

Faculty of Life Sciences

Syllabus

For

M.Sc. (HONS.) ZOOLOGY

(Semester: I-IV)

(Under Credit Based Continuous Evaluation Grading System)

Examinations: 2012–13



Guru Nanak Dev University
Amritsar.

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M.Sc. (Hons.) Zoology (Semester System)
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Scheme of Courses

Programme Code: ZOB2

Semester -I						
Course No.	C/E/I	Course Title	L	T	P	Total Credits
ZOL 401	C	Biosystematics	2	0	0	2
ZOL 402	C	Evolution	3	0	0	3
ZOL 403	C	Structure and Functions of Animal -I	4	0	0	4
ZOL 404	C	Matabolic Regulation of Cell	3	0	0	3
ZOL 405	C	Molecular Genetics	2	0	0	2
ZOP 421	C	Comparative Anatomy of Animals -I	0	0	3	3
ZOP 422	C	Evolutionary Trends in Animals	0	0	1.5	1.5
ZOP 423	C	Collection and Preservation of Animals	0	0	1.5	1.5
	C	Computer Applications	3	0	0	3
						23

Semester -II						
Course No.	C/E/I	Course Title	L	T	P	Total Credits
ZOL 451	C	Wildlife and Conservation Biology	3	0	0	3
ZOL 452	C	Structure and Function of Animals –II	4	0	0	4
ZOL 453	C	Animal Ecology	3	0	0	3
ZOL 454	C	Applied Zoology –I	3	0	0	3
ZOL 455	C	Cell Biology	4	0	0	4
ZOP 471	C	Comparative Anatomy of Animals –II	0	0	3	3
ZOP 472	C	Ecological Exercises	0	0	1.5	1.5
ZOP 473	C	Experiments in Cytology	0	0	1.5	1.5
	I	Interdisciplinary course	3	0	0	3
						26

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Semester -III						
Course no.	C/E/I	Course Title	L	T	P	Total Credits
ZOL 501	C	Applied Zoology –II	3	0	0	3
ZOL 502	C	Molecular Cell Biology	4	0	0	4
ZOL 503	C	Developmental Biology	4	0	0	4
MTL -261	C	Biostatistics	4	0	0	4
ZOS 505	C	Seminar	0	0	2	2
ZOP 521	C	Advanced Cytology Practical	0	0	3	3
ZOP 522	C	Experimental Developmental Biology	0	0	3	3
	I	Interdisciplinary Course **	3	0	0	3
						26

Semester -IV						
Course no.	C/E/I	Course Title	L	T	P	Total Credits
ZOL 551	C	Tools and Techniques	4	0	0	4
ZOL 552	C	Animal Behaviour	4	0	0	4
MBB 451	I	Concepts of Immunology	4	0	0	4
	E	Elective *	4	0	0	4
ZOP 571	C	Behavioural Zoology Exercises	0	0	3	3
ZOP 572	C	Techniques in Zoology	0	0	3	3
ZOP 573	C	Practicals in Specialized Field	0	0	3	3
Total Credits						25

* The students are required to study one of the following Elective papers.

ZOL 581: Introductory Entomology

ZOL 582 :Introduction to Aquatic Biology

ZOL 583 :Introduction to Parasitology

ZOL 584 :Biology of Chromosomes

** Interdisciplinary courses are to be opted from scheme of courses of other Departments.

ZOL 401: Biosystematics

Credit 2-0-0

Unit- I

Fundamental concepts:

Definition and basic concepts of Biosystematics and Taxonomy

Historical resume of Systematics.

Importance and applications of Biosystematics in Biology.

Material basis of Biosystematics

Evidences

Character-kinds and character weighing.

Trends in Biosystematics:

An introduction to concepts of different conventional and newer aspects.

Cytotaxonomy

Chemotaxonomy

Molecular Taxonomy

Unit – II

Taxonomic Procedures :

Taxonomic collections, preservation, curating and process of identification.

Taxonomic keys- different kinds, their merits and demerits.

Nomenclature:

International code of Zoological Nomenclature (ICZN), Its operative principles, interpretation and application of important rules, formation of scientific names of various taxa.

Process of typification and different Zoological types.

Unit – III

Species – A Taxonomic Category

Lower and higher categories.

Species Category and various species concepts

Sub species and other sub specific categories.

Decision at species and sub species level.

Different kinds of publications:

Scientific publications

Systematic publications

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Suggested Reading Material

- Futuyma, D. J. (1998), Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
- Gote, H.E. (1982), Animal Taxonomy, Edward Arnold.
- Jeffery, C. (1973), Biological Nomenclature, Edward Arnold.
- Kapoor, V. C. (2001), Theory and practice of Animal Taxonomy, IPH Pub. New Delhi.
- Mayer, E. (1969), Principles of Systematic Zoology, McGraw Hill Book Co. London.
- Mayer, E. and Aschhok (1991), Principles of Systematics, McGraw Hill Book Co. London.
- Meglitsch, P. A. (1991), Invertebrate Zoology (3rd edition), Oxford University Press.
- Minelli, A. (1993), Biological Systematics - The state of art, Chapman and Hall, London.
- Quicke, D. L. J. (1996), Principles and Techniques of Contemporary Taxonomy, Black Academic and Professional, London, New York, Madras.
- Savory, T. (1970), Animal Taxonomy, Heinemann Educational Books Ltd., London.
- Sebuh, R. T. (2000), Biological Systematics: Principles and Applications. Cornell University Press.
- Simpson, G. G. (1962), Principles of Animal Taxonomy, Oxford IBH Publishing Company.
- Stace, C. A. (1980), Plant Taxonomy and Biosystematics, Edward Arnold (Publishers) Ltd. London.
- Winston, J. (1999), Describing species- practical taxonomy procedure of biologists, Columbia University Press.

ZOL 402: Evolution**Credit 3-0-0****Unit-I****Brief account of:**

Evolution of genome in viruses, prokaryotes and eukaryotes
Evolution of Multicellularity & Sexual Reproduction
Extinctions and its kinds.
Theories of organic evolution with an emphasis on Darwinism and NeoDarwinism

Unit- II**Variation**

Types of variation
Causes of variation
Mutation Rates and direction

Adaptation

Types of Adaptation
Co-adaptation
Adaptive Resemblances

Natural Selection

Types of Selection
Selection forces
Sexual selection
Selection and non-adaptive characters

Unit- III**Speciation and Distribution of Species**

Types of Speciation
Island, Ocean and Continental distribution
Continental Drift

Quantitative aspect of Evolution

Hardy Weinberg Law
Genetic Drift
Selection Pressures

Suggested Reading Material

Freeman, S. and Herron , Jon C. (2007). Evolutionary analysis Pearson Prentice Hall, New Jersey.
Futuyma, D. J. (1998), Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
Meglitsch, P. A. (1991), Invertebrate Zoology (3rd edition), Oxford University Press.
Minkoff, E. C. (1983), Evolutionary Biology, Addison Wesley Pub. Co., London.
Wen-Hsiung Li (1997), Molecular Evolution, Sinauer associates Inc.Pub. USA.

ZOL 403: Structure and Function of Animals – I

Credit 4-0-0

Unit- I

Cytoskeleton : Basic characteristics and its role in locomotion .
Muscles and mechanism of muscle contraction
Skeleton, its role and types: an overview
Hydrostatic skeleton in Cnidaria and Flatworms etc.
Exoskeleton in arthropods, molluscs.
Locomotory mechanisms in terrestrial, aquatic and aerial animals (including flight in birds and insects).
Evolution of Coelom, Bilateral symmetry and Metamerism, and their significance in locomotion.

Unit –II

Ingestion of food.
Symbiotic nutrition.
Mechanism and regulation of digestion.
Intracellular transport in Protozoa.
Open and closed circulatory systems.
Chambered, tubular and ampullary hearts, neurogenic and myogenic hearts.

