

**SIDHO-KANHO-BIRSHA  
UNIVERSITY**

**COMPLETE SYLLABUS**

**SUBJECT : ZOOLOGY**

**SIDHO-KANHO-BIRSHA UNIVERSITY**  
**SYLLABUS**  
**SUBJECT : ZOOLOGY**  
**Total Marks :1200**

<b>SEMESTER</b>	<b>Course Code</b>	<b>Course title</b>		<b>Credit</b>	<b>Marks</b>	<b>No. of Class hr./week</b>
<b>SEMESTER- I</b>	<b>MZOOCCT101</b>	<b>Non-Chordates: Structures &amp; Function</b>		<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT102</b>	<b>Chordates: Structures &amp; Function</b>		<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT103</b>	<b>Unit-I</b> <b>Endocrinology &amp; Reproductive biology</b>	<b>Unit-II</b> <b>Animal Physiology &amp; Biochemistry</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT104</b>	<b>Unit-I</b> <b>Cell structure and Function</b>	<b>Unit II</b> <b>Developmental Biology</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT105</b>	<b>Practical</b>		<b>4</b>	<b>50</b>	<b>8</b>

	<b>MZOCCS106</b>	<b>Practical</b>	<b>4</b>	<b>50</b>	<b>8</b>
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<b>SEMESTER</b>	<b>Course Code</b>	<b>Course title</b>		<b>Credit</b>	<b>Marks</b>	<b>No. of Class hr./week</b>
<b>SEMESTER- II</b>	<b>MZOOCCT201</b>	<b>Unit-I Genetics</b>	<b>Unit – II Evolutionary Biology</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT202</b>	<b>Unit-I Ethology and Ethnobiology</b>	<b>Unit-II Ecology</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT203</b>	<b>Unit-I Parasitology and Microbiology</b>	<b>Unit-II Immunobiology</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT204</b>	<b>Unit-I Applied Entomology</b>	<b>Unit – II Aquaculture</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOCCS205</b>	<b>Practical</b>		<b>4</b>	<b>50</b>	<b>8</b>

	<b>MZOCCS206</b>	<b>Practical</b>	<b>4</b>	<b>50</b>	<b>8</b>
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<b>SEMESTER</b>	<b>Course Code</b>	<b>Course title</b>		<b>Credit</b>	<b>Marks</b>	<b>No. of Class hr./week</b>
<b>SEMESTER III</b>	<b>MZOOCCT301</b>	<b>Unit-I Molecular Biology and Biotechnology</b>	<b>Unit – II Environmental Biology &amp; Toxicology</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOCCT302</b>	<b>Unit-I Bio Systematics</b>	<b>Unit-II Biodiversity and Wild life conservation</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOMET303</b>	<b>Unit-I</b>	<b>Unit-II</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOOET304</b>	<b>Open Elective</b>		<b>4</b>	<b>50</b>	<b>4</b>
	<b>MZOCCS305</b>	<b>Practical</b>		<b>4</b>	<b>50</b>	<b>8</b>

	<b>MZOOOPP306</b>	<b>Outreach Program</b>	<b>4</b>	<b>50</b>	<b>8</b>
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<b>SEMESTER</b>	<b>Course Code</b>	<b>Course title</b>		<b>Credit</b>	<b>Marks</b>	<b>No. of Class hr./week</b>
<b>SEMESTER IV</b>	<b>MZOOCCT401</b>	<b>Unit-I Neurobiology</b>	<b>Unit – II Biostatistics &amp;Introduction to bioinformatics</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOMET402</b>	<b>Unit-I</b>	<b>Unit-II</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOMET403</b>	<b>Unit-I</b>	<b>Unit-II</b>	<b>4</b>	<b>40+10</b>	<b>4</b>
	<b>MZOOMES404</b>	<b>Practical</b>		<b>4</b>	<b>50</b>	<b>8</b>
	<b>MZOOMEPEP405</b>	<b>Project</b>		<b>4</b>	<b>50</b>	<b>8</b>

	<b>MZOOACT406</b>	<b>Add on Course</b>	<b>4</b>	<b>50</b>	<b>4</b>
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## **Semester-I**

### **Paper –MZOOCCT101**

#### **(Non Chordates: Structure and function)**

**Total marks: 50**

**No. of Class Hrs. 60**

#### **1. General Organization**

1.1 Organelles in Protozoans- Cilia, flagella, pseudopodia, vacuoles, Kinetoplast, Pellicle and skeleton.

1.2 Integument of insect: Structure and functions.

#### **2. Feeding and Digestion**

2.1 Nutrition in Protozoa -Types and mode of feeding.

2.2 Feeding diversity in Insects, Bryozoans and Echinoderms- Structural diversities.

#### **3. Movements**

3.1 Movements in Amoeba , Annelids (Earthworm); Echinoderms (Starfish).

#### **4. Blood Circulation**

Insect blood - Composition, structure and function.

Circulation in Earthworm, Cockroach and Pila

Types of blood circulation (open and close types).

#### **5. Excretion**

5.1 Structure and function of kidneys in cephalopods

#### **6. Photogenic Organs**

6.1 Diversity of photogenic organs.

6.2 Photogenic organs and light production in insects.

## **7. Reproduction**

7.1 Reproductive mechanism: Parthenogenesis, viviparity, paedogenesis, polyandry and hermaphroditism in insects.

7.2 Budding and regeneration in Hydra and Planarians.

7.3 Invertebrate hormones of reproduction with reference to Crustacea and Insects.

## **8. Growth and Development**

8.1 Metamorphosis and diapause in insects: Types and hormonal regulation

8.2 Moulting in Crustaceans: Hormonal regulation

8.3 Larval forms in echinoderms and hemichordates.

### **Books Recommended :**

1. Barrington, ESW – Invertebrate structure and Function. Nelson & Sons Ltd,
2. Ruppert & Barnes – Invertebrate Zoology.
3. Anderson – Invertebrate Zoology
4. Meglisch & Schram – Invertebrate Zoology,
5. Gillot, C. (1995) – Entomology. Plenum Press.



6. Gullan & Cranston, PJ (2005). An outline of Entomology. Blackwell Press.
7. J.A. Pechenik-Biology of the Invertebrates
8. Brusca and Brusca-Invertebrate

## **SEMESTER I**

### **Paper MZOOCCT102**

#### **Chordates: Structures and Functions**

**Marks: 50**

**No. of Class Hrs. 60**

#### **1. Protochordates**

- 1.1 Ultrastructure and role of notochord and endostyle in Amphioxus and Ascidia with evolutionary significance.

#### **2. Skeletal system**

- 2.1 Origin of jaw and modification of jaw bones and jaw suspension.
- 2.2 Jaw kinetics in relation to feeding.

#### **3 Respiratory system**

- 3.1. Prerequisites of respiratory system and functional requirements
- 3.2. Ventilatory mechanisms in relation to diverse adaptations: aquatic and terrestrial

#### **4. Circulatory system**

- 6.1 Heart and Circulation in foetal and neonatal mammals.

#### **5. Excretion**

- 5.1. Evolution of urinogenital system in vertebrate series

5.2 Structure and functions of kidneys with sp. ref. to fish and mammals

**6. Nervous system**

8.1 Functional organization of brain and evolution of cerebrum.

8.2. Functional association of CNS and information processing.

**7. Sense organs**

7.1. Diversity of sensory organs-Organs of olfaction and taste, Vomeronasal organs in reptiles, electroreception in fish

**8.Locomotion and movement**

9.1 Aquatic

9.2 Evolution of land vertebrates

9.3 Kinetics of locomotory organs in land vertebrates: general requirements of cursors, design for economy of effort, mechanism of bipedal running

9.4 Aerodynamics-general requirements of flyers: lift, drag, flight and control

**Books Recommended:**

1. Kent - Comparative Anatomy of the vertebrates, 9<sup>th</sup> Edition.
2. Hilderbrand M- Analysis of vertebrate structure, 5<sup>th</sup> edition.
3. McFarland, W N Pough, F.H. and Cade, T - Vertebrate life, L 4<sup>th</sup> Edition, 1996
4. Klugg - Chordate Structure and function
5. Kardong- Vertebrate comparative anatomy, function and evolution, , 3<sup>rd</sup> Edition
6. Young J Z - Life of Vertebrates
7. Romer - Vertebrate Body
8. Walker and Liem- Functional anatomy of the vertebrates
9. Kingsley, J.S.: Outline of comparative anatomy of vertebrates

## **SEMESTER - I**

### **Paper MZOOCCT103**

#### **Unit I**

#### **Endocrinology and Reproductive biology**

**Marks: 25**

**No. of Class Hrs. 30**

#### **Endocrinology**

##### **1. Hormones:**

- 1.1. Classification of hormones.
- 1.2. Nature of hormone receptors.
- 1.3. Hypothalamic hormones – their structure and functions.
- 1.4. Anterior pituitary cell ultra structures, nature of hormones and their functions.

##### **2. Mechanism of hormone action**

- 2.1 General principles of hormone action
- 2.2 Receptor Biology
- 2.3 Cell signaling transduction pathways

##### **3. Biosynthesis, functions and metabolism of hormones.**

- 3.1 Thyroid hormone structure and functions.
- 3.2 Adrenocortico-medullary hormones -- structure and functions.
- 3.3 Endocrine pancreas : cell types, hormone structure and their role in glucose homeostasis.
- 3.4 GI tract hormones : source, composition and functions.

4. Neurosecretion - structure and functions of oxytocin and vasopressin.

## **Reproductive Biology**

- 1. Development of male and female genital systems in rat/human.**
- 2. Hormonal control of testicular functions:**
  - 2.1 Biosynthesis and metabolism of androgens.
  - 2.2 Hormonal control of spermatogenesis, Sertoli-cell-spermatid interaction and sperm induction.
  - 2.3 Influence of androgens on extra-gonadal tissues.
- 3. Endocrinology of female sexual cycle :**
  - 3.1 Biosynthesis and metabolism of ovarian hormones.
  - 3.2 Interrelationship between ovarian hormones and ovarian follicles, uterus and vagina.
  - 3.3 Hormonal control of folliculogenesis, ovulation and oocyte maturation.
  - 3.4 Physiological role of ovarian steroids on extragonadal tissues.
- 4. Endocrine physiology of gestation , parturition and lactation.**
- 5. Control of fertility:**
  - 6.1 Modes and methods of male and female fertility control.
  - 6.2 Endocrine malfunction induced male and female infertility.

