



UNIVERSITY OF CALICUT

Abstract

M.Sc Programme in Applied Zoology -Choice based Credit Semester System -PG in the Teaching Department of the University- Revised and approved -Implemented w.e.f 2014 admissions- Orders issued.

G & A - IV - J

U.O.No. 10670/2014/Admn

Dated, Calicut University.P.O, 17.11.2014

*Read:-*1. U.O.No. GA IV/J1/1373/08 dated 07.07.2008.

2. U.O.No:GAV/J1/2316/06 Dtd 19.12.2008

3. U.O.No. GAV/J1/4279/10 dtd 26.07.10

4. Item no.7 of the minutes of the meeting of the Board of Studies in Zoology held on 16.07.2014.

5. Remarks of the Dean, Faculty of Science on 28.08.2014

6. Orders of the Vice Chancellor in the file of even number on 30.09.2014

ORDER

As per the reference cited (1) above, sanction was accorded to implement the choice based credit semester system in the Teaching Department of the University from Academic Year 2008-09 onwards.

As per the paper read as 2nd above, the scheme and syllabus of MSc Applied Zoology under CCSS in the University teaching Departments was implemented from the academic year 2008-09 onwards and was revised as per paper read as 3 rd above.

As per The paper read as (4), the revised Scheme and Syllabus of MSc Applied Zoology under CCSS in the Teaching Department of the University was approved by the Board of studies in Zoology PG.

As per paper read as (5) above, the Dean, Faculty of Science has recommended to approve the item pertaining to the syllabus in the minutes. The Vice Chancellor in view of exigency exercising the powers of the Academic Council has approved the item pertaining to the syllabus in the minutes under reference, subject to ratification of the Academic Council as per paper read as (6).

Sanction has therefore been accorded for implementing the Scheme and Syllabus of MSc Applied Zoology under CCSS in the University Teaching Department with effect from 2014 admission onwards.

Orders are issued accordingly.

Revised Syllabus appended. The Modified Scheme and Syllabus is available in the
University website:www.universityofcalicut.info

Muhammed S
Deputy Registrar

To

Forwarded / By Order

Section Officer

**DEPARTMENT OF ZOOLOGY
UNIVERSITY OF CALICUT
CALICUT UNIVERSITY P. O.
KERALA, 673 635**



**RESTRUCTURED CURRICULUM AND SYLLABUS FOR
M. Sc. APPLIED ZOOLOGY
(Choice based Credit Semester System – CCSS)**

(w. e. f. 2014 Admission)

2014

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FOREWORD

1. The syllabus and curriculum of M. Sc. Applied Zoology course under the Choice based Credit semester System (CCSS) offered by the Department of Zoology, University of Calicut have been revised and restructured with effect from 2014 admissions.
2. The two-year Post Graduate Programme will be in the semester pattern. There will be four semesters in the entire course, with two semesters in each year. Each semester will have 90 instructional days with a minimum of 6 hours of instructions each day under the five-day system. End-semester examinations will be held within the 90 regular instructional days. The papers in the first two semesters will constitute the Core Courses only, in the third semester both Core and Elective Courses and in the fourth semester only Elective Courses are included. Entomology is the broad area of elective subjects offered in this Department for the time being.
3. Evaluation of all semester theory/ practical papers will be done in two parts namely by continuous internal evaluation and external evaluation.
4. Details of Choice based Credit Semester System (CCSS) implemented in the Teaching Departments/Schools of the University of Calicut are provided in the Regulations.

REGULATIONS FOR THE CHOICE BASED CREDIT SEMESTER SYSTEM (CCSS) (PG) FOR THE TEACHING DEPARTMENTS / SCHOOLS OF THE UNIVERSITY OF CALICUT

(See University Order No. GA I / J1 / 1373 / 08 dated Calicut University PO, 01.07.2008)

1. SHORT TITLE

- 1.1 This regulation shall be called “Calicut University Regulations for Choice based Credit Semester System (CCSS) 2008.”

2. SCOPE

- 2.1 The regulation provided herein shall apply to all regular post-graduate programmes conducted by the Teaching Departments/Schools of the University of Calicut with effect from the academic year 2008-2009.
- 2.2 The provisions herein supersede all the existing regulations for the regular post-graduate programmes conducted by the Teaching Departments/Schools of the University of Calicut unless otherwise specified.
- 2.3 The Department of Biotechnology and Department of Education may be allowed to follow the present system

3. DEFINITIONS

- 3.1 ‘*Academic Committee*’ means the Committee constituted by the Vice-Chancellor under this regulation to manage and monitor the running of the post-graduate programmes under the Credit based Credit Semester System (CCSS).
- 3.2 ‘*Programme*’ means the entire course of study and Examinations (traditionally referred to as course).
- 3.3 ‘*Duration of Programme*’ means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be 4 Semesters; except for M. Ed. programme, for which the duration shall be 2 Semesters.
- 3.4 ‘*Semester*’ means a term consisting of a minimum of 90 working days including examination days distributed over a minimum of 18 weeks each of 5 working days.
- 3.5 ‘*Course*’ means a segment of subject matter to be covered in a semester (traditionally referred to as paper). Each course has an alpha numeric code number, title and credit.
- 3.6 ‘*Core Course*’ means a course of a particular Degree Programme, which must be successfully completed by a student to receive the degree and which cannot be substituted by any other course. Core courses are offered by the Department conducting the programme.
- 3.7 ‘*Elective Course*’ means a course, which can be substituted by equivalent course from the same or other Departments/Schools and which must be successfully completed by a student to receive the degree.
- 3.8 ‘*Audited Course*’ means a course which the student can register without earning credits (zero credit course). Credit courses can be registered as zero credit courses if a student desires so.

- 3.9 *'Repeat Course'* is a course that is repeated by a student for having failed in that course in an earlier registration.
- 3.10 *'Re-examination Course'* is a course registered by a student for improving his performance in that particular course.
- 3.11 *'Department/School'* means Teaching Departments/Schools instituted in the University as per the Statute and Act.
- 3.12 *'Parent Department/School'* means the Department/School which offers a particular degree programme.
- 3.13 *'Credit' (C)* of a course is a measure of the weekly unit of work assigned for the course. A theory class of one hour per week or a practical class of three hours per week shall be counted as one credit.
- 3.14 *'Grade Point' (G)* of a student in a course is the value obtained by dividing her/his % of marks in the course by 10. Grade point is expressed on a 10.0 point scale rounded off to the first decimal place and varies from 0.0 to 10.0. Grade point indicates the exact level of performance of a student in a course.
- 3.15 *'Letter Grade'* or simply *'Grade'* in a course is a letter symbol (e.g. A⁺, A, B⁺, B etc) which indicates a particular range of grade points (e.g. 8.0 to 10.0, 7.0 to 7.9, 6.0 to 6.9, 5.0 to 5.9 etc) and is used to refer to the broad level of performance of a student in a course.
- 3.16 *'Credit Point' (P)* of a course is the value obtained by multiplying the Grade point (G) by the Credit (C) of the course: $P = G \times C$.
- 3.17 *'Semester Grade Point Average' (SGPA)* is the value obtained by dividing the sum of credit points (P) obtained by a student in the various courses studied in a semester by the total number of credits taken by him/her in that semester. The grade points shall be rounded off to the first decimal place. SGPA determines the overall performance of a student at the end of a semester.

For instance, if a student has registered for 'n' courses of credits C_1, C_2, \dots, C_n in a semester and if she/he has scored credit points P_1, P_2, \dots, P_n respectively in these courses, the SGPA of the student in that semester is calculated using the formula

$$\text{SGPA} = \frac{P_1 + P_2 + \dots + P_n}{C_1 + C_2 + \dots + C_n}$$

- 3.18 *'Cumulative Grade point average' (CGPA)* is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and is calculated based on the same formula given above. CGPA shall be rounded off to the first decimal place.
- 3.19 Words and expressions used and not defined in this regulation but defined in the Calicut University Act and Statutes shall have the meaning assigned to them in the Act and Statutes.

4. ACADEMIC COMMITTEE

- 4.1 There shall be an Academic Committee constituted by the Vice-Chancellor to manage and monitor the working of the CCSS.
- 4.2 The Committee consists of:
 - a) The Vice-Chancellor.
 - b) The Pro-Vice-Chancellor.
 - c) The Registrar.
 - d) The Controller of Examinations.
 - e) Deans of Faculties representing the subjects of the University Teaching Departments/Schools.
 - f) Syndicate member representing the University Teachers
 - g) One teacher other than Dean from each Department/School, nominated by the Department Council based on seniority and by rotation.
 - h) Student Syndicate member
 - i) Chairman, Department Students Union
- 4.3 The Vice-Chancellor shall be the Chairman of the Academic Committee and the Pro-Vice-Chancellor the Vice Chairman. A senior Professor nominated by the Vice-Chancellor from among the members of the committee shall be the Convener of the Academic Committee.
- 4.4 The normal term of the Academic Committee shall be two years. It is mandatory to reconstitute the committee before its term expires.
- 4.5 The Academic Committee shall meet at least twice in a semester.
- 4.6 The Academic Committee shall manage the activities starting from the conduct of admission of the students to the issuance of the final score sheet at the end of the course.
- 4.7 *Administrative Committee:* There shall be a 5-member Administrative Committee within the Academic Committee to look after the day-to-day affairs of the CCSS in consultation with the Vice-Chancellor. The Convener of the Academic Committee shall be the Convener of the Administrative Committee. The other members of the Administrative Committee shall be nominated by the Vice-Chancellor from among the members of the Academic Committee.
- 4.8 There shall be a separate Administrative Office for the management of the CCSS.

5. PROGRAMME STRUCTURE

- 5.1 The Programme shall include three types of courses, *viz.* Core Courses, Elective Courses and Audited Courses. Core Courses should be generally be offered by the parent Department/School concerned. Elective Courses and Audited Courses are offered by the parent Departments and/or other departments. A Department/School shall come forward to offer more and more Elective Courses and Audited Courses suitable for other Departments/Schools. There shall be a compulsory Project/Dissertation to be undertaken by all students.

- 5.2 No Course shall have more than 4 credits and for dissertation, for which the maximum credits shall be 8 and minimum 4. Audited Courses will not carry any credits.
- 5.3 A student is free to register for as many courses as she/he can manage if facilities permit, meeting the minimum credit requirements.
- 5.4 A student shall accumulate a minimum of 36 credits in the case of 2 semester programmes, 72 credits in the case of 4 semester programmes other than MBA as advised by the parent Department/School, for the successful completion of the programme. These credits shall be distributed among the Core Courses, Elective Courses and Project/Dissertation as stated below:
- The minimum number of credits from Core Courses, Elective Courses and Project/Dissertation shall be 24, 8 and 4 respectively for 2 semester programmes, 48, 16 and 8 respectively for 4 semester programmes other than MBA and 54, 16 and 8 respectively for MBA.
- 5.5 No student shall register for more than 24 credits (32 in the case of MBA) excluding re-examination and repeat courses and less than 16 (20 in the case of MBA) credits per semester.
- 5.6 The parent Department/School shall decide the core courses and appropriate elective courses for a specific programme.
- 5.7 The odd semester shall be from August to December and the even semester shall be from January to July excluding the April-May summer vacation. Each semester shall have a minimum of 90 working days inclusive of all examinations.
- 5.8 *Attendance:* The minimum requirement of attendance during a Semester shall be 75% for each course. Attendance shall be maintained by the course teacher. 10% condonation can be granted on the attendance requirements by the Chairman of the Academic Committee on genuine grounds, provided it is also recommended by the Department Council. A fee for this purpose may be collected as prescribed by the Academic Committee and approved by the Syndicate. Candidates who do not satisfy the required minimum attendance in a course shall be awarded zero grade point in that course.
- 5.9 The general structure of the programme shall be summarized as given below:

Sl. No.	Programme Duration	4 semesters (MA/MSc/MCom/MCJ)	4 semesters (MBA)
1	Accumulated minimum credits required for successful completion of programme	72	80
2	Minimum credits required from Core Courses	48	56
3	Minimum credits required from Elective Courses	16	16
4	Minimum credits required from compulsory Project/Dissertation	8	8
5	Minimum and Maximum credits required to be registered in a semester	16-24	20-32
6	Minimum attendance required	75%	75%

6. BOARD OF STUDIES

- 6.1 The Department Council shall prepare the Syllabus for Choice based Credit Semester System and the same shall be reported to the respective Board of Studies.
- 6.2 The Department Council shall have the freedom to design and introduce new courses, to modify or re-design existing courses and replace any existing courses with new/modified/re-designed courses to facilitate better exposures and training for the students.
- 6.3 New/modified courses designed under the above clause shall be informed to the Academic Committee sufficiently in advance so that the information is available before the student is required to register for courses during the semester. The date of registration for courses during a semester shall be three weeks before the end of previous semester. It is desirable not to change the core courses once a programme gets started. However modified or new courses can be offered in the middle of a programme at the elective level, with such changes made available well in advance of the starting of a semester.
- 6.4 The Syllabus of a course shall include the title of the course, the number of credits and reference materials.
- 6.5 Each course shall have an alpha numeric code giving comprehensive information on the Department/School offering the course, the semester in which it is offered and a serial number.
- 6.6 The Department Council shall report the details of the courses designed/modified to the respective Board of Studies in the first sitting following such modifications.
- 6.7 Every Programme conducted under Credit Semester System in a Department/School shall be monitored by the Department Council.

7. ADMISSION

- 7.1 It is the responsibility of the Academic Committee to finalize the admission to all courses as per the rules and regulations of the University.
- 7.2 The admission shall be based on the marks scored by a student in the qualifying examinations.
- 7.3 Separate rank lists shall be drawn up for reserved seats as per the existing rules.
- 7.4 On admission to a particular programme, the student shall be assigned an admission number, which shall consist of 3 components: Department offering the programme, Year of admission and the serial number of the student in the admission list of the year (e.g. ZOO-2014-01).
- 7.5 The Academic Committee shall make available to all students admitted a Prospectus listing all the courses offered in various Departments/Schools during a particular semester. The information so provided shall contain title of the course, credits for the course, prerequisites, place and time of the classes and examination schedule.
- 7.6 There shall be a uniform calendar prepared by the Academic Committee for the conduct of the courses. The Academic Committee shall ensure that the calendar is strictly followed.

8. ELIGIBILITY FOR ADMISSION

8.1 The eligibility for admission shall be announced by the University from time to time.

9. REGISTRATION

- 9.1 Every Department/School shall have a Student Advisory Committee constituted by the Department Council comprising a maximum of 4 faculty members and a student representative of the batch concerned.
- 9.2 The student shall register for the course she/he plans to do during a semester three weeks prior to the end of the previous semester in consultation with the Student Advisory committee.
- 9.3 The first semester shall be dealing with only Core courses so that the student gets time to decide on the elective courses to be opted. Elective courses and other Core courses shall be distributed in the remaining semester(s).
- 9.4 The number of courses a student can take is restricted by the rules that govern the minimum and maximum credits she/he may earn during a semester.
- 9.5 The Department/School offering any course shall prescribe the maximum number of students that can be admitted taking into consideration the facilities available.
- 9.6 In a Department/School, preference shall be given to those students for whom the course is a Core course, if the demand is beyond the maximum prescribed
- 9.7 The student can reduce the number of credits by opting out if she/he has registered for more courses than she/he can handle, within 30 days of the commencement of classes.

10. EVALUATION AND GRADING

10.1 The evaluation scheme for each course shall contain two parts:

- (a) Internal evaluation
- (b) External evaluation

20% weightage shall be given to internal evaluation and the remaining 80% to external evaluation.

10.2 *Internal evaluation:* The internal evaluation shall be based on predetermined transparent system involving periodic written tests, viva-voce, seminars and attendance in respect of theory courses and based on written tests, viva-voce, lab skill/ records in respect of practical courses as detailed below:

Theory Paper	Marks	Practical Paper	Marks
Attendance*	3	Lab skill/Records	5
Seminar	5	Practical test	10
Test Paper	8	Viva-voce	5
Viva-voce	4		
Total	20	Total	20

*90% & above: 3 marks, 80 to 89%: 2 marks, 75 to 79%: 1 mark, below 75%: Nil

The details of executing the internal evaluation shall be decided by the concerned Department Council. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination.

- 10.3 *External evaluation:* The external examination in theory courses is to be conducted by the question papers set by external examiners. The evaluation of the answer scripts shall be done by the teacher offering the paper and an external expert based on a well-defined scheme of valuation framed by them. The external examination in practical courses shall be conducted and evaluated by two examiners: one external and one internal.
- 10.4 The external evaluation shall be done in a Centralized Valuation Camp, to be held in the respective Department/School immediately after the examination under the supervision/control of the Academic Committee. It is desirable to have the semester results announced within 10 days of the conduct of the last examination of the semester.
- 10.5 Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny on request along with required fees within 7 days of publishing the results and revaluation/scrutiny of answer scripts shall be done as per the existing rules prevailing in the University.

11. GRADING SYSTEM

- 11.1 Based on the % of marks scored (external and internal marks put together), the students are graded in each course applying the following grading system:

% of Marks	Grade point	Letter grade
80 – 100	8.0 – 10.0	A+
70 – 79	7.0 – 7.9	A
60 – 69	6.0 – 6.9	B+
50 – 59	5.0 – 5.9	B
40 – 49	4.0 – 4.9	C (Lowest passing grade)
00 – 39	0.0	F (Failed)
Course incomplete	--	I

- 11.2 Each student shall be assigned a Grade Point and a Letter Grade in each course on the basis of the % of marks scored in the course (external and internal marks put together) as shown above. The minimum Grade point required for passing a course is 4.0. The Grade Point for marks in the range 0 to 39 is taken as 0.0.
- 11.3 The student is required to pass all core courses and the stipulated minimum number of elective courses in order to complete the programme successfully.
- 11.4 After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given under its definition. The minimum SGPA required for the successful completion of semester is 5.0. However, a student with SGPA less than 5.0 in a semester is permitted to proceed to the next semester.

- 11.5 The Cumulative Grade Point Average (CGPA) of the student is calculated at the end of the programme. For the CGPA computation only the best performed courses with the maximum credit points (P) alone shall be taken subject to the restrictions on the credits of the Core and Elective courses prescribed for a specific degree. The CGPA of a student determines the academic level of the student in a particular programme and is the criterion for ranking the students.

12. MARK / GRADE SHEET

- 12.1 The University under its seal shall issue to the students, a mark/grade sheet on completion of each semester, which shall contain the following information.
- a) Name of the University.
 - b) Name of the Parent Department.
 - c) Title of the Post Graduate Programme.
 - d) Name of the Semester.
 - e) Name and Register number of student.
 - f) Code number, Title and Credits of each course opted in the semester.
 - g) Internal, external and Total marks out of 100, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester.
 - h) The Total credits, total credit points and SGPA in the semester.
- 12.2 The Final Mark/Grade sheet issued at the end of the final semester shall contain the details of all courses and project taken by the student including those taken over and above the prescribed minimum credits for obtaining the degree. The Final Mark/Grade sheet shall show the CGPA and the overall letter grade of a student for the entire programme.

13. AWARD OF DEGREE

- 13.1 The successful completion of all the courses (Core and Elective) and the compulsory project prescribed for the degree programme with CGPA of 5.0 shall be the minimum requirement for the award of the degree.

14. STUDENT EVALUATION OF THE COURSE AND THE TEACHERS

- 14.1 There shall be a questionnaire prepared by the Academic Committee to evaluate the specific courses and the concerned teachers confidentially by the students at the end of the courses in each semester. The required questionnaire shall be designed by the Academic Committee. These confidential reports shall be used positively to improve the quality of the courses and academic standards and should not be linked with the career advancement of teachers.

15. FAIRNESS OF THE EVALUATION

- 15.1 The Department Council has the responsibility to ensure fair evaluation of the students. Any complaints from the students about the conduct of courses and evaluation or any complaint from the teacher about the students shall be enquired into by the Department Council. If the Council fails to sort out such complaints, it shall be reported to the Academic Committee to be further enquired into by an Enquiry Committee duly

constituted by the Academic Committee. In case the Academic Committee also fails to resolve the issue, it shall be reported to the Vice Chancellor for further action and the Vice Chancellor's decision will be final.

16. TRANSITORY PROVISION

- 16.1 Notwithstanding anything contained in this regulation, the Vice-Chancellor shall, for a period of one year from the date of coming into force of this regulation, have the power to provide by order that this regulation shall be applied to any programme with such modifications as may be necessary.

17. REPEAL

- 17.1 The Regulations now in force in so far as they are applicable to programmes offered by the University Departments/Schools and to the extent they are inconsistent with this regulation are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Choice based Credit Semester System in their application to any course offered in a University Department/School, the latter shall prevail.

