

B.Sc. (Hons.) Zoology

Year.	Paper	THEORY Title	PRACTICALS			
			Examination		Examination	
			Marks	Duration	Marks	Duration
1st	I	ANIMAL DIVERSITY-I (NON-CHORDATA)	75	3 hrs.	75	5 hrs
	II	DEVELOPMENTAL BIOLOGY	75	3hrs		
2nd	III	ANIMAL DIVERSITY-II (CHORDATA)	75	3hrs		
	IV	BIOLOGICAL CHEMISTRY and IMMUNOLOGY	75	3hrs	100	5hrs
	V	ECOLOGY and ENVIRONMENTAL MANAGEMENT	75	3hrs		
3rd	VI	PHYSIOLOGY and FUNCTIONAL HISTOLOGY	75	3hrs		
	VII	GENETICS, GENOMICS and BIOTECHNOLOGY	75	3hrs	175	2 × 5 hrs
	VIII	EVOLUTION and ZOOGEOGRAPHY	75	3hrs		
	IX	CELL and MOLECULAR BIOLOGY	75	3hrs		
	X	OPTIONAL PAPER (any one of the following)	75	3hrs		
	(a)	APPLIED ENTOMOLOGY				
	(b)	REPRODUCTIVE BIOLOGY and HUMAN WELFARE				
	(c)	MEDICAL ZOOLOGY				

PAPER I: ANIMAL DIVERSITY I (Non- chordata)

All the non-chordate phyla when put together constitute the largest assemblage of biological world, which makes it most challenging yet equally interesting to study. A systematic study not only unfolds an almost entire picture of events of animal evolution but also the geological ch. Each phylum, as we go up in the phylogenetic hierarchy, reflects a major leap from the previous one, upwards or sideways in its organization in harmony with the conditions on the Earth. The syllabus has been drafted to enable the students to understand significant interphylar and intraphylar changes, and hence, the fundamental aspects of biology.

Theory

General characters and outline classification of different phyla

Protista:

Type study of *Euglena* and *Paramecium*

Locomotion, nutrition, reproduction and organelles in Protozoa; life history, transmission, pathogenicity and control of *Trypanosoma*, *Leishmania*, *Entamoeba* and *Plasmodium*

Metazoa:

Introduction, origin and evolution, symmetry, metamerism and coelom

Phylum Porifera:

Type study of *Sycon*; canal system, reproduction and skeleton in sponges

Phylum Cnidaria:

Type study of *Obelia* and *Aurelia*, polymorphism in Cnidaria; mesenteries in Anthozoa, corals and coral reefs

Phylum Ctenophora:

Type study of *Pleurobrachia*

Phylum Platyhelminthes:

Type study of *Dugesia* and *Fasciola*, life history, pathogenicity and control of important parasites in humans; parasitic adaptations and evolution of parasitism

Phylum Aschelminthes:

Type study of *Ascaris* and its parasitic adaptations; pathogenicity and control of important human parasites

Phylum Annelida:

Type study of *Pheretima* and *Hirudinaria*, adaptive radiations in Polychaeta, coelom, and excretion in Annelida

Arthropods:

Salient features of phyla Trilobitomorpha and Chelicerata

Phylum Crustacea:

Type study of *Palaemon*; larval forms of crustacea

Phylum Uniramia:

Type study of *Periplaneta*; social life, moulting and metamorphosis in Insecta; salient features of Myriapoda

Respiration, excretion and vision in arthropoda; affinities of Onychophora

Phylum Mollusca:

Type study of *Pila* and *Sepia*; hypothetical ancestral mollusc; torsion and detorsion, modifications of shell, mantle, foot and gills, and their significance; pearl formation and culture

Phylum Echinodermata:

Type study of *Pentaceros*; water-vascular system and larval forms; structure and function of Aristotle's lantern, evisceration in holothurians

Minor Phyla:

Type study and affinities of one representative each of Rhynchocoela, Acanthocephala, Rotifera, Brachiopoda, Chaetognatha and Bryozoa

Practicals Protista:

Examination of live protozoans-*Amoeba*, *Euglena*, *Monocystis*, *Paramecium*, *Balantidium* and *Opalina*

Study of *Trypanosoma*, *Leishmania*, *Entamoeba*, *Globigerina*, *Ceratium*, *Noctiluca*, foraminiferan and radiolarian ooze, *Plasmodium*, *Vorticella*.

Porifera:

Study of *Leucosolenia*, *Sycon* (including T.S. and L.S.), *Spongilla*, *Hyalonema*, *Euspongia* and *Euplectella*; temporary mounts of spicules, gemmules and spongin fibres

Cnidaria:

Study of *Hydra*, *Tubularia*, *Obelia*, *Sertularia*, *Physalia*, *Millepora*, *Aurelia*, *scyphistoma* and *ephyra* larvae, *Tubipora*, *Alcyonium*, *Gorgonia*, *Pennatula*, *Adamsia*, *Metridium* (including T.S. and L.S. through different regions) and *Fungia*.

Ctenophore:

Study of *Pleurobrachia* and *Beroe*

Platyhelminthes:

Study of *Fasciola*, *Fasciolopsis*, *Schistosoma*, *Taenia*, *Diphyllobothrium* and *Echinococcus*; life history and sections of *Fasciola* and *Taenia*

Aschelminthes:

Examination of live soil and aquatic nematodes

Study of *Oxyuris*, *Ancylostoma* and *Ascaris* (including sections)

Annelida:

Dissections- digestive, reproductive and nervous systems of earthworm; digestive, excretory and reproductive systems of leech

Temporary mounts ovary, pharyngeal and septal nephridia of earthworm; testicular nephridium and jaw of leech

Study of T.S. through pharynx, gizzard, seminal vesicles, prostate glands and typhlosolar intestine of earthworm; T.S. through pharynx and crop of leech;

Specimens: *Aphrodite*, *Heteronereis*, *Chaetopterus*, *Serpula*, *Arenicola*, *Sabella*, *Eutyphaeus*, *Pheretima*, *Tubifex*, *Hirudinaria*, *Tomopteris*, *Glossiphonia* and *Pontobdella*.

Arthropods:

Dissections- digestive and nervous systems of prawn; digestive, reproductive and nervous systems of cockroach

Temporary mounts- statocyst and hastate plate of prawn; mouth parts, salivary apparatus, trachea, testis and ovary of cockroach

Specimens/slides- *Limulus*, *Palamnaeus*, spider, tick, crustacean larvae, *Daphnia*, *Cypris*, *Cyclops*, *Lepas*, *Balanus* *Sacculina*, *Gammarus*, *Squilla*, *Cancer*, *Eupagurus*, *Hippa*, *Scolopendra*, *Julus*, silver fish, grasshopper, termite, bedbug, louse, wasp, honeybee, beetle, housefly, butterfly, silkworm and *Peripatus*,

Mollusca:

Dissections- digestive and nervous systems of *Pila*

Temporary mounts- radula and gill of *Pila*

Slides: T. S. gill of *Unio* and *Glochidium* larva

Specimens: *Chiton, Patella, Doris, Lymnaea, Helix, Limax, Dentalium, Unio, Mytilus, Pecten, Ostrea, Teredo, Loligo, Sepia, Octopus, Nautilus shell*

Echinodermata:

Temporary mounts- *Pedicellaria* and Aristotle's lantern

Slides: T. S. arm of *Pentaceros*, *echinoderm* larvae

Specimens- *Pentaceros, Astropecten, Ophiura, Astrophyton, Clypeaster, Echinus, Echinocardium, Spatangus, Cucumaria, Holothuria, Synapta, and Antedon*

Minor phyla:

Specimens- one each from those listed in theory

Suggested Reading

Barnes, R.D. *Invertebrate Zoology*. Saunders College Publishers 1980

Barnes, R.S.K., Calow, P. and Olive P.J.W. *The Invertebrates: A New Synthesis*.

