

ZOOLOGY- Syllabus-2015

Semester	Paper	Paper Code No	
Semester – I	Paper-I : (Theory) Paper-I (Practical)	ZOOELH-101 ZOOELH- 101 (P)	75 25
Semester – II	Paper-II : (Theory) Paper-II : (Practical)	ZOOELH-201 ZOOELH-201(P)	75 25
Semester – III	Paper-III (Theory) Paper (Practical)	ZOOELH-301 ZOOELH-301(P)	75 25
Semester – IV	Paper-IV : (Theory) Paper IV : (Practical)	ZOOELH-401 ZOOELH-401(P)	75 25
Semester – V	Paper-V : (Theory) Paper V (Practical) Paper VI : (Theory) Paper :VI (Practical)	ZOOH-501 ZOOH-501(P) ZOOH-502 ZOOH-502(P)	75 25 75 25
Semester – VI	Paper-VII (Theory) Paper-VII : (Practical) Paper-VIII. (Theory) Paper VIII: (Practical)	ZOOH-601 ZOOH-601(P) ZOOH-602 ZOOH-602(P)	75 25 75 25

DEPARTMENT OF ZOOLOGY  
- SAC - 25-04-2015

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Department of Zoology  
North-Eastern Hill University, Shillong

B. Sc. Zoology (Honours)  
Syllabus  
(Under Semester System)  
2014

Year	Semester	Title	Paper No. & Marks	Papers	Paper-wise Marks
First Year	1 <sup>st</sup> Semester	Systematics, Animal Diversity and Evolution	Paper 1 100 Marks (4 Credits)	Paper 1A (Theory) Paper 1B (Practical)	75 25
	2 <sup>nd</sup> Semester	Cell Biology and Genetics	Paper 2 100 Marks (4 Credits)	Paper 2A (Theory) Paper 2B (Practical)	75 25
Second Year	3 <sup>rd</sup> Semester	Animal Physiology; Endocrinology and Biochemistry	Paper 3 100 Marks (4 Credits)	Paper 3A (Theory) Paper 3B (Practical)	75 25
	4 <sup>th</sup> Semester	Developmental Biology, Ecology and Economic Zoology	Paper 4 100 Marks (4 Credits)	Paper 4A (Theory) Paper 4B (Practical)	75 25
Third Year	5 <sup>th</sup> Semester	Functional Anatomy, Zoogeography and Adaptations	Paper 5 100 Marks (4 Credits)	Paper 5A (Theory) Paper 5B (Practical)	75 25
		Cell and Molecular Biology, and Genetics	Paper 6 100 Marks (4 Credits)	Paper 6A (Theory) Paper 6B (Practical)	75 25
	6 <sup>th</sup> Semester	Biochemistry, Animal Physiology and Endocrinology	Paper 7 100 Marks (4 Credits)	Paper 7A (Theory) Paper 7B (Practical)	75 25
		Developmental Biology, Environmental Biology and Biotechnology	Paper 8 100 Marks (4 Credits)	Paper 8A (Theory) Paper 8B (Practical)	75 25
Total Marks			800 Marks (32 Credits)		800 Marks (32 Credits)

Maria  
24/11/2015

Paper 1A

Systematics, Animal Diversity and Evolution (Theory)

Marks: 75  
Time: 3 Hours

- Unit-I:** Systematics: Definition; Taxonomic hierarchy; Binomial nomenclature; Six-kingdom classification (Bacteria, Protozoa, Fungi, Plantae, Animalia and Chromista); Classification, salient characteristics and examples of Non-chordates (Kingdom Protozoa up to phyla, other major phyla up to classes) and Chordates (up to classes); Introduction to minor phyla.
- Unit-2:** Protozoa: *Paramecium* - Morphology and reproduction; Life cycle and pathogenicity of *Entamoeba histolytica* and *Plasmodium vivax*.  
Porifera: *Sycon* - Skeletal and canal systems.  
Coelenterata: *Obelia* - Morphology and reproduction.  
Helminthes: *Ascaris lumbricoides* - Morphology, life cycle and pathogenicity.
- Unit -3:** Annelida: Leech - Morphology; digestive and urinogenital systems.  
Arthropoda: Cockroach - Morphology; Digestive, respiratory, excretory and reproductive systems.  
Mollusca: *Pila* - Morphology; digestive, respiratory and nervous systems.  
Echinodermata: *Asterias* - Morphology and water vascular system.
- Unit - 4:** Hemichordata: Salient features of *Balanoglossus*.  
Protochordata: Salient features of *Amphioxus*.  
*Petromyzon* - Morphology, Respiratory and reproductive systems.  
Pisces: *Labeo* - Morphology, digestive and respiratory systems.  
Rabbit - Type study (morphology; digestive, respiratory, circulatory, urinogenital and nervous systems).
- Unit - 5:** Origin of life; Theories of evolution: Lamarckism, Darwinism and Synthetic theory; Evidences of evolution - anatomical, embryological and paleontological; Geological time scale; Introduction to Evolution of man.