Unit – III

Respiratory organs in aquatic animals and aquatic respiration.
Respiratory organs and aerial mode of respiration.
Distribution and brief chemistry of respiratory pigments and their function in non-chordates and chordates.

Suggested Reading Material:

- Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
- Barth, R. H. and Broshears, R. E (1982), The Invertebrate world. Holt Saunder, Japan.
- Bekleimishv, W. M. (1969), Principles of Comparative Anatomy of Invertebrates, Vol. I Morphology, Vol. II – Organology. Chicago University Press, Chicago.
- Brusca, R. C. and Brusca, G. J. (2003), Invertebrates second edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
- Cooper, G. M. (2004), The Cell: A Molecular Approach 3rd edition, ASM Press, Washington, D.C.
- Engemann, J. G. and Hegner, R. W. (1981), Invertebrate Zoology (3rd ed.) Macmillan, New York.
- Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
- Goodrich, E. S. (1958), Structure and Development of Vertebrates, Vol. I and II. D. E. Publication, New York.
- Hildebrand, M. and Goslow. Jr. G.E. (2001), Analysis of Vertebrates Structure John Wiley, N. Y.
- Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusettes, USA.

M.Sc. (Hons.) Zoology (Semester-I)
(Under Credit Based Continuous Evaluation Grading System)

- Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
- Hyman, L. H. The Invertebrates. Vol I– Protozoa through Ctenophora (1940), Vol. II – Platyhelminthes and Rhynchocoela (1951), Vol. III- Acanthocephala, Aschelminthes and Entoprocta (1951), Mc Graw Hill, New York.
- Jollie, M. (1968), Chordate Morphology, Reinhold, New York.
- Kardong, K. V. (1995), Vertebrates – Comparative Anatomy, Function, Evolution. W.B.C. Pub. , Oxford.
- Karp, G.(2005), Cell and Molecular Biology; concepts and experiments (4th ed.),Hoboken, John Willy and Sons, New York.
- Kent, G. C. and Carr, R. K. (2001), Comparative Anatomy of the Vertebrates 9th edition, McGraw Hill Higher Education, New York.
- Linzey, D. (2001), Vertebrate Biology. McGraw Hill Publishing Company, New York.
- McGowan, C. (1999), A Practical Guide to Vertebrates Mechanics, Cambridge University Press, UK.
- Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
- Pechenik, A. Jan. (2000), Biology of the invertebrates, Fourth Edition, McGraw HillBook Co. Singapore.
- Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books seller & Publishers, Agra.
- Pough, F. H., Heiser, J. B. and McFarland, W. N. (1990), Vertebrate Life 3rd ed., Macmillan Pub. Co., New York.
- Purves, W. K., Oriane, G. H., Space, H. C. and Salava, D. (2001), Life – The Science of Biology 6th ed., Sinauer Assoc. Inc., USA.
- Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
- Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ., Philadelphia.
- Saxena, A. (2005). Text book of Mollusca. Discovery Publishing House, New Delhi.
- Willmer, P. Stone, G. and Johnston, I (2000). Environmental Physiology of Animals, Blackwell Science.
- Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.
- Young, J. Z. (1982), The Life of Vertebrates, New York.

M.Sc. (Hons.) Zoology (Semester-I)
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ZOL 404: Metabolic Regulation of Cell

Credit 3-0-0

Unit – I

Bioenergetics and metabolism

Brief introduction to bioenergetics and thermodynamics

Glycolysis

An overview of glycolysis

Fates of pyruvate under aerobic and anaerobic conditions

Regulations of carbohydrate catabolism

Gluconeogenesis

Pentose phosphate pathway of glucose oxidation.

Unit – II

Citric acid cycle

Production of acetate /oxidation of pyruvate

Reactions of citric acid cycle

Regulation of citric acid cycle

Glyoxylate cycle

Oxidation of fatty acids

Digestion, mobilization and transport of fats

Oxidation of fatty acid

α & β oxidation of fatty acids

Unit – III

Amino acid oxidation and production of urea

Metabolic fates of amino groups

Nitrogen excretion and the urea cycle

Pathways of amino acid degradation

Oxidative phosphorylation

Electron transport reaction in mitochondria

Shuttle system in mitochondria

Regulation of oxidative phosphorylation

Suggested Reading Material:

Abeles, R.H., Fray, P.A. and Jencks, W.P. (1992) Biochemistry, Jones and Bartlett Publishers, London.

Berg, J. M., Tymoczko, J.L. and Stryer (2002) Biochemistry (5th Ed.) W.H. Freeman and Co., NY.

Cohn, E.E., Stump.P.K., Bruening , G. and Doi, R.H. (1987) Outlines of Biochemistry (5th Ed) Johan Wiley & Sons, NY.

Elliott, W.H. and Elliot, D.C. (2001) Biochemistry & Molecular Biology (Second Edition) Oxford University Press, New York.

Horton , H.R., Moran, L.A., Ochs, R.S. Rawn, J.D. and Scrimgeour, K.G. (2002) Principles of Biochemistry (3rd Ed.) Prentice Hall, Upper Saddle River N.J. 07458.

Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W.(2003) Harper's Illustrated Biochemistry (Twenty Sixth Edition) Mc Graw Hill.

Nelson, David L. and Cox Michael M. (2000). Lehninger Principles of Biochemistry (3rd Edition) Mc Millan Worth Publishers.

Rawn, J.D. (1983) Biochemistry. Harper and Raw Publishers, New York.

Vasudevan, D. M. and Sree Kumari, S. (2001) Text Book of Biochemistry (3rd Ed.) Jaypee Brothers Medical Publisher (P) Ltd. New Delhi.

Voet, D. and Voet, J.G. (2001) Biochemistry (3rd Ed.) John Wiley and Sons, NY.

Zubay, G. (1993). Biochemistry (3rd Edition) Wm.C. Brown Publishers, USA.

ZOL 405: Molecular Genetics

Credit 2-0-0

Unit – I

DNA replication

Prokaryotic and eukaryotic DNA replication
Mechanics of DNA replication
Enzymes and accessory proteins involved in DNA replication.

Transcription

Prokaryotic Transcription
Eukaryotic Transcription
RNA polymerases
General and specific transcription factors

Unit – II

Post- transcriptional Modifications in RNA

5' –Cap formation
Transcription termination
3' – end processing and polyadenylation
Splicing , Editing
Nuclear export of mRNA
mRNA stability

Translation

Genetic code
Prokaryotic and eukaryotic translation
The translational machinery
Mechanisms of initiation, elongation and termination
Co- and post translational modification of proteins

Unit-III

Regulation of gene expression

Regulatory elements and mechanism of transcription regulation .
Transcriptional and post transcriptional gene silencing
Regulation of translation.

Suggested Reading Material

Brown, T. A. (2006) Gene cloning and DNA analysis and introduction (5th Edition), Oxford, Blackwell Publishers.

Lodish, H., Berk, A., Matsudaira, P., Kiser, C. A., Kriger, M., Scott, M. P., Zipursky, S.L. and Darnell, J. (2004) Molecular Cell Biology, 5th Edition W.H. Freeman and Company, New York.

Weaver, R.F. (2005) Molecular Biology,

Alberts, B., Johanson, A., Lewis, J. Raff, M., Roberts, M. and Walter, P. (2000) Molecular Biology of the cell, 4th Edition, Garland Science, New York.