Barrington, E.J.W. *Invertebrate Structure And Functions*. E.L.B.S. and Nelson .1971

Boradale, L.A. and Potts, F.A. *Invertebrates: (A Manual for the use of Students)*. Asia Publishing Home 1961

Bushbaun, R. *Animals without Backbones*. University of Chicago Press 1964

Hegner, R.N. *Invertebrate Zoology*. The Macmillan Company 1963
Blackwell Scientific Publications 1988

Laverack, M.S. and Dando, J. *Lecture Notes on Invertebrate Zoology*.
Blackwell Scientific Publications, Oxford 1979

Marshall, A.J. and Williams, W.D. *Text Book of Zoology Vol- I-Invertebrates*. Macmillan 1979

- Webb, J.E., Wallwork, J.A. and Elgood, J.H. Guide to Invertebrate Animals. English Language Book Society & Macmillan 1981
- Willmer, P. Invertebrate Relationships: Patterns in Animal Evolution. Cambridge University Press 1990.
- Willmoth, J.H. Biology of Invertebrates. Prentice Hall Biological Science Series. 1967

PAPER II: DEVELOPMENTAL BIOLOGY

The field of Developmental Biology has progressed tremendously in the past few decades owing mainly to expansions in Cell and Molecular Biology as well as Genetics. It is recognized that development of an embryo is a manifestation of changes in individual cells and that an understanding of the fundamental principles of development would come from studying cellular structure and function. Keeping these developments in view, a revision of the syllabus has been undertaken.

Besides the conventional topics, human development has been included as to make the study more relevant and interesting to students. Several new topics such as body plan and patterns during development have been included. Topics of general interest such as teratology and ageing find place in the revised contents.

Much of the current approach in developmental biology involves the cellular and intercellular events that signal the nucleus to express genes or initiate a sequence of gene expression. A chapter on developmental genetics and embryo technology focuses on the recent developments in stem cell research, cloning and transfer of genes to cells and tissues.

Theory

Introduction and general aspects of animal development:

History, Principles, Differentiation, Growth, Preformation, Epigenesis

Gametogenesis:

Formation of gametes, spermatogenesis, oogenesis, egg maturation, structure and growth of ovum, vitellogenesis, egg membranes and types of eggs

Fertilization:

Significance, types, changes in gametes, mono- and polyspermy

Parthenogenesis:

Natural and artificial, significance

Body plan during development:

Polarity, axis, gradient, cell lineage

Patterns of development:

Schizocoelous, enterocoelous, regulative, non-regulative development.

Cleavage patterns and blastulation; gastrulation in Amphioxus, frog, chick and human; fate maps, fate of germ layers.

Early vertebrate development - up to organ rudiment

Differentiation of germ layers: Ectoderm-neural tube, skin; mesoderm-notochord, somites, coelom, and endoderm-digestive tube

Organogenesis:

Development of central nervous system, sense organs- eye and ear.
Extra-embryonic membranes:

Structure, development and functions in chick and human.

Placenta:

Implantation, development of placenta, types and physiology

Regeneration:

Types, process of regeneration, factors, significance

Metamorphosis and Heterochrony:

Metamorphic changes, endocrine control and significance, allometry, progenesis, paedomorphosis/ neoteny in Amphibia.

Embryonic induction:

Tissue interaction and progressive determination of embryonic cells

Cellular interaction during development:

Cell affinity, cell interaction, extra-cellular matrix and its role in differentiation

Ageing:

Concepts and models

Teratology:

Effect of chemicals, X-rays, ionizing radiation, metals and drugs on embryonic development

Developmental genetics:

Role of genes in development, amniocentesis, *in vitro* fertilization, stem cell culture and cloning, transfer of genes into animal oocytes, embryos and animal tissues, biosafety and ethical issues of cloning.

Practicals

Frog: Study of developmental stages-whole mounts and sections; cleavage stages, blastula, gastrula, neurula, tail bud stages, tadpole.

Chick: Study of whole mounts and sections of chick embryo at different stages: primitive streak, 24, 28, 32, 48, 72 and 96 hours/ H.H. Stages.

Sections of placenta.

Examination of frog / rat- sperms and ova.

A report on visit to Poultry farm, Hatchery; Tissue culture laboratory, Animal breeding centers

Suggested Reading

- Austin" C.R, and Short, R.V. Embryonic and Foetal development. Cambridge Univ. Press. 1982
- Balinsky, B.I. Introduction to Embryology. Saunders College Publishers, Philadelphia. 1981 .
- Berril, N.J. and Carp, G. Developmental Biology. Tata-McGraw Hill. 1976.
- Carlson, B.M. Patten's Foundations of Embryology. McGraw-Hill Inc. 1996.
- Davenport. An Outline of Animal Development. Addison- Wesley.
- Gilbert, S.F. Developmental Biology. Sinauer Associates Inc. Publishers 2003.
- Grant and Philip. Biology of Developing Systems. Holt and Rinehart.
- Hopper. Foundations of Animal Development. Oxford University Press.
- Larsen, J. W. (ed) Human Embryology. Churchill Livingstone.
- McEwen, R. S. Vertebrate Embryology. Oxford I.B.H. 1973
- Oppenheimer, S.B. Introduction to Embryology. Allyn and Bacon. 1981.
- Sussman. Animal Growth and Development. Prentice Hall.

PAPER III : ANIMAL DIVERSITY II (CHORDATA)

The study of chordates arouses curiosity about their organization and behaviour. This group also has an immense potential and utility in integration with modern scientific fields of bioengineering, biomechanics and biophysics. Contemporary studies of Chordata thus need to be carried out not only in terms of their structure and function but also extended to their inter-relations with other disciplines. The present draft provides a strong and comprehensive base for studies of diverse chordates with this perspective.

Theory

Introduction to major and satellite characters of Chordata; outline classification, theories and speculations on origin

Protochordata:

Classification up to orders; general characters of Hemichordata, Urochordata and Cephalochordata; structure and post-embryonic development of larval forms and their significance in Chordate phylogeny; affinities of protochordates

Vertebrata:

Advancement over Protochordates

Agnatha:

Classification up to classes

Pisces:

Classification- Placoderms up to subclasses, Chondrichthyes (extant) up to suborders. Osteichthyes up to orders; migration and parental care in fishes

Amphibia:

Classification- Labyrinthodontia up to orders; Lisamphibia up to suborders; origin and evolution of terrestrial ectotherms; parental care in amphibia

Reptilia:

Classification- Diapsida (Lepidosauria and Archosauria) up to suborders and others up to orders; *affinities of Sphenodon*; biting mechanism in snakes

Aves:

Classification up to orders; rostral and pedal modifications in Palaeognathae and Neognathae; flight adaptations; principles and aerodynamics of bird flight; migration and origin

Mammalia:

Classification- Prototheria and Metatheria up to families, Eutheria up to orders; eco- location in bats, origin of mammals

Comparative account of the following:

Integument- Structure, function and derivatives

Digestive system -Alimentary canal and associated glands

Circulatory system- General plan; evolution of heart and aortic arches; venous and lymphatic systems

Respiratory system- Skin, gills, lungs, air sacs and voice apparatus; airbladder and accessory breathing organs in fishes; mechanism of breathing

Skeletal system- General plan of axial and appendicular skeleton; jaw suspensorium, visceral arches; evolutionary trends and adaptations of vertebral column, girdles and limbs to terrestrial life

Sense organs- Types of sensory receptors; structure and working of eye and ear in mammals