M.Sc. APPLIED ZOOLOGY (2014 admission onwards)

SUMMARY OF COURSE

Semester	Course Type	Course Mode	No. of Course	Credits/ course	Marks/ course	Total Credits	Total Marks
FIRST	Core	Theory	4	4	100	16	600
	Core	Practical	2	2	100	4	
SECOND	Core	Theory	4	4	100	16	600
	Core	Practical	2	2	100	4	
THIRD	Core	Theory	2	4	100	8	600
	Core	Practical	1	2	100	2	
	Elect	Theory	2	4	100	8	
	Elect	Practical	1	2	100	2	
FOURTH	Core	Project	1	8	200	8	600
	Elect	Theory	2	4	100	8	
	Elect	Practical	2	2	100	4	
Grand Total						80	2400

Total credits: Core course : Theory - 40; Practical - 10; Total - 50
 Elective course : Theory - 16; Practical - 06; Total - 22
 Project : 08
Grand total : 80

SEMESTER-WISE DETAILS**FIRST SEMESTER**

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 1C 01 – BIOCHEMISTRY	80 hrs	4	80	20	100
ZOO 1C 02 – BIOPHYSICS & BIOSTATISTICS	80 hrs	4	80	20	100
ZOO 1C 03 – BIOSPHERE ECOLOGY	80 hrs	4	80	20	100
ZOO 1C 04 – SYSTEMATICS & ANIMAL BEHAVIOUR	80 hrs	4	80	20	100
ZOO 1C 05 – BIOCHEMISTRY, BIOPHYSICS & BIOSTATISTICS PRACTICAL	40 PS	2	80	20	100
ZOO 1C 06 – SYSTEMATICS, BEHAVIOUR & BIOSPHERE ECOLOGY PRACTICAL	40 PS	2	80	20	100
Total for First Semester		20	480	120	600

C - Core course, PS – Practical Session

SECOND SEMESTER

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 2C 07 – CYTOGENETICS & EVOLUTION	80 hrs	4	80	20	100
ZOO 2C 08 – MOLECULAR BIOLOGY	80 hrs	4	80	20	100
ZOO 2C 09 – BIOTECHNOLOGY	80 hrs	4	80	20	100
ZOO 2C 10 – ANIMAL PHYSIOLOGY & ENDOCRINOLOGY	80 hrs	4	80	20	100
ZOO 2C 11 – CYTOGENETICS, ANIMAL PHYSIOLOGY & ENDOCRINOLOGY PRACTICAL	40 PS	2	80	20	100
ZOO 2C 12 - MOLECULAR BIOLOGY & BIOTECHNOLOGY PRACTICAL	40 PS	2	80	20	100
Total for Second Semester		20	480	120	600

C - Core course, PS – Practical Session

THIRD SEMESTER

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 3C 13 – DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS	80 hrs	4	80	20	100
ZOO 3C 14 – MICROBIOLOGY & IMMUNOLOGY	80 hrs	4	80	20	100
ZOO 3E 15 – GENERAL ENTOMOLOGY	80 hrs	4	80	20	100
ZOO 3E 16 – INSECT PHYSIOLOGY & BIOCHEMISTRY	80 hrs	4	80	20	100
ZOO 3C 17 – DEVELOPMENTAL BIOLOGY, MICROBIOLOGY & IMMUNOLOGY PRACTICAL	40 PS	2	80	20	100
ZOO 3E 18 – GENERAL ENTOMOLOGY, INSECT PHYSIOLOGY & BIOCHEMISTRY PRACTICAL	40 PS	2	80	20	100
Total for Third Semester		20	480	120	600

C - Core course; E - Elective course; PS – Practical Session

FOURTH SEMESTER

Code No. & Course	Allotted Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 4C 19 – PROJECT	160 hrs	8	160	40	200
ZOO 4E 20 – AGRICULTURAL ENTOMOLOGY & ACAROLOGY*	80 hrs	4	80	20	100
ZOO 4E 21 – INSECT PESTS – CONTROL AND MANAGEMENT*	80 hrs	4	80	20	100
ZOO 4E 22 – ECOLOGY & ETHOLOGY OF INSECTS*	80 hrs	4	80	20	100
ZOO 4E 23 – MEDICAL, VETERINARY & FORENSIC ENTOMOLOGY*	80 hrs	4	80	20	100
ZOO 4E 24 – PRACTICAL ON 4E 20*	40 PS	2	80	20	100
ZOO 4E 25 – PRACTICAL ON 4E 21*	40 PS	2	80	20	100
ZOO 4E 26 – PRACTICAL ON 4E 22*	40 PS	2	80	20	100
ZOO 4E 27 – PRACTICAL ON 4E 23*	40 PS	2	80	20	100
Total for Fourth Semester		20	480	120	600

* Elective Courses (Any Two Theory course and its Practical is to be opted by the student)

Semester wise allotment of instructional hours per week

Course/ Activity	Hours allotted per Week				
	First Semester	Second Semester	Third Semester	Fourth Semester	Total
Core Theory	4 hrs X 4 courses = 16 hrs	4 hrs X 4 courses = 16 hrs	4 hrs X 2 courses = 8 hrs	--	40 hrs
Core Practical	2 Practical X 2 courses = 12 hrs	2 Practical X 2 courses = 12 hrs	2 Practical X 1 courses = 6 hrs	--	30 hrs
Elective Theory	--	--	4 hrs X 2 courses = 8 hrs	4 hrs X 2 courses = 8 hrs	16 hrs
Elective Practical	--	--	2 Practical X 1 course = 6 hrs	2 Practical X 1 course = 6 hrs	12 hrs
Seminar/ Assignment	2 hrs	2 hrs	2 hrs	2 hrs	8 hrs
Project/ Dissertation	--	--	--	14 hrs	14 hrs
Total hrs per week	30 hrs	30 hrs	30 hrs	30 hrs	

FIRST SEMESTER

ZOO 1C 01 BIOCHEMISTRY

- 1. Introduction (4 h)**
 - 1.1. Structure of atoms, molecules and chemical bonds.
- 2. Water: its effect on dissolved bio molecules (6 h)**
 - 2.1. Water as an ideal biological solvent: Hydrogen bonds; Ionisation of water.
 - 2.2. Weak acids and weak bases; Equilibrium constant; pH and pKa scale. Problems involving the determination of pH and pKa .
 - 2.3. Buffers and buffer action. Henderson-Hasselbalch equation; Phosphate and bicarbonate buffer system in biological system.
- 3. Enzymes (8 h)**
 - 3.1. Introduction, classification and nomenclature.
 - 3.2. Specificity and regulation of enzymes
 - 3.3. Enzyme kinetics and Michaelis-Menten equation, Lineweaver-Burk plot.
 - 3.4. Factors influencing velocity of enzyme catalysed reactions.
 - 3.5. Enzyme inhibition-reversible and irreversible (competitive and non-competitive) with examples. Enzyme inhibition in the treatment of AIDS.
 - 3.6. Regulatory enzymes -Allosteric enzymes, Key enzymes.
 - 3.7. Zymogens, Isozymes and Co-enzymes
 - 3.8. Ribozymes
- 4. Bioenergetics (6 h)**
 - 4.1. Bioenergetics: Laws of thermodynamics and biological system, Entropy, Enthalpy, Concept of free energy. Standard Free energy change and equilibrium constant. Coupled reactions.
 - 4.2. High-energy compounds. Role of ATP as a free energy carrier in the biological system.
- 5. Carbohydrates: Structure and Reactions (6 h)**
 - 5.1. Structure of Monosaccharides, Disaccharides, Oligosaccharides and polysaccharides (chitin, bacterial cell wall and glycogen)
 - 5.2. Physical and chemical properties of monosaccharides: Isomerism and optical activity. Oxidation, reduction, ester formation, osazone formation.
- 6. Metabolism of Carbohydrates (7 h)**
 - 6.1. Glycolysis; Gluconeogenesis; HMP pathway; Glycogenolysis; Glycogenesis.
 - 6.2. Regulation of glycogen synthesis and breakdown.
 - 6.3. Citric acid cycle; Electron transport chain; Oxidative phosphorylation, Chemiosmotic hypothesis; Uncouplers; Inhibitors of electron transport chain.

- 7. Lipids: Structure and Reactions (6 h)**
- 7.1. Classification of lipids, classification of fatty acids.
 - 7.2. Physical and chemical properties of lipids: Reactions-Hydrolysis, Saponification, Rancidity. Iodine number.
 - 7.3. Structural lipids in membranes, Sphingolipids in biological recognition.
- 8. Metabolism of Lipids (6 h)**
- 8.1. Oxidation of fatty acids: Beta oxidation, alpha oxidation and omega oxidation. Ketone bodies.
 - 8.2. Biosynthesis of fatty acids.
 - 8.3. Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Biosynthesis of cholesterol.
 - 8.4. Prostaglandins: structure, types, synthesis and functions.
- 9. Amino acids: Structure, Classification and Reactions (6 h)**
- 9.1. Structure of different amino acids in proteins.
 - 9.2. Classification of proteins
 - 9.3. Physical and chemical properties of amino acids: Zwitter ions. Isoelectric point. Reactions of carboxyl group, amino group and side chains. Colour reactions of amino acids and proteins. Peptide bonds.
- 10. Metabolism of Amino acids (6 h)**
- 10.1. Metabolism of amino acids: Synthesis of amino acids
 - 10.2. Degradation of amino acids.
 - 10.3. Transamination, decarboxylation and deamination reactions in the biological system.
- 11. Proteins structure and classification (6 h)**
- 11.1. Structure of proteins. Ramachandran plot
 - 11.2. Classification of proteins, Glycoprotein and proteoglycans.
 - 11.3. Sequencing of proteins.
 - 11.4. Nitrogen excretion & urea cycle.
- 12. Nucleic acids (7 h)**
- 12.1. Structure of nucleic acids: Structure of DNA and RNA
 - 12.2. Biosynthesis of nucleic acids
 - 12.3. Degradation of nucleic acids.
 - 12.4. Sequencing of DNA.
- 13. Vitamins: Classification, structure and functions (6 h)**
- 13.1. Classification and structure of vitamins
 - 13.2. Functions of vitamins

13.3. Role of B-complex vitamins as coenzymes.

REFERENCES

1. Alberts, B. Bray, D. Lewis, J., Raff, M. Roberts, K. and Watson, J. D. (1994). Molecular Biology of the Cell. Garland, NY.
2. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, W.H. Freeman and Co., New York.
3. Cohn R. M. and Roth K. S. (1996). Biochemistry and Disease, Williams And Wilkins, A Waverly Company.
4. Delvin, T. W. (2000). A Text Book of Biochemistry with Clinical Correlations, Wiley-Liss, NY.
5. Deb, A. C. (2004). Fundamentals of Biochemistry. New Central Book Agency (P) Ltd. New Delhi.
6. Elliott, W. H. and Elliott, C. (2003). Biochemistry and Molecular Biology. Oxford University Press, Oxford,UK.
7. Levinson, S. A. and Mac Fate, R. P. (1969). Clinical Laboratory Diagnosis. Lea & Fabiger, Philadelphia.
8. Lenhninger, A. L. (2008). Principles of Biochemistry. (5th edn). CBS Publishers and Distributors, New Delhi.
9. Mathews, H. R., Freeland, R. and Miesfeld, R. L. (1997). Biochemistry: A Short Course - Wiley - Liss, Inc. NY.
10. Mary, K. Campbell (1995) Biochemistry. II Ed. Harcourt Brace and Co. Florida.
11. Murray, Robert, Granner, K. and Harper, Daryl K. (2006). Harper's Illustrated Biochemistry. Mc Graw-Hill, New York.
12. Nelson, D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, 4th Ed. Freeman and Co, NY.
13. Stryer, L. (2011). Biochemistry. 7th Ed. W. H. Freeman & Co. New York.
14. Zubay, G. L., Parson, W. W. and Vance, D. E. (1995). Principles of Biochemistry, Brown Publishers, England

ZOO 1C 02 BIOPHYSICS & BIostatISTICS

PART A: BIOPHYSICS

1. **Principles of Biophysical chemistry** **(5 h)**
 - 1.1. pH, buffer, Electrometric determination of pH
 - 1.2. Colligative properties: relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure
 - 1.3. Diffusion: Fick's law and diffusion coefficient, Stoke-Einstein's law, Application of diffusion processes in biology: hemolysis, cyclosis, plasmolysis

- 1.4. Osmosis: Vant Hoff's laws, Osmotic concentration, osmotic gradient, Electro-osmosis, Electrolytic and ionic balance in biological fluid
- 1.5. Viscosity: Factors affecting viscosity, Determination of viscosity of liquids, significance
- 1.6. Stratifications of cellular components against gravity

2. Radiation Biology (5 h)

- 2.1. Radioactivity, ionizing radiations, interaction of radiation with matter
- 2.2. Properties of different types of radioisotopes normally used in biology
- 2.3. Detection, measurement and incorporation of radioisotopes in biological tissues and cells
 - 2.1.1 Radiation dosimetry
 - 2.1.2 G.M. counter
 - 2.1.3 Ionizing chambers
 - 2.1.4 Autoradiography
 - 2.1.5 Cerenkov radiation
 - 2.1.6 Liquid Scintillation
- 2.2 Molecular imaging of radioactive material in nuclear medicine: MRI, FMRI, PET
- 2.3 Safety guidelines

3. Electrophysiological methods (4 h)

- 3.1 Single neuron recording
- 3.2 Patch-clamp recording
- 3.3 Electro Cardio Graphy (ECG)
- 3.4 Brain activity recording - Lesion and stimulation of brain
- 3.5 EEG, CAT

4. Biophysical methods (6 h)

- 4.1 Spectroscopy
 - 4.1.1 UV/visible
 - 4.1.2 Fluorescence
 - 4.1.3 Circular dichroism
 - 4.1.4 NMR and ESR spectroscopy
 - 4.1.5 Multiwell spectrometry
- 4.2 Structure determination using X-ray diffraction and NMR
- 4.3 Analysis using light scattering: Static Light scattering
- 4.4 Different types of mass spectrometry
- 4.5 Surface Plasmon Resonance (SPR) methods

- 5. Microscopic techniques** (7 h)
- 5.1 Resolving powers of different microscopes
 - 5.2 Visualization of cells and subcellular components by light microscopy
 - 5.3 Microscopy and detection of molecules in living cells
 - 5.4 Phase contrast, Immunofluorescence and Confocal microscopy
 - 5.5 Electron microscopy: Scanning and Transmission (SEM and TEM)
 - 5.6 Freeze-etch and freeze-fracture methods for Electron Microscope
 - 5.7 Cytophotometry
 - 5.8 Micrometry
 - 5.9 Different fixation and staining techniques
 - 5.10 Cryotechnique
- 6. Chromatography** (5 h)
- 6.1 Principle and applications:
 - 6.2 Adsorption chromatography
 - 6.3 Partition chromatography
 - 6.4 Column chromatography
 - 6.5 Paper chromatography
 - 6.6 Thin layer chromatography
 - 6.7 Gel-filtration
 - 6.8 Ion-exchange chromatography
 - 6.9 Gas chromatography
 - 6.10 Affinity chromatography
 - 6.11 HPLC
- 7. Electrophoresis** (5 h)
- 7.1 Paper electrophoresis
 - 7.2 Disc electrophoresis
 - 7.3 PAGE - Two-dimensional PAGE
 - 7.4 High voltage and immuno electrophoresis
 - 7.5 Isoelectric focusing
- 8. Principles and applications of** (3 h)
- 8.1 Laser
 - 8.2 Flow cytometry
 - 8.3 Hydrodynamic methods

PART B: BIOSTATISTICS

- 1. Introduction** **(3 h)**
 - 1.1 Sample and test biostatistics
 - 1.2 Role of biostatistics in modern research
 - 1.3 Descriptive and Inferential biostatistics
 - 1.4 Limitations of statistical methods
 - 1.5 Applications of biostatistics
 - 1.6 Attributes and variables
- 2. Measures of Central tendency** **(5 h)**
 - 2.1 Characteristics
 - 2.2 Arithmetic mean, Geometric mean and Harmonic mean
 - 2.3 Correcting incorrect arithmetic mean
 - 2.4 Combined arithmetic mean
 - 2.5 Merits and demerits
 - 2.6 Median
 - 2.7 Mode
- 3. Measures of dispersion or variability** **(5 h)**
 - 3.1 Variability or dispersion
 - 3.2 Importance of dispersion
 - 3.3 Range
 - 3.4 Mean deviation
 - 3.5 Standard deviation
 - 3.6 Quartile deviation
 - 3.7 Variance
 - 3.8 Standard error
 - 3.9 Coefficient of variation
 - 3.10 Lorenz curve – construction
- 4. Probability distribution** **(6 h)**
 - 4.1 Normal distribution
 - 4.1.1 Skewness and Kurtosis
 - 4.1.2 Nature of Skewness
 - 4.1.3 Measures of Skewness
 - 4.1.4 Fitting of normal curves

- 4.2 Binomial distribution
 - 4.2.1 Properties and Fitting of binomial distribution
- 4.3 Poisson distribution
- 5. Statistical inference (7 h)**
 - 5.1 Test of significance
 - 5.2 Test of hypothesis
 - 5.3 Level of significance
 - 5.4 Degree of freedom
 - 5.5 Critical region
 - 5.6 Parametric and Non-parametric test
 - 5.7 Type I and Type II error
 - 5.8 Types of t-test
 - 5.9 Chi-square test
- 6. Analysis of Variance (4 h)**
 - 6.1 Assumptions and techniques of ANOVA
 - 6.1.1 One-way classification
 - 6.1.2 Two-way classification
 - 6.2 Basic introduction to Multivariate statistics
- 7. Correlation and Regression analysis (5 h)**
 - 7.1 Types of correlation
 - 7.1.1 Graphic methods – Scatter diagram, Simple graph, Correlogram
 - 7.1.2 Mathematical methods – Karl Pearson’s coefficient of correlation, Spearman’s Rank correlation coefficient
 - 7.1.3 Tied ranks and Repeated ranks
 - 7.1.4 Coefficient of concordance
 - 7.2 Types of regression
 - 7.2.1 Graphic method and Algebraic method
 - 7.2.2 Regression lines
 - 7.2.3 Regression equation
- 8. Methods in field biology (5 h)**
 - 8.1 Methods of estimating population density of animals and plants
 - 8.2 Ranging patterns through direct, indirect and remote observations
 - 8.3 Sampling methods

REFERENCES

BIOPHYSICS

1. Ackerman, E. (1962). Biophysical Science. Prentice Hall Inc.
2. Alonso, A. and Arrondo, J. L. R. (2006). Advanced techniques in Biophysics. Springer Verlag.
3. Baker, E. J. and Silverton, R. E. (1978). Introduction to Medical Laboratory Technology, ELBS.
4. Bengt, Nolting (2006). Methods in Modern Biophysics, 2nd edition, Springer.
5. Daniel, M. (2002). Basic Biophysics for Biologists. Agro Botanics, Bikaner.
6. Das, D. (1991). Biophysics and Biophysical Chemistry, Academic Publishers, Calcutta.
7. Ernster, L. (Ed.) (1985). Bioenergetics, Elsevier, New York.
8. Ghatak. L. (2011). Techniques and methods in Biology. PHI , Learning Pvt. New Delhi.
9. Gupta, A. (2009). Instrumentation and Bio-analytical techniques. Pragati Prakashan, Meerut.
10. Hoppe, W., Lohmann, W., Markl, H. and Ziegler, H. (1983). Biophysics. Springer Verlag, New York.
11. Nicholis, D. G. and Ferguson, S. J. (1992). Bioenergetics, Academic Press, New York.
12. Roy, R. N. (1996). A Textbook of Biophysics. New Central Book Agency. Pvt. Ltd., Calcutta.
13. Sandhu, G. S. (1990). Research Techniques in Biological Sciences, Anmol Publications, New Delhi.
14. Slayter, E. M. (1970). Optical methods in biology. Wiley Interscience.
15. Srivastava, P. K. (2006). Elementary Biophysics, An introduction. Narosa Publishing House, New Delhi.
16. Subramanian, M. A. (2005). Biophysics: Principles and techniques.
17. Upadhyay, A., Upadhyay, K. and Nath, N. (1997). Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House, Nagpur.

BIOSTATISTICS

1. Agarwal, B. L. (1996). Basic Statistics. 3rd Edition, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N. T. J. (1981). Statistical Methods in Biology. Hodder and Stongtton, London.
3. Campell, R. C. (1978) Statistics for Biologists. Blackie and Son Publishers, Bombay.
4. Wilfrid, Joseph Dixon and Frank, Jones Massey (1957). Introduction to Statistical Analysis, 3rd Edn., Mc Graw Hill, New York.
5. Elhance, D. N. (1985). Fundamentals of Statistics. Kitab Mahal WD Pvt Ltd., Allahabad.
6. Finney, D. J. (1980). Statistics for Biologists. Chapman & Hall, London.
7. Gupta, C. B. and Gupta, V. (2002). Statistical Methods. Vikas Publishing House, New Delhi.

8. Gupta, S. P. (1996). Statistical Methods. Sultan Chand & Sons Publishers, New Delhi.
9. Lewis, A. E. (1971). Biostatistics. Affiliated East-West Press, Pvt. Ltd., New Delhi.
10. Wayne, Daniel. (1987). Biostatistics – Foundation for Analysis in the Health Sciences, 5th Edition. John Wiley & Sons, New York.
11. Hollander, M. and Wolfe, D. A. (1973). Nonparametric Statistical Methods. John Wiley & Sons, New York.

ZOO 1C 03 BIOSPHERE ECOLOGY

- 1. Population Ecology** **(8 h)**
 - 1.1. Population growth –Chaotic systems, Catastrophic theory. Intrinsic rate of natural increase, r- and k-selection
 - 1.2. Human population growth – consequences and solutions
 - 1.3. Life tables and survivorship curves.
 - 1.4. Meta population dynamics
- 2. Ecological modeling** **(3 h)**
 - 2.1 Introduction
 - 2.2 Statistical Models
 - 2.3 Non-statistical models
 - 2.3.1 Analytical model
 - 2.3.2 Simulation model
 - 2.3 Validation of models
- 3. Molecular ecology** **(4 h)**
 - 3.1 Introduction to molecular ecology
 - 3.2 Emergence of molecular ecology
 - 3.3 Applications of molecular ecology in Agriculture
- 4. Ecosystem studies** **(9 h)**
 - 4.1 Ecology of Wetlands: Uses, threats and management
 - 4.2 Ecology of Coral Reefs: Uses, threats and management
 - 4.3 Ecology of Tropical Rain Forests: Vegetation structure, Productivity and nutrient cycling in forests, Uses, threats and management
- 5. Conservation Ecology** **(8 h)**
 - 5.1 Impact of major ecosystem process like habitat degradation and loss, fragmentation, over exploitation, species invasion and land use changes on biodiversity.