Suggested Readings:

1. Ghosh, K. C. and Manna, B. (2004). Fundamentals of Zoology. New Central Book Agency. Kolkata.
2. Hall, B.K. and Hallgrimsson, B. (2008), Strickberger's Evolution, 4<sup>th</sup> Edition. Jones and Bartlett Publishers.
3. Jordan, E. L. and Verma, P. S. (1993). Chordate Zoology. S. Chand Company Ltd.
4. Jordan, E. L. and Verma, P. S. (1992). Invertebrate Zoology. S. Chand Company Ltd.
5. Kotpal, R. L. (2012). Modern Textbook of Zoology: Invertebrates. R. K. Rastogi Publications.
6. Kotpal, R. L. (2012). Modern Textbook of Zoology: Vertebrates. R. K. Rastogi Publications.
7. Mayer, E. (1980). Principles of Systematic Zoology. Addison-Wesley Publishing Company, Inc.
8. ~~Mayr, E. and Ashlock (1991), Principles of Systematic Zoology, 2<sup>nd</sup> Edition. McGraw Hill and Company.~~
9. Minelli, A. (1993). Biological Systematics. Chapman & Hall.
10. Pough, F.H., Janis, C.M. and Heiser, J. B. (2012). Vertebrate Life, 9<sup>th</sup> Edition. Pearson Benjamin Cummings.
11. Raven, P. H. (2005). Biology. McGraw Hill Education Ltd.
12. Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V. and Jackson, R.V. (2011). Campbell Biology. Pearson Benjamin Cummings.
13. Ruppert, E. E., Fox, R. S. and Barnes, R. D. (2006). Invertebrate Zoology: A Functional Evolutionary Approach, 7<sup>th</sup> Edition. Cengage Learning India.
14. Sadava, D., Hillis, D. M., Heller, H. C. and Berenbaum, M.R. (2011). Life: The Science of Biology, 9<sup>th</sup> Edition. Sinauer Associates Inc. Publishers.

15. Sinha, A.K., Adhikari, S. and Ganguly, B. B. (2012). Biology of Animals, Vol. I & II. New Central Book Agency. Kolkata.
16. Sinha, A.K., Adhikari, S. and Ganguly, B. B. (2012). Fundamentals of Biology, New Central Book Agency, Kolkata.
17. Young, J. Z. (2004). Life of Vertebrates, 3<sup>rd</sup> Edition, Oxford University Press.

### Paper 1B (Practical)

#### Systematics, Animal Diversity and Evolution

Marks: 25

Time: 4 Hours

#### A. Dissections:

1. Nervous system of cockroach.
2. Reproductive system of cockroach. ✓✓
3. Digestive system of *Channa/Labeo/common carp*.
4. Afferent brancial system of *Channa/Labeo/common carp*.
5. Demonstration of dissections of arterial, digestive and urinogenital systems of albino rat/albino mouse/chicken.

#### B. Mounting:

1. General protocol for preparation of permanent microscopic slides: Basic concepts of fixation, staining, dehydration, clearing and mounting.
2. Permanent stained preparations of the following:
  - i) *Paramecium/Euglena* (whole mount)
  - ii) *Obelia* Colony
  - iii) Parapodium of *Nereis*
  - iv) Gemmules of sponge (whole mount)
  - v) Blood film of a vertebrate (single stain)

#### C. Osteology - Mammalia:

1. Vertebrae
2. Limb bones and girdles
3. Skull

#### D. Study of Prepared Slides:

1. T/S of Earthworm through typhlosolar region.
2. T/S of male and female *Ascaris*
3. T/S of *Amphioxus* through branchial region
4. T/S of stomach, intestine, liver, pancreas, lung, kidney and gonads of a vertebrate.

#### E. Study of Museum Specimens:

1. Representatives from Non-chordates and Chordates.
2. Study of fossils.
3. Evidences of evolution through chart and models.

4 ✓

Distribution of Marks

1. Dissection
2. Mounting
3. Spotting
  - a) Museum specimens
  - b) Osteology
  - c) Prepared slides
4. Laboratory Record

Total

(25) (Internal test - 7 + End semester test - (18))

Paper 2A

Cell Biology and Genetics (Theory)

Marks: 75

Time: 3 Hours

- Unit-1:** Prokaryotic and eukaryotic cells. Ultrastructure and function of plasma membrane, mitochondria, endoplasmic reticulum, Golgi complex, ribosomes, centrioles and lysosomes. Cytoskeleton: Introduction to microtubules and microfilaments.
- Unit-2:** Nuclear envelope and nucleolus. Chromatin: Chemical composition and organization of Euchromatin and heterochromatin; Chromosome: Morphology, primary constriction, secondary constriction, and satellite bodies; Classification on the basis of position of centromere; Polytene and lampbrush chromosomes.
- Unit-3:** Cell cycle: Phases and regulation; Mitosis, meiosis, synaptonemal complex. Cancer: Characteristics of cancer cells, classification according to tissue types; Common carcinogens. Immunity: innate and acquired; Active and passive immunity; cells and organs of immune system.
- Unit-4:** Mendel's experiments and principles of inheritance; Concept of genotype, phenotype, dominance, recessiveness, co-dominance and incomplete dominance; Back cross and Test cross. Chromosomal theory of inheritance; Multiple alleles (ABO blood groups in man); Gene interactions: Complementary, supplementary, inhibitory and duplicate types; Pleiotropic genes and lethal genes (Tay Sachs disease and sickle cell anemia).
- Unit - 5:** Linkage and crossing over. Sex determination: Chromosomal and genic balance theories, environmental factors. Chromosomal aberrations: Structural (deletion, duplication, inversion and translocation) and numerical (euploidy and aneuploidy).