Nervous system- Central and autonomic; cranial nerves

Urinogenital system- Succession of kidney; evolution of urinogenital ducts, urinary bladder and uterus

Practicals

Protochordata:

Study of *Balanoglossus*, *Herdmania*, *Ciona*, *Botryllus*, *Salpa*, *Doliolum*, *Pyrosoma* and *Branchiostoma*, *Balanoglossus*-sections through proboscis, collar, branchio-genital and hepatic region; *Herdmania*-W.M. of branchial sac and spicules; *Amphioxus*- oral hood (W.M), velum (W.M.) and sections through pharyngeal (with and without gonads), intestinal and caudal region

Pisces:

Dissections- afferent branchial system, cranial nerves and internal ear of *Scoliodon*, Weberian ossicles and air bladder of *Mystus* Temporary unstained mounts- placoid, cycloid and ctenoid scales

Study of *Petromyzon*, *Myxine*, *Scoliodon*, *Sphyrna*, *Rhinohatus*, *Pristis*, *Myliohatus*, *Trygon*, *Torpedo*, *Chimaera*, embryo of shark with yolk sac, egg case of skate, *Notopterus*, *Hilsa*, *Labeo*, *Catla*, *Barbus*, *Clarias*, *Heteropneustes*, *Wallago*, *Anguilla*, *Mystus*, *Exocoetus*; *Diodon*, *Ostracion*, *Tetrodon*, *Antennarius*, *Fistularia*, accessory branchial organs of *Anabas*, *Clarias* and *Heteropneustes* (to be studied from dissected specimens)

Osteology- articulated skeleton of *Scoliodon*, axial, opercular and appendicular skeleton of *Labeo* *Mystus*

Amphibia:

Dissections- cranial nerves, arterial, venous and urinogenital systems of frog Temporary mount- hyoid apparatus of frog

Study of *Uraeotyphlus*, *Necturus*, *Salamandra*, *Alytes*, *Bufo*, *Hyla* and *Rhacophorus* Osteology- disarticulated skeleton of frog

Reptilia:

Study of *Chelone*, *Dermochelys*, *Testudo*, *Kachuga*, *Trionyx* or *Lissemys*, *Heyrcidaectylus*, *Calotes*, *Varanus*, *Uromastix*, *Mabuia*, *Ophisaurus*, *Chamaeleon*, *Draco*, *Typhlina*, *Python*, *Eryx*, *Xenochrophis*, *Natrix*, *Ptyas*, *Dendrelaphis*, *Bungarus*, *Naja*, *Hydrophis*, *Enhydrina*, *Viper*, *Echis* and *Crocodilus*

Osteology- disarticulated skeleton of *Varanus*, skull, lower jaw and vertebrae of snake; skull, lower jaw, carapace and plastron of tortoise, skull and lower jaw of crocodile

Aves:

Dissection- brain of fowl

Temporary mounts- pecten, barbs and columella auris of fowl

Study of a dozen common birds of Delhi, types of feathers

Osteology- disarticulated skeleton of fowl; different types of palate in birds

Mammalia:

Dissections- arterial, venous and urinogenital systems, neck region, ear ossicles and brain of rat.

Study of *Paraechinus* or *Hemiechinus*, *Suncus*, *Pteropus* or *Rousettus*, *Pipistrellus* or *Hipposideros*, *Loris*, *Oryctolagus*, *Funambulus* and *Herpess*

Osteology-disarticulated skeleton of rabbit; skulls of cow, horse, goat, camel, dog, cat, *Loris*, langur/macacca, human, hedgehog/ shrew, insectivorous bat, frugivorous bat, squirrel and mongoose to study dietary adaptations.

Report on field trip to Delhi Zoological Park, National Museum of Natural History or a wildlife sanctuary/national park

Suggested Reading

Colbert, E. H. *Evolution of Vertebrates*. Wiley Eastern Pvt. Ltd. 1970

Hilderbrand, M. and Gaslow, G.E. *Analysis of Vertebrate Structure*. John Wiley and Sons 2001

Kardong, K. V. *Vertebrates Comparative Anatomy, Function and Evolution*.

Kent, G.C. and Carr R.K. *Comparative Anatomy of the Vertebrates*. The McGraw Companies Inc. 2001

Miller, S.A. and Harley, J.B. Zoology. Tata McGraw Hill Publishing Company 2002

Parker, T.J. and Haswell, W.A. Text Book of Zoology-Vertebrates. ELBS and McMillan 1995

Pough, F.H. Vertebrate Life. Prentice Hall of India 1996

Walter, H.E, and Sayles, L.P. Biology of the Vertebrates Khosla Publishing Home, N.Delhi 1994

Weichert, C.K. Anatomy of Chordate. McGraw Hill International Book. Co. 1970

Young, J.Z. The Life of Vertebrates. ELBS , Oxford Univ. Press 1962

PAPER IV : BIOLOGICAL CHEMISTRY AND IMMUNOLOGY

In drafting this paper we have endeavoured to make the language of biological chemistry clear and well focused so as to help even an average Zoology student overcome the fear of chemical formulae. Biomolecules have been dealt with in detail so that the subsequent understanding of metabolic pathways does not become a mechanical learning effort. Wherever possible, biological significance of the molecules and pathways have been highlighted so that the students relate biochemical reactions to the working of their own body. Metabolic disorders have been included for the same purpose. Immunology, in view of its surging interest and application, is being introduced as a separate part of the paper. The focus again has been on developing basic concepts. Some of the techniques, which have made strides in the subject, have been woven into the teaching of this paper.

Theory

BIOLOGICAL CHEMISTRY

Carbohydrates:

Structure and physiological importance of mono-, di- and polysaccharides

Lipids:

Structure, nomenclature and functional significance of fatty acids, triglycerides, phospholipids, glycolipids and steroids; lipid peroxidation, and role of antioxidants.

Amino acids and Proteins:

Structure and general properties; role of chaperones in protein conformation, physiologically important peptides and proteins

Carbohydrate metabolism:

Pathways and regulation of glycolysis; citric acid cycle; pentose phosphate pathway; gluconeogenesis, shuttle systems and their significance, disorders of carbohydrate metabolism

Lipid Metabolism:

Pathways and regulation of β -oxidation of fatty acids; ketogenesis; biosynthesis of saturated fatty acids; metabolism of adipose tissue; action of phospholipases; lipoprotein complexes; disorders of lipid metabolism

Protein metabolism:

Overview of protein degradation; catabolism of amino acids: transamination, oxidative deamination; blood transport of amino nitrogen; biosynthesis of urea and its regulation; fate of glucogenic and ketogenic amino acids; disorders of amino acid catabolism

Intermediary metabolism:

Inter-relationships of carbohydrate, lipid and protein metabolism

Enzymes:

Nomenclature, classification, kinetics, mechanism of action, inhibition

Bioenergetics and biological oxidation:

Free energy change in biochemical systems; energy state of a cell; ATP and other high-energy phosphates as energy carrier; concept of redox systems; respiratory chain and its inhibitors; oxidative phosphorylation in mitochondria

IMMUNOLOGY

Overview of immune system:

Historical perspective, clonal selection theory; cardinal features of vertebrate immune system; innate, active and passive immunity

Cells and organs of immune system:

Haematopoiesis, immune system cells, lymphatic system, primary and secondary lymphoid organs

Generation of immune response:

Antigens, immunogens and haptens; factors influencing immunogenicity; recognition of antigens; properties of B-cell and T-cell epitopes

Molecules recognizing antigens:

Immunoglobulins- basic structure; classes and functions; antigen-antibody interactions; polyclonal sera; monoclonal antibodies and hybridoma technology; antigen processing and presentation; major histocompatibility complex

Immune effector mechanisms:

Cytokines; complement system; hypersensitive reactions; immune system in health and disease: vaccines, autoimmunity, AIDS; diagnostic tools

Practicals

BIOLOGICAL CHEMISTRY

Preparations:

Normal, molar and standard solutions; phosphate/citrate buffer; serial dilutions: use of micropipettes

Qualitative techniques:

Colour reactions to identify functional groups in given solutions of carbohydrates, proteins and lipids; paper chromatography of a mixture of sugars and of amino acids.