- 5.2 Restoration Ecology
- 5.3 Sustainable development
- 5.4 Ecological foot printing
- 6. Environmental issues (7 h)**
 - 6.1 Global environmental issues – Ozone hole, effects on human life
 - 6.2 Human mediated Global climate change – Greenhouse effect and its impact
- 7. Soil Biology (4 h)**
 - 7.1 Mechanism of erosion
 - 7.2 Soil conservation: Managing topography
- 8. Remote sensing as a tool for the study and the Management of ecosystems (5 h)**
 - 8.1 Physical basis for remote sensing
 - 8.2 Role of remote sensing in ecological research
- 9. Pollution (8 h)**
 - 9.1 Environmental Impact Assessment
 - 9.2 Brief account of Environmental laws
- 10. Taxasphere and inventorying (12 h)**
 - 10.1 Reason for undertaking inventorying, priority conservation area recognition
 - 10.2 Indexing of world's known species, *species2000*
 - 10.3 Evaluation of biodiversity indices – Shannon- Weiner indices, Similarity and dissimilarity index, Association index
- 11. Environmental Biotechnology (12 h)**
 - 11.1 Cleaner technologies: sewage treatment, Solid waste and soil pollution management, Bioremediation, Bioreactors for liquid waste treatment, Biofilters, Vermicomposting, Biomethanation, Removal of oil spills
 - 11.2 Environmental monitoring and biomonitoring
 - 11.3 Ecological impact of genetically modified plants and other organisms

REFERENCES

1. Arora, C. K. (1997). Encyclopedia of Laboratory Techniques, 8., Anmol Publications, India
2. Alfred, J. R., Das, B. and Sanyal, A. K. (1998). Faunal diversity in India. En Vis Centre. Zoological Survey of India
3. Bhandari, S. C. and Somani, L. L. (1994). Ecology and Biology of Soil organisms. Agrotech Publ. Acad., Udaipur
4. Bossel, Hartmut (1998). Earth at a crossroads - Path for a sustainable future. Cambridge University Press.

5. Brewer, R. (1994). Science of Ecology. Saunders, USA
6. Caughley, G. S. and Antony, R. (1994). Wild life Ecology and Management. Blackwell Science, USA
7. Carson, R. (1963). Silent Spring, Houghton, Mifflin, Boston, USA.
8. Chauhan, T. S. and Joshi, K. N. (1996). Applied remote sensing and Photo-Interpretation. Vigyan Prakash, Jodhpur
9. Cunningham, P. W. and Woodworth, S. B. (1999). Environmental Science. WCB/McGraw Hill
10. Francois, Ramade (1984). Ecology of Natural resources. John Wiley and Sons, N. York
11. Fred, Van Dyke (2003). Conservation biology: foundations, Concepts, Applications. McGraw Hill.
12. Gary, K. Meffe, Ronald Carroll, C. and Contributors (1997). Principles of Conservation biology, 2nd Ed. Sinauer Associates.
13. Goldman, R. C. (1994). Limnology. McGraw Hill book Co., London
14. Heywood, V. H. and Watson, R. T. (1995). Global biodiversity Assessment, UNEP, Cambridge University Press
15. Jhanwar, M. L. and Chauhan, T. S. (1998). Remote sensing and Photogrammetry. Vigyan Prakash, Jodhpur.
16. Kormondy, E. J. (1986). Concepts of Ecology. Prentice hall, New Delhi
17. Krebs, C. J. (1985). Ecology: The experimental analysis, distribution and abundance. Harper Collins, N.York
18. Minelli, A. (1993). Biological Systematics. Chapman and Hall, London.
19. Mukerjee, A. (1982). Endangered animals of India. Zoological Society of India
20. Moss, B. (1998). Ecology of freshwater. Blackwell Science, USA
21. Miller, Tyler Jr. G. (2005). Living in the Environment: Principles, Connections and Solutions. 13th Ed. Thomson Brooks Cole.
22. Negi, S. S. (1993). Biodiversity and Conservation in India. Indian Publ. Co.
23. Odum, E. P. (1997). Ecology: A bridge between science and society. Sinauer associates Inc.
24. Osborne, P. L. (2000). Tropical Ecosystems and Ecological concepts. University Press, UK
25. O' Riordan, T. and Stoll Kleemann, S. (2002). Biodiversity, Sustainability and Human communities. Cambridge University Press, UK
26. Peter, S. (2002). Ecology: Theories and Applications. Prentice Hall of India
27. Quarrie, J. E. G. (1992). Earth Summit, 1992. The Regency Press, London
28. Ricklefs, R. E. (1990). Ecology. W. H. Freeman & Co., San Francisco
29. Ross, H. H. (1974). Biological systematic. Addison- Wesley Publishing company, London
30. Smith, R. (1996). Ecology and Field Biology. Addison Wesley, USA

31. Southwood, T. R. E. and Henderson, P. A. (2000). Ecological methods. Blackwell Science
32. Scragg, A. (1999). Environmental Biotechnology. ELBS
33. Seragelgin (1999). Biotechnology and Biosafety. World Bank, Washington, D.C.
34. UNEP (1995). Global Biodiversity Assessment. Cambridge University Press, UK
35. Wild, A. (1993). Soil and Environment: An Introduction. Cambridge University Press, UK
36. Wilson, E. O. (1992). The diversity of life. Harvard University Press, USA
37. Wilson, E. O. (1988). Biodiversity. Academic Press, Washington

ZOO 1C 04 SYSTEMATICS AND ANIMAL BEHAVIOUR

PART A: SYSTEMATICS

- 1. Definition and basic concepts in Systematics and Taxonomy (3 h)**
 - 1.1. Systematics and Taxonomy
 - 1.2. Historical resume of Systematics
 - 1.3. Levels of Taxonomy: Alpha, beta and gamma taxonomy
 - 1.4. Place, importance and applications of taxonomy
 - 1.5. Goals of taxonomy
- 2. Classification (4 h)**
 - 2.1. Practice of classification: purpose of classification
 - 2.2. Use of classification: storage of data, recovery of data.
 - 2.3. Theories of biological classification – hierarchy of categories.
 - 2.4. Types of classification: evolutionary and phylogenetic classification- typological classification, phenetic classification, omnispersive classification, horizontal and vertical classification.
 - 2.5. Components of classification.
- 3. Taxonomic procedures (6 h)**
 - 3.1. Taxonomic collections: types of collections, value of collections.
 - 3.2. Curation: preservation of collection in field and laboratory.
 - 3.3. Recording of field data, storage of collection, labeling and cataloguing of collection.
 - 3.4. Identification: methods of identification
 - 3.5. Use of taxonomic keys: kinds, merits and demerits
 - 3.6. Taxonomic descriptions: Presentation of findings.
 - 3.7. Kinds of taxonomic publications.
- 4. Species concepts (4 h)**

- 4.1. Species category: different species concepts: typological, nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological) species concepts
- 4.2. Taxonomic diversity within species, different kinds of species, subspecies and other infraspecific categories, hybrids.

5. Taxonomic characters (9 h)

- 5.1. Different kinds of taxonomic characters.
- 5.2. Functions of taxonomic characters.
- 5.3. Taxonomic characters and classification.
- 5.4. Taxonomic characters and evolution.

6. Zoological nomenclature (10 h)

- 6.1. International Code of Zoological Nomenclature, development of Code of Zoological Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa.
- 6.2. Principle of priority: Homonymy and Synonymy.
- 6.3. Type method and its significance: Different kinds of types in descriptive taxonomy.

7. Newer trends in systematics (8 h)

- 7.1. Chemotaxonomy and serotaxonomy
- 7.2. Cytotaxonomy
- 7.3. Numerical taxonomy
- 7.4. Cladistics
- 7.5. Molecular systematics.

8. Ethics in taxonomy (3 h)

- 8.1. Ethics related to collections: Credit, Lending and borrowing of specimens, Loan of material, Exchange of materials, Collaboration and co-operation with co-workers, Use of language
- 8.2. Ethics related to taxonomic publication: Authorship of taxonomic papers, Correspondence, Suppression of data, Undesirable features of taxonomic papers
- 8.3. Taxonomists and user communities

9. Taxonomic impediments (3 h)

- 9.1. Impediments to build up taxonomic collections and maintenance
- 9.2. Shortage of man power, Lack of funding for taxonomic research, Lack of training in taxonomy, Lack of library facilities.
- 9.3. Impediments in publishing taxonomic work
- 9.4. Solutions to overcome the impediments: International co-operation, Development of taxonomic centers

9.5. Need for efficient international networking

9.6. The Desired end product

PART B: ANIMAL BEHAVIOUR

- 1. Mechanisms of animal behaviour** (2 h)
 - 1.1. Definition and Methodology
 - 1.2. Ethology and its relation to other schools of studying animal behaviour.
- 2. Development of behavior** (10 h)
 - 2.1 Behavioural development – Genes and Environment
 - 2.1 Environmental difference and Behavioural differences
 - 2.2 Genetic differences and Behavioural differences
 - 2.3 Single-Gene effects on behaviour
 - 2.4 Experimental methods demonstrating genetic basis of behaviour
- 3. Nerve cells and behaviour** (6 h)
 - 3.1. Neural basis of behaviour
 - 3.2. Stimulus filtering and behaviour
- 4. Physiology of behavior** (5 h)
 - 4.1. Hormonal influence on behaviour
 - 4.2. Factors influencing effects of hormones on behaviour
- 5. Biological communications** (4 h)
 - 5.1. Pheromones in mammals: Lee Boot effect, Whitten effect, Bruce effect, Coolidge effect, Vandenberg effect
- 6. Sociobiology** (3 h)
 - 6.1 Altruism and Kinship selection

REFERENCES

SYSTEMATICS

1. Alfred, J. R., Das, B. and Sanyal, A. K. (1998). Faunal diversity in India. EN Vis Centre Zoological Survey of India.
2. Blackwelder, R. C. (1967). Taxonomy- A text and reference book. John Wiley and Sons Inc., New York, London, Sydney, 698 pp.
3. Dalela, R. C. and R. S. Sharma (1992). Animal Taxonomy. Jaiprakashnath & Co., Meerut.
4. Heywood, V. H and Watson, R. T. (1995). Global biodiversity assessment. UNEP, Cambridge University Press.

5. Hillis, D. M., Moritz, C. and Mable, B. K. (eds.) (1996). *Molecular Systematics*. Sinauer Associates, Sunderland, MA
6. Kapoor, V. C. (1998). *Theory and Practice of Animal Taxonomy*. Oxford & IBH, Publ., Co., New Delhi.
7. Mayr, E., Springer Mayr, E., Linsley, E. G. and Usinger, R. L. (1953). *Methods and Principles of Systematic Zoology*. Mc Graw Hill Book Company, Inc., New York,
8. Mayr, E. (1969). *Principles of Systematic Zoology*. Mc Graw Hill Inc., New York.
9. Minelli, A. (1993). *Biological Systematics*. Chapman & Hall, London, 387 pp.
10. Narendran, T. C. (2006), *An introduction to Taxonomy*, Zoological Survey of India, Kolkata
11. Ross, H. H. (1974). *Biological Systematics*. Addison-Wesley Publishing Company, Inc.
12. Sandiurd, O. T., Hindar, K. and Brown, A.H.D. (1982). *Conservation of biodiversity for sustainable development*. Scandinavian University Press, Columbia.
13. Simpson, G. C. (1961). *Principles of Animal Taxonomy*, Oxford IBH
14. Tikader, B. K. (1983). *Threatened Animals of India*, ZSI Publication, Calcutta.
15. Wilson, E. O. (1988). *Biodiversity*, Academic Press, Washington

ANIMAL BEHAVIOUR

1. Alcock, J. (2005). *Animal Behaviour*. 8th edition. Sinauer, Associates, USA.
2. Boulenger, E. G. (1993). *An Introduction to Animal Behaviour*. Discovery Publ., New Delhi.
3. Goodenough, J., McGuire, B. and Robert, W. (1993). *Perspectives on Animal behaviour*. John Wiley and Sons, Lond.
4. Lehner, P. (1996). *Handbook of Ethological methods*. Cambridge University Press, UK.
5. Manning, A. and Dawkins, M.S. (1995). *An Introduction to Animal Behaviour*. Cambridge University Press, UK.
6. Manning, A. (1967). *An Introduction to Animal Behaviour*. Edward Arnold Pub., London.
7. Martin, P. and Bateson, P. (2001). *Measuring Behaviour—an Introductory guide*. Cambridge University Press, UK.
8. Postlewait, J. H. and Hopkins, B. L. (1995). *Nature of Life*. McGraw Hill.
9. Salim, Ali (1996). *Book of Indian Birds*. BNHS, India
10. Slater, P. J. B. and Halliday, T. R. (1994). *Behaviour and Evolution*. Cambridge University Press, UK.
11. Slater, P. J. B. (1995). *An Introduction to Ethology*. Cambridge University Press, UK.
12. Slater, P. J. B. (1999). *Essentials of Animal Behaviour*. Cambridge University Press, UK.

ZOO 1C 05 – BIOCHEMISTRY, BIOPHYSICS & BIostatISTICS PRACTICAL
BIOCHEMISTRY

1. Comparison of the capacities of two buffers of the same pH.
2. Estimation of blood glucose.
3. Estimation of blood/serum cholesterol
4. Estimation of serum urea
5. Estimation of serum/blood bilirubin
6. Determination of alkaline phosphatase activity in serum
7. Estimation of total carbohydrates by phenol-sulphuric acid method.
8. Estimation of protein by Biuret method.
9. Estimation of protein by Bradford's method.
10. Isolation of casein from milk.
11. Saponification value of fat.
12. Estimation of total lipids in the serum
13. Determination of salivary amylase activity and effect of substrate concentration
14. Effect of pH on salivary amylase activity.
15. Electrophoresis (PAGE).
16. Determination of molecular weight of proteins by SDS-Polyacrylamide Gel Electrophoresis.
17. Two dimensional gel electrophoresis.

REFERENCES

1. Keith, Wilson and John, Walker (2006). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Oser, B. L. (1965). Hawk's Physiological Chemistry. McGraw Hill Book Co. New York.
3. Plummer, David T, (2007). An Introduction to Practical Biochemistry. III Ed. Tata Mc Graw-Hill, New Delhi.
4. Sawhney, S. K. and Singh, Randhir (eds) (2006). Introductory Practical biochemistry, Narosa Publishing House, New Delhi.
5. Thimmaiah, S. K. (ed) (2004). Standard Methods of Biochemical Analysis, Kalyani Publishers, Ludhiana.
6. Varley, Harold (1988). Practical Clinical Chemistry, CBS Publishers and Distributors, New Delhi.

BIOPHYSICS

1. Absorption spectrum of potassium permanganate. Determination of absorption coefficient and concentration of unknown solutions by calibration as well as by absorption coefficient.

2. Separation of mixtures of sugars and amino acids by paper/thin layer chromatography.
3. Measurement of size of microscopic objects using stage and ocular micrometers.
4. Demonstration of working principle of Light, Phase contrast and Fluorescence microscope, Camera Lucida and Photomicrographic equipment, HPLC.
5. Determination of coefficient of viscosity using Ostwald's Viscometer.
6. Determination of pH of biological fluids using pH meter.
7. Demonstration of cryosectioning.
8. Densitometric documentation of electrophoretogram - determination of protein concentration and molecular weight.

REFERENCES

1. Ackerman, E. (1962). Biophysical Chemistry, Prentice Hall Inc.
2. White, D. C. S. (1974). Biological Physics, Chapman and Hall, London.
3. Hoppe, W. (ed.) (1983). Biophysics, Springer Verlag.
4. Slayter, E. M. (1970). Optical Methods in Biology
5. Gassey, E. J. (1962). Biophysics Concepts and Mechanics. Van Norstrant Reinhold Co.
6. Daniel, M. (1998). Basic Biophysics for Biologists. Agro Botanica, Bikaner.
7. Das, D. (1987). Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.

BIOSTATISTICS

1. Computation of measures of central tendency and dispersion in anthropometric data of school children.
2. Simulation of binomial and Poisson distributions.
3. Estimation of the mean number of children per family from selected populations
4. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA.
5. Regression analysis and correlation analysis of a data of heights and weights of a group of students.
6. Data Analysis by SPSS.

REFERENCES

1. John, T. (2002). Practical Statistics for Environmental and Biological Scientists. John Wiley & Sons

ZOO 1C 06 – SYSTEMATICS, BEHAVIOUR & BIOSPHERE ECOLOGY PRACTICAL

SYSTEMATICS

1. Preparation of dichotomous keys with reference to the following insect orders:
 - 1.1. ORTHOPTERA : Dichotomous key to selected families
 - 1.2. HEMIPTERA: Dichotomous key to selected families.
 - 1.3. COLEOPTERA : Dichotomous key to selected families
 - 1.4. DIPTERA: Dichotomous key to selected families
 - 1.5. HYMENOPTERA: Dichotomous key to selected families
2. Identification and classification of given 5 species of insects up to family level.

REFERENCES

1. Heywood, V. H and Watson, R. T. (1995). Global biodiversity assessment. UNEP, Cambridge University Press.
2. Mayr, E., Linsley, E .G. and Usinger, R. L. (1953). Methods and Principles of Systematic Zoology. McGraw Hill Book Company, Inc., New York, 336 pp.
3. Mayr, E. (1969). Principles of Systematic Zoology. McGraw Hill Inc., New York.
4. Kapoor, V. C. (1998). Theory and Practice of Animal Taxonomy. Oxford & IBH Publ. Co., New Delhi.

ANIMAL BEHAVIOUR

1. Foraging behaviour of ants
2. Demonstration of Photo tactic behaviour in earthworms.
3. Field study on the identification and behaviour of birds (with emphasis on feeding behaviour)
4. Study of behaviour modifications in animals under stress.

REFERENCES

1. Goodenough, J., Mc. Guire, B. and Robert, W. (1993). Perspectives on Animal Behaviour. John Wiley press.
2. Manning, A. and Dawkins, M. S. (1995). An introduction to Animal Behaviour. Cambridge Press.
3. Bonnie J. Ploger and Ken Yasukawa (2003) Exploring Animal Behaviour in Laboratory and Field. Academic Press.

BIOSPHERE ECOLOGY

1. Determination of primary productivity in pond water-light and dark method.
2. Separation and Identification of soil micro arthropods applying Berlese funnel
3. Small scale field inventorying on biodiversity and calculation of richness and evenness: Simpson's diversity index

4. Demonstration of GPRS based land mapping
5. Tabulation and preparation of species diversity indices using field inventorying data.
6. Intertidal studies: rocky shores, sandy (marine) shore, muddy shore and estuaries.
7. Preparing a report on invasive plant species in your locality
8. Estimation of salinity, phosphates, chlorides and silicates in water samples.
9. BOD in polluted water
10. COD open reflex in two water samples
11. Methane index calculation in different substrates. E.g. starch, canteen waste, liquid waste
12. Volatile fatty acid (VFA) estimation in anaerobic fermenting system
13. Estimation of total organic and inorganic substance in solid waste
14. Estimation of total dissolved solids in waste water
15. Estimation of total suspended solids in waste water

***Study tour:** A study tour is to be conducted for the purpose of field observation of animals belonging to different niches other than local area and study of their actual habitat conditions and their behaviour. A report of the field study is to be included in the practical record to be submitted at the time of examination*

REFERENCES

1. Michael, P. (1984). Ecological methods for field and laboratory investigations. Tata –McGraw – Hill Publ. Company.
2. Grainer, J. M. and Lynch, J. M. (1984). Microbial methods for Environmental Biotechnology. Academic Press
3. Manual on Sewerage and Sewage Treatment (1980). Ministry of Works and Housing, New Delhi
4. George, T., Franklin, L. Burton and David, S. H. (2002). Waste Water Engineering, Metcalf and Eddy. 4th Ed. INC Tata McGraw Hill.
5. Webber, W. J. (1972). Physicochemical Processes: For Water Quality Control. Wiley inter-science
6. Arceivala, S. J. and Asolaker, S. R. (2007). Waste Water Treatment for Pollution Control and Reuse. Tata McGraw Hill Education.
7. Indian Standard for Drinking Water. Bureau of Indian Standards, New Delhi

SECOND SEMESTER

ZOO 2C 07 CYTOGENETICS AND EVOLUTION

PART A: CYTOGENETICS

- 1. Cellular communication (6 h)**
 - 1.1 Regulation of hematopoiesis
 - 1.2 General principles of cell communication
 - 1.3 Cell-cell interactions – cell adhesion and roles of different adhesion molecules
 - 1.4 Extracellular matrix: Basal membrane and Laminin, Collagen, Proteoglycan, Fibronectin
 - 1.5 Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.
 - 1.6 Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.
 - 1.7 Neurotransmission and its regulation
- 2. Cell signaling (7 h)**
 - 2.1 Hormones and their receptors
 - 2.2 Signal transduction
 - 2.3 Concept of cell-signaling
 - 2.4 Signaling through intracellular receptors
 - 2.5 Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca²⁺/calmodulin, PKC, Ca-MK, ion channels, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK-STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors, bacterial chemotaxis and quorum sensing
 - 2.6 Receptor desensitization
 - 2.7 Signaling by nitric oxide, carbon monoxide
 - 2.8 Signaling network
 - 2.9 Impairment of signaling mechanism: Tumorigenesis: Role of oncogenes and oncoproteins, NIDDM: low level of receptors
- 3. Apoptosis and its significance (5 h)**
 - 3.1 Necrosis; Programmed and induced cell death
 - 3.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis
 - 3.3 Regulation of apoptosis - Extracellular and Intracellular
 - 3.4 Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population
 - 3.5 Mechanism of cell death
 - 3.6 Genes involved in apoptosis

3.7 Therapeutic interventions of apoptosis

4. Organization of genes and chromosomes (5 h)

4.1 Interrupted genes and gene families

4.2 Structure of chromatin and chromosomes

4.3 Unique and repetitive DNA

4.4 Heterochromatin and euchromatin

4.5 Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests

4.6 Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Mendelian principles and extension of Mendelian principles (5 h)

