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	2C
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			**13C**

(T = Theory ; P = Practicals)

Total credits =27

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

ZY 101 T: BIOCHEMISTRY – I (3 Credits = 45 lectures)

1. Water :Structure and Function, pH and Buffers, Biological Buffer System **(3L)**
2. Carbohydrates: Classification, basic Chemical Structures, General Reactions and properties, Biological Significance. **(6L)**
3. Lipids: Classification, structure and function of major lipid subclasses. Formation of micelles,monolayers,bilayer **(5L)**
4. Vitamins and Coenzymes: Classification, water-soluble and fat-soluble vitamins, coenzyme forms and their significance **(6L)**
5. Amino acids: Classification, properties and reactions (N / C terminal reactions, ninhydrin reaction) **(4L)**
6. Proteins: **(4L)**
    a. Peptide bond, formation, End group analysis and sequencing, Ramachandran plot
    b. Protein structure :
        i. Levels, primary structure and its importance
        ii. Secondary structure- X ray diffraction, alpha-helix, beta-helix
        iii. Tertiary structure: Forces stablizing, unfolding and refolding.
        iv. Quaternary structure- hemoglobin.
    c. Biological Roles of Proteins
7. Enzymes: **(10L)**
    a. Classification, nomenclature and properties
    b. Enzyme kinetics -one substrate reaction (Michaelis-Menten Equation)
    c. Factors affecting enzyme activity
    d. Enzyme inhibition
    e. Allosteric Enzymes.
    f. Isozymes.(LDH)

REFERENCE BOOKS

1. *Biochemistry*, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
2. *Biochemistry* 6th Ed, (2007) Berg Jeremy, Tymoczko John, StryerLubert, Publisher: W. H. Freeman, New York.
3. *Lehninger's Principles of Biochemistry*, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
4. *Biochemical Calculations*, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
5. *Enzymes: Biochemistry, Biotechnology & Clinical chemistry,* (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

ZY 101 P: PRACTICALS IN BIOCHEMISTRY I (3 Credits: 45hours)

1. Preparation of Acid & Alkali solutions and acid-base titration **(4H)**
2. To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity **(4H)**
3. Estimation of alpha amino nitrogen by formal titration. **(4H)**
4. To find saponification value of a given fat. **(4H)**
5. Estimation of Inorganic Phosphate **(4H)**
6. Estimation of Sugar (Glucose) by Folin Wu method. **(4H)**
7. Estimation of Amino Acid (Tyrosine) **(4H)**
8. Isolate proteins by salting out / by adjusting isoelectric point. **(4H)**
9. Estimation of vitamin. **(4H)**
10. Isolation of amylase/ invertase, to find specific activity and progress curve **(5H)**
11. Estimation of protein by Lowry et.al method. **(4H)**

REFERENCE BOOK:

1. An introduction to Practical Biochemistry by David Plummer; Eds. 3, Tata McGraw Hill Publishing Company.
2. Practical Biochemistry by Jayraman.
3. Biochemical Methods by S. Sadasivam and A. Manickam; New Age International Publisheres.

ZY 102 T: CELL BIOLOGY (3 Credits= 45 Lectures)

1. Introduction to the cell types and shapes **(2L)**
2. Overview of chemical nature of the cell **(2L)**
   Carbon as backbone of biologically important molecules
   Macromolecules and their role in form and function of living systems.
3. Plasma membrane : **(9L)**
   Structure, Location of Intrinsic and extrinsic proteins and channels; Receptors- Structure and role in signal transduction; membrane potential and synaptic transmission; glycocalyx; cell junction, cell adhesion molecules
4. Endomembrane system: (Endoplasmic reticulum, Golgi complex, Lysosomes; Glyoxysomes, peroxisomes: Structure and function), protein trafficking **(10L)**
5. Mitochondria and chloroplast- Structure, Genetic system, Functions; protein import. **(6L)**
6. Nucleus: Ultrastructre, Nuclear pore complex, nuclear cytoplasmic interactions, Nucleolus, Nuclear lamina and its role in cell division. (Lamin Dissociation) **(4L)**
7. Cell Cycle: Phases, Check points of cell cycle mechanism of regulation (Cyclin and cyclindependent kinases) Regulation of CDK cyclin activity. **(7L)**
8. Cytoskeleton:types,Chemistry,Organisations,associated proteins and their role **(5L)**

REFERENCE BOOKS

1. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. (1995). Molecular Biology of the Cell. Eds. 3, Garland Publi. New York and London.
2. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (1995). Molecular Cell Biology, Eds. 3, Scientific American & W. H. Freeman. New York.
3. Cell and Molecular Biology By De Robertis, EDP. And De Robertis EME,Molt Saunders Inc

ZY 102 P: PRACTICALS IN CELL BIOLOGY (2 Credits: 30hr) (1P= 4hr)