Quantitative techniques:

Estimation of glucose and total protein in given solution by using colorimeter

Enzymology:

Study of the action of salivary amylase, trypsin, pepsin and lipase using fresh tissue extracts; effect of pH, temperature and inhibitor on the action of salivary amylase; effect of substrate concentration on the activity of a suitable enzyme Detection of abnormal constituents in urine Study of biological oxidation using liver extract

IMMUNOLOGY

Isolation, staining and counting of mononuclear cells from peripheral blood

Double simple immunodiffusion test (Ouchterlony method)

Zone electrophoresis of serum using cellulose acetate as support medium

ABO blood group determination

Preparation and viability test of splenocytes

Phagocytic activity of splenocytes on yeast cells *in vitro*

Estimation of immunoglobulins

Theoretical knowledge of ELISA and RIA

Suggested Reading

- Champe, P.C. and Harvey, R.A. Biochemistry: Lippincott's Illustrated Reviews. J.B.Lippincott and Co. 1994
- Devlin, T.M. Biochemistry. John Willey and Sons 1982
- Hames, B.D., Hooper, N.M. and Houghton, J.D. Instant notes in Biochemistry Viva Books Pvt. Ltd. 1998
- Lehninger, A.L., Nelson, D.L. and Cox, M.M. Principles of Biochemistry. CBS Publishers and Distributers. 1993
- Murray, R.K., Granner, D.K., Mayes, R.A and Rodwell, V.W. Harper's Biochemistry. Prentice Hall International Inc.. 1996
- Richard, A.G, Kindt, T.J., Osborne, B.A. and Kuby, J. Immunology. W.H. Freeman and Co., N.Y. 2003
- Roitt, I.M. Essential Immunology. Blackwell Scientific Publications. 2001

PAPER V: ECOLOGY AND ENVIRONMENTAL MANAGEMENT

In revising the syllabus of this paper, an attempt has been made to make the teaching of Ecology and Environmental Management more interactive and informative for both students and teachers alike. Besides dealing with the fundamental aspects of population and community ecology, ecosystems and biomes, a new section on Environmental Management has been included keeping in view the current global environmental awareness. This section deals not only with the physical and biological resources of the environment at length but also highlights topics like urbanization, waste management, disaster management and oil spills, which all have a mass appeal.

Theory

ECOLOGY

Introduction to ecology, concepts of species, population, community, ecosystem, biome and biosphere; laws of limiting factors

Population Ecology:

Density, natality, mortality, age ratio, sex ratio, dispersal and dispersion of population; exponential and logistic growth, Verhulst- Pearl growth equation, 'r' and 'k' strategies; density dependent and independent regulation; population fluctuation and cycles; Perspectives of human population growth, demographic transitions and population control

Population interactions under field and laboratory conditions, Gause's principle, Lotka-Volterra model and multidimensional niche concept; predation- types, predator-prey-system examples, evolution and significance; functional and numerical response, host-parasite interactions, social parasitism and evolution of parasitism

Community and Ecosystem Ecology:

Community characteristics- organization, life forms/life zones, stratification, dominance, species diversity, relative abundance and succession; community development-succession in different habitats, theories of climax and bioenergetics of ecosystem development; estimation of primary and secondary productivity and influencing factors, ecotone and edge effect; ecosystem- classification and examples, food chain, food web, trophic levels. energy flow, ecological pyramids and ecological efficiency; biogeochemical cycles of nitrogen, sulphur and carbon in ecosystems; role of organisms in nutrient cycling

Biomes:

Structure and function of the terrestrial and aquatic biomes

ENVIRONMENTAL MANAGEMENT

Acquaintance with various aspects of environmental management

Physical Resources:

Use, degradation (mining and erosion) of land; soil pollution and control

Composition and structure of atmosphere, air pollution- sources, effects on human health and control

Hydrologic cycle, sources, uses and management of water resources, ground water and drinking supplies, causes and consequences of water pollution and its control; oil spills

Biological Resources:

Biodiversity- types and significance, natural forests, wildlife- an ecological necessity, causes of its depletion, major wildlife sanctuaries/ parks and biosphere reserves in India; endangered and threatened species of wild animals in India; principles of wildlife management

Renewable and Nonrenewable resources:

Conservation and needs

Global issues:

Green house effect, ozone depletion, acid rain, urbanization, disaster- and waste management; environmental policies and legislation

Practicals

Study of an aquatic ecosystem- Measurements of total area, locality, temperature and turbidity/penetration of light; determination of pH, dissolved oxygen content (Winkler's method) and dissolved carbon dioxide; study of biotic community with special reference to plankton

Plotting of survivorship curves from hypothetical life table data

Determination of density, abundance, frequency of occurrence and diversity index of a species in a community by quadrat method

Mechanical analysis of soil from various habitats by sieve method

Chemical analysis of soil for pH, nitrites and carbonates

Study of the ecological significance of five representatives of each of the following: phytoplankton, zooplankton, fishes, amphibians, reptiles, aves and mammals

Study of a few endangered reptiles, birds and mammals of India

Report on a visit to National park / Wildlife sanctuary / Waste management organization-TERI, Mahatma Gandhi Institute for non conventional energy sources, (BAKOLI village), Solar Power Station at Gawal Pahari, Gurgaon, and Sulabh International

Suggested Reading

Botkin, D. and Keller, E. Environmental Science- Earth as a Living Planet. John Wiley and Sons 1995

Colinvaux, P. A. Introduction to Ecology. John Wiley and Sons

Cunningham, W.P. and Saigo, B.W. Environmental Science. WCB, McGraw Hill 1999

Faurie, C" Ferra, C., Medori, P. and Devaux, J. Ecology (Science and Practice). pxford and IBH Publishing House

Grosse, G.M. and Marsh, W.P. Environmental Geography. John Wiley and Sons.

Krebs, C.J. Ecology. Harper and Collins 1985

McNaughten, S.J. and Wolf, L.L. General Ecology. Holt, Rinehart and Winston 1973

Michael, P. Ecological Methods for Field and Laboratory Investigations. Tata McGraw Hill.

Odum, E.P. Fundamentals of Ecology. W.B. Saunders 1971

Raven, B and Johnson. Environmental Science. Saunders College Publishing 2001

Ricklefs, R.E. Ecology. Chiron Press

Smith, R.L. Ecology and Field Biology. Harper and Collins 1996 Turk, J.
Introduction to Environmental Studies. W.B. Saunder

Tyler, G. and Miller Jr Environmental Science, Working with the Earth
(Brooks /Cole)

Wright, R. T. and Nebel, B. J. Environmental Science-Towards sustainable
future. Asoke K. Ghosh 2002

PAPER VI : PHYSIOLOGY AND FUNCTIONAL HISTOLOGY

Physiology is a nodal science among the subdivisions of Zoology. The modern Zoology is tending more and more towards a reductionist and mechanistic approach so much so that students are in danger of studying processes in isolation without a proper understanding of the functioning at the organism level. The science of physiology bridges this schism between the "classical zoology" and molecular biology. The following syllabus has been drafted keeping this viewpoint in mind. Emphasis has been placed on histological structures, which have been correlated with their functional aspects. This brings new insights into the functioning of organs in isolation and sum of the organ's functioning with its cumulative impact at the level of the organism.

