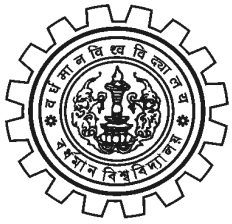
SYLLABUS FOR
M. SC. COURSE IN ZOOLOGY
(With effect from the session 2007–2009)



DEPARTMENT OF ZOOLOGY
THE UNIVERSITY OF BURDWAN
BURDWAN 713 104
WEST BENGAL

THE UNIVERSITY OF BURDWAN
SYLLABUS FOR M. SC. COURSE IN ZOOLOGY
(With effect from the session 2007–2009)

TOTAL MARKS - 1200

Summary of the M.Sc. course in Zoology

	Theory & term paper	Practical	Marks Distribution				Total Marks
			Theory	Term paper	Practical	Internal assessment	
Semester I	**4**	**2**	**180**	**-**	**100**	**20**	**300**
Semester II	**4**	**2**	**180**	**-**	**100**	**20**	**300**
Semester III	**4**	**2**	**180**	**-**	**100**	**20**	**300**
Semester IV	**4**	**2**	**135**	**50**	**100**	**15**	**300**
	16	**8**	**725**		**400**	**75**	**1200**

THE UNIVERSITY OF BURDWAN
SYLLABUS FOR M. SC. COURSE IN ZOOLOGY
(With effect from the session 2007 - 2009)
Total Marks: 1200
(Theoretical: 750 + Practical: 400 + Term paper: 50)

Semester- I				**F.M. 300**
		Theory		
TGZ: 101	-	**Unit-I**	**Biosystematics and Taxonomy**	
(F.M. 45)	-	**Unit-II**	**Evolution and Population Genetics**	
TGZ: 102	-	**Unit-I**	**Histology and Histochemistry**	
(F.M. 45)	-	**Unit-II**	**Comparative Anatomy**	
TGZ: 103	-	**Unit-I**	**Cytology**	
(F.M. 45)	-	**Unit-II**	**Genetics**	
TGZ: 104	-	**Unit-I**	**Biochemistry**	
(F.M. 45)	-	**Unit-II**	**Toxicology**	
Internal assessment:				
(F.M. 4×5=20)				
		Practical		
PGZ: 105	-	**Unit-I**	**Dissection and Taxonomy**	
(F.M. 50)	-	**Unit-II**	**Histology and Histochemistry**	
PGZ: 106	-	**Unit-I**	**Cytology and Genetics**	
(F.M. 50)	-	**Unit-II**	**Biochemistry and Toxicology**	
Semester- II				**F.M. 300**
		Theory		
TGZ: 201	-	**Unit-I**	**Ecology and Ethology**	
(F.M. 45)	-	**Unit-II**	**Soil Zoology**	
TGZ: 202	-		**Physiology**	
(F.M. 45)				
TGZ: 203	-		**Microbiology**	
(F.M. 45)				
TGZ: 204	-		**Immunology**	
(F.M. 45)				

Internal assessment:			
(F.M. 4× 5=20)			
		Practical	
PGZ: 205	**-**		**Ecology and Soil Zoology & Educational tour**
(F.M. 40+10=50)			
PGZ: 206	**-**	**Unit-I**	**Physiology**
(F.M. 50)	**-**	**Unit-II**	**Microbiology and Immunology**
		Semester- III	**F.M. 300**
		Theory	
TGZ: 301	-		**General Entomology**
(F.M.-45)			
TGZ: 302	-		**Parasitology and Vector Biology**
(F.M. 45)			
TGZ: 303	-		**Ichthyology and Aquaculture**
(F.M. 45)			
TSZ: 304	**-**		**Special paper**
(F.M. 45)			
Internal assessment:			
(F.M. 4 × 5=20)			
		Practical	
PGZ: 305	**-**		**Entomology, Parasitology and Ichthyology**
(F.M. 50)			
PSZ: 306	**-**		**Special Paper**
(F.M. 50)			
		Semester- IV	**F.M. 300**
		Theory	
TGZ: 401	-	**Unit-I**	**Developmental Biology**
(F.M. 45)	**-**	**Unit-II**	**Biostatistics and Bioinstrumentation**
TSZ: 402	**-**		**Special Paper**
(F.M. 45)			
TSZ: 403	**-**		**Special Paper**
(F.M. 45)			
TSZ: 404	**-**		**Term paper/Project work (based on special paper)** [Submission &
(F.M. 50)			Seminar Presentation – 40 (25+15) & Discussion – 10]

Internal assessment: **(F.M. 3×5=15)**		
		Practical
PGZ: 405 **(F.M. 50)**	-	**Developmental Biology & Computer Application**
PSZ: 406 **(F.M. 50)**	-	**Special paper**

Special papers offered:

1. ENTOMOLOGY
2. AQUACULTURE & FISHERIES
3. PARASITOLOGY & MICROBIOLOGY
4. ECOLOGY & ENVIRONMENT
5. MOLECULAR BIOLOGY & GENETICS

TGZ: 101

Time: 2 hrs. **Full Marks: 45**

Unit – I: BIOSYSTEMATICS & TAXONOMY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Taxonomy 2L
History and Importance
General concepts 4L
Micro- and Macro-taxonomy
Levels of taxonomic study
Concepts of species 15L
Types –Typological, Biological and Evolutionary
Kinds of species, Taxonomic types
Hierarchy
New trends in taxonomy 10L
Biochemical, Cytological & Molecular
Zoological nomenclature 4L
Rules of Nomenclature.

Suggested readings:

Blackwelder, R. E., (1967). *Taxonomy- A text and reference book*. John Wiley & Sons.
Forey, P. L. *et al.* (1992) *Cladistics – A practical course in systematics*. Clarendron Press.
Kapoor, V. C. (1994). *Theory and practice of animal taxonomy.* 3rd. ed. Oxford & IBH.
Mayr, E. (1969). *Principles of Systematic Zoology.* Tata McGraw-Hill.
Mayr, E. & Ashlock, P. D. (1991). *Principles of Systematic Zoology.* 2 ed., McGraw-Hill.
Mayr, E. (1997). *This is biology: the science of the living world*. Belknap, Harvard University Press, Cambridge, Mass.
Scott-Ram, N. R. (1990). *Transformed cladistics, taxonomy and evolution*. Cambridge University Press.
Simpson, G. G. (1961). *Principles of Animal Taxonomy.* Columbia University Press. New York.
Quicke, D.A.J. (1993). *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic & Professional.

Unit – II: EVOLUTION & POPULATION GENETICS

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Population Genetics

Molecular Population genetics 6L
Neutral theory
Molecular evolution and Phylogenetics.
Variation and Evolution 10L
Genetic variation in population (Morphological, Chromosomal and biochemical)
Quantification of genetic variation in populations

Quantitative genetics 9L

Hardy–Weinberg equilibrium – Testing population samples
Factors affecting Hardy – Weinberg equilibrium.

Evolution

Natural Selection 8L

Darwinian fitness
Genetic burden or load
Polymorphism and balancing Natural Selection
Diversifying natural selection with examples.

Macro and Micro evolution 12L

Evolutionary pattern and rate
Isolating mechanisms and speciation.
Punctuated equilibrium

Suggested readings:

Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. & Patel, N.H. (2007). *Evolution.* CSHL Press.

Brooker. (2001). *Genetics*. McGraw-Hill.

Dobzhansky, T., Ayala, F. J., Stebbins, G. L. & Valentine, J. W. (1977). *Evolution*. Surjeet Publications, New Delhi.

Futuyama, D. (1997). *Evolutionary Biology*. 3rd ed. Sinauer Associates, INC.

Futuyama, D. (2005). *Evolution*. Sinauer Associates, INC.

Hall, B. K., Hallgrimson, B. (2008). *Strickberger's Evolution*. 4th ed. Jones and Bartlett.

Hartl, D. L. (2005) *Principles of Population Genetics.* 4th ed. Sinauer Associates.

Minkoff, D. (1983). *Evolutionary Biology*. 3rd ed. Sinauer Associates, INC.

Page, R. D. M. & Holmes, E. C. (1998). *Molecular Evolution: A Phylogenetic Approach* Blackwell Science Ltd (2nd Reprint, 2001).

Ridley, M. (1996). *Evolution.* 2nd ed. Blackwell Science Ltd.

Savage, J. M. (1969). *Evolution.* 2nd ed. NY, Holt.

Stansfield, W. D. (2001). *Principles of Genetics.* (5th ed.). Tata McGraw-Hill. Publ. Co.

Stearns, S. C. & Hoeskstra, R. F. (2005). *Evolution*. Blackwell Science Ltd.

Stebbins, G. L. (1969). *Process of Evolution*. Tata McGraw-Hill.

Volpe, E. P. & Rossenbaum, P. A. (1999). *Evolution*. Mc-Graw Hill Science Engineering.

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TGZ: 102

Time: 2 hrs. **Full Marks: 45**

Unit – I: HISTOLOGY & HISTOCHEMISTRY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Fixation and related procedures 8L

Types of fixation, Fixation process; fixation of whole tissue;
fresh-frozen sections; Decalcification

Embedding 2L

Gum-sucrose/gelatin and paraffin wax embedding

Microtomy 3L

Methods, problems and remedies of microtomy including cryostat and freezing microtome

Structure and function

Tongue, Intestine and Thymus 6L

Biological dyes and stains 8L

Properties, source and use of haematoxylin, eosin and carmine

Theoretical basis and application of following histochemical methods: 8L

PAS/AB test for carbohydrates

Fuelgen reaction for DNA

Metallic and Azo dye methods for alkaline and acid phosphatase, adenosine tri-phosphatase

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Suggested readings:

Bancroft, J. D. & Gamble, M. (2002). *Theory & practice of Histological Technique.* Churchill Livingstone.

Bloom, W. & Fawcett, D. W. *A Textbook of Histology*. 10th ed, W.B. Saunders Company.

Fawcett, D. W. (2001). *Bloom & Fawcett: Concise Histology*. Arnold.

Friefelder, D. (1982). *Physical Biochemistry.* W. H. Freeman & Co. (Reprint 1999).

Junqueira, L. C. & Carneiro, J. (2005). *Basic Histology*:*Text and Atlas* 11th ed. McGraw Hill Lange Med. Pub.

Kiernan, J. A. (1999). *Histology and Histochemical Methods: Theory & Practice.* 3rd ed, Butterwork Heinemann.

Leeson, T. S., Leeson, C. R. & Paparo, A. A. (1988). *Text/Atlas of Histology*. 1st Ed. W. B. Saunders Company.

Ross, M, H., Reith, E. J. & Romell, L, J. (1998). *Histology: a text and atlas*. 2nd ed. Williams & Wilkins.

Ross, M. H. & Reith, E. (1985). *Histology: A Text & Atlas.* Harper & Row Publishers.

Sharma, B. K. (1991). *Techniques in Microscopy and Cell Biology.* Tata-McGraw Hill.

Stoward, P. J. & Everson Pearse, A. G. (1991). *Histochemistry: Theory and Practical.* 4th ed. Churchill Living Stone.

Weesner, F. M. (1965). *General Zoological Techniques*. The William & Wilkins Company.

Unit – II: COMPARATIVE ANATOMY

Full Marks: 22.5

Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Comparative study of invertebrates

Digestive system 4L

Nervous system 4L

Reproduction and Larval forms 3L

Comparative study of vertebrates

Stomach 2L

Respiratory system 4L

Brain and sense organs 8L

Thyroid and Adrenal glands 4L

Development, uses and comparative account in vertebrates

The integument and its derivatives (except glands) 6L

Suggested readings:

Anderson, D. T. (Ed.) (2001). *Invertebrate Zoology.* 2nd ed. Oxford University Press.

Barnes, R. D. & Ruppert, E. E., (1996). *Invertebrate Zoology.* 6th ed. Brooks Cole.

Ruppert, E. E., Fox, R. & Barnes R. D. (2003). *Invertebrate Zoology*: *A Functional Evolutionary Approach.* 7th ed. Brooks Cole.
Barrington, E. J. W. (1981*). Invertebrate Structure and function*. 2nd ed. ELBS & Nelson.
Brusca, R. C. & Brusca, G. J. (2002). *Invertebrates.* 4th ed. Sinauer Associates.
Hildebrand, M. (1995). *Analysis of Vertebrate Structure.* John Wiley & Sons.
Kardong, K. V. (2002). *Vertebrates: Comparative anatomy, function evolution.* Tata McGraw Hill.
Kent, G. C. & Carr, R. K. (2001). *Comparative anatomy of the Vertebrates.* 9th ed. Mc Graw Hill.
Meglitsch, P. A. & Schram, F. R. (1991). *Invertebrate Zoology.* Oxford University Press.
Pechenik, J. A. (1998). *Biology of the Invertebrates*, 4th Ed. McGraw Hill.
Romer, A. S. & Parsons, T. S. (1986). *The vertebrate body. 6th ed.* Saunders College Publishing.
Weichert, C. K. & Presch, W. (1984). *Elements of Chordate Anatomy.* Tata-McGraw Hill Pub. Comp.

TGZ: 103

Time: 2 hrs. **Full Marks: 45**

Unit – I: CYTOLOGY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Gene and the genome 6L
- Complexity of the genome: eukaryotic genome
- C–value enigma. DNA reassociation kinetics, Cot curves, Tm values
- Centromeric and telomeric DNA, Telomeric repeats and chromosome-end replication problem, rescue by telomerase.

DNA replication in Eukaryotes 4L
- Components and mechanics.

Cell cycle Kinetics 4L
- Labeling index and cell cycle duration measurement
- Cell synchronization and cell cycle inhibitors.

Cell-cell communication 7L
- Cell signaling molecules
- Cell surface receptors and ion channels
- Signal transduction pathways (DAG and cAMP)

Cell cycle deregulation and cancer 9L
- Hallmark features of cancer
- Cancer critical genes and their role in tumourigenesis
- Carcinogenesis-Two hit- model of Knudson and multi- hit model of Vogelstein
- Cancer-Multifactorial disease
- Hybridoma technology and its application in monoclonal antibody production

Cell and its environment 5L
- Mutagens, clastogens, carcinogens and teratogens
- Mutagenicity test protocols, mammalian *in vivo* and *in vitro* test protocols

Unit – II: GENETICS

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Techniques in moleculer genetics 9L
Restriction endonuclease and cloning of genes;
Cloning vectors; production of recombinant DNA molecules;
Construction and screening of genomic and cDNA library; DNA sequencing;
PCR and RT PCR.

