

## DETAILS OF THE COURSE:

SEMESTER I	Animal Behaviour, Biosystematics, Non-Chordata & Chordata, Cell Biology, Biochemistry, Lab Course on CC/03-05.
SEMESTER II	Basic Techniques in Biology, Immunology, Molecular Biology, Animal Physiology, Endocrinology, Lab Course on CC/09-11. Human Health Awareness (OE).
SEMESTER III	Developmental Biology, Genetics and Evolution, Biostatistics and Bioinstrumentation, Lab Course on CC/14-16. <b>Specialization Course:</b> Cancer and Molecular Biology, Entomology and Toxicology, Ecology and Biodiversity.
SEMESTER IV	Animal Biotechnology and bioinformatics, Lab Course on CC/22, Dissertation. <b>Specialization Course:</b> Chronobiology and Reproductive Biology, Fish Biology and Toxicology, Conservation Biology.

## Course structure of M.Sc. Zoology

	CourseCode	Name of Course	Type of course	Credit distribution			Total Credits
				L	T	P	
<b>FIRST SEMESTER: 22 CREDITS</b> (Foundation Courses = 4 Credits; Core Course = 18 Credits)							
<b>1 SEMESTER</b>	ZOO/1/FC/01	*Animal Behaviour	FC	2	0	0	2
	ZOO/1/FC/02	*Biosystematics	FC	2	0	0	2
	<i>* Two FC courses can be selected from the pool of courses offered by the School</i>						
	ZOO/1/CC/03	Non-Chordata & Chordata	CC	4	1	0	5
	ZOO/1/CC/04	Cell Biology	CC	4	1	0	5
	ZOO/1/CC/05	Biochemistry	CC	4	1	0	5
	ZOO/1/CC/06	Lab Course on CC/03-05	CC	0	0	3	3
<b>SECOND SEMESTER: 22 CREDITS</b> (Foundation Courses = 4 Credits; Core course= 16 Credits; Open elective=2 Credits)							
<b>2 SEMESTER</b>	ZOO /2/FC/07	*Basic Techniques in Biology	FC	2	0	0	2
	ZOO/2/FC/08	*Immunology	FC	2	0	0	2
	<i>* Two FC courses can be selected from the pool of courses offered by the School</i>						
	ZOO/2/CC/09	Molecular Biology	CC	4	1	0	5
	ZOO /2/CC/10	Animal Physiology	CC	3	1	0	4
	ZOO /2/CC/11	Endocrinology	CC	3	1	0	4
	ZOO /2/CC/12	Lab Course on CC/09-11	CC	0	0	3	3
	ZOO /2/OE/13	Human Health Awareness	OE	2	0	0	2
<b>THIRD SEMESTER: 22 CREDITS</b> (Core course=12 Credits; Specialization Course=8 Credits; Open elective=2 Credits)							
<b>3 SEMESTER</b>	ZOO/3/CC/14	Developmental Biology	CC	2	1	0	3
	ZOO/3/CC/15	Genetics and Evolution	CC	2	1	0	3
	ZOO/3/CC/16	Biostatistics and Bioinstrumentation	CC	2	1	0	3
	ZOO/3/CC/17	Lab Course on CC/14-16	CC	0	0	3	3
	ZOO/3/SC/18	*Cancer and Molecular Biology	SC	2	1	1	4
	ZOO/3/SC/19	*Entomology and Toxicology	SC	2	1	1	4
	ZOO /3/SC/20	*Ecology and Biodiversity	SC	2	1	1	4
	<i>*Two SC courses can be select from the pool of courses offered by the Department. Students have flexibility to specialize in one or two specific areas. Specialization is through choosing a specific set of electives belonging to the chosen area or subject (<b>Option 1:</b> ZOO/3/SC/18 and ZOO /4/SC/24; <b>Option 2:</b> ZOO/3/SC/19 and ZOO /4/SC/25; and <b>Option 3:</b> ZOO /3/SC/20 and ZOO /4/SC/26).</i>						
	ZOO /3/OE/21	Poultry farming	OE	2	0	0	2
	<b>FOURTH SEMESTER: 22 CREDITS</b> (Core course= 14 Credits and Specialization Course=8 Credits)						
<b>4 SEMESTER</b>	ZOO /4/CC/22	Animal Biotechnology and bioinformatics	CC	4	1	0	5
	ZOO /4/CC/23	Lab Course on CC/22	CC	0	0	1	1
	ZOO /4/SC/24	* Chronobiology and Reproductive Biology	SC	2	1	1	4
	ZOO /4/SC/25	* Fish Biology and Toxicology	SC	2	1	1	4
	ZOO /4/SC/26	* Conservation Biology	SC	2	1	1	4
	<i>* Two SC courses can be selected from the pool of courses offered by the Department. Students have flexibility to specialize in one or two specific areas. Specialization is through choosing a specific set of electives belonging to the chosen area or subject (<b>Option 1:</b> ZOO/3/SC/18 and ZOO /4/SC/24; <b>Option 2:</b> ZOO/3/SC/19 and ZOO /4/SC/25; and <b>Option 3:</b> ZOO /3/SC/20 and ZOO /4/SC/26).</i>						
	ZOO /4/CC/27	Dissertation	CC	0	0	8	8
<b>Total Course Credits</b>							<b>88</b>

*The course for Master of Science (M.Sc.) in Zoology shall be based on choice based credit system and will comprise of four semesters of six months duration each. The whole course has been allocated 88 credits and will consists of 13 theory and 4 lab based courses out of which six courses come under the category of specialized courses with choice and two fundamental and two as open electives courses. The entire PG programme will have 64 credits for core courses, 16 credits for specialized courses, and 2 credits each for fundamental and open elective courses with a total of 8 credits. There will be a major project based on specialized courses of eight credits during the fourth semester. Each credit value for theory, tutorial and practical component shall be as defined in CBCS regulations (2012) of Mizoram University. The open electives shall be chosen from the other departments only.*

*There shall be continuous assessment for each theory paper that shall be based on written test, oral presentation, tutorial and assignments (40%) and practical course comprising 40% of total marks. There will be two components of assessment known as C1 and C2 in each semester. The remaining 60% marks will be evaluated during end semester examination.*

