

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

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 (With effect from the session 2007 - 2009)
Total Marks: 1200

(Theoretical: 750 + Practical: 400 + Term paper: 50)

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

<u>Internal assessment:</u>		
(F.M. 4 × 5=20)		
<u>Practical</u>		
PGZ: 205 (F.M. 40+10=50)	-	Ecology and Soil Zoology & Educational tour
PGZ: 206 (F.M. 50)	-	Unit-I Physiology
	-	Unit-II Microbiology and Immunology
Semester- III		F.M. 300
<u>Theory</u>		
TGZ: 301 (F.M.-45)	-	General Entomology
TGZ: 302 (F.M. 45)	-	Parasitology and Vector Biology
TGZ: 303 (F.M. 45)	-	Ichthyology and Aquaculture
TSZ: 304 (F.M. 45)	-	Special paper
<u>Internal assessment:</u>		
(F.M. 4 × 5=20)		
<u>Practical</u>		
PGZ: 305 (F.M. 50)	-	Entomology, Parasitology and Ichthyology
PSZ: 306 (F.M. 50)	-	Special Paper
Semester- IV		F.M. 300
<u>Theory</u>		
TGZ: 401 (F.M. 45)	-	Unit-I Developmental Biology
	-	Unit-II Biostatistics and Bioinstrumentation
TSZ: 402 (F.M. 45)	-	Special Paper
TSZ: 403 (F.M. 45)	-	Special Paper
TSZ: 404 (F.M. 50)	-	Term paper (based on special paper) [Paper submission – 30; Seminar Presentation – 15 &

Discussion – 5]

Internal assessment:

(F.M. 3×5=15)

Practical

PGZ: 405 - **Developmental Biology & Computer Application**
(F.M. 50)

PSZ: 406 - **Special paper**
(F.M. 50)

Special papers offered:

ENTOMOLOGY
AQUACULTURE & FISHERIES
PARASITOLOGY & MICROBIOLOGY
ECOLOGY & ENVIRONMENT

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.

<i>Taxonomy</i>	2L
History and Importance	
<i>General concepts</i>	4L
Micro- and Macro-taxonomy	
Levels of taxonomic study	
<i>Concepts of species</i>	15L
Types –Typological, Biological and Evolutionary	
Kinds of species, Taxonomic types	
Hierarchy	
<i>New trends in taxonomy</i>	10L
Biochemical, Cytological & Molecular	
<i>Zoological nomenclature</i>	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*. Clarendon Press.
- Kapoor, V. C.** (1994). *Theory and practice of animal taxonomy*. 3rd. ed. Oxford & IBH.
- Mayr, E. & Ashlock, P. D.** (1991). *Principles of Systematic Zoology*. 2 ed., McGraw-Hill.
- Mayr, E.** (1969). *Principles of Systematic Zoology*. Tata McGraw-Hill.
- 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.

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

<i>Molecular Population genetics</i>	6L
Neutral theory	
Molecular evolution and Phylogenetics.	
<i>Variation and Evolution</i>	10L
Genetic variation in population (Morphological, Chromosomal and biochemical)	
Quantification of genetic variation in populations	
<i>Quantitative genetics</i>	9L

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

Evolution

<i>Natural Selection</i>	8L
Darwinian fitness	
Genetic burden or load	
Polymorphism and balancing Natural Selection	
Diversifying natural selection with examples.	
<i>Macro and Micro evolution</i>	12L
Evolutionary pattern and rate	
Isolating mechanisms and speciation.	
Punctuated equilibrium	

Suggested readings:

- 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.
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.

<i>Fixation and related procedures</i>	8L
Types of fixation, Fixation process; fixation of whole tissue; fresh-frozen sections; Decalcification	
<i>Embedding</i>	2L
Gum-sucrose/gelatin and paraffin wax embedding	
<i>Microtomy</i>	3L
Methods, problems and remedies of microtomy including cryostat and freezing microtome	
<i>Structure and function</i>	
Tongue, Intestine and Thymus	6L
<i>Biological dyes and stains</i>	8L

Properties, source and use of haematoxylin, eosin and carmine	
<i>Theoretical basis and application of following histochemical methods:</i>	8L
PAS /AB test for carbohydrates	
Fuelgen reaction for DNA	
Metallic and Azo dye methods for alkaline and acid phosphatase, adenosine tri-phosphatase	

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, Butterworth 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.** (1989). *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
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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, T_m 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.