1. Measurements of cell size using light microscope. **(1P)**
2. Temporary preparation of human epithelial cheek cells **(1P)**
3. Study of different stages of mitosis in suitable material and mitotic index **(1P)**
4. Study of meiosis in Grasshopper testes / Onion flower buds / Aloe vera with emphasis on all stages of prophase. **(1P)**
5. Limits of cleanliness (To check for microbial flora) **(2P)**
6. Cell fractionation- Nuclei, mitochondria observation, nuclear count. **(2P)**
7. Study of Cyclosis in *Paramoecium* **(1P)**
8. Ultra structure of cell organelles. **(1P)**
9. Study of different types of Cells. **(1P)**
10. Study of disaggregation and reaggregation in sponge cells and effect of toxicant or cytochalasin / pesticide endosulfan / $CuSO_4$ or toxicant **(1P)**
11. Study of metaphase spreads from bone marrow of rat / mouse **(1P)**

ZY 103 T: GENETICS (2 Credits= 30 lectures)

1. Recapitulation of Mendelian principles; Practical applications of genetics in brief**. (3L)**
2. Classical concept of a gene: multiple alleles (blood groups), gene interactions (dominant and recessive epistasis) **(3L)**
3. Linkage and crossing over: Linkage, linkage groups, types of crossing over, recombination maps in diploids for 3 point test cross, (determintation of gene order with suitable examples) **(5L)**
4. Inheritance of qualitative and quantitative traits: genetic basis and influence of environment on quantitative inheritance. **(3L)**
5. Principles of Population Genetics: Hardy-Weinberg law and its application for autosomal genes. Calculations of gene frequencies with suitable examples. **(5L)**
6. Organization and regulation of lac and arabinose operons. **(4L)**
7. Somatic cell genetics and its applications. **(3L)**
8. Human genetics: dominant and recessive disorders, physical and physiological traits. **(4L)**

REFERENCE BOOKS:

1. Strickberger, M.W., Genetics, Edn.III, MacMillan, 1976.
2. Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. Principles of Genetics, Jhon Wiley AND Sons, New York, 2006.
3. William S Klug and Michael R Cummings. Concepts of Genetics. Edn. IX. Prentice Hall Internatl, Inc., New York, 2008.
4. Trends in Genetics. Elsevier Publications, Amsterdam.
5. Lewin, Benjamin. Genes IX. John Wiley and Sons, New York, 2008.
6. Genetics By Verma,PS. And Agrawal, VK., S.Chand and Co.,New Delhi
7. Genetics By Gupta, PK., Rastogi Publication, Meerut
8. Genetics By Sarin,C., Tata McGraw Hill,New Delhi
9. Genetics: Daniel J Fairbanks, W. Ralph Andersen; Brooks / Cole Publ. co. (1999).
10. Genetics-A Molecular Approach: Peter J. Russell;Pearson Inc. publishing as Bejnamin Cummings; 2006

ZY 103 P: PRACTICALS IN GENETICS : (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. Study of sex linked inheritance in *Drosophila sp.* **(1P)**
2. Study of monohybrid ratio in *Drosophila sp.* **(1P)**
3. Study of dihybrid ratio in *Drosophila sp.* **(1P)**
4. Non-allelic gene interaction in *Drosophila sp.* **(1P)**
5. Linkage study in *Drosophila sp.* **(1P)**
6. Determination of gene distances and gene order for a given three point test cross **(1P)**
7. Polytene chromosomes of *Drosophila or Chironomous*-examination of puff and bands **(1P)**
8. Estimation of allelic frequencies, heterozygote frequencies in human populations **(1P)**
9. Human Mendelian traits (blood groups, attached ear lobe, tongue rolling, etc.) family studies. Estimation of gene frequencies & persentage of heterozygotes for the given data. **(1P)**
10. Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive. **(1P)**
11. Analysis of quantitative trait in a plant/ animal.: frequency distribution **(1P)**
12. Analysis of quantitative trait in a plant/ animal.: standard deviation variance **(1P)**
13. Microbial Genetics: Basic methodology; colony counts, growth curve **(2P)**
14. Bacterial transformation- antibiotic resistance marker **(2P)**

ZY 104 (T) BIOSTATISTICS **2 Credits= 30 lecturers**

1. Introduction: (2)
   - 1.1 Applications and Uses of Statistics
   - 1.2 Population & sample, Different types of Sample
   - 1.3 Exercise & Problems.

2. Data Classification: (3)
   - 2.1 Some important terms (Class frequency, class- limits, Class-width, class –mark)
   - 2.2 Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve.)
   - 2.3 Exercise & Problems.

3. Measures of central tendency: (3)
   - 3.1 Concept of central tendency, Types of central tendency (Arithmatic mean, Median and mode) combined mean.
   - 3.2 Partition values (Quartiles, Deciles, and Percentiles)
   - 3.3 Exercise & Problems.