*There shall be thirty seats in M.Sc. (Zoology) programme. Department reserves the absolute right not to fill all the seats in M.Sc. Programme. The reservation policy for admission to this programme will be as per University rules and regulations. The candidates seeking admission to the M.Sc. programme should have passed B.Sc. taking Zoology as one of the subjects. The admission will be given on the basis of entrance examination alone or as the university rules prevailing at the time of admission.*

#### **INSTRUCTIONS**

- Smoking is strictly prohibited in the departmental premises including the class rooms, laboratory, other rooms and office.
- Use of departmental computers for printing and photocopying of the study materials by students is not permitted.
- 75% attendance is mandatory and failure to maintain this limit would debar a student to appear in the university examination.
- **Students are advised to maintain punctuality and strictly adhere to the time table.**
- **No break is allowed between class lectures except the lunch break of 30 minutes.**
- It is mandatory to submit practical records after completing the practical for signature from the concerned authority. Failure to compile with this direction could debar the students to appear in the final practical examination.
- Deposition of university examination fee within due date is mandatory.
- **NO CHANGE IN *OE* COURSES WILL BE ALLOWED ONCE OPTED.**
- The students are advised to be present in the examination hall ½ h before during the University examination.
- Maintenance of cleanliness and tidiness in the class room/s and laboratory is mandatory.
- The students are not allowed to enter into the store room/s.

- The students are advised to wash all the used glass and laboratory wares and deposit the same to the lab attendant immediately after completion of the practical work.
- It is mandatory to submit passport size photos for admit cards latest by 16 June, which can be collected by 30 June.
- Students are advised to maintain cordial relation among themselves and with the departmental staff.

# **ANIMAL BEHAVIOUR**

**ZOO/1/FC/01**

**Marks Scaled – 100**

**Credit =2**

**(L:T:P-2:0:0)**

**Lecturer Hrs – 30**

## **UNIT – I**

Concept and scope of ethology. Types of behaviour: innate and learned behavior. Learning and instincts: different types of learning behavior, habituation, conditioning-classical and instrumental, imprinting, and insight learning.

## **UNIT-II**

Communication: chemical, visual, and acoustic. Parental care: pattern and types. Biological rhythms and Biological clocks. Hormonal and Pheromones: their effect in control of behavior.

### **Suggested Readings : ZOO/1/FC/01**

1. Reena Mathur. (2009)Animal Behaviour. Rastogi Publications. 3<sup>rd</sup> revised and enlarge edition.
2. Alcock J. Animal Behaviour : An Evolutionary approach. Sinauer Assoc.Sunderland. Mass. USA.

# **BIOSYSTEMATICS**

**ZOO/1/FC/02**

**Marks Scaled – 100**

**Credit =2**

**(L:T:P-2:0:0)**

**Lecturer Hrs – 30**

## **UNIT I**

Basic concepts, importance and applications of Biosystematics. Trends in Biosystematics: conventional and current approaches (chemotaxonomy, cytotaxonomy and molecular taxonomy). Theories of biological classification and its importance; hierarchy of categories.

## **UNIT II**

Taxonomic procedures: Taxonomic collections, preservation, curating, process of identification. Typification: Details of different zoological types. Taxonomic keys: Different kinds of taxonomic keys, their merits and demerits. International code of zoological Nomenclature (ICZN): principles, interpretation and application of important rules, formation of scientific names of various taxa.

### **Suggested Readings : ZOO/1/FC/02**

1. Mayr E: Principles of Systematics Zoology. Tata McGraw Hill Pub. Company Ltd. 1980
2. Minelli A: Biological Systematics. Chapman and Hall. 1993
3. Alfred J R B, Das A K and Sanyal A K; Faunal Diversity in India. Zoological Survey of India. 1998

## **Non-Chordata and Chordata**

**ZOO/1/CC/03**

**Marks Scaled – 100**

**Credit =5**

**(L:T:P-4:1:0)**

**Lecturer Hrs – 75**

### **UNIT – I**

Protozoa: Nucleus and reproduction. Colonial protozoans and theories of the origin of metazoans. Porifera: canal system, Cnidaria: Nematocysts. Annelida: Adaptive radiation in polychaetes. Trochophore larva: structure and significance.

### **UNIT – II**

Mollusca: Modifications of foot. Arthropoda: Affinities of trilobites, Crustacean larvae and their significance. Echinodermata: larval forms and their significance. Salient features and affinities of Placozoa, Mesozoa, Rotifera and Phoronida.

### **UNIT – III**

Characteristic features and affinities: Protochordata, Hemichordata, Urochordata, Cephalochordata, Cyclostomes. Transition from agnatha to gnathostomata.

### **UNIT – IV**

Adaptive radiation in vertebrates: Aquatic, Terrestrial, Aerial, Arboreal, Fossorial. Parental care in amphibians. Egg laying mammals.

### **Suggested readings: (ZOO/1/CC/03)**

1. Barnes: Invertebrate Zoology (4th ed 1980, Holt-Saunders International)
2. Barnes: The Invertebrates – A synthesis (3rd ed 2001, Blackwell)
3. Hunter: Life of Invertebrates (1979, Collier Macmillan)
4. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)

# CELL BIOLOGY

**ZOO/1/CC/04**

**Marks Scaled 100**

**Credit – 5**

**(L:T:P-4:1:0)**

**Lecturer Hrs – 75**

## **UNIT - I**

Structure of model membrane, lipid bilayer. Structural organization and function of intracellular organelles (nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes).

## **UNIT – II**

Membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes). Cell division and cell cycle, regulation of cell cycle.

## **UNIT – III**

Structure & function of cytoskeleton and its role in motility. Cellular communication. Cell signaling: JAK-STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Signaling by nitric oxide and carbon monoxide. Bacterial chemotaxis.

## **UNIT – IV**

Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons). Polytene and lampbrush chromosomes.