### **Referred Books:**

1. William's Text Book of Endocrinology ---- S.Melmed,  
K.S.Polonsky, P.Reed and others, 12<sup>th</sup> Edition, 2012, W.B.Saunders  
Co. --.1920.
2. Basic Medical Endocrinology ----- H.M.Goodman, Academic  
Press, San Diego 2003. Printed in India by Elsevier India Pvt. Ltd.  
2006.
3. Endocrinology-- L.J.De Groot and J.L.Jameson (ed.), 2005,  
W.B.Saunders Co. Philadelphia, USA. ( 3 Volumes
4. Molecular Endocrinology: G.Ramsby and S.M. Farrow

## **SEMESTER- I**

### **Paper MZOOCCT103**

#### **Unit II**

#### **Animal Physiology & Biochemistry**

**Marks : 25**

**No. of Class Hrs. 30**

#### **Animal Physiology**

#### **1. Size and scale of organisms**

- 1.1. Size and surface area to volume ratio.
- 1.2. Scaling relationship between BMR and body mass
- 1.3. Metabolic rate as a function of animal speed in Locust and Cheetah.

#### **2. Thermal physiology**

- 2.1. Body temperature: physical, chemical and neural regulation.
- 2.2. Heat transfer between animal and environment.

2.3. Poikilothermy and homoeothermy.

### **3. Physiology of Respiration**

3.1. Respiratory pigments and mechanism of respiration in animals.

3.2. Respiratory adaptation in animals in oxygen deficient environment.

3.3. Regulation of blood pressure.

### **4. Physiology of Excretion**

4.1. Physiology of urine formation and its regulation.

4.2. Renal regulation of water and electrolyte balance.

### **5. Physiology of blood and body fluid**

5.1. Haemopoiesis

5.2. Composition and functions of blood plasma and corpuscles in vertebrates.

5.3. Body fluid: Function and regulation.

### **5. Physiology of muscles**

6.1. Role of ATP and signal molecules in muscular contraction

6.2. Neural regulation in muscular contraction.

## **Biochemistry**

### **1. Protein, Carbohydrates and Lipid metabolism**

1.1. Proteins : Protein folding and protein stability

1.2. Carbohydrates: Glycolysis, glycogenolysis, gluconeogenesis, TCA cycle, Digestion and absorption.

1.3. Lipids : Biosynthesis and transport of cholesterol.

1.4. Amino- acid metabolism: Urea cycle

## **2. Enzymes**

2.1. Kinetic analysis of enzyme – catalyzed reaction

2.2.Regulation of enzyme activity.

2.3. Co-enzymes and isoenzymes.

3. Brief knowledge of growth factors and their mechanism of action in normal cell growth.

4. Bioenergetics: Energy production and utilization, redox potential, electron transfer and oxidative phosphorylation.

5. Free radicals and antioxidants

## **Reference Books :**

1. Ganong, W. F. (2003). Review of Medical physiology. 21<sup>st</sup> e2d. McGraw Hill.
2. Greenspan, F. S. & Gardener, F. G. (2003). Basic and Clinical Endocrinology. 7<sup>th</sup> ed. McGraw Hill.
3. Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10<sup>th</sup>ed.
4. Norris, D. O., (2006). Williams Textbook of Endocrinology: Vertebrate Endocrinology. 3<sup>rd</sup> ed. Academic Press.

5. Sherwood, L. (2004). Human Physiology: From cells to systems. 5 ed. Thomson Brooks Cole.
6. Willmer, P. et al. (2001). Physiological Adaptations. W. H. Freeman.
7. Schiemdt and Nielson: Animal Physiology
8. Berg, J. M., Tymoczko, J. K. & Stryer, L. (2007). Biochemistry. 6<sup>th</sup> ed. W. H. Freeman & Company.
9. Metzler, D. E. (2003). Biochemistry: The Chemical reactions of living cell.. Vol. 1 & 2. Academic Press.
10. Murray, R. K., Granner, P., Mayes A. & Rodwell, V. W. (2003). Harper's Illustrated Biochemistry. 25 ed. McGraw-Hill.
11. Nelson, D. L. & Cox. M. M. (2004). Lehninger's Principles of Biochemistry. 2<sup>nd</sup> ed., Macmillan Worth Publishers.
12. Switzer, R. L. & Garritty, L. F. (1999). Experimental Biochemistry. W. H. Freeman & Company.
13. Voet, D., Voet, J. G. & Pratt C. W. (1999). Fundamentals of Biochemistry. Upgrade edition. John Wiley & Sons.
14. Ernest Hodgson: A text book of Modern Toxicology
15. Duffus, J.H. & Worth H.G.J. (Ed.) (2006). Fundamental Toxicology. RSC publishing.
16. Klaassen, C. D. (Ed.) (1996). Casarett & Daul's Toxicology: The Basic Science of Poisons. 5<sup>th</sup> ed. McGraw-Hill, New York.



**SEMESTER - I**  
**Paper MZOOCCT104**

**Unit I**

**Cell Structure and Function**

**Marks: 25 marks**

**No. of Class Hrs. 30**

1. Ultrastructure of cellular membranes: Golgi, mitochondria, lysosome
2. Cell membranes and their functions: Membrane pumps, carriers, Channels,
3. Cell adhesion molecules: Extracellular matrix molecules, Cellular adhesion, Intercellular junctions, Connective tissues, microtubules and cytoskeleton ( RBC cytoskeleton as a model) .
4. Cell signaling , G- protein and signal transduction, Signal hypothesis, Intracellular protein trafficking
5. Cytoskeleton and cellular motility: Actin and actin binding proteins, microtubules, intermediate filaments, motor proteins.
6. Cell to cell communication, extracellular matrix.
7. Cell cycle, mitotic check-points, cyclins, cdks, APC, Mcm, Aurora, condensin, Kinesins
8. Somatic cell fusion, human – rodent hybrid cells, radiation hybrid mapping.
9. Programmed cell death.

**Referred Books :**

1. Alberts, B. et al. (2008). Molecular Biology of the Cell. 5<sup>th</sup>Ed. Garland Publishing House.
2. Becker. (2009). The World of the Cell. 7<sup>th</sup> ed. Benjamin-Cummings.
3. Cooper, G. M. (2004). The Cell. 3<sup>rd</sup>edn. ASM Press.
4. Blackwell Scientific, Oxford.
5. Harvey, L. (2004). Molecular cell Biology. 5<sup>th</sup> ed. W.H.Freeman.
6. Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments. 5<sup>th</sup>edn., John Wiley.

## **SEMESTER - I**

### **PAPER MZOOCCT104**

#### **Unit II**

#### **Developmental Biology**

**Marks : 25**

**No. of Class Hrs. 30**

- 1. Basic principles of differentiation, potency, morphogenetic gradients**
- 2. Stem cells**
  - 2.1. Properties and classification. .
  - 2.3. Niche, regenerative and restoration biology.
  - 2.4. Stem cell therapeutics.
- 3. Gametogenesis, fertilization and early development.**

3.1. Primordial germ cells and development of sex organs.

3.2. Production of gametes, pre-requisite of fertilization.

3.3.. Gastrulation and formation of germinal layers.

#### **4. Organogenesis**

4.1. Axis specification

4.2. Organizer formation and mesoderm specification

#### **5. Environmental regulation of gene expression during development .**

5.1. Importance of symbionts in mammalian development .

5.2. Genetic errors of human development, teratogenicity.

#### **6. Aging and senescence**

6.1. Mitochondrial control of aging .

6.3. Role of telomere.

#### **Reference Books :**

1. Arias, A. M. & Stewart, A. (2002). Molecular Principles of Animal Development.
2. Balinsky (1981). Embryology. Thompson Brooks Cole (India) Pte, Ltd.
3. Gilbert, S.F. (2006). Developmental Biology. 8<sup>th</sup> ed. Sinauer Associates.
4. Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10<sup>th</sup> ed. Williams Oxford University Press.

5. Moody, S.A. (Ed.) (2007). Principles of Developmental Genetics. Academic Press.
6. Wolpert, L., et al. (1998). Principles of Development. Oxford University Press

### **Semester - I**

#### **Paper – MZOCCS105 (Theo. Paper MZOCCCT101 & 102)**

**Marks -50**

#### **Laboratory Course**

##### **A) Non Chordate Anatomy**

- i) Comparative anatomy of excretion, nervous system in arthropoda & mollusca ( Demonstration/ Model)
- ii ) Special structure – stomatogastric nervous system in cockroach, sting apparatus of honey bee/ant , mounting of mouth parts of mosquito, haltere in housefly, mouth parts of house fly
- iii) Distinctive features and identification of non chordate from museum specimen
- iv) Demonstration of live protozoa (free living and parasitic) under microscope

##### **B) Chordate anatomy**

- i) Comparative anatomy of circulatory and urinogenital system in Fish and mammals ( Demonstration/ Model )

- ii) Special structures – olfactory apparatus and otolith in culturable fish, Weberian ossicles and swim bladder in carp
- iii) Distinctive features of chordate from museum specimens.

**C) Internal assessment**

**D) Viva voce**

**Paper – MZOCCS106**

**(Theo. Paper MZOCCCTI03 & I04)**

**Marks-50**

**Laboratory Course**

**A) Endocrinology & Reproductive Biology:**

1. Demonstration of various endocrine glands (Thyroid, Pancreas, Adrenal, Gonads) in mice.
2. Demonstration of Oestrous stages of mice.
3. In vitro study of motility of epididymal spermatozoa.
4. Histology of Testis, Ovary
5. Androgen bioassay (demonstration)

**B) Animal physiology and Biochemistry**

- i) Determination of Protein by Folin Lowry method
- ii) Determination of activity of amylase enzyme
- iii) Determination of  $K_m$  of an enzyme

**C) Cell Structure and Function**

1. Cell separation techniques
2. Primary culture of Cells
3. Determination of cell size and granularity

**D) Developmental Biology**

- i) Preparation of different stages of developing Chick embryo (24hr, 48 hr, 72 hr, 96 hr)
- ii) Developing stages of fish embryo-characteristics and documentation.

**D) Internal assessment**

**E) Viva voce**

**SEMESTER - II**

**PAPER MZOOCCT201**

**Unit I**

**Genetics**

**Marks: 25 marks**

**No. of Class Hrs. 30**

1. Organization of eukaryotic chromosomes, nucleosomes, telomere.
2. Fine structure of gene-cistron, recon, muton etc..
3. Gene activity in polytene and lampbrush chromosomes.
4. Sex determination and dosage compensation in Drosophila and humans.