Mutation 6L
Molecular basis
Mutations in human
Cystric fribrosis.

DNA repair and recombination
NER, PR, SOS, PRR and MMR 6L
Recombination nodule
Cleavage and rejoining of DNA molecules
Gene conversion

Mitochondrial genome 3L
Comparison between mt-genome and human genome;
mt-DNA and limited autonomy of mt-genome

Genomic imprinting 5L
DNA methylation; genetic basis of human disease: Huntington's chorea.

Human genome project 6L
Methodologies
Strategies and applications
Ethics and social implications

Suggested readings:

Alberts, B. et al. (2008). *Molecular Biology of the Cell.* 5th Ed. Garland Publishing House.
Becker. (2009). *The World of the Cell*. 7th ed. Benjamin-Cummings.
Brown, T. A. (2002). *Genomes 2.* Wilely-Liss.
Clark, D. P. (2005). *Molecular Biology*. Elsevier.
Cooper, G. M. (2004). *The Cell*. 3rd edn. ASM Press.
Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C. & Carroll, S. B. 2008. *Introduction to genetic analysis.* 9th ed. W. H. Freeman and Company, New York.
Griffiths, A. J. F. (2002). *Modern Genetic Analysis: Integrating Genes and Genomics,* 2nd ed. W. H. Freeman and Company, New York.
Hartl, D. L. & Jones, E. W. (1998). *Genetics, Principles and analysis.* (4th ed). Blackwell Scientific, Oxford.
Hartl, D. L. & Jones, E. W. (2005). *Genetics: analysis of genes and genomes.* 6th ed. Jones and Bartlett Publishers, Sudbury, Mass.
Hartl, D. L. & Jones, E. W. (2006). *Essential Genetics: a genomics perspective* (4th ed.). Jones and Bartlett Publishers, Boston.
Hartwell et al. (2001) *Genetics: From genes to Genomes.* McGraw Hill
Harvey, L. (2004). *Molecular cell Biology*. 5th ed. W.H.Freeman.
Karp, G. (2008*). Cell and Molecular Biology: Concepts and experiments*.5th edn., John Wiley.
Kendrew, S. J. (Ed.) (1994). *The Encyclopedia of Molecular Biology.* Blackwell Science.
Lewin, B. (2008). *Genes IX*. Jones & Bartlett Publishers.

Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6th ed. Benjamin Cummings.
Malacinski, G. M. (2003). *Essentials of Molecular Biology.* 4th ed. Jones & Bartlett.
McConkey, H. (1993). *Human Genetics: The molecular Revolution.* Jones & Bartlett Publishers.
Rob Phillips, Jane Kondev, Julie Theriot (2008). *Physical Biology of the Cell*. Garland Science.
Snustad, D. P. & Simmons. M. J. (2004). *Principles of Genetics*. 4th ed. John Wiley and Sons.
Stansfield, W. D. (1991). *Schaum's Outline Series: Theory & Problems of Genetics.*3rd ed. McGraw-Hill.
Strachan, T. & Read, A. P. (2004). *Human Molecular Genetics-3*. garland Science.
Strickberger M.W. (1985). *Genetics.* 3rd ed, Prentice Hall of India Pvt. Ltd., New Delhi.
Tamarin, R. H. (2004). *Principles of Genetics.* Tata McGraw-Hill Publishing Comp. Ltd.
Twyman R.M. (2003). *Advanced Molecular Biology*. Viva Books.
Vogel, F. & Motulsky, A. G. (1999*). Human Genetics*. Springer.

TGZ: 104

Time: 2 hrs. **Full Marks: 45**

Unit – I: BIOCHEMISTRY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Bioenergetics 3L
- Laws of thermodynamics and its relevance to biological systems.
- High-energy phosphate bonds and its role in energy capture and transfer

Proteins 6L
- Amino acid structure of protein
- Primary and higher orders of protein
- Protein folding
- Nitrogenase system

Enzymes 4L
- Classification and general properties
- Kinetics
- Mechanisms of enzyme action (chymotrypsin)
- Regulation of enzyme activities. 8L

Carbohydrates
- Carbohydrates of physiologic significance
- Metabolism
- Glycolysis & Krebs cycle: Pathway & regulation
- Oxidative metabolism: electron transport chain, oxidative phosphorylation
- Gluconeogenesis
- Hexose monophosphate Shunt

Lipids 8L
- Lipids of physiologic significance, membrane lipids, cholesterol
- Synthesis and Oxidation of fatty acids
- Ketogenesis

General topics 6L

Integration of metabolic pathways
Pumps and membrane channels

Suggested readings:

Berg, J. M., Tymoczko, J. K. & Stryer, L. (2007). *Biochemistry*. 6th ed. W. H. Freeman & Company.

Devlin, T. M. (Ed.). (2002). *Textbook of Biochemistry with clinical correlations*. 5 ed. Wiley-Liss.

Haynie, D. T. (1998) *Biological Thermodynamics*. Cambridge University Press (South East Asian Reprint 2007)

Mathews, C. K., Van Holde, K. E. & Ahern K. G. (2001). *Biochemistry.*3 ed. Person Education.

Metzler, D. E. (2003). *Biochemistry: The Chemical reactions of living cell..* Vol. 1 & 2. Academic Press.

Murray, R. K., Granner, P., Mayes A. & Rodwell, V. W. (2003). *Harper's Illustrated Biochemistry*. 25 ed. McGraw-Hill.

Nelson, D. L. & Cox. M. M. (2004). *Lehninger's Principles of Biochemistry*. 2nd ed., Macmillan Worth Publishers.

Switzer, R. L. & Garrity, L. F. (1999). *Experimental Biochemistry*. W. H. Freeman & Company.

Voet, D., Voet, J. G. & Pratt C. W. (1999). *Fundamentals of Biochemistry*. Upgrade edition. John Wiley & Sons.

Unit – II: TOXICOLOGY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Concept, history and scope of toxicology 2L

Fundamentals of toxicology 8L

Types of toxic substances (including natural toxins, concept of xenobiotics)
Disposition and biotransformation (phase I and phase II reactions)
Drugs as toxic substance (Paracetamol, Aspirin, Thalidomide)

Effects of toxic substances 4L

Biochemical and physiological effects
Interactive effects: additive effects, potentiation and synergism

Toxicity tests 4L

Dose, dosage, dose response
Acute toxicity tests: Bioassay, LC_{50} and LD_{50}, Probit analysis and Significance.
Chronic toxicity tests: Methods, Significance.

Pesticides 7L

Concept and classification
Insecticides and herbicides: Types (including bioinsecticides), sources, effects and kinetics in the environment
Mechanism of action: Organochlorine, Organophosphate, Carbamates, Paraquat, Phenoxy herbicides

Metal toxicity
and lighter elements (As, Se)
Metal chelation
Applied toxicology 4L
Clinical toxicology
Forensic toxicology

Suggested readings:

De, A. K. (2000). *Environmental chemisrtry.* 4th ed. New Age International (P) Ltd. Publishers.

Duffus, J.H. & Worth H.G.J. (Ed.) (2006). *Fundamental Toxicology*. RSC publishing.

Klaassen, C. D. (Ed.) (1996). *Casarett & Daul's Toxicology: The Basic Science of Poisons.* 5th ed. McGraw-Hill, New York.

Lu, F. C. (1996). *Basic Toxicology: Fundamentals, Target organs and Risk Assessment.* 3rd ed. Taylor & Francis.

Pandey, K., Shukla, J. P. & Trivedi, S. P. (2005). *Fundamentals of Toxicology*, New Central Book Agency (P) Ltd. Kolkata.

Plant, N. (2003). *Molecular Toxicology*, 1st Ed. Bios Scientific Publishers.

Stine, K. E. & Brown, T. M. (2006). *Principles of Toxicology*. 2nd Ed. CRC, Taylor & Francis Group, New York.

Timbrell, J. (2002*). Introduction to Toxicology*, 3rd Ed., Taylor & Francis, London.

Walker, C. H., Hopkin, S. P., Sibly, R. M. & Peakall, D. B. (2000). *Principles of Ecotoxicology*, 2nd Ed. Taylor & Francis, London.

INTERNAL ASSESSMENT

Full Marks: 4 THEORY PAPERS × 5 = 20

PRACTICAL PAPERS

PGZ: 105

DISSECTION & TAXONOMY AND HISTOLOGY & HISTOCHEMISTRY **Full Marks: 50**

Unit – I: DISSECTION & TAXONOMY
Time: 5 Hrs. **Full Marks: 25**

1. DISSECTION: Dissection and display of anatomical systems in vertebrates and invertebrates
2. TAXONOMY: Identification of Prokaryotic and Eukaryotic specimens following taxonomic methods and principles
3. Laboratory note Book
4. Viva-voce

Unit – II: HISTOLOGY & HISTOCHEMISTRY
Time: 5 Hrs. **Full Marks 25**

1. HISTOLOGY
   a. Fixation, dehydration, embedding, section cutting, staining and mounting of different animal tissues. (Haematoxylin and Eosin, Mallory's Triple)
   b. Identification of histological preparations of different animal tissues.
   c. SEM demonstration

2. HISTOCHEMISTRY

Histochemical reactions for: Carbohydrates, Protein, Lipid, DNA/RNA and Alkaline phosphatases

3. Submission of permanent slides prepared for histological and histochemical studies of different tissues
4. Laboratory records
5. Viva-voce

PGZ: 106

CYTOLOGY & GENETICS AND BIOCHEMISTRY & TOXICOLOGY **Full Marks: 50**

Unit – I: CYTOLOGY & GENETICS

Time: 5 Hrs. **Full Marks: 25**

1. CYTOLOGY
   a. Preparation of meiotic chromosomes from the Grasshopper testes: Identification of stages
   b. Preparation of somatic chromosome (untreated and treated) from mouse/rat: Identification of chromosomes and determination of mitotic index
   c. Preparation of polytene chromosomes from Chironomid/*Drosophila/*mosquito larvae: Identification of various land marks
   d. Identification of slides on human chromosomal abnormalities and various genetic diseases

2. GENETICS
   a. Identification of mutants of *Drosophila*, setting up of genetic crosses (monohybrid, dihybrid, test crosses; Detection of lethal mutation
   b. Analysis of human pedigree and construction of pedigree chart
   c. Analysis of human karyotypes
   d. Isolation of DNA from *Drosophila/*mosquito /Rat/Goat (liver tissue)
3. Submission of prepared slides and Laboratory record.
4. Viva–voce

Unit – II: BIOCHEMISTRY & TOXICOLOGY

Time: 5 Hrs.

Full Marks: 25

1. BIOCHEMISTRY
   a. Folin-Lowry method of protein assay
   b. Estimation of DNA by the diphenylamine
   c. Quantification of RNA
   d. Biochemical detection of sugars by Osazone formation test
   e. Separation of amino acids by paper chromatography

2. TOXICOLOGY
   a. Determination of LC_{50} and LD_{50}
   b. Morphological deformities (study of symmetry) in biological organisms due to toxicant exposure.
3. Laboratory note book
4. Viva-voce

SEMESTER - II

TGZ: 201

Time: 2 hrs. **Full Marks: 45**

Unit – I: ECOLOGY & ETHOLOGY

Full Marks: 22.5

Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

The concept of ecosystem, the Gaia Hypothesis, stability in the ecosystem, ecological habitat and niche 2L

Factors of the environment 3L

Concept of limiting factors
Biotic factors: effects of predators, parasites and symbionts
Abiotic factors: effects of temperature, moisture, light and fire

Population dynamics 4L

Population attributes, growth forms, life tables,
Density-dependent and density-independent factors in the population regulation, interspecific competition and coexistence,

Communities and biodiversity 4L

Community organization and structure, relative abundance, species diversity, diversity indices and ecosystem development

Ecoenergetics and biogeochemical cycles 5L

Concepts of primary productivity and secondary production,
food–chains and food webs, energy flow through trophic levels;
Global cycling of water, carbon and nitrogen

A brief survey of major Indian biomes 3L

Tropical Rain Forests
Mangrove ecosystem

Animal behaviour 5L

Concepts of Ethology
Stereotyped and acquired behaviour
Social behaviour, altruistic behaviour, orientation and echolocation;
Biological rhythms

Environmental pollution 5L

Sources and effects of primary and secondary air pollutants,
acid rain, green house effects, water pollution and its control,
anti–pollution laws

Conservation ecology 4L

Conservation of natural resources and wildlife
in situ and *ex situ* conservations
Red Data Book
Conservation of wetlands

Suggested readings

Alcock, J. (2001). *Animal Behaviour: An Evolutionary Approach.* Sinauer Associates. Inc. USA.

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

Chapman, R. L. and Reiss, M. J. (2000). *Ecology – Principles & Application*. Comb.
Colinvaux, P. (1993). *Ecology 2*. John Wiley & Sons, Inc. New York, pp. 688.
Cunningham, W. P. & Cunningham, M. A., (2007). Principles of *Environmental Science: Inquiry & Applications.* 4th ed. Tata McGraw-Hill Company.
Danchin E., Giraldeau L. A., and Cezilly F. (2008). *Behavioural Ecology: An Evolutionary Perspective on Behaviour.* Oxford University Press, USA;
Dash, M. C., (2001). *Fundamental of Ecology.* 2nd ed. Tata McGraw-Hill Company.
Enger, E. D. & Smith, B. F. (2008). *Environmental Science: A study of Interrelationships*. 11th ed. McGraw-Hill Higher Education.
Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). *Ecology-Science and Practice.* Oxford & IBH Publishing Company Pvt. Ltd.
Freedman, B. (1989). *Environmental Ecology.* Academic press, Inc., PP. 424.
Gupta, I. J. & Mondal, D. K. (2005). *Red data Book* (Part – 2): Butterflies of India. ZSI.
Kormondy, E. J. (2002). *Concepts of Ecology*. 4th Indian Reprint, Pearson Education.
Krebs, C. J. (2001). *Ecology.* Benjamin Cummings.
Leveque, C. (2003). *Ecology: from Ecosystem to Biosphere.* Science Publishers. Inc.
Manning, A. & Dawkins, M.S. (1999). *Essentials of Animal Behaviour.* Cambridge Univ. Press.
Mukherjee, B. (1996). *Environmental Biology.* Tata McGraw-Hill Publishing Comp. Ltd.
Odum, E. P. & Barret, G. W. (2005). *Fundamentals of Ecology.* 5th ed. Thompson Brooks/Cole.
Odum, E. P. (1971). *Fundamentals of Ecology*. W. O. Saunders company, Philadelphia, pp 574.
Ricklefs, R. E. & Miller, G. L. (2000). *Ecology.* 4th ed. W. H. Freeman & Company.
Saharia, V. B. (1998). *Wildlife in India.* Natraj Publishers.
Santra, S. (2005). Environmental Science. New Central Book Agency (P) Ltd.
Smith, R. L. & Smith, T. M. (2001). *Ecology and Field Biology.* Benjamin Cummings Pearson Education.
Smith, T. M & Smith, R. L. (2006). *Elements* of *Ecology*. 6th ed. Pearson Education.