<i>Techniques in molecular genetics</i>	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.	
<i>Mutation</i>	6L
Molecular basis Mutations in human Cystic fibrosis.	
<i>DNA repair and recombination</i>	6L
NER, PR, SOS, PRR and MMR Recombination nodule Cleavage and rejoining of DNA molecules Gene conversion.	
<i>Mitochondrial genome</i>	3L
Comparison between mt-genome and human genome; mt-DNA and limited autonomy of mt-genome.	
<i>Genomic imprinting</i>	5L
DNA methylation; genetic basis of human disease: Huntington's chorea.	
<i>Human genome project</i>	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.
- Brown, T. A.** (2002). *Genomes 2*. Wiley-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.
- 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.

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.

<i>Bioenergetics</i>	3L
Laws of thermodynamics and its relevance to biological systems.	
High-energy phosphate bonds and its role in energy capture and transfer	
<i>Proteins</i>	6L
Amino acid structure of protein	
Primary and higher orders of protein	
Protein folding	
Nitrogenase system	
<i>Enzymes</i>	4L
Classification and general properties	
Kinetics	
Mechanisms of enzyme action (chymotrypsin)	
Regulation of enzyme activities.	8L
<i>Carbohydrates</i>	
Carbohydrates of physiologic significance	
Metabolism	
Glycolysis & Krebs cycle: Pathway & regulation	
Oxidative metabolism: electron transport chain, oxidative phosphorylation	
Gluconeogenesis	
Hexose monophosphate Shunt	
<i>Lipids</i>	8L
Lipids of physiologic significance, membrane lipids, cholesterol	
Synthesis and Oxidation of fatty acids	
Ketogenesis	
<i>General topics</i>	6L
Integration of metabolic pathways	
Pumps and membrane channels	

Suggested readings:

- Berg, J. M., Tymoczko, J. K. & Stryer, L.** (2002). *Biochemistry*. 5th 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). *Lehinger'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.

<i>Concept, history and scope of toxicology</i>	2L
<i>Fundamentals of toxicology</i>	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)	
<i>Effects of toxic substances</i>	4L
Biochemical and physiological effects	
Interactive effects: additive effects, potentiation and synergism	
<i>Toxicity tests</i>	4L
Dose, dosage, dose response	
Acute toxicity tests: Bioassay, LC ₅₀ and LD ₅₀ , Probit analysis and Significance.	
Chronic toxicity tests: Methods, Significance.	
<i>Pesticides</i>	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.	
<i>Metal toxicity</i>	6L
Source, exposure, disposition and effects of heavy metals (Cd, Hg, Pb) and lighter elements (As, Se)	
Metal chelation	
<i>Applied toxicology</i>	4L
Clinical toxicology	
Forensic toxicology	

Suggested readings:

- De, A. K.** (2000). *Environmental chemistry*. 4th ed. New Age International (P) Ltd. Publishers.
- Klaassen, C. D.** (Ed.) (1996). *Casarett & Doull'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 vertebrate and invertebrate
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
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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 *Chironomus/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/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 LC₅₀ and LD₅₀
- b. Morphological deformities (study of symmetry) in biological organisms due to toxicant exposure.

3. Laboratory note book

4. Viva-voce

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 and diversity indices,

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*. Blackwell science. (4th ed).
- 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.
- 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., Ferrer, 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.
- 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*. 10thedn, 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.
- Mcclareen, 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., Ferrá, 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)

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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.

<i>Basic concepts: Homeostasis, Acclimatization and Adaptation</i>	2L
<i>Circulation</i>	8L
Blood cells: ultrastructure, pigments, and formation	
Hemostasis: platelet activation cascades, regulation	
Lymph: composition and dynamics	
<i>Respiration</i>	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.	
<i>Excretion & Osmoregulation</i>	8L
Mammalian kidney, Urea cycle, 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	
<i>Thermoregulation</i>	8L
Endothermy & Ectothermy	
Thermoregulatory organs, responses to high & low temperature	