Theory

(with reference to human)

Tissues and glands:

Concept and Classification- Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue, and types of glands

Bone:

Structure and types, ossification, bone growth and resorption, effect of ageing on the skeletal system and bone disorders

Nervous System:

General organization: Neurons resting membrane potential and its basis; origin of action potential and its propagation in myelinated and unmyelinated nerve fibres. Neurodegenerative diseases and neurogenesis. Synaptic transmission; types of synapses; microscopic anatomy of synaptic linkages; the neuro-muscular junction, excitatory and inhibitory synapses; neurotransmitters- their release and action; synaptic facilitation and inhibition, EPSP and IPSP summation of postsynaptic potentials; states of synaptic malfunction. Reflex activity-reflex arc; types of reflexes. Physiology of hearing and vision.

Muscle:

Histology of different types of muscle; ultra structure of skeletal muscle: molecular composition of myofilaments; sarcoplasmic reticulum and T-tubules, excitation-contraction coupling and control of contraction-relaxation cycle; mechanism of muscle contraction, sliding filament model; muscle metabolism; characteristics of muscle twitch- isometric and isotonic contractions; summation and tetanus; motor unit and muscle dystrophies

Heart:

An outline structure of heart; coronary circulation; origin and conduction of cardiac impulse; cardiac cycle; cardiac output and its regulation-Frank-Starling law of the heart, autonomic control and chemical regulation of heart rate.

Blood pressure and its regulation; electrocardiogram; disorders of the cardiovascular system

Blood

Composition; structure and function of haemoglobin; blood substitutes; haemopoiesis; haemostasis; coagulation of blood; disorders of blood

Respiratory system:

Histology of trachea and lung; pulmonary ventilation; respiratory volumes and capacities, transport of oxygen in the blood (oxygen-haemoglobin dissociation curve and its influencing factors), carbon

monoxide poisoning; carbon dioxide transport in the blood; regulation of acid-base balance; control of respiration

Excretory system:

Histology of kidney, ureter and bladder; renal blood supply; mechanisms and regulation of urine formation; regulation of acid-base balance; renal failure and dialysis

Digestive System:

Histology and function of gastrointestinal tract and the associated glands; mechanical and chemical digestion of food; role of gastrointestinal hormones; control and action of gastrointestinal tract secretions; absorption of carbohydrates, lipids, proteins, water, minerals and vitamins; disorders of the digestive system

Endocrine System:

Histology and function of endocrine glands; nature of hormones; regulation of hormone secretion; mode of action of hormones, signal transduction pathways utilised by steroidal and nonsteroidal hormones; hypothalamus- principal nuclei involved in control of endocrine system, control of anterior pituitary hormones by hypothalamic releasing hormones (neuroendocrine mechanisms); effects of hyper- and hyposecretion of hormones; placental hormones

Reproductive system:

Histology of the male and female reproductive systems; puberty physiology of male and female reproduction; methods of contraception (depicted through flow chart); disorders of reproductive system

Practicals

Effects of isotonic, hypotonic and hypertonic salines on erythrocytes

Enumeration of red blood cells using haemocytometer

Enumeration of the total and different types of white blood cells

Estimation of haemoglobin content of blood using Sahli's haemoglobinometer.

- Preparation of haemin and haemochromogen crystals
- Recording of frog's heart beat in situ and with perfused heart
- Recording simple muscle twitch with electrical stimulation of the sciatic nerve-Gastrocnemius muscle preparation of frog.
- Pulmonary volume recording in humans using a spirometer.
- Demonstration of the knee jerk reflex.
- Recording of blood pressure using a sphygmomanometer.
- Preparation of temporary mounts using suitable animals, squamous epithelium, ciliated epithelium, striated muscle fibres, nerve cells, spermatozoa, blood film
- Examination of sections of mammalian skin, salivary glands, oesophagus, stomach, duodenum, ileum, rectum, liver, pancreas, spleen, trachea, lung, kidney, cartilage, bone, pituitary, adrenal, thyroid, parathyroid, ovary and testis
- Microtomy of mammalian organs (at least 5)

Suggested Reading

- Arey, L.B. Human Histology. Khosla Publishing House
- Beresford, W. Lecture Notes on Histology. Blackwell Scientific Publishing/ PG Asian Economy Edition 1986
- Di Fiore, S. Atlas of Human Histology. Lippincott Williams and Wilkins 2000
- Freeman, W.H. and Bracegirdle, B. An Atlas of Histology. ELBS/ Heinemann Educational Books 1987
- Ganong, W.F. Review of Medical Physiology. Prentice Hall International Inc. 1995

Garg, K., Bahl, I. and Kaul, M. A. Textbook of Histology (A colour Atlas and Text). CBS Publishers and Distributors. 1997

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Ross, M and Reith, E. Histology-A Text and Atlas. Harper and Row Publishers/ J.B. Lipincott Co. 1985

Tortora, G.J. and Grabowski, S. Principles of Anatomy and Physiology, Harper Collins.2001

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PAPER VII: GENETICS, GENOMICS AND BIOTECHNOLOGY

With the advent of recombinant techniques the science of genetics has crossed a major milestone. The DNA sequences of a number of organisms including humans have already been worked out. This represents a major advancement, and a new branch of genetics called genomics is developing rapidly. Moreover, recent developments in molecular biology and biotechnology have impacted heavily almost all disciplines of biological sciences. The syllabus of this paper has been prepared keeping in mind the importance of classical genetics and the significance of recent developments. The first part of this paper includes concepts of classical genetics (Mendelism, linkage, crossing over etc.) followed by select topics in genomics. In addition, topics on basic techniques in biotechnology and applications of recombinant DNA technology in medicine, development of vaccines, gene therapy, plant biotechnology and cloning of animals have been included.

Theory

Mendelism and its extensions:

Mendel's study of heredity, applications of Mendel's principles, extensions of genetic analysis, gene interactions (incomplete dominance and co-dominance, multiple alleles, epistasis, pleiotropy, environmental effects on gene expression), lethal genes, polygenes, cytoplasmic inheritance

Linkage, crossing over, and chromosome mapping in eukaryotes:

Normal and abnormal human karyotype, linkage, recombination and crossing over-frequency of recombination as a measure of linkage intensity, crossing over as the physical basis and causal factor of recombination, chiasmata and the time of crossing over, cytological basis of crossing over; chromosome mapping -crossing over as a measure of genetic distance, two factor crosses, three factor crosses, recombination frequency and genetic map distance, chiasma frequency and genetic map distance, genetic distance and physical distance; linkage analysis in humans-detection of linkage loci by pedigree analysis; somatic cell genetics- an alternative approach to gene mapping

Genetics of microorganisms and transposons:

Transformation, conjugation, transduction, transposons in bacteria and eukaryotes

Mutation:

Types, molecular basis, and measurement of mutation

Sex determination:

Chromosomal mechanisms

Genomics:

An overview; human genome project (genomes of bacteria, *Drosophila* and humans). Evolution and comparative genomics; Bioinformatics- introduction, genetic data basis, sequence similarity and alignment, gene feature identification

Biotechnology techniques:

Enzymes used in cloning and cloning vectors; transformation techniques (chemical, electroporation, microinjection, gun projectile method); construction and screening of DNA libraries; molecular analysis of DNA, RNA, and protein (analysis of DNA by southern blot hybridizations, analysis of RNA by northern blot hybridizations, analysis of proteins by western blot techniques, DNA sequencing, PCR, DNA microarrays)

Application of recombinant DNA technology:

Recombinant DNA in medicine and industry (recombinant insulin, recombinant human growth hormone produced in bacteria, recombinant vaccines, human gene therapy and stem cells); Transgenic Plants and Animals (insect resistant and high yielding plants, generation of transgenic animals and their applications); human genetics, eugenics and ethical, legal and social issues; Gene and diseases- molecular mechanism of genetic disorders (albinism, cystic fibrosis, HN infection, inborn errors of metabolism, molecular diagnosis of human diseases; RFLP, RAPD, forensics, DNA fingerprinting; Human cloning, Dolly and Polly, scientific significance, therapeutic implications

Practicals

Mendelian ratio calculations- seed sample analysis to demonstrate simple ratios and various interactions.