### **Suggested readings:ZOO/1/CC/04**

1. Alberts et.al (2002) Molecular Biology of the cell (4<sup>th</sup> Ed.,) Garland.
2. Lodish et.al (2004) Molecular Cell Biology (5<sup>th</sup> Ed.,) Freeman.
3. Friedfelder, D (1998) Molecular Biology, Jones and Bartlett Publication.
4. Gardner, E.J. and Snustad D.P (2000) Principles of Genetics, John Wiley and Sons.



# BIOCHEMISTRY

ZOO/1/CC/05

Marks Scaled – 100

Credit =5

(L:T:P-4:1:0)

Lecturer Hrs – 75

## UNIT – I

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction).

## UNIT – II

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics: enthalpy and entropy, colligative properties). Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

## UNIT – III

Classification and properties of enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis. Enzyme inhibition, allosteric enzymes. Isozymes, ribozymes and abzymes.

## UNIT IV

Glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

### Suggested Readings: ZOO/1/CC/05

1. Nelson, D.L. and Cox, M.M.(2008) Lehninger Principle of Biochemistry, 3<sup>rd</sup> Ed Worth Pub.
2. Stryer, I. (2004). Biochemistry 4<sup>th</sup> edition, H. Freeman and Company.
3. Murray, R.K. et.al (1999) Harper's Biochemistry 25<sup>th</sup> ed. Prentice-Hall International
4. Plummer, L. (1989). Practical Biochemistry, Tata McGraw-Hill
5. Rawn, J.D. (1989) Biochemistry, North Carolina Biol, Supply Co.

## LAB COURSE ON ZOO/1/CC/03 - 05

ZOO/1/CC/06

Marks Scaled – 100

Credit =3

(L:T:P-0:0:3)

Hrs –60

### Non- Chordata and Chordata

1. Preparation of permanent slides: Principles and procedure.
2. Preparation of Museum specimens: Principles and procedure.
3. Study of salient features of museum specimens: Protozoa, Porifera, Cnidaria, Annelida, Arthropoda, Mollusca and Echinodermata.
4. Study of salient features of museum specimens: Fish, Amphibia, Reptiles, Birds and Mammals.
5. Study the digestive, excretory, nervous and reproductive systems.

### Cell biology:

1. Micrometry
2. Study of sex chromatin in human female from buccal epithelial cells.
3. Polytene chromosome preparation.
4. Study of bacterial growth curve.
5. Metaphase preparation of mouse.

### Biochemistry:

1. Buffer preparations.
2. Quantitative estimation of protein.
3. Estimation of enzymes.
4. Quantitative estimation of Carbohydrate.
5. Estimation of nucleic acid.

# **BASIC TECHNIQUES IN BIOLOGY**

**ZOO/2/FC/07**

**Marks Scaled – 100**

**Credit=2**

**(L:T:P-2:0:0)**

**Lecturer Hrs – 30**

## **UNIT – I**

Solutions, Buffer, pH, Molarity, Normality, biochemical calculations.  
Safety-chemical and radiation, Chromatography: principle and applications of TLC,  
column chromatography.

## **UNIT – II**

Principle and use of light microscope. Spectrophotometry, Centrifugation: principle  
and applications.

### **Suggested Readings: ZOO/2/ FC/07**

1. Wilson, K. and Walker, J. (2000). Principles and techniques of practical biochemistry, Cambridge University Press.
2. Boyer: (1993) Modern experimental biochemistry and molecular biology (2<sup>nd</sup> Edition), Benjamin/Cumin.
3. Harsis R (1991) Biological Microscopy for biology: A practical approach, Oxford, IRL press.
4. Murad H and Atique MVA (1991) Biological techniques in electron microscopy, CBSpublication.

# IMMUNOLOGY

**ZOO/2/FC/08**

**Marks Scaled – 100**

**Credit =2**

**(L:T:P-2:0:0)**

**Lecturer Hrs – 30**

## **UNIT – I**

Cells and organs involved in innate and adaptive immunity. Antigens, antigenicity and immunogenicity. Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions. Generation of antibody diversity, antibody engineering, activation and differentiation of B and T cells, B and T cell receptors, primary and secondary immune modulation.

## **UNIT-II**

Major histocompatibility complexes, antigen processing and presentation. Interferons, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies.

### **Suggested Readings : ZOO/2/FC/08**

1. Thomas J Kindt, Barbara A Osborne and Richard A Goldsby(2006) Kuby Immunology 6<sup>th</sup>Edn. WH Freeman Publication.
2. William E Paul (2003) Fundamental Immunology, Lippincott-Raven Publication, Philadelphia.
3. Roitt IM, Martin SJ, Delves PJ and Burton D, Roitt's(2006) Essential Immunology, Blackwell Science Publishing.
4. Owen, J., Punt, J. and Stranford, S. (2013). Kuby Immunology: International Edition Paperback.

# MOLECULAR BIOLOGY

ZOO/2/CC/09

Marks Scaled – 100

Credit =5

(L:T:P-4:1:0)

Lecturer Hrs – 75

## UNIT- I

Nucleic acids: Types, DNA replication, repair and recombination: Unit of replication, enzymes, replication origin and replication fork, fidelity of replication extrachromosomal replicons. DNA damage and repair mechanisms, homologous and site-specific recombination.

## UNIT- II

RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activator, promoter and repressor, RNA polymerases, capping, elongation, and termination. Structure and function of different types of RNA, RNA processing and transport.

## UNIT- III

Genetic code. Protein synthesis and processing, translational proof-reading, translational inhibitors, Post- translational modification of protein.

## UNIT- IV

Control of gene expression at transcription and translation level: regulating the expression of phages, regulation of gene expression by hormones and temperature, transcription attenuation, gene silencing (site directed mutagenesis, RNAi).

### Suggested readings: ZOO/2/CC/09

1. Brown T.A.2006 Genomes-3. John Wiley & Sons, Bios Scientific Publishers.
2. Gibson, Muse: A Primer to Genome Science. Sinauer Associates Inc.Pub.
3. LewinB : Genes VIII, John Wiley and sons.
4. Sambrook, Fritsch, Maniatis 2004.Molecular Cloning, Vol I-III Cold Spring Harbor,
5. Watson, J.D., Baker, T.A. Levine, M. Steohen, P.B. Gann, A. & Losick, R. Roberts & Steitz,Weiner Cummings : Molecular Biology of the Gene ( 5<sup>th</sup> Ed), Pearson education.