5. Human karyotypic disorders: Down's, Edward's, Klinefelter's and Turner's syndromes.
6. Mendelian inheritance of man: Huntington's disease, Sickle cell anemia, Cystic fibrosis, Haemophilia, Muscular dystrophy .
7. Genetic imprinting, methylation ,PraderWilli and Angelman syndromes.
8. Gene mapping, human genome project.

**Relevant Books:**

1. Brown, T. A. (2002). Genomes 2.Wiley-Liss.
2. Hartl, D. L. & Jones, E. W. (2006). Essential Genetics: a genomics perspective (4<sup>th</sup>ed.). Jones and Bartlett Publishers, Boston.
3. Harvey, L. (2004). Molecular cell Biology. 5<sup>th</sup> ed. W.H.Freeman.
4. Karp, G. (2008). Cell and Molecular Biology: Concepts and experiments.5<sup>th</sup>edn., John Wiley.
5. Lewin, B. (2008). Genes IX. Jones & Bartlett Publishers.

**Unit II**

**Evolutionary biology**

**Marks: 25 marks**

**No. of Class Hrs. 30**

1. Natural selection : Concept and operation

2. Neutral theory of evolution vs natural selection
3. Hardy –Weinberg principle and gene frequency. Effect of selection, mutation, inbreeding, migration on gene frequency, genetic drift.
4. Speciation and punctuated equilibrium.
5. Sexual selection: Mate choice. Male-male competition.
6. Kin selection, Hamilton's rule and theory of haplo- diploidy.
7. Evolutionary arms race, ESS and game theory.
8. Pattern and trends in evolution; Molecular clock of evolution. Molecular phylogeny.
9. Origin and evolution of Primates. Evolution of Anthropoid Primates. The first hominids and origin of modern man.

### **Recommended Books**

1. Bowler - Evolution
2. E Mayr - Evolution and the diversity of Life.
3. Jones et al. - The Cambridge encyclopedia of Human evolution
4. Max King Species Evolution.
5. J Futuyma - Evolutionary Biology: Douglas.
6. E H Colbert - Evolution of the vertebrates
7. P A Moody - Introduction to Evolution.
8. Strickberger - Evolution



## **SEMESTER - II**

### **PAER MZOOCCT202**

#### **Unit – I**

#### **Ethology and Ethnobiology**

**Marks: 25.**

**No. of Class Hrs. 30**

1. Principles of animal behavior: Conceptual approaches.
2. Learning: What animals learn? Individual learning. Social learning. Cultural transmission.
3. Foraging: Optimal foraging. Foraging and group living. Predation and foraging.
4. Aggression: Aggressive behaviour. Game theory- Models and strategies.
5. Communication
6. Ethnobiology-Overview, concept and scope
- 7 Ethnomedicine – Concept and overview, definition, history and its scope – Interdisciplinary approaches of ethnobotany – collection of ethnic information.
8. Traditional medicine in chemoprevention and therapeutics: Cancer and diabetes.

#### **Recommended Books:**

- 1..Kumar N.C., An Introduction to Medical botany and Pharmacognosy. Emkay Publications, New Delhi 1993.
- 2.Rao A.P., Herbs that heal. Diamond Pocket Books (P) Ltd., New Delhi,1999.
- 3.Tribal medicine – D.C. Pal & S.K. Jain NayaPrakash, 206, Bidhan Sarani, Calcutta, 1998.
- 4.Contribution to Indian ethnobotany – S.K. Jain, 3<sup>rd</sup> edition, Scientific publishers, B.No.91, Jodhpur, India. 2001
5. Herbs that Heal, AcharyaVipulRao – Diamond Pocket Books, New Delhi, 2005.

## **SEMESTER - II**

### **PAPER MZOOCCT202**

#### **Unit –II**

#### **Ecology**

**Marks: 25**

**No. of Class Hrs. 30**

#### **1. Population growth and regulation**

- 1.1 Age structured population growth and empirical projections
- 1.2 Deterministic and stochastic growth models, time lags and limit cycles, Oscillations, Chaos.
- 1.3 Regulations on population size: Density Dependence (types and nature)

1.4 Discrete time population models: Beaverton-Holt and Ricker model.

## **2. Metapopulation**

2.1. Metapopulation concept

2.2. Levin's model of metapopulation and development of theories.

Comparison of metapopulation and logistic population model.

## **3. Community organization**

3.1. Nature of communities, analysis of community structure.

Gradient analysis and Ordination.

3.2 Competition theory, modeling competitive exclusion and coexistence.

## **4. System concept**

4.1. Fixation, generation and cycling of energy across the food web.

4.2. Measuring ecosystem productivity, patterns in primary and secondary production. Factors affecting primary and secondary production.

## **5. System structure and Function**

5.1 Ecological processes in wet land and mangrove ecosystem.

## **6. Ecology of biological and industrial invasion**

6.1 Eutrophication in freshwater, coastal and marine ecosystem, faunal interaction and changes, remediation.

6.2. Acidification in aquatic and terrestrial environment, effects & remedies.

## **Books Recommended (Ecology):**

1. Begon, M., Harper, J. L. & Townsend, C. R. (2006). Ecology: Individuals, Populations and communities. 4<sup>th</sup> ed. Blackwell science

2. Chapman, R. L. and Reiss, M. J. (2000). Ecology – Principles & Application. Comb.
3. Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). Ecology- Science and Practice. Oxford & IBH Publishing Company Pvt. Ltd.
4. Kormondy, E. J. (2002). Concepts of Ecology. 4<sup>th</sup> Indian Reprint, Pearson Education.
5. Krebs, C. J. (2001). Ecology. Benjamin Cummings.
6. Leveque, C. (2003). Ecology: from Ecosystem to Biosphere. Science Publishers. Inc.
7. Odum, E. P. & Barret, G. W. (2005). Fundamentals of Ecology. 5<sup>th</sup> ed. Thompson Brooks/Cole.
8. Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6<sup>th</sup> ed. Pearson Education.
9. Richlefs and Miller: Ecology

## **SEMESTER - II**

### **PAPER MZOOCCT203**

#### **Unit 1**

#### **Parasitology and Microbiology**

**Marks : 25.**

**No. of Class Hrs. 30**

1. Basic concept of Parasitism
2. Morphology and ultrastructure of *Plasmodium* sp. and integuments of nematode.

3. Life cycle and host-parasite interactions in

3.1. *Giardia* sp.;

3.2. *Entamoeba* sp.;

3.3. *Leishmania* sp.;

3.4. *Ancylostoma* sp.;

4. Major malaria vectors in India: Distribution, bio-ecology, potentiality and present sustainability status; resurgence of malaria in India

**5. Acarines of medical importance**

5.1. Soft tick and hard ticks - external morphology;

5.2. Ticks as disease transmitter;

5.3. House dust mites - general account and importance.

6. Scabies: Vector, pathogenicity and transmission.

7. Bacteria: Structure and function of capsule, pili and flagella.

8. Virus: Structural organization; lytic cycle of bacteriophage with reference to *E. coli*.

9. Microbial genetics: Bacterial gene transfer, transformation, conjugation, transduction.

10. Medical Microbiology: Transmission, pathogenicity and prevention of air borne (Tuberculosis), food and water borne (Typhoid) and arthropod borne (Dengue) diseases.

11. Environmental Microbiology: Soil microbiology, role of microbes in  $N_2$  fixation; Microbes as indicator of water quality.

**Referred Books :**

- 1.Chandler, A. C. & Read. C. P. (1961). *Introduction to Parasitology*, 10<sup>th</sup> ed. John Wiley & Sons Inc.
- 2.Cheng , T. C. (1986). 2<sup>nd</sup> ed. General Parasitology Academic Press, Inc. Orlando.U.S.A.
- 3.Cox, F. E. G. (1993). *Modern Parasitology*.2<sup>nd</sup> ed. Blackwell Scientific Publications.ed. Lea and Febiger, Philadelphia.
- 4.Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.
- 5.Schmidt, G. D. & Roberts, L. S. (2001). *Foundation of Parasitology*, McGraw Hill Publishers, 3<sup>rd</sup>ed.
- 6.Schmidt, G. D. (1989). *Essentials of Parasitology*.Wm. C. Brown Publishers (Indian print; 1990, Universal Book Stall).

**SEMESTER– II**  
**PAPER - MZOOCCT203**

**Unit- II**  
**Immunobiology**

**Marks-25**

**No. of Class Hrs. 30**

**1.Immune system:**

- 1.1. Innate and adaptive immunity.
- 1.2.Cells and organs of the immune system in mammals.

**2.Antigen:**

- 2.1. Immunogenicity and antigenicity.

**3. MHC, antigen processing and presentation**

- 3.1. Organization and inheritance of major histocompatibility complex (MHC)

3.2. Structure and functions of MHC

3.3. Antigen presenting cells: dendritic cell, macrophage

3.4. Antigen processing and presentation

#### **4. Antigen receptor complex**

4.1. Immunoglobulin super family: I<sub>g</sub> types and structure

4.2. Structure and arrangement I<sub>g</sub>G cluster

4.3. Generation of antigen receptor diversity and clonal selection

#### **5. Humoral immunity**

5.1. B-cell maturation, activation and differentiation

5.2. B-cell receptor complex

5.3. Diseases related to B-cell malfunction

#### **6. Cell mediated immunity**

6.1. T-cell maturation, activation and differentiation

6.2. T-cell receptor complex

6.3. Diseases related to T-cell malfunction

#### **7. Cytokines**

7.1. Cytokine receptors and antagonists

7.2. Cytokine Secretion by TH<sub>1</sub> and TH<sub>2</sub> Subsets

#### **8. Hypersensitivity and autoimmune diseases**

8.1. Types of hypersensitivity.

8.2. Mechanisms of induction of autoimmunity.

8.3. Immunodeficiencies.

#### **Books Recommended:**

1. Abbas, A. K., Lichtman, A. H. & Pillai, S. (2006). Cellular and molecular Immunology. 6<sup>th</sup> ed. Saunders.
2. Chakraborty, A. K. (2003). Immunology II. 2<sup>nd</sup> ed. Oxford Univ. Press/N. L. Publishers Siliguri.

3. Khan F. H. (2009) The Elements of Immunology. Pearson.
4. Kindt, T., Goldsby, R. Osborne, B. (2007). Kuby Immunology. 6<sup>th</sup> ed. W.H. Freeman & Co.
5. Male, D., Brostoff, J., Roth, D. & Roitt, I. (2006). Immunology. 7<sup>th</sup> ed. Mosby.
6. Roitt, I. M. & Delves, P. J. (2001). Roitt's Essential Immunology. 10<sup>th</sup> ed. Blackwell Science. Ltd.