Statistical analysis, probability, chi-squares

PTC (Phenyl Thiocarbimide) test to calculate frequency of genes in population and verify Hardy-Weinberg's law.

Analysis of human karyotype (normal and abnormal)

Genomic DNA isolation from *E. coli*

DNA sequence analysis from the data provided

DNA fingerprinting analysis

Preparation of restriction maps of plasmids from the data provided

Transformation of *Escherichia coli* by chemical technique

Plasmid isolation from *E. coli* culture

Restriction digestion of plasmid DNA

Suggested Reading

- Benjamin, P.A.B Genetics: A conceptual Approach. W.H. Freeman and Co. New York 2002
- Brown, T'.D. Gene cloning and DNA Analysis. Blackwell Science. 1999.
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- Gardner, E.J. Principle of Genetics.
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- Snustad, D.P., Simmons, M.J. Jerkine, J.B. Principles of Genetics. John Willey and Sons Inc. 1997
- Strickberger, M.W. Genetics. Macmillan Publishing Gompany, New York 1968
- Watson, J.D. Rcombinant DNA. W.H. Freeman and Co., New York 1992

PAPER VIII : EVOLUTION AND ZOOGEOGRAPHY

'Nothing in biology makes sense except in the light of evolution' - Dobzhansky Considering the significance of this discipline, its contents have been revised in the light of recent researches in molecular genetics, which has had a profound effect on our understanding of the evolutionary process. Evolution is thus no longer a theoretical explanation of historical events. Several new topics pertaining to origin of life, molecular basis of evolution, balanced polymorphism, co-evolution, group and kin selection, sexual and artificial selection, anagenesis, cladogenesis, phyletic gradualism, punctuated equilibrium, and cultural human evolution have been included. A whole new unit on extinction has also been added. The section on Zoogeography acquaints the students with the present day distribution of animals in relation to various evolutionary events.

Theory

EVOLUTION

History of evolutionary thought:

Pre-Darwinian concepts, Darwinism, post-Darwinian concepts-
modern synthetic theory

Life's beginnings-an overview:

Chemogeny, Protein-first or RNA-first hypothesis, protocells

Evidences of Evolution:

Paleobiological evidences- fossils (types, dating and determination of
evolutionary rates), phylogeny of horse

Molecular evidences- biochemical and serological, gene families, and
molecular clock

Process of Evolutionary change:

Organic variation-types, sources (mutation, recombination); concept
of population, gene pool, gene frequency together with its conservation
(Hardy-Weinberg equilibrium) and change (genetic drift, gene flow, fitness,
selection coefficient, genetic load); natural selection in action-kinds of
selection, industrial melanism, adaptive resemblances (coloration and
mimicry), balanced polymorphism, co-evolution, group and kin selection,
character displacement, principle of competitive exclusion, sexual selection:
selection in microorganisms; artificial selection and its applications

Product of the Evolutionary process: Speciation

Concept of species and subspecies, isolating mechanisms, modes of
speciation (allopatric, sympatric, peripatric), anagenesis, cladogenesis, levels
of evolutionary change (micro-and macroevolution), concept of orthotely,
bradytely and tachytely, phyletic gradualism, punctuated equilibrium

Extinction:

Periodic and mass-scale, possible causes

Human origin and evolution:

Primate and hominid characteristics, evolutionary trends and speciation, reference to cultural evolution

ZOOGEOGRAPHY

Patterns of distribution- types and theories, continental drift, plate tectonics, centers of dispersal, barriers to dispersal, zoogeographical realms and their fauna, peculiarities of Indian fauna; distribution on continental and oceanic islands, particularly Galapagos archipelago; ecogeographical rules (Bergmann, Alien, Gloger, Rapoport); parallel, convergent and divergent evolution; endemism

Suggested Reading

Dobzhansky, T., Ayala, F.J., Stebbins, G.L., Valentine, J.W. *Evolution*. Freeman, U.S.A. 1977

Dodson, E.O. Dodson, P., *Evolution: Process and Product*. D. Van Nostrand. 1964

Futuyama, D.J. *Evolutionary Biology*. Sinauer Associates, U.S.A., 1998

Lull, R.S. *Organic Evolution*

Mayr, E. *Animal species and Evolution*. Harvard University Press, U.S.A., 1963

Moody, P. A., *Introduction to Evolution*. Harper and Row. 1970

Ridley, M. *Evolution*. Blackwell Science, U.S.A., 1996

Savage, J.M. *Evolution*. Holt, Rinehart and Winston, U.S.A., 1969

Strickberger, M.W. *Evolution*. Jones & Bartlett, U.S.A., 1996

Watson, J.D. Gilman, M., Witkowski, J., Zeller, M. *Recombinant DNA*. Scientific American Books, U.S.A. 1992

PAPER IX: CELL AND MOLECULAR BIOLOGY

Cellular structure and function is the foundation of almost all fields of biology. The present draft attempts to provide a coherent insight into the viral and bacterial organization besides plant and animal cells. The syllabus has been revised and upgraded to include the latest techniques for cellular study as well as the recent advances in molecular make-up of cells. The topics on gene organization, expression and regulation have been made more exhaustive to include the advances in the field since the discovery of the double helix. To benefit Molecular Biology in the title, the topics in general have been dealt with in their broad biological context. As virtually all human disorders can be traced to disruption of activities at cellular and molecular levels, cell signalling and programmed cell death have been added with the human perspective in mind.

Theory

General introduction:

Overview of animal and plant cell: Cell size and shape; organisms as experimental *models*-*Sachharomyces cerevisiae*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila melanogaster* and *Xenopus laevis*, Viruses-broad categories, lytic and lysogenic cycles, viroids, prions, mycoplasma, and *E. coli*

Techniques:

Confocal, scanning and fluorescence microscope, phase contrast and Nomarski interference microscope; tissue culture; use and detection of radioisotopes, spectrophotometry; x-ray diffraction analysis, enzyme histochemistry

Cell membrane:

Models of plasma membrane; types of membrane transport; specialization of cell surface, extra-cellular matrix of animal cells

Endomembrane system:

Endoplasmic reticulum (ER) and Golgi- morphology, isolation, composition; targeting and entry of proteins into ER; glycosylation of proteins in ER; processing of oligosaccharide chains in Golgi; protein sorting and export from Golgi, coated pits and vesicles and their role in cellular transport

Lysosomes:

Separation, structure, composition, polymorphism, functions and biogenesis

Peroxisomes:

Structure, composition, functions in animals and plants; biogenesis.