Thermogenesis, Characteristics of fever	
Neural Control	
<i>Sensory</i>	8L
Neuron: types; synapse (excitatory and inhibitory post synaptic potential)	
Genesis of membrane potential	
Neurotransmitters (acetylcholine, GABA), chemical transmission through synapse	
<i>Hormones</i>	4L
General classes of hormones, concept of receptors	
Mechanisms of hormone action – second messenger, IP ₃ & DAG	
Neuroendocrine integration	
<i>Hypothalamic & Pituitary hormones</i>	6L
Hypothalamic hormones – structure & functions	
Hypophyseal hormones – structure & functions	
<i>Thyroid hormones</i>	5L
Biosynthesis & function of T ₃ /T ₄	
Role of thyroid hormones in metabolism	
<i>Pancreatic hormones</i>	5L
Structure & biosynthesis: insulin and glucagon	
Role of hormones in glucose metabolism	
<i>Adrenal hormones</i>	4L
Structure and functions of cortical hormones	
Structure and functions of medullary hormones	
<i>Reproductive hormones</i>	4L
Sex steroids: Structure, Source, Role and Receptors	

Suggested readings

- Bolandar, M.** (2001). *Molecular Endocrinology*. Elsevier Science.
- Ganong, W. F.** (2003). *Review of Medical physiology*. 21st ed. 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.
- 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.

<i>History and development of Microbiology</i>	2L
Contributions of Leeuwenhoek, Koch, Pasteur, Jenner and Flemming	
<i>Bacteria</i>	12L
Structure and function of capsule, pili, flagella, cell wall, cell membrane, outer membrane, reserve materials, cytoplasmic inclusions, plasmid and bacterial chromosome.	
<i>Bacterial endospore</i>	4L
Structure, properties, spore –formation and germination	
<i>Virus</i>	10L
Structural organization of viruses	
Prions and Viroids	
Lytic cycle of bacteriophages with reference to <i>E. coli</i> and T ₄	
Lysogeny, lysogenic conversion, induction and significance	
<i>Microbial genetics</i>	8L
Gene transfer in Bacteria: transformation, conjugation and transduction.	
Transcription and translation in <i>E. coli</i>	
Structure and life-cycle of λ Phage virus and control mechanism of lysogeny	
Auxotroph, Prototroph, Replica plating and Ames Test	
<i>Control of microorganisms</i>	6L
Physical and chemical agents, chemotherapeutic agents: sulfa drugs and antibiotics	
<i>General accounts of Mycoplasma, Actinomycetes and Rickettsias</i>	10L
<i>Medical Microbiology</i>	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)	
<i>Environmental Microbiology</i>	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.
- 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.
- 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.

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

Secondary interactions – Agglutination, precipitation.	
<i>Hypersensitivity reactions</i>	4L
<i>Vaccines and immunization</i>	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.
- 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

Unit – I: PHYSIOLOGY

Full Marks: 25

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
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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.

<i>General characters of Class Insecta, diversity and adaptive features of insect</i>	3L
<i>Outline classification up to orders with examples</i>	10L
<i>Structure of insect</i>	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	
<i>Internal organs</i>	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	
<i>Metamorphosis</i>	6L
Introduction – Types with examples	
Larva and pupa – structure and types	
<i>Insect behaviour</i>	4L
Feeding behaviour: types of feeding and damage, host range, specialisation, host selection	
Reproductive behaviour: mate location, mating frequency and oviposition	
<i>Social Insects</i>	8L
Life cycle and Social organization of termites, honeybees and ants	
<i>Sound production</i>	6L
Structure of the organs	
Mechanism of sound production	
Significance	
<i>Bioluminescence</i>	6L
Structure of organs	
Brief mechanism of light production	
Significance	

Suggested readings:

- Borror, D. J. & DeLong, D. M.** (1971). *An Introduction to the Study of insects*. 3rd ed. Holt, Rinehart Winston.
- Chapman, R. F.** (1998). *The Insects: Structure and Function*. 4th Ed. Cambridge University Press.
- 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*. 3 ed. Blackwell Publishing.
- 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.
- 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.
- Tembhare, D. B.** (1997). *Modern Entomology*. Himalaya Publishing House.

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.

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

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 edn. 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
- 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.