**Suggested Readings:**

1. Albert, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (2007). Molecular Biology of the Cell, 5<sup>th</sup> Edition. Garland Publishing, London.
2. Bruce, A., Dennis, B., Karen, H., Alexander, J., Julian, L., Martin, R., Keith, R. and Peter W. (2009). Essential Cell Biology, 3<sup>rd</sup> Edition. Garland Publishing, London.
3. De Robertis, E. D. P. and De Robertis, L. M. F. (1987). Cell and Molecular Biology, 8<sup>th</sup> Edition. Lea and Febiger International Edition.
4. Gardener, E. J., Simmons, M. J. and Snustad, D. P. (2005). Principles of Genetics, 8<sup>th</sup> Edition. John Wiley and Sons.

5. Hardin, J., Bertoni, G. P. and Kleinsmith, L. J. (2012). Becker's World of the Cell. 8<sup>th</sup> Edition. Pearson, Benjamin Cummings.
6. Karp, G. (2010). Cell Biology, 6<sup>th</sup> Edition, John Wiley & Sons, Inc.
7. Klug, Cummings, Spencer and Palladino (2012). Concepts of Genetics, 10<sup>th</sup> Edition. Benjamin Cummings.
8. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott. M. P. (2012). Molecular Cell Biology, 7<sup>th</sup> Edition. W.H. Freeman.
9. Pierce, B. (2012.). Genetics: A Conceptual Approach, 4<sup>th</sup> Edition. W.H. Freeman.
10. Strickberger, M. W. (2006). Genetics, 3<sup>rd</sup> Edition. Macmillan Publishing Company.

### Paper 2B (Practical)

#### Cell Biology and Genetics

Marks: 25

Time: 4 Hours

- Tue ✓ 1. Study of cell organelles from slides/models/charts. ✓ (1 class) + (TUE, THU)
- THU ✓ 2. Preparation and study of different stages of mitosis in onion root tip. (MON, WED)
3. Preparation (demonstration only) and study of different stages of meiosis from grasshopper testis using permanent slides. (MON, WED)
4. Study of chromosome types from slides/photographs. ✓ (TUE, THU)
5. Preparation and study of polytene chromosomes from *Chironomus* larva. (MON, WED)
6. Study of phenotypic variations in a natural population (at least 3 characters). (MON, WED)
7. Determination and study of multiple alleles (ABO blood groups) and Rh factor. (MON, WED)

#### Distribution of Marks

1. Cell Biology
2. Genetics
3. Spotting
4. Viva Voce
5. Laboratory Record

Total

25 (Internal test - 7 + End semester test - 18)

### Paper 3A

#### Animal Physiology, Endocrinology and Biochemistry (Theory)

Marks: 75

Time: 3 Hours

- Unit-1:** Physiology of digestion and absorption of carbohydrates, proteins and lipids; Vitamins: Types, sources and their significance. Respiration: Breathing and gaseous exchange in vertebrate lung. Composition and functions of blood; Types of heart in vertebrates; Structure of mammalian heart.
- Unit-2:** Structure of mammalian kidney and nephron; Physiology of urine formation. Ultrastructure of skeletal muscle; Mechanism of skeletal muscle contraction. Ultrastructure of neuron; Nerve impulse conduction and synaptic transmission; Reflex action.

- Unit-3:** Structure and functions of major endocrine glands: Hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, testis and ovary. Introduction to neuroendocrine system in insects.
- Unit-4:** Classification and significance of carbohydrates, proteins and lipids. Amino acids: Essential and non-essential. Glycolysis and TCA cycle;  $\beta$ -Oxidation of fatty acids.
- Unit-5:** Enzymes: Properties, classification and nomenclature; Active site and mechanism of enzyme action; Factors affecting enzyme activity; Co-factors and co-enzymes. Nucleic acids: Nucleosides, nucleotides and polynucleotides; Double helical structure of DNA and structure of RNA.

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**Suggested Readings:**

1. Berg, J., Tymoczko, J., and Stryer, L. (2012). Biochemistry, 7<sup>th</sup> Edition, W. H. Freeman.
2. Campbell, M. K. and Farrell, S. O. (2010). Introduction to Biochemistry. Cengage Learning India.
3. Hadley, M. E. & Levine (2007). Endocrinology, 6<sup>th</sup> Edition. Pearson, Benjamin Cummings.
4. Hall, J. E., (2011). Guyton and Hall Textbook of Medical Physiology, 12<sup>th</sup> Edition (Indian print). Saunders, Elsevier Inc.
5. Hill, R. W., Wyse, G. A. and Anderson, M. (2012). Animal Physiology, 3<sup>rd</sup> Edition, Sinauer Associates Inc.
6. Melmed, S., Polonsky, K. S., Larsen, P. R., and Kronenberg, H. M., (2011). William's Textbook of Endocrinology, 12<sup>th</sup> Edition. Saunders.
7. Murray, R. K. *et al.*, (2011). Harper's Illustrated Biochemistry, 29<sup>th</sup> Edition. McGraw Hill, Lange Publication.
8. Nelson, D. L. and Cox, M. (2012). Lehninger Principles of Biochemistry, 6<sup>th</sup> Edition, W. H. Freeman.
9. Norman, A. W. and Litwack, G. (1997). Hormones, 2<sup>nd</sup> Edition, Academic Press, Elsevier Inc.
10. Norris, D. O. (2007). Vertebrate endocrinology. 6<sup>th</sup> Edition. Academic Press, Elsevier Inc.
11. Prosser, C. L. (1991). Comparative Animal Physiology. W. B. Saunders & Company.
12. Randall, D. and Burggren, W. (2001). Eckert Animal Physiology, 5<sup>th</sup> Edition. W.H. Freeman.
13. Schmidt-Nielsen, K. (2002). Animal Physiology: Adaptation and Environment. Cambridge University Press.
14. Sherwood, L., Klandorf, H., and Yanchey, P. (2010). Textbook of Animal Physiology. Cengage Learning.