4. Measures of dispersion: (4)
   - 4.1 Concept of dispersion, absolute and relative measure of dispersion.
   - 4.2 Different measures of dispersion (Range, Quartile-Deviation, Variance and standard-deviation, Coefficient of Variation) combined variance
   - 4.3 Exercise & Problems.

5. Correlation and Regression: (5)
   - 5.1 Bivariate data, concept of correlation, Types of Correlation, Scatter diagram, Karl Pearson's coefficient of correlation and its properties.
   - 5.2 Concept of regression, Linear regression, regression Coefficients and its properties.
   - 5.3 Exercise & Problems.

6. Probability and probability distribution: (5)
   - 6.1 Some important terms (types of experiment, sample Space and types of sample space, events and types of events.)
   - 6.2 Definition of probability (mathematical and classical) Conditional probability. Concept of random variable Univariate probability Distribution and its mathematical expectation.
   - 6.3 Some standard probability distributions (binomial, Poisson and normal)their probability distribution, mean, variance,and properties of these distribution .
   - 6.4 Exercise & Problems.

7. Test of hypothesis: (8)

7.1 Some important terms (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p- value)

7.2 Test for mean and equality of two population means, Test for proportion and equality of two population proportions.

7.3 chi-square test for goodness of fit, Unpaired and paired t test.
F test for equality of two population variances.

7.4 Exercise & Problems.

REFERENCES:

1. Principles And Practice of Biostatistics : Dr J.V. Dixit
2. Statistical Methods: Snedecor G.W. & Cochran W.G.
3. Statistical Methods : Dixon W.S. and Massey

ZY 104 (P) - BIOSTATISTICS: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. Construction of frequency distribution and its graphical representation.
2. Measures of Central Tendency.
3. Measures of Dispersion.
4. Correlation and Regression.
5. Computation and application of binomial & Poisson probabilities.
6. Computation and application of normal probabilities.
7. Test for means and proportions.
8. Chi-square test of goodness of fit.
9. Paired and unpaired t- test, F-test.
10. Statistical analysis with Computer software packages.

ZY 105 T: SKILLS IN SCIENTIFIC COMMUNICATION AND WRITING

(2 Credits = 30 lectures)

1. Language as a communication tool, relationship among reading, writing, hearing and speaking, synonyms and antonyms **(2L)**

2. Organization of English language: sentence structure, basic grammar, Syntax, paragraphs, paraphrases and précis- recognizing important statements, key words **(3L)**

3. Common error in written and spoken presentation: tautology, double negative, doubles positive, superfluous words, sequence and tenses. **(2L)**

4. Oral presentation: How to prepare presentation, power point slides, use of communication and IT, Voice, speed of delivery,obstacles in effective communication **(2L)**

5. Hypothesis, theory and concept **(1L)**

6. The Genetic code as a simple language **(2L)**

7. Outline of a science paper and project preparation, funding **(2L)**

8. Introduction: Survey of literature, defining the problem and justification **(2L)**

9. Materials and Methods: contents, importance of measurements, reproducibility etc. **(2L)**

10. Observations and Results: text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends & captions **(3L)**

11. Discussion: What to discuss? Logical sequence and critical analysis of ideas and evidence or data conclusion **(2L)**

12. Citation: How to find references from journals, books and data bases, styles of citations **(2L)**

13. Summary , Abstract, acknowledgements and Title designing **(3L)**

14. Editing & correcting: proof- reading symbols, Jargons and abbreviations **(2L)**

REFERENCE BOOKS:

1. O'Conner, M and Woodford, F.P.(1975). Writing scientific papers in English. Elsevier-Excerpta Medica-North Holland pul., Amsterdam.

2. Trelease, S.F. (1958). How to write Scientific and Technical papers. Williams and Wilkins Co. Baltimore, USA

3. Robert Day (1996). How to write and publish a Scientific Paper. Cambridge University Press
4. McMillan, V (1997). Writing Papers in the Biological Sciences. Edn. 2, W.H. Freeman. New York
5. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques, MJP Publishers, Chennai. WWW.mjppublishers.com

ZY 105 P: PRACTICALS IN SSCW: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun **(1P)**
2. Syntax, paraphrasing and précis writing, synonyms, antonyms, abbreviations **(1P)**
3. Spoken English: pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax **(1P)**
4. Common errors in written and spoken presentation- Tautology, double negatives and double positives, sequence and tenses, ambiguity, spellings, jargons**.** **(1P)**
5. Outline of a scientific paper; preparation of a project and writing Introduction. **(1P)**
6. Writing abstracts, conclusion/ summary and acknowledgements, key words **(1P)**
7. To suggest a title to the given abstract/paper **(1P)**
8. Assigning legends to given graphs, figures and captions to given tables, Deciphering the given pictorals **(1P)**
9. Study of proof correction symbols; proof- reading the given text & correcting the proofs **(1P)**
10. Designing of tables and graphs from the given data**,** **(1P)**
11. How to write materials and methods ,observation section of a research paper **(1P)**
12. Write discussion section for the given discussionless research paper **(1P)**
13. Citations/ Bibliography: how to find and cite references from journals, books and databases` **(1P)**
14. Oral presentation: Rhythm, style, control,mock presentation for 10 minutes **(1P)**
15. Use of animation in scientific communication **(1P)**