Stiling, P. (2002). *Ecology- Science and Applications.* 2nd ed. Prentice Hall of India.
Tikadar, B. K. (1983). *Threatened Animals of India.* ZSI.

Unit – II: SOIL ZOOLOGY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Soil as an ecosystem	
Soil structure, development: types and factors involved in the development	5L
Soil aeration and porosity	2L
Soil profile	
Nature, development and probable impact on soil fauna	3L
Rhizosphere	2L
Sampling, extraction, rearing, preservation and mounting of soil organisms	3L
Soils and soil fauna	6L
Classification of soil fauna; interactions between soils and soil fauna	
Litter decomposition and soil fertility	4L
Vermiculture and vermicomposting	4L
Soil erosion and its control.	2L
Soil pollution and world's food supply	4L

Suggested readings

Brady, N. C. (1991). *The nature of properties of Soil.* 10th ed, Macmillan Publishing Company, New York.

Dutta N. K. (1991). *Nutritional relation of soils,* Annual Pub.

Harley J. L. & Smith, S. (1983*). Mycorrhizal Symbiosis*. Academic Press. New York.

Lee K. E. (1985). *Earthworms: Their Ecology and Relationship with soils and land use.* Academic Press. New York.

Mclearen, A. D. & Skujins, J. (1971). *Soil Biochemistry*. Marcel Dekker.

Paul E. A. &. Clark, F. E. (1989). *Soil Microbiology and Biochemistry*. Academic Press. New York.

Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). *Ecology- Science and Practice.* Oxford & IBH Publishing Company Pvt. Ltd.

Laveille P. & Spain A. V. (2003) *Soil Ecology.* Kluwer Academic Press. Online Book – ISBN 0-306-48162-6.

Abbott L. K. & Murphy D. V. (2007) *Soil Biological Fertility: A key to sustainable land use in Agriculture.* Springer. Online Book –ISBN 978-1-4020-6619-1 (e-book).

TGZ: 202

PHYSIOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Basic concepts: Homeostasis, Acclimatization and Adaptation 2L

Circulation 8L

Blood cells: ultrastructure, pigments, and formation
Hemostasis: platelet activation cascades, regulation
Lymph: composition and dynamics

Respiration 8L

General idea: Total and partial air pressure,
Gas solubility and diffusion in air and water.
Aquatic: Gill architecture; ram ventilation, dual pump,
gas exchange (counter current mechanism)
Terrestrial: Lung ventilation (amphibians, reptiles, birds, mammals),
Lung mechanics (human): Respiratory muscles, lung volumes,
elastic properties, compliance, surface tension, pulmonary surfactants.
Regulation (human): Respiratory centers, receptors, integration.

Excretion & Osmoregulation 8L

Mammalian kidney, Urea cycle and Aquaporins
Ultra structure of nephron
Urine formation – Glomerular filtration and tubular reabsorbtion,
Importance as osmoregulatory organ.
External osmoregulatory organs: Salt glands, Fish gills
Water and electrolyte balance (Na, K, Mg), Acid-base regulation,
Endocrine regulation

Thermoregulation 8L

Endothermy and Ectothermy
Thermoregulatory organs, responses to high and low temperature
Thermogenesis, Characteristics of fever
Neural Control

Sensory 8L

Neuron: types; synapse (excitatory and inhibitory post synaptic potential)
Genesis of membrane potential
Neurotransmitters (Acetylcholine, GABA), chemical transmission through synapse

Hormones 4L

General classes of hormones, concept of receptors
Mechanisms of hormone action – second messenger, IP_3 and DAG
Neuroendocrine integration

Hypothalamic and Pituitary hormones 6L

Hypothalamic hormones – structure and functions
Hypophyseal hormones – structure and functions

Thyroid hormones 5L

Biosynthesis and function of T_3/T_4
Role of thyroid hormones in metabolism

Pancreatic hormones 5L

Structure and biosynthesis: insulin and glucagon
Role of hormones in glucose metabolism

Adrenal hormones 4L

Structure and functions of cortical hormones
Structure and functions of medullary hormones

Reproductive hormones 4L

Sex steroids: Structure, source, role and receptors

Suggested readings

Koppen, B.M. &Stanton, B.A. (2009). *Berne & Levy Physiology*. 6th ed. Mosby.

Bolandar, M. (2001). *Molecular Endocrinology.* Elsevier Science.

Ganong, W. F. (2003). *Review of Medical physiology.* 21st e2d. McGraw Hill.

Chaudhuri, S. K. (2000). *Concise Medical Physiology.* New Central Book Agency (P) Ltd.

Greenspan, F. S. & Gardener, F. G. (2003). *Basic and Clinical Endocrinology*. 7th ed. McGraw Hill.

Hadley, M. E. (2000). *Endocrinology*. 5th ed. Pearson Education.

Hill, R.W., Wyse, G.A. & Anderson, M. (2008). *Animal Physiology.* 2nd ed. Sinauer Associates Inc.

Hoar, W. S. (1984). *General and comparative Physiology*. 3rd ed. Prentice-Hall of India.

Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10th ed.

Norris, D. O., (2006). *Williams Textbook of Endocrinology*: *Vertebrate Endocrinology*. 3rd ed. Academic Press.

Randall, D., Burggren, W. & French, K. (2002). *Eckert Animal Physiology – Mechanisms and Adaptation*. 5th ed. W. H. Freeman.

Sherwood, L. (2004). *Human Physiology: From cells to systems.* 5 ed. Thomson Brooks Cole.

Schmidt Nielsen, K. (1994). *Animal Physiology: Adaptation and Environment.* Low Price Cambridge Edition.

Willmer, P. et al. (2001). *Physiological Adaptations*. W. H. Freeman.

TGZ-203

MICROBIOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

History and development of Microbiology 2L
Contributions of Leeuwenhoek, Koch, Pasteur, Jenner and Flemming

Bacteria 12L
Structure and function of capsule, pili, flagella, cell wall, cell membrane, outer membrane, reserve materials, cytoplasmic inclusions, plasmid and bacterial chromosome.

Bacterial endospore 4L
Structure, properties, spore –formation and germination

Virus 10L
Structural organization of viruses
Prions and Viroids
Lytic cycle of bacteriophages with reference to *E. coli* and T_4
Lysogeny, lysogenic conversion, induction and significance

Microbial genetics 8L
Gene transfer in Bacteria: transformation, conjugation and transduction.
Transcription and translation in *E. coli*
Structure and life-cycle of λ Phage virus and control mechanism of lysogeny
Auxotroph, Prototroph, Replica plating and Ames Test

Control of microorganisms 6L
Physical and chemical agents, chemotherapeutic agents: sulfa drugs and antibiotics

General accounts of Mycoplasma, Actinomycetes and Rickettsias 10L

Medical Microbiology 10L
Microbial virulence
Mode of transmission, pathogenicity and prevention of microbial diseases: Air-borne (Tuberculosis and Influenza), Food and waterborne (Typhoid and Cholera) and Arthropod borne (Dengue, JE and Yellow fever)

Environmental Microbiology 8L
Inter-relationship of microorganisms in natural ecosystems
Soil as a microbial habitat
Microbial diversity in soil; Microorganisms as indicators of water quality, biofilm
Bacteriological examination of water for potability
Characteristics of wastewater and secondary wastewater treatment.

Suggested readings:

Alexander, M. (1977). *Introduction to Soil Microbiology* .New York: John Wiley & Sons.

Atlas, R. M. (1984). *Microbiology, Fundamentals and Applications*. Macmillan.

Atlas, R. M. & Bartha, R. (1997). *Microbial Ecology: Fundamentals and Applications,* 4th ed. Benjamin/ Cummings.

Black, J. G. (2001). *Microbiology: Principles and Explorations, 5th ed*. John Wiley & Sons, New York.

Campbell, R. (1983). *Microbial Ecology*. 2nd ed. Oxford, Blackwell.

Davis, B. D., Dulbecco, R., Eisen, H.N. & Ginsberg, H.S. (1990). *Microbiology,* 4th ed. Harper and Row.
Dimmock, N. J. & Primrose, S. B. (1994). *Introduction to Modern Virology*. 4th ed. Blackwell Scientific Publications. London.
Holt, J.G., Krieg, N.R., Sneath, P.H.A. Staley, J.T. & Williams, S.T. *Bergey's Manual of Determinative Bacteriology*. Lippincott Williams & Wilkins.
Maloy, S. R., Cronan, E. J. & Freifelder, D. (1994). *Microbial Genetics*, 2nd ed. Jones and Bartlett.
Pelczar, M. J., Reid, R. D. & Chan, E. C. (1993). *Microbiology,* 5th ed. Macmillan. London.
Pinehuk, G. (2003). *Schaum's outline Series: Theory and Problems of Immunology*. McGrawHill.
Presscott, L. M., Harley, J. P. & Klein, D. A. (1999). *Microbiology*, 4th ed. McGrawHill, New York.
Schlegel, H. G. (1993). *General Microbiology* .7th ed. Cambridge University Press.
Slonczeweski, J.L. & Foster, J.W. (2009). *Microbiology- An Evolving Science.* Norton.
Stanier, R. Y., Adelberg, E. A. & Ingraham, J. L. (1986). *General Microbiology.* 5th ed. Macmillan.
Talaro, K. & Talaro, A. (1999). *Foundations in Microbiology* 3rd ed. Dubuque, McGraw Hill.
Tortora, G. J., Funke, B. R., & Case. C. L. (1999). *Microbiology. An Introduction*. 6th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
Voyleys, B. A. (2002). *The biology of viruses*, 2nd ed. McGraw-Hill.

TGZ: 204

IMMUNOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Types of Immunity: Innate and Acquired	2L
Cells and Organs of the immune system	4L
Elements of Innate immunity	4L
Antigens and Immunogens	5L
Definition and properties	
Antigenic determinants of immunoglobulin (Isotype, allotype & idiotype)	
Antibodies	4L
Structure, classes and biological activities	
Organization and expression of immunoglobulin genes	6L
T Cell receptors (TCR) and TCR Complex	6L
Structure and roles	
Organization and rearrangement of TCR genes	
Major histocompatibility complex (MHC)	4L
General organization; Structure and Functions of MHC molecules	
Cytokines	4L
General properties and functional categories	
Complement	5L
Activation pathways, Biological functions and Regulation.	
Maturation, activation and differentiation of T and B lymphocytes	8L
Immune effector mechanisms	5L
Antibody mediated functions	
Cell mediated effector responses	

Antigen–antibody interaction 5L
Molecular basis
Secondary interactions – Agglutination, precipitation.
Hypersensitivity reactions 4L
Vaccines and immunization 4L

Suggested readings

Abbas, A. K., Lichtman, A. H. & Pillai, S. (2006). *Cellular and molecular Immunology.* 6th ed. Saunders.
Abbas, A. K. & Lichtman, A. H. (2006). *Basic Immunology.*2nd ed. Elsevier.
Chakraborty, A. K. (2003). *Immunology II*. 2nd ed. N. L. Publishers Siliguri.
Coico R, Sunshine, G., Benjamini, E. (2003). *Immunology: A short Course*. 5th ed. Wiley-Liss: New Jersey.
English, L. S. (1994). *Technological Applications of Immunochemicals (BIOTOL*). Butterworth- Heinemann, Oxford Freeman & Co.
Goldsby, R. A., Kindt, T. J., Kuby, J. & Osborne, B. A. (2003). *Immunology*. 5th ed. W. H. Freeman & Co.
Khan F. H. (2009) *The Elements of Immunology.* Pearson.
Kindt, T., Goldsby, R. Osborne, B. (2007). *Kuby Immunology*. 6th ed. W.H. Freeman & Co.
Male, D., Brostaff, J., Roth, D. & Roitt, I. (2006). *Immunology.* 7th ed. Mosby.
Rao, C. V. (2002). *Immunology*. Narosa Publishing House, New Delhi.
Roitt, I. M. & Delves, P. J. (2001). *Roitt's Essential Immunology*. 10th ed. Blackwell Science. Ltd.

INTERNAL ASSESSMENT

Full Marks: 4 THEORY PAPERS × 5 = 20

PRACTICAL PAPERS

PGZ: 205

ECOLOGY & SOIL ZOOLOGY AND EDUCATIONAL TOUR
Time: 5 hrs. **Full Marks: 50**

ECOLOGY & SOIL ZOOLOGY 40

1. Quantitative estimation of some Physico-chemical parameters in the aquatic ecosystem: Temperature, pH, dissolved oxygen, carbon dioxide and chloride contents
2. Quantitative estimation of some factors of soil and the sediment: soil moisture, pH, nitrates, phosphates and organic matter
3. The study of aquatic and terrestrial habitats: Identification and characterization of zooplankton and ecotypes inhabiting terrestrial and aquatic environments
4. Laboratory note book and class records
5. Viva –voce

EDUCATIONAL TOUR 10

PGZ: 206

PHYSIOLOGY AND MICROBIOLOGY & IMMUNOLOGY
Time: 5 Hrs. **Full Marks: 50**

Full Marks: 25

Unit – I: PHYSIOLOGY

1. Detection of haemoglobin percent, C.T. and B.T.
2. Quantitative estimation of Ascorbic acid by titration.
3. Biochemical estimation of Cholesterol and Sugar from mammalian blood.
4. Total count of RBC and WBC
5. Submission of Laboratory Records
6. Viva-voce

Unit – II: MICROBIOLOGY & IMMUNOLOGY **Full Marks: 25**
Time: 5 Hrs.