# ANIMAL PHYSIOLOGY

**ZOO/2/CC/10**

**Marks Scaled – 100**

**Credit – 3+1=4**

**(L:T:P-3:1:0)**

**Lecturer Hrs – 60**

## UNIT – I

Digestive system – Digestion and absorption of carbohydrates, lipids and proteins, energy balance, BMR. Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, neural and chemical regulation of respiration.

## UNIT – II

Blood and circulation - Haemopoiesis and formed elements, plasma function, blood groups, haemoglobin, haemostasis. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart. ECG – principle and significance, cardiac cycle, neural and chemical regulation of heart function.

## UNIT – III

Nervous system – Types and structure of Neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission and Neuromuscular junction. Sense organs - tactile response. Muscle: Types of muscle, ultra structure of skeletal muscle; Composition of muscle; Molecular, chemical basis and energetics of muscle contraction.

## UNIT – IV

Excretory system – Comparative physiology of excretion. Histological structure of kidney, mechanism of urine formation and its regulation, micturition, regulation of water balance, electrolyte balance, acid-base balance. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

### **Suggested Reading: ZOO/2/CC/10**

1. Hoar, W.S. (1983) General and Comparative Physiology, Prentice-Hall of India Pvt. Ltd.
2. Keele, C.A. and Neil, E. (1996) Samson Wright's Applied Physiology (12<sup>th</sup> Edition), ELBBS and Oxford University Press.
3. Randall, Burggren and French Eckert (1997) Animal Physiology (4<sup>th</sup> Edition), W.H. Freeman and company.
4. Schmidt – Nielsen. K. (1985) Animal Physiology: Adaptation and Environment, Cambridge.
5. Strand, F.L. (1997) Physiology – Regulatory System Approach Macmillan Publishing Co. Inc., New York.

# ENDOCRINOLOGY

**ZOO/2/CC/11**

**Marks Scaled – 100**

**Credit – 3+1=4**

**(L:T:P-3:1:0)**

**Lecturer Hrs – 60**

## **UNIT – I**

Hormones as second messengers: endocrine, paracrine and autocrine hormones. Structure and function of the hypothalamus: hypothalamo – hypophyseal system; feedback mechanism. Biosynthesis and physiological roles of hormones.

## **UNIT – II**

Types of hormone receptors. signal transduction mechanisms. Protein hormones: Membrane receptors G-proteins – cAMP signaling pathway. Thyroid hormones: Mechanism of action of thyroxine, tri-iodothyronine and tetra-iodothyronine. Mechanism of action of steroid hormones (genomic and non-genomic pathway).

## **UNIT – III**

Renin – Angiotensin System (RAS). Erythropoietin and Atrial Natriuretic Factor (ANF). Thymosins and Growth factors. Role of parathormone, calcitonin and cholecalciferol (Vit D) in calcium homeostasis. Role of insulin and glucagon in glucose homeostasis.

## **UNIT – IV**

Ovaries and testis, hormonal control of reproduction. Regulation of gonadal activity: Hypothalamus – hypophyseal – gonadal axis. Oestrous and menstrual cycles and their regulation by hormones. Pineal and photoperiodic regulation of breeding cycle of vertebrates.

### **Suggested readings: ZOO/2/CC/11**

1. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
2. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
3. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
4. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
5. Hadley: Endocrinology, Prentice Hall (2000, International Edition)

## **LAB COURSE ON ZOO/2/CC/09 – 11**

**ZOO/2/CC/12**

**Marks Scaled – 100**

**Credit =3**

**(L:T:P-0:0:3)**

**Lecturer Hrs –60**

### **Molecular Biology:**

1. Electrophoresis – Agarose
2. Isolation of plasmid/genomic DNA
3. Isolation of RNA
4. Restriction Digestion.
5. PCR

### **Animal Physiology:**

1. Measurement of human blood pressure.
2. RBC, WBC, total and differential count.
3. Identification of different blood cells.

### **Endocrinology:**

1. Study of endocrine glands in rat.
2. Estimation of hormones by ELISA (LH, FSH, Progesterone).
3. Demonstration of Hypothalamohypophysio gonadal (HPG) axis.
4. Histological preparation and immunocytochemical demonstration of endocrine tissues.



# Human Health Awareness

ZOO/2/OE/13

Marks Scaled – 100

Credit=2

(L:T:P-2:0:0)

Lecturer Hrs – 30

## UNIT-I

Health and modern life style diseases. Obesity, Diabetes mellitus type 1 and 2, Stroke and Hypertension – classification, effects on health, causes, pathophysiology, epidemiology, history, society and culture, diagnosis, prevention and management. Depression and stress – causes, assessment and treatment.

## UNIT-II

Tobacco use and diseases – forms of tobacco use, Chemicals and carcinogens present in tobacco, Role of tobacco in cardiovascular and dental diseases, Cancer- oral, breast, stomach and lung, Alcoholism: addiction and treatment, Drug abuse and addiction, Drug rehabilitation.

### Suggested readings: ZOO/2/OE/13

1. Peter Gluckman and Mark Hanson. 2008. Mismatch: The lifestyle diseases timebomb. Kindle Edition)
2. World Health Organization (WHO) (2000). Technical report series 894: Obesity: Preventing and managing the global epidemic. Geneva: World Health Organization
3. Centers for Disease Control and Prevention (CDC). 2010. How Tobacco Smoke Causes Disease The Biology and Behavioral Basis for Smoking-Attributable Disease. U.S. department of health and human services public health service.

# DEVELOPMENTAL BIOLOGY

ZOO/3/CC/14

Marks Scaled – 100

Credit =3

(L:T:P-2:1:0)

Lecturer Hrs – 45

## UNIT- I

Gametogenesis: Spermatogenesis - formation of spermatids and spermiogenesis; oogenesis- oocyte growth, maturation and vitellogenesis, types of eggs; Ovulation and ovum transport in mammals.