5.1 Law of dominance, Law of segregation, Law of independent assortment, Non - Mendelian inheritance

5.2 Extension of Mendelian principles: Co-dominance, Incomplete dominance, Gene interactions, Pleiotropy, Genomic imprinting, Penetrance and Expressivity, Phenocopy

5.3 Linkage and crossing over – Coupling and repulsion theory, Cytological basis of crossing over – tetrad analysis

5.4 Sex linkage, sex limited and sex influenced characters

6. Gene mapping methods and Human genetics (7 h)

6.1. Genome maps: Linkage maps, Cytogenetic maps and physical maps, LOD score for linkage testing

6.2. Techniques of restriction mapping

6.3. Mapping with molecular markers: RFLPs, RAPDs, AFLPs, STS, Minisatellites, Microsatellites, Mapping by using somatic cell hybrids

6.4. Cytogenetic maps using molecular markers: PFGE microdissection, Radiation hybrids

6.5. FISH

6.6. Physical and transcript mapping: Low resolution and high resolution physical mapping, Physical maps using molecular markers: STS/EST based mapping, BAC/YAC based mapping, Integrated genomic maps

6.7. Quantitative Genetics: Polygenic inheritance, Heritability and its measurements, QTL mapping

6.8. Pedigree analysis

6.9. Karyotyping

6.10. Genetic disorders: Down's, Klinefelter's and Turner's syndromes

7. Chromosomal aberrations (5 h)

7.1 Deletion, duplication, inversion, translocation, ploidy and their genetic implications

7.2 Homologous and non-homologous recombination, transposition, site-specific recombination

8. Mutation

(5 h)

- 8.1 Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function
- 8.2 Germinal and somatic mutants, insertional mutagenesis

9. Transposable genetic elements

(5 h)

- 9.1 Classification of transposable elements: Class I and Class II
- 9.2 Transposons in bacteria – IS elements, Composite transposons, Tn family, medical significance
- 9.3 Transposons in eukaryotes – P elements in *Drosophila*
- 9.4 Retrotransposon type transposition – Yeast Ty elements, Alu family

PART B: EVOLUTION

1. Emergence of evolutionary thoughts

(8 h)

- 1.1 Overview: Lamarckism, Darwinism, concepts of variation, adaptation, struggle, fitness and natural selection, Neo Darwinism
- 1.2 Evolutionary time scale; eras, periods and epoch
- 1.3 Major events in the evolutionary time scale; origins of unicellular and multicellular organisms
- 1.4 Evolution of major groups of plants and animals

2. Molecular Evolution

(10 h)

- 2.1 Neutral theory of molecular evolution: Principles
- 2.2 Molecular divergence and molecular clocks
- 2.3 Molecular tools in phylogeny: protein, amino acid and nucleotide sequence analysis, Immunological techniques, DNA – DNA hybridizations, Repetitive DNA sequences, Restriction enzyme sites
- 2.4 Phylogenetic tree: Distance and Parsimony methods
- 2.5 Evolution of gene families, Molecular drive
- 2.6 Origin of new genes and proteins; gene duplication and divergence.
- 2.7 Micro and macro evolution

3. Mechanisms of evolution

(12 h)

- 3.1 Variations: Phenotypic and Genetic
- 3.2 Population genetics: populations, gene pool, gene frequency
- 3.3 Hardy-Weinberg law, concepts and rate of change in gene frequency through natural selection
- 3.4 Migration and random genetic drift
- 3.5 Meiotic Drive

- 3.6 Adaptive radiation and modifications
- 3.7 Isolating patterns and mechanisms
- 3.8 Speciation: allopatric, parapatric and sympatric, recombinational
- 3.9 Convergent evolution; sexual selection; co-evolution.

REFERENCES

CYTOGENETICS

1. Becker, W. M., Reece, J. B. and Poenie, M. F. (1999; 2000). The World of the Cell, 4th edition, Benjamin/Cummings Publishing Co.
2. Benjamin Lewin (2008). Genes IX. Jones & Bartlett Learning Publishers, New York.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter (2002). Molecular Biology of the Cell. 4th Edition, Garland Science, New York.
4. De Robertis, E. D. P. and De Robertis, Jr. E. M. F. (1996). Cell and Molecular Biology, Eighth Edition, B.I. Waverly Pvt Ltd, New Delhi.
5. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York.
6. Kleinsmith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology (Second Edition). Harper Collins College Publishers, New York.
8. Peter Snustad, D. and Michael J. Simmons (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
9. Purves W. K., Orians G. H. and Heller H. C. (1995). Life: The Science of Biology, 4th Edition. Sinauer Associates, Sunderland.
10. Robert H. Tamarin (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
11. Sheeler, Philip and Donald, E. Bianchi. (1987) Cell and Molecular Biology. III Ed. John Wiley.
12. Watson J. D., Hopkins N. H., Roberts, J. W., Steits, J. A. and Weiner, A. M. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin Cumming Publishing Company. Menlo Park, California.

EVOLUTION

1. Brian, K. Hall and Benedikt, Hallgrímsson (2008). Strickberger's Evolution, 4th Edition. Jones and Bartlett Publishers International, London
2. Dobzhansky, T. H. (1951). Genetics and Origin of Species, Columbia University Press.
3. Dobzhansky, T. H., Ayala, F. J., Stebbins, C. L. and Valentine, J. M. (1977). Evolution. Freeman, San Francisco.
4. Futuyama, D. J. (1998). Evolutionary Biology, Sinauer Associates, INC Publishers, Dunderland.

5. Futuyama, D. J. (2005). Evolution. Sinauer Associates Inc. Sunderland, Massachusetts.
6. Hartl, D. L. and Clark, A. G. (1989). A Primer of Population Genetics, 2nd Ed. Sinauer Associates, Inc., Massachusetts.
7. King, M. (1993). Species Evolution: the role of chromosomal change. The Cambridge University Press, Cambridge.
8. Merrel, D. J. (1962). Evolution and Genetics. Holt, Reinhart and Winston. Inc.
9. Ohta, T. and Aoki, J. (1985). Population Genetics and Molecular Evolution, Japanese Scientific Society Press, Japan.
10. Strikberger, M. W. (2000). Evolution. Jones and Bartett Publishers, London.

ZOO 2C 08 – MOLECULAR BIOLOGY

- 1. Genes and genomes (5 h)**
 - 1.1 Genomes of prokaryotes and eukaryotes
 - 1.2 Organelle genomes: Mitochondrial and Chloroplast
- 2. Topology of nucleic acids (6 h)**
 - 2.1 Different forms of DNA (A, B, C & Z)
 - 2.2 Supercoiling and Topoisomerases.
 - 2.3 Classification and mechanism of action of topoisomerases.
- 3. Replication of DNA (8 h)**
 - 3.1 Models of DNA replication: Semiconservative mode (Experiments of Messelson and Stahl; Cairns), rolling circle mode and D-loop mode of replication. Role of antisense RNA in replication initiation in plasmids
 - 3.2 Okazaki fragments and semidiscontinuous synthesis.
 - 3.3 Enzymes and accessory proteins involved in DNA replication.
 - 3.4 Replication origin and replication fork, fidelity of replication and extra chromosomal replicons
- 4. Restriction and modification (6 h)**
 - 4.1 Restriction enzymes: Classification and nomenclature of restriction enzymes
 - 4.1 Role of restriction enzymes in bacteria
 - 4.3. Restriction fragment length polymorphism (RFLP)
- 5. DNA repair (6 h)**
 - 5.1 DNA repair mechanisms in bacteria and higher organisms. Base Excision repair, Nucleotide Excision repair. mismatch repair and SOS response
- 6. The Genetic code (7 h)**
 - 6.1 Characteristic features of the genetic code
 - 6.2 Deciphering the code

- 6.3 Degeneracy of the code: Wobble hypothesis.
- 6.4 Reading frame and frame shift
- 6.5 Special feature of the genetic code in ciliates and mitochondria.
- 6.6 Mutations and the genetic code (frame shift, point and suppressor mutations)
- 6.7 Suppressor *t* – RNA and frame shift suppression.
- 6.7 Evolution of the genetic code
- 7. RNA synthesis and processing (8 h)**
 - 7.1 Transcription factors and machinery
 - 7.2 Formation of initiation complex
 - 7.3 Transcription activators and repressors
 - 7.4 RNA polymerases, capping, elongation and termination
 - 7.5 RNA processing, RNA editing, splicing, polyadenylation
 - 7.6 Structure and function of different types of RNA
 - 7.7 RNA transport
- 8. Protein synthesis and processing (6 h)**
 - 8.1 Ribosome - formation of initiation complex
 - 8.2 Initiation factors and their regulation
 - 8.3 Elongation and elongation factors, termination
 - 8.4 Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase
 - 8.5 Translational proof-reading, translational inhibitors
 - 8.6 Post- translational modification of proteins
- 9. Regulation of gene expression in bacteria and phages (6 h)**
 - 9.1 The operon model. : *lac* operon, *lac* repressor negative and positive control
 - 9.2 Constitutive mutants
 - 9.3 Catabolite repression
 - 9.4 Basic features of tryptophan operon: Operator-repressor regulation and attenuation regulation
 - 9.5 Regulation of gene expression in phages
- 10. Regulation of gene expression in eukaryotes (6 h)**
 - 10.1 Interaction with RNA, DNA binding proteins, gene dosage, gene amplification, regulatory transcription factors, Histones, acetylation and deacetylation, epigenetic effects.
 - 10.2 Regulation at transcriptional level: Activation of transcription, Repression of transcription
 - 10.3 Regulation at translational level

- 10.4 Regulation by alternate pathways of transcript splicing.
- 10.5 Anti - sense RNA strategies for regulating gene expression.
- 10.6 si RNA, mi RNA

11. Characteristic features of eukaryotic genome (6 h)

- 11.1 Unique, moderately repetitive and highly repetitive DNA sequences
- 11.2 Reassociation kinetics of the above types of DNA
- 11.3 Cot value and complexity of the genome
- 11.4 Satellite DNA and selfish DNA.

12. Human genome (4 h)

- 12.1 Human genome mapping
- 12.2 Sequencing human genome, HGP

13. Molecular biology of Cancer (6 h)

- 13.1 Biology and causes of cancer
- 13.2 Gene Mutations in cancer and Genetic rearrangements in progenitor cells
- 13.3 Oncogenes and tumor suppressor genes
- 13.4 Virus-induced cancer
- 13.5 Alteration of cell cycle regulation in cancer
- 13.6 Metastasis and angiogenesis in cancer.
- 13.7 Therapeutic interventions of uncontrolled cell growth – Immunotherapy and Gene therapy

REFERENCES

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (2002). Molecular Biology of the Cell. Garland, NY
2. Brown T. A. (2000). Essential Molecular Biology. II Ed. Oxford OUP.
3. Brown T. A. (2006). Genomes 3. Garland Science, New York.
4. Clark, David P. (2005). Molecular Biology. Amsterdam, Elsevier.
5. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York
6. Klinemith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology. 2nd Ed. Harper Collins College Publishers.
7. Lewin, Benjamin. (2008). Genes IX Ed. Boston, Jones, Bartlet.
8. Lewin, Benjamin. (2006). Essential Genes, Pearson, London.
9. Lodish, H., Baltimore, D., Berk , A., Zipursky, S. L., Matsudaira , P. and Darnell, J. (1995). Molecular Cell Biology, Scientific American Books, New York.

10. Malcinski, G. M. and Freifelder, D. (1998). Essentials of Molecular Biology. 3rd Ed. Jones and Bartlett Publishers.
11. Mayers, R. A. (Ed) (1995). Molecular Biology and Biotechnology: A Comprehensive Desk Reference. VCH Publishers, Inc., NY.
12. Nelson D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, IV Ed. Freeman and Co, NY.
13. Panno, Joseph (2005). Gene Therapy. Facts on file. New York.
14. Sinden, Richard R. (2006). DNA structure and function. California, Academic press.
15. Snustad, D. P. and Simmons, M. J. (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
16. Synder, L. and Champness, W. (1997). Molecular Genetics of Bateria. ASM Press Washington, DC.
17. Watson J. D., Gilman M., Witkowski, J. and Zoller, M. (1992). Recombinant DNA, II Edition, Scientific American Books, W.H.Freeman and Company.
18. Strachan, T. and Read, A. P. (2003). Human Molecular Genetics, III ed, John-Wiley & Sons, NY.

ZOO 2C 09 BIOTECHNOLOGY

- 1. Introduction (2 h)**
 - 1.1. History, Scope and importance of biotechnology
- 2. Cloning and expression vectors (6 h)**
 - 2.1. Plasmids, phages, cosmids, transposons, P1, BACs, YACs, Binary and Shuttle vectors
 - 2.2. Expression vectors for high level of expression of cloned genes (use of promoters and expression cassettes including Baculovirus)
- 3. Blotting and Hybridization techniques (6 h)**
 - 3.1. Southern, Northern and Western blotting techniques
 - 3.2. Dot and Slot blots
 - 3.3. Molecular probes and hybridization
- 4. Polymerase Chain Reaction (PCR) (8 h)**
 - 4.1. Basic PCR and its modifications: Inverse PCR, Anchored PCR, PCR for mutagenesis, Asymmetric PCR
 - 4.2. Real time PCR and its applications
 - 4.3. RACE
 - 4.4. Applications of PCR in biotechnology and genetic engineering.
- 5. Cloning in bacteria and eukaryotes (8 h)**
 - 5.1. Steps in gene cloning, Restriction endonucleases, Construction of chimaeric DNA, Transfection, Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.

5.2. Construction and screening of genomic and cDNA libraries

7. Sequencing of whole genomes (7 h)

7.1. BAC/YAC Genomic libraries

7.2. DNA Sequencing methodology

7.3. Sequence assembly by the clone contig approach

7.4. Sequence assembly and analysis.

7.5. Next generation sequencing and direct sequencing of genomes

8. Genotyping techniques and its applications (7 h)

8.1. Polymorphic DNA

8.2. SNP analysis

8.3. DNA fingerprinting

8.4. PCR based genotyping

8.5. Clinical diagnosis

8.6. Prenatal diagnosis

8.7. Paternity/maternity testing

8.8. Forensic analysis

8.9. Molecular taxonomy

8.10. Phylogeny analysis.

9. Gene therapy and other molecular based therapeutic approaches (7 h)

9.1. Principles of molecular genetic based therapies

9.2. General gene therapy strategies

9.3. Therapeutics based on targeted inhibition of gene expression and mutation correction *in vivo*

9.4. Gene therapy for inherited disorders

9.5. Gene therapy for neoplastic and infectious diseases

9.6. Ethics of human gene therapy

9.7. Genetic counseling

9.8. Drug designing, delivery and targeting

10. Gene silencing techniques and Transgenic animals (6 h)

10.1. RNAi

10.2. DNAi

10.3. Intrabodies

10.4. Aptamers

10.5. Transgenic animals and Gene knockouts

10.6. Knockout vectors

10.7. Knockout mouse

11. Animal Tissue Culture, Hybridoma and Monoclonal antibodies (8 h)

11.1. Organ Culture, Cell cultures, Culture media, Initiation of cell cultures, Evolution of cell lines, Large scale culture of cell lines: Monolayer and suspension cultures

11.2. Hybridoma technology and the production of monoclonal antibodies

11.3. Antibody engineering using genetic manipulations

11.4. Alternatives to hybridoma technology

11.5. Production of human and humanized antibodies

11.6. Uses of monoclonal antibodies

12. Intellectual Property Rights (IPR) and Protection (IPP) (5 h)

12.1. Intellectual property rights

12.2. Patents

12.3. Trade secrets

12.4. Copyright

12.5. Trademarks

12.6. Choice of intellectual property protection

12.7. IPR and plant genetic resources (PGR)

12.8. GATT and TRIPs

12.9. Biosafety concepts and issues. General guidelines for recombinant DNA research activity.

13. Patenting of biological material (4 h)

13.1. International conventions and international cooperation

13.2. Obligations with patent applications

13.3. Implications of patenting

13.4. Patents for higher plants and higher animals

13.5. Patenting transgenic organisms and isolated genes

13.6. Patenting of genes and DNA sequences

13.7. Patentability of vectors

13.8. Patent of research tools

14. Bioinformatics (7 h)

14.1. Biological databases : DNA, RNA, Protein

14.2. Nucleic acids and amino acid codes used in database formats

14.3. Sequence alignment and its evolutionary basis

- 14.4. Searching the database for sequence similarity
- 14.5. Search programmes with special reference to FASTA, BLAST and CLUSTAL W
- 14.6. Application of bioinformatics in phylogenetic analysis
- 14.7. Molecular phylogenetic tree construction
- 14.8. Protein visualization and modeling

REFERENCES

1. Alberts, B. Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J. D. (2000). *Molecular Biology of the Cell*. Garland Science, New York
2. Arunima Mukherjee. (2008). *Bioinformatics* (1st Ed.) Oxford University Press.
3. Attwood T. K., Parry-Smith D. J. (2003). *Introduction to Bioinformatics*. Pearson education.
4. Ausubel , F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A. and Struht, K. (2002). *Short Protocols in Molecular Biology*. John Wiley and Sons, Inc.
5. Brown, T. A. (2002). *Genomes*, II Ed., John-Wiley & Sons, New York.
6. Chatterjee, A. K. (2007). *Environmental Biotechnology* (2nd Ed.) Prentice Hall.
7. Freshney, Ian R. (2006). *Culture of Animal Cell* (5th edn).Wiley- Liss publications
8. Glick, B. R. and Pasternak, J. J. (1998). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*
9. Gloveer, D. M. and Hames, B. D. (Eds) (1995). *DNA Cloning: A practical approach*. IRL Press, Oxford.
10. Griffiths, A. J. F., Gelbart, W. M., Miller, J. H. and Lewontin, R. C. (1999). *Modern Genetic Analysis*, W. H. Freeman and Company, New York.
11. Ian Freshney, R. (1994). *Culture of Animal Cells*, 3rd Ed. John Willey & Sons, INC, Publication, New York.
12. Jin Xiony. (2006). *Essential Bioinformatics*, Cambridge.
13. Kothekar, V. (2004). *Introduction to Bioinformatics*. DHRUV Publications, Delhi.
14. Lehninger, A. L., Nelson, D. L. and Cox M. M. (1993). *Principles of Biochemistry*, 2nd Ed. Worth Publishers, New York.
15. Mayers, R. A. (Ed) (1995). *Molecular Biology and Biotechnology: A Comprehensive Desk Reference*. VCH Publishers, Inc., New York.
16. Sambrook , J. and Russell, D. W. (2001). *Molecular cloning: A laboratory Manual*. CSHL Press, New York.
17. Sambrook, J., Fritsch, E. F. and Maniatis, T. (2000). *Molecular cloning: A Laboratory Manual*. CSHL Press, New York.
18. Singh, B. D. (2002). *Biotechnology*, Kalyani Publishers, New Delhi
19. Strachan, T. and Read, A. P. (1999). *Human Molecular Genetics*, II ed, John-Wiley & Sons, New York.
20. Watson, J. D., Gilman, M., Witkowski, J. and Zoller, M. (1992). *Recombinant DNA*, 2nd Edition, Scientific American Books, W.H. Freeman and Company, New York.

21. Westhead, D. R., Parish, J. H. and Twyman, R. M. (1999). Bioinformatics, Bios Scientific Publishers, Ltd., Oxford, UK.

