University of Pune

Two Year M.Sc. Degree Course in

Zoology

M.Sc. Zoology

(Credit and Semester based Syllabus to be implemented from Academic Year 2013-14)

1) Title of the Course:

M.Sc. Zoology

2) Preamble of the Syllabus:

Master of Science (M.Sc.) in Zoology is a post graduation course of University of Pune. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

The students pursuing this course would have to develop in depth understanding various aspects of the subject. The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Genetics and Cell Biology, Biochemistry, Molecular Biology, Biostatistics, Bacterial and Phage technology, Biodiversity ,Entomology, Physiology, Developmental Biology, Endocrinology, Biochemical Techniques, Animal tissue culture, etc.

3) Introduction:

Salient Features of the Credit System:

1. Master's degree course in Zoology would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 hrs. of laboratory exercise including the revision and setting up the practical. Thus, each credit will be equivalent to 15 hours.
2. Student will have to take admission in Zoology and complete 75 credits incorporated in the syllabus structure of Zoology. The remaining 25 credits shall be chosen from the courses offered by the Zoology Department or other Departments of the University/College with credit system structure.
3. Besides Credits related to practical Courses, students may be allowed to take courses with less weightage per semester on the condition they complete the degree in maximum of four years. This provision can be availed which is subject to the availability of concerned courses in a given semester and with a maximum variation of 25 credits (in case of fresh credits) per semester in the concerned department/college.
4. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
5. The student will be declared as failed if he/she does not pass in all credits within a total period of four years. After that such students will have to seek fresh admission as per admission rules prevailing at that time.
6. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.
7. Project course should not be greater than 10% of the total credits of the degree course. Project course is equivalent to 10 credits.

Instructions for the Students:

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.
3. The students opting for dissertation course shall follow the rules framed for the same.
4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

4) Eligibility:

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc.

Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune.
Reservation and relaxation will be as per the government rules.

5) Examination

[A] Pattern of Examination

Evaluation of Students:

1) The In-semester and End-Semester examinations will be of 50 marks each.
2) Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% marks in both assessments separately.
3) A student cannot register for third semester if he/she fails to complete the 50% credits of the total expected within two semesters.
4) Internal marks remain unchaged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.
5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i. **In-semester Examination**: Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) **Theory Courses**: Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

a) Multiple choice questions
b) Combination of objective and subjective questions.
c) Open book test (concerned teacher will decide the allowed books)
d) Tutorial
e) Surprise test specified topics in a given notified period
f) Oral
g) Assignments
h) Review of research paper
i) Seminar presentation
j) Journal/Lecture/Library notes

Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) **Practical Courses**: It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).
   i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.
   ii. Project on Research Methodology
   iii. Industrial/Institution Visit report
   iv. Field visit report/ study tour report

The student strength of practical batch should be 12.

Project Course: Project will be evaluated by the examiner/s in consent with the project guide if required.

ii. **End-Semester Examination**: The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

[B] Standard of Passing

Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% passing in both assessments separately.

[C] ATKT Rules

A student cannot register for third semester if he/she fails to complete the 50% credits of the total credits expected to be ordinarily completed within two semesters.

[D] Award of Class

Grades will be awarded from grade point average (GPA) of the credits.

GPA Rules:

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credit hours indicate the sum of credit hours of the courses which a student has passed.
2. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. If the GPA is higher than the indicated upper limit in the third decimal digit then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded ‘A’)
4. For Semester I, II, III examinations, only the grade points will be awarded for each subject. Final GPA along with final grade will be awarded only at the end of IV semester. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.
5. After the declaration of result, for the improvement of Grade, the student can reappear for the examination of 30 credits worth theory courses.
6. Grade improvement programme will be implemented at the end of the academic year. A student can opt for grade improvement programme only after the declaration of final semester examination i.e. at the end of next academic year after passing M.Sc. (Zoology) examination and within two years of completion of M.Sc. (Zoology). A student can appear for grade improvement programme only once.

Grade and Grade Point Average		
Marks	**Obtained Grade**	**Grade Points**
100 – 75	**'O'** Outstanding	06
74 – 65	**'A'** Very Good	05
64 – 55	**'B'** Good	04
54 – 50	**'C'** Average	03
49 – 45	**'D'** Satisfactory	02
44 – 40	**'E'** Pass	01
39 and less	**'F'** Fail	00

Final Grade Points	
Grade Points	**Final Grade**
5.00 – 6.00	**O**
4.50 – 4.99	**A**
3.50 – 4.49	**B**
2.50 – 3.49	**C**
1.50 – 2.49	**D**
0.50 – 1.49	**E**
0.00 – 0.49	**F**

Common Formula for Grade Point Average (GPA):

$$\text{GPA} = \frac{\text{Total of Grade Points earned} \times \text{Credit hours for each course}}{\text{Total Credit hours}}$$

B Grade is equivalent to at least 55% of the marks

[E]External Students: There shall be no external students.

[F]Setting of Question Paper / Pattern of Question Paper

For core (compulsory) theory courses end semester question papers set by the University of Pune and centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.
Theory examination will be of 3 hours duration for each theory course of 4 credits. There shall be 3 questions each carrying marks as shown below. The pattern of question papers shall be:

Question 1 (20 Marks)	10 compulsory sub-questions, each of 2 marks; answerable in 2 -3 lines
Question 2 (20 Marks)	5 out of 7– short answer type questions.
Question 3 (10 Marks)	2 out of 3 – Long answer type questions.

[G]Verification / Revaluation

There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course. There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

6) Structure of Course

Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two year integrated course leading to M.Sc. (Zoology) in the colleges affiliated to Pune University.

M.Sc. Zoology - Course structure & Credits Distribution

M.Sc. Zoology –Part –I Semester-I

Course No	Title	Credits	Course No	Title	credits
ZY 101**T**	Biochemistry-I	3C	ZY 101 **P**	Practicals in Biochemistry-I	3C
ZY 102**T**	Cell Biology	3C	ZY 102 **P**	Practicals in Cell Biology	2C
ZY 103**T**	Genetics	2C	ZY 103 **P**	Practicals in Genetics	2C
ZY104**T**	Biostatistics	2C	ZY104 **P**	Practicals in Biostatistics	2C
ZY105**T**	Skills in Scientific communication and writing	2C	ZY105 **P**	Practicals in Skills in Scientific communication	2C
ZY106**T**	Fresh Water Zoology	2C	ZY106 **P**	Practicals in Fresh Water Zoology	2C
		14C			**13C**

(T = Theory ; P = Practicals)

Total credits =27

Note:- Courses equivalent to atleast 25 credits should be taken by the students.

Semester-II

Course No	Title	credits	Course No	Title	credits
ZY 201**T**	Biochemistry-II	3C	ZY 201 **P**	Practical Biochemistry-II	3C
ZY 202 **T**	Molecular Biology	3C	ZY 202 **P**	Practical Molecular Biology	3C
ZY 203**T**	Developmental Biology	2C	ZY 203 **P**	Practical Developmental Biology	2C
ZY204**T**	Endocrinology	2C	ZY204 **P**	Practical Endocrinology	2C
ZY205**T**	Comp.Animal Physiology	2C	ZY205 **P**	Practical Comp.Animal Physiology	2C
ZY206**T**	Biochemical techniques/ Ichthyology	2C	ZY206 **P**	Practicals in Biochemical techniques/ Ichthyology	2C
		14C			**14C**

(T = Theory ; P = Practicals)

Total credits =28

Note: - Courses equivalent to atleast 25 credits should be taken by the students.

M.Sc. Zoology –Part –II

Semester-III

Course No	Title	Credit	Course No	Title	credits
ZY 301**T**	Animal Physiology I (special) or Entomology I (special) or Genetics I (special)	4C	ZY 301 **P**	Practicals in Animal Physiology I/Entomology I/Genetics I	3C
ZY 302**T**	Immunology / Environmental biology	2C	ZY 302 **P**	Practicals in Immunology / Environmental biology	2C
ZY 303**T**	Genetic toxicology / Aquaculture	2C	ZY 303 **P**	Practicals in Genetic toxicology / Aquaculture	2C
ZY304**T**	Insect physiology and biochemistry	2C	ZY304 **P**	Practicals in Insect physiology and biochemistry	2C
ZY305**T**	Research methodology	2C	ZY305 **P**	Practicals in Research methodology	2C
ZY306**T**	Parasitology	2C	ZY306 **P**	Practicals in Parasitology	2C
ZY307**T**	Fundamentals of Systematics	2C	ZY307 **P**	Practicals in Fundamentals of Systematics	2C
ZY 308**T**	Insect Ecology	2C	ZY308 **P**	Research Project	2C
ZY 309 T	Toxicology I	2C	ZY 309 P	Practicals inToxicology I	2C
		20C			19C

(T = Theory ; P = Practicals)

Total credits =39

Note:- courses equivalent to atleast 25 credits should be taken by the students.

Semester-IV

Course No	Title	Credit	Course No	Title	Credits
ZY 401**T**	Animal Physiology II (special) or Entomology II (special) or Genetics II (special)	4C	ZY 401 **P**	Practical Animal Physiology II/ Entomology II/ Genetics II	3C
ZY 402 **T**	Economic Zoology / Bacteria and phage Genetics	2C	ZY 402 **P**	Practical Economic Zoology / Bacteria and phage Genetics	2C
ZY 403**T**	Mammalian reproductive physiology / Biodiversity assessment	2C	ZY 403 **P**	Practical Mammalian reproductive physiology / Biodiversity assessment	2C
ZY404**T**	Histology and histochemistry	2C	ZY404 **P**	Practical Histology and histochemistry	2C
ZY405**T**	Pollution biology	2C	ZY405 **P**	Practical Pollution biology	2C
ZY406**T**	Apiculture	2C	ZY406 **P**	Practical Apiculture	2C
ZY 407**T**	Pest control	2C	ZY308 **P**	Research Project	2C
ZY 408 T	Toxicology II	2C	ZY 408 P	Practicals in Toxicology II	2C
		18C			17C

(T = Theory ; P = Practicals)

Total credits = 35

Note:- courses equivalent to Atleast 25 credits should be taken by the students.

a) Question Papers and papers etc.:

Theory
- In-Semester Examination : 50 Marks
- End-Semester Examination : 50 Marks

Practical
- In-Semester Examination : 50 Marks
- End-Semester Examination : 50 Marks

b) Medium of Instructions: English.