## UNIT- II

Fertilization: molecular events during pre- and post-fertilization, prevention of polyspermy, egg activation, embryo sac development. Cleavage- patterns and mechanisms; reorganization of embryonic cells – gastrulation and fate of germinal layers.

## UNIT- III

Morphogenesis and Organogenesis: Morphogenesis, cell aggregation and differentiation in *Dictyostellium*, *Dentalium* and sea urchin. Neural tube formation; organogenesis – development of brain and eye; concepts of embryonic induction, competence and organizer. Vulva formation in *Caenorhabditis elegans*. Metamorphosis. Environmental regulation of normal development.

## UNIT- IV

Developmental genetics: Differential gene expression: *Drosophila*- maternal genes, pattern and axis formation, homeotic genes, segmentation genes, origin of anterior-posterior and dorsal-ventral polarities. Vertebrates; organization and role of Hox gene and other pattern forming genes, formation of limb. Sex determination: Details of sex determination in *Drosophila* and mammals. Genomic imprinting - dosage compensation in *Drosophila* and human.

### Suggested Reading: ZOO/3/CC/14

1. Balinsky, B. I (1981) Introduction to Embryology. Hall Saunders, Philadelphia (5th ed.)
2. Alberts et al: Molecular Biology of the Cell (5th ed 2007, Garland)
3. Gilbert: Developmental Biology (8th ed 2006, Sinauer Associated Inc.)
4. Wolpert: Principles of Development (3rd ed 2007, Oxford)
5. Lewin: Genes IX (2008, Jones and Bartlett)
6. Snustad & Simmons: Principles of Genetics (2003, John Wiley)

# GENETICS AND EVOLUTION

ZOO/3/CC/15

Marks Scaled – 100

Credit =3

(L:T:P-2:1:0)

Lecturer Hrs – 45

## UNIT – I

Concept of evolution, Origin of life, Theories of evolution, Population genetics: Hardy-Weinberg Law, Rate of change of gene frequency through natural selection, migration, random genetic drift, Speciation (Allopatricity and sympatricity), Molecular evolution: gene and gene family, gene duplication and divergence, molecular clock.

## UNIT – II

Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, penetrance and expressivity linkage and crossing over, sex limited and sex influenced characters. Human genetics: Inheritance patterns, Pedigree analysis, Anticipation, Consanguinity and its measurement, Gene mapping methods: Genetic mapping and physical mapping.

## UNIT – III

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sexduction, fine structure analysis of genes, karyotyping. Quantitative genetics: Polygenic inheritance, heritability and its measurements, Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes.

## UNIT – IV

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, polyploidy and their genetic implications, Genetic disorders: Molecular, biochemical and chromosomal.

### Suggested Readings: ZOO/3/CC/15

1. Brooker: Genetics- Analysis and Principles, Benjamin
2. Hartl: Essential Genetics: A Genomic Perspective (3rd ed, Jones Blackett)
3. Dobzhansky: Genetics and the Origin of Species (1964, Columbia)
4. Dobzhansky: Evolution (1976, Surjeet Publ.
5. Freeman and Herron: Evolutionary Analysis (1998, Prentice Hall)
6. Futuyma: Evolutionary Biology (1998, Sinauer)
7. Hartl and Clark: Principles of Population Genetics (1989 & 1997, Sinauer)
8. Li Wen-Hsiung and Dan Graur: Fundamentals of Molecular Evolution (1991, Sinauer)

# **BIOSTATISTICS AND BIOINSTRUMENTATION**

**ZOO/3/CC/16**

**Marks Scaled – 100**

**Credit =3**

**(L:T:P-2:1:0)**

**Lecturer Hrs – 45**

## **UNIT – I**

Mean, median, mode. Sampling theory and sampling methods. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, measures of skewness and kurtosis. Measures of dispersion: variance, standard deviation, standard error, coefficient of variation.

## **UNIT – II**

Experimental design. Binomial, Poisson and normal distribution. Hypothesis testing. Chi square and t- test. ANOVA. Correlation and regression analysis.

## **UNIT – III**

Phase contrast, fluorescence, Electron microscopy: scanning and transmission. Spectrophotometry and spectrofluorometry: principles and applications. Principle and types of electrophoresis: Agarose and polyacrylamide, determination of molecular weight, isoelectrofocussing and SDS-PAGE, pulse field gel electrophoresis. Immunological techniques – antigen and antibody preparation and purifications, immunodiffusion, immunoelectrophoresis,

## **UNIT – IV**

ELISA and its applications. Polymerase chain reaction (PCR) and types. Blotting techniques: Northern, Southern, Western and South Western. Immuno-precipitation and Co-IP. DNA sequencing and genome analysis. DNA microarray.

### **Suggested readings ZOO/3/CC/16**

1. Bailey, N.T.J. (1997) Statistical Methods in Biology, III Edn., Cambridge, University Press, New York.
2. Snedecor, G.W., William, G. (1975) Statistical Methods, Harvard University, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Boyer: (1993) Modern experimental biochemistry and molecular biology (2<sup>nd</sup> Edition), Benjamin/Cumin.
4. Stiles et al (1991) Basic and clinical immunology, Prentice-Hall International Inc.
5. Murad H and Atique MVA (1991) Biological techniques in electron microscopy, CBS publication.

## LAB COURSE ON ZOO/3/CC/14 – 16

ZOO/3/CC/17

Marks Scaled – 100

Credit =3

(L:T:P-0:0:3)

Lecturer Hrs –60

### Developmental Biology:

1. Study of frog and mouse sperm and sperm smear preparation.
2. Study of developmental stages of frog and chick embryos from permanent slides.
3. Observation of chick embryo.