**Paper 3B (Practical)****Animal Physiology, Endocrinology and Biochemistry**

Marks: 25

Time: 4 Hours

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1. Preparation of haemin crystals from human blood.
  2. Determination of clotting time of human blood.
  3. Oxygen consumption in fish with reference to body weight.
  4. Study of histology of endocrine glands from permanent slides (pituitary, thyroid, thymus, pancreas, adrenal, testis and ovary).
  5. Detection of carbohydrates, lipids and proteins (at least 3 tests each).
  6. Estimation of ascorbic acid by titration method.

### Distribution of Marks

1. Physiology
2. Biochemistry
3. Spotting
4. *Viva Voce*
5. Laboratory Record

Total 25 (Internal test – 7 + End semester test - 18)

### Paper 4A

#### Developmental Biology, Ecology and Economic Zoology (Theory)

Marks: 75  
Time: 3 Hours

- Unit-1:** Gametogenesis: Spermatogenesis and oogenesis; Fertilization; Partheno-genesis. Types of eggs; Cleavage and types of cleavage; Process of blastulation, fate map and Gastrulation in frog up to the formation of three germinal layers; Metamorphosis in insects and frog.
- Unit-2:** Ecology: Concepts, subdivisions, scope and importance; Levels of organization in the biosphere. Structure of ecosystem - Ecological factors (biotic and abiotic); Trophic structure: Food chains, food webs and energy flow; Trophic relationships – ecological pyramids. Productivity.
- Unit 3:** — Ecological niche. Population: Growth and regulation. Concepts of biotic community. Inter and intraspecific interactions. Resources (renewable and non-renewable) and their management. Environmental pollution (air, water and soil).
- Unit 4:** Pisciculture: Culturable fish species of India; Culture and management of fish with reference to composite fish culture; Induced breeding. Sericulture: Different species of silk moth; Life history of *Bombyx mori* and methods of culture; Product of sericulture and its economic importance.
- Unit 5:** Apiculture: Species of honey bees; Life history and social organization; Methods of bee keeping, economic importance? Integrated pest management (physical, chemical, hormonal and biological).

#### Suggested Readings:

1. Ayyar, T. V. R. (1984). Handbook of Economic Entomology. International Books and Periodical Supply Service.
2. Balinsky, B. I. (1981). An Introduction to Embryology, 5<sup>th</sup> Edition. Saunders College Publishing, Holt-Saunders.
3. Beeby, A. and Brennan, M. A. (2008), First Ecology - Ecological Principles and Environmental Issues, 3<sup>rd</sup> Edition. Oxford University Press, India.
4. Cain, M. L., Bowman, W. D. and Hacker, S. D. (2011). Ecology, 2<sup>nd</sup> Edition. Sinauer Associates, Inc. Publishers.
5. Carlson, B. M. (2006). Foundations of Embryology. McGraw Hill Education (India) Ltd.
6. Gilbert, S. F. (2010). Developmental Biology, 9<sup>th</sup> Edition. Sinauer Associates, Inc. Publishers
7. Gupta, S. K. and Gupta, P. C. (2003). General and applied Ichthyology (Fish & Fisheries). S. Chand & Co.

8. Kalthoff, K. (2000). Analysis of Biological Development, 2<sup>nd</sup> Edition. McGraw-Hill Professional.
9. Kendeigh, F. C. (1984). Ecology with Special Reference to Animal and Man. Prentice Hall Inc.
10. Kormondy, E. J. (1996). Concepts of Ecology, 4<sup>th</sup> Edition. Prentice Hall of India Pvt. Ltd.
11. Little, V. A. (1972). General and Applied Entomology, 3<sup>rd</sup> Edition. Oxford and I. B. H. Publishing Co.
12. Odum, E. P. & Barrett, G. W. (2006). Fundamentals of Ecology. 5<sup>th</sup> Edition. Cengage Learning India.
13. Odum, E. P. (1971). Fundamentals of Ecology, 3<sup>rd</sup> Edition. W. B. Saunders Company.
14. Ricklefs, R. E. (2010). Economy of Nature, 6<sup>th</sup> Edition. W.H. Freeman.
15. Sharma, P. D. (1990). Ecology and Environment, 7<sup>th</sup> Edition. Rastogi Publications.
16. Shukla, G. S. and Upadhyay (2003). Economic Zoology, 4<sup>th</sup> Edition. Rastogi Publications.
17. Stiling, P. D. (2012). Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.
18. Wolpert, L. and Tickle, C. (2011). Principles of Development, 4<sup>th</sup> Edition. Oxford University Press.

