

UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Vice-Chancellor has, in exercise of the powers vested in him under Section 15(3) of the University of the Punjab Act, 1973 and in anticipation of approval of the Syndicate, approved the recommendations of the Director, Institute of Zoology duly forwarded by the Dean of Faculty of Life Sciences regarding approval of BS 5th to 8th Semester Syllabus (in replacement of M.Sc. Zoology) in the subject of Zoology for Affiliated Colleges with effect from the Academic Session, 2021.

The Syllabus of BS 5th to 8th Semester in Zoology is attached herewith, vide Annexure 'A'.

**Admin. Block,
Quaid-i-Azam Campus,
Lahore.**

Sd/-
**Muhammad Rauf Nawaz
Registrar**

No. D/ 79 /Acad.

Dated: 06-01-2022.

Copy of the above is forwarded to the following for information and further necessary action: -

1. Pro-Chancellor/The Minister of Education,
Govt. of the Punjab, Lahore.
2. Members of the Syndicate
3. Dean, Faculty of Life Sciences
4. Director, Institute of Zoology
5. Principals of Affiliated Colleges
6. Controller of Examinations
7. Director. Quality Enhancement Cell
8. Director, IT (for Uploding on website)
9. Deputy Registrar (Affiliation)
10. Deputy Registrar (General)
11. Secretary to the Vice-Chancellor
12. Secretary to the Pro-Vice-Chancellor
13. PS to the Registrar
14. Admin Officer Syndicate (with file)
15. Assistant Syllabus


Assistant Registrar (Academic)
for Registrar

Program Title: BS Zoology 5th to 8th Semesters
Department: Institute of Zoology
Faculty: Faculty of Life Sciences

1. Mission of the Institute

Our mission at the Institute of Zoology is to help our students and community by staying true to the ontological and epistemological traditions of our discipline. In an open and interactive environment, we encourage our students and faculty to understand ourselves as human beings, our interdependence on each other and the trends of cooperation and conflict that influence our mutual existence. As educators and social scientists, we endeavor to imbue our students with a sense of 'self' that is innately connected to the 'collective'. It is our hope and belief that our pedagogical style will promote peace and compassion through learning. We intend to create indigenous sociological knowledge and apply professional research skills to influence social policies for desirable social change in our own cultural domain. This has the aim of improving our social and cultural environment and raising the quality of life in Pakistan.

2. Introduction of the Institute

The Institute of Zoology, formerly Department of Zoology was established in 1921 and at present it offers BS (Morning & Evening), MS/MPhil (Morning & Evening), M.Phil (In-Service) and Ph.D. programs. The Institute has highly qualified and experienced faculty members to supervise these programs.

The Institute of Zoology is a student-centered and research-oriented institution. It offers a range of high-quality educational programs at undergraduate, graduate, and postgraduate levels. The Institute of Zoology is dedicated to the discovery, sharing and application of knowledge to aid in the due progress of our society and the nation. The core value of the Zoology remains the pursuit of useful knowledge for improving human life.

The Institutional labs are fully equipped with modern research facilities. The Institution has established research collaboration with INMOL, Lahore, PCSIR, Lahore, Post Graduate Medical Institute, Sheikh Zayed Hospital, Lahore, NIBGE, Faisalabad, NIAB, Faisalabad, University of Agriculture, Faisalabad, Departments of Live Stock, Wildlife and Fisheries.

Zoology is an exceptionally broad discipline covering diverse fields such as Biochemistry, Cell Biology, Molecular Biology, Physiology, Microbiology, Developmental Biology, Genetics, Palaeontology, Fisheries, Entomology, Wildlife, Evolution, Environmental Biology and, etc.

Our goal is to provide balanced knowledge of the discipline to students. A Zoologist must be acquainted with all core biological disciplines deriving from major branches of Zoological Sciences. The manpower trained in the subject of Zoology gets accommodated in the academic and research organizations like Education, Health, Agriculture, Fisheries, Wildlife, Environmental sector, Pharmaceutical and Pesticide producing industries.