ZY 106 T: FRESHWATER ZOOLOGY (2 Credits: 30 Lectures)

1. Types of Aquatic environment. **(4L)**
   Lotic Habitat : Major river systems in India / rapid and slow moving rivers.
   Lentic Habitat: Lakes, Pods and Swamps, Bogs lakes and succession of lakes.
   Ephemeral water bodies (Temporary habitat).
2. Physical conditions of water: movement of water, Depth, Viscosity, Density, Buoyancy, (surface film and surface film animals), Temperature and light, Transparency and turbidity. **(4L)**
3. Chemical conditions of water: Dissolved oxygen and Carbon di-oxide, phosphates, Nitrates. Acidity and alkalinity, Mg-hardness, Ca-hardness, dissolved solids, organic Matter, Importance of chemical conditions to aquatic life. **(4L)**
4. Physiological and protective adaptations of the following.
   Protozoa, Rotifera, Crustaceans, Fishes. **(2L)**
5. Diagnostic features and life cycle of temporary rainwater pool animals: Fairy shrimps and Tadpole shrimps. **(3L)**
6. Respiratory and Locomotory adaptations in freshwater insects and their larvae. **(3L)**
7. Amphibia and water: General life cycle of frog. Tadpole as important herbivore of freshwater habitat. **(2L)**
8. Adaptations in freshwater reptiles: Turtles and Crocodiles. economic importance of reptiles. **(3L)**
9. Economic importance of freshwater molluscs (snails and bivalves)- as a food & medicine. **(2L)**
10. Biological changes in freshwater due to sewage pollution (with reference to rivers) and its effect on freshwater animals. **(3L)**

REFERENCE BOOKS

1. Mellanby, H (1975).Animal life in freshwater, 6th Edn., Chapman-Hall.

2. Limnology: Welch P.S.(1957), Mc Grall, and Hill Co. New York.

3. Treatise on limnology: Hutchinson, G.E.(1967). John. Willy.Pub.New York.

4. Aquatic pollution: Edward A.(2000) Laws. 3rd edition.John wiley and Sons. New York.

5. Life in Lakes and Rivers: T.T.Macan and Worthington E.B.(1951) COLLIN, London.

6. Limnology: by Alexander Home, Charles Goldman.

7. Limnology: Lake and River Ecosystem, Robert G. Wetzel 3rd edition.

8. Fundamentals of Limnology: franz Ruttner. 3rd Edition. University of Toronto Press, 1963.

9. The Ecology of Running water: Hugh Bernard Noel Hynes.

10. Limnological methods: Paul Smith Welch.

11. Fresh water animals of India (An Ecological Approach) : G.T.Tonapi

ZY 106 P: PRACTICALS IN FRESH WATER ZOOLOGY: (2 credits) (1P: 3 hrs)

(10PX3= 30 hrs)

1. A qualitative and quantitative analysis of zooplankton from a given sample of water using Sedgwick rafter counting cell. **(1P)**

2. To prepare and maintain a culture of paramecium, Daphnia and Hydra. **(1P)**

3. Study of aquatic and semiaquatic adaptations in amphibians and reptiles. **(1P)**

4. Study of locomotory and respiratory adaptations in aquatic insects and their larvae.(Ranatra, Notonecta, Gerris, Bellostoma, Dytiscus). **(1P)**

5. Estimation of Chlorides in given sample of water. **(1P)**

6. Identification of commercially important freshwater fishes and crustaceans. **(1P)**

7. Study if Bioindicators of pollution by insects, rotifers, algae, diatoms. **(1P)**

8. Determinations of LC50 using fish/insect larvae for known pollutant like Heavy metal/any Pesticide/industrial effluent. **(1P)**

9. Water analysis with regadrs to hardness (Total and Calcium). **(1P)**

10. Visit to freshwater body for the study of aquatic ecosystem. **(1P)**

11. Collection and identification of Benthos. **(1P)**

12. Compulsory Visit to ZSI, Pune and water purification plant and submission of tour report. **(1P)**

ZY 201 T: BIOCHEMISTRY-II (3 Credits = 45 lectures)

A. Bioenergetics I

1. Basic law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds , structure and function of ATP. **(4L)**

2. Concepts of metabolism, Metabolic pathways-Catabolic and anabolic, regulation of metabolic pathways **(2L)**

3. Glycolysis; Detailed study, energetic and its regulation; PFK, gluconeogenesis **(5L)**

4. Carbohydrate metabolisms: Glycogen biosynthesis and its regulation. Role of enzymes in synthesis and degradation of glycogen, role of cAMP **(4L)**