### Paper 4B (Practical)

#### Developmental Biology, Ecology and Economic Zoology

Marks: 25  
Time: 4 Hours

1. Study of the types of eggs in vertebrates. ✓
2. Study of larval forms (crustacean, molluscan and echinoderm) from permanent slides. ✓
3. Study of the stages of development of frog from permanent slides in whole mount/sections (cleavage, blastula and gastrula). ✓
4. Preparation of permanent slides of non-chordate larval forms (Mysis, Nauplius, mosquito larva). ✓
5. Study of metamorphosis in Amphibia (using Charts/Models). ✓
6. Estimation of dissolved oxygen in water samples. ✓
7. Estimation of carbon dioxide in water samples. ✓
8. Estimation of total alkalinity in water samples. ✓
9. Qualitative study of plankton from fresh water samples. ✓
10. Study of the life cycle of silk moth. ✓
11. Study of different castes of honey bee. ✓
12. Identification of Indian major carps and common exotic carps. ✓

#### Distribution of Marks

1. Developmental Biology
2. Ecology
3. Spotting (slides/charts/models)
4. *Viva Voce*
5. Laboratory Record

Total 25 (Internal test - 7 + End semester test - 18)

## Paper 5A

## Functional Anatomy, Zoogeography and Adaptations (Theory)

Marks: 75  
Time: 3 Hours

- Unit - 1:** Protozoa: Locomotion and nutrition.  
Porifera: Canal and skeletal systems.  
Cnidaria: Polymorphism in *Siphonophora*; Corals and coral reefs.  
Morphological and physiological adaptations of parasitic helminthes.  
Annelida: Excretory system.
- Unit - 2:** Onychophora: General organization and affinities.  
Arthropoda: Types of mouth parts and feeding in insects; Vision in insects.  
Mollusca: Torsion and detorsion in Gastropoda.  
Echinodermata: Comparative study of water vascular system.
- Unit - 3:** Hemichordata: Affinities of *Balanoglossus*.  
Protochordata: Affinities of *Amphioxus*.  
Retrogressive metamorphosis in *Ascidia*.  
Agnatha: Comparative study of *Petromyzon* and *Myxine*.  
Pisces: Scales and fins in fishes; Accessory respiratory organs; Migration of fishes.  
Dipnoi: General characters and affinities.
- Unit - 4:** Amphibia: Parental care.  
Reptilia: Poisonous and nonpoisonous snakes; Poison apparatus and mechanism of biting.  
Aves: Flight adaptations and migration in birds.  
Mammalia: Affinities of Monotremata and Marsupialia; Dentition.  
Comparative anatomy of kidney in vertebrates.
- Unit - 5:** Zoogeography: Concepts and Zoogeographic realms. Patterns and regulation of behaviour: genetic and hormonal; Colouration and mimicry.  
Adaptations in vertebrates: Aquatic, desert, arboreal, cursorial and deep sea adaptations.

## Suggested Readings:

1. Agarwal, V. K. (2010). Animal Behaviour (Ethology). S. Chand & Co.
2. Brusca, R. C. and Brusca, G. J. (2003). Invertebrates, 2<sup>nd</sup> Edition. Sinauer Associates, Inc. Publishers.
3. Hall, B.K. and Hallgrímsson, B. (2008). Strickberger's Evolution, 4<sup>th</sup> Edition. Jones and Bartlett Inc.
4. Jordan, E. L. and Verma, P. S. (1992). Invertebrate Zoology. S. Chand Company Ltd.
5. Jordan, E. L. and Verma, P. S. (1993). Chordate Zoology. S. Chand & Co.
6. Kardong, K. V. (2006). Vertebrates: Comparative Anatomy, McGraw Hill Education (India) Ltd.
7. Kotpal, R. L. (2012). Modern Textbook of Zoology: Invertebrates. R. K. Rastogi Publications,
8. Kotpal, R. L. (2012). Modern Textbook of Zoology: Vertebrates. R. K. Rastogi Publications,
9. Lull, R. S. (1984). Organic Evolution. Seema Publication, New Delhi:
10. Manning, A. and Dawkins, M S. (2012). An Introduction to Animal Behaviour, 6<sup>th</sup> Edition. Cambridge University Press.
11. Pough, F. H., Janis, C. M. and Heiser, J. B. (2012). Vertebrate Life, 9<sup>th</sup> Edition, Pearson Benjamin Cummings.
12. Ruppert, E. E., Fox, R. S. and Barnes, R. D. (2006). Invertebrate Zoology: A Functional Evolutionary Approach, 7<sup>th</sup> Edition. Cengage Learning India.

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13. Sinha, A. K., Adhikari, S. and Ganguly, B. B. (2010). Biology of Animals, Vols. I & II. New Central Book Agency. Kolkata.
14. Sinha, A. K., Adhikari, S. and Ganguly, B.B. (2010). Fundamentals of Biology. New Central Book Agency. Kolkata.
15. Young, J. Z. (2004). Life of Vertebrates, 3<sup>rd</sup> Edition, Oxford University Press.