ZOO 2C 10 ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

- 1. The Nature and levels of Adaptation (6 h)**
 - 1.1 Comparative, environmental, and evolutionary physiology
 - 1.2 The meaning of 'environment', 'adaptation'
 - 1.3 Comparative methods to detect adaptation
- 2. The problem of Size and Scale (6 h)**
 - 2.1 Principle of similarity: isometric scaling
 - 2.2 Allometric Scaling
 - 2.3 Scaling of metabolic rate
 - 2.4 Scaling of locomotion
- 3. Nutrition, Digestion and Absorption (8 h)**
 - 3.1. Adaptations to special dietary pattern, ruminant and non ruminant herbivory
 - 3.2. Nutritional disorders – obesity, starvation, Anorexia, vitamin deficiency.
 - 3.3. Neuronal and hormonal regulation of nutritional intake, secretion of digestive enzymes, hunger drive, thirst, glucostatic and hepatostatic theories of hunger drive.
 - 3.4. Adaptation of gut to metabolic rates and diets. Balanced diet- a human perspective
 - 3.5. Physiology of gastro-intestinal disorders- ulcer, constipation
- 4. Circulation (6 h)**
 - 4.1. Haemopoiesis, Blood buffers, Blood groups and Rh factor.
 - 4.2. Cardiac cycle and ECG, Neurohormonal and chemical regulation of cardiac amplitude and frequency, Myocardial infarction, Atherosclerosis, Cerebral circulation, blood brain barrier and cerebrospinal fluids, Placental circulation
- 5. Respiration (5 h)**
 - 5.1. Respiratory muscles, surfactants.
 - 5.2. Regulation of respiration – respiratory centres, neural and chemical regulating respiration.
- 6. Excretion (7 h)**
 - 6.1. Mechanism of tubular reabsorption and secretion, Regulation of urine formation,
 - 6.2. Composition of human urine, Concept of plasma clearance
 - 6.3. Kidney disorders – acute renal failure, chronic renal failure - glomerulonephritis, pyelonephritis, nephritic syndromes and kidney stones, artificial kidney.
- 7. Nerve physiology (6 h)**

- 7.1. Synaptic transmission, Mechanism of excitatory and inhibitory pathway (AchE, GABA)
- 7.2. Electrical and chemical transmission
- 7.3. Parkinson's disease, Epilepsy, Schizophrenia, Alzheimer's syndrome, Dyslexia.
- 8. Sensory and effector physiology (5 h)**
 - 8.1. Structural and functional classification, modality intensity exteroceptors, interoceptors, secondary sense cells, relationship between stimulus, intensity and response, sensory coding.
 - 8.2. Mechanoreceptors-hair cell, organs of equilibrium, vertebrate ear.
- 9. Muscle (5 h)**
 - 9.1. Amoeboid movement and ultrastructure of cilia
 - 9.2. Skeletal muscle, ultrastructure and molecular organization of muscle, protein components of muscle (mechanism and theory), energetic of muscle contraction.
- 10. Sports physiology (6 h)**
 - 10.1 Muscles and exercise
 - 10.2 Respiration and cardiovascular system in exercise
 - 10.3 Dope test, drug abuse.
- 11. Endocrinology (5 h)**
 - 11.1 Morphology and anatomy of major human endocrine glands
 - 11.2 Classification, biosynthesis, secretion and function of hormones
 - 11.3 Regulation of hormone secretion
- 12. Functional Endocrinology (10 h)**
 - 12.1. Hormones as signal transducers
 - 12.2. Hormones in developmental process
 - 12.3. Role of hormones in behaviour of animals
 - 12.4. Control of chromatophores: Pituitary, pineal
 - 12.5. Role of hormones in reproduction of seasonal breeders and continuous breeders
 - 12.6. Hormone therapy in reproductive impairments
- 13. Disorders of hormonal imbalance (3 h)**
 - 13.1. Lipid abnormality
 - 13.2. Weight gain
- 14. Endocrine disruptors in the environment (2 h)**
 - 14.1. Chemical disruptors

REFERENCES

1. Alexander, R. Mc N. (1999). *Energy for Animal Life*, Oxford University Press, Oxford. New York.
2. Arthur, V. J., James, S. H. and Dorothy, L. S. (1990). *Human Physiology International Edn.* (5th) McGraw Hill Publishing Company New York.
3. Barrington, E. J. W. (1975). *An Introduction to General and Comparative Endocrinology*, Oxford, Clarendon Press, London.
4. Bentley, P. J. (1998). *Comparative Vertebrate Endocrinology*, 3rd Ed. Cambridge University Press
5. Bollander, F. (1994). *Molecular Endocrinology*, 2nd Ed., Academic Press, San Diego.
6. Brook, C. G. D. and Marshall, N. J. (1996). *Essential Endocrinology*. 3rdedn., Blackwell Science, London.
7. Brown, J. H. and Wet, G. B (eds) (2000). *Scaling in Biology*, Oxford University Press., Oxford. New York.
8. Clancy, J. and Mc Vicar, A. J. (1995). *Physiology and Anatomy*. Edward Arnold, London.
9. Eckert, R. and Randall, D. (1983). *Animal Physiology, Mechanisms and Adaptation*, 2nd Ed., W. H. Freeman & Company
10. Gorbman, A and Bern, H. A. (1983). *Comparative Endocrinology*, John Wiley & Sons, New York.
11. Guyton, A. C. and Hall, J. E. (2001). *Text Book of Medical Physiology*, 10thEdn. Prism Books, Pvt., Ltd. Harcourt Asia Ltd., India Edn.
12. Hadley, M. G. (2000). *Endocrinology*, 3rd Ed., Prentice Hall International Inc., New Jersey.
13. Hoar, W. S. (1966). *General and Comparative Animal Physiology*, Prentice Hall, Inc., USA.
14. Hochachka, P. W. and Somero, G. N. (2002). *Biochemical Adaptation: Mechanism and Process in Physiological Evolution*, Oxford University Press, New York.
15. Jensen, D. (1976). *The Principles of Physiology*, Appleton-Century-Crofts, New York.
16. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992). *Atlas of endocrine organs: vertebrates and invertebrates*. Springer Verlag, Berlin.
17. Martin C. R. (1985). *Endocrine Physiology*, Oxford University Press.
18. Pat Willmer, Graham Stone and Ian Johnston (2005). *Environmental Physiology of Animals* 2nd Ed. Blackwell., UK.
19. Prosser, C. L., (1973). *Comparative Animal Physiology*, W.B. Saunders & Co
20. Prosser, C. L. (1991). *Environment and Metabolic Physiology*, Wiley-Liss
21. Randall, D., Burgrenn, W. and French, K. (1997). *Animal Physiology*, W. H. Freeman & Co., New York.
22. Schiemdt-Neilsen, K. K. (1994). *Animal Physiology, Adaptation and Environment*, Cambridge University Press.
23. Sperlakis, N. and Banks, R. O. (Eds) (1993). *Physiology*, Little, Brown & Co., London.

24. Storey, K. B. and Storey, J. M. (Eds) (2002). Environmental Stresses and Gene Responses, Elsevier, Amsterdam.
25. Turner, K. and Bagnara, G. (1976). General Endocrinology, W. B. Saunders Company, Philadelphia.
26. Williams, R. H. (1981). Text book of Endocrinology, 6th Ed., W. B. Saunders Company, Philadelphia, London.
27. Williams, R. H. (ed.) (1988). Text Book of Endocrinology, W. B. Saunders Company, Philadelphia.
28. Wolfe, S. L. (1993). Molecular and Cellular Biology, Wadsworth, Belmont, CA.

ZOO 2C 11 – CYTOGENETICS, ANIMAL PHYSIOLOGY & ENDOCRINOLOGY PRACTICAL

CYTOGENETICS

1. Gene mapping of *Drosophila melanogaster*, using text book problems
2. Preparation of chromosomes from rat or mouse bone marrow or human or any other lymphocyte cultures.
3. Analysis of metaphase chromosomes from rat or mouse bone marrow or any other suitable material by means of G and C banding.
4. Preparation of human karyotype from photographs of chromosome spreads – Normal and abnormal
5. Identification of human blood cell types and demonstration of drumstick on neutrophils, employing any suitable stain.
6. Staining of human buccal epithelial smear to demonstrate Barr body.
7. Preparation and analysis of salivary gland polytene chromosomes of *Drosophila* larvae.

REFERENCES

1. Winchester, A. M. (1964). Laboratory Manual, Genetics Brown Co., Publishers Dubuque, Iowa.
2. Jayaraman, J. (1981). Laboratory Manual in Biochemistry. Wiley Eastern Ltd.
3. Neidharth, F. C. and Beyd, R. F. (1965). Cell Biology – A Laboratory Text. Burgees Publishing Co.

ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

1. Detection of digestive enzymes in the hepatopancreas of crab.
2. Effect of temperature on salivary amylase activity.
3. Diffusion of substances through the chick intestine.
4. Demonstration of osmotic stress on human RBC.
5. Estimation of haemoglobin by Sahli's method

6. Determination of haemolymph ammonia concentration of crab with ambient temperature fluctuation.
7. Effect of osmotic stress on rate of respiration.
8. Determination of ventilatory response in fish.
9. Estimation of ammonia level in human blood.
10. Determination of oxygen consumption in fish.
11. Staging of fish chromatophores and effect of adrenaline *in vivo* and Acetylcholine *in vivo*.
12. Blood sugar regulation in the crab- role of eye stalk.
13. Identification of human endocrine gland (histological examination).
14. Laboratory Measurement of T4, T3
15. Laboratory estimation of FSH

REFERENCES

1. Charles F. Lytle and John R. Meyer (2005). Laboratory Manual: Required: "General Zoology Laboratory Guide" (14th ed.)
2. Dounersberger, Anne B., Lesak, Anne C. and Timmons, Maichael, J. (1992). A Laboratory Text Book of Anatomy and Physiology. 5th Ed. D. C. Heath and Co.
3. Hill R. W., Wyse, G. A. (1989). Animal Physiology, 2nd Ed. Harper Collins Publishers Inc. New York. 88-91 pp.
4. Oser, B. L. (1965). Hawk's Physiological Chemistry. Mc Graw Hill Book Co.
5. Schmidt-Nielsen, K. (1997). Animal Physiology, Adaptation and Environment, 5th Ed. Cambridge University Press, New York. 174-175 pp.
6. Arvy, L. (1971). Histoenzymology of the endocrine glands. Pergamon Press, Oxford, New York.
7. Humason, G. L. (1962) Animal Tissue Techniques. W. H. Freeman and Co.

ZOO 2C 12 - MOLECULAR BIOLOGY & BIOTECHNOLOGY PRACTICAL

MOLECULAR BIOLOGY

1. Estimation of DNA by diphenyl amine method/ UV absorption
2. Estimation of RNA by orcinol method/ UV absorption
3. Estimation of Protein by Lowry's method.
4. *E. coli* growth curve.
5. Isolation of plasmid DNA from bacterial culture
6. Isolation of genomic DNA
7. Isolation of RNA from Yeast.
8. Preparation of restriction fragments and their separation by electrophoresis
9. Transformation of *E.coli* with plasmids.

10. Gene cloning

REFERENCES

1. Brown T. A. (1998). Molecular biology Lab Fax. Vol. 1. Recombinant DNA. II Ed. Academic Press.
2. Brown, T. A. (2007). Essential Molecular Biology a practical approach Vol.2. II Ed. Oxford University press.
3. Plummer, David T. (2007) An introduction to Practical Biochemistry,III Ed. Tata Mc Graw-Hill, New Delhi.
4. Sambrook, M. J. and Russel, D. W. (2006). The condensed Protocols from Molecular cloning: A Laboratory Manual. Cold Spring Harbor laboratory Press, Cold Spring Harbor, New York.
5. Wilson Keith and Walker John (2006). Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed., Cambridge University Press, New York.

BIOTECHNOLOGY

1. Separation of DNA by electrophoresis.
2. Cloning in plasmid.
3. Bacterial transformation
4. α - Complementation
5. Southern blotting
6. Northern blotting
7. Western blotting
8. Dot and Slot blotting
9. PCR amplification
10. Cell immobilization.
11. Search databases for getting nucleotide sequence of genes and amino acid sequence of proteins.
12. BLAST search to compare gene sequences.
13. Multiple sequence alignment and construction of phylogenetic tree

REFERENCES

1. Ausubel, F. M., Brebt, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A. and Struht, K. (2002). Short Protocols in Molecular Biology. John Wiley and Sons Inc.
2. Sambrook, J. and Russell, D. W. (2001). Molecular cloning: A laboratory Manual. CSHL Press, New York.
3. Wilson Keith and Walker John (2006). Principles and Techniques of Biochemistry and Molecular Biology 6th Ed., Cambridge University Press, New York.

THIRD SEMESTER

ZOO 3C 13 DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS

- 1. Gametogenesis and Fertilization (12 h)**
 - 1.1. Origin, migration and fate of primordial germ cells
 - 1.2. Spermatogenesis, Factors controlling spermatogenesis, Gamete specific gene expression and genomics, Male infertility
 - 1.3. Oogenesis , Vitellogenesis (Insects and Amphibians) Gene activity (Insects and Amphibians)
 - 1.4. Hormonal Control of gametogenesis
 - 1.5. Biology of Sex determination and sex differentiation
 - 1.6. Fertilization - Biochemical and Physiological aspects, Egg – sperm interactions, Species specific binding of gametes, Cortical reactions, Polyspermy and prevention of polyspermy, Activation of egg, Embryo Transfer (ET) and *In Vitro* Fertilization (IVF) in Humans and Livestock, superovulation and embryo culture
- 2. Cleavage, Blastulation and Gastrulation (8 h)**
 - 2.1. Creating multicellularity, Cleavage types, mechanisms and influence of yolk
 - 2.2. Chemical changes associated with cleavage
 - 2.3. Cytoskeletal mechanisms of cleavage, Midblastula transition
 - 2.4. Morphogenetic movements of cells and epithelia, Exogastrulation
 - 2.5. Metabolic events during gastrulation.
- 3. Cell interactions (8 h)**
 - 3.1. Concept of Primary organizer, embryonic induction and competence, neural induction: regional specificity, double gradient model, secreted protein from the organizer, molecular correlates of neural induction, Nieuwkoop centre, Default model of neurulation, inductive cascades
 - 3.2. Mesodermal induction
 - 3.3. Growth factors
- 4. Cell interactions at a distance (3 h)**
 - 4.1. Amphibian Metamorphosis
 - 4.2. Insect Metamorphosis
- 5. Morphogenetic determinants (6 h)**
 - 5.1 Germ cell determinants
 - 5.2 Regulation of cell determination by ooplasmic determinants, Mosaic development
 - 5.3 Cell position and gradients in development, Regulative development
- 6. Cell differentiation (8 h)**

- 6.1 Equivalence of nuclei and genome constancy
- 6.2 Transcriptional regulation of gene expression
- 6.3 Translational control of gene expression
- 6.4 Levels of differentiation, dedifferentiation, hormones and differentiation
- 7. Stem cells (5 h)**
 - 7.1 Embryonic stem cells
 - 7.2 Adult stem cells
 - 7.3 Medical application
- 8. Genetics of axis formation (8 h)**
 - 8.1. Genetics of axis specification in *Drosophila*, maternal effect genes, determination of dorso-ventral and anterior-posterior axis, zygotic gene activity in development
 - 8.2. Patterns of homeotic gene expression, Homeobox concept in different phylogenic groups
 - 8.3. Axis specification in amphibian and chick
- 9. Regeneration (5 h)**
 - 9.1 Regenerative ability in various groups of animals
 - 9.2 Histological and biochemical changes in regeneration of various invertebrates and vertebrates
 - 9.3 Epimorphic regeneration
 - 9.4 Determination of Polarity and role of gradients in regeneration, neural and endocrine influences
- 10. Ageing (2 h)**
 - 10.1. Cellular ageing: Senescence genes, role of free radicals, hormones and ageing
 - 10.2. Extracellular ageing
- 11. Teratogenesis (2 h)**
 - 11.1. Teratological effects of xenobiotics
- 12. Animal Ethics (13 h)**
 - 12.1 Bioethics, GLP and Bioethics,
 - 12.2 Ethical principles: Beneficence, Least Harm, Respect for Autonomy
 - 12.3 Theories on animals and ethics: Deontology, Utilitarianism, Casuist ethical theory, Virtue ethical theory, Rights Theory
 - 12.4 Animals as Property and Food; Animals in entertainment
 - 12.5 Animals in Research: Experimenting on animals, Specism, Methods to reduce animal numbers in research, Animal Rights and Human Animal repression - Activism and Advocacy

- 12.6 Animal welfare: Bioethics, Environmental ethics and Government ethics
- 12.7 Animal protection: Laws and Rules; IAEC – Rules and Regulation
- 12.8 Ethics on cloning and stem cell research
- 12.9 CPCSEA Guidelines for Laboratory Animal Facility, Veterinary care, Animal procurement, Quarantine, Sterilization and separation, Surveillance, diagnosis, treatment and control of disease

REFERENCES

1. Balinsky, B. I. (1981). An Introduction to Embryology, HoltSaunders, Philadelphia
2. Berril, N. J. and Karp, G. (1978). Development, Tata McGraw hill, New Delhi
3. Brachet, J. (1974). An Introduction to Molecular Embryology, The English University Press, Oxford
4. Browder, L. W. and Erickson, C. A. (1991) Developmental Biology, Saunders College Pub., Philadelphia
5. Davidson, H. (1986). Gene Activity in Early Development, 3rd edition ,Academic Press, New York.
6. Gilbert, L. I., Tata, J. R. and Atkinson, B. G. (1996). Metamorphosis, Academic Press, New York
7. Gilbert, S. F. (2003). Developmental Biology, 7th edn. Sinauer Associates Inc., Massachusetts
8. Gross, R. T. (1979). Principles of Regeneration, Academic Press, New York
9. Gurdon, J. B. (1974). The Control of Gene Expression in animal Development, Howard University Press, New York.
10. Russo, V. E. A., Brody, S., Cove, D. and Ottolenghi, S. (1992). Development: the Molecular and Genetic Approach, Springer-Verlag, Berlin
11. Shaleesha A. Stanley (2008). Bioethics. Published by Wisdom Educational Service, Chennai.
12. Slack, J. (2001). Essential Developmental Biology, Blackwell Publishing, UK
13. Twyman, R. M. (2001). Instant Notes in Developmental Biology, Bios Scientific Publishers Ltd.,Oxford
14. Vasudeva Rao, K. (1994). Developmental Biology, a Modern Synthesis, Oxford-IBH, New Delhi
15. Wolpert, L., Beddington, R., Jessel, T., Lawrence, P., Meyerowitz, E. and Smith, J. (2002). Principles of Development, 2nd Edn, Current Biology, Oxford

ZOO 3C 14 – MICROBIOLOGY AND IMMUNOLOGY

PART A: MICROBIOLOGY

- 1. History and scope of microbiology (2 h)**
 - 1.1. Discovery of microorganisms
 - 1.2. Discovery of microbial effects on organic and inorganic matter
 - 1.3. The composition of microbial world
 - 1.4. The scope and relevance of microbiology
- 2. Microbial taxonomy (5 h)**
 - 2.1 Major characteristics
 - 2.2 Genetic analysis and molecular characteristics
 - 2.3 Numerical taxonomy
 - 2.4 Phylogenetic studies
 - 2.5 Phenetic classification and Bergey's manual
 - 2.6 The kingdom of microorganisms
- 3. Prokaryotic cell structure and function (8 h)**
 - 3.1 Plasma membrane and internal systems: Cytoplasmic matrix, Inclusion bodies, Ribosomes, Nucleoid
 - 3.2 Bacterial cell wall: Peptidoglycan structure, Gram positive and gram negative cell wall, Mechanism of Gram staining
 - 3.3 Components external to cell wall: Pili and fimbriae, Capsule and slime layers, Flagella and motility
- 4. Microbial nutrition and growth (8 h)**
 - 4.1. Common nutrient requirement.
 - 4.2. Autotrophs and heterotrophs.
 - 4.3. Culture media and types of media.
 - 4.4. Microbial growth: Growth curve, Rearrangement of microbial growth, Continuous culture of microorganisms, Influence of environmental factors on growth.
 - 4.5. Control of microorganisms using physical agents: Heat, Filtration and Radiation
 - 4.6. Control of microorganisms using chemical agents: Phenolics, Alcohols, Halogens, Quaternary ammonium compounds, Aldehydes and Sterilizing gases
 - 4.7. Detection of effect of antimicrobial agents.
- 5. Virology (5 h)**
 - 5.1. Morphology and classification of viruses.
 - 5.2. DNA viruses.
 - 5.3. RNA viruses

- 5.4. Enveloped viruses.
- 5.5. Virus-host interactions.
- 5.6. Lytic and lysogenic life cycles

6. Microbial diseases (4 h)

- 6.1. Recognition of the role of microbes in diseases.
- 6.2. Major human microbial diseases: bacterial, viral, fungal

7. Use of microbes in industry and agriculture (8 h)

- 7.1. Isolation and culture of micro-organisms
- 7.2. Production of organic compounds by microbial fermentation (ethanol, acetone, butanol, gluconic acid, etc.)
- 7.3. Production of enzymes by micro-organisms (alpha amylases, proteases, lipases)
- 7.4. Production of antibiotics by micro-organisms
- 7.5. Bioreactors (Fermenters)
- 7.6. Microbial transformations
- 7.7. Single cell proteins (SCP) from micro organisms
- 7.8. Biohydrometallurgy and biomineralization
- 7.9. Biofertilizers
- 7.10. Bioinsecticides
- 7.11. Energy and fuel using micro-organisms: Hydrogen production using hydrogenase and nitrogenase, Hydrocarbon production
- 7.12. Genetically Engineered Microbes

PART B: IMMUNOLOGY

1. Overview of immune system (3 h)

- 1.1. Types of immunity: Innate and acquired, Active and passive
- 1.2. Cells and organs of immune system: haematopoiesis, lymphoid organs
- 1.3. Cell mediated and humoral immunity

2. Antigens and MHC molecules (6 h)

- 2.1. Characteristic features of antigens and super antigens
- 2.2. Factors affecting antigenecity
- 2.3. Antigen processing and presentation- Endogenous and Exogenous pathways
- 2.4. Structure and function of Class I and II MHC molecules
- 2.5. Regulation of MHC expression

3. Antibodies and Generation of Antibody diversity (8 h)

- 3.1. Different classes: Structure and functions
- 3.2. Organization of immunoglobulin genes
- 3.3. VD (J) rearrangements
- 3.4. Expression and secretion of Immunoglobulin
- 3.5. Monoclonal antibodies and applications
- 4. Complement System (3 h)**
 - 4.1. Components of complement system
 - 4.2. Complement activation: Classical, Alternate and Lectin pathways, Formation of Membrane Attack Complex
 - 4.3. Functions of complements
- 5. Immune Effector Mechanisms (4 h)**
 - 5.1. Inflammatory cells
 - 5.2. Types of Inflammation – Acute and Chronic
 - 5.3. Cytokines and their role in immune system
 - 5.4. Properties and functions of cytokines
 - 5.5. Therapeutic applications of cytokines
- 6. Hypersensitivity reactions (3 h)**
 - 6.1. Type I, II and III hypersensitivity
 - 6.2. Delayed type hypersensitivity
- 7. Vaccines (2 h)**
 - 7.1. Principle of vaccination
 - 7.2. Different types: Live attenuated vaccines, Recombinant vaccines, Peptide vaccines, DNA vaccines.
- 8. Transplantation immunology (4 h)**
 - 8.1. Immunologic basis of graft rejection
 - 8.2. General and specific immunosuppressive therapy
 - 8.3. Transplantation antigens
- 9. Auto immunity and Immunodeficiency (3 h)**
 - 9.1. Organ specific and systemic autoimmune diseases with examples
 - 9.2. Treatment of autoimmune diseases
 - 9.3. Primary and secondary immunodeficiency diseases with examples
- 10. Antigen-Antibody interactions and applications (4 h)**
 - 10.1. Antigen – Antibody interaction: Primary and secondary
 - 10.2. Agglutination and Precipitation reactions with examples

10.3. Other diagnostic tests: ELISA, RIA, Immunoprecipitation, Immunofluorescence, Immunoelectrophoresis, FACS, Western blotting.