### Evolution and Genetics:

1. Pedigree analysis
2. Phylogenetic analysis.
3. Handling of *Drosophila* and study of its life cycle

### Biostatistics & Bioinstrumentation

1. Electrophoresis: Agarose and PAGE
2. Isolation of RNA/genomin DNA
3. PCR
4. Western Blot
5. Determination of melting temperature of nucleic acid.
6. ANOVA
7. Correlation and regression analysis

# CANCER AND MOLECULAR BIOLOGY

ZOO/3/SC/18

Marks Scaled – 100

Credit =4

(L:T:P-2:1:1)

Lecturer Hrs – 60

## UNIT – I

Cell cycle and Cell death: Mitosis, Meiosis, Genetic regulation of cell cycle, Apoptosis and Necrosis. Characteristics of Cancer: Benign tumour, Malignant tumour, Mechanism of metastasis, Tumour angiogenesis, Cancer staging.

## UNIT – II

Genetic basis of cancer: Proto-oncogene and oncogene, Tumour suppressor gene, Tumour viruses and retrotransposons, Growth factors and signal transduction, Animal models of cancer, Cytotoxicity testing, concept of LD<sub>50</sub>.

## UNIT – III

Euchromatin and heterochromatin, Chromosome banding pattern, chromosome remodeling and gene expression. Post-transcriptional processing: Slicing and alternate splicing, mRNA stability, RNA editing. Radiation syndrome, Radiation induced chromosome damage.

## UNIT – IV

Chemical carcinogenesis: Initiation, Promotion and Progression, Radiation induced carcinogenesis: Initiation, Promotion and Progression, Ultraviolet ray induced carcinogenesis. Ionizing radiations: particulate and wave radiations. Radiolysis of water. Effects of radiation: Radiosensitization, Radioprotection.

### Practicals: ZOO/3/SC/18

1. Free radical estimation,
2. Trypan Blue dye exclusion,
3. Cytotoxicity (MTT assay) and acute toxicity tests, Tumor transplantation.
4. Apoptosis morphological and DNA ladder.
5. Chromosome aberration.

### Suggested readings ZOO/3/SC/18

1. Lauren Pecorino (2012) Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (2nd Edition) by Oxford University Press
2. Weinberg, Robert A. (2007) The Biology of Cancer. New York: Garland Science.
3. Raymond W. Ruddon (2007) Cancer Biology. Oxford University Press.
4. L. M. Franks, N. M. Teich (1997) Introduction to the Cellular and Molecular Biology of Cancer. Oxford University Press
5. John Mendelsohn (2008) The molecular basis of cancer. Saunders/Elsevier
6. Eric J. Halland Amato Giaccia (2011) Radiobiology for the Radiologist. 7<sup>th</sup> edition. Lippincott Williams and Wilkins.
7. A.P. Casarett (1968) Radiation Biology .Prentice Hall
8. Forshier Steven (2002) Essentials of Radiation Biology and Protection. Delmar

# ENTOMOLOGY AND TOXICOLOGY

**ZOO/3/SC/19**

**Marks Scaled – 100**

**Credit =4**

**(L:T:P-2:1:1)**

**Lecturer Hrs – 60**

## **UNIT-I**

Importance and taxonomic richness of insects. Integument: structure and functions of cuticle, sclerotization and colouration. Types of head and antennae. Types of legs and wings. Endocrine system and function of hormones. Haemolymph. Aerial and aquatic respiration. Digestive, Excretory and Reproductive systems.

## **UNIT-II**

Chemical communication, insect pest management, vector control methods. Parasites and parasitism. Distribution, habit and habitat, structure, life cycle and diseases caused by *Entamoeba histolytica* and *Leishmania donovani*. Larval forms of Platyhelminthes and Nematelminthes. Distribution, habit and habitat, structure, life cycle and diseases caused by *Wuchereria bancrofti*.

## **UNIT-III**

Principles of Toxicology: Introduction, classification of toxicants, characteristics of exposures, route and site exposure, duration and frequency of exposure, undesired effects, interaction of chemicals, dose response, dose response relationship, comparison of dose response, variation in toxic responses, models and bioassay: methods in toxicity testing (Insects and rodents).

## **UNIT-IV**

Classification and effects of toxic agents (pesticides, heavy metals, phytohormones, chemicals, carcinogens and animal toxins). Enzymes involved in metabolism of xenobiotics (Mixed function oxidases (cytochrome P450), Esterases, Glutathione-S-transferases. Synergists and enzyme inhibitors.

### **Practicals: ZOO/3/SC/19**

1. Haemocyte profiling of insect haemolymph.
2. Study of insect antennae, legs, wings.
3. Study of different parasites using permanent slides.
4. Toxicity studies in insects and rodents.

### **Suggested Readings: ZOO/3/SC/19**

1. Chapman, R.F (1998). The insect structure and function, ELBS edition, London.
2. Wigglesworth, V.B. (1973) The Principles of Insect Physiology, 7<sup>th</sup> Ed. Chapman and Hall, London.
3. Chatterjee K D (1980) Parasitology 12th Ed. Chatterjee Medical Pub., Calcutta.
4. Principles of Toxicology by Karen Stine, Thomas M. Brown.
5. Text Book of Pathology by Harsh Mohan, Jaypee Brothers.
6. Principles and Methods of Toxicology by A. Wallace Hayes.
7. Srivastava, R. 1989. Text Book of Insect Toxicology. Himanshu Publications.

# ECOLOGY AND BIODIVERSITY

ZOO/3/SC/20

Marks Scaled – 100

Credit =4

(L:T:P-2:1:1)

Lecturer Hrs – 60

## UNIT-I

Definition, structure and function of ecosystem. Types of ecosystem; Concept of production and ecosystem productivity: primary and secondary productivity. Measurement of productivity of ecosystems, nutrient cycling in different ecosystems, energy flow in terrestrial and aquatic ecosystems.

## UNIT-II

Population: Definition, and types of population. Structure and composition of population. 'r' & 'k' selection. Population dynamics: growth models- logistic, geometric, and stochastic. Population interactions: competition, predation, parasitism, herbivory, and symbiosis.

## UNIT-III

Community: definition, types, structure- composition and analysis. Stratification/hierarchy, Community dynamics- stability, equilibrium, and non-equilibrium. Community development and succession Role of animal community in ecosystem.

## UNIT-IV

Concept of wildlife and biodiversity, value of biodiversity. Ecology of wildlife: population ecology and habitat ecology. Habitat types, structure, and component, and habitat diversity measurement. Measuring species diversity: Theory and calculation of indices of species diversity, evenness, richness, dominance. Concept of biodiversity Hotspots and centre for mega biodiversity. Status at global and regional level. Cause of decline of biodiversity. Global warming and climate change.