7) Equivalence of Previous Syllabus:

Old Course (2008 Pattern)	**New Course (2013 Pattern)**
ZY 101 Biochemistry	ZY101T: Biochemistry
ZY 202 b Cell Biology	ZY102T: Cell Biology
ZY 102 a Genetics	ZY103T: Genetics
ZY 103 b Statistical Methods	ZY104T: Biostatistics
ZY 102 b English for Scientists	ZY105T: Skills in scientific communication and writing
ZY 103 a Fresh Water Zoology	ZY106T: Fresh water zoology
ZY 104 a Biochemistry	ZY101P:Practicals in Biochemistry
ZY 205 b Cell biology	ZY102P: Practicals in Cell Biology
ZY 105 b Genetics	ZY103P: Practicals in Genetics
ZY 105 a Statistical Methods	ZY104P: Practicals in Biostatistics
ZY 105 c English for Scientists	ZY105P: Practicals in Skills in scientific communication and writing
ZY 104 b Fresh water Zoology	ZY106P: Practicals in Fresh water zoology

Old Course (2008 Pattern)	New Course (2013 Pattern)
ZY 101 Biochemistry	ZY 201 T Biochemistry-II
ZY 202 a Molecular Biology	ZY 202 T Molecular Biology
ZY 201 a Developmental Biology	ZY 203 T Developmental Biology
ZY 203 b Endocrinology	ZY 204 T Endocrinology
ZY 201 b Comparative Animal Physiology	ZY 205 T Comparative Animal Physiology
ZY 203 a Biochemical Techniques/ Ichthyology	ZY 206 T Biochemical techniques/ Ichthyology
ZY 104 a Biochemistry	ZY 201P Practical Biochemistry-II
ZY 204 b Molecular biology	ZY 202P Practical Molecular Biology
ZY 205 a Devepolmental Biology	ZY 203P Practical Developmental Biology
ZY 205 c Endocrinology	ZY 204P Practical Endocrinology
ZY 204 a Comparative.Animal Physiology	ZY 205P Practical Comparative.Animal Physiology
ZY 204 c Biochemical techniques/ Ichthyology	ZY 206P Practicals in Biochemical techniques/ Ichthyology

8) University Terms:

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only for duly admitted students. The term shall be granted only on minimum 75 percent attendance at theory and practical course and satisfactory performance during the term.

9) Qualification of Teacher:

i. M.Sc. (Zoology) degree with NET/SET/ Ph.D qualification.
ii. Recognition of Pune University as a post graduate teacher, by papers.
iii. Other criteria as per the guidelines of UGC and University of Pune.

10) Detail Syllabus with Recommended Books

M.Sc. Zoology –Part –II

Semester-III

Course No	Title	Credit	Course No	Title	credits
ZY 301**T**	Animal Physiology I (special) or Entomology I (special) or Genetics I (special)	4C	ZY 301 **P**	Practicals in Animal Physiology I/Entomology I/Genetics I	3C
ZY 302**T**	Immunology / Environmental biology	2C	ZY 302 **P**	Practicals in Immunology / Environmental biology	2C
ZY 303**T**	Genetic toxicology / Aquaculture	2C	ZY 303 **P**	Practicals in Genetic toxicology / Aquaculture	2C
ZY304**T**	Insect physiology and biochemistry	2C	ZY304 **P**	Practicals in Insect physiology and biochemistry	2C
ZY305**T**	Research methodology	2C	ZY305 **P**	Practicals in Research methodology	2C
ZY306**T**	Parasitology	2C	ZY306 **P**	Practicals in Parasitology	2C
ZY307**T**	Fundamentals of Systematics	2C	ZY307 **P**	Practicals in Fundamentals of Systematics	2C
ZY 308**T**	Insect Ecology	2C	ZY308 **P**	Research Project	2C
ZY 309 T	Toxicology I	2C	ZY 309 P	Practicals inToxicology I	2C
		20C			19C

(T = Theory ; P = Practicals)

Total credits =39

Note:- courses equivalent to atleast 25 credits should be taken by the students.

Semester-IV

Course No	Title	Credit	Course No	Title	Credits
ZY 401**T**	Animal Physiology II (special) or Entomology II (special) or Genetics II (special)	4C	ZY 401 **P**	Practical Animal Physiology II/ Entomology II/ Genetics II	3C
ZY 402 **T**	Economic Zoology / Bacteria and phage Genetics	2C	ZY 402 **P**	Practical Economic Zoology / Bacteria and phage Genetics	2C
ZY 403**T**	Mammalian reproductive physiology / Biodiversity assessment	2C	ZY 403 **P**	Practical Mammalian reproductive physiology / Biodiversity assessment	2C
ZY404**T**	Histology and histochemistry	2C	ZY404 **P**	Practical Histology and histochemistry	2C
ZY405**T**	Pollution biology	2C	ZY405 **P**	Practical Pollution biology	2C
ZY406**T**	Apiculture	2C	ZY406 **P**	Practical Apiculture	2C
ZY 407**T**	Pest control	2C	ZY308 **P**	Research Project	2C
ZY 408 T	Toxicology II	2C	ZY 408 P	Practicals in Toxicology II	2C
		18C			17C

(T = Theory ; P = Practicals)

Total credits = 35

Note:- courses equivalent to Atleast 25 credits should be taken by the students.

Equivalence of Previous Syllabus: Sem. III and Sem IV

Old Course -2008 Pattern Sem III	**New Course- 2013 Pattern Sem III**
ZY 311 Entomology I	ZY 301 T Entomology I (Special)
ZY 312 Genetics I	ZY 301 T Genetics I (Special)
ZY 313 Physiology I	ZY 301 T Animal Physiology I (Special)
ZY 321 Immunology	ZY 302 T Immunology
ZY 322 Environmental Biology	ZY 302 T Environmental Biology
ZY 323 Fundamentals of Systematics	ZY 307 T Fundamentals of Systematics
ZY 324 Aquaculture	ZY 303 T Aquaculture
ZY 325 Insect Ecology	ZY 308 T Insect Ecology
ZY 331 Parasitology	ZY 306 T Parasitology
ZY332 Insect Physiology and Biochemistry	ZY 304 T Insect Physiology and Biochemistry
ZY333 Modern Concepts in Animal Evolution	ZY 309 T Toxicology I
ZY 334 Genetic Toxicology	ZY 303 T Genetic Toxicology
ZY 335 Insect Behaviour	No equivalence
ZY 341 Research Project	ZY 308 P Research Project
ZY 351 A Practicals for Special Paper I	ZY 301 P Practicals in corresponding Course
ZY 351 B Laboratory exercises in related courses Zy 321-325 and Zy 331-335	ZY 302 - 309 Practicals in Corresponding courses.

Old Course -2008 Pattern Sem IV	**New Course- 2013 Pattern Sem IV**
ZY 411 Entomology II	ZY 401 T Entomology II
ZY 412 Genetics II	ZY 401 T Genetics II
ZY 413 Physiology II	ZY 401 T Animal Physiology II
ZY 421 Animal tissue Culture	ZY 408 T Toxicology II
ZY 422 Pollution Biology	ZY 405 Pollution Biology
ZY 423 Marine Biology	ZY 402 Economic Zoology
ZY 424 Bacterial and Phage Genetics	ZY 402 T Bacterial and Phage Genetics
ZY 425 Medical Entomology	ZY 407 T Pest Control
ZY 431 Physiology of Mammalian reproduction	ZY 403 T Mammalian Reproductive Physiology
ZY 432 Comparative Invertebrate Histology and Histochemistry	ZY 404 T Histology and Histochemistry
ZY 433 Biodiversity Assessment	ZY 403 T Biodiversity Assessment
ZY 434 Protozoology	No equivalence
ZY 435 Apiculture	ZY 406 T Apiculture
ZY 441 Laboratory Experiments in Special Paper II	ZY 401 P Practicals in corresponding Course
ZY 451 Laboratory Exercises in related courses Zy 421-425 and ZY 431-435	ZY 402 -408 Practicals in Corresponding courses.

ZY 301 (T) – Animal Physiology I (4 credits)

Sr.No	Topic	Hours
1	**Bioluminescence and Animal electricity** 1.1 Bioluminescence: phyletic distribution, structure of luminescent organs, biochemical and molecular mechanism. 1.2 Animal electricity: electro receptors electro organs and their structure and	10
2	**Buoyancy:** definition, density reduction, gas floats with examples swim bladder with example.	7
3	**External and Internal environment:** 3.1 External environment: the atmosphere, aquatic & terrestrial environment 3.2 Internal environment: Extracellular and intra cellular environment 3.3 Homeostasis and regulation: tolerance and resistance, acclimatisation and acclimation, regulatory mechanism. 3.4 Biological clock and their regulation: Circadian rhythms lunar and tidal rhythm, circa annual rhythm, photoperiodism.	7
4	**Membrane physiology** 4.1 Membrane structure, membrane permeation, diffusion mediated transport, dynamics of semi permeable membrane. 4.2 resting membrane potential, diffusion, equilibrium potential, Goldman-Hodkin- Katz potential, conductance, current, capacitance 4.3 Excitable cell membrane: action potential, role of various ion channels, role of Na^+ K^+ pump, properties of action potentials	10
5	**Energy metabolism:** 5.1 Metabolic rate 5.2 Energy storage: Fat and glycogen 5.3 Effect of O_2 concentration: acclimation to low O_2 level, anaerobic metabolism, lactic acid and glycolysis 5.4 Problem of diving and deep sea hydro thermal vent 5.5 Metabolic rate and body size: mammals, birds, marsupials & monotremes 5.6 Energy cost of locomotion: running, swimming, flying 5.7 Effect of high altitude	15
6	**Excretion:** 6.1 Nitrogenous waste- ammonia and its excretion, urea, urea cycle, uric acid and its excretion, products of nucleoprotein metabolism, miscellaneous end product of nitrogen metabolism. 6.2 Organ of excretion and urine formation 6.3 Renal regulation and acid –base balance.	6
7	**Osmoregulation -** Maintaining water and electrolyte balance and its regulation in aquatic invertebrates & vertebrate, moist skinned animals, arthropods, terrestrial, vertebrate and marine air breathing vertebrates	5

References

1. Guyton A.C and Hall J.E,Text book of medical physiology, Hartcort bracc and co.Asia Pvt.Ltd.,Singapore.
2. Baldwin, E. An introduction to Comp Biochemistry. Cambridge.
3. Hill, R.W. & GA Wyse, . Animal physiology. Harper & Row, NW.
4. Randall, D, W.Burggen & K, French. Eckert Animal Physiology : Mechanism and adaptation,W H Freeman, NY
5. Schmidt-Nielsen, Animal Physiology: Adaptation and Environment. Cambridge.
6. Hoar, W S General and Comparative physiology. Prentice Hall, India, New Delhi.
7. Vernberg, F.J. & Vernberg, WB . Animal and the environment. Holt, Rienhart& Winston, NY.
8. Prosser and Brown. Comparative physiology.