## SEMESTER – II

### PAPER MZOOCCT204

#### Unit I:

#### Applied Entomology

**Marks: 25**

**No. of Class Hrs. 30**

#### **1. Economic decision levels for pest population**

- 1.1. Concepts
- 1.2. Dynamics of economic injury levels
- 1.3. Calculation of economic decision levels using economic levels.

#### **2. Pest Management theory and practice**

- 2.1. The concept of pest management
- 2.2. Kinds of Pests and likely Strategies

#### **3. Pests and their managements**

- 3.1. Sugarcane pests – Biology, bionomics and management.
- 3.2. Mango pests - Biology, bionomics and management.

#### **4. Beneficial insects**



**4.1.Lac culture** – Lac insects, composition of lac, lac host plants, Diseases and pests of lac insects.; processing of lac and its uses. Problems and prospects of lac culture in India.

**4.2.Sericulture:** Kinds of silk worm, host plant and improvement of their variety. Brief idea on non-mulberry silk. Life history and rearing of *Bombyxmori*. Harvesting and processing of cocoon. Reeling and extraction of silk.; Disease and pests of mulberry silkworm; Biotechnology in sericulture. Scope and future of sericulture in India.

**4.3. Apiculture:** Types of honey bee, modern methods of apiary management, products and its use. Problems and prospects of apiculture in India. Diseases and pests of honey bee;

**4.4** Bee pollination (honey bees and solitary bees); prospects and problems in bee pollination.

**5.** Natural enemy diversity in India and their potentialities in pest management.

**6.** Insects of commercial importance: Medicinal, Dye, Resin, food and food product producing insects- Diversity and uses.

#### **Referred Books:**

Atwal, A.S. & Dhaliwal (2005). Agricultural Pest of India and Sour-East Asia. Kalyani Publishers.

Pedigo, L.P. & Rice, E.M. (2009). Entomology and Pest Management. Pearson/ Prentice Hall.

Vincent H. Resh & Ring T. Carde (2003). Encyclopedia of Insects. Elsevier.

**SEMESTER– II**  
**PAPER MZOOCCT204**

**Unit – II**

**Aquaculture**

**Marks: 25.**

**No. of Class Hrs. 30**

**1. Aquaculture of carps**

- 1.1. Qualities of cultivable indigenous and exotic species
- 1.2. Preparation and management of Nursery and Rearing ponds
- 1.2. Management of Grow out pond and polyculture

**2. Biotechnology in improvement of live stock**

- 2.1 Fish induced breeding and hybridization
- 2.2 Sex reversal in fish

**3. Air breathing fish culture**

- 3.1. Breeding of *Clariasbatrachus*
- 3.2. Larval rearing and culture of *Clariasbatrachus*

**4. Integration of aquaculture**

- 4.1 Rationale of integrated farming of fish and live stock
- 4.2 Rice-field aquaculture and Makhana cum fish culture
- 4.3 Aquaponics

**5. Ornamental fish and their management**

- 5.1 Common ornamental fish species (Indian and exotic)
- 5.2 Breeding and rearing of some common ornamental fishes

### 5.3 .Marketing of ornamental fishes

#### **Referred Books:**

- 1.Jhingran, V. G. (1991). Fish and Fisheries of India.3rd ed., Hindusthan Pub.Corp.John Wiley & Sons.
- 2.Lowe, H. (2005). Beginner's Guide to Aquarium Fish and Fish Care.
- 3.Pillay, T. V. R. (1993). Aquaculture.Fishing News Books, Abhishek Press, New Delhi.
- 4.Chondar S L (1995) Culturable Indian fishes

### **SEMESTER – II**

#### **Paper MZOCCS205**

#### **Unit I (PracticalGenetics /Ethnobiology/ Ecology)**

Marks: 50

#### **A. Genetics:**

1. Identifying certain mutations (Cy, w, vg, etc.) of Drosophila.
2. Human pedigree analysis
3. Karyotype analysis from the metaphase chromosomes of human/Rat/Mice..
4. Chironomas /giant chromosome or bone marrow preparation.

#### **B. Ethnobiology**

1. Local field survey.
2. Identification of some medicinal plants used by the local tribal people and submission of herbarium of local medicinal plants.

### **C. Ecology**

- i) Quantitative and qualitative estimation of zooplankton communities
- ii) Estimation of total hardness, total alkalinity and salinity of water
- iii) Estimation of Primary productivity and assessment of nutrient status of water bodies
- iv) Qualitative analysis of sampled terrestrial community

### **D. Internal Assessment**

### **E. Viva voce**

## **SEMESTER – II**

### **Paper MZOCCS206**

#### **Unit II Practical (Parasitology and Microbiology / Immunobiology/ Applied Entomology/Aquaculture)**

### **A. Parasitology and Microbiology**

1. Collection, preparation, preservation and identification of ecto- and endoparasites.
2. Gram staining bacteria
3. Preparation and staining of lactobacillus.

### **B. Immunobiology**

1. Antigen antibody interaction (Blood groups)

2. Identification of histological slides of lymphoid (Thymus/ spleen) tissues.
3. Demonstration of macrophages.

### **C. Applied Entomology**

1. Identification and Calculation of damage in stored grain.
2. Silk content estimation; cocoon diversity study; .
3. Lac insect; Identification of lac insects; Estimation of phenolics from lac insect secretion
4. Vegetable, Sugarcane and Mango pests: Collection and identification
5. Visit to Lac kuthi/ sericulture/ apiculture farm
6. Identification of economically important insects

### **D. Aquaculture**

1. Collection, preservation of pituitary gland; preparation of extract; administration of pituitary extract.
2. Identification of aquatic weeds, predatory and weed fishes

### **E. Internal Assessment**

### **F. Viva voce**

## **SEMESTER– III**

### **Paper – MZOOCCT301**

### **Unit – I**

### **Molecular Biology & Biotechnology**

## **Molecular Biology**

**Marks: 25.**

**No. of Class Hrs. 30**

1. Structure of DNA and RNA, DNA replication. DNA damage (due to UV, ionizing radiation) and repair (base excision, photoreactivation).
2. Restriction endonucleases, rDNA technology, cloning of DNA, DNA libraries, vectors: plasmid, cosmid, retro- and adenoviruses, BAC and YAC, shuttle and expression vectors.
3. Transcription mechanism, processing of different types of RNA (viz., capping, splicing, polyadenylation).
4. DNA polymorphism: macro- and microsatellites, VNTR, RFLP, AFLP, STS, EST, RAPD, FISH and GISH.
5. Molecular basis of Fragile X mental retardation, Alzheimer's disease.
6. Cancer biology: Oncogenes and protooncogenes, p53, tumor suppressor genes, retinoblastoma, Philadelphia chromosome.
7. DNA microarray.

### **Referred Books:**

1. Alberts, B. et al. (2008). *Molecular Biology of the Cell*. 5<sup>th</sup> Ed. Garland Publishing House.
2. Brooker. (2001). *Genetics*. McGraw-Hill.
3. Hartwell et al. (2001) *Genetics: From genes to Genomes*. McGraw Hill.

4. Primorose S.B. and Twyman R.M. (2007). *Principles of Gene Manipulation and Genomics* (7<sup>th</sup> ed.). Blackwell Publishing
5. Russel P. A. (2003). *Essential of iGenetics*. Benjamin Cummings.
6. Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6<sup>th</sup> ed. Benjamin Cummings.
7. Snustad, D. P. & Simmons. M. J. (2006). *Principles of Genetics*. 4<sup>th</sup> ed. John Wiley and Sons.

### **Biotechnology**

1. Biotechnological production of living organism (oil- eating and solid waste degrading bacteria, oncomouse); their uses and patenting.
2. *In vitro* fertilization and ART, embryo sexing, animal cloning, Practical application.
3. Genetically engineered insulin, growth hormones
4. Transgenesis and knock- out procedures
5. Gene targeting in mammalian cells *in vitro* and *in vivo*.
6. Gene therapy using i) homologous recombination, ii) viruses, iii) antisense technology, iv) ribozyme,
7. Pharmacogenomics, tailor-made medicines, drug-delivery systems.
8. Nuclear and mitochondrial DNA based protocols relating to i) Forensic (disputed percentage, rapist identity), ii) multilineage familial inheritance and human evolution. DNA fingerprinting and ELSI.

### **Referred Books:**

1. Grasberger - Current concept of Forensic entomology.
2. Singh & Sreevastab - Development of Vaccine: From discovery to clinical testing
3. S H E Kaufmann - Concept of vaccine development
4. Glick and Pastermack – Molecular Biotechnology

### **SEMESTER – III**

### **Paper – MZOOCCT301**

### **Unit – II**

### **Environmental Biology and Toxicology**

**Marks: 25.**

**No. of Class Hrs. 30**

### **Environmental Biology**

1. **Fundamental of environmental physiology**
  - 1.1. Physical & chemical environment, Macro & Micro environment
  - 1.2. Major environment regimes of earth
2. **Extreme environmental adaptation**
  - 2.1. High altitude adaptation
  - 2.2. Deep sea adaptation
3. **Environmental pollution**
  - 3.2. Pesticides
  - 3.3. Radio-active pollution

### **Toxicology**

#### **1. Toxins**

- 6.1.. Microbial Toxins
- 6.2. Mycotoxins and algal Toxins
- 6.3. Bioaccumulation and biomagnification
- 6.4. Metabolism of drugs, pesticides and toxins

#### **2. Toxicity**



- 7.1. Acute and chronic effects; factors influencing toxicity.
- 7.2. Food additives and contaminants
- 7.3. Hepatotoxicity, Nephrotoxicity, Neurotoxicity and Reproductive toxicity.

### **3. Dimensions of toxicological study**

- 8.1. Industrial toxicology
- 8.2. Biomonitoring and biomarker study
- 8.3. Environmental Impact Assessment (EIP)

### **4. Biodegradation and Bioremediation Concept**

#### **Books Recommended (Environmental Biology):**

1. Enger, E. D. & Smith, B. F. (2008). Environmental Science: A study of Interrelationships. 11<sup>th</sup> ed. McGraw-Hill Higher Education.
2. Mukherjee, B. (1996). Environmental Biology. Tata McGraw-Hill Publishing Comp. Ltd.