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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

<i>Classification of fishes</i>	15L
Principles of classification, extinct fish groups, Detailed study of major fish orders: Cypriniformes, Clupeiformes, Ophiocephaliformes, Perciformes, Mastacembeliformes.	
<i>Structure, development, comparative account and functions</i>	9L
Bioluminescent organ Poison gland Acoustico-lateralis system	
<i>Structure and functions</i>	10L
Digestive systems, olfactory organ and chemoreception, Osmoregulatory and Circulatory systems, Electric organs, Endocrine glands (Pituitary and Thyroid), Caudal neurosecretory organ	
<i>Reproduction and Development</i>	8L
Structure and functions of reproductive organs, Types of reproduction, Breeding and Parental care	
<i>Fish migration – types and regulation</i>	2L
Aquaculture	
<i>Inland fisheries</i>	6L
Pond management for carp culture, induced breeding of prawn and air breathing fishes, Composite culture of air breathing fishes	

<i>Shell fisheries</i>	6L
Edible oysters, chank fishery, pearl fishery	
<i>Ornamental fish culture and aquarium management.</i>	2L
<i>Fish biotechnology: Production of transgenic fish.</i>	2L
<i>Marine fisheries</i>	10L
Resources, Hilsa fishery, pomfrets and flat fishes	
Elasmobranch 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

<i>Morphology and Biology of the orders</i>	15L
Collembola, Orthoptera, Thysanoptera, Hemiptera, Siphonaptera, Lepidoptera, Coleoptera, Diptera, Strepsiptera & Hymenoptera	
<i>Integument</i>	8L
Structure and functions of cuticle	
Cuticular modifications	
Moulting	
<i>Head</i>	8L
Head segmentation and evolution	
Generalized Pterygote Head	
Modified Mouthparts (Orthopteroid, Hemipteroid and Neuropteroid)	
<i>Thorax</i>	8L
Generalized thoracic structure	
Structure and morphological variation of wing	
Appendages of thorax	
<i>Abdomen</i>	6L
Segmentation	
Skeletal composition	

<i>Vision</i>	10L
The dorsal ocelli	
The stemmata	
Structure of compound eye	
Formation of image	
<i>Perception</i>	10L
Chemoreception: structure of cuticular and contact receptors, distribution & functions	
Mechanoreception: Structure and functions of cuticular, cellular, proprioceptors. chordotonal and tympanal organs.	
<i>Exocrine glands</i>	5L
Important exocrine glands: origin, structure and functions	

Suggested readings:

- Atwal, A. S. & Dhaliwal, G. S.** (2002). *Agricultural pests of South Asia and their management*. Kalyani Publishers, New Delhi.
- 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.
- Hoy, M. A.** (2003). *Insect Molecular Genetics– An introduction to principles and Applications*. 2nd ed. Academic Press.
- Klowden, M.** (2002). *Physiological Systems in Insects*, 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.
- 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 tools 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	
<i>Molecular probes in diagnosis, epidemiology and taxonomy</i>	6L
General consideration and specific applications of DNA probes (Leishmaniasis, Malaria, Lymphatic filariasis).	
<i>Parasites and the immune system</i>	5L
Immunity and the immune response	
Evasion and suppression of the immune response.	
<i>Antigens of parasitic helminths</i>	4L
Protection and pathology	
Microbial Taxonomy	5L
Characters used in microbial taxonomy	
Classical and molecular taxonomy	
Species concept	
Bacteriology	15L
<i>Bacterial nutrition</i>	
Nutrition and nutritional types of bacteria	
Types of culture media: natural, synthetic, semi-synthetic and selective	
<i>Bacterial Growth</i>	
Phases of growth, Kinetics of growth, generation time	
Batch culture, continuous culture and synchronous culture	
Chemostat and turbidostat	
Pure culture techniques	
Preservation of bacteria.	
<i>Environmental factors influencing growth</i>	
Temperature, pH, salt concentration, oxygen, osmotic concentration.	
<i>Mode of transmission, pathogenicity and prevention of bacterial diseases</i>	
Anthrax, Tetanus, Diphtheria and Botulism	
Virology	15L
<i>Cultivation and assay of animal viruses</i>	
<i>Morphology, chemical composition and mode of reproduction</i>	
Herpes simplex virus, Poliovirus and HIV	
<i>Mode of transmission, pathogenicity and prevention of viral diseases</i>	
Common cold, Mumps, Measles and Rabies	
Applied Microbiology	10L
<i>Biofertilizers</i>	
<i>Bio-insecticides</i>	
<i>Bacillus thuringiensis,</i>	
<i>Bacillus sphaericus</i>	
Nuclear polyhedrosis virus	
<i>Bioremediation</i>	
<i>Industrial production</i>	
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 edn. 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.
- Schlegel, H.G.** (1993). **General Microbiology** .7th ed. Cambridge University Sons, New York.
- Stanier, R. Y., Adelberg, E. A. & Ingraham, J. L.** (1986). *General Microbiology*.
- Talaro, K. and 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