1. MICROBIOLOGY:
   a. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria
   b. Preparation of slant and stab
      Pure culture techniques: Spread plate, pour plate and streak plate
   c. Isolation and enumeration of bacteria from natural sources: soil, air and water
   d. Simple staining of bacteria and study of cell types; differential staining: Gram staining, endospore staining and acid-fast staining
   e. Biochemical tests for characterization: Catalase, Nitrate reduction, Indole production, Methyl red and Voges–Proskauer test
   f. Sugar fermentation test
2. IMMUNOLOGY:
   a. Agglutination reactions: Direct and indirect agglutination tests.
   b. Precipitation reactions: Precipitation in liquid media; precipitation in gels – single and double diffusion
3. Submission of slides
4. Laboratory note book
5. Viva-voce

SEMESTER - III

TGZ: 301

GENERAL ENTOMOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

General characters of Class Insecta, diversity and adaptive features of insect 3L

Outline classification up to orders with examples 10L

Structure of insect 15L

Structure of head - sutures - types of head in various insects
Thorax, its structure, segmentation, sclerites, modification
Components of mouthparts and types
Structure of leg - articulation - modification with reference to mobility
Structure and modifications of eyes and antenna
Origin and development of wings - venation –
types and modifications – mechanism of flight - wing coupling
Structure of abdomen - genital and pregenital abdominal appendages
Formation and modification of cuticle

Internal organs 12L

Digestive structure and their modifications and functions
Circulatory system
- Organs of circulation
- Haemolymph
- Haemocytes with functions
- Mechanism of circulation
- Fat-Body

Excretory system
- Principal organs
- Physiology of excretion
- Excretory products

Metamorphosis 6L

Introduction – Types with examples
Larva and pupa – structure and types

Insect behaviour 4L

Feeding behaviour: types of feeding and damage, host range,
Specialisation and host selection
Reproductive behaviour: mate location, mating frequency and oviposition

Social Insects 8L

Life cycle and Social organization of termites, honeybees and ants

Sound production 6L

Structure of the organs
Mechanism of sound production
Significance

Bioluminescence 6L

Structure of organs
Brief mechanism of light production
Significance

Suggested readings:

Chapman, R. F. (1998). *The Insects: Structure and Function.* 4th Ed. Cambridge University Press.

Gillott, C. (2005) *Entomology*. 3rd ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).

Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3 ed. Blackwell Publishing.

Johnson, N. F. & Triplehorn C. A. (2004). *Borror and DeLong's Introduction to the Study of Insects.* 7th ed. Brooks Cole.

Richards, O. W. & Davies, R. G. (1977). *Imms: A General Text Book of Entomology.*10th ed. Vol. 1 & 2. Chapman and Hall.

Romoser, S. W., & J.G. Stoffolano. (1998). *The Science of Entomology*. 4th ed. McGraw Hill.

Srivastava, K. P. (1988). *A textbook of Applied Entomology Vol. I.* 2nd ed. Kalyani Publishers, New Delhi.

Tembhare, D. B. (1997). *Modern Entomology.* Himalaya Publishing House.

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TGZ: 302

PARASITOLOGY & VECTOR BIOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

General idea on parasitism	2L
Classification of parasitic protozoa	2L
Intestinal Sarcodina and Flagellates General account, structure, life cycle, pathogenicity and control of *Entamoeba histolytica* and *Giardia lamblia*	7L
Haemoflagellates Ultrastructure and morphological stages; morphology, life cycle, clinical features and control of *Trypanosoma cruzi* and *Leishmania donovoni*	8L
Haemosporina Zoonosis Evolution of malarial parasites Morphology, life cycle, clinical features and control of *Plasmodium falciparum*	6L
Classification of parasitic helminthes	2L
General morphology (including ultrastructure) of parasitic Platyhelminthes.	6L
Morphology, life history, pathogenicity and control *Paragonimus westermani, Schistosoma haematobium, Taenia saginata, Trichinella spiralis, Dracunculus medinensis, Ancylostoma duodenale*	12L
Biology, importance and control Sand fly, Black fly, Tabanid flies *Anopheles,* Ticks and Mites	20L
Vector- microbe interaction Symbiotic association of microbes with vectors Role of microbes as controlling agents of vectors	5L

Suggested readings

Chandler, A. C. & Read. C. P. (1961). *Introduction to Parasitology*, 10th ed. John Wiley & Sons Inc.

Chandra, G. (2000). *Mosquito*. Sree Bhumi Publication Co. Kolkata.
Cheng , T. C. & Bogitsch. *Human Parasitology.*
Cheng , T. C. (1986). 2nd ed. General Parasitology Academic Press, Inc. Orlando.U.S.A.
Cox, F. E. G. (1993). *Modern Parasitology*. 2nd ed. Blackwell Scientific Publications. ed. Lea and Febiger, Philadelphia.
Hati, A. K. (2001). *Medical Entomology*. Allied Book Agency, Kolkata.
Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.
Noble, E. R. & Noble G. A. (1982). *Parasitology. The Biology of animal Parasites*. 5th ed.
Schmidt, G. D. & Roberts, L. S. (2001). *Foundation of Parasitology*, McGraw Hill Publishers, 3rd ed.
Schmidt, G. D. (1989). *Essentials of Parasitology*. Wm. C. Brown Publishers (Indian print; 1990, Universal Book Stall).
Smyth, J. D. (1994). *Animal Parasitology*. 3rd ed. Cambridge University Press.
Soulsby, E. J. L. (1982). *Helminths, Arthropods and Protozoa of domesticated animals.* ELBS and Bailliere Tindall. London.

TGZ: 303

ICHTHYOLOGY & AQUACULTURE

Time: 2 hrs. **Full Marks: 45**
Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Ichthyology

Classification of fishes 15L
Principles of classification, extinct fish groups,
Detailed study of major fish orders: Cypriniformes, Clupeiformes, Ophiocephaliformes, Perciformes, Mastacembeliformes.

Structure, development, comparative account and functions 9L
Bioluminescent organ
Poison gland
Acoustico-lateralis system

Structure and functions 10L
Digestive systems, olfactory organ and chemoreception, Osmoregulatory and Circulatory systems, Electric organs, Endocrine glands (Pituitary and Thyroid), Caudal neurosecretory organ

Reproduction and Development 8L
Structure and functions of reproductive organs, Types of reproduction, Breeding and Parental care

Fish migration – types and regulation 2L

Aquaculture

Inland fisheries 6L
Pond management for carp culture, induced breeding of prawn and air breathing fishes, Composite culture of air breathing fishes

Shell fisheries 6L

Edible oysters, chank fishery, pearl fishery

Ornamental fish culture and aquarium management. 2L

Fish biotechnology: Production of transgenic fish. 2L

Marine fisheries 10L

Resources, *Hilsa* fishery, pomfrets and flat fishes

Elasmobrach fishery (major groups, fishery methods, importance)

Suggested readings

Bardach, J. E. & Ryther, J. H. (1972). *Aquaculture*. John Wiley and Sons.

Beaumont, A. R. & Hoare, K. (2003). *Biotechnology & Genetics in Fisheries and Aquaculture.* Blackwell Publishing.

Bond, C.E. *Biology of Fishes*. 2nd ed. Saunders Pub.

Evans, D. H. (1998). The Physiology of Fishes. CRC Press.

Jayaram, K. C. (1999). *The Freshwater Fishes of the Indian Region.* Narendra Publishing House, New Delhi.

Jhingran, V. G. (1991). *Fish and Fisheries of India*.3rd ed., Hindusthan Pub. Corp.

John Wiley & Sons.

Lagler, K. F., Bardach, J. E., Miller, R. R. & Passino, D. R. (2003). *Ichthyology*.

Lowe, H. (2005). *Beginner's Guide to Aquarium Fish and Fish Care*. Abhishek Press, New Delhi.

Pillay, T. V. R. (1993). *Aquaculture*. Fishing News Books.

Srivastava, C. B. L. (1999). *Fish Biology.* Narendra Pub. House.

TSZ: 304

SPECIAL PAPER: ENTOMOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Insect Anatomy

Morphology and Biology of the orders 15L

Collembola, Orthoptera, Thysanoptera, Hemiptera, Siphonaptera, Lepidoptera,Coleoptera, Diptera, Strepsiptera & Hymenoptera

Integument 8L

Structure and functions of cuticle

Cuticular modifications

Moulting

Head 8L

Head segmentation and evolution

Generalized Pterygote Head

Modified Mouthparts (Orthopteroid, Hemipteroid and Neuropteroid)

Thorax 8L

Generalized thoracic structure

Structure and morphological variation of wing

Appendages of thorax

Abdomen 6L

Segmentation

Skeletal composition

Vision 10L

The dorsal ocelli
The stemmata
Structure of compound eye
Formation of image

Perception 10L

Chemoreception: structure of cuticular and contact receptors, distribution & functions
Mechanoreception: Structure and functions of cuticular, cellular, proprioceptors. chordotonal and tympanal organs.

Exocrine glands 5L

Important exocrine glands: origin, structure and functions

Suggested readings:

Chapman, R. F. (1998). *The Insects: Structure and Function.* 4th ed. Cambridge University Press.

Gillott, C. (2005) *Entomology*. 3rd ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).

Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed.

Johnson, N. F. & Triplehorn C. A. (2004). *Borror and DeLong's Introduction to the Study of Insects.* 7th ed. Brooks Cole.

Klowden, M. (2002). *Physiological Systems in Insects,* Academic Press.

Nation, J. L. (2008). *Insect Physiology and Biochemistry*. 2nd ed. CRC Press. Taylor & Francis Group.

Richards O. W. & Davies, R. G. (1977). *Imms: A General Text Book of Entomology.* 10th ed. Vol.1 & 2. Chapman and Hall.

Rockstein, M. (1978). *Biochemistry of Insects.* Academic Press.

Rockstein, M. (Ed.) (1986-1996) *Advances in Insects Physiology* Vols. 19-26 Academic Press,

Snodgrass, R. F. (1935). *Principles of Insect Morphology.* McGraw-Hill Publishing Company Ltd.

Srivastava, K. P. (1988). *A textbook of Applied Entomology.* Vol.I 2nd ed. Kalyani Publishers, New Delhi.

Wigglesworth, V. B. (1972). *Principles of Insect Physiology.* ELBS (Methuen & co.)

TSZ: 304

SPECIAL PAPER: PARASITOLOGY AND MICROBIOLOGY

Time: 2 hrs. **Full marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Molecular Parasitology

Basic techniques for molecular analysis of parasitic systems 10L

Isolation of DNA and RNA
Hybridisation
ELISA
Blotting techniques
DNA sequencing
Amplification of DNA by polymerase chain reaction

Molecular probes in diagnosis, epidemiology and taxonomy 6L

General consideration and specific applications of
DNA probes (Leishmaniasis, Malaria, Lymphatic filariasis).

Parasites and the immune system 5L

Immunity and the immune response
Evasion and suppression of the immune response.

Antigens of parasitic helminths 4L

Protection and pathology

Microbial Taxonomy 5L

Characters used in microbial taxonomy
Classical and molecular taxonomy
Species concept

Bacteriology 15L

Bacterial nutrition

Nutrition and nutritional types of bacteria
Types of culture media: natural, synthetic, semi-synthetic and selective

Bacterial Growth

Phases of growth, Kinetics of growth, generation time
Batch culture, continuous culture and synchronous culture
Chemostat and turbidostat
Pure culture techniques
Preservation of bacteria

Environmental factors influencing growth

Temperature, pH, salt concentration, oxygen, osmotic concentration

Mode of transmission, pathogenicity and prevention of bacterial diseases

Anthrax, Tetanus, Diphtheria and Botulism

Virology 15L

Cultivation and assay of animal viruses

Morphology, chemical composition and mode of reproduction

Herpes simplex virus, Poliovirus and HIV

Mode of transmission, pathogenicity and prevention of viral diseases

Common cold, Mumps, Measles and Rabies

Applied Microbiology 10L

Biofertilizers

Bio-insecticides

Bacillus thuringiensis,
Bacillus sphaericus
Nuclear polyhedrosis virus

Bioremediation

Industrial production

Beer and wine
Antibiotic (Penicillin)

Suggested readings:

Alexander, M. (1977). *Introduction to Soil Microbiology*. John Wiley & Sons.

Atlas , R. M. (1984). *Microbiology, Fundamentals and Applications*. Macmillan & Co.

Atlas, R. M. & Bartha, R. (1997). *Microbial Ecology: Fundamentals and Applications.* 4th ed. Benjamin/ Cummings. Menlo Park, California.(Indian Print: Pearson Education)

Black, J. G. (2001). *Microbiology: Principles and Explorations*, 5th ed. John Wiley & Sons.

Campbell, R. (1983). *Microbial Ecology*. 2nd ed. Oxford, Blackwell.

Davis, B. D., Dulbecco, R., Eisen, H. N. & Ginsberg, H. S. (1990). *Microbiology*, 4th ed. Harper and Row. New York.

Dimmock, N. J. & Primrose, S. B.(1994). *Introduction to Modern Virology*. 4th ed. Blackwell Scientific Publications. London.
Freifelder, D. *Molecular Biology*. Narosa Publishing House, New Delhi.
Hyde, J. E. (1990). *Molecular Parasitology*. Open University Press. London.
Maloy, S. R., Cronan, E. J. and Freifelder, D. (1994*). Microbial Genetics*, 2nd ed. Jones and Bartlett, Boston.
Pelczar, M. J., Reid, R. D. & Chan, E. C. (1993). *Microbiology*, 5th ed. Tata Mc Graw Hill.
Presscott, L. M., Harley, J. P. & Klein, D. A. (1999). *Microbiology*, 4th ed. McGrawHill, New York.
Schlegel, H.G. (1993). General Microbiology .7th ed. Cambridge University Press.
Stanier, R. Y., Adelberg, E. A. & Ingraham, J. L. (1986). *General Microbiology.*
Talaro, K. & Talaro, A. (1999). *Foundations in Microbiology*, 3rd ed. McGraw-Hill.
Tortora, G. J., Funke, B. R., & Case. C. L. (1999). *Microbiology. An Introduction.* 6th ed. Benjamin/Cummings Publishing.
Voyleys, B. A. (2002). *The Biology of viruses.* 2nd ed. McGraw-Hill.