REFERENCES

MICROBIOLOGY

1. Arora, D. R. and Arora, B. (2008). Text Book of Microbiology. CBS Publishers and Distributors, New Delhi
2. Chakraborty, P. A. (2009). Text Book of Microbiology. New Central Book Agency. New Delhi
3. Claus, W.G. (1989). Understanding microbes: A laboratory text book for Microbiology. W.H. Freeman & Company, New York.
4. Harma, R. and Kanika, J. (2009). Manual of Microbiology Tools and Techniques. Ane Books Pvt. Ltd. New Delhi
5. Harper, D. R. (1994). Molecular virology, Bios Scientific Pub.Uk.
6. Harvey, R. A. and Champe, P. A. (2001) Microbiology, Lippincott, Williams and Wilkins.
7. Ingraham, J. L. and Ingraham, C. A. (2000). Microbiology (2ndedn). Brooks/Cole-Thomson Learning, MA,USA
8. Laning, M. Prescott, John,P. Harley and Donald A. Klein. (2008). Microbiology (7thedn). Mc Graw Hill International, NJ, USA
9. Madigan, M. T., Martinko, J. M. and Parker, J. (2000). Brock Biology of Microorganisms. Prentice Hall International, Inc.
10. McKane, L. and Kanel, J. (1996) Microbiology – Essentials and Applications (2nd Edition). Mc Graw Hill Inc. New York.
11. Pelczar, M. J. (Jr.), Chan, E. C. S. and Kreig, N. R. (1998). Microbiology, Tata McGraw Hill Inc. New York.
12. Salle, A. J. (1961) Laboratory Manual on the Fundamental Principles of Bacteriology. McGraw Hill Book. Co., New York.
13. Stainer, R., Ingraham, J., Wheelis, M. and Painter, P. (1987). General Microbiology, Macmillan Press, New York.
14. Talaro, Park, Kathelee, N and Talaro,Arthur. (2002). Foundations of Microbiology. McGraw Hill Higher Education, New York.
15. Wheelis, Mark. (2010). Principles of Modern Microbiology. Jones and Bartlett Publishers, New York.

IMMUNOLOGY

1. Adul K. Abbas and Andrew H. Lichtman (2003). Cellular and Molecular Immunology. 5th Ed. Elsevier Science, USA.
2. Chakraborty, A. K. (2006). Immunology and Immunotechnology. Oxford University Press, New Delhi

3. Collier, L. and Oxford, J. (2000). Human Virology, Oxford University Press.
4. Darla, J., Wise and Gordeon, R. Carter. (2004). Immunology- A Comprehensive Review. Iowa State University Press. A Blackwell Science Co,USA
5. David Male, Jonathan Brostoff, David Roth and Ivan Roitt. (2006). Immunology. Mosby, Edinburgh, UK
6. Goldsby, R. A., Kindt, T. J. and Osborne, B. A. (2000). Immunology.4th Ed. W.H. Freeman and Co. NY, USA.
7. Hannigan, B. M., Moore, C. B. T. and Quinn, D. G. (2010). Immunology. Viva Books, New Delhi.
8. Helen Chappel and Mased Harney. (2006). Essentials of Clinical Immunology. 5th Ed. Blackwell Scientific Publications
9. Ivan M. Roitt. (2002). Essential of Immunology. ELBS, New Delhi.
10. Janis Kuby (1997). Immunology. W. H. Freeman, New York.
11. Joshi, K. R. and Osamo N. O. (1994). Immunology. Agro Botanical Publishers, Bikaner.
12. Kenneth M. Murphy, Paul Travers and Mark Walport (2007). Janeway's Immunobiology. 7th Ed. Garland Science, New York
13. Khan. F. H. (2009). The Elements of Immunology. Pearson Education. New Delhi.
14. Kuby J. (2000). Immunology. 7th Ed. W. H. Freeman & Co. New York.
15. Peter Parham (2004). The Immune System (2nd Edition). Garland Science, New York
16. Raif Geha and Fred Rosen (2007). Case Studies in Immunology: A Clinical Companion.5th Ed. Garland Science, New York
17. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne and Janis Kuby (2003). Immunology. 5th Ed. W. H. Freeman, New York.
18. Richard, Coico and Geoffrey, Sunshine. (2009). Immunology: A short course. Wiley-Blackwell, CA, USA
19. Shetty, N. (1993). Immunology. Wiley Eastern Ltd. New Delhi.
20. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby (2007). Kuby Immunology. 6th Ed. W. H. Freeman, New York.

ZOO 3E 15 – GENERAL ENTOMOLOGY

1. Insect Morphology

(25 h)

- 1.1. Division and segmentation of body
- 1.2. Morphology of head, thorax and abdomen.
- 1.3. Mouth parts – various modifications, feeding mechanisms.
- 1.4. Antennae – structure, various types and modifications

- 1.5. Locomotion - Movement on or Through a Substrate, Walking, Jumping, Crawling and Burrowing, Movement on or Through Water, Surface Running, Swimming by means of Legs.
- 1.7 Wings – structure, venation, pteralia, wing coupling, wing movements and flight, wing modifications.
- 1.8 Sound-producing organs - Stridulatory structures in various insects, auditory tympanum.

2. Insect reproduction and development (15 h)

- 2.1. Reproductive system – morphology, structure and diversity of male and female external genitalia and genital organs.
- 2.2. Eggs – structure and adaptation.
- 2.3. General pattern of embryonic development.
- 2.4. Causal analysis of insect embryogenesis – Growth & development
- 2.5. Viviparity
- 2.6. Polyembryony, Parthenogenesis, Paedogenesis.

3. Taxonomy and biology of insects (40 h)

- 3.1. Objectives of classification
- 3.2. General classification with diagnostic features of subclasses, divisions and orders
- 3.3. Classification of orders up to and including families with diagnostic features and biology of orders, superfamilies and families (only important families):
 - 3.3.1. Collembola
 - 3.3.2. Protura
 - 3.3.3. Diplura
 - 3.3.4. Microcoryphia
 - 3.3.5. Zygentoma
 - 3.3.6. Ephemeroptera
 - 3.3.7. Odonata
 - 3.3.8. Plecoptera
 - 3.3.9. Embioptera
 - 3.3.10. Dictyoptera
 - 3.3.11. Isoptera
 - 3.3.12. Grylloblattodea
 - 3.3.13. Dermaptera
 - 3.3.14. Phasmida
 - 3.3.15. Mantophasmatodea

- 3.3.16. Orthoptera
- 3.3.17. Psocoptera.
- 3.3.18. Phthiraptera
- 3.3.19. Hemiptera
- 3.3.20. Thysanoptera
- 3.3.21. Mecoptera
- 3.3.22. Diptera
- 3.3.23. Siphonaptera
- 3.3.24. Trichoptera
- 3.3.25. Lepidoptera
- 3.3.26. Megaloptera
- 3.3.27. Raphidioptera
- 3.3.28. Neuroptera
- 3.3.29. Coleoptera
- 3.3.30. Strepsiptera
- 3.3.31. Hymenoptera

REFERENCES

1. Aswathy, V. B. (1998). Introduction to General and Applied Entomology. ISBN. Scientific Publishers, Jodhpur.
2. Borror, D. J. and DeLong, D. M. (1964). An Introduction to the Study of Insects. Holt Reineheart & Winston, New York.
3. Carde, R. T. and Bell, W. J. (1995). Chemical Ecology of Insects, 2. Chapman and Hall, New York.
4. Counce, S. J. and C. H. Waddington (1973). Developmental Systems in Insects (Vol I & II) Academic Press, New York).
5. Essig, E. O. (1974). College Entomology. Mac Millan Co. London.
6. Fox, R. M. and I. W. Fox (1964). Introduction to Comparative Entomology. Reihold & East West Press.
7. Frost, S. W. (1959). Insect life. Dover Publication Inc. New York.
8. Gillot, C. (2005). Entomology. 3rd Ed. Springer
9. Gullan, P. J. and P. Scranstone. (1994). The Insect - An Outline of Entomology. Chapman & Hall, London.
10. Haskel, P. T. (1966). Insect Behaviour. Royal Entomological Society, London.
11. Kumar, K and Weisman, F. M. (1970). Biology of Termites (Vol. I & II). Academic Press, New York.

12. Lefroy, M. (1909). Life of Indian Insects. Today & Tomorrow Printers and Publishers, New Delhi.
13. Mani, M. S. (1962). General Entomology. Oxford & IBH, New Delhi.
14. Mani, M. S. (1974). Modern Classification of Insects. Satish Book Enterprise, Agra.
15. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. (1976). General and Applied Entomology, Tata Mac Grew Hill, New Delhi.
16. Pedigo. L. P. (1996) Entomology and Pest Management. Prentice Hall India Private Limited, New Delhi.
17. Richards, O. W. and Davies, R. G. G. (1977). Imm's General Text Book of Entomology. Chapman & Hall, London.
18. Romoser, W. S. and Stoffolano, J. G. (1994). The Science of Entomology. 3rd Ed. WCB Publishers, Oxford, England
19. Snodgrass, R. E. (1935). Principles of Insect Morphology. Mac Graw Hill Book Company, Inc. USA.
20. Wigglesworth, V. B. (1964). The Life of Insects. Heidenfield & Necolson, London.
21. Wilson, E. O. (1972). The Insect Societies. Belknap. Harvard University Press.

ZOO 3E 16 INSECT PHYSIOLOGY AND BIOCHEMISTRY

- 1. Insect integument** **(7 h)**
 - 1.1. Organization of insect integument
 - 1.2. Major components of insect cuticle
 - 1.3. Moulting
 - 1.4. Sclerotisation and melanisation of insect cuticle
- 2. Digestive system** **(7 h)**
 - 2.1. General structure of alimentary canal: foregut, midgut, hindgut and their modifications
 - 2.2. Digestive enzymes and physiology of digestion
 - 2.3. Specialized digestion: Digestion of wood, keratin wax and silk, Extra-intestinal digestion
 - 2.4. Role of micro flora/ fauna in insect digestion
 - 2.5. Assimilation.
- 3. Circulatory system** **(8 h)**
 - 3.1. General structure: Heart, dorsal and ventral vessels, pulsatile organs
 - 3.2. Composition and functions of haemolymph
 - 3.3. Heart beat rate and control of heart beat
 - 3.4. Course of circulation of haemolymph
- 4. Respiratory system** **(6 h)**

- 4.1. Structure and modification of respiratory system
- 4.2. Closed and open tracheal system
- 4.3. Physical gill and plastron respiration
- 4.4. Diffusion, ventilation, control of ventilation, cyclic release of carbon dioxide
- 4.5. Respiratory pigments
- 5. Excretory system (6 h)**
 - 5.1. Malpighian tubules, Nephrorectal complex and labial glands
 - 5.2. Physiology of excretion
 - 5.3. Synthesis of uric acid and formation of excreta
- 6. Nervous system (12 h)**
 - 6.1. General structure and organization of central and peripheral nervous system
 - 6.2. Anatomy and histology of brain, ganglia and nerves
 - 6.3. Reception of stimuli and transmission of nerve impulses, transmission at synapse
 - 6.4. Sense organs – anatomy, histology and physiology of mechanoreceptors, chemoreceptors and photoreceptors.
- 7. Muscular system (5 h)**
 - 7.1 Histomorphology of insect muscles
 - 7.2 Neuromuscular junctions
 - 7.3 Excitation of muscle fibres, activation of muscle fibres, role of fast and slow axons
- 8. Fat body and Intermediary Metabolism (6 h)**
 - 8.1. Structure of fat body - anatomy, histology and development
 - 8.2. Role of fat body in storage of reserves
 - 8.3. Intermediary metabolism - Glycolysis, Glycerol phosphate shuttle, Trehalose biosynthesis
- 9. Endocrine system (7 h)**
 - 7.1 Histomorphology of neurosecretory cells and major endocrine glands (corpora cardiaca, corpora allata and prothoracic glands)
 - 7.2 Types of insect hormones and their functions
 - 7.3 Mechanisms of hormone action
- 10. Insect Toxicology (8 h)**
 - 10.1. Chemical insecticides: General classification
 - 10.2. Nerve poisons and their effects on acetyl choline esterase, membrane receptors, synapses, nerve axons
 - 10.3. Metabolic poisons
 - 10.4. Other inhibitors

10.5. Inhibitors of chitin synthesis

11. Detoxification mechanism in insects

(8 h)

11.1. Phase I reactions – mixed function oxidases, reduction, hydrolysis, epoxide hydrases, DDT dehydrochlorinase

11.2. Phase II reactions – glutathione conjugation, glucoside formation, amino acid conjugation, sulfate conjugation, other conjugations

11.3. Role of detoxification enzymes in insecticide resistance

REFERENCES

1. Annual Review of Entomology (1956 onwards). (All volumes). Annual Reviews Inc. USA.
2. Beament, J. W. L., Treherne, J. E. and Wigglesworth, V. B. (1972 onwards). Advances in Insect Physiology. Academic Press, London.
3. Blum, Murray Sheldon (Ed) (1985). Fundamentals of Insect Physiology. John Wiley & Sons
4. Bursell, E. (1970). An Introduction to Insect Physiology. Academic Press
5. Candy, D. J. and Kilby, B. A. (1975) Insect Biochemistry and Function. Chapman & Hall London
6. Chapman, R. F. (1998). The Insects: Structure and Function. 4th Edn. ELBS, London
7. Gilbert, L. I. and Kerkut, G. A. (1985). Comprehensive Insect Physiology, Biochemistry and Pharmacology Vol. 1-12.
8. Gilmour, D. (1965). The Metabolism of Insects. Oliver & Boyd. Edinburgh & London.
9. James, L. N. (2001). Insect Physiology and Biochemistry. CRC Press. London.
10. Pant N. C. and Ghai, R. (Eds) (1981). Insect Physiology and Anatomy. Indian Council of Agricultural Research, New Delhi.
11. Pathak, S. C. (Ed) (1986). Recent Advances in Insect Physiology, Morphology and Ecology. Today and Tomorrow Printers and Publishers, New Delhi.
12. Patton, R. (1963). Introductory Insect Physiology. Saunders, USA.
13. Richards, O. W. and Davies, R. G. (1977). Imm's General Text Book of Entomology. Vol. I. Chapman & Hall, London.
14. Rockstein, M. (Ed.) (1974). Physiology of Insecta Vol I - VI. Academic Press, New York.
15. Rockstein, M. (1978). Biochemistry of Insects. Academic Press, New York.
16. Roeder, K. D. (1953). Insect Physiology. Wiley, New York.
17. Simpson, Stephen (2005). Advances in Insect Physiology. Elsevier
18. Wigglesworth, V. B. (1972). Principles of Insect Physiology. Methuen, London.

ZOO 3C 17 - DEVELOPMENTAL BIOLOGY, MICROBIOLOGY & IMMUNOLOGY PRACTICAL

DEVELOPMENTAL BIOLOGY

1. Hormonal Control of Amphibian metamorphosis: Effect of thyroxine
2. Removal of blastoderm and preparation of stained whole mounts
3. Vital staining experiments on chick embryos employing the window method and tracing the development of stained parts.
4. Collection, identification and study of invertebrate/vertebrate larval forms
5. Histological preparations of stained slides of chick and amphibian embryos

REFERENCES

1. Balinsky, B. I. (1981). An introduction to Embryology 5th Ed. Holt Saunders Publ., Philadelphia.
2. Browder, L. W., Erickson, C. A. and Jeffery, R. W. (1991). Developmental Biology 3rd Ed. Saunders College Publ., Philadelphia.
3. Diwan, A. P. and Dhakad, N. K. (1995). Avian Embryology, 1st Ed. Anmol Publ. Pvt. Ltd., New Delhi.
4. Jenkin, P. M. (1970). Control of growth and metamorphosis, 1st Ed. Pergamon Press, Oxford.

MICROBIOLOGY AND IMMUNOLOGY

1. Preparation and sterilization of media
2. Preparation of broth and agar media and agar slants
3. Antibiotic sensitivity test – Disc diffusion method
4. Isolation of bacteria using pour plate method and spread plate method
5. Streak plate method for isolation of pure culture
6. Maintenance of *E. coli* culture (Shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.
7. Aseptic transfer of microorganisms
8. Staining techniques – Gram staining, spore staining
9. Motility testing using semi-solid medium and hanging drop method
10. Oxidase and Catalase tests
11. Oxidation/fermentation (O/F) test
12. Estimation of bacterial load in a given sample
13. Water quality testing using MPN coliforms
14. Biochemical estimation of fermentation food by-products

15. Microbial degradation of xenobiotic pollutants
16. Blood group determination using agglutination reaction
17. WIDAL test
18. VDRL test
19. Complement fixation test
20. Radial immunodiffusion - Mancini method
21. Double immunodiffusion - Ouchterlony method
22. Immunoelectrophoresis
23. ELISA

REFERENCES

1. Cappuccino, J. G. and Sherman, N. (2007). Microbiology: A Laboratory Manual Published by Benjamin-Cummings Publishing Company, USA.
2. Kannan, N. (2002). Lab Manual in General Microbiology. Panima Publishing Company, India.
3. Talwar, G. P. and Gupta, S. K. (2002). A handbook of practical and clinical immunobiology (2nd Edition) CBS Publishers, India.
4. Wilson, K. and Walker, J. (Eds.) (1995). Practical Biochemistry - Principles and Techniques. Cambridge University Press.

ZOO 3E 18 - GENERAL ENTOMOLOGY & INSECT PHYSIOLOGY BIOCHEMISTRY PRACTICAL

GENERAL ENTOMOLOGY

1. Dissection and display of organ systems (digestive, nervous and reproductive) of available specimens belonging to different orders.
2. Dissection of different types of mouth parts.
3. Dissection and comparison of legs of different insects.
4. Dissection of sound-producing organs of Orthopterans.
5. Preparation of whole mounts of spiracles, gills, siphons, external genital organs in different insects.
6. Preparation of whole mounts of air sac, pulsatile organs, dorsal aorta, malpighian tubules, mandibular glands, ovarioles, accessory sex glands, rectal pads/ papilla in different insect groups.
7. Preparation of keys for identification of insects up to family level (common families of Orders Orthoptera, Homoptera, Heteroptera and Coleoptera).
8. Collection and preservation of insects. {Students shall submit insects belonging to 50 families (including 10 whole mounts) at the time of practical examination}.

9. A study tour for the purpose of collecting insects belonging to different ecological niches other than local is required with a report of the field study which is to be included in the record of drawing for evaluation at the practical examination.
10. Use of Y-tube olfactometer to study responses to olfactory cues.

REFERENCES

1. Borror, D. J. and DeLong, D. M. (1964). An Introduction to the Study of Insects. Holt Rineheart & Winston, New York.
2. Pedigo, L. P (1996). Entomology & Pest Management Practice. Hall India Pvt. Ltd., New Delhi.
3. Mani, M. S. (1962). General Entomology. Oxford & IBH, New Delhi.
4. Mani, M. S. (1974). Modern Classification of Insects. Satish Book Enterprise, Agra.
5. Nair, K. K., Ananthakrishnan T. N. and David, B. V. (1976). General and Applied Entomology, Tata Mac Grew Hill, New Delhi.
6. Richards, O. W. and Davies, R .G. G. (1977). Imm's General Text Book of Entomology. Chapman & Hall, London.
7. Romoser, W. S. and Stoffolano, J. G. (1994). The Science of Entomology. 3rd Edition. WCB Publishers, Oxford, England.

INSECT PHYSIOLOGY AND BIOCHEMISTRY

1. Preparation of stained slides of insect haemolymph and identification of haemocytes.
2. Estimation of digestive carbohydrases in the alimentary canal of insect.
3. Analysis of the uptake of dye by the insect malpighian tubules.
4. Estimation of total protein in the body of insects from different orders.
5. Effect of corpora cardiaca extract on the lipid release from the fat body of insects – dose response.
6. Qualitative and quantitative estimation of total free amino acids in the haemolymph / fat body of insects from different orders.
7. Estimation of glucose content in the body of insects from different orders.
8. Estimation of amino transferase activity in the insect haemolymph.
9. Estimation of catalase activity in the insect haemolymph.
10. Preparation of stained serial section of various organs from different insects.

REFERENCES

1. Deb, A. C. (1997). Comprehensive Practical Biochemistry. New Central Book Agency, Culcutta.

2. Jayaraman, J. (1992). Laboratory Manual in Biochemistry. Wiley Eastern Ltd.
3. Osser, B. L. (1965). Hawk's Physiological Chemistry, 14th Edition. McGraw Hill Book Company, New York.
4. Plummer, D. T. (1977). An Introduction to Practical Biochemistry. Tata Mac Graw Hill, Bombay.
5. Sadasivam, S. and Manikam, A. (1992). Biochemical Methods for Agricultural Sciences. Wiley Eastern Ltd.