M.Sc. (Hons.) Zoology (Semester-I)
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- DeRoberties, M. D. and DeRoberties, M.D. (Jr) (1995) . Cell and Molecular Biology (8th ed.)
B.I. Waverly, Pvt. Ltd., ND.
- Freifelder. D. (1993). Molecular Biology (2nd ed.) Narosa Publishing House, India
- Freifelder. D. and Malacinski, G. M. (1993). Essentials of Molecular Biology (2nd ed), John and
Bartlett Publishing, U.K.
- Lewin B (2001) Genes VII, Oxford University Press, New York.
- Primrose, S.B. , Twyman R.M. and Old R.W. (2001) Principles of Gene manipulation, 6th Ed.
Blackwell Scientific Publication, Oxford, U.K.
- Waston J.D., Tooze J. and Kurtz, D.T. (1991) Recombinant DNA. A short course 2nd Ed., W.H.
Freeman and Company , New York.
- Brown, T.A. (2001) Gene Cloning and DNA analysis, An Introduction, 4th Ed. Blackwell
Scientific publication, Oxford, UK.
- Christophger Howe (1995) Gene cloning and Manipulation, Cambridge University Press, New
York.
- Dale, J.W.Shantz MU (2002) From Genes to Genome: Cons, New York.

ZOP 421: Comparative Anatomy of Animals –I

Credit 0-0-3

Temporary mount of setae of Earthworm.

Observation of pseudopodial, cilliary and flagellar movements in Protozoans.

Study of jaws and alimentary canal of leech.

Study of mouth parts of Insects (housefly, butterfly, mosquito, bug and cockroach)

Study of radula in *Pila*.

Study of position of mouth and anatomy of gut according to feeding habits (Insect / annelids / fish).

Study of respiratory structures in Crustaceans, Insects, Bivalves, scorpion, cockroach, grasshopper, Chilopods, Elasmobranchs and bony fishes.

Study of heart and circulatory system of fish, frog, lizard, pigeon, mouse.

Study of permanent slides of blood cell types of vertebrate representatives.

Study of skin of vertebrate representatives through permanent slides.

Study of appendicular skeleton of vertebrates and invertebrate skeletal forms.

Temporary mount of spicules of Herdmania.

Study of permanent slides of haemopoiesis.

Analysis of gut contents in fishes with different feeding habits

Study of morphometric and meristic characters in fishes.

Age and growth study using fish body scales.

***Some changes in the contents of the practical can be expected depending upon the availability of the live material and the required equipment.**

ZOP 422: Evolutionary Trends in Animals

Credit 0-0-1.5

Calculation of regression, correlation - coefficient, variance of genetic frequencies and genetic equilibrium in natural populations using peapods.

To calculate gene and genotype frequency in a given population.

Demonstration of Hardy – Weinberg Law and deviations (role of external forces) from the equilibrium in a population.

Comparison of skeletons for listing evolutionary trends.

Comparison of molluscan shells to depict polyphyletic origin.

Comparison of homologous and analogous structures (Insect antennae, insect legs, limbs of vertebrates etc).

Demonstration of kinds of mimicry in various groups of animals.

Mapping of geographic distribution of birds, insects, fishes etc.

Study of fossils.

Study of various evolutionary phenomena using slides / photographs.

Wet Mounting

***Some changes in the contents of the practical can be expected depending upon the availability of the live material and the required equipment.**

ZOP 423: Collection and Preservation of Animals

Credit 0-0-1.5

Demonstration of various kinds of equipments used for animal collection.

Collection and Preservation of Animals.

Taxidermy.

Alizarine preparation.

Raisin Embedding..

Wet Mounting.

Dry Mounting.

Identification of Insects with the help of keys upto order level.

Indentification of food fish with help of keys.

Construction of phylogenetic tree using some priory weighed characters.

Phylogeny of various animal phyla.

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ZOL 451: Wildlife Conservation and Biology

Credit 3-0-0

Biodiversity as a resource and causes of its depletion.
Ecological sub regions and distribution of wildlife in India
Red Data Book & Conservation status (endangered, vulnerable, rare, threatened and near threatened species) - definitions
National & State mammals and birds of India.

Policies and Laws in Wildlife Management (National)
Important projects for the conservation of Endangered species in India
Conservation of invertebrates with special reference to corals and butterflies
Wildlife and its status in Punjab – Important ecological sites and their status.

Suggested Reading Material:

- Aggarwal, (2000), Wildlife of India.
Ali, S. (1971), The Books of Indian Birds, Bombay Natural History Society, Bombay.
Burton, L. D. (2003), Fish and Wildlife: Principles of Zoology and Ecology. Delmar Thompson Learning Pb.
Dasmann, R. F., (1982), Wildlife Biology, Wiley Eastern, New Delhi.
Fulbright, Timothy, E. and Hewitt, D. G. (2008). Wildlife Science: Linking Ecological Theory and Management Applications. CRC Press, Taylor and Francis: BocaRaton, F L.
Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
Gopal, R. (1992), Fundamental of Wildlife Management Justice Home Allahabad.
Hosetti, B. B. (1997), Concepts in Wildlife Management, Chawla Press, Delhi.

ZOL 452: Structure and Function of Animals –II

Credit 4-0-0

Unit – I

Excretory structures and waste disposal
Adaptations to different environments / habitats.
Development and structural organization of chordate kidney and its role in excretion.

Unit-II

Pattern of reproduction in non-chordates and larval forms.
Evolution of the urino-genital system in chordates with special reference to separation of the two systems.
Reproductive process and its regulation in chordates.
Endocrine organs and their role in body functions.

Unit – III

Chemical coordination of body functions through neuro secretions in non-chordates.
Physiology of nerve net and giant fibre system
Evolution of functional anatomy of chordate brain.
Common characteristic of receptors
Various types of receptors and their function

Suggested Reading Material:

- Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
- Barth, R. H. and Broshears, R. E (1982), The Invertebrate world. Holt Saunder, Japan.
- Bekleimishev, W. M. (1969), Principles of Comparative Anatomy of Invertebrates, Vol. I – Morphology, Vol. II – Organology. Chicago University Press, Chicago.
- Brusca, R. C. and Brusca, G. J. (2003), Invertebrates second edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
- Engemann, J. G. and Hegner, R. W. (1981), Invertebrate Zoology (3rd ed.) Macmillan, New York.
- Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
- Goodrich, E. S. (1958), Structure and Development of Vertebrates, Vol. I and II. D. E. Publication , New York.
- Hildebrand, M. & Goslow. Jr. G. E. (2001), Analysis of Vertebrates Structure John Wiley , New York.
- Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusettes, USA.
- Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
- Hyman, L. H. The Invertebrates. Vol. I–Protozoa through Ctenophora (1940), Vol. II – Platyhelminthes and Rhynchocoela (1951), Vol. III- Acanthocephala, Aschelminthes and Entoprocta (1951), McGraw Hill, New York.
- Jollie, M. (1968), Chordate Morphology, Reinhold, New York.
- Kardong, K. V. (1995), Vertebrates – Comparative Anatomy, Function, Evolution. W.B.C. Pub., Oxford.

M.Sc. (Hons.) Zoology (Semester-II)
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- Kent, G. C. and Carr, R. K. (2001), Comparative Anatomy of the Vertebrates 9th edition, McGraw Hill Higher Education, New York.
- Linzey, D. (2001), Vertebrate Biology. McGraw Hill Publishing Company, New York.
- McGowan, C. (1999), A Practical Guide to Vertebrates Mechanics, Cambridge University Press, UK.
- Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
- Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books seller & Publishers, Agra.
- Pough, F. H., Heiser, J. B. and McFarland, W. N. (1990), Vertebrate Life 3rded. , Macmillan Pub. Co. , New York.
- Purves, W. K., Oriane, G. H., Space, H. C. and Salava, D. (2001), Life – The Science of Biology 6th ed. , Sinauer Assoc. Inc. , USA.
- Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
- Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ. , Philadelphia.
- Saxena, R. K. and Saxena, S. (2008). Comparative anatomy of Vertebrates. Viva Books Pvt. Ltd. New Delhi.
- Willmer, P., Stone, G. and Johnston, I. (2000). Environmental Physiology of Animals, Blackwell Science.
- Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.
- Young, J. Z. (1982), The Life of Vertebrates, New York.

ZOL 453: Animal Ecology

Credit 3-0-0

Unit – I

Important abiotic factors

Temperature, Moisture, Light, fire, Malentite and Pollution.