TSZ: 304

SPECIAL PAPER: AQUACULTURE AND FISHERIES

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Fresh Water Aquaculture

Inland fisheries resources in India and their principal species. 4L

Food fishes and their economic importance 18L

- Indian Major carps: *Catla catla, Labeo rohita, Cirrhinus mrigala*
- Exotic carps: *Hypophthalmicthys molitrix, Ctenopharyngodon idella, Cyprinus carpio*
- Cat fishes : *Clarias batrachus, Heteropneustes fossilis*
- Other groups: *Anabas testudineus, Channa striatus, Etroplus suratensis*

Fish culture practices 20L

- Collection of spawn, fries and fingerlings and their subsequent transport
- Culture of air-breathing fishes
- Integrated aquaculture: crop-livestock-fish farming
- Paddy-cum-fish culture
- Sewage-fed fish culture
- Impact of invasive fish species
- Cold water fisheries: resources, management and development.

Fish breeding 14L

- Neuro-endocrine control of fish reproduction
- Induced breeding in carps and catfishes
- Ecological requirements for induced breeding

Hybridization and genetic manipulation 14L

- Selective breeding (Intergeneric, interspecific)
- Ploidy manipulation, Androgenesis, Gynogenesis
- Transgenesis: Transgene delivery, integration, expression

Suggested readings:

Bardach, J. E. & Ryther, J. H. (1972). *Aquaculture*. John Willey and Sons.
Beaumont, A. R. & Hoare, K. (2003). *Biotechnology & Genetics in Fisheries and Aquaculture.* Blackwell Publishing.
Bond, C. E. (1996). *Biology of Fishes.* 2nd ed. Saunders Pub.
Chakrabarti, N. M. (1998). *Biology, Culture and Production of Indian Major Carps – A Review*. Narendra Publishing House. New Delhi.
Evans, D. H. (1998). *The Physiology of Fishes*. CRC Press.
Jhingran, V. G. (1991). *Fish and Fisheries of India*.3rd ed. Hindusthan Pub. Corp.
Pillay, T. V. R. (1993). *Aquaculture.* Fishing News Books.
Reddy, P. V. G. K., Ayyappan, S., Thampy, D. M. & Krishna, G. (2005). *Textbook of Fish Genetics and Biotechnology*. ICAR, New Delhi.
Srivastava, C. B. L. (1999). *Fish Biology*. Narendra Pub. House.

TSZ: 304

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs. **Full Marks: 45**
Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Evolution of the biosphere/ecosphere 5L
The biosphere, climate and vegetation, stability of the atmosphere, cybernetic nature and stability in the ecosystem, environmental perspectives and human development

Physical aspects of the environment 8L
Lotic and lentic environments, marine biota and zonations, estuarine biota and productivity, terrestrial biota, soil sub-systems, vegetational sub-system

Concept of productivity 6L
Biomass, Primary and secondary productivity patterns, tropic structure and ecological pyramids, ecological efficiencies

Populations in communities 8L
Species diversity, similarities and divergence, ecological guild, ecotone and edge effect, interspecific competition and co-existence, diversity indices, ecotypes, keystone species

Behavioural ecology 10L
Natural selection and social behaviour, territorial behaviour and habitat selection, domestication, ecology of sex, signals and mating; colonizing ability, distance movements and dispersal, altruism and reciprocal altruism, eusociality, colouration and mimicry, photoperiodism and circadian rhythms

Development and evolution of ecosystem 8L
Ecosystem development, concept of climax, micro-evolution and macro-evolution, co-evolution

Chemical ecology and adaptations 10L

Feeding preferences, biochemical basis for food plant selection by insects; feeding attractants, feedings deterrents, ovipositon stimulants in insects, pheromones, plant toxins and their effects (types and fate in animals), cyanogenic glycosides, cardiac glycosides, pyrrolizidine alkaloids, utilization of plant toxins by animals, allelochemicals and environment

Ecological energetics 7L

The entropy law, energy transfer across trophic links, energy budget, chemolithoautotrophs and hydrothermal vents

Biogeochemistry and reactions 8L

Patterns and basic types of biogeochemical cycles, global cycling of carbon, nitrogen, phosphorus and water, watershed studies, nutrient cycling in the tropics, recycling pathways and recycling index

Suggested readings:

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

Brewer, R. (1994). *The Science of Ecology.* Saunders College Publishing, 2nd ed.

Chapman R. L. & Reiss, M. J. (2000). *Ecology – Principles & Application.* Cambridge Low Price Edition.

Colinvaux, P. (1993). *Ecology 2*. John Wiley & Sons, Inc. New York, pp. 688.

Cunningham, W. P., Cunningham**,** M. A., & Saigo, B. W. (2003). *Environmental Science: A Global Concern.* 7th ed. McGraw-Hill Higher Education.

Dugatkin, L. A. (2004). *Principles of Animal Behaviour Behaviour.* W. W. Norhon & Company.

Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). *Ecology- Science and Practice.* Oxford & IBH Publishing Company Pvt. Ltd.

Freedman, B. (1989). *Environmental Ecology.* Academic press, Inc., PP. 424.

Krebs, J. R. & Davis, N. B. (1991). *Behavioural Ecology: An Evolutionary Approach.* Oxford, UK: Blackwell Scientific Publications.

Kormondy, E. J. (2007). *Concepts of Ecology.* 4th ed. Indian reprint, Pearson Education.

Odum, E. P. (1971). *Fundamentals of Ecology*. W. O. Saunders company, Philadelphia.

Odum, E. P. & Barret, G. W. (2005). *Fundamentals of Ecology.* 5th ed. Thompson Brooks/Cole.

Ricklefs, R. E. & Miller, G. L. (2000). *Ecology.* 4th ed. W. H. Freeman & Company.

Wilson, E. O. (2000). *Sociobiology: The New Synthesis*. 25th Anniversary Ed. The Beknap Press of Harvard University Press.

TSZ: 304

SPECIAL PAPER: MOLECULAR BIOLOGY AND GENETICS

Time: 2 hrs. **Full Marks: 45**

Lectures: 70 hours

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Genetic inheritance 15L

Mendelian principles and its deviation, extension of Mendelian principles – co-dominance, incomplete dominance, gene interactions, pleitropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linked, sex-limited and sex-influenced character. Sex determination, dosage compensation in *Drosophila, Caenorhabditis elegans* and mammals.

Gene concept and gene function analysis 15L

Modern gene concept: concepts of transcriptome and proteome, gene duplication – gene families, interrupted gene, pseudogenes, and transposable genetic element. Random mutagenesis, mutation screens, complementation & suppression, Manipulation of genes, site-specific mutagenesis, reporter genes expression, genomic expression profiling.

Recombinant DNA technology and animal cloning 10L

Molecular techniques in gene cloning, DNA modifying enzymes (restriction endo-Nuclease, kinase, polymerases, ligases). Gene transfer and transfection methods, transgenic animal production- DNA integration. Use of cre/loxp in transgenic animal production. Somatic cloning.

RNA interference and antisense technology 5L

siRNA, shRNA, miRNA, therapeutic use of RNA interference.

Molecular detection and gene therapy 10L

Detection of Sickle cell anaemia, thalassemia, cystic fibrosis, haemophilia, muscular dystrophy.

Gene therapy: *Ex vivo* and *in vivo* therapy, strategies and delivery.

Molecular biology techniques . 15L

PCR, RT-PCR, Real time PCR, Restriction mapping, RAPD, RFLP. AFLP, Chromosome walking, site directed mutagenesis. Gel retardation assay, RNase protection assay, Protein sequencing, *in situ* localization - FISH and GISH, Microarray technique.

Suggested readings:

Alberts, B. et al. (2008). *Molecular Biology of the Cell.* 5th Ed. Garland Publishing House.

Brooker. (2001). *Genetics*. McGraw-Hill.

Brown, T. A. (2002). *Genomes 2.* Wilely-Liss. Clark, D. P. (2005). *Molecular Biology*. Elsevier.

Clark, D.P. (2009). *Understanding the Genetic Revolution.* Academic Press.

Cooper, G. M. (2004). *The Cell*. 3rd edn. ASM Press.

Hancock, J.T. (2008). *Molecular Genetics.* Viva Book Private Ltd.

Hartl, D. L. & Jones, E. W. (1998). *Genetics, Principles and analysis.* (4th ed). Blackwell Scientific, Oxford.

Hartl, D. L. & Jones, E. W. (2005). *Genetics: analysis of genes and genomes.* 6th ed. Jones and Bartlett Publishers, Sudbury, Mass.

Hartl, D. L. & Jones, E. W. (2006). *Essential Genetics: a genomics perspective* (4th ed.). Jones and Bartlett Publishers, Boston.

Hartwell et al. (2001) *Genetics: From genes to Genomes.* McGraw Hill.

Harvey, L. (2004). *Molecular cell Biology*. 5th ed. W.H.Freeman.

Karp, G. (2008*). Cell and Molecular Biology: Concepts and experiments*.5th edn., John Wiley.

Kendrew, S. J. (Ed.) (1994). *The Encyclopedia of Molecular Biology.* Blackwell Science.

Lewin, B. (2008). *Genes IX*. Jones & Bartlett Publishers.

Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6th ed. Benjamin Cummings.

Malacinski, G. M. (2003). *Essentials of Molecular Biology.* 4th ed. Jones & Bartlett.

McConkey, H. (1993). *Human Genetics: The molecular Revolution.* Jones & Bartlett Publishers.

Snustad, D. P. & Simmons. M. J. (2004). *Principles of Genetics*. 4th ed. John Wiley and Sons.

Stansfield, W. D. (1991). *Schaum's Outline Series: Theory & Problems of Genetics.*3rd ed. McGraw-Hill.

Strachan, T. & Read, A. P. (2004). *Human Molecular Genetics-3*. garland Science.

Strickberger M.W. (1985). *Genetics.* 3rd ed, Prentice Hall of India Pvt. Ltd., New Delhi.

Tamarin, R. H. (2004). *Principles of Genetics.* Tata McGraw-Hill Publishing Comp. Ltd.
Twyman R.M. (2003). *Advanced Molecular Biology*. Viva Books.
Vogel, F. & Motulsky, A. G. (1999*). Human Genetics*. Springer.

INTERNAL ASSESSMENT

Full Marks: 4 THEORY PAPERS × 5 = 20

PRACTICAL PAPERS

PGZ: 305

ENTOMOLOGY, PARASITOLOGY & ICHTHYOLOGY
Time: 5 Hrs. **Full Marks: 50**

1. Digestive system of Grasshopper / Dragonfly/ Honey bee
2. Nervous system of Grasshopper / Dragonfly/ Honey bee
3. Mouthparts of mosquito and Dragonfly
4. Study of buccopharynx and gut content analysis in relation to food habits in teleosts.
5. Urinogenital system of teleosts
6. Efferent branchial system of teleosts
7. Smear preparation and staining of parasitic protozoa
8. Drawing and staining of blood films for parasitic protozoa and microfilaria
9. Whole mount preparation of trematode and arthropod parasites
10. Staining of Scolex and proglottids of cestodes
11. Histological preparation of testis, ovary, kidney and intestine of fish
12. Identification of common pests, vectors and fishes
13. Laboratory notebook and submission of prepared slides
14. Viva-voce

PSZ –306

SPECIAL PAPER PRACTICAL: ENTOMOLOGY
Time 5 hrs. **Full Marks: 50**

1. Anatomy
    a. Cockroach: Sympathetic Nervous and male reproductive system
    b. Blue bottle fly: Digestive and Nervous systems
    c. Mounting: antenna, scales, spiracles and tympanum
2. Taxonomy
    a. Study of insect collecting devices
    b. Identification (up to family) with reasons of Apterygote and Exopterygote (Hemimetabolans) insects
    c. Study of insects of economic importance (5 species).
3. Physiology
    a. Preparation insect blood smear and identification of blood cells under microscope after proper staining
    b. Detection of amino acids by chromatography

4. Toxicology
    a. Preparation of insecticidal formulation (emulsion, dust and suspension)
5. Field Entomology
    Laboratory Note Book and submission of collected Apterygote and Exopterygote (Hemimetabolans) insects
6. Viva-voce

PSZ –306

SPECIAL PAPER PRACTICAL: PARASITOLOGY AND MICROBIOLOGY

Time: 5 hrs. **Full Marks: 50**

1. Determination of bacterial load of different water sources by standard plate count method
2. Determination of potability of water (presumptive test)
3. Microbiological examination of curd sample.
4. Enrichment culture of spore formers.
5. Microbiological examination of milk (Methylene blue reductase test)
6. Antibiotic sensitivity test.
7. Study on Physiological and bio-chemical characteristics: Starch hydrolysis, Gelatin hydrolysis, Fat hydrolysis, Tryptophan hydrolysis, Urea hydrolysis, Citrate utilization.
8. Study of bacterial growth; Study of different factors (temperature, pH, osmotic concentration and heavy metal) on bacterial growth.
9. Isolation of asymbiotic (free living) nitrogen fixing bacteria in soil.
10. Isolation of plasmid DNA from bacteria
11. Electrophoretic separation of DNA
12. ELISA
13. Identification
14. Laboratory notebook
15. Viva-voce

PSZ: 306

SPECIAL PAPER PRACTICAL: AQUACULTURE AND FISHERIES

Time 5 hrs. **Full Marks: 50**

1. Dissection of different organ systems.
2. Studies of life histories of cultivated freshwater fishes, preparation and mounting of the various stages and their identification.
3. Techniques of induced breeding.
4. Detection of food and feeding habit by analyzing gill rakers, buccopharynx and gut content.
5. Systematic identification of fishes.
6. Separation of amino acids by paper and thin layer chromatography.
7. Field study, Laboratory Note Book and class records.
8. Viva-voce.