<i>Inland fisheries resources in India and their principal species.</i>	4L
Food fishes and their economic importance	18L
Indian Major carps: <i>Catla catla</i> , <i>Labeo rohita</i> , <i>Cirrhinus mrigala</i>	
Exotic carps: <i>Hypophthalmichthys molitrix</i> , <i>Ctenopharyngodon idella</i> , <i>Cyprinus carpio</i>	
Cat fishes : <i>Clarias batrachus</i> , <i>Heteropneustes fossilis</i>	
Other groups: <i>Anabas testudineus</i> , <i>Channa striatus</i> , <i>Etrophus suratensis</i>	
<i>Fish culture practices</i>	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.	
<i>Fish breeding</i>	14L
Neuro-endocrine control of fish reproduction	
Induced breeding in carps and catfishes	
Ecological requirements for induced breeding	
<i>Hybridization and genetic manipulation</i>	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.

<i>Evolution of the biosphere/ecosphere</i>	5L
The biosphere, climate and vegetation, stability of the atmosphere, cybernetic nature and stability in the ecosystem, environmental perspectives and human development	
<i>Physical aspects of the environment</i>	8L
Lotic and lentic environments, marine biota and zonations, estuarine biota and productivity, terrestrial biota, soil sub-systems, vegetational sub-system	
<i>Concept of productivity</i>	6L
Biomass, Primary and secondary productivity patterns, trophic structure and ecological pyramids, ecological efficiencies	
<i>Populations in communities</i>	8L
Species diversity, similarities and divergence, ecological guild, ecotone and edge effect, interspecific competition and co-existence, diversity indices, ecotypes, keystone species	
<i>Behavioural ecology</i>	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	
<i>Development and evolution of ecosystem</i>	8L
Ecosystem development, concept of climax, micro-evolution	

and macro-evolution, co-evolution	
<i>Chemical ecology and adaptations</i>	10L
Feeding preferences, biochemical basis for food plant selection by insects; feeding attractants, feedings deterrents, ovipositor 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	
<i>Ecological energetics</i>	7L
The entropy law, energy transfer across trophic links, energy budget, chemolithoautotrophs and hydrothermal vents	
<i>Biogeochemistry and reactions</i>	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*. W. W. Norton & 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.** (2002). *Concepts of Ecology*. 4th ed. (2007, 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 Belknap Press of Harvard University Press.

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.
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PSZ: 306

SPECIAL PAPER PRACTICAL: ECOLOGY & ENVIRONMENT

Time 5 hrs.

Full Marks: 50

1. 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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SEMESTER IV

TSZ: 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 (<i>Dictyostelium</i> , <i>C.elegans</i> , <i>Drosophila</i> & Chick)	
<i>Gametogenesis</i>	4L
Spermatogenesis: phases, cellular changes	
Oogenesis: types, stages, ooteleosis & luteinization	
<i>Fertilization in mammals</i>	3L
Recognition of gametes and acrosomal reaction	
Gamete fusion	
Activation of egg	
<i>Cleavage</i>	2L
Mechanism: molecular aspects	
<i>Gastrulation</i>	5L
Cell lineages	
Gastrulation in vertebrate embryos	
Formation of germ layers in amphibia and birds	
Induction, Determination and Differentiation	
<i>Pattern formation</i>	4L
Anterior-Posterior & Dorsal- Ventral polarity in <i>Drosophila</i> ;	
Molecular control of segmentation and homeotic genes.	
Gap genes, HOX genes in vertebrate, Niuekwoop center & ventral organizer	
Neurogenesis and Neural tube in vertebrates	
<i>General Topics</i>	9L
Mesoderm induction & patterning	
Regeneration	
<i>In vitro</i> fertilization in human	
Embryonic stem cell & their application	

Suggested readings

- Arias, A. M. & Stewart, A.** (2002). *Molecular Principles 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.
Shostak, S. (1991). *Embryology – An Introduction to Developmental Biology*. Harper
Collins.
Slack, J. M. W. (2006). *Essential Developmental Biology*. 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.
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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.

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.