Paper 5B (Practical)

Functional Anatomy, Zoogeography and Adaptations

Marks: 25  
Time: 4 Hours

A. Dissections:

- A [ 1. Nervous system in prawn/earthworm. ✓  
2. Accessory respiratory organs in teleost fish. ✓  
B [ 3. Digestive system in albino rat/ albino mouse/chicken. ✓  
3. Reproductive system in albino rat/ albino mouse/chicken. ✓ ]

B. Mounting (Permanent):

1. Cyclops. ✓  
A → 2. Setae of earthworm. ✓  
3. Spicules of sponge. ✓  
A 4. Scales (cycloid, ctenoid and placoid) of fishes. ✓  
B 5. Feathers of birds (filoplumes, down feathers, barbs and barbules). ✓ (1)

C. Study of Permanent Slides and Specimens:

- B 1. Histology: T/S of stomach, intestine, liver, kidney, spleen and gonads of fish/Aves/mammals. ✓  
A 2. Permanent slides of representatives from Protozoa to Echinodermata (sections and whole mounts).  
B 3. Adaptive modifications of beak and feet in birds using charts and models.

Distribution of Marks:

1. Dissection  
2. Mounting  
3. Spotting  
4. Viva Voce  
5. Laboratory Record

Total 25 (Internal test = 7 + End semester test - 18)

Paper 6A

Cell and Molecular Biology, and Genetics (Theory)

Marks: 75  
Time: 3 Hours

- Unit-1: Genome organization in virus, bacteria and eukaryotes. Central dogma of molecular biology; DNA replication in prokaryotes; Transcription and translation in prokaryotes; Genetic code. Regulation of gene expression in prokaryotes: lac operon.
- Unit-2: Fine Structure of gene: Cistron, recon and muton; Split genes and overlapping genes; Transposons. Gene mutation: Types and mutagenic agents; DNA damage and repair. Detection of mutation in *Drosophila* (Muller's CIB method).
- Unit-3: Extra-nuclear inheritance: Kappa particles in *Paramecium*, Sex-linked inheritance in *Drosophila* (eye color) and man (colour blindness); Dosage compensation and Lyon's hypothesis. Non-disjunction of sex chromosomes in *Drosophila*; Human karyotype; Sex determination in man; Genetic disorders in man - Down's, Turner's and Klinefelter's syndromes, Phenylketonuria, Hemophilia.
- Unit-4: Humoral and cell mediated immunity; Characteristics of antigens; Antibodies: Structure, classes and functions; Antigen-antibody interaction; Major histocompatibility complex; Introduction to cytokines.
- Unit-5: Principles and applications of biological techniques: Light and electron microscopy; Centrifugation; Chromatography (paper, gel filtration and ion-exchange).

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Suggested Readings:

1. Albert, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (2007). Molecular Biology of the Cell, 5<sup>th</sup> Edition. Garland Publishing, London.
2. Brown, T. A. (2006). Genomes 3. Garland Science.
3. Cooper, G. M. and Hausman, R. E. (2009). The Cell: A Molecular Approach, 5<sup>th</sup> Edition, Sinauer Associates Inc. Publishers.
4. Delves, P. J., Martin, S. J., Burton, D. R. and Roitt, I. M. (2011). Roitt's Essential Immunology, 12<sup>th</sup> Edition. Wiley-Blackwell.
5. Gardener, E. J., Simmons, M. J. and Snustad, D. P. (2005). Principles of Genetics, 8<sup>th</sup> Edition. John Wiley and Sons.
6. Hardin, J., Bertoni, G. P. and Kleinsmith, L. J. (2012). Becker's World of the Cell, 8<sup>th</sup> Edition. Benjamin Cummings.
7. Karp, G. (2010). Cell Biology, 6<sup>th</sup> Edition. John Wiley & Sons, Inc.
8. Khan, F. H. (2010). Immunology. Pearson Education India.
9. Klug, W. S., Cummings, M. R., Spencer, C. A. and Palladino, M. A. (2012). Concepts of Genetics, 10<sup>th</sup> Edition. Benjamin Cummings.
10. Krebs, J., Goldstein, E. and Kilpatrick, S. (2011). Lewin's Genes X. Jones & Bartlett Learning.
11. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. (2012). Molecular Cell Biology, 7<sup>th</sup> Edition. W.H. Freeman.
12. Owen, J., Punt, J. and Stranford, S. (2012). Kuby Immunology, 7<sup>th</sup> Edition. W. H. Freeman & Company.
13. Pathak, S. and Palan, U. (2012). Immunology, 11<sup>th</sup> Edition. Science Publishers.
14. Pierce, B. (2012). Genetics: A Conceptual Approach, 4<sup>th</sup> Edition. W.H. Freeman
15. Strickberger, M. W. (2006). Genetics, 3<sup>rd</sup> Edition. Macmillan Publishing Company.
16. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, 6<sup>th</sup> Edition. Pearson, Benjamin Cummings.