3. Program Introduction

Zoology as a subject is multidisciplinary in nature involving studies of organisms and their genetic, morphological and physiological attributes, their surrounding environment, and role in conservation of environment. This subject has significant role in human resource development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty. The BS in Zoology (5th to 8th Semester) is designed to produce qualified zoologists/professionals who are able to make meaningful contribution in enhancing understanding about zoological issues of Pakistan. This program is a blend of theoretical and practical knowledge to equip students with current data in this field. This is achieved through providing high quality education and training to our students. Like most of the developing countries, Pakistani population has been suffering from a variety of nutritional deficiency disorders ranging from protein malnutrition to specific micro-nutrients in certain areas of the country. These nutrient deficiencies are propagated by multiple factors like dietary insufficiencies of micronutrients, poor maternal and child health, high burden of morbidity, low levels of micronutrients in the soil, bioavailability issues and have resulted in retardation of growth and mental development and various types of physical disabilities. Increasing rates of

chronic and acute malnutritions in the country is primarily attributed to poverty, high illiteracy among the mothers, nutritional insecurity and lack of cutting edge research to devise local solutions to curb this situation.

It is a multidisciplinary program comprising of 63 credit hours to be completed in four semesters. Apart from compulsory and basic courses, this program consists of major and minor courses, including internship and research thesis. This BS Zoology (5th to 8th semester) Program is being offered at the Institute of Zoology and in the affiliated colleges.

4. Program Objectives

The objective of this degree program is to create graduates in core subjects of Zoology with wide-ranging theoretical, practical, and methodological competencies to enable them:

1. Acquire knowledge about the major disciplines of Zoology. It will enable the students to understand the principles of organizations and inter- relationships in the biological systems with particular reference to animal diversity.
2. To teach different methods of exploration, investigation, organization of biological data and its utilization in practical life.
3. To trained students for advance studies and specialization on recently emerging technological and multidisciplinary fields such as Biotechnology, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and Aquaculture, Pests and Pest Management, etc. After completing the degree /the students will be able to apply their knowledge to their respective fields effectively.
4. To equip the students with knowledge and skills for better planning and management of animal resources, environment, health, medicine, agriculture and population in the country.
5. To develop the scientific culture and demonstrate professional skills in teaching / research/ administrative positions in wide range of professions in national and international organizations.

6. Market Need / Rationale of the Program

This degree program will enable the students to professionally excel in the zoological field through meeting today's market requirements. The students after graduation will be able to demonstrate their expertise in multiple fields which include:

Positions in various government and non governmental organizations, teaching and research institutions, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock and other related areas.

a) Scope

i. Public Sector:

- Public Sectors Departments
- School, Education Departments/Programs
- Research and Teaching Institutes
- International Organizations: UNICEF, UNDP, WHO, FAO, World Bank
- Non-Governmental Organizations
- Community Development Program
- Motivational speaker

ii. Private Sector:

- Multinational Companies
- Independent Private Practice
- Fisheries Departments
- Food Industries
- Pharmaceuticals Industry
- Hospitality industry
- Private Companies and Hospitals

iii. Foreign Countries:

- Public Departments in Middle East, Europe etc.
- Independent Private Practices

7. Admission Eligibility Criteria

- Years of Study Completed 14 Years B.Sc./ADP/
- Study Program/Subject BS (5th to 8th Semester in Zoology)
- Percentage/CGPA As per university rules and regulations
- Entry Test (If applicable) No Entry Test (Open Merit)
- Any Other As per University Rule & Regulation

8. Duration of Degree Program

Minimum duration 2 Years
Total number of Credit hours (Flexible from 90-92)
Semester duration 16-18 weeks
Semesters 4
Course Load per Semester 15-24 Cr hr
Number of courses per semester 4-6

9. Assessment Criteria

As per University Rules and Regulations

10. Curriculum Difference

The designed courses of BS Zoology 5th to 8th Semester have total 90 (flexible to 92 credit hours) as per the University Rules & Regulations for B.S 5th to 8th Semester 2 Years Program. However, Quran classes have been added as compulsory course.

SCHEME OF STUDIES FOR BS ZOOLOGY 5th to 8th SEMESTER (2 YEARS)