Mitochondria:

Structure, fractionation, marker enzymes, composition, topography of electron transport system, transport of metabolites across the inner membrane, superoxide dismutase and catalase, biogenesis, semiautonomous organelle, symbiont hypothesis, respiration versus fermentation

Cytoskeleton:

Mitotic apparatus, microtubules-structure, assembly and dynamic instability, role in chromosomal movements; models of chromosomal movements, role of kinesin in vesicle and organelle transport; cilia and flagella

Nucleus:

Nuclear envelope (NE)- structure of nuclear pore complex, nuclear lamina, NE during mitosis, transport across NE; Chromatin: molecular organization, DNA packaging in prokaryotes, levels of chromatin packaging in eukaryotes - heterochromatin and euchromatin, nucleolus and its role in ribosome, biogenesis, polytene and lampbrush chromosomes

Genetic material:

Miescher to Watson and Crick - historic perspective, DNA structure- salient features of double helix, types of DNA, genome size, types of genetic

material, denaturation and renaturation, cot curves, genome complexity; telomeric, mitochondrial and chloroplast DNA

Cell cycle:

Molecular events during different phases, role of cyclins and checkpoints

DNA replication (pro- and eukaryotes):

Types of replication, DNA polymerases and other enzymes at replication fork, DNA synthesis at telomeres, kinds of DNA damage and excision repair, inhibitors of DNA synthesis

Transcription (pro-and eukaryotes):

Types and structure of RNA, role of polymerases, transcriptional factors and promoters, initiation, elongation and termination of transcription, post-transcriptional modifications and inhibitors

Translation:

Genetic code (GC)- general characteristics and deciphering, codon bias. (near) universality of GC, GC in mitochondria and chloroplasts

Protein synthesis-role of protein factors, co- and post-translational modifications and inhibitors of protein synthesis in pro- and eukaryotes, mitochondria and chloroplasts

Regulation of gene expression:

Prokaryotes- lactose system of *E. coli* and the operon concept, tryptophan operon attenuation,

Eukaryotes- at genomic, transcriptional, post-transcription, translation and post-translational levels.

Cell-signalling:

Modes - endocrine, paracrine and autocrine signalling, Ex. steroid and peptide hormones, growth factors, nitric oxide, eicosanoids and plant hormones; functions of cell surface receptors-G protein-coupled receptors, receptor protein-tyrosine kinases and receptors linked to other enzymatic activities

Intracellular signal- transduction: cAMP, cGMP, phospholipids (inositol triphosphate, diacylglycerol), Ca²⁺ ions, and MAP kinase pathways; signal transduction in cancer

Apoptosis (programmed cell death):

Mechanisms of apoptosis triggered by internal and external signals, role of apoptosis in human diseases

Biology of cancer:

Origin and terminology, oncogenes, tumor suppressor genes, prevention and cure

Practicals

Microscopy:

Theoretical knowledge of Light and Electron microscope Principles of fixation and staining

Permanent slide preparation:

Cytochemical staining of DNA- Feulgen; DNA and RNA- MGP; polysaccharides-PAS, total proteins -Bromophenol blue; and histones- Fast green

Mitosis (root tip), meiosis (grasshopper testis)

Mammalian metaphase chromosomes

Polytene chromosomes (*Chironomus* I *Drosophila*)

Sex chromatin

Demonstration of Southern, Northern and Western blots

Suggested Reading

Atherly, A.G, Girton, J.R. and Me Donald, J.F. The Science of Genetics. Saunders College Publishers. 1999

- Becker, W.M., Rees, J.B. and Poenie, M.F. The world of the Cell. Benjamin/Cummings Publishing Company, U.S.A. 1996
- Bruce, A. et.al. Molecular Biology of the Cell. Garland Publishing Company, New York and London. 2002
- Cooper, G. M. The Cell: A Molecular Approach. ASM Press, Washington, D.C., U.S.A. 2001
- De Robertis, E.D.P. and De Robertis, E.M.F. Jr. Cell and Molecular Biology. Lippincott Williams and Wilkins. 2002
- Karp, G. Cell and Molecular Biology-Concepts and Experiments. John Wiley and Sons Inc. 2002
- Lodish, H. et.al. Molecular Cell Biology. W.H. Freeman and Company, New York. 2000.
- Russell, P. Genetics. Benjamin / Cummings Publishing Company. 1998
- Snustad, D.P. and Simmons, M.J. Principles of Genetics. John Wiley and Sons Inc. 2003

PAPER Xa : APPLIED ENTOMOLOGY

This paper presents some of the vocationally oriented aspects of Entomology. It acquaints the students with a select variety of harmful insects infesting agricultural crops and stored products besides household insect pests and insects of medical and veterinary importance. Reference has been made to their chemical control and pesticide application equipments. Besides considering the method of safe storage of food grains, emphasis has been placed on a wide spectrum of insect control measures other than chemical, especially those resulting from recent scientific researches related to microbial insect control, genetic interventions and integrated pest management. The students are also acquainted with useful insects of industrial significance, particularly with reference to the production of honey, silk and lac..

Theory

Introduction to Applied Entomology:

Importance of insects

Bionomics and control of the following crop pests:

Earias vittella, *Pectinophora gossypiella*; *Sesamia inferens*; *Leptocorisa acuta*, *Tryporyza incertulas*; *Heliothis armigera*; *Scirpophaga nivella*, *Pyrilla perpusilla*; *Rhaphidopalpa foveicollis*, *Leucinodes orbonalis*; *Papilio demoleus*, *Aspidiotus perniciosus*; *Achoea janata*.

Bionomics of the following stored grain pests and their management for control:

Sitophilus oryzae, *Corcyra cephalonica*; *Trogoderma granarium*; *Ephestia cautella*, *Callosobruchus chinensis*.

Safe storage of grains and storage structures.

Economic importance and control of: fleas, mosquitoes, houseflies, sandflies, house crickets, cockroaches, bedbugs, lice, clothes moths, ants.

Locusts: life cycle, phases, and control measures.

Termites: castes, termitaria and control measures

Insect control: Mechanical, Physical, Cultural, Insecticidal-classification of insecticides. control with reference to chlorinated hydrocarbons. DDT, BHC, dieldrin; organophosphates: parathion, malathion; carbamates: carbaryl, carbofuran, propoxur; dinitrophenols; organic thiocyanates: thanite, botanical, nicotine, rotenone, pyrethrum, neem extracts; synthetic pyrethroids: allethrin, cyfluthrin; fumigants: phosphine, methylbromide; insecticide adjuvants and formulations, biological including microbial control, genetic, sterile male technique (with emphasis on Knipling model), physiological-use of insect hormones (insect growth regulators) and pheromones, regulatory (legislative), general aspects of integrated pest management.

Outlines of Apiculture, Sericulture with emphasis on *Bombyx mori*, Lac culture.

Practicals

Collection, dry mounting, labeling and preservation of insects

Permanent slide mount of a microscopic insect

Culture of two insects of economic importance (including one crop pest) and submission of culture reports

Identification of insects up to orders (ordinarily 2-3 representatives of each commonly available order) with the help of a Key (Key to be provided to students in examination)

Economic importance of the following insect pests based on identification of their adult:

Earias vittella, *Heliothis armigera*, *Leucinodes orbonalis*, *Papilio deoleus*, *Leptoorisa acuta*, *Pyrilla perpusilla*, *Rhaphidopalpa foveicollis*, *Sitophilus oryzae*, *Trogoderma granarium*, *Tribolium castaneum*, *Callosobruchus chinensis*, *Aphis* sp., *Dacus* sp., *Dysdercus* sp., *locust*, *termite*, *flea*, *mosquito*, *bed bug*, *louse*.

Study of the life history of 6 different insect pests (two life cycles, including one of crop pest, drawn from culture, to be submitted)

Damage caused by commonly occurring insect pests

Determination of LD_{50} or LC_{50} of insecticides based on 6 different data provided

Acquaintance with insecticide dusting and spraying equipments and their working

Study of beneficial insects, their life stages and products

Field trips to entomological institutes, museums, laboratories etc.