#### **Books Recommended (Toxicology):**

1. Ernest Hodgson: A text book of Modern Toxicology
2. Duffus, J.H. & Worth H.G.J. (Ed.) (2006). Fundamental Toxicology. RSC publishing.
3. Klaassen, C. D. (Ed.) (1996). Casarett & Doull's Toxicology: The Basic Science of Poisons. 5<sup>th</sup> ed. McGraw-Hill, New York.
4. Pandey, K., Shukla, J. P. & Trivedi, S. P. (2005). Fundamentals of Toxicology, New Central Book Agency (P) Ltd. Kolkata.
5. Plant, N. (2003). Molecular Toxicology, 1<sup>st</sup> Ed. Bios Scientific Publishers.

6. Stine, K. E. & Brown, T. M. (2006). Principles of Toxicology. 2<sup>nd</sup> Ed. CRC, Taylor & Francis Group, New York.
7. Walker, C. H., Hopkin, S. P., Sibly, R. M. & Peakall, D. B. (2000). Principles of Ecotoxicology, 2<sup>nd</sup> Ed. Taylor & Francis, London.

**SEMESTER– III**  
**Paper MZOOCCT302**

**Unit I**

**Taxonomy**

**Marks: 25.**

**No. of Class Hrs. 30**

**1. Taxonomic characters**

1.1 Character and character states, Discrete and overlapping characters; polymorphic characters, character of special consideration; method for identifying plesomorphic and apomorphic character states.

1.2 Microcharacters, Cryptic character and internal characters

1.3 Artifacts and behavioral characters.

1.4 Character State Transitions.

**2. Taxa and Species**

2.1. Phylogenetic groups: Monophyly, polyphyly; paraphyly.

2.2. Problems with parthenogenetic and asexual taxa.

**3. Theories of Biological Classification**

3.1. Classification and phylogeny

3.2. Types of classification, hierarchic classification

#### **4. Phenetic method of classification**

4.1. Numerical taxonomy and numerical phenetics.

4.2. Preparation of data matrix and similarity matrix using distance method (Manhattan distance and Euclidian distance); cluster analysis (different methods).

#### **5. Cladistics and related methods**

5.1. Differences in the application of phenetic and cladistic classification.

5.2. Cladistics and cladograms.

5.3. Cladistic methods.

5.4. Application of parsimony and Maximum Likelihood.

#### **6. Taxonomic applications**

6.1 Cytotaxonomy, Biochemical taxonomy, Immunotaxonomy and Barcoding.

#### **Referred Books :**

1. Futuyma, D. (2005). *Evolution*. Sinauer Assn. Inc.
2. Hall, B.K. & Harrington, B. (2008). *Strickberger's Evolution*. Jones & Bartlett.
3. Mayr, E. & Ashlock, P. D. (1991). *Principles of Systematic Zoology*. 2 ed., McGraw-Hill.
4. Quicke, D.A.J. (1993). *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic & Professional.

5. Simpson, G. G. (1961). *Principles of Animal Taxonomy*.  
Columbia University Press. New York.

### **SEMESTER - III**

#### **Paper MZOOCCT302**

#### **Unit II**

#### **Biodiversity and Wild Life Conservation**

**Marks: 25.**

**No. of Class Hrs. 30**

##### **1. Concept of Biodiversity**

- 1.1. Framework of Biodiversity; Biodiversity hotspots -- Global and Indian and Biodiversity act.
- 1.2. Problems and scales of Biodiversity extinctions in time and space.
- 1.3. Levels and Measures of Biodiversity; Interrelationships between diversity measures; application and integration of diversity measures.
- 1.4. Process and pattern of local and regional biodiversity --- Niche assembly, unified Natural theory; Island biogeography model., Rain forest.
- 1.5. Values of Biodiversity: ethical, aesthetic, intrinsic and Special (indicator species and Environmental monitoring).

##### **2. Threats to Species diversity**

- 2.1. Natural and human induced threats and vulnerability of species extinctions.
- 2.2. Biodiversity and Rarity, Endemism and Biodiversity.

2.3. Problem of genetic diversity loss over time; Bottleneck, Genetic drifts, Inbreeding depression.

2.4. Extinction Vortex.

### **3. National and International efforts for conservation**

3.1. Information on CITES, IUCN and PBR.

3.3. Regional and National approaches for biodiversity conservation

#### **Referred Books :**

- 1.M J Jeffries - Biodiversity &Conservtion:
- 2.Gaston & Spicer - Biodiversity: An introduction
- 3.UNEP - Global Biodiversity Assessment
- 4.R B Primack - A primer of Conservation Biology
- 5.M Kato - The Biology of Biodiversity
- 6.Wilson - Biodiversity

## **SEMESTER– III**

### **Paper – MZOOMET303 A**

**(Elective – Parasitology and Immunology)**

**Marks: 50.**

**No. of Class Hrs. 60**

#### **Unit-I**

#### **Parasitism and diversity of Parasites**

1. Concept on animal association and parasitism.
2. General knowledge, diversity of parasites and their classification

- 2.1. Classification of protozoans with suitable examples up to subclasses following Levine et al. (1980).
- 2.2. Classification of Trematoda, Cestoda and Nematoda with examples up to orders.
- 2.3. Classification of parasitic insects, ticks and mites with examples up to orders.
3. Evolution of parasitism and parasites - protozoans and helminthes
4. Parasite ecology
5. Vertebrate alimentary canal, blood and tissues as parasite's habitat
6. Parasite- Host specificity

## Unit-II

### Biology of Parasites

1. Life cycle pattern of trematodes, cestodes, and nematodes and their larval stages.
2. Life cycle stages and biology of following parasites of medical and veterinary importance
  - 2.1. **Protozoa** (i) *Entamoeba histolytica*, (ii) tissue invading *Naegleria* and *Acanthamoeba*, (iii) *Giardia intestinalis*, (iv) *Trypanosoma* and sleeping sickness, and Chagas disease, (v) *Leishmania* and visceral Leishmaniasis, (vi) *Toxoplasma* and Toxoplasmosis, (vii) *Plasmodium* and cerebral malaria, (viii) *Balantidium* and human colitis

- 2.2. **Trematodes:** (i)*Schistosoma haematobium* – the blood fluke,  
(ii)*Paragonimus westermani* – the lung fluke,  
2.3. **Cestods:** (i)*Echinococcus granulosus*- and hydatid disease,  
2.4. **Nematodes:**(i) *Ancylostoma duodenale* and hookworm disease  
(ii)*Dracunculus medinensis* and Guinea worm disease, (iii) Human  
filariasis – a brief review of the parasites involved

3. Brief idea on biology and life cycle of Acanthocephala

**Semester III**

**Paper – MZOOMET303- B**

**(Elective – Fisheries and Aquaculture)**

**Marks: 50.**

**No. of Class Hrs. 60**

**Unit I -(Limnology & Oceanography)**

**1. Freshwater Resources**

- 1.1. Rivers, ponds, lakes and reservoirs – zonation, characteristics and morphometry  
1.2. Productivity in ponds, lakes and reservoirs  
1.3 Manipulation of productivity for aquaculture

**2. Stratification in lakes and reservoirs**

- 2.1. Thermal stratifications and their modifications  
2.3. Stratification and dynamics of oxygen, nitrogen, phosphorus and inorganic carbon

### **3. Water quality**

3.1. Water quality parameters necessary for aquaculture and their role in fish production

### **4. Costal and marine fishery resources & factors**

4.1. Classification, topography of marine environment and salient features of different zones

4.2 Physical environmental factors (Temp, Light, Pressure, Tides and waves); Chemical environmental factors (Oxygen, CO<sub>2</sub>, Carbonates, Salinity, pH, N<sub>2</sub>).

4.3. Mangrove ecosystem and its interaction with fish resources.

## **Paper – MZOOMET 303C (Elective-Genetics and Cell Biology)**

**Marks: 50.**

**No. of Class Hrs. 60**

### **Genetics and Cell Biology**

1. Behaviour of genes: Penetrance, Expressivity, Pleiotropy, Pseudoalleles, phenocopy, co-dominance, epistasis, Unique and repetitive DNA, Gene clusters, Super-families; Euchromatin and Heterochromatin, Constitutive and facultative heterochromatin, C-value paradox. DNA re-association kinetics, Cot curves, T<sub>m</sub> values.

2. Sex-determination (molecular aspect) and dosage compensation in *C. elegans*, *Drosophila* and Human, Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

3. Linkage and crossing over, Sterns experiment, Holliday model, Tetrad analysis, Mutation induced by chemical mutagen and repair mechanisms



4. Nucleic Acid and Chromosome Structure, The Regular Backbone of DNA, Grooves in DNA and Helical Forms of DNA, Dissociation and Reassociation of Base-paired Strands, Topological Considerations in DNA Structure, Generating DNA with Superhelical Turns Measuring Superhelical Turns Determining Lk, Tw, and Wr, DNA replication: Detail mechanism, enzymology and accessory proteins, Processivity and accuracy of DNA Polymerases.

5. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

6. Signaling mechanism and its Hardware: RTKs, Receptor serine/threonine kinases, TNF, toll like receptors, Notch receptors, Hedgehog receptors. Second messengers: NO, Ca<sup>2+</sup>, IP<sub>3</sub>, Lipid derived.

### **SEMESTER– III**

#### **Paper – MZOOOET304**

#### **Open Elective**

#### **Option A:**

#### **Course Name: Evolving Life: Cosmos to Consciousness**

##### **1. Cosmic evolution:**

Origin of the Universe, Emergence of Heavy elements, Earth –the beginning, Formation of organic and biological molecules-building blocks of life.

##### **2. Great Oxygenation event-A metabolic switch.**

Explosion of life diversity and some extinction. The basic diversity of animals and their proposed evolutionary orders.

### **3. How things change? Part-I.**

The basic evolutionary theories. Darwin vs Creationists. Natural selection –the blind watchmaker.

### **4. How things change? Part-II.**

Evolution, an orchestra of genes: Genes are the basic unit of evolution. Variation-the stack of cards to choose from. Mutation as source of variation- how genes change the destiny of organisms.

### **5. Behaviour –Nature or nurture?**

The basic units of behaviour. How evolution shape animal behaviour. The selfish gene. Arms race and cooperation- why Thompson gazelle prong, cheetah run fast, lemmings commit suicide but Lady Widow Eats her husband?

### **6. Genes and Survival Strategies-**

Introduction to elementary concept regarding evolutionary games.

### **7. Cognition and consciousness.**

Learning, memory and self awareness. Story of Us- Biological and cultural evolution of *Homo sapiens*.