ZY 301 (P) – Animal Physiology I (3 credits) (1P: 3 hrs) (15PX3= 30 hrs)

1	Estimation serum uric acid	1p
2	Body size and oxygen consumption in aquatic animals	1p
3	Effect of salinity on oxygen consumption in aquatic animals	1p
4	Absorption spectra of blood pigment	1p
5	Osmotic stress and volume change in earthworm	1p
6	Effect of temperature on water loss in cockroach	1p
7	Carbohydrates in mammalian gut	1p
8	Detection of allantoin in mammalian urine	1p
9	Glomerular filtration rate by creatinine clearance	1p
10	Effect of starvation on liver and muscle glycogen in mouse	2p
11	Induction of heat shock puff in salivary gland chromosomes of Drosophila	1p
12	Estimation of blood Sodium, potassium, Calcium	1p
13	Estimation of blood alkaline & acid phosphatases	1p
14	Normal & abnormal constituents of human urine	1p

ZY- 301 T Entomology I (Special) 4 Credits

1. Introduction to Entomology: Definition, Origin , Evolution and Inter-relationship of insects with other arthropods. 03L
2. General outline of Classification and Phylogeny of insects: Aptrygote insects (1-4 order), Exopterygote insects (5-20 order) and Endopterygote insects (21-29 order). 20L
3. Integument and it's derivatives. 02L
4. Comparative study of : Head and its appendages; Thorax and its appendages ; Abdomen and it's appendages. 08L
5. Comparative and histological studies of the following systems: Digestive system, Respiratory system, Circulatory system and Excretory system and Reproductive system, Nervous system. 20L
6. Studies of the following systems: The Sense organs, Endocrine glands and Exocrine glands. 05L
7. Light and sound producing organ. 02L

Reference Books

1. Imms' Text book of Entomology- By O. W. Richards and R. G. Davies, (Methuen &Cc., London,), Vols. I & II.
2. Principles of Insect Morphology- By R. E. Snodgrass, (Tata, McGraw- Hill, Bombay, .
3. Introduction of Comparative Entomology- By R. M. Fox & J. W. Fox, (Reinhold, New York,).
4. The Insect: Structure & Function- By R.F. Chapman (E. L.B.S., & E.U.P. London,).
5. General & Applied Entomology- By K.K. Nayar, T.N. Anathakrishnan & B.V.David, (Tata,McGraw-Hill, New Dehli,).
6. A Text book of Entomology' by H. H. Ross (John Wiley and Sons, Ins. New York,).

ZY- 301P Entomology I <u>Practical Cource</u> (3 Credits)

1. Method of collection, preservation & presentation of insect. 1P
2. Study of generalized insect including Systematic position, Habit and Habitat, Important morphological features and Dissection of so as to study: Digestive. Nervous and Reproductive system and Retrocerebral complex. 3P
3. Study of head capsule, mouthparts and antenna and their modification. 2P
4. Study of generalized wing and their modification with significance. 1P
5. Study of insect orders; (i)Apterygote insects, (ii) Exopterygote insects and (iii) Endopterygote insects inclusive of Taxonomy and diagnostic features upto family (atleast one insect from each order). 6P
6. Dissection of an insect pest (Plant bug or any insect pest as per local availability and legal permissibility) so as to study Taxonomy, Diagnostic features and Anatomy pertaining to Digestive, Nervous and Reproductive systems. 3P
7. Temporary mounting of Mouth parts, Antenna, Wings and Appendage of the insect pest used in practical number 4. 1P

Note:- 15 practicals are to be performed by the students.

ZY-301T: Genetics I 4 Credits.

1. Model Genetic System: Life cycles and advantages of the following organisms commonly used in genetic studies 08 L

1.1 T4 and T1 phages
1.2 *Neurospora*
1.3 *E.coli*
1.4 *Saccharomyces cerevisea* and *Schizosaccharomyces pombe*
1.5 *Caenorhabditis*
1.6 *Drosophila*
1.7 Zebra fish
1.8 Mouse

2. Advanced Population Genetics: 13L

2.1 Recapitulation of basic concepts and H-W law
2.2 Estimation of gene frequencies in population through mutation, migration and selection, selection-mutation equilibrium, derivation and genetic equations for above.
2.3 Assortative matings, inbreeding, genetic drift

3. Evolutionary genetics: 13L

3.1 Concept of continuous variation, phenotypic variance and its partitioning into subcomponents.
3.2 Co-variance, correlation and regression, degree of genetic determination, measurement of heritability, quantitative inheritance in humans.

4. Evolutionary Genetics: 13L

4.1 Genetic polymorphism
4.2 Selection strategies and effects
4.3 Genetics of speciation- classical and modern concepts
4.4 Use of molecular information in understanding phylogenetic relationship

5. Applications of Molecular methodologies in genetic analysis: 13L

5.1 Introduction to gene localization on chromosomes
5.2 Chromosomal Probes and Paints
5.3 Gene Therapy: Ex vivo and In vivo gene therapy and two examples of gene delivery system
5.4 Reverse Genetics

Reference books

1. Strickberger,M.W., genetics, Edn III, Mac Millan,
2. Gardner, E.J., Simmons, M.J. and Snustad, D.P.Principles of genetics, John Wiley and Sons, NY,
3. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T.lewotin. R.C. and Gelbert, W.M. An introduction to Genetics analysis. W.H. Freeman and Co. NY,
4. Trends in genetics, Elsevier Publication, Amsterdam.
5. Genetics: Analysis of Genes and Genomes, D.L. Hartl , E .W Jones, Jones and Barlett Publ. 2009.
6. Genes X: Benzamin Lewin, Jones and Bartlett Publications 2014.

ZY 301 P Practicals in Genetics I Credits - 03

1. Analysis of metric trait and estimation of phenotypic variance. [1P]

2. Partitioning of phenotypic variance in genetic and nongenetic components in a simulated population. Estimation of DGD. [1P]

3. Detection of polymorphism in a population – Biochemical (Enzyme, protein etc.) [1P]

4. To study population cage experiments using Drosophila: [1p]

   a) Genetic Drift

   b) Artificial selection- Experimental simulation and modeling.

5. Extraction of Genomic DNA from *Drosophila*. [2P]

6. Microbial genetics: Basic methodology, colony count, growth curve [2P]

7. Microbial genetics: Isolation of Auxotroph (Estimation of frequency) Replica plate technique. [2P]

8. Bacterial transformation and blue white selection. Calculation of transformation efficiency. [1P]

9. Study of conventions of nomenclature of genes and gene products in different model systems. [2P]

ZY 302 (T) – Immunology (2 credits)

Sr. No.	Topic	Lectures
1	Immune System: a) Introduction to Immunology b) Concept of immunity (self –nonself, antigen, antibody, immune response, immunological tolerance, autoimmune disease) and active and passive immunization, c) Primary and Secondary lymphoid organ. Tissue, cells and molecules of the human immune system.	**3**
2	Humoral immunity, and cell mediated immunity, T cell receptors.	**2**
3	Immediate response to infection:, Inflammation, cell migration, acute phase response interferon's and NK cell.	**3**
4	Antibody structure, antibody classes, subclasses, structure- function relationship, iso, idio and allo types	**4**
5	Theories of antibody synthesis, generation of antibody diversity (molecular basis), Antibody class switching	**3**
6	Antigen antibody reaction and complement fixation pathways.	**2**
7	Immunogenetics: HLA and Disease association, immune deficiencies and disorders. Antigen processing and MHC	**5**
8	Hybridoma principle and application, ELISA, Immunofluorescence, Immunoelectrophoresis, RIA and Monoclonal & Polyclonal Antibody and its application	**5**
9	Immunological Memory and Vaccination	**3**

Reference books

1. Essential immunology, Ivon Roitt, Blackwell scientific publications, London.
2. Immunology,I.V. Roitt, Butterworth publishers, USA
3. Kuby Immunology: Kindt T.J., Goldsby R.A., Osborne B.A., Kuby J. : Freeman WH Publ.

ZY 302 (P) – Immunology (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1	Ouchterlony technique of agar gel diffusion	2p
2	Immunoelectrophoresis	2p
3	Haemagglutination inhibition test	2p
4	Histology of Lymphoid organ- Skin, Spleen,Thymus, Ilium, Lymph node, Bone marrow	2p
5	Blood smear preparation to study various blood cells	2p
6	Blood group analysis with reference to cross matching	2p
7	To estimate the antigen concentration using rocket electrophoresis	2p
8	Dot immunobinding assay to detect antibodies in the serum	2p
9	To perform ELISA.	2p

ZY302 T Environmental Biology (2 C= 30 Lectures)

1. Introduction: Fundamentals of Ecology, Ecosystems: Definition and, concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Food-chains, ecotone, edge effects, ecological niche, and ecosystem stability. (6 L)

2. Environmental Microbiology: Microbes - classification and their applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents. (2L)

3. Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Human impact on the natural environment. (2L)

4. Biological diversity of lndia: Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna. (4L)

5. Population and Community Ecology. (2L)

6. Wetlands Forests and Semi-arid Habitats of India: Definition and types of wetlands, important wetlands of India and their conservation issues. Forests and semi-arid habitats of lndia: their distribution in India, ecological status of forests and arid lands, and their conservation. (4L)

7. Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books. (3L)

9. Wildlife management and conservation. Protected Areas Network in India: Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., tools for data collection and analysis. Human land-use and wildlife management units, important projects for the conservation of wildlife in India, Role of local communities in wildlife management. (7L)

References:

1. Fundamentals of Ecology: E. P. Odum
2. Modern concepts in Ecology: H: D. Kumar
3. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. John Wiley and Sons.
4. Elements of Microbiology: Pelczar, M.J. and Chan ECS, McGraw Hill.
5. General Microbiology: Stainer, R.Y .. , Adelberg, EA and Ingraham, J.L. . Macmillan Press.
6. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. . Academic Press.
7. Microbiological Methods for Environmental Scientists and Enginners : Gaudy, A.F. and Guady, E.T. McGraw Hill.