Sr. No.	Course Codes	Title of Course	Course Type	Credit Hours
Semester V				
1.	HQ- 005	تدریس ترجمہ قرآن	Compulsory	0(0+0)
2.	Z-3501&2	Biochemistry-I	Compulsory	3(2+1)
3.	Z-3503&4	Cell and Molecular Biology-I	Compulsory	3(2+1)
4.	Z-3505&6	Genetics and Biostatistics-I	Compulsory	3(2+1)
5.	Z-3507&8	Physiology-I	Compulsory	3(2+1)
6.	Z-3509&10	Developmental Biology-I	Compulsory	3(2+1)
7.	Z-3511&12	Animal Diversity	Compulsory	3(2+1)
Total Credit Hours				18
Semester VI				
1.	HQ-006	تدریس ترجمہ قرآن	Compulsory	1(1+0)
2.	Z-3601&2	Biochemistry-II	Compulsory	3(2+1)
3.	Z-3603&4	Cell and Molecular Biology-II	Compulsory	3(2+1)
4.	Z-3605&6	Genetics and Biostatistics-II	Compulsory	3(2+1)
5.	Z-3607&8	Physiology-II	Compulsory	3(2+1)
6.	Z-3609&10	Developmental Biology-II	Compulsory	3(2+1)
7.	Z-3611&12	Wildlife	Compulsory	3(2+1)
Total Credit Hours				19
Semester VII				
1.	Z-701	تدریس ترجمہ قرآن	Compulsory	0(0+0)
2.	Z-702	Environmental Biology-I	Compulsory	4(3+1)
3.	Z-703	Evolution	Compulsory	4(3+1)
4.	Z-704	Zoogeography	Compulsory	4(3+1)
5.	Z-1000	Thesis (Research)	Optional	6(6+0)
6.	Z----	Special Paper A-I	Optional	3(2+1)
7.	Z----	Special Paper B-I	Optional	3(2+1)
8.	Z----	Elective/Supporting Paper	Optional	3(2+1)
Total Credit Hours				21
Semester VIII				
1.	Z-801	تدریس ترجمہ قرآن	Compulsory	0(0+0)
2.	Z-802	Environmental Biology-II	Compulsory	4(3+1)
3.	Z-803	Principles of Systematic Zoology	Compulsory	4(3+1)
4.	Z-804	Principles of Palaeontology	Compulsory	4(3+1)
5.	Z-1000	Thesis (Research)	Optional	6(6+0)
6.	Z----	Special Paper A-II	Optional	3(2+1)
7.	Z----	Special Paper B-II	Optional	3(2+1)
8.	Z----	Elective/Supporting Paper	Optional	3(2+1)
Total Credit Hours				21
Total Credit Hours (24+24+21+21) =				90

11. **Research Thesis** 12 Credit hours

12. **Award of Degree**

The degree will be awarded as per University of the Punjab rules and regulations. The students have to complete 90 credit hours, to qualify for the degree.

13. **Faculty Strength**

Degree	Area/Specialization	Total
PhD	Molecular Biology, Developmental Biology, Fisheries, Environmental Biology, Evolution, Ecology, Genetics, Biochemistry, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and Aquaculture, Pests Management, Biotechnology, Anatomy, Physiology, Microbiology, Immunology	15
Total		15

14. **Present Student Teacher Ratio in Institute**

Not Applicable

15. **NOC from Professional Councils (If Applicable)**

Not Applicable

SPECIAL PAPERS (FOR 7TH SEMESTER)

List of Special Paper A and Special Paper B (i.e., two papers for non research students)

Paper #	Title
Z-711	Entomology A (Morphology, Physiology and Ecology)-I
	Lab. Entomology A (Morphology, Physiology and Ecology)-I
Z-712	Entomology B (Classification of Insects and Pest management)-I
	Lab. Entomology B (Classification of Insects and Pest management)-I
Z-713	Endocrinology A (General and comparative endocrinology)-I
	Lab. Endocrinology A (General and comparative endocrinology)-I
Z-714	Endocrinology B (Molecular and clinical endocrinology)-I
	Lab. Endocrinology B (Molecular and clinical endocrinology)-I
Z-715	Physiology A (Physiology of Coordination)-I
	Lab. Physiology A (Physiology of Coordination)-I
Z-716	Physiology B (Physiological systems and adaptations)-I
	Lab. Physiology B (Physiological systems and adaptations)-I
Z-717	Parasitology A)-I
	Lab. Parasitology A-I
Z-718	Parasitology B)-I
	Lab. Parasitology B-I
Z-719	Microbiology A (General Microbiology)-I
	Lab. Microbiology A (General Microbiology)-I
Z-720	Microbiology B (Applied Microbiology)-I
	Lab. Microbiology B (Applied Microbiology)-I
Z-721	Fisheries A (Principles of Fish Biology)-I
	Lab. Fisheries A (Principles of Fish Biology)-I
Z-722	Fisheries B (Fish Physiology and Breeding)-I
	Lab. Fisheries B (Fish Physiology and Breeding)-I
Z-723	Environmental Health and Ecosystems A (Principles of Environmental Health))-I
	Lab. Environmental Health and Ecosystems A (Principles of Environmental Health))-I
Z-724	Environmental Health and Ecosystems B (Ecosystem Health Dynamics)-I
	Lab. Environmental Health and Ecosystems B (Ecosystem Health Dynamics)-I