Biotic Factors

Resource

Food, its distribution, relative and absolute shortages

Place in which to live

Community structure

Population, Ecological Niche, Food chains, Food webs, biomagnifications, succession / temporal changes.

Interactions and Coactions

Competition, Predation, Parasitism, Commensalism, Mutualism etc.

Unit- II

Adaptations

Cave, deep sea, arboreal, aerial, and subterrestrial.

Co-adaptations and adaptive resemblances (mimcry, warning colouration, seasonal, polymorphism)

Applied Ecology

Bio monitoring of environment using animal species

Use of remote sensing (GIS) in ecology (introduction)

Unit – III

Concept of Population

Biotic potential and carrying capacity, dispersal and distribution, population growth and its regulations

Methods of sampling

Life tables and longevity.

Migration and Ecesis.

Zoo Geographical regions

Suggested Reading Material

Anderwartha, H.G. and Birch, L. C. (1970), The distribution and abundance of animals, University of Chicago Press, Chicago London.

Beeby, A. (1992), Applying Ecology Chapman and Hall Madras.

Begon, M., Harper J. L. and Townsend, C. R. (1995), Ecology – Individuals, populations and communities, Blackwell Science, Cambridge UK.

Brewer, R. (1994), The science of Ecology, Saunders College of Publishing, New York.

Chapman, J. L. and Resis, M. J. (1995), Ecology- Principles and applications, Cambridge University Press, Cambridge UK.

Kaeighs, S. C. (1974), Ecology with special references to animal and Man, Prentice Hall Inc.

Odum, E. P. (1983), Basic Ecology.

Putmann, R. J. and Wratten, S. D. (1984), Principles of Ecology, Crown Helm, London.

Salanki, J., Jeffery E. and Hughes G. M. (1994), Biological Monitoring of the Environment (A manual of Methods) CAB International, Wallingford UK.

ZOL 454: Applied Zoology-I

Credit 3-0-0

Unit – I

Apiculture

Introduction
Honey bee and kinds
Life Cycle
Flora for Apiculture
Cultivation and Harvesting
Products of Bee keeping and their importance
Honey composition, quality and importance
Enemies of Honey bees

Lac culture

Introduction
Species for lac culture, Life cycle and Host plants
Lac composition, properties & importance
Cultivation and Harvesting of Lac
Enemies of Lac insect

Unit – II

Sericulture

Introduction
Species and their Life Cycle and host plants.
Silk composition, kinds and uses
Rearing of silkworm and Silk Production
Enemies of Silk worm

Prawn Culture

Introduction
Prawn: species and life cycle
Fresh water and Marine Prawn farming
Processing and Preservation
Enemies of Prawns

Unit – III

Vermi Culture:

Introduction
Species and life cycle
Methods of Vermiculture
Factors affecting vermiculture
Economics of Vermiculture
Enemies of earthworm

M.Sc. (Hons.) Zoology (Semester-II)
(Under Credit Based Continuous Evaluation Grading System)

Pearl Culture

Introduction
Species and life cycle
Pearl Culture – Freshwater and Marine
Pearl Composition, kinds and uses
Enemies of Oysters

Suggested Reading Material:

- Bhamrah, H. S. & Juneja, K. (2001), An introduction to Mollusca. Anmol publications Pvt., Ltd. New Delhi.
- Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm; Vermiculture and Vermicomposting, Kalyani Publishers India.
- Carter, G. A. (2004) Beekeeping, Biotech Books, New Delhi.
- Fenemore, P. G. and Prakash, A. (1992), Applied Entomology, Wiley Eastern Ltd. New Delhi.
- Ghorai, N. (1995), Lac Culture in India. International Books and Periodicals, New Delhi.
- Jhingran, V. G. (1991) Fish and Fisheries of India, Hindustan Publishing Company India.
- Kumar, A. and Nigam, P. M. (1989), Economic and Applied Entomology EMKAY Publishing Co. New Delhi.
- Mishra, R. C. (1995), Honey Bees & their Management in India. ICAR, New Delhi.
- Mustafa, S. (1990) Applied and Industrial Zoology. Associated Publishing Company, New Delhi.
- Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
- Sathe, T. V. and Jadhav, A. D. (2001) Sericulture and Pest Management, Daya Publishing House, New Delhi.
- Shimizu, M. (1972) Handbook of Silkworm rearing (Agricultural Techniques Manual-1) Fuji Publishing Co. Ltd, Tokyo, Japan.
- Singh, S. (1962), Bee Keeping in India, I. C. A. R. Publications, New Delhi.
- Sobti, R. C. (1992), Medical Zoology, Nagin Chand & Co. Jalandhar.
- Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
- Ullal, S.R. and Narsimhanna, M. N. (1981), a Handbook of Practical Sericulture, Central Silk Board, Bombay.
- Venkatanarasaiah, P. (1992), Sericulture in India, Ashish Publishing House, New Delhi.

ZOL 455: Cell Biology**Credit 4-0-0****Unit-I****Introduction**

General properties of the cell

Cell types: Prokaryotes and eukaryotes and their organization.

Transition from prokaryotes to Eukaryotes

Stem cells.

Structure of cell membrane

General properties of cell membrane, chemical composition.

The concept of unit membrane.

Various Lipoprotein models including fluid mosaic model.

Cell surface modifications – Glyocalyx, villi, Caveolae.

Ribosomes

A complex of ribonucleoproteins,

Dynamics of association - disassociation of ribosomes into polysomes, microsomes,

Site of protein synthesis (initiation, elongation, translocation and termination phases of protein synthesis)

Central dogma.

Unit – II**Endoplasmic Reticulum**

Extension of cell membrane, cisternae, Site of location

Compartmentalization of enzymes and metabolites and their associated functions.

Golgi complex

Structure: Cisternae, vacuoles and vesicles, functions

Role in secretion, cell wall formation, packaging of intracellular products and other functions

GERL concept.

Mitochondria

Elaboration of the plasma membrane and multi enzyme complex, outer and inner membranes, cristae, matrix, inner and outer compartments,

Location of enzyme complexes of TCA cycle (and ATP generation)

Electron transport chain , semi autonomous nature (mitochondrial DNA, RNA, ribosomes and protein synthesis)

Unit – III

Lysosomes

Polymorphic single membrane structure, site of proteolytic activity for intracellular digestion

Phagocytosis, increase in lysosomal activity with age

Lipofuscin pigments, diseases associated with lysosomes.

Peroxisomes and glyoxisomes

Single membrane structure; site of enzyme complexes involved in hydrogen peroxide, metabolism, gluconeogenesis (conversion of non carbohydrate into carbohydrates)

Glyoxylate pathway, microperoxisomes.

Nucleus

Nuclear membrane, pores, chromatin, (euchromatin & heterochromatin), nucleolus, Eukaryote chromosomes structure (DNA, Histone and other proteins, Nucleosome and solenoid concept). Kinetochore, centromere and gene structure.

Suggested Reading Material:

Alberts, B. Bracy, P. Lewis , J. Raff, M. Roberts K and Watson, J. (eds) (1994). Molecular Biology of the Cell, Garland Publishing , New York.

Avers, C. J. (1976). Cell Biology , Van Nostrand Reinhold, New York.

Cooper, G. M. (1997). The cell, A Molecular Approach ASM press, Washington, D. C.

Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.

Darnell, J. Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Freeman, New York.

Derobertis, E. D. P. and Derobertis, E.M.F. (1987). Essentials of Cell and Molecular Biology. Hold Saunders – Philadelphia.