ZY302 P Environmental Biology (2C)

1. A visit to aquatic ecosystem and methods for water and plankton collection 2P

2. Plankton identification and quantification from river / lake water samples. 2P

4. Vegetation studies by line, quadrates and belt transect methods and their analysis. 2P

5. Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples. 2P

5. Water analysis for physico-chemical characteristics. 1P

6. Physico chemical analysis of soil. 1P

ZY 303 (T) – Genetic Toxicology (2 credits)

Sr.No.	Topic	Lectures
1	Toxicology: Definition and its subdivisions, scope and significance of genetic toxicology	**3**
2	Mutations at molecular, functional and chromosomal levels. Mechanisms of Mutagenesis End point mutations and its function, carcinogenicity and transformation. Biological significance of mutagenesis	**7**
3	Mutagenic agents in human environment. Applications of genetic toxicology to human and environmental monitoring	**5**
4	Methodologies used in detection of mutation, functional, cytogenetic effects. Use of Ames test, mammalian systematics, Drosophila etc.	**5**
5	Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis tests. Common assays used for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	**7**
6	Genetic toxicology and its role in the study of congenital malformations	**3**

Reference books

1. Chemical mutagens- principles and methods for their detection, Ed. Hollander, A. Vol. 1-5, Plenum press
2. Chemical mutagenesis in mammals and men. Eds. Vogel, F. and Rohtborn, G. Springer Verlag
3. Mutagenic effects of Environmental contaminants, Eds. Suttoa, H.E. and Harris, M.I., Academic press
4. Mutation research (section on genetic toxicology testing)
5. Journal of environmental pathology and toxicology, Patnotox Publ. Inc.
6. Genetic Toxicology: Principles and methods, Parry J.M., Parry E.M. (eds) Springer Publ. (2012)
7. Principles of Genetic Toxicology: David Brusick. Springer

ZY 303 (P) – Genetic Toxicology (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1	Dominant lethal test in *Drosophila*	2 P
2	Sex linked recessive lethal test in *Drosophila*	2 P
3	Micronucleus test in mouse	2 P
4	Bone marrow chromosome analysis in mouse	2P
5	Auxotrouph mutation induction in bacteria	2P
6	Ame's test	2P
7	Study of *Drosophila* mutants and maintaining *Drosophila* culture.	2p

ZY 303 T: AQUACULTURE (2 Credits = 30 lectures)

I. Aquaculture concept, Culture systems: Freshwater aquaculture systems: Freshwater prawn culture, fish culture in paddy fields, Brackish water culture, Mariculture: Oyster culture, Crab culture, Lobster culture, mussel culture, culture of Eels, Culture of aquatic weeds. (3 L)

2. Composite fish culture: (5L)

2.1 Definition and various patterns.
2.2 Mixed fish farming in India.
2.3 Techniques of composite culture.
2.3.1 Culture of buffalo fish ..
2.3.2 Culture of Catfishes.
2.3.3 Culture of miscellaneous fishes.
2.3.4 Cray fish culture.

3. Preparation and management of fish culture ponds. (3L)

3.1 Nursery ponds.
- 3.1.1 Predatory and Weed fishes and their control.
- 3.1.2 Fish toxicants.
- 3.1.3 Fertilization.
- 3.1.4 Aquatic insects and their control.
- 3.1.5 Fish food organisms and their production.
- 3.1.6 Stocking.
- 3.1. 7 Supplementary feeding.

3..2 Rearing ponds
3.3 Stocking ponds.
3.4 Fish breeding: Natural & Artificial.

4. Transport of fish seed and Brood fish. (5L)

4.1 Causes of mortality in transport.
4.2 Methods for packaging and transport.
- 4.2.1 Open systems.
- 4.2.2 Closed systems.

4.3 Use of chemicals in live fish transport.
- 4.3.1 Anesthetic drugs.
- 4.3.2 Antiseptics & Antibiotics.

5. Harvesting: Fishing techniques, preservation & processing of fish, (2L)

6. Fish pathology:

6.1 Parasitic infections.
- 6.1.1 Fungus infections.
- 6.1.2 Protozoan diseases.

6.1.3 Worm diseases.
6.2 Non parasitic diseases.

7. Fresh water prawn culture. (2L)

7.1 Introduction.
7.2 Breeding characteristics.
7.3 Juvenile prawn migration.
7.4 Seasonal & regional distribution of seeds.
7.5 Identification of juveniles.
7.6 Controlled breeding.
7.7 Culture:
- 7.7.1 Ponds.
- 7.7.2 Monoculture.
- 7.7.3 Mixed culture.
- 7.7.4 Role of hard water in culture of *Macrobrachium* species.
- 7.7.5 Fertilization & feeds. (3L)

8. Pearl culture: Introduction, Pearl producing mollusks, pearl formation, collection of oysters, rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl. (4L)

9. Technologies in Fisheries development: Recirculation technology, Geographic Information System (GIS) technology, passive Acoustics in fisheries, Use of Information Communication Technology (lCT) in fishes: production aspects, marketing aspects. (3L)

REFERENCE BOOKS

I. Fish and fisheries of India, V. G. Jingran, Hindustan pub. corp. New Delhi.

2.Textbook of fish culture, Marcel Hute and Heny Kahn, Blackwell Scientific Publication, Australia.

3.Text book of Aquaculture, M. Srinivasulu, Reddy, KRS Sambhasiva Rao, Discovery Publishing House New Delhi.

4.Fisheries & Aquaculture Biotechnology. Yawn Mehta, Campus Books International, Prahalad street, Ansari Road, Durga Ganj, New Delhi.

ZY 303 P: <u>PRACTICALS IN AQUACULTURE</u> (2 Credits) (1P: 3 hours) (I0PX 3= 30 hours)

1. Culture of Daphnia & Rotifers as fish food animals. (I P)
2. Histopathological & Biochemical investigations to test freshness of the fish, Prawn tissue. (This is necessary as the fresh fish are good.) (3P)
3. Study of Indian Oysters (Shells & their brief biology) . (IP)
4. Visit to artificial pearl culture. (IP)
5. Methods of processing, storing fish & prawns (ex. Salting & Drying) (2P)
6. To study the habit & habitat of some important culturable freshwater fishes. (lP)
7. Estimation of productivity of water bodies. (IP)
8. Hypophysation of fishes. (lP)

ZY 304 T Insect Physiology and Biochemistry (02 Credits)

1. Integument : Structure, Chemistry, sclerotization, functions. 03 L
2. Digestion and absorption of proteins, Carbohydrates and lipids. 03 L
3. Fat body : Structure, physiology, biochemistry, functions. Integration of carbohydrate, fat and acid metabolism 04 L
4. Ventilatory mechanisms and their control 03 L
5. Haemolymph :Physico-chemical characteristics of plasma : types and structure of haemocytes, functions. 03 L
6. Muscle : structure, physiology and biochemistry of flight muscles 03 L
7. Excretion and water balance: Structure and function of malphigian tubules. Water balance and nitrogen excretion. 04 L
8. Microsomal and extramicrosomal enzymes insecticide degradation and detoxification. 03 L
9. Endocrines, neurosecretory hormones, chemistry, function and mechanism of hormone action, moulting and juvenile hormones ; chemistry and physiology, other peptide and steroid hormones 04 L

Reference books :

1.Fundamentals of insect physiology, Blum N.S., John Wiley and sons, NY

2. An introduction to insect physiology, Bursell, e. academic press, NY

3. Insect biochemistry and function Candy D.J. and Kilby D.A. Chapman and hall, London

4. Comprehensive insect physiology, biochemistry and pharmacology, Kerkut G.A and Gilbert L.I., Vol 1 to 13 Pergamon press, Oxford, NY

ZY 304 P Practicals in Insect Physiology And Biochemistry (02 Credits)

1. Kymographic study of ventilatory movement in beetle. 01 P
2. Oxygen consumption in dragon fly nymph 01 P
3. Study of heart and haemocytes of cockroach 01 P
4. To determine the trehalase activity in haemolymph of any insect. 01 P
5. Amino acid in haemolymph of any insect by chromatographic technique. 02 P
6. Study of fat body glycogen of cockroach and effect of starvation 01 P
7. Assay of amylase in midgut of cockroach 01 P
8. Effect of temperature on water loss in cockroach 01 P
9. Von Wisselinghs test for presence of chitin in insect cuticle 01 P

ZY 305 T RESEARCH METHODOLOGY :(2 Credits - 30 h)

01. Research Methodology: Literature review, Defining the research question, Approaches and Methodology, Documentation and presentation of data, Analysis and interpretation of data, manuscript preparation (3L)

02. Quantitative methods**:** Biostatistics used for analysis of Biological data (06L)

03. Computer application**:** bioinformatics, databases and their applications (03L)

04. Tools and techniques**:** (18L)

- Techniques used Purification and characterization of biomolecules: Centrifugation**,** Ultrafilteration, Chromatography, electrophoresis, spectrophotometry, GC-MS, lC-MS, NMR, MALDI-TOF, X-ray crystallograpgy,Circular Dichroism CD
- Microscopic techniques including Fluroscence microscopy, Confocal microscopy, Atomic force microscopy and live cell imaging FACS analysis
- Histology and histochemistry**:** Fixation and sectioning of tissue, embryos and cells.
- Immunohistochemistry, immunoflurosecence, histochemical staining for characterization of cell type.
- Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarry, protein sequencing, FRET analysis

References:

1. O'conner, M. and Woodford, F.P. Writing scientific papers in English. Elsevier – Ecerpata Medica- North Holland Publ., Amsterdam.
2. Trelease, S.F. How to write Scientific and Technical papers. Williams & Willikins Co.,Baltimore, USA.
3. Day, R.A.How to write and publish a Scientific Paper. Cambridge University Press.
4. McMillan, V.E., writing Papers in the Biological Sciences, W.H.Freeman, NY
5. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker J.M., Cambride University Press
6. Biophysical& Biochemical Techniques, Wilson K and Walker J.M.,
7. Laboratory Exercises and techniques in Cellular Biology, Anthony Contanto, Wiley Publ.2012
8. Histological and Histochemicalmethods: Theory and Practice, Kiernan J.A. Scion Publ Ltd.
9. Histochemistry , Pearse A.G.E, Garfield.