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

<i>Digestive system</i>	10L
The alimentary canal	
The salivary glands	
Mechanism of digestion	
Micro-organisms and their role in digestion	
Nutritional requirements	
<i>Respiratory system</i>	10L
Structure of respiratory organs	
Mechanism of gaseous exchange	
Aquatic respiratory organs	
Physiology of gill and plastron respiration	
<i>Excretory system</i>	10L
Types of excretory systems	
Organs of excretion	
Accessory organs of excretion	
Physiology of excretion	
Composition of insect urine	
Vitamins in Malpighian tubules	
<i>Nervous system</i>	6L
The neurons	
The central nervous system	
The brain	
The Sympathetic nervous system	
<i>Reproduction</i>	10L
Male and Female reproductive system	
Special types of reproduction	
Factors controlling fecundity and fertility	
Swarming and oviposition	
Egg maturation	
<i>Development</i>	8L
The insect egg	
Embryonic development and dynamics	
Post-embryonic development and metamorphosis	
<i>Endocrine system</i>	8L
Anatomical organization	
Structure and hormones	
Endocrine control of metamorphosis, diapause	
<i>Gall formation</i>	8L

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

Suggested readings:

- Atwal, A.S. & Dhaliwal, G. S.** (2002). *Agricultural pests of South Asia and their management*. Kalyani Publishers, New Delhi. Blackwell Publishing.
- 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.
- Hoy, M. A.** (1994). *Insect Molecular Genetics– An introduction to principles and Applications*. Academic Press.
- Klowden.** (2002). *Physiological Systems in Insects*, Academic Press.
- Pedigo, L.P. & Rice E. M.** (2009). *Entomology and Pest Management*. Pearson/Prentice Hall.
- 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.)

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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

<i>Microenvironment and the phases of parasitism</i>	10L
The vertebrate alimentary canal, blood, tissues and the other habitats	
<i>Parasite host specificity</i>	5L
<i>Protozoan Parasites</i>	
Origin and evolution of parasitic protozoa	5L
Haemoflagellates	20L
General morphology and morphological stages	
Life cycle and pathogenicity of <i>Trypanosoma brucei gambiense</i>	
Physiology and biochemistry of Haemoflagellates	
Apicomplexa	20L

Ultrastructure of apical complex Biology and pathogenicity of <i>Toxoplasma gondii</i> General biology, Characteristic of species and Indian vectors of <i>Plasmodium</i> ; Immunopathology associated with malaria; Biochemistry and physiology of <i>Plasmodium</i> and <i>Babesia</i>	10L
Ciliophora General morphology with special reference to parasitic forms; Structure, Life cycle and pathogenicity of <i>Balantidium coli</i>	

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. & Oltmann, 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

<i>Aquaculture hazards</i>	12L
Common diseases of fish: Causative organisms, effects, control	
Shrimp diseases and treatment	
Pollution: sources, effects and control.	
<i>Present status of brackish water fish farming in India</i>	8L
Mixed culture of brackish water fish species	
Estuarine fisheries	
<i>Spoilage of fresh water and brackish water fishes</i>	8L
Aminoacid changes	
Breakdown products indicative of spoilage	
Other substances	
<i>Development strategies</i>	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 & Hall, 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

Time: 2 hrs.

Full Marks: 45

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

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.

<i>Stresses on ecosystem structure and function</i>	8L
Advent of stress, long-term chronic stress, alleviation of stress;	
biological indicators and their use in monitoring pollution;	
bioaccumulation and biomagnifications	
<i>Ecotoxicology</i>	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	
<i>Air pollution</i>	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	
<i>Water, soil and noise pollution</i>	10L
Types, sources, characteristics, effects and control	
<i>Waste disposal & Treatments</i>	10L
Solid waste disposal; sewage disposal and treatments; toxic wastes and their disposal	
<i>Radiation and warfare ecology</i>	10L
Nuclear concepts, impacts of nuclear warfare and radiation effects at the ecosystem level, fallout problems, destruction of conventional warfare	
<i>Urbanization ecology</i>	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.) WileyBlackwell.
- 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: 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

<i>Crop Husbandry</i>	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	
<i>Control/Management of insect pests</i>	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

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

5L

Forensic Entomology

Insects associated with the corpses and carrions
 Forensic entomological techniques

5L

Industrial Entomology

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

10L

Medical Entomology

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

10L

Insect molecular genetics

Insect genome organization
 Transgenic pest and application

10L

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 Publishing.
- 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.** (1994). *Insect Molecular Genetics– An introduction to principles and Applications*. Academic Press.
- Ignacimuthu, S. & Jayraj, S.** (Eds.) (2007). *Biotechnonology 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.
- Metcalf, R. L. & Luckmann, W. H.** (1994). *Introduction to Insect Pest Management*. 3rd Ed. John Wiley & Sons, Inc.
- 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.
- Rechcigl J. E. & Rechcigl, N. A.** (1998). *Biological and Biotechnological control of Insect pests*. Lewis Publishers.
- Srivastava, K. P.** (1988). *A textbook of Applied Entomology*. Vol. II 2nd ed. Kalyani Publishers, New Delhi.