### Practicals: ZOO/3/SC/20

1. Specific conductivity of soil and water samples.
2. Estimation of organic content of soil samples.
3. Estimation and comparison of dissolved oxygen in water samples.
4. Estimation of primary production of aquatic body by light and dark bottle method.
5. Estimation of population size of known and unknown samples.
6. Analysis of soil macro fauna on disturbed and undisturbed habitat.

### Suggested readings: ZOO/3/SC/20

1. Smith, R.L and Sminth, T.M. (1998) Elements of Ecology. Benjamin/Cummings Science Publishing. 4<sup>th</sup> edition.
2. Dash, M.C. (2003) Fundamentals of Ecology. Tata McGraw-Hill publishing company Ltd, New Delhi.
3. Margurran, A.E. (2003) Measuring Biological Diversity. Blackwell Publishing Company.
4. Richard Primack. Essentials of Conservation Biology. Saunders Philadelphia Inc. USA
5. Krebs, C.J.: Ecological Methodology. Harper & Row, New York
6. Louw G.N.: Physiological Animal Ecology. Longman Harloss. U.K.



# **POULTRY FARMING**

**ZOO/3/OE/21**

**Marks Scaled – 100**

**Credit =2**

**(L:T:P-2:0:0)**

**Lecturer Hrs – 30**

## **UNIT-I**

Classification of poultry. common breeds of poultry including duck, quail, turkey and guinea fowl and their descriptions. Economic importance of poultry farming. Description of indigenous fowls. Reproduction in fowl, Hatching and feeding norms for chicken.

## **UNIT-II**

Care and management of growing, laying/broiler birds of both breeders and commercial categories of poultry. Types of poultry houses. Common poultry diseases and drugs for treatment; vaccinations schedule for commercial layers and broilers.

### **Suggested readings: ZOO/3/OE/21**

1. Scanes, C.G. Brant, G and Ensminger, M.E. (2004). Poultry Science, 4<sup>th</sup> Ed.
2. Sreenivasaiah, P.V. (2006). Scientific Poultry Production – a unique encyclopedia, 3<sup>rd</sup> Ed.
3. Jull, M.A. (2003). Successful Poultry Management.

# **ANIMAL BIOTECHNOLOGY AND BIOINFORMATICS**

**ZOO/4/CC/22**

**Marks Scaled – 100**

**Credit =5**

**(L:T:P-4:1:0)**

**Lecturer Hrs – 75**

## **UNIT – I**

Genetic engineering: Restriction endonucleases and other enzymes, Plasmids and plasmid vectors, Phages and Phage Vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC).

## **UNIT – II**

Recombinant DNA techniques, construction of genomic DNA and cDNA libraries, screening of recombinants,. Reporter assays, Phage display, Yeast two hybrids. Stem cells.

## **UNIT – III**

Sterilization, Culture media, Basic techniques of mammalian cell cultures: Primary, secondary and suspension culture, contamination, Cell viability and Cytotoxicity, Cell freezing, Hybridoma technology, Organ culture.

## **UNIT – IV**

Protein and nucleotide databases, BLAST and FASTA, Sequence alignment, local and global alignments, PAM and BLOSUM, Motifs and Domain, Protein structure prediction.

### **Suggested Readings: ZOO/4/CC/22**

1. Orengo(2003) Bioinformatics, Genes, Proteins and Computers Garland Book Publishers.
2. Primrose (2007) Principles of genome analysis and genomics Indian reprint edition.
3. Barnes and Gray (eds.) (2003) Bioinformatics of geneticists, Wiley.
4. Lesk(2003) Bioinformatics, Oxford (Indian ed).
5. Westhead et.al (2003) Bioinformatics Instant Notes, Viva Books (Indian edition).
6. Baxevanis A.D. and FrancisOuelletele B.F. (2001) Bioinformatics – A practical guide to the analysis of genes & proteins John Wiley &sons publication, New York.

## Lab Course on ZOO/4/CC/22

ZOO/4/CC/23

Marks Scaled – 100

Credit =1

(L:T:P-0:0:1)

Lecturer Hrs –30

### Animal Biotechnology

1. Preparation of liquid and solid media for growth of microorganisms (*E.coli*).
2. Isolation and maintenance of organisms by plating, streaking and serial dilution method, slant and stab cultures, storage of microorganisms.
3. Preparation of cell culture medium and membrane filtration.
4. Preparation of single cell suspension from spleen and thymus.
5. Cell counting, cell viability, MTT and clonogenic assays
6. PCR
7. SDS-PAGE and Western blotting

### Bioinformatics

1. Retrieval of DNA and protein information from Databases.
2. Blast
3. Physico-chemical properties of protein
4. Restriction mapping and in silico PCR
5. Prediction of protein structure

# CHRONOBIOLOGY AND REPRODUCTIVE BIOLOGY

ZOO/4/SC/24

Marks Scaled – 100

Credit =4

(L:T:P-2:1:1)

Lecturer Hrs – 60

## UNIT – I

Geophysical environment - Seasons; proximate and ultimate factors. Photoperiodism: concepts and models. Evolution of photoperiodism: comparative studies; Photosensitivity and photorefractoriness. Photo-transduction.

## UNIT II

Role of photic and non-photoc cues in reproduction, Critical day length, Melatonin and seasonal phenomena. The physiological clock and measurement of day length, Circannual rhythms and seasonality, Endocrinology and Molecular bases of seasonal breeding.

## UNIT III

Testis: Spermatogenesis and hormonal regulation, Sertoli cell, Leydig cell, Cell – cell interactions; Male accessory sex glands, Functions of accessory sex glands. Regulation of ovarian function: Follicular development and selection, Regulation of steroidogenesis, Factors involved in follicular rupture, Follicular atresia.