5. Citric acid cycle: Detailed study, energetics, regulation and significance, Role of PDH. **(7L)**

6. Electron transport chain and oxidative phosphorylation **(4L)**

B. Bioenergetics II

1. Oxidative degradation of amino acids: transamination, oxidative deamination, ureacycle, Ammonia excretion **(6L)**
2. Purine and pyrimidine degradation, biosynthesis of purine and pyrimidine nucleotides **(6L)**

3. Lipid metabolism: Introduction, oxidation of even chain saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, omega (ω)-oxidation of fatty acids, Ketogenesis. Transport of Fatty Acids. **(7L)**

REFERENCE BOOKS

1. *Biochemistry*, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
2. *Biochemistry* 6th Ed, (2007) Berg Jeremy, Tymoczko John, StryerLubert, Publisher: W. H. Freeman, New York.
3. *Lehninger's Principles of Biochemistry*, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
4. *Biochemical Calculations*, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
5. *Enzymes: Biochemistry, Biotechnology & Clinical chemistry*, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

ZY 201 P: PRACTICALS IN BIOCHEMISTRY II (3Credits: 45hours)

1. Units and specific activity of enzymes. **(4H)**
2. Effect of substrate concentration on enzyme activity **(4H)**
3. Effect of pH and temperature on enzyme activity. **(4H)**
4. Effect of inhibitor and activator on enzyme activity. **(5H)**
5. Colorimetry and spectrophotometry **(2H)**
6. Estimation of cholesterol **(4H)**
7. Separation sugars by paper chromatography **(5H)**
8. Estimation of uric acid in Lizard excreta/ Human blood etc. **(4H)**
9. To find absorption spectrum of haemoglobin, BSA, Tyrosine **(4H)**
10. Estimation of Nitrogenous Base (Guanine) **(4H)**
11. Estimation of free aminoacids by Ninhydrin method. **(5H)**
12. Estimation of Starch **(3H)**
13. Separation of amino acids by TLC **(4H)**

REFERENCE BOOK:

1. An introduction to Practical Biochemistry by David Plummer; Eds. 3, Tata McGraw Hill Publishing Company.
2. Practical Biochemistry by Jayraman.
3. Biochemical Methods by S. Sadasivam and A. Manickam; New Age International Publisheres.

ZY 202T: MOLECULAR BIOLOGY (3 Credits = 45 lectures)

1. DNA structure and topology :-Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization - chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin, type of DNA **(A, B,Z)** **(5L)**
2. Physical properties of DNA : Tm, hypo and hyper chromicity, solubility, mutarotation and buoyancy**.** **(2L**)
3. **Genome organization:** C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and, kinetic and sequence complixicity,satellite DNA**. Types of RNA and their significance** **(2L)**
4. **DNA Replication:** DNA replication in *E. coli*, Origin of replication, , types of *E. coli* DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA, replication features of single stranded phages. Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication. **(10L)**
5. **DNA damage and repair:** Different types in DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair,recombination repair, Double strand break repair, transcriptional coupled repair, Nick Translation and SOS Repair **(5L)**
6. Transcriptrional Unit in prokaryotes and eukaryotes, role and significance of promoter,enhancer, intron, exon, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, structure of RNA polymerase,post transcriptional processing: Capping,polyadenylation and splicing in eukaryots. Ribonucleoproteins (SnRNPs &ScRNPs) **(10L)**
7. Protein synthesis:Genetic Code ribosome structure, activation of aminoacids,peptide bond formation and translocation of peptides, post-translational modifications, inhibitors of protein synthesis **(7L)**
8. **Mobile DNA elements:** Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transpositionControlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon **(4L)**

REFERENCE BOOKS:

1. *Genes IX*, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
2. *Molecular Biology of the Gene*, 5th Edition (2004), James D. Watson, Tania Baker,
3. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher -
4. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.

5. *Molecular Biology*, 4th Edition (2007), Weaver R., Publisher-McGrew Hill Science.
6. *Molecular Biology of the Cell*, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian
7. Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
8. *Essential Cell Biology*, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin,
9. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
10. *Fundamentals of Molecular Biology*, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.

ZY 202 P: PRACTICALS IN MOLECULAR BIOLOGY (2 credits) (9 PX5hrs= 45)

1. Isolation of bacterial DNA and estimation by UV spectrophotometry **(2P)**
2. Absorption studies of isolated DNA **(1P)**
3. Isolation of Liver DNA and quantification by Agarose gel electrophoresis **(2P)**
4. Isolation of RNA and agarose gel electrophoresis. **(1P)**
5. Demonstration of plasmid DNA in *E. coli.* and its characterization by UV-spectrophotometry **(1P)**
6. Concept of biological database, gene and protein search by BLASTA and FASTA **(1P)**
7. Lab Safety Techniques and sterilization. **(1P)**
8. To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis **(2P)**

ZY 203 T: DEVELOPMENTAL BIOLOGY (2 Credits = 30 lectures)