SPECIAL PAPERS (FOR 8TH SEMESTER)

List of Special Paper A and Special Paper B (i.e., two papers for non research students)

Paper #	Title
Z-811	Entomology A (Morphology, Physiology and Ecology)-II
	Lab. Entomology A (Morphology, Physiology and Ecology)-II
Z-812	Entomology B (Classification of Insects and Pest management)-II
	Lab. Entomology B (Classification of Insects and Pest management)-II
Z-813	Endocrinology A (General and comparative endocrinology)-II
	Lab. Endocrinology A (General and comparative endocrinology)-II
Z-814	Endocrinology B (Molecular and clinical endocrinology)-II
	Lab. Endocrinology B (Molecular and clinical endocrinology)-II
Z-815	Physiology A (Physiology of Coordination)-II
	Lab. Physiology A (Physiology of Coordination)-II
Z-816	Physiology B (Physiological systems and adaptations)-II
	Lab. Physiology B (Physiological systems and adaptations)-II
Z-817	Parasitology A-II
	Lab. Parasitology A-II
Z-818	Parasitology B-II
	Lab. Parasitology B-II
Z-819	Microbiology A (General Microbiology)-II
	Lab. Microbiology A (General Microbiology)-II
Z-820	Microbiology B (Applied Microbiology)-II
	Lab. Microbiology B (Applied Microbiology)-II
Z-821	Fisheries A (Principles of Fish Biology)-II
	Lab. Fisheries A (Principles of Fish Biology)-II
Z-822	Fisheries B (Fish Physiology and Breeding)-II
	Lab. Fisheries B (Fish Physiology and Breeding)-II
Z-823	Environmental Health and Ecosystems A (Principles of Environmental Health)-II
	Lab. Environmental Health and Ecosystems A (Principles of Environmental Health)-II
Z-824	Environmental Health and Ecosystems B (Ecosystem Health Dynamics)-II
	Lab. Environmental Health and Ecosystems B (Ecosystem Health Dynamics)-II

ELECTIVE / SUPPORTING PAPERS

List of Elective / supporting papers

Code	Title
Z-901	Integrated Pest Management
	Lab. Integrated Pest Management
Z-902	Medical and veterinary entomology
	Lab. Medical and veterinary entomology
Z-903	Classification of insects, pest of agriculture and pest management
	Lab. Classification of insects, pest of agriculture and pest management
Z-904	Structure and functions of insects
	Lab. Structure and functions of insects
Z-905	Physiology of reproduction
	Lab. Physiology of reproduction
Z-906	General and comparative endocrinology
	Lab. General and comparative endocrinology
Z-907	Molecular and clinical endocrinology
	Lab. Molecular and clinical endocrinology
Z-908	Physiology of Coordination
	Lab. Physiology of Coordination
Z-909	Physiological systems and adaptations
	Lab. Physiological systems and adaptations
Z-910	Molecular Physiology
	Lab. Molecular Physiology
Z-911	Comparative vertebrate endocrinology
	Lab. Comparative vertebrate endocrinology
Z-912	Animal behaviour
	Lab. Animal behaviour
Z-913	Exercise physiology
	Lab. Exercise physiology
Z-914	Principles of Toxicology
	Lab. Principles of Toxicology
Z-915	Biochemical Toxicology
	Lab. Biochemical Toxicology
Z-916	Applied Fisheries
	Lab. Applied Fisheries
Z-917	Fish Disease and Health Management
	Lab. Fish Disease and Health Management
Z-918	Fundamentals of Microbiology
	Lab. Fundamentals of Microbiology
Z-919	Bioremediation and Environmental Biotechnology
	Lab. Bioremediation and Environmental Biotechnology
Z-920	Mammalogy
	Lab. Mammalogy
Z-921	Immunology
	Lab. Immunology
Z-922	Vector Biology
	Lab. Vector Biology
Z-923	Helminthology
	Lab. Helminthology