## UNIT IV

Control of male fertility: Suppression of spermatogenesis, Chemicals acting directly on the testis, Vasectomy; Male sterility: Parameters of male sterility, Origin and cause of male sterility, Azoospermia, Oligozoospermia. Control of female fertility: oral contraceptives, intrauterine devices, Female sterility: Tubal factors Premature ovarian failure, Polycystic ovarian syndrome, Primer pheromones: Estrous cycle disruption, Whitten effect, Bruce effect

## Practicals:

1. Preparation of permanent slides of reproductive organs: testis and ovary.
2. Biochemical estimation of  $3\beta$ -hydroxyl steroid dehydrogenase
3. Study of oestrous cycle of rat by vaginal smear preparation.
4. Study of sperm motility, sperm morphology, and sperm count.
5. Experiments demonstrating the photoperiodic clock.
6. Melatonin measurement from seasonal breeders

## Suggested Readings: ZOO/4/SC/24

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
2. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.
3. Leung and Adashi: The Ovary (2004, Raven Press)
4. Adashi et al: Reproductive Endocrinology, Surgery and Technology (1996, Lippincott- Ravenpublishers)
5. Mann & Lutwak-Mann: The Male Reproductive Function and Semen (1998, Springer)

# FISH BIOLOGY AND TOXICOLOGY

ZOO/4/SC/25

Marks Scaled – 100

Credit =4

(L:T:P-2:1:1)

Lecturer Hrs – 60

## UNIT I

Diversity and characteristic features of freshwater, marine and brackish water habitat. Classification of planktons and planktonic adaptations. Distribution and impact of environment on the aquatic biota. Types, origin and thermal stratification of lakes. Biomagnification. Process of eutrophication and its impact. Water bodies of Mizoram.

## UNIT II

Locomotion and locomotory organs in fishes. Respiratory system and accessory respiratory organs in fishes. Physiology of respiration. Urino-genital system. Migration in fishes. Common fish diseases. Fish diversity in Mizoram

## UNIT-III

Oxidative stress, non-enzymatic enzymatic and other sources, function and generation of ROS, pathways involved in ROS. pathophysiological role of ROS, antioxidant defense systems (endogenous and exogenous). Role of dietary nutrients, phytochemicals in defense mechanism.

## UNIT-IV

Organ toxicity: Blood, liver, kidney, respiratory, nervous, cardiovascular, skin, reproductive, eye, endocrine and immune systems.

### Practicals:ZOO/4/SC/25

1. Estimation and comparison of free CO<sub>2</sub> content of aquatic system.
2. Estimation of total alkalinity/total hardness/ chloride contents in water samples.
3. Qualitative and quantitative analysis of plankton from different aquatic systems.
4. Estimation of lipid peroxidation and antioxidant enzymes.
5. Organ toxicity studies in mice/rats.

### Suggested Readings:ZOO/3/SC/25

1. Allan, J.A:(1995) Stream Ecology: Structure and function of running waters. Chapman & Hall.
2. Brown M.E: The Physiology of Fishes Vol.I&II. Academic Press.
3. Closs G, Downes B, Boulton A (2004) Freshwater Ecology, Blackwell Science Publishing.
4. Davenport J (2003) Aquaculture, Blackwell Science Publication.
5. Jefferies, M. and Mills. D (1992) Freshwater Ecology, CBS Publishers.

## Conservation Biology

ZOO/4/SC/26

Marks Scaled – 100

Credit =4

(L:T:P-2:1:1)

Lecturer Hrs – 60

### UNIT -I

Introduction and scope of conservation biology; Value of biodiversity: ecological, economic, ethical and social value; Concept and categories of threatened species. Concepts of biodiversity; Patterns, processes, and levels of biodiversity. Threats to biodiversity

### UNIT-II

Genetics and conservation biology. Heterozygosity and population genetics, fitness consequences of variation, co-adaptations, local adaptations. Out-breeding depression and inbreeding depression. Loss of genetic variations, genetically effective population size, and bottleneck effect. Metapopulations and their role in conservation.

### UNIT-III

Impact of human activities on habitat alternation; fragmentation, heterogeneity, mosaics and patch dynamics. Edge effect and, changes in species composition. Area effects and island biogeography theory. Impact of climate change.

### UNIT-IV

Prioritization of Conservation: Single species approach, Multi species approach. Methods of setting conservation priorities. Conservation strategies: *in-situ*, *ex-situ*, *in-vitro*; Protected areas: categories, protected area network; role of protected area in conservation. National level conservation projects.

### Practicals ZOO/4/SC/26

1. Animal Sampling techniques.
2. Animal population Census techniques.
3. Population analysis techniques.
4. Sampling techniques for community analysis
5. Quantitative characterization of community for frequency.
6. Quantitative characterization of community for diversity.
7. Quantitative characterization of community for dominance.

### Suggested Reading: ZOO/4/SC/26

1. Rajesh Gopal: (1993) Fundamentals of wildlife management. Justice Home Publications.
2. Agrawal, K.C. (2002) Global biodiversity. Nidhi Publications.
3. Groombridge. (1992) Global biodiversity-status of earth's living resources. Chapman & Hall, London.
4. Gary, K.M. & Carroll, R.C. (1994) Principles of Conservation Biology. Sinauer Associates, Inc. Publishers, Sunderland, USA.
5. Primack, Richard B. (2002) Essentials of Conservation Biology. Sinauer Associates, Inc. Publishers, Sunderland, USA.
6. Berwick, S.H. and Sahara, V.B. (1995) Wild life research and management – Asian and American approaches. Oxford University Press, Delhi.
7. Southwood, T.R.E and P.A. Henderson (2000) Ecological Methods. Blackwell Science, Oxford.

## DISSERTATION

ZOO/4/CC/27

Marks Scaled – 100

Credit =8

(L:T:P-0:0:8)

Hrs: 120

**Dissertation is based on the specialization courses opted in III and IV semester by the student. Students have flexibility to specialize in one or two specific areas. Specialization is through choosing a specific set of electives belonging to the chosen area or subject (Option 1: ZOO/3/SC/18 and ZOO /4/SC/24; Option 2: ZOO/3/SC/19 and ZOO /4/SC/25; and Option 3: ZOO /3/SC/20 and ZOO /4/SC/26).**