1. Basic concepts of Developmental Biology: Model systems: Fish, Frog, Chick, Mouse and *Drosophila*. **(2L)**
2. Introduction of gametogenesis, regulation of sperm motility (tail fiber complex and role of dyenin ATPase), role of pH and divalent cation. **(2L)**
3. Oogenesis: synthesis and storage of maternal transcripts, proteins and cell organelles, rDNA amplification, transcription lampbrush chromosomes, vitellogenesis **(3L)**
4. Fertilization : Species specific sperm attarction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to ensure monospermy and species-specificity in fertilization **(4L)**
5. Types of eggs and cleavage patterns**:**Concepts in Pattern formation, animal vegetal axis, gradients, origin, and specification of germ layers **(2L)**
6. Egg actvation: regulation of cell cycle and utilization of maternal macromolecules and organelles during early development. **(2L)**
7. Organizers: Role of Spemann's organizers in frog and Hensen's node in birds **(2L)**
8. Mesoderm induction in *Xenopus:* Role of signals in dorsal, intermediate and ventral mesoderm induction. **(3L)**
9. Pattern formation in *Drosophila*.: Bicoid , Nanos and Torso Morphogen gradients and regulation of Hunchback **(3L)**
10. Neural competence and molecular signaling during neural induction **(3L)**
11. Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death. **(2L)**
12. Growth and post embryonic development: Apoptosis, aging and senescence Hayflicks experiment **(2L)**

REFERENCE BOOKS:

1. *Developmental Biology,* 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.
2. *Principles of Development*, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
3. *An Introduction to Embryology*, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd.
4. *Developmental Biology,* (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.

ZY 203 P: PRACTICALS IN DEVELOPMENTAL BIOLOGY: (2 CREDITS) (1P: 3 HRS) (10PX3= 30 HRS)

1. Mounting of chick embryos and preparation of permanent mounts **(1P)**
2. Filter paper ring method for *in vitro* culturing of chick Embryo & observations. **(1P)**
3. Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development. **(1P)**
4. Drosophila development on live material: egg structure, egg laying and early development in culture by phase contrast **(1P)**
5. Study of embryonic and post-embryonic development using frog egg as a model system. **(1P)**
6. Study of effect of ligature in Drosophila / House fly larva **(1P)**
7. Study the imaginal disc in Drosophila larva **(1P)**
8. Chick limb bud staining with neutral red for morphogenetic cell death **(2P)**
9. Study of grafting of Hensen's node **(2P)**
10. Regeneration of Hydra/Planaria **(1P)**

ZY 204 T: ENDOCRINOLOGY (2Credits=30 Lectures)

1. Hormones as chemical messenger, structure of hormones **(2L)**
2. Hormone receptors; on the plasma membrane, cytoplasm & nucleus **(2L)**
3. Mechanism of hormone action- signal transduction cascade **(2L)**
4. Hypothalamic hypophysiotropins **(2L)**
5. Adenohypophysial hormones: ACTH, PRL, STH and TSH **(2L)**
6. Control of chromatophores: Pituitary, pineal **(2L)**
7. Hormonal regulation of carbohydrates, protein & lipid metabolism: pancreatic hormones-glucocorticoids **(3L)**
8. Osmoregulatory hormones: ADH, mineralcorticoids, renin-angiotensin **(2L)**
9. Gastrointestinal hormones **(2L)**
10. Control of calcium and phosphate metabolism **(2L)**
11. Endocrine mechanism in crustacean: X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, colour change, moulting **(3L)**
12. Hormonal regulation of yolk synthesis, secretion & uptake in oogenesis w.r.t amphibian. **(2L)**
13. Hormones and reproduction in cephalopod mollusks and echinoderms **(2L)**
14. Hormones regulation in insect larval development and metamorphosis **(2L)**

REFERENCE BOOKS

1. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.
2. Bollander, F. (1994). Molecular endocrinology, edn.2,Acad. Press, SanDiego.
3. Hadely, M.E. (1996). Endocrinology. Edn.4, Prentice Hall, Upper Saddle Park.
4. Thomdyke, M.C. and Goldsworthy, G.J. (1988). Neurohormones in Invertebrates. Cambridge University Press.
5. Hoar, W.S. and Hickman, C.P., Jr. (1983). A laboratory companion for general and comparative physiology. Edn.3, Prenticed- Hall, Englewood Cliffs, N.J., USA.
6. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992).Atlas of endocrine organs: vertebrates and invertebrates. Springer Verlag, Berlin.
7. Zarrow, M.X., Yachim, J.M. and McCarthy, J.L. (1964). Experimental endocrinology: a sourcebook of basic techniques. Academic Press, New York

ZY 204 P: PRACTICALS IN ENDOCRINOLOGY: (2 credits) (1P: 3 hrs)

(10PX3= 30 hrs)