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

<i>General organization and outline classification of Platyhelminthes, Nematoda and Acanthocephala with reference to parasitic forms</i>	4L
<i>Origin and evolution of Parasitic helminths</i>	4L
<i>Structure and Composition of cuticle in helminths.</i>	5L
<i>Structure of Scolex in Cestodes</i>	4L
<i>Reproductive system, mating behavior, fertilization and egg formation in helminths</i>	3L
<i>Larval development and patterns of life cycle in Digenea, Cestoda and Nematoda.</i>	7L
<i>Carbohydrate, protein and lipid metabolism in Nematoda</i>	5L
<i>Biology, Pathogenicity and Control:</i>	10L
<i>Opisthorchis sinensis, Diphyllbothrium latum, Echinococcus granulosus, Loa loa.</i>	
<i>Gastrointestinal nematode infection in man and ruminants and their antihelminthic treatment.</i>	4L
<i>Human lymphatic filariasis and its transmission dynamics.</i>	3L
<i>Zoonoses in nematodes and cestodes.</i>	4L
<i>General organization and life cycles in Acanthocephala</i>	4L

Vector Biology :

<i>Biology, importance and control:</i>	12L
<i>Chrysops, Tse-tse fly, Fleas, Lice and mosquitoes (Aedes and Culex)</i>	

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

<i>General survey of marine fisheries in India</i>	4L
<i>Marine biology and oceanography in relation to fisheries</i>	6L
<i>Principal marine fisheries and exploited species</i>	14L
Oil sardine and lesser sardines, Indian Mackerel, Bombay duck, Pomfrets, Prawns, Molluscs	
<i>Fishing crafts and Gears</i>	4L
Types of Indigenous crafts and gears, designing Modernization of craft, Preservation	
<i>Life in sea</i>	5L
Phytoplankton, Zooplankton Nekton and fisheries	
<i>Fluctuation in marine fisheries</i>	4L
Causes of fluctuation, Over fishing problem Rational exploitation of fisheries	
<i>Preservation and processing</i>	5L
Chemical composition of fish Drying and salting, Chilling and freezing, Smoking and canning	
<i>Mariculture</i>	8L
Cultivable fin-fishes, Cultivable crustaceans, Cultivable mollusca	
<i>Fish in human nutrition</i>	10L
Nutritive value of fish protein,	

Fish oils, fatty acids and nutrition	
Fish as a source of mineral, Fish as a source of vitamins	
<i>Fish by-products, Marketing of fish and aquaculture products</i>	6L
<i>Conservation of marine environment through establishing National marine reserves</i>	4L

Suggested readings:

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

<i>Population ecology</i>	9L
Intrinsic rate of natural increase, 'r' and 'k' selections, life-history traits and tactics, human demography, dynamics of metapopulations	
<i>Resources</i>	8L
Renewable and non-renewable resources, fossil fuel, nuclear fuels, biogas, solar energy, food production trends, agriculture and forestry	
<i>Conservation and management</i>	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	
<i>Environmental policy</i>	9L
Social forestry, economic and legal aspects, enforcement of anti-pollution laws, environment awareness - role of government, media and voluntary groups, Green Bench	
<i>Man-environment interaction</i>	9L
Global population size, management of energy utilization, public health, human right, animal rights and human wrongs, important movements on environmental issues	
<i>Environmental health and Ecological Economics</i>	
Environmental health hazards and laws, capital and reserves, Population, technology and scarcity, natural resources accounting, trade development and jobs, green designs and the environment	
<i>Systems analysis and modeling in ecology</i>	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., Ferrá, C., Medori, P. & Devaux, J.** (2001). *Ecology- Science and*
- 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.
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Term Paper /Project Work (based on special paper)
(Paper submission – 30; Seminar presentation-15; Discussion -5)

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 <i>Hydra</i> | |
| 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
 - b. 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 LC₅₀ 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
 2. Submission of collected endopterygote insects (Holometabolans)
 3. 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
-
-

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-calorimetry - 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
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