ZY 305 P - RESEARCH METHODOLOGY :(2 Credits)

1	Selecting a title for the paper, writing the abstract and key words	1P
2	Writing the Discussion Conclusions and Results: Citation of references	1P
3	Importance of scientific surveys, primary data and secondary data in	1P

	research	
4	. Writing a project proposal to a funding agency.	1P
5	Use of MS Excel in data presentation.	1P
6	Examples of some common statistical tests	2P
7	Purification of a biomolecule	2P
8	Making a ICT enabled scientific presentation	1P
9	Microscopic techniques	1P

ZY 306 T: PARASITOLOGY 02 credits

1. **Host-Parasite systems:** (7L)

1.1 Preadaptation to infectiousness, Myasis: Classification according to tissue, vectors specific, sub specific, accidental; clinical presentation humans, syndrome, symptoms, diagnostic, control method prevention, treatment.;
Transmission: Types, categories: A. Conspecific: Contact, Transplacental, Transovarian, B. Heterospecific: Mechanical (Indirect & Direct), Biological, Paratenic, Hyper parasitic, Parasitoidal.
1.2 Manipulation of Host behavior, Parasitism & Altruism, parasites & social behavior of hosts, parasitism & life history, parasitic effects benefiting the host.

2. **Type study:** (8L)
Classification geographical distribution, morphology, life-cycle, transmission, pathogenecity, treatment and prophylaxis of:

2.1 Protozoa: *Trypanosoma* Sps. , *Leishmania* Sps.
2.2 Platyhelminthes: *Schistosoma* Sps., *Echinococcus* Sps.
2.3 Nematoda: *Ancylostoma* Sps., *Dracunculus* Sps.

3. **Genetics & Molecular Biology:** (7L)
3.1 *Trypanosoma:* Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surface glycoprotein (VSG) and VSG gene expression.

3.2 Plasmodium: Diploid & haploid stages, Chromosome polymorphism, gene encoding Circum sporozoite protein & merozoites S- antigens, surface antigen diversity.

Resistance of Malaria to drugs, its mechanism & assessment.

3.3 Platyhelminthes: Inseminative behaviour, parthenogenesis and polyspermy, sex determination, sex linked inheritance in Schistosomes.

3.4 Nematoda: chromosome germ line limited DNA & chromatin diminution in *Ascaris.*

4. Serology & immunodiagnostic methods: (6L)
4.1 Serology & antibody synthesis, preparation & demonstration of specific antigens of *Entamoeba, Plasmodium, Trypanosoma* & *Leishmania*
4.2 Immunodiagnostic assays, Immunodiffusion, Indirect haemogglutination test, indirect fluorescent antibody test, Radio immuno assay, ELISA, complement fixation test, Latex agglutination test

5. Prophylaxis & control: Biologic, Genetic, Chemical, Physical & Other methods (2L)
chemical, Physical & Other methods

REFERENCE BOOKS:

1. Comparative protozoology, Ecology, Physiology, Life history, Anderson, O.R. , Springer verlag, Berlin.
2. General Parasitology, Cheng T. C., Academic Press.
3. Modem Parasitology, Cox F.E.G.,Eds.Parasitology in focus, facts & trends, Melhorn h., Eds., Spriger Verlag, Beriin.
4. Medical Parasitology, Piakarsky G. L., Springer Verlag, Berlin.
5. Modern Parasitology, Cellular immunological & immunological aspects, Wyler D. J., Eds., W. H. Freeman, NY

ZY 306 P PRACTICALS IN PARASITOLOGY (2 Credits) (10p x3= 30 Hrs.)

1. Study of life cycle, role as vector & control measures of: (2P)
Ticks(*Argas, Boophilus*)
Mosquito - anyone from- *Anopheles/ Aedes/ Culex*

	Any two flies: *Tabanus/ Phlebotomus/ Sarcophaga*. Cyclops	
2.	Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta.	(2P)
3.	Study of life cycle of parasitic protozoa: *Trypanosoma, Leishmania*	(1P)
4.	Study of life cycle of helminth parasites: *Schistosoma. Echinococcus, Ancylostoma, Dracunculus.*	(2P)
5.	Culturing of *Entamoeba & Plasmodium*	(2P)
6.	Study of Parasites from digestive tract of Cockroach/gut / parasites of hen	(1P)

ZY 307 (T) – Fundamentals of Systematics (2 credits)

Sr.No.	Topic	lectures
1	Fundamental of Systematics: Biological classification, Hierarchy of categories and higher taxa, Taxonomic characters – procedures and keys, Species concepts: varieties, subspecies, sibling species, race etc.	**7**
2	Kingdoms of Life : General outline of kingdoms including Monera& Protista; Broad outline & Diversity in kingdom Animalia	**3**
3	Methodologies in systematics : Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematics, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism,RFLP, RAPD etc.	**8**
4	Taxonomic keys: Types of taxonomic keys, their merits and demerits .International code of Zoological nomenclature. Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names and various taxa	**6**
5	Taxonomic procedures: taxonomic collection preservation, curetting process and identification.	**3**
6	Molecular phylogenetics and phylogeography.	**3**

Reference books:

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
3. Wilson A.O., biodiversity, Academic Press, Washington.
4. Principals of systematic Zoology by Ernst Mayr.

ZY 307 (P) – Fundamentals of Systematics (2 credits) (10PX3= 30 hrs)

Sr.No.	Topic

1	Minor phyla-specimen Study	1p
2	Study of museum specimens and slides(invertebrates,1-2 examples from each phyla)	2p
3	Study of museum specimens(protochordates and chordates,1-2 examples from each phyla)	2p
4	Identification of animals with the help of keys-House fly, Honey bee etc.	1p
5	Identification of animals with the help of keys- Cockroach, Earthworm.	1p
6	Method of collection, Preservation, and Curetting of any insect Specimen	2p
7	Visits to Scientific Institute like Zoological Survey of India and Report writing	1p

ZY : 308. T:Insect Ecology (2 credits/30h)

1. Introduction to Insect ecology: (5L)
   History of ecology & Entomology Ecological associations
   Insect and humans

2. Insect and Climate: (5L)
   Temperature Photoperiod Rainfall
   Wind
   Climate change

3. Insect Herbivores: (5L)
   Feeding strategies of herbivorous insects
   Plant defences

4. Natural enemies and insect population dynamics: (5L)
   The variety of Natural enemies
   Inpact of enemies on insect populations
   The Concept of niche & competition among insects

5. Insects in ecosystems (5L)
   Fundamentals of ecosystem ecology
   Leaf shredding insects, Insect defoliators & cycling of nutrients insect,
   plant community : structure and successor.

6. Insect conservation: (5L)
   Threats to insects
   Conservation and restoration
   Prospects for insect conservation

ZY-308P- Research Project (2C)

The project course would involve training to students in literature survey, planning and execution of experimental work, analysis of date and its presentation.

Studies would utilize few of the practical's from their course more intensively for this cource. Project should start at third semester and will be assessed at end of fourth semester. The experimentation work during the project should be equivalent to minimum 10 practicals in each semester.

ZY 309T- Toxicology I (2 Credits:30Hr.)

1. **Basic Concept of Toxicology:** Introduction of toxicology, history of toxicology, definition of toxicology, definition of poison, definition of toxicity and classification of toxicants. 2 L
2. **Toxic agent and their mode of action:** Introduction, Toxic agent and mode of action of toxic agents. 3L
3. **Xenobiotics:** Introduction,Important of xenobiotics concerned to Human health, Adverse effects of xenobiotics through Biological Magnification and Biotransformation, mechanism of Xenobiotic Translocation, Membrane permeability and mechanism of chemical transfer, absorption of xenobiotics, distribution of xenobiotics, accumulation of xenobiotics, elimination, biotransformation and excretion. 8L
4. **Pesticides and Heavy Metal Toxicity: Pesticides and their toxicological effects:** Classification of Pesticides, Insecticides, Mode of action of Insecticide. 4L
5. **Heavy Metal Toxicity:** Introduction, dispersion, general principal of metal toxicity, sources, toxic metals and their toxicity. Arsenic, Alumunium, Cadmium (Itai-Itai disaster), Chromium Lead, Mercury, Manganese, Zinc and Nickel. 6L
6. **Evaluation of toxicity.** Acute subAcute and chronic assays LD_{50}, LC_{50} ,NOEL. 3L
7. Maintenance and general handling of animals for toxicological laboratory. 2L
8. **Ecotoxicology,** clinical toxicology, occupational and nanotoxicology. 2L

Reference Books:

1. Principles of Toxicology: Environmental and Industrial Applications – Eds. : Phillip L. Williams, Robert C. James, Stephen M. Roberts; JOHNWILEY & SONS, INC.
2. Casarett and Doull's Toxicology The basic science of poisons – Ed: Curtis Klaassen; McGraw-Hill.
3. Fundamental Toxicology – Eds: John Duffs & Howard Worth; RSC Publishing.