### **Referred Books;**

1. Species Evolution: Max King
2. Evolutionary Biology: J. Futuyama
3. Evolution: Strickberger

**Paper – MZOOOET304**

**Open Elective**

**Option B**

**Biodiversity and Wildlife Conservation**

**1. Concepts of Biodiversity:**

Concepts and components of biodiversity, genetic, species and ecosystem diversity; biodiversity indices, value of biodiversity. Indian and global biodiversity.

**2. Biodiversity conservation:**

Conservation of biodiversity, in-situ and ex-situ conservation. Biodiversity hotspots in the world, national and global red data lists, categories of species and their management, IPR of biodiversity and its products, patent protection and biopiracy.

**3. Management of wildlife:**

Distribution, status, habitat utilization pattern, threats to survival of Lion-tailed macaque, NilgiriTahr, Bengal vulture, Great Indian Bustard, Olive ridley turtle.

**4. National and International efforts for conservation:**

CITES, IUCN, CBD, Ramsar Convention on Wetland

**5. Practical:**

- i) Biodiversity study of any ecosystem with indices
- ii) Quadrature analysis
- iii) A study of habitat specificity in birds or small mammals on campus principally based on observations.

iv) Field methods of studying diet. Examination and recording of stomach contents of some local insects or fishes.

**Referred Books:**

1. Biodiversity and environment.: S K Agarwal
2. Textbook of Biodiversity: K V Krishnamurthy
3. Biodiversity Conservation: RameshwarShrivastava
4. Biodiversity and Conservation: M J Jeffries

**SEMESTER– III**

**Paper – MZOCCS305**

**Marks: 50**

**A.Molecular Biology and Biotechnology.**

1. Restriction enzyme cleavage of DNA.
2. Agarose gel electrophoresis.
3. Plasmid DNA isolation.
4. Handling of PCR apparatus.
5. Use of EtBr for visualizing DNA bands.

**B. Environmental Biology & Toxicology**

- i) Haemocytes from different models in different stress conditions.
- ii) Study of micronucleus in fish model in different stress conditions.

iii) Determination of LC 50 of an environmental toxin in static water environment.

### **C. Taxonomy & Biodiversity and Wild Life Conservation**

1. Study of salient taxonomic study: Insect and fish models
2. Recognition of taxa from museum study and preparation of taxonomic keys.
3. Biodiversity assessment: Aquatic and terrestrial communities, dominance diversity analysis; analysis of community indices.
4. Major Field study in any national park/marine ecosystem and submission of field reports

### **D.Internal Assessment**

### **E.Viva voce**

## **SEMESTER – III**

### **Paper – MZOOOPP306**

**Marks:50**

**Outreach program**

## **SEMESTER– IV**

### **Paper – MZOOCCT401**

### **Unit – I**

## **Neurobiology**

**Marks: 25.**

**No. of Class Hrs. 30**

### **1. Fundamentals of Neurobiology**

1.1. Neurons: Histological structure and types. Molecular biology of neurons – membrane proteins, lipids cytoskeleton, regulation of axonal transport.

1.2. Neurological cells: Different types and functions.

### **2. Cellular Neurobiology and Neurochemistry**

2.1. Synapse: Characteristics features of type- I and type- II synapses. Cell adhesion molecules in synapse. Synaptic vesicles. Glial influence on synaptic transmission. Neuromuscular junctions and neuromuscular transmission.

2.2. Action potential generation in postsynaptic neurons: Theories of neuronal information processing.

2.3. Biosynthesis, storage and inactivation of classical neurotransmitters – Acetylcholine, Catecholamines, GABA, Serotonin – Substance P, Enkephalins, NPY, Neuropeptide Y.

### **3. Cognitive Neuroscience**

3.1. Memory: Types of memory- Explicit, implicit. Long term and working memory. Molecular basis of early and late LTP.

### **4. Neurodegenerative disorder**

4.1. Neurodegenerative diseases: Parkinson's disease, Huntington Chorea, Alzheimer's disease.

4.2. Other diseases: Schizophrenia, Autism, Prion disease.

**Referred Books:**

1. Dale Purves, G J Augustine, D Fitzpatrick & W C Hall – Neuroscience.
2. Sheffard – Neurobiology.
3. Mathews – NeuroBiology.
4. Roger A. Barker, Stephen Barasi - Neuroscience at a Glance.
5. Charles A. Nelson, Monica Luciana - Handbook of Developmental Cognitive Neuroscience.

**SEMESTER – IV**  
**Paper – MZOOCCT401**

**Unit – II**

**Biostatistics and Introduction to Bioinformatics**

**Marks: 25.**

**No. of Class Hrs. 30**

**Biostatistics**

1. Probability: Definition; important terms and concepts Random experiment, events. Mutually exclusive, equally likely, exhaustive events. Classical and statistical definitions of probability, applications.
2. Probability models: Bernoulli, Binomial, Poisson, Normal (without deviation), Mean variation), Mean, Variance (without variation). Applications of the models using zoological data.
3. Testing hypothesis: Hypothesis- null and alternative. Two kinds of error; Level of significance, p-value and variance. Statistical tests: Tests of population mean and variance- one population, two

populations (correlated and uncorrelated) under normal set up; test for  $p=0$ .

4. Analysis of Variance (ANOVA): Concept of ANOVA; one way and two way lay out.
5. Correlation: Types of correlations; Measure of Correlation – Scatter diagram, Pearson's Correlation Coefficient, Spearman's Rank Correlation.
6. Regression: Types of Regression; Regression equation; Regression Coefficient.

### **Introduction to Bioinformatics:**

7. Genomics and Proteomics. Database and search tool
  - 7.1 Computational tools and biological databases
  - 7.2 National centre for Biotechnology information (NCBI)
  - 7.3 European Bioinformatics Institute (EBI)
8. Sequence alignment and database searching
  - 8.1 The evolutionary basis of sequence alignment
  - 8.2 Database similarity searching
  - 8.3 Sequence Similarity search tools : BLAST and FASTA.
9. Primer designing.
  - 9.1. Si RNA and Sh RNA designing tools.
  - 9.2 Genome browser for promoter recognition.

### **Referred Books:**

1. Batschelet- Introduction to Mathematics for life sciences:
2. R S Sokal & F J Rohlf- Biometry
3. G W Snedecor & W G Cochran - Statistical Methods.
4. R H Green - Sampling design and statistical methods for environmental biologist.
5. D Das - Biostatistics.
6. Goon Gupta – Biostatistics.



**Paper – MZOOMET402A**

**(Elective – Parasitology and Immunology)**

**Marks: 50**

**No. of Class Hrs. 60**

**Unit -I**

**FM=25**

**Structure, metabolism and pathophysiology of parasites**

**1. Ultra structures :**

(i) Different stages of malarial parasites (ii) *Leishmania* (iii) *Trypanosoma*  
(iv) *Cryptosporidium* (v) Spores of *Nosema* (vi.)  
Integuments of trematodes, cestodes and nematodes.

**2. Carbohydrate and Protein metabolism in *Plasmodium sp.* and *Ascaris sp.***

**3. Nematode induced gall and their histopathology :** gall and its classification; Systematics of gall producing nematodes ; Life cycle stages of *Meloidogyne sp.* ; Histopathological changes induced by *Meloidogynesp.* during gall formation;

**4. Epidemiology:** Definitions, classification, landscape epidemiology, epidemiology of, malaria, leishmaniasis( KalaAzar ) and filariasis

**5. General idea on different types of Zoonoses and Myiasis (classification, evolution etc.).**

**Vector biology andMolecular parasitology**

1. Vectors and its importance in transmission of Parasitic diseases ; General morphology of fleas, flies, ticks and mites Life cycle stages of (i) *Boophilussp.* – the vector of *Babesia*, (ii) *Trombiculasp.* – the vector of *Rickettsia etc.* , (iii) *Xenopsyllacheopis* - plague vector, (iv) *Phlebotomussp.* - *Leishmania* vector, (v) *Glossina sp-* vector of Gambian trypanosomiasis. ( vi) Mosquito as vector
- 2.Host-parasite interaction: Recognition and entry process of different pathogen and parasites in the host cell/body; alteration of host cell behavior by pathogens;
3. Molecular parasitology: Molecular basis of antigenic variation and diversity of parasites; Molecular organization and gene structure in Plasmodium; Strategies of molecular cloning and protection against malaria.

**Paper – MZOOMET402- B****(Elective – Fisheries and Aquaculture)****Marks: 50****No. of Class Hrs. 60****(Freshwater Aquaculture; Coastal and Marine Water Fisheries)****1. Aquaculture of carps**

- 1.1. Breeding of fish, Hormonal interactions for fish breeding
- 1.2. Modern hatcheries and management

1.3. Site selection, culture system, preparation and management of ponds for culture

4.2. Transportation of fish seeds

4.3 Major diseases in aquaculture, control and management

## **2. Fish Nutrition and Growth**

2.1. Nutritional requirements, Digestive energy in fish feed and Energy flow through

fish; Feed formulation

## **3. Aquaculture of Freshwater prawns**

3.1. Major cultivable species of prawns

3.2. Reproduction and larval rearing of prawns, site selection, construction of farms, grow out.

## **4. Fish pathology and diseases**

4.1. Major diseases in aquaculture, control and management.

4.2. Immune protection in fish systems

## **5.Non conventional aquaculture system**

5.1 Raceways, Flow through & recirculation technology in aquaculture, Pens and Cage aquaculture

## **6.Mariculture**

6.1. Breeding and larval rearing of shrimps and management

6.2. Different shrimp culture system, construction of farm, selection of larvae, water and feeding management, harvesting and disease management

6.3. Culture of mud crab

6.4. Edible oyster farming

## **7. Marine fisheries**

7.1. Exclusive economic zone – potentialities, exploitations & problems

7.2. Modern devices of exploitation (different crafts and gears used in Indian capture fishery)

7.3. Major fisheries of Indian coasts: Bionomics and production of Hilsa, Sardine, Bombay duck, Pomfret

## **Paper – MZOOMET 402C (Elective-Genetics and Cell Biology Special)**

**Marks: 50**

**No. of Class Hrs. 60**

1. Regulation of gene expression in prokaryotes-overview, arabinose operon

2. Regulation of gene expression in eukaryotes:

2.1 Regulation at transcriptional level: Transcription factors, leucine zipper, helix turn helix, helix loop helix, enhancers and silencers, Chromatin-remodelling complexes,

2.2 RNA interference (RNAi), shRNA, sno RNA

2.3 Regulation at translational level

2.4 Regulation at chromosomal level: chromatin remodeling, histone modification.

2.5 Translation: Nature and Properties of Genetic code, Wobble; Prokaryotic and eukaryotic translation - The translational machinery, Mechanisms of initiation, elongation and termination; Regulation of translation, Co-and post-translational modifications of proteins

3. Genetic Imprinting: Imprinting of genes, Epigenetic regulation by DNA methylation, Epigenetic control of gene expression
4. Human genetics: Pedigree analysis, lod score for linkage testing, genetic disorders
5. Oncogenesis: Transformation and Oncogenesis by Damaging the Chromosome, Identifying a Nucleotide Change Causing Cancer, Retroviruses and Cancer, Tumor Suppressors-p53, Rb, Programmed cell death, apoptotic and necrosis, proapoptotic and antiapoptotic proteins, ras-fos-jun Pathway, Directions for Future Research in Molecular Biology.