M.Sc. (Hons.) Zoology (Semester-II)
(Under Credit Based Continuous Evaluation Grading System)

- Dewitt., W. (1977). *Biology of the Cell – An evolutionary approach*, Saunders – Philadelphia.
- Holtzman, E. and Novikoff, A. B. (1984). *Cells and Organelles*. Saunder – Philadelphia.
- Hopkins, C. L. (1978). *Structure and Functions of Cells* . Saunders – Philadelphia.
- Karp, G. (1984). *Cell Biology* 4th Edition, McGraw Hill, New York.
- Karp G. (1999). *Cell and Molecular Biology. Concepts and Experiments*, 2nd Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
- Loewy, A. G. , Siekevitz, P, Menningee, J. R. , and Allant, J. A. N. (19991). *Cell structure and Functions. An integrated Approach* 3rd edition . Saunders College Publishing, Philadelphia, London.
- Pollard. T.D. and Earnshaw, W.C. (2002) *Cell Biology*. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
- Powar, C. B. (1990). *Cell Biology*. Himalaya Publishing House, Bombay.
- Sadava, D. E. (1993). *Cell Biology – Organelle, Structure and Fucntions*. H. Jones and Bartlett-Boston.
- Sheeler, P. and Binachi, D. E. (1983). *Cell Biology*, John Wiley, New York.
- Smith & Wood (1992). *Cell Biology*, Chapman & Hall, London, New York.
- Wolfe, S. L. (1983). *Introduction of Cell Biology*, Woodworth Belmont.

ZOP 471: Comparative Anatomy of Animals –II

Credit 0-0-3

Analysis of normal and abnormal constituents in urine sample.

Study of influence of insulin on glucose level (Blood).

RBC, WBC (TLC, DLC), platelet and reticulocyte counts.

Study of osmotic fragility in erythrocytes.

Determination of ESR and PCV of human blood.

Estimation of haemoglobin by Sahli's / cyanometglobin method.

Study of reflexes in frog after single and double pithing.

Study of gastronomic muscle twitch (fatigued and non fatigued).

Recording and analyzing heartbeat of frog.

Study of different forms of excretory structures in invertebrates and vertebrate groups

- (nephridium in annelids, green glands in crustacean, malphigian tubules in insects, kidneys of molluscs, fish , frog, lizard, bird and mammal).

Study of reproductive system of *Hydra*, flat worm, earthworm, cockroach and *Pila*.

Study of nervous system of cockroach, *Pila*, *Sepia*, fish, frog, lizard, pigeon and mouse.

Histological study of reproductive system of invertebrates and vertebrates from permanent slides.

Histological study of endocrine glands of vertebrates from permanent slides.

***Some changes in the contents of the practical can be expected depending upon the availability of the live material and the required equipment.**

ZOP 472: Ecological Exercises

Credit 0-0-1.5

To study temperature and pH of a given water sample.

To determine the amount of dissolved oxygen (DO) in a water sample.

To determine the total alkalinity of a water sample.

To determine the total hardness of a water sample.

Total count (quantitative estimation) of plankton

Plotting of survivorship curves from hypothetical life table data.

Population estimation using Mark and Release method (using beads / pulses etc).

***Some changes in the contents of the practical can be expected depending upon the availability of the live material and the required equipment.**

ZOP 473: Experiments in Cytology

Credit 0-0-1.5

Study of Histology of animal tissue using microtomy.

Study of permanent slides of various kinds of tissues.

Study of electron micrographs of various kinds of cell organelles.

Study of prokaryotic (*Lactobacillus*, *E. coli*) and Eukaryotic Cells (pond water culture, intestine of frog and earth worm) through temporary and permanent preparation.

Study of different stages of mitosis in root type of *Allium cepa* / bone marrow of rat.

To estimate cell size with the help of occulometer.

***Some changes in the contents of the practical can be expected depending upon the availability of the live material and the required equipment.**

ZOL 501: Applied Zoology –II

Credit Hours: 3-0-0

Unit-I

Pisciculture

Economically important fresh water and marine fishes
Fish culture: aims and evolution
Techniques and factors affecting fish culture
Problems of seed collection from natural resources (in brief)
Induced breeding methods

Poultry

Nomenclature and breeds of poultry birds
Poultry Rearing / Farming
Egg structure and quality, abnormalities in eggs, factors affecting size
Broilers, meat processing and egg processing

Unit - II

Fur Industry

Fur producing animals
Fur farming, dressing, Fur processing and dyeing

Leather Industry

Animals of leather industry
Processing of skin, flaying, Curing, salting and tanning
Enemies of skin industry

Dairy Farming

Milching animals, Breeds
Housing and raising
Milk composition and dairy products
Improvement of stocks

Unit-III

Wool Industry

Animals of wool industry
Types of wool, structure and their physicochemical properties
Removal of wool
Processing of wool, clearing, drying, bleaching, dyeing, spinning and twisting.

Piggery

Characteristics of swine and their products
Breed selection
Housing and raising
Products (Pork, Bristles, Lard, Sausages) and by products
Diseases of Pigs

Other Utilities of animals

Pharmaceuticals from animals (in brief)
Vaccines from animals

Suggested Reading Material:

- Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
- Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, New Delhi.
- Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
- Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co. India.
- Khanna, S. S. (1986), An introduction to fishes, Central Book Depot, Allahabad.
- Mustafa, S. (1990), Applied and Industrial Zoology, Rastogi publications, Meerut.
- Sarkar, K. T. (1991), Theory and Practice of Leather manufacture. The Author, Madras.
- Shami, Q. J. and Bhatnagar, S. (2002) Applied Fisheries . Agrobios India.
- Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
- Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
- Toor, H. S. and Kaur, K. (1996), Fish Culture manual. PAU, Ludhiana.
- Yadav, M. (2003) Economic Zoology , Discovery Publication House, New Delhi.

ZOL 502: Molecular Cell Biology

Credit Hours -4

Unit – I

Biomembranes

Molecular composition, arrangement and functional consequences.

Transport across cell membrane – Diffusion, active transport and pumps, uniports, symports and antiports.

Membrane potential and Nerve Impulses

Trafficking Mechanisms (Endocytosis, Phagocytosis etc.)

Unit - II

Cell-Cell adhesion and communication

Ca⁺⁺ dependent homophillic cell-cell adhesion

Ca⁺⁺ independent homophillic cell-cell adhesion

Gap junctions and connexins

Cell matrix adhesion

Integrins

Collagen

Non-collagen components

Cell- Cell signaling

Cell surface receptors

Second messenger system

MAP kinase pathways

Signalling from plasma membrane to nucleus

Unit - III

Cell cycle

Various cell cycle check points

Cyclin and cyclin dependent kinases

Regulation of CDK –cyclin activity.

Biology of cancer

Biology of aging

Apoptosis – definition, mechanism and significance

Suggested Reading Material:-

Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, M. & Walter, P. (2002), Molecular Biology of the Cell, 4th Edition Garland Science, New York.

Becker, W. M., Kleinsmith, L. J. & Hardin, J. (2000), the World of the Cell, B. C. Pub. Co., San Francisco.

Cooper, G. M. (2004), The Cell: A Molecular Approach IIIrd edition, ASM Press, Washington, D.C.

Darnell, J. Lodish, H. & Baltimore, D. (1990), Molecular Cell Biology 2nd Edition Freeman, New York.

DeRobertis, M. D. & DeRobertis, M.D. (Jr.) (1995), Cell and Molecular Biology (8th ed.), B.I. Waverly Pvt. Ltd., New Delhi.

Karp, G.(2005), Cell and Molecular Biology; concepts and experiments (4th ed.),Hoboken, John Willy and Sons, New York.

Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, S. L. & Darnell, J., (2004), Molecular Cell Biology 5th Edition W. H. Freeman & Co., New York.

Pollard, T. D. & Earnshaw, W. C. (2000), Cell Biology, Saunders, U.S.A.

Ray, S.C. & Kumar, K. (2006), Cell Biology, New Central Book Agency, Kolkata.

Sadava, D. E. (1993), Cell Biology Organelle Structure and Functions. H. Jones & Bartlett-Boston.

ZOL 503: Developmental Biology

Credit Hours -4

Unit – I

Introduction

Concept of growth at cellular , subcellular and organ level.