Z-924	Protozoology
	Lab. Protozoology
Z-925	Comparative anatomy and biology of vertebrates
	Lab. Comparative anatomy and biology of vertebrates
Z-926	Human Embryology and Teratology
	Lab. Human Embryology and Teratology
Z-927	Cancer Biology
	Lab. Cancer Biology
Z-928	General parasitology
	Lab. General parasitology
Z-929	Molecular Biology
	Lab. Molecular Biology
Z-930	Virology and Viruses
	Lab. Virology and Viruses
Z-931	Cell and Tissue culture
	Lab. Cell and Tissue culture
Z-932	Cell signaling systems
	Lab. Cell signaling systems
Z-933	Immune system and immunochemistry
	Lab. Immune system and immunochemistry
Z-934	Proteins and Proteomics
	Lab. Proteins and Proteomics
Z-935	Signal transduction and biomembrane
	Lab. Signal transduction and biomembrane
Z-936	Biosafety and Ethics
	Lab. Biosafety and Ethics
Z-937	Genes and Disease
	Lab. Genes and Disease
Z-938	Inflammation, cytokines and chemokines
	Lab. Inflammation, cytokines and chemokines
Z-939	Apiculture
	Lab. Apiculture
Z-940	Air Pollution Monitoring
	Lab. Air Pollution Monitoring
Z-941	Communicable Disease and Environmental Health
	Lab. Communicable Disease and Environmental Health
Z-942	Ecological Modeling and Natural Photography
	Lab. Ecological Modeling and Natural Photography

Books Recommended

1. Plummer, David T., 1990. An Introduction to Practical Biochemistry, 4th Ed. McGraw-Hill Book Company, London.
2. Wilson, K and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press.
3. Sawhney, S.K and Singh, R., 2008. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, India.

Z-3503 & Z-3504 CELL AND MOLECULAR BIOLOGY-I & LAB Cr. 3(2+1)

Theory

Chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle,

DNA physical and chemical structure, characteristics of DNA,

DNA replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with special reference to DNA polymerases, concept of Replicons etc.), DNA repair,

Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes, involved, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), Genetic code, point mutations,

Translation (with reference to the specific role of Ribosomes, various factors, and posttranslational processing),

Regulation of Gene Expression (enzyme induction, enzyme repression, role of promoter and operator to be elucidated taking examples of Lac operon and Trip Operon, Gene Regulation in Eukaryotes with reference to elaborate promoter and diverse transcription factors involved, concept of examples of Transcriptional Regulation and Translational Regulation).

Nuclear Envelope, Nucleolus

Practicals

Histochemistry of tissues, preparation and study of tissue structure; Extraction of DNA (bacterial); Minipreparation of plasmid DNA; Restriction digestion of plasmid DNA

Books Recommended:

Text Book

1. DeRobertis and DeRobertis Cell And Molecular Biology, 8 Ed., Publisher: Lippincott Williams and Williams (2008)

Books Recommended:

2. Albert, B., Bray, D., Lewis, J., Raff, M. et al. 2002. Molecular Biology of the cell 4th Ed. Garland publishing Inc. New York.
3. Karp G. 2009. Cell and Molecular Biology Wiley; 6 Ed., ISBN-10: 0470483377
4. Harvey Lodish et al. 2000. Molecular Cell Biology 4th Ed. W.M. Freeman, New York.
5. Fobert F. Weaver. 2005. Molecular Biology 3rd Ed. The McGraw Hill companies Inc. International Ed.
6. Bernard R. Glick and Jack J. Pasternate. 1994. Molecular Biotechnology: Principles and applications of Recombinant DNA. ASM press, Washington, D.C., USA.

Z-3505 & Z-3506 GENETICS AND BIostatISTICS-I & LAB Cr. 3(2+1)

Theory

Genetics, History of Genetics,

Classical Genetics –Multiple Alleles, Genetics of Blood Groups, Chromosomal Basis of Inheritance, Interaction of Genes, Chromosomal changes (Euploidy, Aneuploidy, Structural

changes), Sex-Determination and Sex-Linkage, Linkage, Recombination and Chromosome mapping in Eukaryotes.

Biostatistics

Introduction and scope, use of statistics in biology. Population and sample. Stages of research, types of data and methods of data collection. Data arrangement and presentation, formation of tables and charts. Measures of central tendency (computation of from grouped and ungrouped data). Measures of dispersion, computation of variance, standard deviation, standard error and their coefficients

Practicals

Problems related to concepts of Classical and Population genetics, Pedigree Analysis

Books Recommended:

1. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
2. Text Book for Biostatistics: ELEMENTARY STATISTICS A STEP BY STEP APPROACH, By Bluman.A. G Latest available Addition
3. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.