## **SEMESTER – IV**

### **Paper – MZOOMET403A**

**(Elective – Parasitology and Immunology)**

**Marks: 50**

**No. of Class Hrs. 60**

**Unit-I**

**FM=25**

### **Immunology and Immunoparasitology**

1. Concept of immunity and development of immune system in vertebrates; Cells, tissues and molecules of the human immune system ;

#### **2. Molecular mechanism of Immune function**

Concept of lipid raft and local signaling. Signaling cascades during T and B cell maturation. Generation of TCR and BCR diversity, class switch. Signal transduction during BCR and TCR activation. Costimulatory pathways.

**3. Overview of Inflammation, Global regulator of inflammation: IL10, IL1 and Th17 subset. Cytokine storm, sepsis shock and inflammatory cascade.**

**4. Immunity and host defense :** Hypersensitivity reaction to helminthes ; Mechanism of inflammation and inflammatory mediators from parasites; Malaria and sickle cell anemia , co evolution of host defense; MHC and co-evolution of host immune system .

### **5.Immunotechniques**

Concept of flowcytometry and FACS, Si RNA and Sh RNA: Application in immunological research and therapeutics. Concept of immunohistochemistry , population markers.ELISA

## **Unit-II**

**FM=25**

### **Immunity and Therapeutics**

#### **1. Tolerance and Autoimmunity**

Peripheral and Central Tolerance of T and B cell.Clonal anergy. Negative and positive regulation of immune system .Molecular mechanism of autoimmunity. Concept of autoimmunity: Type 1 diabetes, Multiple sclerosis, Arthritis .

#### **2. Immunodeficiency and Vaccination**

Congenital Immunodeficiency.Acquired Immunodeficiency.Principles and Significance of Vaccine production.Types of Vaccines (subunit, killed, attenuated etc.). Future trend and target of vaccination .

#### **3. Transplantation Immunology**

3.2 Molecular basis of graft vs host reaction. Acute, Hyperacute and chronic Graft rejection Modern techniques of transplantation (e.g., BMT, liver, cornea etc) .

#### **4. Tumor Immunology**

Immune surveillance theory, Mechanism of Immune evasion by tumor. Anti-tumor Immune response. Role of regulatory components of immune system in tumor establishment. Targeted Immunotherapy of Cancer .

#### **5. Immunomodulation and immunopharmacology**

Mechanism of action of common immunosuppressant drugs. Immunoboosters . Nutrition and immune system. Mouse-human hybrid antibodies. Anti-idiotypic vaccines. Antibody mediated drug delivery .

#### **Suggested Readings:**

1. Larry S. Roberts, and John Janovy Jr. 2005. Gerald D. Schmidt & Larry S. Roberts' FOUNDATION OF PARASITOLOGY 7<sup>th</sup> Ed., McGraw Hill Company, Inc.
2. J.D. Smyth 1994. ANIMAL PARASITOLOGY 3<sup>rd</sup> Edn. , Cambridge University Press
3. Thomas C. Cheng 1999 GENERAL PARASITOLOGY 2<sup>ND</sup> Edn. Academic Press, Inc.
4. K.D. Chatterjee 2009 PARASITOLOGY : Protozoology, and Helminthology in relation to clinical medicine 13<sup>th</sup> Edn. CBS Publishers and Distributors Pvt. Ltd., New Delhi
5. Heinz Mehlhorn 2007 PARASITOLOGY IN FOCUS ( Encyclopedic approach ) 3<sup>rd</sup> Edn. Springer-Verlag , Germany

6. Norman D. Levine 1985 VETERINARY PARASITOLOGY Iowa State University Press, Iowa- 50010
7. A. Mukhopadhyay and A.K.De 2002 PERSPECTIVES IN ENVIRONMENTAL HEALTH : Vector and Water borne diseases, Section-I, ORIGINALS D.K.Publishers Distributors(P) Ltd, New Delhi- 110002
8. R.Beaglehole, R.Bomita and T.Kjelstorm 1993. BASIC EPIDEMIOLOGY. Orient Longman in collaboration with WHO, Geneva
9. W. Peters and R. Killick-Kendrick 1987. THE LEISHMANIASIS in Biology and Medicine. Academic Press(Inc), Ltd.
10. Paul Schmid-Hempel 2011. EVOLUTIONARY PARASITOLOGY Oxford University Press
11. S.R. Palmer , Lord Soulsby and D.I.M.Simpson 1998 . ZOONOSES Oxford Medical Publication
12. Irwin W. Sherman 1998 . MALARIA ParssiteBiology , Pathogenesis and Protection. ASM Press, Washington,D.C.
13. Baker , Ben Dawes , Advances in Parasitology Vol-1-42. Academic Press
14. Paul Chester Beaver, Rodney Clifton Jung, and Eddie Wayne Cupp, 1984 Faust's CLINICAL PARASITOLOGY 9<sup>th</sup>Edn . Lea &Fabeiger, Philadelphia
15. E.J.L. Soulsby, 2002 HELMINTHS , ARTHROPODS AND PROTOZOA of domesticated animals . 7<sup>th</sup>Edn.The English Longman Book Society and BailliereTindall, London
16. Jullius P. Krier 1978 PARASITIC PROTOZOA 2Edn. Vol-1-12. Academic Press
17. Lynne Shore Garcia 2010 . DIAGNOSTIC MEDICAL PARASITOLOGY 5<sup>th</sup>Edn. ASM Press, Washington,D.C.
18. John Hyde 1996 . MOLECULAR PARASITOLOGY Open University Press



19. J. Joseph Marr and Miklos Mullar 1995 BIOCHEMISTRY & MOLECULAR BIOLOGY OF PARASITES Academic Press
20. Theodor von Brand 1973 BIOCHEMISTRY OF PARASITES 2<sup>nd</sup> Edn. Academic Press
21. John Barret 1981 BIOCHEMISTRY OF PARASITIC HELMINTHES Macmillan Publishers Ltd.
22. Felipe Kierszenbaum 1994 . PARASITIC INFECTIONS AND THE IMMUNE SYSTEM Academic Press
23. Ashim K. Chakravarty 2006. IMMUNOLOGY AND IMMUNOTECHNOLOGY Oxford University Press
24. Arun Ingale 2010 BASIC IMMUNOLOGY New Central Book Agency(P) Ltd. Kolkata -700009
25. Thomas J. Kindt, Richard A. Goldsby and Barbara A. Osborne 2007 Kuby's IMMUNOLOGY 6<sup>th</sup> Edn., W.H. Freeman and Company
26. Abdul K. Abbas and Andrew H. Litchman CELLULAR & MOLECULAR IMMUNOLOGY 5<sup>th</sup> Edn. Saund

#### **SEMESTER – IV**

#### **Paper – MZOOMET403- B**

**(Elective – Fisheries and Aquaculture)**

**Marks: 50**

**No. of Class Hrs. 60**

**(Fish genetics, Biotechnology, microbiology, fish processing and conservation)**

**1. Sex determination in fish**

**2. Technique of stock improvement**

2.1 Cryopreservation , cryoprotection and gamete banking

2.2 Production of Monosex and Sterile fish and their significance in aquaculture

2.3 Production of hybrids in captivity – techniques ,inter specific and intergeneric hybrids, application of successful hybrids, limitations

2.4 Polyploidy in fish

2.5 Production of sex reversed fish – different techniques, identification of successful sex reversed fish, process of preparation of steroid hormone treated feed & application, sex reversion in *Tilapia*.

2.6 Production of transgenic fish – mechanism, example, advantages and limitation

### **3. Waste water recycling through aquaculture**

### **4. Processing ,preservation & curing**

4.1. Fish spoilage and methods of preservation

Spoilage (causes, changes in protein, amino acid and breakdown products)

Preservation (Drying, salting, smoking, freezing and canning, IQF etc.)

4.2. Fish by-products

4.3. Shrimp processing technology- processing, packaging, HACCP, ISI standard, problems & precautions

### **5. Conservation of fishery resources**

5.1. Sustainability of Fisheries development.

5.2. Open water stocking & ranching programme.

### **Referred Books:**

1. Bal, D. V. & Rao, K. V. (1984). Marine Fisheries. Tata McGraw Hill Pub. C Ltd.
2. Bardach, J. E. & Ryther, J. H. (1972). Aquaculture. John Wiley and Sons.
3. Beaumont, A. R. & Hoare, K. (2003). Biotechnology & Genetics in Fisheries and Aquaculture. Blackwell Publishing.
4. Dodson, Introduction to limnology, 2005, Mc Grow Hill
5. Chaudhuri H L (1990) Induced breeding of carps (ICAR)
6. Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd ed., Hindustan Pub. Corp. John Wiley & Sons.
7. Kent, Reservoir limnology: ecological perspectives, 1990, John Wiley Sons
8. Khanna, S. S. & Singh, H. R. (2003). A Text Book of Fish Biology & Fisheries. Narendra Publishing House. New Delhi.
9. Midlen & Redding, Environmental management for aquaculture, 1998, Springer
10. Philip Kotler, Marketing management, Printice Hall of India
11. Pillay, T. V. R. (1993). Aquaculture. Fishing News Books.
12. Ruttner et al Fundamentals of limnology, 1974, Univ. of Toronto Press  
Srivastava, C. B. L. (2006). A Text Book of Fishery Science & Indian Fisheries. Kitab Mahal. Allahabad. Publishing House. New Delhi.
13. Tundisi, Limnology, 2012, Taylor & Francis
14. Wetzel, Limnology 1995 Saunders

15. Wetzel , Limnology,lake and river ecosystem ,2001, Academic Press

16. DuttaMunshi and Hughes: Air Breathing Fishes of India

**Paper – MZOOMET 403C**  
**(Elective-Genetics and Cell Biology Special)**

**Marks: 50**

**No. of Class Hrs. 60**

1. Membrane Structure and Dynamics:
  - a. Overview of membrane structure and its components.
  - b. Regulation of fluidity, Various modes of attachment of membrane proteins
  - c. Membrane Pumps- Diversity of Membrane Pumps.
  - d. Membrane Carriers-Diversity of Carrier Proteins, Carrier Physiology and Mechanisms- Uniporters, Antiporters, Symporters
  - e. Membrane Channels - Channel Diversity and activity, Channel Structure
2. Organization of plant cell wall and vacuole
3. Cytoskeleton and Cellular Motility: Microtubules- structure and composition,microtubule-associated proteins, dynamic properties of microtubules. Microfilaments and intermediary filaments- intermediate filament assembly and disassembly, Movements along Microtubules, Movement of Cytoplasm Driven by Actin and Myosin
5. Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan, Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens Junctions and desmosomes. Tight junctions, Gap junctions and Plasmodesmata.