Induction, organization, competence and inductive response, Hierarchies of Induction.

Development of central nervous system, eyes, blood vascular system and accessory organs of alimentary canal.

Molecular basis of fertilization and development

Unit – II

Metamorphosis and regeneration

Control of metamorphosis.

Morphophysiology of metamorphosis in insects and frog

Regenerative abilities in platyhelminthes and coelentrates.

Histomorphological changes in amphibians during regeneration of limb.

Vertebrate Lens regeneration.

Unit – III

Genetic control of development

Nuclear determination of developmental events.

Differential gene expression during development

RNA localization techniques

Nucleus and cytoplasmic interactions during development.

Assisted reproduction technologies

Embryo sexing and cloning

In vitro fertilization and embryo transplantation.

Techniques for screening of genetic disorders (Amniocentesis, chorionic villi sampling and ultrasound)

Suggested Reading Material

- Balinsky, B. I. (1981), An introduction of Embryology, Saunders, Philadelphia.
- Bellairs, R. (1971), Development Processes in Higher Vertebrates, University of Miami Press , Miami.
- Berril, N. J. (1971), Development Biology. McGraw Hill, New Delhi.
- Dawnpart, Development Biology.
- Ebert, J. D. & Sussex , I. M. (1970), Interacting Systems in Development, Holt, Rinehart and Winston, New York.
- Elder, K. and Dale, B.(2001). In vitro fertilization 2nd edition. Cambridge University Press, Cambridge.
- Gilbert, S.F. (2003), Developmental Biology, Sinauer – associates, Inc. USA.
- Goel, S. C (1984), Principles and Animal Developmental Biology, Himalaya, Bombay.
- Grant, P. (1978). Biology of Developing System.
- Jangir, O.P. (2005). Developmental Biology. A manual. Agrobios (India)
- Karp, G. & Berrill, M. J. (1981), Development McGraw Hill, New Delhi.
- Loomis, W. F. (1986), Developmental Biology Macmillan, New York.
- Miller, W. A. (1986), Developmental Biology Springer Verlag, New York, Inc.
- Oppenheimer, J. M. and Willer , B. H. (1964), Foundation of Experimental Embryology, Prentice – Hall, New Delhi.
- Pritchard, D. J. (1986), Foundation of Development Genetics, Taylor and Francis, London.
- Saunders, J. W. (1982), Developmental Biology, Patterns, Principles, Problems, MacMillan, New York.
- Spratt, N. T. Jn. (1971), Developmental Biology. Macmillan, New York.
- Waddington, C. H. (1966), Principles of Development and Differentiation. Macmillan, New York.

ZOP 521: Advanced Cytology Practical

Credit Hours-3

Separation of WBC from blood.

To check the viability of WBC with trypan blue.

Isolation of DNA from human blood.

Isolation of DNA from insects

To detect protein activity using haemeagglutination assay.

Isolation of DNA from buccal cells.

Amplification of DNA using PCR.

ZOP 522: Experimental Developmental Biology

Credit Hours -3

Study of growth (multiplicative; accretionary) through permanent slide and specimens.

Study of spermatogenesis (rat / frog / grasshopper).

Ovariectomy and castration of rat.

Candling of chick eggs for assessing fertilization status.

Study of various larval and pupal forms of insects and other invertebrates from slides and museum jars.

Study of metamorphosis in insects through museum specimens.

Study of the effect of pH and temperature on sperm motility.

Preparation of permanent slides of chick embryo (24 hr, 36 hr, 48 hr, 72 hr and 96 hr).

Study of permanent mount of mammalian embryo (pig, monkey).

Study of Oestrous cycle of rat.

ZOL 551: Tools & Techniques**Credit Hours -4****Unit-I**

Introduction:

pH, Buffers, Homogenisation.

Centrifugation and Ultra centrifugation:

Types, Principles and Instrumentation.

Chromatography:

Principles, Types, Instrumentation and applications.

Electrophoresis:

Principles, Types, Instrumentation and applications.

Unit-II

Spectroscopy :

Principles, Instrumentation and application of various types of spectroscopy: (UV-Visible spectrophotometry, Spectrofluorometry, X-ray Spectroscopy, Infra-red Spectroscopy and Atomic Spectroscopy)

Radio Isotopes

Principles of Radioactivity and its applications.

Auto Radiography

Microscopy :

General Principles, Instrumentation and application of Light Microscopy, Phase contrast microscopy, Fluorescent microscopy, SEM, TEM, Confocal, cryo, Interference, polarization etc.

Unit – III

Histological techniques:

Equipment (microtome, cryostat)

Cryopreservation for cells, tissues and organisms.

Animal cell culture techniques:

Design & functioning of tissue culture laboratory

Cell proliferation measurements, Culture media preparation, Cell viability testing, cell separation & harvesting through Flow cytometry..

Suggested Reading Material:

Broadway, S. Bracegirdle, B. (1998), Introduction to light microscopy. Bios Scientific Publisher , Oxford. In association with The Royal Microscopical Society, London (Microscopy) Handbook , 42), 123 pp.

Butler, M. (1996), Animal Cell Culture and Technology. The Basic, IRL Press, Oxford.

Freifelder, D. (1982), Physical Biochemistry : Applications to Biochemistry and Molecular Biology, WH Freeman and Company, San Francisco.

Freshney , R. I. (1992), Animal cell Culture : A Practical Approach. Second Edition , IRL press, Oxford.

Freshney, R. I. (2000), Culture of Animal Cells: A manual of Basic Techniques. Fourth Edition. Wiley –Liss, Inc. New York.

Gupta, M. N. (2002), Methods for Affinity- Based separations of Enzymes and Proteins.

Hajibangheri, Nasser, M. S. (ed.) (1999), Electron microscopy methods and protocols. (Methods in molecular biology volume 117). Human Press, Totowa, N. J. 296 pp.

Humasson, G. L. (1967), Animal Tissue Techniques W. H. Freeman and Company, London.

Jayaram, J. (2001), Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi.

Kelly, R. A. (1971), The use of English for technical students, second edition. ELBS , London.

Mather, J. P. and Barnes, D. (1998), Animal Cell Culture : Methods in Cell Biology Volume 57. Academic Press, New York.

Neelameghan, A. (1975), Presentation of ideas in technical writing , Vikas, Delhi.

Osterman, Lev. A. (1984), Methods of Protein and Nucleic Acid Research: Electrophoresis, Isoelectric focusing, Ultracentrifugation, Springer-Verlag, New York.

M.Sc. (Hons.) Zoology (Semester-IV)
(Under Credit Based Continuous Evaluation Grading System)

- Plummer, D. T. (1978), An Introduction to Practical Biochemistry, Tata Mc Graw Hill, Publishing Company Ltd. New Delhi.
- Shah, V. V., Bahtavakar, J. Chinoy, N. J. and Murthy, S. K. (1988), Essential techniques in cell biology, Anand Book Depot, Ahmedabad.
- Sheehan, D. (2000), Physical Biochemistry: Principles and Applications. John Wiley & Sans Ltd, Chichester, England.
- Silvan, J. (1966), Raising of laboratory Animal : A handbook for biological and behavioural research. American Museum of Natural History.
- Skoog, D. A. (1985), Principles of Instrumental Analysis, 3rd Edition, Saunders College Publishing, New York.
- Smith, C. N. (1996), Insect colonization and Mass Production. Academic Press, New York.
- Sumner, B.E.H. (1988), Basic Histochemistry. John Wiley and Sons Ltd. Chichester, London.
- Vago, C. (1972), Invertebrate tissue Culture. Volume I and II. Academic Press, New York.
- Wilson, K. And Walker, J (1994), Practical Biochemistry : Principles and Techniques. Cambridge University Press, Cambridge.
- Wilson, K. and Goulding, K. H. (1992), A Biologist Guide to principles and techniques of practical Biochemistry. 3rd Edition, Foundation Brothers, New Delhi.