ZY 309 P - Toxicology I (2 credits: 30hr) 3hr = 1P

1. To determine LC_{50} of pesticide using suitable animal model 1P
2. Effect of heavy metal ions on heart beat of Daphnia 1P
3. *In situ* toxicity assessment using avian model 1P
4. *In vitro* toxicity testing using chick embryo 2P
5. Sediment-water toxicity test using chironomids 1P
6. Hydra and zebra fish as a model for various toxicity testing 2P
7. Acute dermal toxicity testing 1P
8. Acute oral testing 1P
9. Skin senitizing assay. 1P
10. Effect of heavy metal/pesticide on organ system in test organism 1P
11. Carcinogenicity studies 1P
12. Visit to toxicity/ genotoxicity testing facility 1P

M.Sc. Zoology Semester IV

ZY 401 T ANIMAL PHYSIOLOGY II (04 Credits)

1.Nutition and digestion (10)

a) Nutrition

b) Nutrients and Nutrirtive types

c) Calorimetry and BMR

d) Digestion

e) Components of digestive system

f) General mechanism of digestion; Autonomous smooth muscle function, instrinsic nerve flexes, extrinsic nerve and gastrointestinal hormones

2.Respiration (11)

a) Internal and external respiration ; Anatomy of respiratory system

b) Pulmonary respiration: Partial pressure, inspiration and expiration, Lung volume and capacities

c) Gas exchange across the pulmonary and systemic capillaries

d) Gas transport; O_2 transport, CO_2 transport and abnormalities in the blood gas content

e) Neuronal control of respiration, role of central and peripheral receptors

f) Other functions of respiratory system

3.Blood and blood vessels (9)

a)Blood composition and function, Haematopoiesis

b) Blood clotting and it's molecular mechanism

c) Blood vessels and blood pressure: Blood vessel types, Arteries, role as pressure reservoir and arterial pressure: Aeteriole:role in distribution in cardiac output and maintainance of arterial blood pressure, Capillaries and it's functions, veins:its role as blood reservoir and venous return

d) Blood pressure-Hypertension and Hypotension

4.Cardiac Physiology (10)

a) Anatomy of heart

b) Electrical activity of the heart pace makers, spread of cardial coupling, action potential of cardiac cells

c) Elecrocardiography

d) Mechanism events of cardiac cycle, Heart sound

e) Neuronal and Hormonal control of heart

f) Cardiovascular response of exercise

5. Neuronal Physiology (8)

a) Nerve cells : Structure & Function

b) Excitation and conduction of nerve fiber: Resting membrane potential, Action potential, all or none law, electronic potential, saltatory conduction

c) Ionic basis of excitation and conduction

d) Neurotransmitter types and receptors: Metabolism of neurotransmitters, Neuropeptides

e) Synapse and Neuronal integration

f) impact of drugs and disease on synaptic transmission

6.Muscle Physiology (05)

a) Structure of skeletal muscle and molecular basis of skeletal muscle contraction, types of contraction, twitch summation and tetanus, relation between muscle length and tension, velocity of contraction

b) Pathways of ATP formation during contraction

c) Skeletal muscle fiber types, contractile machinery of smooth muscle

7. Sensory Physiology (07)

a) Receptor types, receptor potential and receptor adaptation

b) Eye-structure and physiology of vision

c) Ear-Hearing and equilibrium, sound waves and it's characters, structure of ear and physiology of hearing and equilibrium

d) Chemical senses : Taste and smell

References:

1. Guyton A.C and Hall J.E,Text book of medical physiology, Hartcort bracc and co.Asia Pvt.Ltd.,Singapore.
2. Baldwin, E. An introduction to Comp biochemistry. Cambridge.
3. Hill, R.W. & GA Wyse, Animal physiology. Harper & Row, NW.
4. Randall, D, W.Burggen & K, French. Eckert Animal Physiology : Mechanism and adaptation , W H Freeman, NY
5. Schmidt-Nielsen,. Animal Physiology: Adaptation and Environment. Cambridge.
6. Hoar, W S General and Comparative physiology. Prentice Hall, India, New Delhi.
7. Vernberg, F.J. & Vernberg, WB . Animal and the environment. Holt, Rienhart& Winston, NY.
8. Prosser and Brown. Comparative physiology.

ZY 401 P - ANIMAL PHYSIOLOGY II (03 Credits)

1.Effect of exercise on breathing rate, pulse rate and blood lactate of man

2.Determination of bleeding time and clotting time in man

3.Study of invertebrate (earthworm and crab) heart

4.Ionic effects on perfused heart of frog

5.Effect of vagotomy on frog heart

6.Effect of adrenalin and acetylcholine on perfused heart of frog

7.Capillary circulation in frog and cockroach/Fish.

8.Study of glycerinated muscles fibers

9.LDH isoenzymes isolation and detection using agarose gel electro phoresis in heart / skeletal muscle of rat

10.Phosphagen kinase in mouse and crab muscle phosphagen

11.Effect of load on muscles contraction in frog

12.Cobalt back filling of cockroach ventral nerve cord

13. Detection and measuring of heart beats(Manually) in Drosophila larva/Daphnia.

14. Estimation of Respiratory Quotient by Warburg's Respirometer

15. Mapping of taste areas on human tongue.

16. Study of Types of heart (Myogenic and Neurogenic)

17.Effect of pH, temperature and incubation on human salivary amylase activity.

18.Determination of protein, glucose in Urine.
19.Determination of protein, glucose in Urine from diabetic patient.
20. Qualitative Analysis:
    1)Preparation and study of Urine crystals.
    2)Estimation of serum urea.

Any 15 Practicals to be completed by the students

ZY-401T: Entomology II (Special)- 4 Credits

1. Gametogenesis: Spermatogenesis , Oogenesis, Seminal transfer, Fertilization and oviposition. **08L**
2. Insect early embryonic development: Cleavage and Blastoderm formation, Germ band, Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief. **21L**
3. The post embryonic development; Eclosion from the egg. The developmental stages: larva, Pupa, Nymph, Emergence from the pupa/cocoon. Metamorphosis and Growth. **20L**
4. Hadorn's experiments with imaginal disc, Regeneration and Aging. **06L**
5. Diapause: Occurrence, Initiation and Preparations for diapauses, Diapause development and Controls. **05L**

Reference Books

1. 'The Insect- structure and Function' by R.F. Chapman ,ELBS, London
2. 'A Text book of Entomology' by H. H. Ross (John Wiley and Sons, Ins. New York,
3. 'Imms' Text Book of Entomology- By O. W. Richards and R. G. Davies, (Methuen &Cc., London,), Vols. I & II.
4. 'Embryology of Insects and Mariapods' by O. A. Johanson and F.H. Butt, (McGraw Hill, New York,).
5. 'The ecology of insect populations in theory and practice' by L.R. Clarks P. W. Geier, R.D. Hughes, R.F. Morris (Methen, London).
6. 'Developmental system: Insects' Vol. I, by S. J. Counce and C.H. Waddington (Academic Press, London,).
7. 'Developmental system: Insects' Vol. II, by S. J. Counce and C.H. Waddington (Academic Press, London,).

ZY- 401P- Entomology II <u>Practical Cource</u> (3 Credits)

1. Study of different types of insect Eggs. **1P**
2. Early embryology of insect: egg, cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 day old and 3 day old in suitable insect. **1P**
3. Study of post embryonic development of insects: Collection and study of types of larvae, pupae, Nymph (Aquatic and Terrestrial). **2P**
4. Histological studies of male reproductive system (Testes, Vasa deference, Ejaculatory duct, Accessory gland and spermatogenesis). **1P**
5. Histological studies of female reproductive system (Ovariole, oviduct, common oviduct, Accessory glands and bursa copulatris, spermatheca). **1P**
6. Dissection of House fly: The digective system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, haltere, legs and ovipositor. **3P**
7. Dissection of butterfly: The digective system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, scales and ovipositor. **3P**
8. Study of Beneficial Insects: Any 5 insects to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Economics and Ecological significance, Threats and Conservation measures. **1P**
9. Study of Harmful Insects: Any 5 insect Pests, Predators, Parasites and Vectors of diseases to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Nature of damage and control measures. **1P**
10. Morphological and taxonomic study of insect pest of agricultural importance. (any 10). **1P**
11 Study of insect pests and veterinary and public health importance. Nonconventional pests. **1P**
12 Study of efforts of contact poison on pests:
    a) Chlorinated hydrocarbons,
    b) Organophosphates
    c) Carbamate.
    Calculation of LD_{50} and effects on behavior. **1P**
13 Study of respiratory poisons (fumigants)-
    Carbon tetrachloride, ethylene dichoride, Nicotine. **1P**

14 Study of insect repellants (any two). **1P**
15 Study of insect attractants (any two). **1P**

Note: 15 practicals are to be performed by the students.

ZY401 T Genetics II 4 Credits

1. Solving problems (Numerical Probability estimation) of Mendelian and non-mendelian genetics. 03 L

2. Basic Human Genetics: 18L

2.1 History of Human Genetics

2.2 Pedigree- Gathering Family history, pedigree symbols, construction of pedigrees, Autosomal inheritance- Dominant & Recessive, Monogenic traits (Sex Linked inheritance, Sex Limited & Sex-influenced traits, mitochondrial traits), MIM number.

2.3 Presentation of molecular genetic data in pedigrees

2.4 Complications to the basic pedigree patterns- non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, genetic heterogeneity, genomic imprinting & uniparental disomy, spontaneous mutations, mosaicism & chimerism, male lethality, X- inactivation.

2.5 Parametric and non- parametric analysis, identifying recombinants & non recombinants in pedigree, two- point mapping- LOD score analysis, genetic & physical map distances, genetic markers.

3. Clinical Genetics: 16L

3.1 Monogenic diseases

2.1.1 Cystic Fibrosis

2.1.2 Tay-Sachs syndrome

2.1.3 Marphan syndrome

3.2 Triplet repeat based disorders

3.3 Inborn metabolic errors-

3.3.1 Disorders of carbohydrate metabolism

33.3.2 Disorders of nucleic acid metabolism

3.3.3 Disorders of lipid metabolism

3.3.4 Lysosomal storage disorders

3.3.5 Peroxisomal disorders

3.4 Disorders of Hematopoietic systems-

3.4.1 Over view of blood cell types & haemoglobin

3.4.2 Sickle cell anemia

3.4.3 Thalassemias

3.4.4 Hemophilia's

3.5 Prenatal and pre-implantation diagnosis

3.5.1 Indications for prenatal diagnosis

3.5.2 Indications for chromosomal testing

3.5.3 Non- invasive methods
3.5.4 Invasive methods

4. Physical mapping methods: 3L
4.1 Low resolution mapping- cell hybrids, radiation hybrid mapping, synteny homology.
4.2 Restriction maps, clone contig maps, STS map, EST map, DNA sequence map.

5. Immunogenetics: 4L

4.1 Genetic basis of antibody diversity.
4.2 Regeneration of TCR diversity.
4.3 HLA polymorphism and disease association.

5. Oncogenetics: 3L
5.1 Concepts of oncogenes and tumor suppressor genes.
5.2 Role of oncogenes.
5.3 Cytogenetic studies.

6. Behavioural Genetics: 5L
6.1 Rothen Buhler's experiment on genetics of Bee behavior (hygienic and unhygienic Trait).
6.2 Nature- nurture and behavior-
6.2.1. Genetics experiments to investigate animal behavior
6.2.1.1 Selection studies.
6.2.1.2 Inbred strain studies.
6.3 Identifying genes for controlling behavior
6.3.1 Induced mutations
6.3.2 Quantitative trait loci.
6.3.3 Synteny orthology
6.4 Twin and adoption study designs.
6.5 Environmental influence- shared and non- shared environment.
6.6 Genetics of human behavioural defects- Schizophrenia.