6. Cellular Movement: Motility and Contractility- intracellular microtubule-based movement: kinesin and dynein, microtubule-based motility: cilia and flagella, actin-based cell movement: the myosins, filament-based movement in muscle, actin-based motility in nonmuscle cells
7. Cell and Molecular Biology based Instrumentation: TEM, SEM, AAS, GC-MS, Radioactive tracer techniques, AFM, fluorescent microscopy, HPLC, FPLC, NMR, ESR, Flow Cytometry, FISH, GISH; DNA finger printing; Automated karyotyping, Chromosome painting.
8. Transposable elements in Prokaryote and eukaryote: Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Transposable Elements in Eukaryotes, SINES and LINES, retro-transposon. Evolutionary significance of Transposition.

#### **Suggested Readings:**

1. Schleif R. (1993) Genetics and Molecular Biology, The Johns Hopkins University Press Baltimore and London.
2. Brooker RJ. (2009) Genetic Analysis and Principles, 3<sup>rd</sup> Edition, McGraw-Hill, New York.
3. Pierce BA. (2012) Genetics a Conceptual approach, 4<sup>th</sup> Edition, Freeman and Co. New York.
4. Snustad DP, Simmons MJ. (2012) Principles of genetics, 6<sup>th</sup> Edition, JohnWiley& Sons Inc.
5. Lewin B. (2006) Essential Genes, Published by Pearson Education, Inc.
6. Russell, PJ.(2010) i-Genetics : a molecular approach. 3<sup>rd</sup> Edition.
7. Pollard TD and Earnshaw WC.(2008) Cell Biology.
8. Lodish , Bark, Keiser et al. Molecular Cell Biology. 7<sup>th</sup> Edition.
9. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.(2014) Essential Cell Biology, 4<sup>th</sup> Edition. Garland Science

**SEMESTER – IV**  
**Paper –MZOOMES404-A**

**(Elective – Practical) – Experimental Parasitology and immunology**

**50 Marks**

**1. Identification of the prepared slides :** *Trypanosoma*, *Leishmaniasp*, ( Pro and amastigote), *Opalina sp.*, *Nyctotherus*, *Sicuophora*, *Balantidium*, *Stomatophora*, *Monocystis*, *Giardia*, *Entamoebahistolytica*, *Gregarina*, *Eimeria*, *Haemoproteus*, *Plasmodium* (*vivax* & *falciparum* species), *Conchophthirus*, *Myxobolus*, *Taeniasolium*, *T. saginata*, *Raillietina sp.*, (mature proglottid and scolex), *Echinococcus*, *Fasciola*, *Isoparorchis*, *Paramphistomum*, *Ascaris* male and female, *Argulus*, *Pediculus*, *Phthirus*, *Cimax*, *Xenopsylla*, *Ctenocephalids*, *Boophilus*, *Phlebotomus*, mosquitoes (adult male & female, mouth parts of *Anopheles*, *Culex*, and *Aedes*)

2. Cell counting and cell viability

3. Mononuclear leukocyte separation

4. Preparation of serum and Isolation of Spleen, Thymus and Bone marrow cells

5. Peritoneal Lavage / Macrophage Activity

6. Primary culture of PBMC

7. Immunodiffusion (Radial and/or Ochterlony), ELISA, SDS PAGE AND Western Blot

8. Primer design for reverse transcriptase and normal PCR, PCR

9. Histological preparation of spleen, thymus, and bursa of Fabricius and their identification and drawing in the laboratory note book and submission of prepared slides

10. Preparation of media, maintenance of *Leishmania* sp. in *in vitro* culture and preparation of growth curve .

11. Post-mortem examination , fixation, preservation, staining and preparation of permanent slides of available protozoans helminths, insects and ticks of medical importance and submission of at least 12 prepared slides during examination for evaluation.

12. Visit to the slaughter house and poultry farm, collection of specimens and submission of collections and reports.

### **13. Biostatistics ( Common for any elective)**

1. Statistical Analysis:

a) t test

b) Chi-square test

c) Population analysis **(Marks=30)**

Internal assessment (Field study, Laboratory Note Book and class records). 10

d) Viva-voce examination, submission of prepared slides, field note book and practical records .10

**Paper – MZOOMES404-B**

**(Elective – Practical) – Fisheries and Aquaculture**

**Marks 50**

## 1. Laboratory Work

25

- A. Analysis of important water & soil parameters.
- B. Histological studies of different fish tissues and their identification.
- C. Dissection of different organ systems (digestive system, urinogenital system, accessory respiratory organs).
- D. Techniques of induced breeding (Collection of pituitary gland, preparation of extraction and administration)
- E. Estimation of maturity and fecundity of fish specimens.
- F. Estimation of relative gut length, hepato-somatic index and interpretations
- G. Zooplankton sampling: methods of collection, preservation, identification and interpretations
- H. Benthos of diverse biotopes
- I. Identification of fresh water and brackish water fish fauna.
- J. Identification of aquatic weeds, predatory fishes and aquatic insects
- K. Fish Physiology experiment-Digestive enzymes, biochemical composition of fish.
- L. Statistics of aquaculture data

2. Field study and submission of field report  
10

3. Internal Assessment (Field study, Laboratory Note Book and class records).  
10

4. Viva-voce. 5

## MZOOMES 404C



## **Practical (Major Elective)**

**(Elective – Practical – Genetics and Cell Biology)**

**50 Marks**

1. Handling of Drosophila, Culture techniques, Handling techniques, Study of mutant phenotypes of Drosophila and genetic crosses.
2. Preparation and study of polytene chromosomes
3. Preparation and study of metaphase chromosomes: mitotic and meiotic from mice/rats
4. Chromosome banding (C, G, NOR banding).
5. Preparation of human/mice karyotype and study of chromosomal aberrations
6. Isolations of genomic DNA from bacteria/mouse/rat liver.
7. Measurement of absorption-spectrum of DNA, RNA, and nucleotides.
8. Separation of amino acids by paper chromatography and TLC
9. Separation of proteins and DNA – SDS PAGE and Agarose and western blot
10. Quantitative estimation of Acid/Alkaline phosphatase/antioxidant assay
11. Study of mitotic indices, micronuclei, and sperm head abnormality in mice/rat/fish
12. Measurement of activity of GGT/creatinine/cholesterol.
13. Histological sections of tissues from mice/rats (liver/kidney/spleen/testis/ovary), and comparison between treated and untreated sets.
14. Visit to any Institute

### **13. Biostatistics (Common for any elective)**

Statistical Analysis:

- A. t test,
- B. Chi-square test,
- C. Population analysis

**Marks=30**

**Internal assessment (Field study, Laboratory Note Book and class records). 10**

**Viva-voce examination, submission of prepared slides, field note book and practical records.  
10**

#### **SEMESTER – IV**

##### **Paper – MZOOMEP 405A**

**Project of Experimental Parasitology and immunology.**

**Marks 50**

- 1. Contents 10
- 2. Methodology, experiment design and results 15
- 2. Presentation 15
- 3. Interaction 10

##### **Paper- MZOOMES405-B**

##### **Project of Fisheries and Aquaculture**

**Marks 50**

- 1. Content 10
- 2. Methodology, experiment design and results 15

3. Presentation	20
4. Interaction	5

#### **SEMESTER – IV**

##### **Paper – MZOOME P-405C Genetics and Cell Biology**

##### **Project 50**

A. Content	10
B. Methodology, experiment design and results	15
C. Presentation	15
<b>D. Interaction</b>	<b>10</b>

#### **SEMESTER – IV**

##### **Paper – MZOOACT 406**

##### **Health, hygiene, sanitization**

##### **A. Microbiology and Parasitology:**

- 1) Classification and Characteristics of microorganisms
- 2) Common diseases, causing microorganisms and their characteristics – AIDS, Leprosy, Malaria, Filariasis
- 3) Activities of microorganisms in relation to the environment and the human body, Immunity
- 4) Basic principle of control and destruction of microorganisms
  - i) Vaccination, Sterilization, Disinfection
  - ii) Chemotherapy and antibiotics
  - iii) Control of spread of infection
  - iv) Pasteurization
  - v) Bio safety and waste management

##### **B. Community Health and life style diseases :**

- 1) Definition of Health, Health assessment-Characteristics of healthy individual
- 2) Definition and aims of epidemiology
- 3) Disease cycle
- 4) Disinfection
- 5) Life style diseases such as Obesity, Diabetes, Cardiac diseases, Cancer

**C. Environmental Hygiene:**

- 1) Components of environment
- 2) Importance of environmental health
- 3) Water – i) Potable and non-potable ii) Water pollution iii) Water borne diseases iv) Water purification
- 4) Air- Air pollution, prevention and control of air pollution
- 5) Waste- Health hazards, Waste treatment
- 6) Noise-Source, effect and control
- 7) Arthropod and Rodents of Public health importance:  
Mosquitoes, housefly, sandfly, rodents, Control measures

**D. Nutrition:**

- 1) Classification of food
- 2) Common foods in health and diseases
- 3) Adulteration of Food

**E. Mental Health:**

- 1) Substance and Abuse
- 2) Depressive disorders
- 3) Alzheimer's, Parkinson's, Autism

**Referred Books:**

1. Principles of microbiology: G. Sumbali and R.S. Mehrotra
2. Microbiology: P.D.Sharma