17. Wilkins, K. and Walker, J (2012). Practical Biochemistry: Principles and Techniques. Cambridge University Press.

### Paper 6B (Practical)

#### Cell and Molecular Biology, and Genetics

Marks: 25  
Time: 4 hours

1. Separation and identification of amino acids by paper chromatography.
2. Demonstration of antigen-antibody interaction *in vitro*: Single radial immuno-diffusion in agarose gel.
3. Study of nucleic acids from models/charts.
4. Calorimetric estimation of DNA and RNA.
5. Preparation and identification of meiotic stages from grasshopper testis.
6. Karyotyping of normal human chromosomal complement from supplied photographic plates.
7. Karyotyping of chromosomal complement of Down's/Turner's/Klinefelter's syndrome from supplied photographic plates.
8. Demonstration of electrophoretic separation of DNA/protein.

#### Distribution of Marks

1. Cell biology & Genetics
2. Molecular Biology
3. Spotting
4. *Viva Voce*
5. Laboratory Record

Total 25 (Internal test – 7 + End semester test - 18)

### Paper 7A

#### Biochemistry, Animal Physiology and Endocrinology (Theory)

Marks- 75  
Time – 3 Hours

- Unit-1: Chemical foundations of physiology: Concept of normal, molar, and molal solutions; Acids, bases, pH and buffers; Diffusion and osmotic pressure. Enzyme kinetics: Michaelis-Menten equation and its relation to enzyme activity; Significance of  $K_m$  and  $V_{max}$ ; Enzyme inhibition (reversible and irreversible).
- Unit -2: Carbohydrates: Linear and ring forms of monosaccharides (Pentose and Hexose); Polysaccharides (starch, glycogen and hyaluronic acid); Glycogenesis and glycogenolysis. Electron transport system and oxidative phosphorylation. Amino acids, peptides and proteins: levels of organization, Transamination, deamination and urea cycle.
- Unit -3: Structure and functions of haemoglobin; Blood coagulation: Coagulation factors and mechanism. Cardiac cycle. Blood pressure and its regulation. Mechanism of gaseous exchange through gills and lungs. Osmoregulation in fish.

- Unit-4: Neurosecretory cells; Types of neurohormones; Endocrine and paracrine hormones; Placental hormones; Hormones of gastrointestinal tract; Pheromones. Biosynthesis of thyroid hormones. Mechanism of hormone action: Peptide/protein and steroid hormones.
- Unit -5: Reproductive cycles (estrous and menstrual) in mammals; Hormonal regulation of spermatogenesis and oogenesis in humans; *In vitro* fertilization and embryo transfer technology; Pregnancy hormones; Lactation; Contraceptive methods for males and females.

### Suggested Readings

1. Berg, J., Tymoczko, J. and Stryer, L. (2012). Biochemistry, 7<sup>th</sup> Edition, W. H. Freeman.
2. Campbell, M. K. and Farrell, S. O. (2010). Introduction to Biochemistry. Cengage Learning India.
3. Chaudhury, S. K. (1996). Practice of Fertility Control: A Comprehensive Textbook. B. I. Churchill Livingstone Pvt. Ltd, India.
4. Hadley, M. E. and Levine, M. (2007). Endocrinology, 6<sup>th</sup> Edition. Pearson, Benjamin Cummings.
5. Hafez, E. S. E. and Evans, T. N. (1973). Human Reproduction: Contraception and Conception. Harper and Row, New York.
6. Hall, J. E. (2011). Guyton and Hall Textbook of Medical Physiology, 12<sup>th</sup> Edition. Saunders, Elsevier Inc. (Indian print).
7. Hill, R. W., Wyse, G. A. and Anderson, M. (2012). Animal Physiology, 3<sup>rd</sup> Edition, Sinauer Associates Inc.
8. Hoar, W S. (1983). General and Comparative Physiology. Prentice-Hall of India. Pvt. Ltd.
9. Knobil, E. and Neill, J. D. (2006). The Physiology of Reproduction, Vol. 2. Elsevier Publication.
10. Kronenberg, H. M., Larsen, P. R., Melmed, S. and Polonsky, K. S. (2012). William's Textbook of Endocrinology. Saunders, Elsevier Inc.
11. Lehninger Principles of Biochemistry. Nelson, D. L. and Cox, M. (2012). 6<sup>th</sup> Edition. W.H. Freeman.
12. Murray, R. K., Bender, D., Botham, K. M., Kenelly, P. J., Rodwell, V. and Weil, P. A. (2012). Harper's Illustrated Biochemistry, 29<sup>th</sup> Edition. McGraw Hill, Lange publication.
13. Norman, A. W. and Litwack, G. (1997). Hormones, 2<sup>nd</sup> Edition. Academic Press, Elsevier Inc.
14. Norris, D. (2007). Vertebrate Endocrinology, 6<sup>th</sup> Edition. Academic Press, Elsevier Inc.
15. Prosser, C. L. (1991). Comparative Animal Physiology. W. B. Saunders & Company.
16. Randall, D. and Burggren, W. (2001). Eckert Animal Physiology, 5<sup>th</sup> Edition. W.H. Freeman.
17. Sherwood, L., Klandorf, H. and Yancey, P. (2010). Textbook of Animal Physiology. Cengage Learning India.

