria and worms, ranikhet, fowl pox, worms and other parasites, toxicosis and account of aspergillus, aflotoxin, Salmonella; deworming and insecticide treatment; machanised dressing methods; cold storage, avoiding aflotoxin.

Suggested topics for assignments / seminars

Dairy farming

1. Breeds of Taurus (exotic) dairy cattle, Breeds of zebu (Indian) cattle, Breeds of dairy buffaloes.
2. Planning to establish dairy farm.
3. Setting a small farm.
4. Feeding and providing feed to dairy animals.
5. General rule for feeding dairy herd.
6. Role of hormones in male reproduction.
7. Role of hormones in female reproduction.
8. Care and management of newborn animals.
9. Advantages of Artificial insemination over natural breeding.
10. Common parasites in India and cure methods - External parasites and pest.
11. Reproductive diseases - Milk borne diseases.
12. Determining quality of milk.
13. Marketing fluid milk.

Broiler farming

1. Role of broiler farm to remove protein deficiency.
2. Role of broiler farm in employment potential and export potential
3. Day old chicks and their maintenance.

4. Parental stocks and their maintenance.
5. Setting up of broiler farming.
6. Feed formulation. Availability of raw material for feed; Use of antibiotics, aminoacids and minerals.
7. Brooding and rearing baby chicks.
8. Summer management and monsoon management.
9. Diseases and health management.

References

Dairy farming

- Banerji, G.C. A text book of Animal husbandry, 1998. Oxford & IBH.
- ICAR. Handbook of Animal Husbandry, 1990/97, ICAR, PUSA.

Broiler farming

- Gnanamani. Profitable Poultry Farming.
- Banerji, G.C. Poultry. Oxford & IBH.

First Degree Programme Semester VI Zoology Project and Field study

Course Code – ZOI646

No. of credit – 4

Project

Aim of the course

To develop an aptitude for research in Zoology

Objective of the course

To inculcate proficiency to identify appropriate research topic and presentation

Specifications

Topics of biological interest can be selected for the project.

Project is to be done by a group not exceeding 10 students.

Every student should submit typed (A4 paper, 12 Font, 1.5 Space), spirally bind project report in duplicate to the department on the day of the examination of Practical II.

A copy duly attested by the supervising teacher and the Head of the Department must be placed for ESE before a board of two Examiners.

The viva-voce based on the Project is conducted individually.

Project topic once chosen shall not be repeated by any later batches of students.

The project report may contain the following sections

1. Preliminary (Title page, declaration, Certificate of the supervising teacher, content etc.)
2. Introduction with relevant literature review and objective
3. Materials and Methods
4. Result
5. Discussion
6. Conclusion / Summary
7. References.

Field study

A total of eighteen hours (1hour/week) are allotted to field study in the fifth semester. Field study of 4 days is compulsory. Students are directed to visit one research institute and one wild life sanctuary / ecosystem / museum / zoo, preferably within the state of Kerala. Scientifically prepared hand written study tour report must be submitted by each student for ESE on the day of the examination of Practical II.