7 Neurogenetics: 3L
7.1 Circadian rhythms, learning and memory mutants in Drosophila.
7.2 Psychopathology- Alzheimer's disease

8. Drosophila genetics: 6L
8.1 History of Drosophila genetics.
8.2 Genetic basis of Sex determination and dosage compensation in *Drosophila.*
8.3 Genetic Regulation of Drosophila early embryonic development and pattern formation:
Maternal genes and formation of body axis,Segmentation genes,Homeotic gene functions,Regulation of Hox- gene expression;

REFERENCE BOOKS:

1. Strickberger, M.W., Genetics, MacMillan,
2. Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. Principles of Genetics, John Wiley AND Sons, New York,
3. William S Klug and Michael R Cummings. Concepts of Genetics. Prentice Hall Internatl, Inc., New York,
4. Trends in Genetics. Elsevier Publications, Amsterdam.
5. Lewin, Benjamin. Genes X. John Wiley and Sons, New York,
6. Deveplomental Biology, S.F. Gilbert, Sinaur Associates.
7. Genetics: Analysis of Genes and Genomes, D.L. Hartl , E .W Jones, Jones and Barlett Publ. 2009.
8. Genetics By Sarin,C., Tata McGraw Hill,New Delhi
9. Genetics: Daniel J Fairbanks, W. Ralph Andersen; Brooks / Cole Publ. co.
10. Genetics-A Molecular Approach: Peter J. Russell;Pearson Inc. publishing as Bejnamin Cummings;

ZY 401 P Practical in Genetics II 03 credits.

1. Methodology for constructing Human Pedigree. [lP]
2. Analysis and construction of typical pedigrees for autosomal dominant and recessive genes, sex linked dominant and recessive genes. [lP]
3. Preparation of metaphase chromosomal spreads of one vertebrate. [2P]
4. Enzyme polymorphism in natural population. [2P]
5. Visit to a medical genetics laboratory for cytogenetic, biochemical and other studies. [lP]
6. G banding on mouse metaphase spread [lP]
7. In-silico design of PCR primers for a gene of interest. [lP]
8. C banding on mouse metaphase chromosomes. [2P]
9. Study of courtship behavior in wild type and mutant Drosophila. [lP]
10. Study of maternal effect mutants for genes- Bicoid and Nanos. [lP]
11. Preparation of metaphase chromosomal spread of 3'd instar larva of Drosophila (from brain Ganglion) [2P]
12. Measurement of olfaction activity in *Drosophila* larvae and Adult Fly. [1P]
13. Measurement of locomotor activity in Drosophila larvae and Adult Fly. [1P]
14. Larval mechanosensation assay in Drosophila. [1P]
15. Chromatography of Drosophila eye colour pigment. [1p]
16. To Study effect of mitogen induction on lymphocytes. [2p]
17. Concept of genetic disorder databases and demonstration of use of OMIM. [lP]
18. Genetic monitoring (using immunogenetic marker) in laboratory animals. [by skin grafting] [2P]
19. Open field Activity test and Elevated plus maze test for anxiety levels in laboratory mice. [lP]

Any 15 Practicals to be performed by the students.

ZY 402 (T) Economic Zoology (2 Credits) 30 Lectures

1) Parasitic protozoans and their role in human welfare, soil protozoans and their role in agriculture. (2L)
2) Sponge culture and its importance in industry. (1L)
3) Concept of Coral reef and its significance. (1L)
4) Helminths as human and animal parasites. (2L)
5) Nematodes- parasitic roundworms of animals and plants. (1L)
6) Vermiculture industry in India. (1L)
7) Household insects, Apiculture, Lac culture, Sericulture, Prawn culture, Insects of commercial value and stored grain pests. (10L)
8) Economic importance of amphibian, reptiles and birds (2L)
9) Poultry, Piggery, Dairy industry and wool industry. (8L)
10) Model animals in pharmaceutical industry. (2L)

References:

1) Economic Zoology-Shukla and Upadhaya
2) Economic Zoology-P.D.Srivastava
3) Economic Zoology-Manju Yadav
4) Economic Zoology-K.R.Ravindranathan
5) Textbook of Economic Zoology- P.R.Venkitaraman

ZY 402 P / Economic Zoology (2Credits)

1) Prawn culture in laboratory aquarium 1P
2) Apiculture equipments. 1P
3) Poultry breeds, feeding utensils in poultry 2P
4) A visit to piggery/poultry/pearl culture centre/ apiculture centre/sericulturecentre. 1P
5) Fishing tools, crafts and gear. 1P
6) Morphology of Edible, freshwater fishes-Catla,Rohu, Labeo, Mrigala, Notopterus, Mystus sp. , Clarius, Channa, Heteropneustes, Reba,Wallago . 2P
7) Collection and identification of locally available/cultured fishes. 2P

REFERENCE BOOKS

A Handbook on Economic Zoology , Dr Jawaid Ahsan And Dr Subhas Prasad Sinha S. Chand Group.

Economic Zoology , G.S Shukla and V. B Upadhyay. Rastoi Publications

Encyclopedia of Economic Zoology, A.A. Khan. Anmol Publications

Economic Zoology by. Manju Yadav, Discovery Publishing House Pvt. Limited.

Economic Zoology by Malhotra ,Prakash, Adhyayan Puhlishers & Distributers

ZY 402 T Bacterial and Phage Genetics -2Credits

1. Bacterial Chromosome, Mechanism of gene transfer: Conjugation, transformation and transduction, chromosomal mapping, two-three point crosses, concept of cistron, complementation and complementation groups, mutations: auxotrophs, conditional, suppressors, transposable elements and chromosomal mapping. [14]
2. Bacteriophages: General introduction and properties [01]
3. Bacteriophage lambda: morphology and structure of nucleic acids, lytic cycle and lysogeny [03]
4. T even and odd phages: bacteriophage T2 and T4 morphology, nucleic acid structure and life cycle. Special features compared to lambda [05]
5. Bacteriophage T7: morphology and structure of nucleic acid , salient features [03]
6. RNA phages: Q beta and MS2, replication nd concept of overlapping genes [03]
7. Bacteriophage Mu [01]

Reference books:

1.Microbial Genetics,Frifielder D.
2. Genetics, Strickberger,M.W.millan Pub.
3. Genes of Bacteria and their viruses,Hays www.,CBS Press.

ZY 402 P Practicals in Bacterial and Phage Genetics 02 Credits.(10Px3hrs.)

1. Bacterial viable count, determination of growth curve, gram staining [1P]
2. Mutagenesis and auxotroph selection, replica plating [2P]
3. Bactriophage lambda titration, determination of pfu/ml [2P]
4. UV survival curve and phage mutagenesis [2P]
5. Transduction in bacteria [1P]
6. Conjugation and selection with genomic markers [2P]
7. Tetrad analysis in Fungi [1P]

ZY 403 (T) Mammalian Reproductive Physiology (2 Credits)

1. Reproductive organ: male and female gonads, duct systems and sex accessories, external sexual dimorphisms (3L)
2. Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders (3L)
3. Sexual cycles: puberty, oestrous and menstrual cycles. Ovarian event: follicular phase, cycling of non-pregnant uterus and vagina. (5L)
4. Hormonal regulation: hypothalamus –pituitary and gonad axis; other hormones. Hypothalamic GnRH, pituitary gonadotropins, behavioural effects, testicular hormones, testosterone derivatives, inhibin, ovarian hormones: oestrogen, progesterone's feedback relationships (4L)
5. Pregnancy: conception and blastocyst formation , implantation and delayed implantation, placenta: formation, types and functions, hormones in pregnancy (2L)
6. Parturition; birth process and its neuroendocrine control, puerperium (3L)
7. Lactation: mammary glands, milk synthesis, secretion. Hormonal regulation and suckling reflex. (3L)
8. Reproductive dysfuctions: Aging and reproduction. Climacteric, anatomical, endocrine and genetic disorders. (3L)
9. Artificial control of reproduction: increasing reproductive potential, artificial insemination, *in vitro* fertilization and embryo transfer, induced breeding, synchronisation of oestrus and ovulation, chemical and hormonal aspect, limiting reproductive potential, physical, physiological, surgical, chemical methods of contraception in male , female. Infertility: its causes and treatment, hormonal aspects. (4L)

Reference books

1. Austin C.R. and short R V., reproduction in mammals Books 1-5, Univ of Cambridge

2. Hogarth PH Biology of Reproduction, Blackie and Son, Glasgow, London.

3. Nalbandov, AV, reproductive Physiology, Lea and Febiger, Philadelphia

ZY 403(P) – Mammalian reproductive physiology
(2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. Anatomy of male and female reproductive system in rat/mouse 1P
2. Histology of male reproductive organs 1P
3. Histology of female reproductive organs 1P
4. Vaginal smear technique in mice. 1P
5. Ovarectomy in white rats 1P
6. Study of placental type 1P
7. Archectomy in white rat 1P
8. Study of uterine smooth muscles 1P
9. Study of contraceptive devices 1P
10. Visit to artificial insemination centre and family planning clinic 1P

ZY403 T Biodiversity assessment (2Credits = 30 lectures)

1. Concepts of Biodiversity : Biodiversity as natural ,biological capital of the earth. It's importance at global and local level. Genetic biodiversity, Species biodiversity, Agro biodiversity. (3L)
2. Kingdom of life: General outline of all kingdom - Broad outline and diversity of kingdom animalia (Major phyla with unique characteristics and examples) (2L)
3. Biodiversity distribution: Hot spots of biodiversity of the world. Biogeographical classification of India .India as a megadiversity Nation. (2L)
4. Value of Biodiversity: Consumptive, productive, social ethical aesthetic and option values. (2L)
5. Wild life: Wild life in India, Rare and endangered species, wild life values and human culture. (2L)
6. Threats to biodiversity: Loss of Biodiversity and its causes. Patterns of Losses Causes and factors of mass extinction. Listing of threatened biodiversity including vulnerable, rare, and threatened. Endangered and extinct animal species. Red data Book, Blue data book. (5L)
7. Conservation: Objective of, conservation, strategies and conservation. Modern tools and techniques to assess biodiversity in situ vs ex situ conservation. Action plan of conservation. Conservation of rare and endangered species. Conservation through a network of protected areas. Role of N G O s in conservation. Ecodevelopment for biodiversity conservation. Conservation movements in India - Chipko, Devrai , Bishnoi's movements etc. (8L)

8. Conservation and Prevention Acts in India: Forest conservation Act Protection Act 1971,1972 ,1980, Wild life (2L)
9. Case studies: Project Tiger, Project breeding. Vulture culture project. Elephant, Project Rhino, Project Crocodile and Turtle (4 L)

REFERENCE BOOKS

Guide to India's wild life A.N.Jagnnath Rao
Biodiversity .E.O Wilson ,Academic Press 1988
Biodiversity status and prospects by Tandon.
An Introduction to Biodiversity. Prithipalsingh
Biodiversity and biotechnology. Ray
Biodiversity and its significance. Y.A. Abrol
Conservation Biology S.K. Jain
The Preservation of species: The value of Biological Diversity by Norton B.G.