FOURTH SEMESTER

ZOO 4C 19 COMPULSORY PROJECT / DISSERTATION

ZOO 4E 20 AGRICULTURAL ENTOMOLOGY & ACAROLOGY

- 1. Insect Pests (4 h)**
 - 1.1. Kinds of insect pests (major and minor) - Sporadic pests, endemic pests, exotic pests, seasonal pests, occasional pests, regular pests, persistent pests.
- 2. Pest outbreak (5 h)**
 - 2.1. Causes of pest outbreak: Destruction of forests, Favourable weather conditions, Large scale monoculture practices-extensive and intensive cultivation of crops, Improved agronomic practices, Introduction of new crops, Introduction of new pests, Indiscriminate use of pesticides, Destruction of natural enemies
 - 2.2. Pest resurgence (pest flare back) and replacement (secondary pest outbreak)
 - 2.3. Causes and Management of resurgence and replacement
 - 2.4. Forecasting pest outbreaks and surveillance: Short-term and long-term forecasting, Forecasting based on observations – climatic and empirical factors.
- 3. Insect population (5 h)**
 - 3.1. Methods of assessment of insect population, Stage to be counted, nature of sample
 - 3.2. Methods of collection – net sweeping, sudden trapping, screen traps, narcotized collections, light traps, water traps, suction traps, sight counting, crop samples, emergence cages – marking and recapture
 - 3.3. Methods of sampling and number and size of samples
- 4. Estimation of damage caused by insect pests to crops (4 h)**
 - 4.1. Estimates from general observation.
 - 4.2. Estimates based on survey.
 - 4.3. Estimates from experimental plots.
 - 4.4. Other methods such as cage experiments.
- 5. Insect pests of agricultural and other economically important plants. (15 h)**
 - 5.1. Diagnosis, nature of damage and control measures of the pests of paddy, vegetables, pulses, oil seeds, fibre crops, sugarcane, fruit crops, spices and condiments, plantation crops, insect pests of stored foods and grains
- 6. Other destructive insects (5 h)**
 - 6.1. Locusts and their control – diagnosis, life history, damage, methods of control.
 - 6.2. Termites and their control – diagnosis, damage, control measures, protective measures for furniture and other wooden structures, fence, posts etc.

7. Types of insect injury to crops (6 h)
7.1. Injury by chewing insects, Injury by piercing and sucking insects- yellowing, silvering, wrinkling, curling, injury by internal feeders.

7.2. Galls – types of galls, gall formation and gall forming insects.

7.3. Role of allelochemicals in insect plant interaction.

8. Productive, useful and beneficial insects (15 h)

8.1. Honey bees, lac insects, silkworm moths.

8.2. Apiculture, sericulture, lac cultivation

8.3. Insect pollinators, dung beetles.

8.4. Other insects of use.

9. Agricultural Acarology (13 h)

9.1. Introduction

9.2. Mite pests of agricultural importance-Spider mites, false spidermites, Eriophyid mites, Tarsonemid mites.

9.3. Diagnosis, nature of damage and control measures of important mite pests of cereals, millets, pulses, vegetables, sugarcane, oil seeds and horticultural plants.

10. Beneficial mites. (8 h)

10.1. Mites as predators and parasites of insect/mite pests.

10.2. Mites as biocontrol agents of weeds.

10.3. Mites in biodegradation-direct and indirect role of mites in enhancement of soil fertility.

REFERENCES

1. Ananthkrishnan, T. N. (Ed.). (1992). Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
2. Ananthkrishnan, T. N. (1984). Biology of Gall Insects. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Apple, J. L. and Smith, R. R. (1976). Integrated Pest Management. Plenum Press, New York.
4. Atwal, A. S. (1986). Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
5. Banerjee, B. (1988). An introduction to Agricultural Acarology - Biology and control of mite pests in the tropics. S.K. Dutta Associated Publishing Co., 8798/7, Shidipura, Karolbagh, New Delhi.
6. Bucherl, W. and Buckley, E. (Eds). (1971).Venomous Animals and Their Venoms. Academic Press New York, London.
7. Claussen, C. P. (1962). Entomophagous Insects. Haner Publishing Co.,
8. David, B. V. and Ananthkrishnan, T. N. (2004). General and Applied Entomology Second Edition. Tata McGraw Hill Publishing Company Limited, New Delhi.

9. Debach, Paul (1964). *Biological Control of Insect Pests and Weeds*. Chapman & Hall.
10. Dent, D. (1991). *Insect Pest Management*, CAB International, UK.
11. Evans, G. O. (1992). *Principles of Acarology*, CAB International, U.K.
12. Gupta, S. K. (1985). *Handbook on plant mites of India*. Zoological Survey of India, Calcutta, 520pp.
13. Haq, M. A. and Ramani, N. (Eds.) (1992). *Man, mites and environment*. Anjengo publications, Calicut, 171 pp.
14. Jeppson, L. R., Keifer, H. H. and E. W. Baker, (1975). *Mites injurious to economic plants*, University of California Press, Berkeley, Los Angeles, London.
15. Kilgore, W. W. and Douthett, R. L. (1967). *Pest Control*. Academic Press, London
16. Krantz, G. W. (1978). *A manual of Acarology*, D.S.U. Book Stores, Corvallis, Oregon.
17. Lephroy, H. M. (1971). *Indian Insect Life – Today and Tomorrow's Printers*.
18. Metcalf, G. L. and W. P. Flint. (1962). *Destructive and Useful Insects, their Habits and Control*. Tata McGraw Hill Publ. Co. Ltd., New York.
19. Nayar, K. K., Ananthakrishnan, T. N. and B. V. David (1976) *General and Applied Entomology*. Tata McGraw Hill Publ.Co.Ltd., New Delhi.
20. Nair, M. R. G. K. (1975, 1996). *Insect & Mites of Crops in India*. ICAR, New Delhi
21. Pedigo, L. P. (1996). *Entomology & Pest Management Practice*. Hall India Pvt. Ltd., New Delhi.
22. Ramakrishna Ayyer, R. V. (1963). *A Handbook of Economic Entomology of South India*. Govt. of Madras publication.
23. Rao, V. P., Ghani, M. A., Sankaran, T. and Mathur, K. C. (1971). *A Review of Biological Control of Insects and other Pests in South East Asia and the Pacific Region*. CAB, England.
24. Sadana, G. L. (1985). *Plant feeding mites of India*. Kalyani Publishers, New Delhi.
25. Srivastava, K. P. (1996). *A Text Book of Applied Entomology Vol I& II*. Kalyani Publishers. Ludhiana, New Delhi.
26. Thacker, J. R. M. (2002). *An Introduction to Arthropod Pest Control*. Cambridge University Press, UK.
27. Walter, G. (2003). *Insect Pest Management and Ecological Research*, Cambridge University Press, UK.
28. Walter, D. and H. Proctor, (1999). *Mites, Ecology, Evolution and Behaviour*, CABI Publishing.
29. Yadav, P. R., Chauhan, R. Putantunda, B. N. and B. S. Chhillar (Eds.) (2002). *Mites, their identification and management*, ICAR Centre of Advanced Studies, Department of Entomology, CCS Haryana Agricultural University, Hisar.

ZOO 4E 21 – INSECT PESTS – CONTROL AND MANAGEMENT

- 1. Insect Pests (4h)**
 - 1.1. Kinds of insect pests (major and minor)- Sporadic pests, endemic pests, exotic pests, seasonal pests, occasional pests, regular pests, persistent pests
- 2. Pest outbreak (4 h)**
 - 2.1. Causes of pest outbreak
 - 2.2. Pest resurgence and replacement (secondary pest outbreak). Causes and Management of resurgence and replacement.
 - 2.3. Forecasting pest outbreak and surveillance: Short-term and long-term forecasting, Forecasting based on observations –climatic and empirical factors.
- 3. Insect pests of agricultural and other economically important plants (13 h)**
 - 3.1. Diagnosis, nature of damage, life history and control measures of important insect pests of paddy, vegetables, cotton, oilseeds, fruit crops, plantation crops
- 4. Methods of pest control (8 h)**
 - 4.1. Natural and Artificial - Physical, Mechanical, Cultural, Legal, Chemical, Biological, Microbial, Behavioural and Biotechnological.
- 5. Chemical control (10 h)**
 - 5.1. Chemical insecticides – natural, synthetic, inorganic and organic
 - 5.2. Insecticide appliances and application.
 - 5.3. Insecticide formulations.
 - 5.4. Insecticide hazards – Resistance, resurgence and residue – pesticides in the environment.
- 6. Biopesticides (4 h)**
 - 6.1. Plant based insecticides.
 - 6.2. Allelochemicals, allomones, synomons and their importance in pest control.
- 7. Principles of behavioural control (10 h)**
 - 7.1. Pheromonal considerations, orientation.
 - 7.2. Theories of orientation.
 - 7.3. Use of hormone analogues and other insect growth and behaviour regulators in insect control programmes.
 - 7.4. Use of repellants and antifeedants.
 - 7.5. Autocidal control – use of chemosterilants and radiations.
- 8. Biological control (9 h)**
 - 8.1. History and principles of biological control, ecological basis of biological control
 - 8.2. Strategies in biological control
 - 8.3. Biological control of pests-. Importance of parasitic Hymenoptera, and other parasitic insects in biological control.

8.4. Different types of parasitism, phoresy, behaviour of parasitoids.

9. Microbial control (8 h)

9.1. Bacteria, viruses, fungi – merits and demerits

10. Biological control of weeds (2 h)

10.1. Major examples of successful biological control projects

11. Pest management strategies (8 h)

11.1. Concepts of economic levels, Concepts of pest management, definition and characteristics of pest management

11.2. Pest management strategies and techniques.

11.3. Development of pest management programmes: Integrated Pest Management.

11.4. Ecological management of crop environment

11.5. Ecological backlash and its management.

REFERENCES

1. Ananthakrishnan T. N. (Ed.). (1992). Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
2. Apple J. L. and R. R. Smith. (1976). Integrated Pest Management. Plenum Press, New York.
3. Atwal. A. S. (1986). Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
4. Claussen, C. P. (1962). Entomophagous Insects. Haner Publishing Co.,
5. David, B. V. and Ananthakrishnan, T. N. (2004). General and Applied Entomology Second Edition. Tata McGraw Hill Publishing Company Limited, New Delhi.
6. Debach, Paul (1964). Biological Control of Insect Pests and Weeds. Chapman & Hall.
7. Dennis S. Hill (1993). Agricultural insect pests of the Tropics and their control, 2nd Edition, Foundation Books, New Delhi.
8. Dent, D. (1991). Insect Pest Management, CAB International, UK.
9. Hall, F. R. and Menn, J. J. (1999). Biopesticides: Use and delivery. 3rd Edition, Totowa, Humana Press.
10. Kilgore, W. W. and Douth, R. L. (1967). Pest control. Academic Press.
11. Metcalf. G. L. and Flint, W. P. (1962). Destructive and Useful Insects, their Habits and Control. Tata McGraw Hill Publ.Co.Ltd., New York.
12. Nayar. K. K., Ananthakrishnan, T. N., and David, B. V. (1976). General and Applied Entomology. Tata McGraw Hill Publ.Co.Ltd., New Delhi.
13. Pedigo, L. P. (1996). Entomology & Pest Management Practice. Hall India Pvt. Ltd., New Delhi.

14. Ramakrishna Ayyer, R. V. (1963). A Handbook of Economic Entomology of South India. Govt.of Madras publication.
15. Rao, V. P., Ghani, M. A., Sankaran, T. and Mathur, K. C. (1971). A Review of Biological Control of Insects and other Pests in South East Asia and the Pacific Region. CAB, England.
16. Srivastava, K. P. (1996). A Text Book of Applied Entomology Vol I& II. Kalyani Publishers. Ludhiana, New Delhi.
17. Thacker, J. R. M. (2002). An Introduction to Arthropod Pest Control. Cambridge University Press, UK.
18. Walter, G. (2003). Insect Pest Management and Ecological Research, Cambridge University Press, UK.

ZOO 4E 22 – ECOLOGY & ETHOLOGY OF INSECTS

- 1. Scope of Insect Ecology and Ethology (3 h)**
- 2. Multitrophic interactions (10 h)**
 - 2.1 The trophic level concept
 - 2.2 Plant characteristics that effect enemy-prey interactions: Secondary metabolites, Nutritional resources, Morphology
 - 2.3 Intraguild predation
 - 2.4 Trophic cascades
- 3. Herbivory (10 h)**
 - 3.1 Types and Patterns of Herbivory: Herbivore Functional Groups, Measurement of Herbivory, Spatial and Temporal Patterns of Herbivory
 - 3.2 Effects of Herbivory: Plant Productivity, Survival and Growth Form, Community Dynamics, Water and Nutrient Fluxes
- 4. Pollination (9 h)**
 - 4.1 Types and Patterns of Pollination: Pollinator Functional Groups, Measurement of Pollination, Spatial and Temporal Patterns of Pollination
 - 4.2 Effects of Pollination
 - 4.3 Floral scent, olfaction, and scent-driven foraging behaviour
- 5. Seed Predation and Seed Dispersal (8 h)**
 - 5.1 Types and Patterns of Seed Predation and Dispersal: Seed Predator and Disperser Functional Groups, Measurement of Seed Predation and Dispersal, Spatial and Temporal Patterns of Seed Predation and Dispersal
 - 5.2 Effects of Seed Predation and Dispersal
- 6. Pheromone-mediated communication in parasitoids (10 h)**

- 6.1 Pheromones and sexual behavior: Volatile sex attractants, Female-derived courtship pheromones, Male-derived courtship pheromones, Marking pheromones, Putative alarm and appeasement pheromones, Aggregation pheromones, Anti-aggregation pheromones

7. Insect dispersal and migration (7 h)

- 7.1 Factors Affecting Dispersal Behaviour: Life History Strategy, Crowding, Nutritional Status, Habitat and Resource Conditions, Mechanism of Dispersal
- 7.2 Insect invasions

8. Chemical ecology of insect natural enemies (7 h)

- 8.1 Essential elements in parasitoid chemical ecology
- 8.2 Manipulation of the population levels of natural enemies by semiochemicals
- 8.3 Recruitment of predators and parasitoids by herbivore-injured plants
- 8.4 The use of synthetic HIPVs in pest management
- 8.5 Arthropod pest management strategies used in organic farming

9. Behavioural Ecology (7 h)

- 9.1 Patterns of behaviour
- 9.2 Mating and courtship
- 9.3 Oviposition strategies in terrestrial and aquatic insects
- 9.4 Food finding mechanism
- 9.5 Evolution of feeding behaviour

10. Introduction to Insect Diversity Conservation (9 h)

- 10.1 Ethical foundation for insect conservation;
- 10.2 Mapping, inventorying, and monitoring insect diversity;
- 10.3 Insects and the conservation of ecosystem processes;
- 10.4 Insects and the Climate Change: Process patterns and implications for Conservation
- 10.5 Responses by insects to changes in land use, degradation and fragmentation of Ecosystems
- 10.6 Conserving and Managing Insect Diversity: Methods, approaches, and Prioritization
- 10.7 Impediments in insect conservation
- 10.8 Insects for food security, livelihood and Environment

REFERENCES

1. Arnold van Huis, Joost Van Itterbeeck, Harmke Klunder, Esther Mertens, Afton Halloran, Giulia Muir and Paul Vantomme (2013). Edible insects: future prospects for food and feed security. FAO Forestry Paper No 171. Food and agricultural Research Organisation, Rome. (ISBN 978-92-5-107595-1 (print), E-ISBN 978-92-5-107596-8)
2. Brian, Morris (2004). Insects and Human Life Pub. Berg, oxford, New York

3. Colwell, Robert K. and Jonathan A. Coddington, (1994). Estimating Terrestrial Biodiversity through Extrapolation. *Phil. Trans. R. Soc. Lond. B* 29 July 1994 vol. 345 no. 1311 101-118.
4. Eric, Wajnberg and Stefano, Colazza (1994). *Chemical Ecology of Insect Parasitoids*. Wiley-Blackwell
5. Éric, Wajnberg, Carlos, Bernstein and Jacques, van Alphen (2008). *Behavioral Ecology of Insect Parasitoids: From Theoretical Approaches to Field Applications*. Blackwell publishing
6. Hodkinson, I. D. and Hughes, M. K. (1982). *InsectHerbivory*. Chapman and Hall, London New York
7. Ke, Chung Kim (1993). Biodiversity, Conservation and Inventory: why insects matter. *Biodiversity & Conservation*, Volume 2, Issue 3, pp 191-214.
8. Lars, Chittka and James, D. Thomson (2004). *Cognitive Ecology of Pollination: Animal Behavior and Floral Evolution*. Edited by pp. 344.
9. Martin, R. Speight, Mark, D., Hunter Allan D. Watt (2008). *Ecology of Insects: Concepts and Applications*. Wiley- Blackwell
10. Morris, Rebecca J. (2010). Anthropogenic impacts on tropical forest biodiversity: a network structure and ecosystem functioning perspective. *Phil. Trans. R. Soc. B* 27 November 2010 vol. 365 no. 1558 3709-3718.
11. Pedro Cardoso, Terry L. Erwin, Paulo A.V. Borges, Tim R. New, (2011). The Seven Impediments in Invertebrate Conservation and How to Overcome them. *Biological Conservation* 144 (2011) 2647–2655.
12. Peter W. Price, Robert F. Denno, Micky D. Eubanks, Deborah L. Finke and Ian Kaplan (2011). *Insect Ecology: Behavior, Populations and Communities*. Cambridge University Press.
13. Ring T. Card E. and Jocelyn G. Millar (2004). *Advances in Insect Chemical Ecology*. Cambridge University Press.
14. Samways, Michael J. (1994). *Insect Conservation Biology*, Chapman & Hall
15. Samways, Michael J. (1993). Insects in biodiversity conservation: some perspectives and directives. *Biodiversity and Conservation*, Volume 2, Issue 3, pp 258-282.
16. Samways, Michael J. (2005). *Insect Diversity Conservation*, Cambridge University Press, UK 342pp. ISBN 0-521-78338-0, ISBN 0-521-78947-8.
17. Schoonhoven, L. M., Loon, J. A. V. and Dicke, M. (2005). *Insect-Plant Biology*. 2nd Ed. Oxford Press
18. Stewart, Alan J. A., New, T. R. and Lewis, O. T. (2007). *Insect Conservation Biology: Proceedings of the Royal Entomological Society's 23rd Symposium*. The Royal Entomological Society, UK. Pp.457 (ISBN 978-1-84593-254-1).
19. Timothy, D. Schowalter (2011). *Insect Ecology: An Ecosystem Approach* (2011) 3rd Ed. Elsevier Publication

ZOO 4E 23 – MEDICAL, VETERINARY AND FORENSIC ENTOMOLOGY

1. Medical Entomology

(30 h)

- 1.1. Introduction – History, definition, objectives, training; importance of insects as vectors, feeding mechanisms and modifications of insect mouth parts.
- 1.2. Evolution of tissue feeding and pathogen transfer by insects
- 1.3. Origin of parasitism.
- 1.4. Adaptations of vectors: Morphological, Reproductive and Biochemical.
- 1.5. Biology of important vectors: Mosquitoes, Simuliids, Ceratopogonids, Tabanids, Fleas, Tsetse flies, Syrphids, Chloropids, Houseflies, Bird lice, Head lice and Body lice
- 1.6. Diagnostic and clinical features and epidemiology of various arthropod-borne diseases: Malaria, filariasis, dengue fever, Japanese encephalitis, yellow fever, chickungunya, trypanosomiasis, plague, typhus, pink eye disease and onchocerciasis.
- 1.7. Other insects of medical importance – bugs, bees, ants, wasps, lepidopterans and beetles. Clinical features of their bites and stings; treatment.

2. Veterinary Entomology

(25 h)

- 2.1. Introduction – Insects as vectors of animal diseases
- 2.2. Insect groups of veterinary importance
- 2.3. Taxonomy and Biology of insects of veterinary importance: Lice, Tabanids, Hippoboscids, Calliphorids, Sarcophagids, Stomoxydidae, Oestridae, Pulicidae
- 2.4. Important diseases of domestic animals – clinical features, treatment.
- 2.5. Myiasis – definition, insects causing myiasis, different types of myiasis and treatment

3. Forensic Entomology

(25 h)

- 3.1. Introduction: Insects of forensic importance
- 3.2. Insects as tools in forensic science.
- 3.3. Crime detection using entomological science.
- 3.4. Taxonomy & Biology of forensically important insects
 - 3.4.1. Coleoptera – General characters, taxonomy and biology of Silphidae (carrion beetles), Staphylinidae (rove beetles), Histeridae (clown beetles), Dermestidae (hide & skin beetles).
 - 3.4.2. Diptera - General characters, taxonomy and biology of Calliphoridae, Sarcophagidae, Phoridae, Muscidae, Fannidae.
- 3.5. Ecology of forensically important flies and beetles
- 3.6. DNA techniques in forensic entomology

REFERENCES

1. Apple, J. L. and Smith, R. R. (1976). Integrated Pest Management. Plenum Press, New York.
2. Bucherl, W. and Buckley, E. (Eds). (1971). Venomous Animals and Their Venoms. Academic Press New York, London.
3. Byrd, J. H. and Castner, J. L. (Eds.) (2000). Forensic Entomology: The utility of arthropods in legal investigations, CRC Press
4. Dent, D. (1991). Insect Pest Management, CAB International, UK.
5. James, M. T. and Harwood R. F. (1969). Herms' Medical Entomology. Macmillan Company-Collier Macmillan Ltd., London.
6. Kettle, D. S. (1995). Medical and Veterinary Entomology. CAB International.
7. Kilgore, W. W. and Douth, R. L. (1967). Pest control. Academic Press.
8. Metcalf, G. L. and W. P. Flint (1962). Destructive and Useful Insects, their Habits and Control. Tata McGraw Hill Publ.Co.Ltd., New York.
9. Mullen, G. and Durden, L. (2002). Medical and Veterinary Entomology. Academic Press
10. Patton, W. S. and Crag, F. N. (1973). A Textbook of Medical Entomology. International Books and Periodicals, New Delhi.
11. Pedigo, L. P. (1996). Entomology & Pest Management Practice. Hall India Pvt. Ltd., New Delhi.
12. Ramakrishna Ayyer, R. V. (1963). A Handbook of Economic Entomology of South India. Govt.of Madras publication.
13. Smith, K. V. G. (1986). A Manual of Forensic Entomology. British Museum Natural History.
14. Srivastava, K. P. (1996). A Text Book of Applied Entomology Vol I & II. Kalyani Publishers. Ludhiana, New Delhi.
15. Thacker, J. R. M. (2002) An Introduction to Arthropod Pest Control. Cambridge University Press, UK.
16. Wall, Richard and Shearer, David (1998) Veterinary Entomology, Chapman & Hall.
17. Walter, G. (2003) Insect Pest Management and Ecological Research, Cambridge University Press, UK.
18. Williams, R. E., Hall. R. D., Brece, A. B. and School, P. J. (1985). Livestock Entomology. Wiley Interscience Publication, USA.
19. Yazdani, S. S. and Agarwal, M. L. (1997). Elements of Insect Ecology. Narosa Publishing House, New Delhi.