The experiments and collection of animals will be in accordance with the guidelines laid by CPSEA (Committee for the purpose of Control and Supervision of Experiments on Animals, Govt. of India)

Suggested Readings

- Aruga, H. Principles of Sericulture. Oxford and IBH, N. Delhi, 1994
- Atwal, A.S. Agricultural Pests of India and South East Asia. Kalyani Pub., N. Delhi 1993
- Bindra, O.S. and Singh, H. Pesticide- Application Equipment. Oxford and IBH, N. Delhi, 1980
- Entomology in India. Published by the Entomological Society of India. 1964.
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- Little, V.A. General and Applied Entomology. Oxford and IBH, N. Delhi, 1974
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- Pedigo, L.P. Entomology and Pest Management, Prentice-Hall, N. Delhi, 1996

Pradhan, S. Insect Pests of Crops. National Book Trust, India, N. Delhi, 1983

Prost, P.J. Apiculture, Oxford and IBH, N. Delhi, 1994

Singh, S., Bee Keeping in India. ICAR, N. Delhi, 1962.

Wealth of India, CSIR, N. Delhi, 1965-76

PAPER Xb : REPRODUCTIVE BIOLOGY AND HUMAN WELFARE

The content of this paper is devised to include topics from both human and animal source. The information on reproduction is changing very fast and new areas are emerging. To cope with such developments, the present syllabus has been updated. It includes new topics like the role of hypothalamus on reproduction and assisted reproductive techniques. The present syllabus has thus an inbuilt provision to accommodate any future development in the subject.

We hope this paper will excite the interest of many average students and help them understand the subject better. We believe that such exposure will also motivate them to explore this subject further in higher classes and in the field of research.

Theory

Reproductive Endocrinology

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo-hypophyseal - gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation

Functional anatomy of male reproduction:

Outline and histology of male reproductive system in rat and human

Testis: cellular functions, germ cell, stem cell renewal

Spermatogenesis: kinetics and hormonal regulation.

Androgen synthesis and metabolism

Epididymal function and sperm maturation

Accessory glands function.

Sperm transport in male tract.

Functional anatomy of female reproduction:

Outline and histology of female reproductive system in rat and human.

Ovary: folliculogenesis, ovulation, corpus luteum formation and regression;

Steroidogenesis and secretion of ovarian hormones.

Reproductive cycles (rat and human) and their regulation, changes in the female tract.

Ovum transport in the fallopian tubes

Sperm transport in the female tract, fertilization

Hormonal control of implantation

Hormonal regulation of gestation, pregnancy diagnosis, foeto--maternal relationship

Mechanism of parturition and its hormonal regulation

Lactation and its regulation

Reproductive Health and human welfare

Infertility in male and female: causes, diagnosis and management.

Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, *in vitro* fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST

Modern contraceptive technologies

Demographic terminology used in family planning

Animal Husbandry

Semen collection, preservation and artificial insemination in cattle
Induction of early puberty and synchronization of estrus in cattle

Practicals

Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

Examination of vaginal smear in rats from live animals

Surgical techniques: Principles of surgery in endocrinology. Ovanectomy, hysterectomy, castration and vasectomy in rats

Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive system; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina

Human vaginal exfoliate cytology.

Estimation of fructose in male accessory glands of rat

Sperm count and sperm motility in rat

Study of modern contraceptive devices

Project on topics associated with human reproduction

Visit to centres of proficiency in reproductive physiology and ART.

Suggested Reading

Austin, C.R. and Short, R.V. Reproduction in Mammals. Cambridge University Press.

Chaudhury, S. K. Practice of Fertility Control. B.I. Churchill Livingstone Pvt. Ltd.

Degroot, L.J. and Jameson, J.L. (eds). Endocrinology vol I II. W.B. Saunders and Company

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Greep, R.O. et al. Reproduction and Human Welfare-A Challenge to Research. The MIT Press.

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Hafez, E.S.E and Evans, T.N. Human Reproduction. Harper and Row

Hatcher, R.A. et al. *The Essentials of Contraceptive Technology*. Population Information Programme.

Johnson, M.H. and Everitt, B.J. *Essential Reproduction*. Blackwell Science.

Knobil, E. et al (eds). *The Physiology of Reproduction*. Raven Press Ltd.

Larsen, J. W. (ed) *Human Embryology*. Churchill Livingstone.

Pinon, R., Jr. *Biology of Human Reproduction*. University Science Books.

PAPER Xc : MEDICAL ZOOLOGY

This paper presents the study of microbial and parasitic infections, pathogenicity, transmission, prophylaxis and treatment of diseases supplemented with topics on pathology, epidemiology and medical entomology, which enhances the awareness of students about human health and disease. Exposure to some fundamentals of microbiology and pathology can generate interest for further studies in these fields. Current developments in the concerned fields are especially incorporated. This is important in view of the fact that we are entering into an era of technological developments in biosciences.

Theory

Parasitism; types of parasites, hosts and vectors; parasitic adaptations and effects on hosts

General organization and pathogenicity of bacteria, viruses, *Rickettsia*, *spirochaetes*, *Borrelia*, *Treponema* and *Leptospira*.

Life history, mode of infection and pathogenicity of *Entamoeba histolytica*, *Trypanosoma brucei*, *Trypanosoma cruzi*, *Leishmania donovani*, *Leishmania brasiliensis*, *Giardia intestinalis*, *Trichomonas vaginalis*, *Plasmodium* spp., with a note on prophylaxis and treatment of diseases caused by them.

Life history and pathogenicity of *Fasciolopsis buski*, *Schistosoma haematobium*, *Echinococcus granulosus*, *Ancylostoma duodenale*, *Trichinella spiralis*, *Dracunculus medinensis*, *Enterobius vermicularis* and *Wuchereria bancrofti*.

Histopathology of liver and kidney

Tumours: types, causative agents and treatment; skin and lung cancer.

Allergy, anaphylaxis and delayed hypersensitivity.

Familiarization with terms pertaining to epidemiology, types of carriers, epidemiology and eradication programmes of typhoid, cholera and leprosy

Study of arthropods as agents of human discomfort and as vectors of human diseases (malaria, yellow fever, dengue haemorrhagic fever, filariasis, Japanese B. encephalitis, plague, epidemic Typhus) and measures for their control.

Practicals

Staining of bacteria using Gram's stain

Study of permanent slides of parasitic protozoans listed in theory

Study of permanent slides and specimens of pathogenic helminthes listed in theory

Study of permanent slides of arthropod vectors of human diseases listed in theory

Study of slides of liver cirrhosis

Study of slides of kidney showing diffuse membranous glomerulonephritis, **Hpoid** nephrosis, **protein cast**, amyloidosis, hypokalemic nephrosis, **chronic glomerulonephritis and acute glomerulonephritis**

Quantitative estimation of haemoglobin by colorimetric method

Determination of erythrocytic sedimentation rate

Determination of haematocrit

Determination of bleeding and blood coagulation time

Preparation of permanent stained mounts of rectal ciliates of frog

Preparation of permanent stained mounts of intestinal helminthes of pigeon or rat

Preparation of rat's blood film to detect *Trypanosoma*

Eosinophil count by haemocytometer

Blood platelet count by haemocytometer.

Study of various types of cysts and helminth eggs

Suggested Reading

Arora, D.R. and Arora, B. Medical Parasitology. CBS Publications and Distributers. 2001

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Dey, N.C. and Dey, T.K. Medical Parasitology. New Central Book Agency (P) Ltd. 1997

Harwood, R.F. and James, M.T. Entomology in Human and Animal Health. Macmillan Publishing Co. 1979

Robbin, and Cotrance, Pathological Basis of Disease

Vander, A.J., Sherman, J.h. and Luciano, D.S. Human Physiology-Mechanism and Body Function. Tata McGraw Hill 2001