ZOL 552: Animal Behaviour**Credit Hours -4****Unit-I**

Introduction

Ethology as a branch of biology
Animal Psychology –classification of behavior patterns, analysis of behavior (ethogram)

Neural and hormonal control of behavior

Genetic and environmental components in the development of behavior

Communication

Chemical, Visual tactile and Audio communication

Functions of Communication

Song specificity of birds
Evolution of language (primates)
Host-parasite relations

Unit-II

Social behavior

Aggregations-schooling in fish, flocking in birds, herding in mammals, advantages and disadvantages of living in groups.

Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness

Social organization in insects and primates

Parental care

Reproductive behavior

Evolution of sex.
Mating and courtship behavior
Sperm competition
Sexual selection and Parental care

Unit-III

Learning and memory

Conditioning, Habituation, Associative learning, Reasoning and Cognitive skills.

Biological Clocks

Rhythmic Behaviour
Advantages of Biological clocks
Adaptiveness of biological clocks
Molecular basis of clock mechanism.

M.Sc. (Hons.) Zoology (Semester-IV)
(Under Credit Based Continuous Evaluation Grading System)

Suggested Reading Material:

- Alcock John. 2005 Animal Behaviour . An Evolutionary Approach (8th Edition)
 Aggarwal,. (2000), Biodiversity.
 Aggarwal,. (2000), Wildlife of India.
 Alcock, J. (1998), Animal behaviour, An evolutionary approach Sinauer Assoc., Sunderland, Mass , USA.
 Ali, S. (1971), The Books of Indian Birds, Bombay Natural History Society, Bombay.
 Burton, L. D. (2003), Fish and Wildlife: Principles of Zoology and Ecology. Delmar Thompson Learning Pb.
 Dasmann, R. F., (1982), Wildlife Biology, Wiley Eastern, New Delhi.
 Drickamer, L. C. and Vessey, S. H. (1986), Animal Behaviour - Concepts, Processes and Methods. (2nd ed.), Wordsworth Publ. Co., California.
 Fulbright, Timothy, E. and Hewitt, D. G. (2008). Wildlife Science: Linking Ecological Theory and Management Applications. CRC Press, Taylor and Francis : BocaRaton, F L.
 Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
 Gopal, R. (1992), Fundamental of Wildlife management Justice Home Allahabad.
 Goodenough, J., McGurie and Wallace, R. A. (2001), Perspective on animal behaviour. John Wiley & Sons, Inc. New York.
 Hosetti, B. B. (1997), Concepts in Wildlife Management, Chawla Press, Delhi.
 Huntingford F. (1984), The study of animal Behaviour, Chapman and Hall, London.
 Manning, A. and Dawkins, M. S. (1992 & 1998), An Introduction to Animal Behaviour , 4th ed.(Cambridge low price editions). Cambridge University Press, Cambridge.
 Manning, A. (1979), An Introduction to Animal Behaviour, 3rd Edition . The English Language Book Society and Edward Arnold Publishers Ltd.
 McFarland, D. (1985 & 1999), Animal Behaviour. Pitman Publishing Ltd. London.
 Majupuria T. C. (1990), Wildlife Wealth of India (Resources and Management), ISBN, Tecpress Services, Thailand.
 Moulton, M. P. and Sanderson, J. (1997), Wildlife issues in a changing world. St. Luice Press Florida.
 Negi, S. S. (1995), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
 Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay.
 Saharia, V. P. (1982), Wildlife in India, Natraj Publisher, Dehradun.
 Samways, M. J. (1994), Insect Conservation Biology, Chapman and Hall, New York.
 Sharma, B. D. (1994), High Altitude Wildlife of India, Oxford IBH, New Delhi.
 Sharma, B.D. (1999), Indian Wild Life Resources Ecology and Development . Daya Publishing House, Delhi.
 Sharma, B.D. (2002), Man environment and wildlife animal. IBH Publishing Co., Pvt . Ltd. New Delhi.
 Teague, R. D. (1987), A manual of Wildlife Conservation, Natraj Publishers, Dehradun.
 Tikadar, B. K. (1988), Threatened Animals of India, Publications of Zoological Survey of India, Calcutta.
 Tirvedi, P.R. and Singh , U. K. (1996), Environmental Laws of Wildlife.

ZOL 581: Introductory Entomology (Elective*)

Credit Hours -4

Unit-I

Introduction:

Salient features of Insects.

Insect abundance and diversity.

What Entomology is ?

Insect Classification:

Classification of class Insecta upto order level with salient features of each group

Insect Body

Integument (in brief)

General organisation :

Head, thorax and abdomen.

Unit-II

Modifications and functions of mouthparts, . antennae, wings and legs.

General account of digestive, respiratory, circulatory, excretory, nervous and reproductive system.

Growth and Development (in brief)

Sensory system:

Photoreceptors

Chemoreceptors

Mechanoreceptors.

Unit-III

Definition of Pests

Major pests of cotton, rice, sugar, wheat, vegetables and their biology (in brief).

Major pests of stored grain pests and their biology (in brief)

Different methods of pest management.

M.Sc. (Hons.) Zoology (Semester-IV)
(Under Credit Based Continuous Evaluation Grading System)

Suggested Reading Material:

- Alford, D. V. (1999), A text book of Agricultural Entomology, Blackwell Science.
- Atwal, A. S. and Dhaliwal, G. S. (1997). Agricultural pest of South Asia and their management. Kalyani Publishers, New Delhi.
- Borror, D. J., Triplehorn, C. A and Johnson, N.F. (1989). An introduction to the study of insects, Saunders College Publications, Philadelphia (USA).
- Davies, R. G. (1988), Outlines of Entomology, Chapman & Hall.
- Dent, D. (1991), Insect Pest Management, CAB International Wallingford, U.K.
- Dhaliwal, G. S. and Arora, R. (1996). Principles of insect management. Globe offset press, New Delhi.
- Elizinga, R. J. (2004), Fundamentals of Entomology, 6th edition, Prentice Hall, New Jersey.
- Evans, H. E. (1985), Insect Biology: A text book of Entomology, Springer – Verlag.
- Fenmare, P.G. and Parkash, A. (1992), Applied Entomology. Newage International Limited Pb.
- Gullan, P.S. and Crannton, P. S. (2000), The Insects: an Outline of Entomology, Blackwell Science Ltd. Pb.
- Herrick, G. W. (1999). Insect enemies of trees, Logos Press, New Delhi.
- Hill, D. S. (1993), Agricultural insect pests of the Tropics and their Control. 2nd Ed. , Cambridge University Press, Cambridge, New York.
- Mariau, D. (1999) Integrated pest management of tropical perennial crops. Science Publisher Inc. U.S.A.
- Mani M.S. (1982), General Entomology, Oxford & IBH Pb., N. Delhi.
- Mathur, V. K. and Upadhyay, K. D. (2000), A Text book of Entomology, Aman Publication House.
- Mayer, K. K., Anantha Krishnan, T. N. and David , B.V. (1976), General and Applied Entomology, Tata McGraw.
- Neumann, I. D. (1994), Systematic and Applied Entomology. Melbourne University Press.
- Pedigo, L. R. (2002). Entomology and pest management. 4th edition, Pearson education, Inc. , New Jersey.
- Pradhan, S. (1991) Agricultural entomology and pest control ICAR, New Delhi.
- Romoser, W. S. (1981), The Science of Entomology, Macmillan Pub. Co. Second edition.
- Roses, H. H. , Ross, C.A. and Ross, J. R. (1991), A Text book of Entomology , John Wiley and Sons, 4th edition.
- Roy, D. N. and Brown, A.W.A. (2003), Entomology (Part – I), Published by Biotech Books, Delhi.
- Roy Van Driesche, Mark Huddle and Ted Center (2008). Control of Pests and weeds by Natural enemies- An Introduction to Biological Control, Blackwell Publishers, U.S.A.
- Saxena, A. B. (1996). Harmful Insects, Anmol publications, New Delhi.
- Srivastava, K. P. (1996), A text book of Applied Entomology, Vol. II Kalyani Publishers.
- Van Ender, H. F. (1989) Pest control, second edition Cambridge University Press U. K.
- Verma, D. K. (1999), Applied Entomology, Mittal Publications.
- Venugopal, Rao, N., Uma Maheswar, T., Rajendraprasad, P., Govardhan Naidu, V. and Savithri, P. (2003) Integrated Insect pest management Dr. Updesh Purohit for Agrobios, Jodhpur.