ZOO 4E 24 AGRICULTURAL ENTOMOLOGY & ACAROLGY PRACTICAL

1. Collection, identification and preservation of pests of local crops. The collection should include a minimum of 25 crop pests. The collection has to be submitted during the practical examination.

2. Preparation and submission of wet collections of pest damaged portions of crop plants (at least 5 collections are to be submitted for examination).
3. Preparation of dichotomous keys to any 5 species of insect pests.
4. Study of salient features of any 10 major insect pests.
5. Study of life histories of insect pests (at least two) and the damages caused by them.
6. Study of stained sections of normal and galled leaves.
7. Morphological description of any one species of insect pests.
8. Collection, preservation and preparation of slide mount of 5 species of mite pests.
9. Preparation of dichotomous key to any 5 species of major mite pests.

REFERENCES

1. Atwal, A. S. (1986). *Agricultural Pests of India and South East Asia*. Kalyani Publishers, Ludhiana.
2. Banerjee, B. (1988). *An introduction to Agricultural Acarology - Biology and control of mite pests in the tropics*. S.K. Dutta Associated Publishing Co., 8798/7, Shidipura, Karolbagh, New Delhi.
3. Gupta, S. K. (1985). *Handbook on plant mites of India*. Zoological Survey of India, Calcutta, 520pp.
4. Jeppson, L. R., Keifer, H. H. and Baker, E. W. (1975). *Mites injurious to economic plants*, University of California Press, Berkeley, Los Angeles, London.
5. Lephroy, H. M. (1971). *Indian Insect Life – Today and Tomorrow’s Printers*.
6. Metcalf, G. L. and W. P. Flint. (1962). *Destructive and Useful Insects, their Habits and Control*. Tata McGraw Hill Publication Co.Ltd., New York.
7. Nayar, K. K., Ananthakrishnan, T. N., and David, B. V. (1976). *General and Applied Entomology*. Tata McGraw Hill Publ.Co.Ltd., New Delhi.
8. Nair, M. R. G. K. (1975; 1996). *Insect & Mites of Crops in India*. ICAR, New Delhi
9. Ramakrishna Ayyer, R. V. (1963). *A Handbook of Economic Entomology of South India*. Govt.of Madras publication.
10. Srivastava, K. P. (1996). *A Text Book of Applied Entomology Vol. I & II*. Kalyani Publishers. Ludhiana, New Delhi.
11. Yadav, P. R., Chauhan, R. Putantunda, B. N. and Chhillar, B. S. (Eds.) (2002). *Mites, their identification and management*, ICAR Centre of Advanced Studies, Department of Entomology, CCS Haryana Agricultural University, Hisar.

ZOO 4E 25 INSECT PESTS – CONTROL AND MANAGEMENT PRACTICAL

1. Collection, identification and preservation of pests of local crops. The collection should include a minimum of 20 pests and has to be submitted during practical examination.
2. Study of external morphology of at least two economically important parasitoids.

3. Study of various insecticides (Natural and synthetic) and their mode of action on their target pests.
4. Study of various insecticide appliances and their applications in the field.
5. Whole mount preparation of at least 10 insect pests of agricultural/medical/ veterinary importance
6. Role of IGRs and their influence in the morphology of pest.
7. Study of life histories of insect pests (at least two) and the damage caused.
8. Visit to an organic farm and the report on activities is to be included in the record and has to be submitted during practical examination.

REFERENCES

1. Atwal, A. S. (1988). Agricultural pests of India and South East Asia. Kalyani Publishers, New Delhi.
2. Kettle, D. S. (1995). Medical and veterinary Entomology. CAB International.
3. Mike, Service (2008). Medical Entomology for students, 4th Edition. Cambridge University Press, U.K.
4. Narendran, T. C. (1994). Parasitic Hymenoptera. Interline Publ.
5. Thacker, J. R. M. (2002). An introduction to Arthropod pest control. Cambridge University Press, U.K.
6. Tonapi, G. T. (1994). Experimental Entomology- An aid to field and laboratory, New Delhi.
7. Trigunayat, M. M. (2002). A Manual of practical Entomology. Scientific Pulbl., Jodhpur

ZOO 4E 26 ECOLOGY & ETHOLOGY OF INSECTS PRACTICAL

1. Study of courtship and mating behaviour in insects
2. Managing pheromone traps
3. Setting up and collection of insects with Malaise trap, Pitfall traps, Light trap, Sweep net, Yellow pan trap
4. Insect culture methods (Hosts, parasitoids and predators)
5. Field observation on insect pollination on any focal plant
6. Dissection and display of pollen gathering apparatus in hymenopterans
7. Use of Y-tube olfactometer to study responses to olfactory cues in insects
8. Feeding preference studies in some common pests

REFERENCES

1. Bonnie, J. Ploger and Ken, Yasukawa (Eds.) (2003). Exploring Animal Behaviour in laboratory and field. Academic press.

2. Éric, Wajnberg, Carlos, Bernstein and Jacques van Alphen (2008). Behavioral Ecology of Insect Parasitoids: From Theoretical Approaches to Field Applications. Blackwell Publishing Ltd.
3. Gullan, P. J. and Cranston, P. S. (2004). The Insects: An outline of Entomology, 3rd dition. Blackwell Science, Malden, Massachusetts.
4. Hodkinson I. D. and Hughes, M. K. (1982). Insect Herbivory. Chapman and Hall, London New York
5. Lars, Chittka and James D. Thomson (2004) Cognitive Ecology of Pollination: Animal Behavior and Floral Evolution. Edited by pp. 344.
6. Martin, R., Speight, Mark D., Hunter, Allan and Watt, D. (2008) Ecology of Insects: Concepts and Applications. Wiley- Blackwell
7. Schoonhoven, L. M., Loon, J. J. A. and Dicke, M. (2005). Insect – Plant Biology, 2nd edition. Oxford Press, New York.
8. Southwood, T. R. E. and Henderson, P. A. (2000). Ecological Methods, 3rd Edition. Blackwell Publishing Ltd.

ZOO 4E 27 MEDICAL, VETERINARY, FORENSIC ENTOMOLOGY PRACTICAL

1. Preparation of keys for the identification of major species of mosquitoes
2. Collection and identification of eggs/larvae of mosquitoes (Genus level).
3. Mounting of mouth parts of blood feeding insects.
4. Collection of insects associated with carcasses. Write brief write-ups of the different life stages of these insects
5. Dichotomous keys for the identification of families belonging to the orders : Coleoptera and Diptera.
6. Population density studies (mosquitoes/houseflies/Tabanids)
7. Preparation of whole mounts of animal ectoparasites.
8. Students are required to submit a collection of a minimum of 25 specimens of medical/veterinary/forensically important arthropods

REFERENCES

1. Borror, D. J. and DeLong, D. M. (1964). An Introduction to the Study of Insects. Holt Reineheart & Winston, New York.
2. Gennard, D. E. (2007) Forensic Entomology – An Introduction. John Wiley.
3. Richards, O. W. and Davies, R. G. G. (1977). Imm's General Text Book of Entomology. Chapman & Hall, London.
4. Wall, Richard and Shearer, David (1998). Veterinary Entomology, Chapman & Hall. London.

Model Question Papers

FIRST SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2015

(CCSS)

APPLIED ZOOLOGY

ZOO 1C 01 – BIOCHEMISTRY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following:

(2 X 15 = 30 marks)

1. Glycolysis and its regulation.
2. Kinetics and regulation of Enzyme action.
3. Role of B-complex vitamins.
4. Fatty acid oxidation

II. Write short essays on any *THREE* of the following:

(3 X 10 = 30 marks)

5. Separation and purification of proteins
6. Regulation of glycogen synthesis and degradation.
7. Role of ATP as a free energy carrier.
8. Sequencing of DNA.
9. Prostaglandins

III. Write short notes on any *FIVE* of the following:

(5 X 4 = 20 marks)

10. Isozymes.
11. Ribozymes.
12. Chemiosmotic hypothesis.
13. Buffers
14. Enthalpy
15. Vitamin E
16. Disaccharides
17. Transamination

FIRST SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2015

(CCSS)

APPLIED ZOOLOGY

ZOO 1C 02 – BIOPHYSICS & BIostatISTICS

Time: Three Hours

Maximum: 80 Marks

Part A - Biophysics

I. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

1. Explain the principle, procedure and application of UV spectroscopy.
2. General account of electrophoresis.

II. Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)

3. Magnetic resonance imaging.
4. Affinity chromatography.
5. Liquid scintillation counter and its applications.
6. Immuno fluorescence microscopy.

III. Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)

7. X-Ray diffraction.
8. EEG.
9. Fick's law and diffusion coefficient.
10. HPLC.
11. Electro osmosis.

Part B - Biostatistics

IV. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

12. One-way and two-way classification of ANOVA.
13. Properties of normal distribution and fitting of normal curves.

V. Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)

14. Write a brief account on mathematical methods of correlation.
15. Mention the role of biostatistics in modern research.
16. Chi square test.
17. What is sampling. Add a note on the methods of sampling.

VI. Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)

18. Attributes
19. Quartile deviation
20. Skewness
21. Degree of freedom
22. Type I and Type II error

FIRST SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2015

(CCSS)

APPLIED ZOOLOGY

ZOO 1C 03 – BIOSPHERE ECOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Importance of coral reefs, threats faced by the coral reefs and conservation strategies.
2. With proper illustration elaborate on the different models of energy flow
3. Global warming and its impacts
4. Write an essay on cleaner technologies in waste management

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Habitat fragmentation and its impact
6. Ecological applications of remote sensing
7. Sustainable development
8. Ecological impact of genetically modified crops
9. Environmental Impact Assessment

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Conservation tillage
11. Vermicomposting
12. Types of life table
13. Metapopulation
14. r and k selection
15. Biofilters
16. Simulation model
17. Species 2000

FIRST SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2015

(CCSS)

APPLIED ZOOLOGY

ZOO 1C 04 - SYSTEMATICS AND ANIMAL BEHAVIOUR

Time: Three Hours

Maximum: 80 Marks

Part A – SYSTEMATICS

I. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

1. Different kinds of taxonomic characters used in the discrimination of taxa.
2. International Code of Zoological nomenclature and the rules for naming taxa.

II. Write short essays on any *TWO* of the following: (2 X 10 = 20 marks)

3. History of taxonomy
4. Taxonomic procedures
5. Types of Zoological classification
6. Taxonomic key

III. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

7. Taxonomic publications
8. Cladistics
9. Types of classification
10. Molecular systematics
11. Chemotaxonomy
12. Phonetic classification
13. Alpha taxonomy

Part B – ANIMAL BEHAVIOUR

IV. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

14. Give an account how hormones influence behavior and the factors influencing hormonal effects on behaviour.
15. Discuss how genes and environment influence behaviour .

V. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

16. Lee Boot effect and Whitten effect
17. Brief account of altruism
18. Stimulus filtering
19. Give examples of experimental origin to demonstrate genetic basis of behaviour
20. Brief account of neural basis of behaviour
21. Imprinting
22. Circadian rhythm

SECOND SEMESTER M. Sc. DEGREE EXAMINATION, JULY 2015

APPLIED ZOOLOGY (CCSS)

ZOO 2C 07 – CYTOGENETICS & EVOLUTION

Time: Three Hours

Maximum: 80 Marks

Part A - Cytogenetics

I. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

1. Transposons in bacteria
2. Apoptosis in *Caenorhabditis elegans* and the genes involved in it

II. Write short essays on any *TWO* of the following: (2 X 10 = 20 marks)

3. Signal transduction
4. Neurotransmission and its regulation
5. Extrachromosomal inheritance
6. Cytological basis of crossing over

III. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

7. Mutation
8. P elements
9. Down's syndrome
10. Ploidy
11. Co-dominance
12. Euchromatin
13. cAMP
14. Linkage

Part B - Evolution

IV. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

15. Molecular divergence in evolution and molecular clocks
16. Stages in human evolution

V. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

17. Genetic drift
18. Adaptive radiation
19. Hardy-Weinberg equilibrium
20. Neutral hypothesis
21. Speciation
22. Natural selection
23. Co-evolution

SECOND SEMESTER M. Sc. DEGREE EXAMINATION, JULY 2015

APPLIED ZOOLOGY (CCSS)

ZOO 2C 08 – MOLECULAR BIOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Models of DNA replication and Enzymes associated with DNA replication.
2. Transcriptional regulation of gene expression
3. DNA repair mechanism and Importance of DNA repair.
4. Characteristic features of Genetic code.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Gene therapy.
6. RNA Splicing.
7. Organelle genomes.
8. Interrupted genes.
9. SOS response.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Promoter
11. Wobble hypothesis
12. Pseudogenes.
13. Replicons
14. Telomere.
15. Restriction endonucleases
16. Okazaki fragments
17. Antisense RNA.

SECOND SEMESTER M. Sc. DEGREE EXAMINATION, JULY 2015
APPLIED ZOOLOGY (CCSS)
ZOO 2C 09 – BIOTECHNOLOGY & BIOINFORMATICS

Time: Three Hours

Maximum: 80 Marks

- I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)**
1. Distinguish different types of blotting procedures
 2. Genotyping techniques and its applications
 3. Hybridoma technology, production and uses of monoclonal antibodies
 4. Patenting of biological forms
- II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)**
5. Applications of bioinformatics tools in phylogenetic analysis
 6. Cloning vectors
 7. Polymerase Chain Reaction
 8. Molecular probes in hybridization
 9. Transgenic systems
- III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)**
10. Real time PCR
 11. Intellectual Property Rights
 12. BLAST
 13. Chimeric DNA
 14. DNA fingerprinting
 15. Expression vectors
 16. Reporter genes
 17. Dot and Slot blots

SECOND SEMESTER M. Sc. DEGREE EXAMINATION, JULY 2015

(CCSS)

APPLIED ZOOLOGY

ZOO 2C 10 – ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following:

(2 X 15 = 30 marks)

1. Describe endocrine disruptors in the environment
2. Explain blood buffering and gas transport
3. Mechanism of urine formation, tubular reabsorption, secretion and counter current.
4. Describe ultra-structure and functional mechanism of skeletal muscle.

II. Write short essays on any *THREE* of the following:

(3 X 10 = 30 marks)

5. Placental circulation.
6. Hormones as signal transducers
7. Role of hormones in developmental process
8. Allometric and isometric scaling.
9. Myocardial infarction.

III. Write short notes on any *FIVE* of the following:

(5 X 4 = 20 marks)

10. Anorexia
11. Regulation of hormone secretion
12. Parkinson's disease
13. Blood brain barrier.
14. Surfactants
15. Role of pituitary and pineal body in chromatophores expression
16. Hormones in behaviour of animals
17. Kidney stones

THIRD SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2016
(CCSS)

APPLIED ZOOLOGY

ZOO 3C 13 – DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Discuss the role of hormones and senescence genes in cellular ageing.
2. Give an account of gamete specific gene expression and factors controlling oogenesis
3. Morphogenetic movements
4. Describe types of cleavage and associated chemical changes

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Cell position and gradients in development
6. Mesodermal induction
7. Explain the theories on animal ethics
8. Physiological aspects of fertilization
9. Proximate cell interactions

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Regulative development
11. Mesodermal induction
12. Xenobiotics
13. Specism
14. Human Animal repression
15. Epimorphic regeneration
16. Embryonic stem cells
17. IVF

THIRD SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2016

(CCSS)

APPLIED ZOOLOGY

ZOO 3C 14 – MICROBIOLOGY AND IMMUNOLOGY

Time: Three Hours

Maximum: 80 Marks

Part A - Microbiology

I. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

1. The structure of prokaryotic cell wall and mechanism of Gram staining.
2. Describe the control of microorganisms using physical and chemical agents.

II. Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)

3. Influence of environmental factors on microbial growth.
4. Microbial growth and food spoilage.
5. Major types of culture media.
6. Uses of microbes in agriculture.

III. Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)

7. Pasteurization.
8. Numerical taxonomy.
9. Fermented foods.
10. Capsules and slime layers.
11. Reproduction in animal viruses

Part B - Immunology

IV. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

12. Complement activation pathways.
13. Structure and functions of immunoglobulin.

V. Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)

14. Hypersensitivity reactions.
15. Monoclonal antibodies and applications.
16. Autoimmune diseases.
17. MHC molecules.

VI. Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)

18. ELISA
19. Vaccines and vaccination.
20. VD(J) rearrangements.
21. Primary lymphoid organs.
22. Cytokines

THIRD SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2016

(CCSS)

APPLIED ZOOLOGY

ZOO 3E 15 – GENERAL ENTOMOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Write an essay on general structure and modifications of insect mouthparts with appropriate diagrams
2. Giving diagnostic features classify the order Embioptera
3. Sound producing mechanisms in insects
4. With suitable diagrams give an account of diversity of external reproductive organs in insects

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Wing coupling mechanism
6. Types of antennae
7. Give diagnostic characters of five families of Order Coleoptera
8. Give an account of diversity of wing venation in Order Hymenoptera
9. Insect embryogenesis

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Jumping apparatus in Collembola
11. Parthenogenesis
12. Give a brief account of objectives of classification
13. Modifications for predatory forms of life in Mantoidea
14. Economic importance of family Scarabaeidae
15. Secondary segmentation
16. Adaptations in insect eggs
17. Characteristics of Order Phasmida

THIRD SEMESTER M. Sc. DEGREE EXAMINATION, JANUARY 2016

(CCSS)

APPLIED ZOOLOGY

ZOO 3E 16 - INSECT BIOCHEMISTRY AND PHYSIOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Explain the mechanism of detoxification in insects.
2. Describe the composition and biochemistry of insect cuticle.
3. Write an essay on insect hormones and their role.
4. Structure and physiology of insect photoreceptors.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Insect haemocytes and their functions.
6. Digestive enzymes in insects.
7. Moulting and sclerotization in insects.
8. Describe the significance of insect fat body.
9. Physiology of insect muscles.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Physical gill and plastron respiration.
11. Insect chemoreceptors.
12. Glycerol phosphate shuttle.
13. Slow and fast axons.
14. Acetyl cholinesterase inhibitors.
15. Extra intestinal digestion.
16. Insect excretion.
17. Metabolic poisons.

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APPLIED ZOOLOGY

ZOO 4E 20- AGRICULTURAL ENTOMOLOGY & ACAROLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Reasons and remedies for insect pest upset.
2. Biology and management of important insect pests of paddy in India.
3. Important groups of phytophagous mites.
4. Types of honey bee and methods in bee keeping.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Factors governing insect pest outbreaks.
6. Techniques in insect pests damage assessment.
7. Important borer pests of vegetables.
8. Types of insect damage to plants.
9. Damage caused by termites and control measures.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Sericulture.
11. Plant galls and insects.
12. Role of mites in biodegradation.
13. Insect pollinators.
14. Classification of insect pests based on occurrence.
15. Lac insect.
16. Predatory mites.
17. Light trap.

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APPLIED ZOOLOGY
ZOO 4E 21 – INSECT PESTS – CONTROL AND MANAGEMENT

Time: 3 hours

Maximum: 80 marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Illustrate strategies in biological control and importance of parasitic insects.
2. Give an account of microbial formulations for control of insect pests.
3. Concepts of pest management and characteristics of pest management.
4. Write an account on pest resurgence, replacement and the management of these.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Forecast of pest outbreak.
6. Behavioral manipulation of insect pest for the pest control programme.
7. Different strategies of pest management.
8. List out five major insect pests of oilseeds, its bionomics, damage & control measures.
9. Chemical insecticides, formulations & its hazards.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Ecological backlash
11. Repellents
12. Plant based insecticides
13. Antifeedants
14. Chemosterilents
15. Vegetable pests
16. Causes of pest outbreak
17. Kinds of insect pests

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(CCSS)

APPLIED ZOOLOGY

ZOO 4E 22 – ECOLOGY AND ETHOLOGY OF INSECTS

Time: 3 hours

Maximum: 80 marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. With suitable examples give an account pheromones mediated communication in parasitoids
2. Comment on nitrogenous and non-nitrogenous defense in plants
3. Give an account of pollination in plants
4. Write an essay on food finding mechanism in insects

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Effects of herbivory
6. Role of HIPVs in recruitment of insect natural enemies
7. Mechanism of seed dispersal and advantages
8. Oviposition strategies in terrestrial and aquatic insects
9. Factors affecting insect dispersal

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Intraguild predation
11. Insect response to fragmentation of ecosystems
12. Ethics in insect conservation
13. Pest management strategies used in organic farming
14. Pitfall trap
15. Chemicals influencing feeding behaviour
16. Invasive insects
17. Trophic cascades

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APPLIED ZOOLOGY

ZOO 3E 23 – MEDICAL, VETERINARY & FORENSIC ENTOMOLOGY

Time: Three Hours

Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Explain epidemiology, clinical aspects and treatment of malaria.
2. Methods in control of mosquitoes
3. Morphological adaptations of insect vector
4. DNA techniques in forensic entomology

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Treatment and preventive measures of Trypanosomiasis
6. Explain the use of insects as tools in forensic science
7. Insects of veterinary importance
8. Describe the taxonomy and biology of Tabanids
9. Different types of Myiasis and its treatment.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Mechanical and biological vectors
11. Microfilariae
12. Dengue fever
13. Pink eye disease
14. Sleeping sickness
15. Japanese encephalitis
16. Maggot therapy
17. Pharmacological aspects of insect toxins