1. Histology of invertebrateand vertebrate neurosecretory and endocrine structures. **(1P)**

2. Staging of fish chromatophores and effect of adrenaline *in vivo* and *in vivo*, and Acetylcholine in vivo. **(1P)**

3. Blood sugar regulation in the crab- role of eye stalk. **(1P)**

4. Study of retrocerebral complex of the cockroach. **(1P)**

5. Introduction of alloxan diabetes in the mouse/ rat / human. **(1P)**

6. Gonadectomy in the mouse/ rat. **(1P)**

7. Pancreatectomy in the mouse/ rat. **(1P)**

8. Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human. **(1P)**

9. Adrenalectomy and self- selection of fluid by the rat. **(1P)**

10. Thyroidectomy in the rat. **(1P)**

11. Estimation of thyroxine from human blood. **(1P)**

12. Determination of Acetylcholine esterase. **(1P)**

ZY 205 T: COMPARATIVE ANIMAL PHYSIOLOGY (2 Credits = 30 lectures)

1. Digestion: Physiology of digestion. **(3L)**
2. Respiration: Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. Blood pigment, role in Oxygen transport.O_2 dissociation curves-physiological and ecological significance, CO_2 **(4L)**
3. Muscle contraction : Structure (light & electron microscopic) of the skeletal muscle,proteins of the myofilaments, nature of actin-myosin interaction, sarcoplasmic recticulum and role of Ca++ in contraction **(4L)**
4. Osmotic regulation: Concepts of osmole, osmolarity and tonicity, ionic regulation, Hyper-and hypo-osmotic regulators, ureosmotic animals **(4L)**
5. Excretion: Basic processes in urine formation,renal function in animals specially the mammalian kidney, Renal pressure system, Comparative biochemistry of nitrogen excretion. **(4L)**
6. Temperature: Biokinetic Zones, tolerance and resistance. Thermobiological terminology. Compensatory patterns in piokilotherms.Critical temp, and zone of thermal neutrality.Mechanism of thermoregulation in homeotherms. **(4L)**
7. Chemical Communication: Nuerosecretion, neuroheamal & endocrine organs. chemistry of vertebrate hormones, Mechanism of hormone action **(4L)**
8. Sense organ: classification & functions (details of photoreception as a model).Reflexes, Principles of neural integration**.** **(3L)**

ZY 205 P: PRACTICALS (2 credits) (10PX3= 30) (Any 10)

1. Study of nitrogenous waste products of animals from different habitats. **(1P)**
2. RBCs in different vertebrates and in different physiological conditions. **(1P)**
3. Body size and oxygen consumption in aquatic animals (crab/fish). **(1P)**
4. Estimation of sugar in rat/crab/human blood. **(1P)**
5. Effect of insulin on the blood sugar of rat. **(1P)**
6. Estimation of lactate content of rat/crab/human blood. **(1P)**
7. Determination of bleeding time & clotting time of human blood. **(1P)**
8. Estimation of chloride content of rat/crab/human blood. **(1P)**
9. Capillary circulation in the foot-web of frog/tail-fin of fish. **(1P)**
10. Effect of load on muscle contraction in the frog/rat/fowl. **(1P)**
11. Determination of the heart beat in the crab-effect of temperature & ions. **(1P)**
12. Effect of eye stalk ablation on chloride & glucose in the haemolymph of the crab. **(1P)**

References:

1. Comparative animal physiology,Clifford Ladd Prosser, John Wiley & Sons
2. Animal physiology, Richard W. Hill, Gordon A. Wyse.Harper and Row
3. Comparative animal physiology, Philip Carew Withers,Saunders College Pub., 1992

ZY 206 T: BIOCHEMICAL TECHNIQUES (2 Credits = 30 lectures)

1. **Chromatography**: Principles and applications of: Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, RPLC, selection of chromatographic system. **(9L)**
2. **Electrophoresis**: Moving boundary electrophoresis, zone electrophoresis, different supports used for electrophoresis, electrophoresis under native, dissociating and denaturing conditions, occurrence of artefacts, isoelectricfocussing, activation analysis **(5L)**
3. **Absorption spectroscopy:** Concepts of light & electromagnetic spectrum, IR: identification of functional groups, atomic absorption spectrometry and applications **(5L)**
4. **Radioactivity:** Properties of radioisotopes, commonly used isotopes, structure & working of G.M, counter, isotopic dilution analysis, use of isotopes in biology, radiation hazards. **(3L)**
5. **Manometry:** Respiratory quotient determination, Principle of Warbug's apparatus, working and applications. **(2L)**
6. Methods for protein and DNA sequencing. **(3L)**
7. **Centrifugation:** Principle, basic theory of ultracentrifuge, molecular weight determination and its applications **(3L)**

REFERENCE BOOKS:

1. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press.
2. Light Microscopy in Biology: A Practical Approach, 2nd edition (1999), Alan J. Lacey, Publisher–Oxford University Press.
3. Electron Microscopy: Principles and Techniques for Biologists, (1992), Lonnie D. Russell, Publisher-Jones & Bartlett