Paper 7B (Practical)

Biochemistry, Animal Physiology and Endocrinology

Marks: 25  
Time: 4 Hours

1. WBC count in human blood.
2. RBC count in human blood.
3. Estimation of glucose by colorimetric method.
4. Estimation of protein by colorimetric (Lowry's/Biuret) method.
5. Estimation of hemoglobin in human blood.
6. Study of human salivary amylase activity in relation to temperature.
7. Dissection and display of pituitary and gonads in a teleost.
8. Dissection and display of endocrine glands in albino mouse/rat.
9. Microtomy: Preparation of histological slides of vertebrate tissues - liver, kidney, gonads, intestine and adrenal (minimum four slides of different tissues).

Distribution of Marks

1. Biochemistry and Physiology
2. Endocrinology
3. Microtomy
4. *Viva Voce*
5. Laboratory Record

Total 25 (Internal test - 7 + End semester test - 18)

Paper 8A

Developmental Biology, Environmental Biology and Biotechnology (Theory)

Marks: 75  
Time: 3 Hours

- Unit-1: Patterns of cleavage; Morphogenetic movements (epiboly, invagination, ingression, involution and delamination); Embryonic induction and concept of Organizer; Gastrulation in chick up to formation of three germinal layers.
- Unit 2: Foetal membranes and types of placenta in mammals; Organogenesis of the vertebrate eye; Regeneration in invertebrates and vertebrates; Teratogenesis and developmental birth defects. Concepts of Ageing.
- Unit - 3: Salient features of aquatic and terrestrial ecosystems. Liebig's law of limiting factors and Shelford's law of tolerance. Biogeochemical cycles: carbon, phosphorus and nitrogen cycles. Ecological succession. Major Biomes.
- Unit - 4: Environmental concerns: Radioactive pollution; Biological indicators; Biomagnification; Anthropogenic activity and environment: Ozone depletion; Green house effect and global warming; Acid rains. Wild life conservation: *In situ* (sanctuaries, national parks and biosphere reserves) and *ex situ* (botanical and zoological gardens, Germplasm Bank).

Unit - 5      Biotechnology & Genetic Engineering

Introduction to genetic engineering; Restriction enzymes. Cloning vectors: Plasmid, cosmid,  $\lambda$  phage, shuttle vectors; Expression vectors. Introduction in to host cells: Transformation, transduction; Particle gun. Southern blotting; PCR; DNA Fingerprinting; Genomic library and cDNA library; Application of recombinant DNA technology. Ethical issues and Biosafety regulations.

Suggested Readings:

1. Balinsky, B.I. (1981). An introduction to Embryology, 7<sup>th</sup> Edition. Cengage Learning India.
2. Beeby, A. and Brennan, M. A. (2008). First Ecology - Ecological Principles and Environmental Issues, 3<sup>rd</sup> Edition, Oxford University Press, India.
3. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell.
4. Cain, M. L., Bowman, W. D. and Hacker, S. D. (2011). Ecology, 2<sup>nd</sup> Edition. Sinauer Associates, Inc. Publishers
5. Carlson, B. M. (2006). Foundations of Embryology. McGraw Hill Education (India) Ltd.
6. Gilbert, S. F. (2010). Developmental Biology, 9<sup>th</sup> Edition. Sinauer Associates, Inc. Publishers.
7. Kalthoff, K. (2000). Analysis of Biological Development, 2<sup>nd</sup> Edition, McGraw-Hill Professional.
8. Kendeigh, F C. (1984). Ecology with Special Reference to Animal and Man. Prentice Hall Inc.
9. Odum, E. P. (1971). Fundamentals of Ecology, 3<sup>rd</sup> Edition. W. B. Saunders Company.
10. Odum, E. P. and Barrett, G. W. (2006). Fundamentals of Ecology, 5<sup>th</sup> Edition, Cengage Learning India.
11. Primrose, S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics, 7<sup>th</sup> Edition. Wiley-Blackwell.
12. Ratledge, C. (2006). Basic Biotechnology. John Wiley and Sons.
13. Ricklefs, R. E. (2010). Economy of Nature, 6<sup>th</sup> Edition. W.H.Freeman.
14. Sharma, P. D. (1990). Ecology and Environment, 7<sup>th</sup> Edition. Rastogi Publications.
15. Shyam, D. and Rosencranz, A. (2001). Environmental Law and Policy in India. Oxford University Press.
16. Stiling, P. D. (2012). Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.
17. Thieman, W. J. and Palladino, M.A. (2008). Introduction to Biotechnology, 2<sup>nd</sup> edition. Cengage Learning India.
18. Wolpert, L. and Tickle, C. (2011), Principles of Development, 4<sup>th</sup> Edition, Oxford University Press.

## Paper 8B (Practical)

## Developmental Biology, Environmental Biology and Biotechnology

Marks: 25  
Time: 4 Hours

1. Permanent preparation of whole mount of chick embryo.
2. Study of regeneration in *Hydra/Planaria*.
3. Study of whole mount /sections of different developmental stages of chick embryo from permanent slides.
4. Community analysis.
5. Qualitative analysis of aquatic communities from different water bodies.
6. Estimation of total hardness of water samples.
7. Quantitative estimation of Plankton.
8. Analysis of community similarities and species diversity indices.
9. Field trip and submission of Field Report.

## Distribution of Marks

1. Developmental Biology
2. Environmental Biology
3. Spotting
4. *Viva Voce*
5. Laboratory Record
6. Field Report

**Total 25 (Internal test - 7 + End semester test - 18)**