PSZ: 306

SPECIAL PAPER PRACTICAL: ECOLOGY & ENVIRONMENT

Time: 5 hrs. **Full Marks: 50**

Sampling and measurement of factors (air/water /soil)

(a) Light; illumination and intensity; Transparency (Secchi disc method)
(b) Primary productivity in an aquatic ecosystem (light and dark bottle method)
(c) Minerals dissolved in water - Temporary and permanent hardness
(d) Total dissolved solids (TDS), total phosphorus, and total silica in freshwaters
(e) Moisture contents of the soil and stored-grain samples

2. Field-works and Quantitative/numerical studies
   (a) Estimation of population density (direct counts, marking capture-recapture methods)
   (b) Use of statistical methods (standard deviation, Pie diagram, Histogram, Bar diagram, Scattergram etc.)
   (c) Population dispersion
   (d) Life table estimation
   (e) Biodiversity measurement
3. Ecotypes of terrestrial, freshwater and marine habitats
   (a) Characterization and identification of different ecotypes inhabiting terrestrial, freshwater and marine habitats
   (b) Identification of different tools/instruments used in Ecology and Environmental sampling and analysis
4. Laboratory Note Book and field records
5. Viva-voce

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PSZ: 306

SPECIAL PAPER PRACTICAL: MOLECULAR BIOLOGY AND GENETICS

Time 5 hrs. (2 days) **Full Marks: 50**

1. Basic principle of experimental animal handling and ethical issues and bio-safety for molecular biology work.
2. Identification of different embryonic stages of *Drosophila*, Preparation of *Drosophila* food.
3. Karyotype and idiogram preparation (G, C banding), human lymphocyte culture.
4. Extraction of DNA from animal tissue/blood.
5. Extraction of RNA from animal tissue.
6. Preparation of culture media, *E. coli* culture preparation and plasmid isolation.
7. Agarose gel electrophoresis for plasmid, genomic DNA and RNA.
8. PCR and RT-PCR.
9. Separation of protein from mouse/rat tissue on native and /denaturation gel (PAGE) and western blotting.
10. Laboratory Note Book.
11. Viva voce.

SEMESTER IV

TGZ: 401

Time: 2 hrs. **Full Marks: 45**

Unit – I: DEVELOPMENTAL BIOLOGY

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Overview 3L
- Scope of Developmental Biology & Future impact
- Totipotency
- Cell surface proteins, Extra cellular matrix
- Signaling

Techniques & experimental biology 5L
- Cell labeling & genetical methods
- Model systems (*Dictyostelium, C. elegans, Drosophila* & Chick)

Gametogenesis 4L
- Spermatogenesis: phases, cellular changes
- Oogenesis: types, stages, ooteleosis & luteinization

Fertilization in mammals 3L
- Recognition of gametes and acrosomal reaction
- Gamete fusion
- Activation of egg

Cleavage 2L
- Mechanism: molecular aspects

Gastrulation 5L
- Cell lineages
- Gastrulation in vertebrate embryos
- Formation of germ layers in amphibia and birds
- Induction, Determination and Differentiation

Pattern formation 4L
- Anterior-Posterior & Dorsal- Ventral polarity in *Drosophila;*
- Molecular control of segmentation and homeotic genes.
- Gap genes, HOX genes in vertebrate, Niuekwoop centre & ventral organizer
- Neurogenesis and Neural tube in vertebrates

General Topics 9L
- Mesoderm induction & patterning
- Regeneration
- *In vitro* fertilization in human
- Embryonic stem cell & their application

Suggested readings

Arias, A. M. & Stewart, A. (2002). *Molecular Priciples of Animal Development.*
Balinsky (1981). *Embryology.* Thompson Brooks Cole (India) Pte, Ltd.
Browder, L. W. (1984). *Developmental Biology*. 2nd ed., CBS College Publishing.
Carlson, B. M. (1999). *Patten's Foundations in Embryology.* 6th ed. McGraw Hill.
Gilbert S. F. (1999). *Embryology.* Sinauer Associates, Sunderland, Massachusetts.
Gillbert, S.F. (2006). *Developmental Biology.* 8th ed. Sinauer Associates.
Kalthoff, K., (2001). *Analysis of Biological Development*. 2 ed. McGraw Hill.

Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10th ed. Williams Oxford University Press.
Moody, S.A. (Ed.) (2007). *Principles of Developmental Genetics.* Academic Press.
Shostak, S. (1991). *Embryology – An Introduction to Developmental Biololgy.* Harper Collins.
Slack, J. M. W. (2006). *Essential Developmental Biololgy*. 2nd ed. Blackwell Publishing.
Twyman, R.W. (2001). *Instant Notes-Developmental Biology.* Viva Books Private Ltd.
Wilt, F. H. & Hake, S. C. (2004). *Principles of Developmental Biology.* W. W. Norton Company.
Wolpert, L., et al. (1998). *Principles of Development.* Oxford University Press.

Unit – II: BIOSTATISTICS & BIOINSTRUMENTATION

Full Marks: 22.5
Lectures: 35

*Three questions (out of five) of **1.5** marks each, two questions (out of four) of **4** marks each and one question (out of two) of **10** marks are to be answered.*

Biostatistics

Measures of dispersion 4L

Concepts and applications - measures of dispersion, range, mean deviation, skewness and kurtosis, coefficient of variation, variance, Standard deviation, Quartile deviation and standard error

Testing of hypotheses 7L

Concepts of Normal, Binomial and Poisson distribution; Student's – t distribution, G-tests; Concepts of Null hypothesis and alternative hypothesis, degrees of freedom Level of significance, errors of inference; one-way ANOVA – applications in biology Concepts and applications of correlation and regression

Bioinstrumentation

Microscopy 6L

Light, Fluorescence and Confocal microscopy, TEM, SEM

Centrifugation 2L

Basic principles and application
Types of rotors
High speed and Ultracentrifugation

Spectroscopy 4L

UV-vis absorption spectrophotometry - principles, instrumentation (single and double beam) and applications

Chromatography 6L

Planar chromatography (paper & TLC)
Gas chromatography
High Performance Liquid chromatography

Electrophoresis 6L

Principle
PAGE, Agarose Gel electrophoresis, Isoelectric focussing of proteins
Blot techniques: Southern, Northern & Western.

Suggested readings:

Bailey, N. T. J. (1995). *Statistical Methods in Biology*. 1st ELBS ed.

Boyer, R. (2000). *Modern Experimental Biology*. Pearson Education. English Universities Cambridge Low-price Ed.

Cantor, C.R. & Schimmel, P.R. (2003). *Biophysical chemistry* (3 vol. set). W. H. Freeman & Co.

Forthofer, N. & Lee, E. S. (2006). *Introduction to Biostatistics: A Guide to Design, Analysis and Discovery.* Academic Press.

Friefelder, D. (1982). *Physical Biochemistry.* W. H. Freeman & Co. (Reprint 1999).

Selvin, S. (2004). *Biostatistics*: *How it works?* Pearson Education .

Sharma, V. K. (1991). *Techniques in Microscopy and Cell Biology.* Tata-McGraw Hill.

Sokal, R. R., Rohlf, F. J., (1995). *Biometry: the principles and practice of statistics in biological research.* 3rd ed. W. H. Freeman and Company, New York.

Van Holde, K. E., Johnson, W. C. & Ho, P. S. (2006). *Principles of Physical Biochemistry.* 2nd ed. Pearson Prentice Hall.

Wilson, K., & Walker, J. (eds.) (2001). *Principles & Techniques of Practical Biochemistry.* 5th ed. Cambridge University Press.

Zar J. H. (1999). *Biostatistical Analysis*, 3rd Ed. Pearson Education (India) Ltd.

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TSZ: 402

SPECIAL PAPER: ENTOMOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Insect Physiology

Digestive system 10L

- The alimentary canal
- The salivary glands
- Mechanism of digestion
- Micro-organisms and their role in digestion
- Nutritional requirements

Respiratory system 10L

- Structure of respiratory organs
- Mechanism of gaseous exchange
- Aquatic respiratory organs
- Physiology of gill and plastron respiration

Excretory system 10L

- Types of excretory systems
- Organs of excretion
- Accessory organs of excretion
- Physiology of excretion
- Composition of insect urine
- Vitamins in Malpighian tubules

Nervous system 6L

- The neurons
- The central nervous system

The brain
The Sympathetic nervous system

Reproduction 10L

Male and Female reproductive system
Special types of reproduction
Factors controlling fecundity and fertility
Swarming and oviposition
Egg maturation

Development 8L

The insect egg
Embryonic development and dynamics
Post-embryonic development and metamorphosis

Endocrine system 8L

Anatomical organization
Structure and hormones
Endocrine control of metamorphosis, diapause

Gall formation 8L

Insects involved in formation of galls
Mechanism of galls formation
Importance of galls

Suggested readings:

Chapman, R. F. (1998). *The Insects: Structure and Function.* 4th Ed. Cambridge University Press.

David, B. V. & Ananthakrishnan, T. N. (2006). *General and Applied Entomology*. Tata McGraw-Hill Publishing.

Gillott, C. (2005). *Entomology*. 3 ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).

Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed.

Klowden. (2002). *Physiological Systems in Insects,* Academic Press.

Richards O.W. & Davies, R.G. (1977). *Imms: A General Text Book of Entomology.* 10th ed. Vol.1 & 2. Chapman and Hall.

Rockstein, M. (1978). *Biochemistry of Insects.* Academic Press.

Rockstein, M. (Ed.) (1973). *The Physiology of Insecta.Vol.I.* 2nd ed. Academic Press.

Snodgrass, R.F. (1935). *Principles of Insect Morphology.* Tata McGraw-Hill Publishing Company Ltd.

Srivastava, K. P. (1988). *A textbook of Applied Entomology.* Vol. I. 2nd ed. Kalyani Publishers, New Delhi.

Wigglesworth, V. B. (1972). *Principles of Insect Physiology.* ELBS (Methuen & co.)

TSZ: 402

SPECIAL PAPER: PARASITOLOGY & MICROBIOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

General Parasitology & Protozoology

Microenvironment and the phases of parasitism 10L

The vertebrate alimentary canal, blood, tissues and the other habitats

Parasite host specificity 5L

Protozoan Parasites

Origin and evolution of parasitic protozoa 5L

Haemoflagellates 20L

General morphology and morphological stages
Life cycle and pathogenicity of *Trypanosoma brucei gambiense*
Physiology and biochemistry of Haemoflagellates

Apicomplexa 20L

Ultrastructure of apical complex
Biology and pathogenicity of *Toxoplasma gondii*
General biology, Characteristic of species and Indian vectors of *Plasmodium*; Immunopathology associated with malaria;
Biochemistry and physiology of *Plasmodium* and *Babesia*

Ciliophora 10L

General morphology with special reference to parasitic forms;
Structure, Life cycle and pathogenicity of *Balantidium coli*

Suggested readings:

Bird, A. F. (1971). *The structure of Nematodes.* Academic Press, New York.

Bogitsh, B. J. & Cheng, T. C. (2000). *Human Parasitology*. 2nd ed. Academic Press, New York.

Bogitsh, B. J., Carter, C. E. & Oltomann, T. N. (2006). *Human Parasitology*. 2nd ed. Academic Press, New York.

Bush, A. O., Fernández, J. C., Esch, G. W. & Seed, J. R. (2001). *Parasitism*. Cambridge University Press. U. K.

Cheng, T. C. (1986). *General Parasitology Academic Press*. 2nd ed. Inc. Orlando. U.S.A.

Dawes, D., Bakers, J. R. & Muller, R. (Eds.). *Advances in Parasitology (yearly volumes)*. Academic Press, New York.

Hati, A. K. (2001). *Medical Parasitology.* Allied Book Agency, Kolkata.

Hyman, L. H. (1951). *The Invertebrates* (Vol-I). Mc.GrawHill Book Company.

Noble, E. R. & Noble, G. A. (1982). *Parasitology. The Biology of animal Parasites*. 5th ed. Lea and Febiger, Philadelphia.

Schmid, G. D. (1989). *Essentials of Parasitology.* Wm. C. Brown Publishers (Indian Reprint; 1990. Universal Book Stall).

Smyth, J. D. (1994). *Animal Parasitology.* 3rd ed. Cambridge University Press.

Soulsby, E. J. L. (1982). *Helminths, Arthropods and Protozoa of domesticated animals*. ELBS and Bailliere Tindall. London.

TSZ: 402

SPECIAL PAPER: AQUACULTURE & FISHERIES

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Fresh Water & Brackish Water Aquaculture

Nutrition and supplementary feeding 20L

- Nutritional requirements
- Intermediary metabolism and bioenergetics
- Feed types, composition, ingredients, formulation
- Feeding schedules, feed dispensing methods
- Storage and quality control of feed

Maintenance of Fish Farm 15L

- Productivity of freshwater bodies
- Limnological methods and their application (oxygen and carbon-di-oxide)
- Pond fertilization
- Control of aquatic weeds, insects, predatory and weed fishes

Aquaculture hazards 12L

- Common diseases of fish: Causative organisms, effects and control
- Shrimp diseases and treatment
- Pollution: sources, effects and control.

Present status of brackish water fish farming in India 8L

- Mixed culture of brackish water fish species
- Esturine fisheries

Spoilage of fresh water and brackish water fishes 8L

- Aminoacid changes
- Breakdown products indicative of spoilage
- Other substances

Development strategies 7L

- Fish conservation
- Fish marketing: imports and exports.

Suggested readings:

Bardach, J. E. & Ryther, J. H. (1972). *Aquaculture*. John Willey and Sons.

DE Silva, S. S. & Anderson, T. A. (1995). *Fish Nutrition in Aquaculture*. Chapman & Halll, London.

Guillaume, J., Kaushik, S., Bergot, P. & Metailler, R. (2001). *Nutrition and Feeding of Fish and Crustaceans*. Springer and Praxis, U. K.

Halver, J. E. (1972). *Fish Nutrition*. Academic Press, New York & London.

Jhingran, V. G. (1991). *Fish and Fisheries of India.* 3rd ed., Hindusthan Pub. Corp.

Pillay, T.V.R. (1993). *Aquaculture*. Fishing News Books.

Srivastava, C. B. L. (1999). *Fish Biology*. Narendra Pub. House.