ZY 206 P: PRACTICALS (2 credits) (10 PX3= 30) (Any 10P)

1. Estimation of proteins by colorimetric and spectrophotometric methods **(1P)**
2. To find out the capacity and nature of a given ion-exchanger. Investigate the % retention and %elution of aminoacids on a given ion exchanger **(1P)**
3. To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis **(2P)**
4. To separate protein by gel filtration G-50 **(1P)**
5. To locate enzymes on electrophoreogram by active staining **(1P)**
6. Enzyme purification by salting out and organic solvent precipitation **(2P)**
7. To study the effect of different solvents for a given dye using thin layer chromatography **(1P)**
8. Characterization of DNA by density gradient centrifugation **(1P)**
9. In situ detection of different enzymes **(1P)**
10. Estimation of respiratory quotient by Warburg's Respirometer **(1P)**
11. Enzyme isolation and purification by fractionation methods **(2P)**
12. Immobilization of enzymes **(1P)**
13. Analysis of sequences by BLAST and FASTA. **(1P)**

ZY 206 T: ICHTHYOLOGY (2 Credits= 30 lectures)

1. Classification and diagnostic characters (up to orders) of extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes) **(4L)**
2. Phylogeny of fishes **(1L)**
3. External morphology, body form, appendages, pigmentation, skin and scales. Principles of morphometry, Locomotion **(2L)**
4. Endoskeleton: Skull, axial and appendicular skeleton **(2L)**
5. Food and feeding habits, Digestive system and its anatomical modifications **(3L)**
6. Respiration: Structure and functions of gills; adaptations for air breathing; role of air bladder. Respiratory functions of food **(2L)**
7. Buoyancy mechanisms: Role of fat and swim bladder **(2L)**
8. Excretion and Osmoregulation; Glomerular and aglomerular kidneys; Nitrogen(ammonia,urea, TMAO) excretions; water and salt and balance in steno-and euryhayline fishes. Role of skin and gills **(3L)**
9. Catadromous and anadromous fishes **(1L)**
10. Reproduction: Structure of gonads, gametogenic cycles; spawning, Parental care **(4L)**
11. Nervous system and Sense organs: Organization of the central and peripheral nervous systems. Eye, lateral line organs and chemoreceptors **(3L)**
12. Endocrine organs: Functions of the pituitary, thyroid, inter-renal and chromaffin tissues, ultimaobranchial and corpuscles of Stannius **(3L)**

REFERENCE BOOKS:

1. Bal, D. V. & K.V.Rao (1984). Marine Fisheries. Tata McGraw-Hill, New Delhi.
2. Bone, Q., N.B. Marshall & J.H.S. Blaxter (1995). Biology of Fishes, Edn.2, Blackie, Academic % Professional (Chapman & Hall), London.
3. Hoar, W.S. & D.J. Randall, (1969). Fish Physiology. Vols.I onwards, Academic Press, New York.
4. Jayaram, K.C. (1981). The freshwater fishes of India. Pakistan, Bangladesh, Burma and Sri Lanka- A Handbook. Zool. Survey of India, Academic Press, New York.
5. Khanna, S.S. (1984). An Introduction to Fishes. Central Book Depot., Allahabad.

6. Lagler, K.E., J.E. Bardach, R.R. Miller 7 D.R.M. Passino (1977). Ichthyology, Edn.2, Wiley, New York.

7. Talwar, P.K. & A.G. Jhingran (1991). Fish and Fisheries of India and Adjacent Countries, Vols. I & II. Oxford & I.B.H., New York.

8. Wake, M.H. (Ed.) (1979). Hyman's Comparative Vertebrate Anatomy. Edn.3, University of Chicago Press, Chicago

ZY 206 P: PRACTICALS IN ICHTHYOLOGY: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)

1. General external characters, fins and scales (permanent slides & temporary preparations); morphometric measurements **(1P)**

2. Classification of fishes (12-18 representatives of different orders); use of diagnostic keys **(1P)**

3. Pharyngeal basket and skull of lamprey; endoskeleton 9 articulated and disarticulated) of carp **(1P)**

4. Length-weight relationship, conditions factors, gonosomatic and hepatosomatic indices of any one species **(1P)**

5. Adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes, spiral valve, electric organs etc **(1P)**

6. Digestive, and reproductive systems of carp/catfish/Tilapia **(1P)**

7. Cranial nerves (V, VII, IX &X) and eye ball musoulature and innervations in Scoliodon and carp/catfish **(1P)**

8. Histology of digestive, respiratory, excretory, reproductive and endocrine organs **(1P)**

9. Chromatophores and their responses to external agent **(1P)**

10. Satiation index (e.g.Gambusia-mosquito larvae system) **(1P)**

11. Setting up of an aquarium and study of breeding behaviour of gourami Siamese fighter, swordtail/tilapia **(1P)**

12. Visit to fish farm/fish market. **(1P)**