ZY403 P Biodiversity assessment 2 Credits

1. Study of fauna of different zoogeographical regions - with minimum three examples from each region. (1P)
2. Biodiversity studies of fishes, amphibians ,reptiles, aves ,mammals available in the local area. (1P)
3. Study of biodiversity indices with suitable examples (1P)
4. Qualitative analysis of zooplanktons. (1P)
5. Study of community characteristics by quadrat and transect method. (1P)
6. Sampling technique and experimental design in soil/water/forest. (1P)
7. Checklist preparation of fish/ birds/ mammal fauna in local area. (1P)
8. Study of endangered fauna of Maharashtra . (1P)
9. Supportive instruments in Biodiversity assessment. (1P)
10. Visit to wild life sanctuary. (1P)

ZY 404 (T) Histology and Histochemistry (2 Credits)

1. Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues. (5)

2. Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra microtome, cryostat, problems and troubleshooting (3)

3 Techniques in histology:

Sample preparation, obtaining tissue samples, handling reagents, fixatives (types of fixatives and effect on tissue), processing of fixed samples, dehydration(procedure and significance), embedding, block making, staining(staining methods histochemical and immunohistologial methods), dyes and dye binding reactive groups, mordants and mordanting, temporary and permanent preparations, whole mount preparation (7)

4. Fundamentals of histochemical techniques: principle and practice, detection of glycogen, neutral and acid mucopolysaccharides, detection of basic proteins, detection of specific and nonspecific lipids, detection of nonspecific esterases, detection of acid /alkaline phosphatase. (15)

Reference Books:

1. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
2. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
3. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY

ZY 404 (P) – Histology and histochemistry (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. Enzyme detection: acid phosphatase, alkaline phosphatase, esterases (1P)
2. Nucleic acid staining: methyl green, pyronine, feulgen stain (1P)
3. Study of different types of tissue with help of permanent slides (2P)
4. Effect of fixatives, fixation of tissues (1P)
5. Block preparation and sectioning (2P)
6. Mucolpolysaccharide staining, AB pH 1.5, 2.5 (1P)
7. Proteins (basic mellrg) and lipid staining by sudan black (1P)
8. Comparative study of effect of fixative on a given tissue (1P)
9. Effect of fixatives on tissue sections- liver (1P)

ZY 405T: Pollution Biology (2 credits = 30 lectures)

1. Biosphere: Introduction, hydrosphere, lithosphere, atmosphere. (2L)

2. Pollution: Kinds of pollution and pollutants(Air, Water, Agricultural). (3L)

3. Noise pollution: Characteristics of sound, source and effects of noise pollution. (3L)

4. Pesticide pollution: Pesticides and their kinds, possible sources and pathways of pesticide Pollution. Impact of pesticides on living organisms. (3L)

5. Radioactive pollution: Types , sources and effects, radioactivity assessments and control. (2L)

6. Bioassay: Purpose of bioassay, selection and test organisms, pollutant bioassay using fish. (3L)

7. Pollution monitoring: strategies for water, soil, noise. (2L)

8. Histological, biochemical and physiological methods to study Impact of pollutants on animals. (3L)

9. Bioconcentration, Bioaccumulation and Biomagnifications of pollutants. Causes and Consequences. (3L)

10. Biological methods for assessment of environmental quality. (3L)

11. Biomedical waste – Handling and Management, Hazardous Waste in India. (3L)

References

1. Ecology, E.P. Odum, Amerind publ.
2. Environmental biology, P.D. Sharma, Rastogi Publ.
3. Environmental pollution, H.M. Dix, John Wiley Publ.
4. Pesticides in aquatic environment, M.A. Q. Khar, Plenum Press.
5. Environmental pollution and its control under international law, R.A. Malviya , Chay Publ.
6. Ecology, Ricklefs, freeman, W.H.
7. Limnology, Welch McGrew Hill Publ.
8. Practical Ecology – K.S. Rao, Ujjain (M.P) Anmol Publ. New Delhi (India)

ZY-405P: Practicals in Pollution Biology (2 Credits) (10P =30hrs.)

1. Study of bio – indicators of pollution. (1P)
2. Analysis of CO, CO_2 NO pollution level data in collaboration with district pollution dept. of Maharashtra state. (1P)
3. Study of Eutrophic ponds /lakes /river. (1P)
4. Visit to water filtration plant/Pollution. (1P)
5. Analysis of pH and salinity form water /soil sample. (1P)
6. Determination of LC_{50} / LD_{50} for insecticide / pollution /molluscicide etc. (1P)
7. Estimation of Biomass by:- (1P)
   i) Wet weight and ii) Dry weight.
8. Estimation of calcium and magnesium in polluted water. (1P)
9. Soil analysis for calcium carbonate. (1P)
10. Estimation of sulphate in polluted water (1P)

ZY- 406 (T) Apiculture, 2 Credits/30 L

1. **Introduction to Apiculture:** History of Bees and Beekeeping, Systematics, Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Foraging and Honey flow periods. (7 L)

2. **Bee keeping as an occupation:** Extent of Beekeeping in Maharashtra and India, Limitations on the development of beekeeping, Advantages of extensive beekeeping, Beekeeping equipments and initiation into keeping a colony, the future of beekeeping. (7 L)

3. **The first step in beekeeping:** Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony, taking care of bee diseases and enemies. (7 L)

4. **Beekeeping techniques and Apiary management:** Establishment of a colony,, Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products, Bee flora and planned pollination services. (7 L)

5. **Important Institutions pertinent to Apiculture:** National Bee Board, Bee Research and Training Institute, Apiaries. Economics and extension of Bee keeping. (2 L)

Reference Books

1. Bees and Beekeeping
   D. P. Abrol , Kalyani Publisher, New Delhi.

2. A Comprehensive guide to Bees and Beekeeping.
D. P. Abrol. Scientific Publisher, New Delhi.
3. Honey bees and their management
S. B. Withhead. Axis books Publisher, Jodhpur.
4. Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal , M.J.P Publisher, Chennai.
5. A Handbook of Beekeeping Dharamsing and D. P. Singh (, Agrobios India (Publisher), Jodhpur.

ZY- 406(P) Apiculture, 2 Credits/10 Practical.

1. Study of Honey bee species, Castes and Bee morphology. (3P)

2. Study of Beekeeping equipments: Bee box and tools. (2P)

3. Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. (2P)

4. A compulsory visit to an Apiary or Central Bee Research & Training Institute or a Beekeeper to gain a first hand experience in handling bees. (2P)

5. Study of bee flora in the locality and observations on bee foraging Behaviour. (1P)

ZY 407 T -Pest Control (2 Credits)

1. Introduction of the pest control, types of pests and their importance, Damage caused by pests. **02L**
2. Brief outline of medical and veterinary entomology with reference to important measures to control the vectors. House hold and stored grain pest and their control measures. **06L**
3. Principles and methods of pest control: Cultural control measures, Physical control measures, Mechanical Control measures, Chemical control measures. Types and mode of action. Insecticidal formulations and dilutions. Drawbacks of chemical control. Biological control measures: Biological agents, Advantages and Drawbacks of Biological control, Biological Control Management. **12L**
4. Autocidal control ,Chemosterilents,Kniplings model,Pheromonal and hormonal control. Concept of Integrated pest management. **06L**
5. Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels. **02L**
6. Pesticide- Appliances: Sprayers and Dusters, Hazards of Pesticides and Antidotes. **02L**

Reference Books

1. “Pest control- A Survey” By A. Woods. (McGraw-Hill, London, 1974).
2. Pest control” – By W. W. Kilgore and R. L. Doutt (Academic Press, New York, 1967).

ZY 408 T Toxicology II (2 credits : 30hr)

1. Absorption, distribution, and elimination of toxic agents: transfer of molecules across membranes, absorption from GI tract and lung, and across the skin, deposition/ distribution, biotransformation and excretion 7h

2. Bioactivation & detoxification: metabolism of xenobiotic, enzymology of xenobiotic metabolism, bioactivation & inactivation of xenobiotics
(Any two OP and CP compounds) 8h

3. Toxicogenomics: microarray, proteomics, metabolomics 3h

4. Toxicity testing: Regulatory agencies, Regulatory testing methods 6h

5. Lab safety, disposal of bio-medical waste, GLP 3h

6. Legal aspects: CPCSEA guidelines, IAEC, rational use of animals, alternatives for animal models 3h

Reference books:

1. Principles of Toxicology : Environmental and Industrial Applications – Ed. : Phillip L. Williams, Robert C. James, Stephen M. Roberts; JOHNWILEY & SONS, INC.

2. Casarett and Doull's Toxicology The basic science of poisons – Ed: Curtis Klaassen; McGraw-Hill

3. Fundamental Toxicology – Eds: John Duffs & Howard Worth; RSC Publishing

4. http://envfor.nic.in/division/committee-purpose-control-and-supervision-experiments-animals-cpcsea.

ZY 408 P Practicals in Toxicology II (2 credits : 30hr) 3hr = 1P

1. Estimation of phosphate in water 1P
2. Effect of pollution on the oxygen consumption of suitable animal 1P
3. Qualitative assessment of polluted water sample for presence of lead or mercury pollution. 1P
4. Developmental toxicity testing by using Drosophila model 1P
5. Bacterial reverse mutation test in *S. typhimurium* 1P
6. Sperm shape abnormality assay 1P
7. Prenatal developmental toxicity test 1P
8. MTT test for cytotoxicity 1P
9. Monitoring cell death by LDH (Lactate dehydrogenase) 1P
10. Alternatives to animals in toxicity testing 1P
11. Visit to authorized Animal House facility 1P
12. Estimation of Acetyl cholinesterase activity on exposure to OP compounds on test organism. 1P