Srivastava, C. B. L. (2006). *A Text Book of Fishery Science & Indian Fisheries*. Kitab Mahal. Allahabad.

TSZ: 402

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Stresses on ecosystem structure and function 8L

Advent of stress, long-term chronic stress, alleviation of stress; biological indicators and their use in monitoring pollution; bioaccumulation and biomagnification

Ecotoxicology 12L

Basic concept, Background concentration in the environment, naturally occurring contaminants and their ecological effects; anthropogenic source of toxic elements; movement, distribution and fate of toxins ; minimizing toxic effects; xenobiotics; pesticides, heavy metals, industrial effluents, organic pollutants, radio-active pollutants; food additives and contaminants, bioassay and safety evaluations

Air pollution 12L

Emission, transformation and toxicity of air pollutants; impacts of air pollution on human health; ozone hole, greenhouse effects; global climate change and plant growth; acid rain; monitoring and control of air pollution

Water, soil and noise pollution 10L

Types, sources, characteristics, effects and control

Waste disposal & Treatments 10L

Solid waste disposal; sewage disposal and treatments; toxic wastes and their disposal

Radiation and warfare ecology 10L

Nuclear concepts, impacts of nuclear warfare and radiation effects at the ecosystem level, fallout problems, destruction of conventional warfare

Urbanization ecology 8L

Urban land use and growth, urban structure and crisis, urban planning, urban regeneration, open space, green belts and parks; ecotourism

Suggested readings:

Begon, M., Harper, J. L. & Townsend, C. R. (2005). *Ecology: From Individuals to Ecosystems* (4th ed.) Wiley Blackwell.

Begon, M., Harper, J. L. & Townsend, C. R. (1996). *Ecology: Individuals, Populations and communities.* (3rd ed.). Blackwell science.

Chapman R. L. & Reiss, M. J. (2000). *Ecology – Principles & Application.* Cambridge Low Price Edition.

Colinvaux, P. (1993). *Ecology 2*. John Wiley & Sons, Inc. New York. Eastern economy Edition.

Das, R. C. & Behera, D. K. (2008). *Environmental Science.*

Freedman, B. (1989). *Environmental Ecology.* Academic press, Inc.

Kormondy, E. J. (2002). *Concepts of Ecology*. 4th Indian Reprint, Pearson Education.

Odum E. P. (1971). Fundamentals of Ecology. W. O. Saunders company, Philadelphia.
Odum, E. P. & Barret, G. W. (2005). *Fundamentals of Ecology.* 5th ed. Thompson Brooks/Cole.
Patwardhan, A. D. (2008). *Industrial waste Water Treatment.* Eastern Economy Edition.

TSZ: 402

SPECIAL PAPER: MOLECULAR BIOLOGY AND GENETICS

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Cellular organization 15L

Membrane structure and transport of small molecules, electrical properties of membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, structure and function of cytoskeleton and its role in motility, cell junction, cell adhesion and extracellular matrix.

Cell signaling 10L

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial two-component signaling systems, bacterial chemotaxis and quorum sensing.

Cancer 10L

Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth. Tumor angiogenesis.

Programmed cell death 5L

Apoptosis, aging and senescence.

Methods of cell and tissue culture: 5L

Monolayer and Suspension culture, co-culture, Cell Freezing. Embryonic stem cell culture.

Host cell-pathogen interaction 10L

Recognition and entry process of bacteria and virus in to host cell, alteration of host cell behaviour by pathogens, virus induced cell transformation, cell-cell fusion in both normal and abnormal cells.

Molecular biology instrumentation 15L

Flow cytometry. Microscopy: differential, interference, phase contrast microscopy. Spectroscopy: GC-MS, MALDI -TOF. NMR, X-ray crystallography. Surface plasma resonance method, PET, MRI, fMRI, CAT.

TSZ: 403

SPECIAL PAPER: ENTOMOLOGY

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Applied Entomology

Crop Husbandry 10L

Morphology, Bionomics and Management of pests of paddy, wheat, jute, sugarcane, mango, oil-seed crops, pulses, vegetables and stored grains

Distribution, bionomics and control of polyphagous pest:locusts and termites

Control/Management of insect pests 20L

Integrated pest Management:
Concept of injury level, Economic level of injury,
Economic threshold level, IPM.
Chemical control: Organochlorines, Organophosphates,
Carbamates, Pyrethroids and Botanicals
Biological Control. Predators, Parasitoids and Nematodes
Hormonal control: Concept, use of juvenoids, ecdysoids
and Insect growth regulators (IGRs)
Genetic control: Methods of genetic manipulation and field trials.
Biotechnological control- use of transgenic plants, transgenic agents and impact of environment on the method.

Non-insecticidal method

Insect attractants, fumigants, repellents and antifeedants

Forest Entomology 5L

Insects common to forests and their damage
Defoliators, borers and sapsuckers.

Forensic Entomology 5L

Insects associated with the corpses and carrions
Forensic entomological techniques

Industrial Entomology 10L

Non-Mulberry sericulture-Tasar, muga and eri.
Lac culture: Lac insects, Life history, Industrial importance.
Honey bees and Apiculture

Medical Entomology 10L

Insects of medical importance - naming with its status in Entomology
Morphology of mosquitoes, house flies, human lice and rat fleas with role in disease transmission and control

Insect molecular genetics 10L

Insect genome organization
Transgenic pest and application

Suggested readings:

Atwal, A. S. & Dhaliwal, G.S. (2002). *Agricultural pests of South Asia and their management.* Kalyani Publishers, New Delhi.

Dent, D. (2000). *Insect Pest Management*. 2nd ed. CABI.

Dhaliwal, G.S. & Singh, R. (2004). *Host plant Resistance to Insects: Concepts and Applications.* Panima Publishing Corporation.
Dorothy, E. G. (2006). *Forensic Entomology*. Wiley.
Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed. Blackwell Publishing.
Hill, D.S. (1994). *Agricultural Entomology.* Timber Press.
Hoy, M. A. (2003). *Insect Molecular Genetics– An introduction to principles and Applications.*2nd ed. Academic Press.
Ignacimuthu, S. & Jayraj, S. (Eds.) (2007). *Biotechonology and Insect Pest Management.* Elite Publishing House Pvt. Ltd.
Jha, L. K. & Sen Sarma, P. K. (1993). *Agroforestry – Indian Perspective*. Ashish Publishing House.
Kettle, D. S. (1995). *Medical and veterinary Entomology*. 2nd Ed. CAB International.
Koul, O, Cuperus, G.W. & Elliot, N. (Ed.) (2008) *Area wide pest management Theory and Implementation*. CAB International.
Metcalf, R. L. & Luckmann, W. H. (1994). *Introduction to Insect Pest Management*. 3rd Ed. John Wiley & Sons, Inc.
Mullen, G.R. & Durden, L.A. (2009). *Medical and Veterinary Entomology.* 2nd Ed.Academic Press.
Nation, J. L. (2008). *Insect Physiology and Biochemistry*. 2nd ed. CRC Press. Taylor & Francis Group.
Pedigo, L. P. & Rice E. M. (2009). *Entomology and Pest Management.* Pearson/Prentice Hall.
Pimentel D. (Ed.) (2007). *Encyclopedia of Pest Management.* Vol.II. CRC Press, Taylor & Francis.
Radclife, E.B., Hutchinson, W.D. & Cancelado, R.E. (2009) *Integrated Pest Management – Concepts, Tactics, Strategies & Case studies.* Cambridge University Press.
Rechcigl J. E. & Rechcigl, N. A. (1998). *Biological and Biotechnological control of Insect pests.* Lewis Publishers.
Shukla, G. S. & Upadhyay, V. B. (2005-2006). *Economic Zoology*. 4th ed. Rastogi Publication.
Speight, M. R., Hunter, M.D. & Watt A. D. (2008). *Ecology of Insects: Concepts and Applications*. 2nd ed. Wiley-Blacwell.
Srivastava, K. P. (1988). *A textbook of Applied Entomology.* Vol. II 2nd ed. Kalyani Publishers, New Delhi.
Stewart A.J.A., New, T.R. & Lewis, O.T. (Ed.) (2007). *Insect Conservation* Biology. CABI.

TSZ: 403

SPECIAL PAPER: PARASITOLOGY & MICROBIOLOGY

Time: 2 hrs. **Full Marks: 45**
Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

HELMINTHOLOGY AND VECTOR BIOLOGY:

Helminth Parasites

General organization and outline classification of Platyhelminthes, Nematoda and Acanthocephala with reference to parasitic forms	4L
Origin and evolution of Parasitic helminths	5L
Structure and Composition of cuticle in helminths	4L
Structure of Scolex in Cestodes	3L

Reproductive system, mating behavior, fertilization and egg formation in helminths 7L

Larval development and patterns of life cycle in Digenea, Cestoda and Nematoda. 5L

Carbohydrate, protein and lipid metabolism in Nematoda 5L

Biology, Pathogenicity and Control: 10L

Opisthorchis sinensis, Diphyllobothrium latum, Echinococcus granulosus, Loa loa

Gastrointestinal nematode infection in man and ruminants and their antihelmintic treatment 4L

Human lymphatic filariasis and its transmission dynamics 3L

Zoonoses in nematodes and cestodes 4L

General organization and life cycles in Acanthocephala 4L

Vector Biology

Biology, importance and control: 12L

Chrysops, Tse-tse fly, Fleas, Lice and mosquitoes (*Aedes* and *Culex*)

Suggested readings:

Bird, A. F. (1971). *The structure of Nematodes.* Academic Press, New York.

Bogitsh, B. J. & Cheng, T. C. (2000). *Human Parasitology*. 2nd Ed. Academic Press, New York.

Bogitsh, B. J., Carter, C. E. & Oltomann, T. N. (2006). *Human Parasitology*. 2nd Ed. Academic Press, New York.

Bush, A. O., Fernández, J. C., Esch, G. W. & Seed, J. R. (2001). *Parasitism*: Cambridge University Press. U. K.

Cheng, T. C. (1986). *General Parasitology*. 2nd ed. Academic Press, Inc. Orlando. U.S.A.

Chowdhury, N. & Toda, I. (Eds) (1994). *Helminthology*. Narosa Publishing House, New Delhi.

Dawes, D., Bakers, J. R. & Muller, R. (Eds). *Advances in Parasitology* (yearly volumes). Academic Press, New York.

Hati, A. K. (2001). *Medical Entomology.* Allied Book Agency, Kolkata.

Hati, A. K. (2001). *Medical Parasitology.* Allied Book Agency, Kolkata.

Hyman, L. H. (1951). *The Invertebrates*. (Vols- II, III) Mc.GrawHill Book Company.

Noble, E. R. & Noble G. A. (1982). *Parasitology. The Biology of animal Parasites.* 5th ed. Lea and Febiger, Philadelphia.

Roberts, L. S. & Janovy, Jr. J. (2006). *Foundations of Parasitology.* McGraw-Hill International Ed.

Schmid, G. D. (1989). *Essentials of Parasitology*. Wm. C. Brown Publishers (Indian Reprint; 1990. Universal Book Stall).

Smyth , J. D. (1994). *Animal Parasitology.* 3rd ed. Cambridge University Press.

Soulsby, E. J. L. (1982). *Helminths, Arthropods and Protozoa of domesticated animals.* ELBS and Bailliere Tindall.

Smyth, J. D. & McManus, D. P. (1989). *The Physiology and Biochemistry of cestodes.* Cambridge Univ. Press.

TSZ: 403

SPECIAL PAPER: AQUACULTURE & FISHERIES

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Marine Fisheries

General survey of marine fisheries in India 4L

Marine biology and oceanography in relation to fisheries 6L

Principal marine fisheries and exploited species 14L

Oil sardine and lesser sardines, Indian Mackerel, Bombay duck, Pomfrets, Prawns, Molluscs

Fishing crafts and Gears 4L

Types of Indigenous crafts and gears, designing
Modernization of craft, Preservation

Life in sea 5L

Phytoplankton, Zooplankton
Nekton and fisheries

Fluctuation in marine fisheries 4L

Causes of fluctuation, overfishing problem
Rational exploitation of fisheries

Preservation and processing 5L

Chemical composition of fish
Drying and salting, Chilling and freezing, Smoking and canning

Mariculture 8L

Cultivable fin-fishes, Cultivable crustaceans, Cultivable mollusca

Fish in human nutrition 10L

Nutritive value of fish protein,
Fish oils, fatty acids and nutrition
Fish as a source of mineral, Fish as a source of vitamins

Fish by-products, Marketing of fish and aquaculture products 6L

Conservation of marine environment through establishing National marine reserves 4L

Suggested readings:

Bal, D. V. & Rao, K. V. (1984). *Marine Fisheries*. Tata McGraw Hill Pub. C Ltd.

Bardach , J. E. & Ryther, J. H. (1972). *Aquaculture*. John Willey and Sons.

Chandy, M. (1994). *Fishes*. NBT. New Delhi.

Jhingran, V. G. (1991). *Fish and Fisheries of India*.3rd ed., Hindusthan Pub. Corp.

Khanna, S. S. & Singh, H. R. (2003). *A Text Book of Fish Biology & Fisheries*. Narendra Publishing House. New Delhi.

Pillay, T. V. R. (1993). *Aquaculture*. Fishing News Books.

Srivastava, C. B. L. (1999). *Fish Biology*.Narendra Publishing House. New Delhi.

Srivastava, C. B. L. (2006). *A Text Book of Fishery Science & Indian Fisheries*. Kitab Mahal. Allahabad.

TSZ: 403

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Population ecology 9L

Intrinsic rate of natural increase, 'r' and 'k' selections, life-history traits and tactics, human demography, dynamics of metapopulations

Resources 8L

Renewable and non-renewable resources, fossil fuel, nuclear fuels, biogas, solar energy, food production trends, agriculture and forestry

Conservation and management 9L

Principles of conservations, conservation of natural resources, mineral resources, endangered species, wetlands management, ecological principles to pest managements, ecology of biological invasion, restoration ecology

Environmental policy 9L

Social forestry, economic and legal aspects, enforcement of anti-pollution laws, environment awareness - role of government, media and voluntary groups, Green Bench

Man-environment interaction 9L

Global population size, management of energy utilization, public health, human right, animal rights and human wrongs, important movements on environmental issues

En*vironmental health and Ecological Economics*

Environmental health hazards and laws, capital and reserves, Population, technology and scarcity, natural resources accounting, trade development and jobs, green designs and the environment

Systems analysis and modeling in ecology 9L

Types of systems models - dioristic, component, strategic, management and statistical; basic mathematical tools in model building, analysis and simulation in models, deterministic and stochastic models, differences and differential models

Society and environmental sociology 9L

Politics, economics, and ethics; western philosophy and ethical compromise, social environment, modernism and post-modernism, Malthus and Marx today

Suggested readings:

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

Berryman, A. A., Kindlmann, P. (2008). *Population Systems: A General Introduction.* Springer Science & Business Media.