ZOL 582: Introduction to Aquatic Biology (Elective*)

Credit Hours -4

Unit I

Fresh water ecosystems
Introduction, types and main characteristics
Primary Productivity
Decomposition
Conservation and management.
Biotic factors : Planktons, nektons, periptilons , aufwuchs and benthos

Unit-II

Water as a substance: molecular structure and properties , specific heat, density , surface tension.
Abiotic factors
Light and temperature , dissolved oxygen, inorganic nutrients, organic matter.
Eutrophication
Thermal stratification

Unit-III

Fish within Aquatic Ecosystems
Form and locomotion
Structural adaptations for aquatic life.
Feeding relationships among fish
Predation of fishes
Size selectivity of planktons
Fish as bioindicators of aquatic ecosystem health.

Suggested Reading Material:

- Wetzel, R. G. (2001). Limnology. Elsevier Academic Press . Sandiago.
Wetzel R. G. and Likens , G. E. (2004). Limnological analysis . Springer India. Pvt. Ltd.
Findlay SEG and Sinsabaugh R. L. (2003). Aquatic ecosystems , Academic Press, U.S.A.
Norman, J. R. and Green Wood , P. H. (1963). A history of fishes. Ernest Benn Ltd., London.
Chandy, M. (1994). Fishes, National Book trust India.
Singh, H. R. and Kumar, N. (2006). Ecology and Environmental Science. Vishal Publishing Co. Jalandhar, Sharma P. D.

ZOL 583: Introduction to Parasitology (Elective *)

Credit Hours-4

Unit I

Parasitism : General account
Parasite, Classes of Parasites
Host, Classes of Hosts
Adaptations to Parasitism
Effects of Parasites on hosts and vice versa
General morphology and life cycle of parasites

Unit-II

Protozoan parasites :
Protozoan parasites pathogenic to man
Life cycle, pathogenesis and treatment of :-
Entamoeba histolytica
Trypanosoma gambiense
Leishmania donovani
Plasmodium sp.

Unit-III

Helminth parasites :-
Life cycle, pathogenesis and treatment of
Taenia solium
Schistosoma haematobium
Trichinella spiralis
Ancylostoma duodenale
Ascaris lumbricoides

Suggested Reading Material:

Chatterjee, K.D. (1977). Parasitology , Chatterjee Medical Publishers, Calcutta, India.
Roberts, L. S. and Janovy, J. (2009). Foundation of Parasitology, 8th edition , McGraw Hill Higher Education, Boston.

ZOL 584: Biology of Chromosomes (Elective*)

Credit Hours-4

Unit I

Origin of genetics and chromosome theory of inheritance.

General features of mitotic chromosomes:

Centromeres, Kinetochores, telomeres, NOR and r RNA genes.

Molecular organization of chromosomes and chromatin:

Nucleosome, Packing nucleosomes into solenoids. Other ways to pack DNA.

Chromosomes in Interphase :

Interphase nuclei, arrangement of chromosomes, sites of replication transcription and nuclear matrix.

Unit II

Structure of mitotic and meiotic chromosomes:

Chromosome condensation, biochemistry of condensation, Meiotic and mitotic chromosomes compared.

Constitutive and facultative heterochromatin.

Sex chromosomes and Sex determination:

Evaluation and mechanisms of sex determination, Dosage Compensation and sex chromosomes in meiosis and gametogenesis.

Lampbrush, Polytene and B chromosomes:
their structure and role.

Unit III

Chromosomes, the karyotype and evolution:

Chromosomes and evolution.

Constraints on chromosome size, shape and number.

Chromosomes changes and speciation. Nucleotypic effects.

Chromosomes engineering and artificial chromosomes :

What is artificial chromosome ?

Future of artificial chromosome.

Suggested reading material:

Hartl, D. L. and Jones, E. W. (2006). Essential genetics, A Genomic Perspective. Jones and Bartlett Publishers, Sudbury, Boston.

Sumner, A. T. (2003). Chromosomes organization and function, Blackwell publishing, U.K

ZOP 571: Behavioural Zoology Exercises

Credit Hours-3

To investigate locomotive, associative learning and habituation in earthworm.

Study of latent and operant learning in rat.

Study of the phenomenon of thigmotaxis in insects.

Study of the phenomenon of geotaxis in insects.

Study of the phenomenon of photo taxis from point source and different colours of light (earthworm and insect).

Study of grooming behaviour, tarsal responses and equilibrium in cockroach, housefly and butterfly.

Study of chemosensory responses in insects.

Study of web spinning habits in spiders.

Study of behaviour patterns using slides / photographs.

Wild life projects.

ZOP 572: Techniques in Zoology

Credit Hours-3

Working, use and care of various types of microscopes.

Demonstration of working of weighing balances, autoclaves, incubators, laminar flow, water bath and centrifuge.

Qualitative and Quantitative estimation of Carbohydrates, Lipids and proteins

To prepare a buffer solution.

Study of absorption spectra of coloured solutions.

Preparation of Titration curve of weak acids and strong base and calculations of pKa value.

ZOP 573: Practicals in Specialized field

Credit Hours-3

Parasitology Lab.

- Permanent slides of Parasites.
- Preparation of blood films for the study of protozoans.
 - Wet Blood film
 - Dried and stained film
 - Thin and thick blood film
- Staining blood films for the study of Protozoa.
 - Leishman's stain
 - Romanowsky stain
- Identification of different kinds of blood cells in humans
- Extraction of plant –parasitic nematodes
- Extraction of insect-parasitic nematodes

ZOP 573: Practicals in Specialized field

Credit Hours-3

Entomology Lab.

Classification of insects upto order level

Modification of insect mouthparts, antennae, legs and wings.

Study of different body parts of Grasshopper.

Study of digestive, circulatory, excretory, nervous and reproductive system of grasshopper / cockroach.

Different types of insect larvae.

ZOP 573: Practicals in Specialized field

Credit Hours-3

Cytogenetics Lab.

Study of sex chromatin (Barr body, drumstick).

Study of meiosis from testicular follicles of Grasshopper and testis of rodent.

To determine chiasma frequency and terminalization coefficient from meiosis slides.

Karyological preparation from bone marrow of a rodent.

Localization of heterochromatin using C-banding technique.

Localization of active NOR's using Ag-NOR banding technique .

Study of DNA damage from micronucleated buccal mucosa cells.

ZOP 573: Practicals in Specialized field

Credit Hours-3

Aquatic Biology Lab:

To study physico-chemical characteristics of water (pH, temp, DO, alkalinity, electrical conductivity, turbidity, colour).

To measure solids (dissolved and suspended) in water.

To study the morphology of a cartilaginous and a bony fish.

Identification of freshwater fishes with the help of standard key.

Determination of age with help of scale.

To study the life cycle of a fish.

To study the position of mouth with respect to feeding habits of fish.

Effect of pH and temperature on fish.

ZOP 573: Practicals in Specialized field

Credit Hours-3

Earthworm biology- Practicals / Field work.

To culture earthworms in the Lab.

Life cycle of earthworm.

To study palatability of different kinds of leaves.

To collect worms and cocoon from your area.

To study distribution of earthworms in various habitats.C

Reaction of worms to moisture gradient in soil.

Identification of earthworms with the help of standard keys.

To study the effect of temperature on hatching time in earthworm.