Bill, F. (1989). *Environmental Ecology*. Academic Press, Inc.

Brewer, R. (1994). *The Science of Ecology.* Saunders College Publishing, pp. 773 (2nd ed.).Cambridge University Press, (CLP 2nd ed.).

Case, T. J. (2000). *An Illustrated Guide to Theoretical Ecology.* Oxford Univ. Press.
Chapman R. L. & Reiss, M. J. (2000). *Ecology – Principles & Application.* Cambridge Low Price Edu. 2nd ed.
Colinvaux, P. (1993). *Ecology 2*. John Wiley & Sons, Inc. New York, pp. 688.
Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). *Ecology- Science and Practice.* Oxford & IBH Publishing Company Pvt. Ltd.
Freedman, B. (1989). *Environmental Ecology.* Academic press, Inc.
Hong, S-K, Nakagoshi, N., Fu, B. & Morimoto, M. (2007). *Landscape Ecological Applications in man-influenced area: Linking man and nature systems.* Springer.
Kormondy, E. J. (2002). *Concepts of Ecology.* 4th Indian Reprint.
May, R. M. & McLean, A. R. (2007). *Theoretical Ecology: Principles and Applications.*3rd Ed. (Indian Ed.). Oxford Univ. Press.
Moriarty, F. (1999). *Ecotoxicology:The study of pollutants in ecosystems.*3rd Ed. Elsevier.
Odum, E. P. (1971). *Fundamentals of Ecology*. W. O. Saunders company, Philadelphia.
Odum, E. P. (1983). *Basic Ecology*. CBS College Publishing.
Odum, E. P. & Barret, G. W. (2005). *Fundamentals of Ecology.* 5th ed. Thompson Brooks/Cole.
Rajagopalan, R. (2005). *Environmental Studies: from Crisis to Cure.* Oxford Univ. Press.
Smith, R. L. (2002) Ecology and Field Biology. Pearson Education (India) Ltd.
Van Dyke, F. (2008). *Conservation Biology: Foundations, Concepts, Application.* 2nd Ed. Springer Science and Business Media.
Zuur, A. F., Ieno, E. N. & Smith, G. M. (2007). *Analysizing Ecological data.* Springer Science & Business Media.

TSZ: 403

SPECIAL PAPER: MOLECULAR BIOLOGY AND GENETICS

Time: 2 hrs. **Full Marks: 45**

Lectures: 70

*Five questions (out of eight) of **2** marks each, three questions (out of five) of **5** marks each and two questions (out of four) of **10** marks each are to be answered.*

Complex traits and quantitative genetics 10L

Heritability and its measurements, oligogenic trait, polygenic trait, multifactorial trait, threshold trait; QTL mapping. LOD score and linkage testing.

DNA replication (prokaryotes and eukaryotes), repair and recombination: 10L

Unit of replication, enzymes involved,
replication origin and replication fork, fidelity of replication, extrachromosomal replicons, licensing factors, DNA damage and repair mechanisms.

Chromatin structure 10L

Nucleosome structure, chromatin activation and inactivation, heterochromatin, chromatin binding proteins, Histone modification, DNA methylation, polycomb and trithorax group of proteins.

Gene expression and its regulation 20L

The operon, regulatory circuits, phage strategies, promoters and enhancers, activating transcription – transcription factors and machinery, Histone acetylation and deacetylation, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing and editing

Protein synthesis process

ribosome, initiation complex and their regulation, chain elongation, termination, genetic code aminoacylation of tRNA, tRNA identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post translational modification, protein trafficking, signal transduction, protein sorting, chaperons.

Microbial genetics 10L

Transformation, conjugation, transduction and sex-duction; life cycle and reproduction in retroviruses, adenoviruses; prion and their pathogenecity. Gene expression and regulation (at transcription and translation level) of prokaryotic – phages and viruses.

Bioinformatics: 10L

Basic concept of Bioinformatics, sequence Databases, Sequence formats- FASTA, Gene Bank, Database searching and pair wise comparison of sequence, BLAST, Multiple sequence Alignment, clustal W/X, Protein analysis tool-Expasy, data mining methods for sequence analysis.

Suggested readings (TSZ 402 & TSZ 403):

Alberts, B. et al. (2008). *Molecular Biology of the Cell.* 5th Ed. Garland Publishing House.

Brock T.D. (1990). *The Emergence of Bacterial Genetics*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Brooker. (2001). *Genetics*. McGraw-Hill.

Brown, T. A. *Genomes 3.* Wilely-Liss.

Clark, D. P. (2005). *Molecular Biology*. Elsevier.

Clewell, D.B. (Ed.) (1993). *Bacterial Conjugation. New York: Plenum Press.*

Cooper, G. M. (2004). *The Cell*. 3rd ed. ASM Press.

Dear, P.H. (Ed.) (2007). *Bioinformatics.* Scion Publishing.

Dimmock, N. J. & Primrose, S. B. (1994). *Introduction to Modern Virology*. 4th ed. Blackwell Scientific Publications. London.

Freifelder, D. (1987). *Molecular Biology*. Narosa Publishing House, New Delhi.

Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C. & Carroll, S. B. (2008). *Introduction to genetic analysis.* 9th ed. W. H. Freeman and Company, New York.

Hartl, D. L. & Jones, E. W. (1998). *Genetics, Principles and analysis.* (4th ed). Blackwell Scientific, Oxford.

Hartl, D. L. & Jones, E. W. (2005). *Genetics: analysis of genes and genomes.* 6th ed. Jones and Bartlett Publishers, Sudbury, Mass.

Hartl, D. L. & Jones, E. W. (2006). *Essential Genetics: a genomics perspective* (4th ed.). Jones and Bartlett Publishers, Boston.

Hartwell et al. (2001) *Genetics: From genes to Genomes.* McGraw Hill.

Harvey, L. (2004). *Molecular cell Biology*. 5th ed. W.H.Freeman.

Karp, G. (2008*). Cell and Molecular Biology: Concepts and experiments*. 5th ed., John Wiley.

Kendrew, S. J. (Ed.) (1994). *The Encyclopedia of Molecular Biology.* Blackwell Science.

Lewin, B. (2008). *Genes IX*. Jones & Bartlett Publishers.

Lewin B. et al.(2007). *Cells.* Jones and Bartlett Publishers.

Pierce B. A. (2003). *Genetics – A conceptual approach.* WH Freeman Company.

Primorose S.B. and Twyman R.M. (2007*). Principles of Gene Manipulation and Genomics* (7th ed.). Blackwell Publishing

Russel P. A. (2003). *Essential of iGenetics* . Benjamin Cummings.

Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6th ed. Benjamin Cummings.

Westhead, D. R. et. al. (2003). *Instant notes on Bioinformatics*. Viva Book House.

Mount D.V. *Bioinformatics – Sequence & Genome analysis* . CBS publishers

Maloy, S. R., Cronan, E. J. & Freifelder, D. (1994*). Microbial Genetics*, 2nd ed. Jones and Bartlett, Boston.

Malacinski, G. M. (2003). *Essentials of Molecular Biology.* 4th ed. Jones & Bartlett.

McConkey, H. (1993). *Human Genetics: The molecular Revolution.* Jones & Bartlett Publishers.

Pollard T.D. and Earnshaw W.C. (2007*). Cell Biology*. Elsevier.

Snustad, D. P. & Simmons. M. J. (2006). *Principles of Genetics*. 4th ed. John Wiley and Sons.

Stansfield, W. D. (1991). *Schaum's Outline Series: Theory & Problems of Genetics.*3rd ed. McGraw-Hill.

Strachan, T. & Read, A. P. (2004). *Human Molecular Genetics-3*. garland Science.
Sudbery P. (2002). Human Molecular Genetics. Prentice Hall
Tamarin, R. H. (2004). *Principles of Genetics.* Tata McGraw-Hill Publishing Comp. Ltd.
Tramontano et. al. (2006). Introduction to Bioinformatics. Chapman & Hall.
Trun N. & Trempy J. (2004). *Fundamental Bacterial Genetics.* Blackwell Publishing. Indian Reprint.
Vogel, F. & Motulsky, A. G. (1999*). Human Genetics*. Springer.

TSZ – 404

Full Marks: 50

Term Paper / Project Work (based on special paper)

[Submission (within 10,000 words) & Seminar presentation **– 40 (=25+15);** Discussion – 10]

INTERNAL ASSESSMENT

Full Marks: 3 THEORY PAPERS × 5 = 15

PRACTICAL PAPERS

PGZ – 405

DEVELOPMENTAL BIOLOGY & COMPUTER APPLICATION

Time: 5 hrs. **Full Marks: 50**

1. Developmental Biology 30
   a. Culture and Regeneration of *Hydra*
   b. Morphological studies on the developmental stages of snail, fish, frog, chick and mouse
   c. Histological slides of various organs and systems during development using stained serial sections
   d. Identification of whole mounts and histological sections of embryos larvae, pupae and nymphs
   e. Submissions of preparations of different stages of development.
2. Computer Applications 10
   a. Basics of computers
      CPU & I/O units, Operating systems
   b. Computer networking
      Internet & Email, Home pages, Web pages, WWW,URL
   c. Software packages
      MS word, MS Excel, MS Power point, Photoshop, and SPSS
   d. Scope, application of Bioinformatics
3. Laboratory records 5
4. Viva voce. 5

PSZ: 406

SPECIAL PAPER PRACTICAL: ENTOMOLOGY

Time: 5 hrs. **Full Marks: 50**

1. Anatomy
    a. Butterfly: Digestive and Reproductive system
    b. Any coleopteran: Nervous system
    c. Mounting: wings (small insects-at least 5 types), legs (at least 5 types) and mouthparts at least two types
2. Taxonomy
    a. Methods of insect collection and preservation
    d. Identification (up to family) with reasons of Endopterygote (Holometabolans) insects
3. Physiology - Chitosan test of cuticle
4. Toxicology
    a. Study of insect infestations (at least 5) in grains and forest trees.
    b. Study of LC_{50} of two common insecticides against any two pests (graphical representation).
5. Study (life cycle, damage etc.) of at least 2 types of pests.
6. Laboratory Note Book and
7. Submission of collected endopterygote insects (Holometabolans)
8. Viva-voce.

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PSZ: 406

SPECIAL PAPER PRACTICAL: PARASITOLOGY & MICROBIOLOGY

Time: 5 hrs. **Full Marks: 50**

1. Autopsy of hosts for parasitic infection.
2. Permanent preparation of protozoan parasite.
3. Fixation and preservation of helminth parasites.
4. Staining and mounting of trematode and cestode.
5. Histological preparation of helminth parasites.
6. Cytochemical and histochemical studies on protozoa and helminth parasites-DNA, polysaccharides, Protein, Lipid, Alkaline and Acid phosphatases.
7. Clinical parasitological techniques.
8. En-face view preparation of nematode parasites.
9. Whole mount preparation of arthropod parasites and vectors.
10. Identification
11. Submission of parasitological preparation
12. Laboratory notebook
13. Viva- voce

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PSZ: 406

SPECIAL PAPER PRACTICAL: AQUACULTURE & FISHERIES

Time: 5 hrs. **Full Marks: 50**

1. Histological studies of different tissues and their identification.
2. Limnological studies.
3. Biochemical estimation of protein, lipid and carbohydrate from fish tissues.
4. Qualitative and quantitative detection of digestive enzymes.
5. Identification and mounting of some common freshwater Zooplankton, benthos, aquatic weeds and insects).
6. Electrophoretic separation of proteins and nucleic acids.
7. Laboratory Note and class records, submission of prepared slides.
8. Viva voce.

PSZ: 406

SPECIAL PAPER PRACTICAL: ECOLOGY & ENVIRONMENT

Time: 5 hrs. **Full Marks: 50**

1. Quantitative analysis of some inorganic and organic materials in the environment
    a. Chemical Oxygen Demand (COD)
    b. Biochemical Oxygen Demand (BOD)
    c. Organic Matter (OM)/Organic carbon (OC) in the soil/sediment
2. Animal energetics
    a. Bomb-calorimetery - Invertebrate/Vertebrate tissue
    b. Material drying (gravimetric) and pellet forming techniques
    c. Computation of energy budget and energy flow diagrams
    d. Determination of ash-free biomass of invertebrate and vertebrate samples (Muffle-furnace technique)
3. Air sampling and air analysis
    a. Temperature - Minimum and Maximum; Relative Humidity (RH)
    b. Particulate matters (Electrostatic precipitation method)
    c. Nitrogen oxides (monochromatic method), Sulfur dioxide (New- Castle method)
    d. Hydrocarbons in exhaust gases
4. Animal feeding and nutrition
    a. Measurement of consumption and assimilation rates
    b. Chemical composition of animals body and its food (e.g. carbohydrates, proteins, lipids and polyphenolics)
    c. Respirometry of some terrestrial animals
5. Ecotypes of terrestrial, freshwater and marine habitats
    a. Characterization and identification of different ecotypes inhabiting terrestrial, freshwater and marine habitats
    b. Identification of different tools/instruments used in Ecology and Environmental sampling and analysis
6. Laboratory Note Book and field records
7. Viva-voce

PSZ: 406

SPECIAL PAPER PRACTICAL: MOLECULAR BIOLOGY & GENETICS

Time: 8 hrs. (2 days) **Full Marks: 50**

1. Sex chromatin study
2. Gene expression study by GFP / lac Z staining/immunostaining
3. Cloning of gene
4. Monolayer and/suspension cell culture
5. Visit to R & D laboratory
6. Submission of laboratory notebook
7. Viva voce