Z-3507 & Z-3508

PHYSIOLOGY-I & LAB

Cr. 3(2+1)

Theory

Central themes in Physiology: Structure-Function Relationship, Adaptations, Homeostasis, Conformity and Regulation.

Physiological basis of Neuronal Function: *Mechanisms in Resting Membrane Potentials:* Electrogenic ion pump, Donnan equilibrium, diffusional potentials, ion channels, ***Ionic mechanisms in action potentials:*** Roles of ion channels, Properties of action potential. ***Propagation of Action Potential; Synaptic transmission;*** Structure and function of electrical synapse, Structure and function of chemical synapse; Neurotransmitters; Synaptic receptors; Excitatory postsynaptic potential; Inhibitory postsynaptic potential; Presynaptic inhibition; Integration at synapses: Facilitation, Posttetanic Potentiation.

Receptors Physiology: Transduction; Sensory coding; Mechanoreception: Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: Ultrastructure of photoreceptors, Photochemistry, Phototransduction and physiological basis of color vision.

Chemical Messenger and Regulators/Endocrine Physiology: Types and functions of secretions. An overview of hormones, their chemistry and physiological roles of Hypthalamus, Pituitary, Thyroid, Parathyroid and associated structures, Endocrine pancreas, Gastroenteropancreatic system, Adrenal medulla, Adrenal cortex, Ovary, Testis and placenta. A generalized model account of hormone synthesis, storage and secretion (a peptide hormone model and steroid hormones); Hormonal interactions in metabolic and developmental function; Water and electrolyte balance; reproduction; glycemia and calcium hormostasis. Mechanisms of action in hormones involving membrane receptors and nuclear modulated gene expression

Movements and Muscles: Structural basis of muscle contraction: molecular structures of contractile components and their interaction, sarcoplasmic reticulum, Role of calcium, calcium pump and membrane mechanisms in regulation of contraction, Types of muscle fibers, Types of muscle contractions

Books Recommended:

1. Guyton, A.C. and Hall, J.E., 2016. Textbook of Medical Physiology, 13th Ed.. W.B. Saunders Company, Philadelphia.

2. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
3. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York

Practicals

Muscle and Neuromuscular Activity: Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.

Excitability, Sensation and Behaviour: Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.

Books Recommended:

1. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

Z-3509 & Z-3510

DEVELOPMENTAL BIOLOGY-I & LAB

Cr. 3(2+1)

Theory

Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis; Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm; Cleavage: Patterns of embryonic cleavage, mechanism of cleavage; Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals. Early Vertebrate Development: Neurulation, ectoderm, mesoderm and endoderm.

Practicals

Study of structure of gametes in some representative cases, i.e., frog, fish, fowl and mammal. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc.

Books Recommended:

1. Scott F. Gilbert. 2008-onward. Developmental Biology, Sinauer Associates Inc., Publishers, Massachusetts.
2. Bruce M. Carlson. 2000. Human Embryology and Developmental Biology, Mosby, London.
3. Balinsky, B.I. 1985. An Introduction to Embryology, W.B. Saunders, New York.

Z-3511 & Z-3512

ANIMAL DIVERSITY & LAB

Cr. 3(2+1)

Theory

Animal diversity

Animal diversity in different ecosystems, desert animals, polar animals, forest dwelling animals, grassland and savannah animals, high altitudes animals, freshwater animals, shore animals, deep sea animals, animals that live around hydrothermal vents.

Structural diversity and adaptations to different modes of existence in the different phyla of the animal kingdom.

The hierarchical organization of animal diversity, Complexity and body size, Animal body plan, Animal Symmetry,

Major sub divisions of the animal kingdom, Phylogenetic relationship of all major phyla. Modern classification of animals including minor phyla.

Practicals:

Study of museum specimens with their notes on adaptive characteristics, ecology and habitats.

Books Recommended:

1. Bailey, J.A., 1986. Principles of Wildlife Management, John Wiley.
2. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
3. Grimmett, R. Inskipp, C. and Inskipp, T. 2001, Birds of the Indian Sub-Continent. Helm.
4. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
5. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition). McGraw Hill, New York.
6. Hickman, Roberts, and Larsen, 2004. Integrated principles of Zoology (12th Edition). McGraw Hill, New York.
7. Jordan, E. L. and Verma, P. S. 2011. Invertebrate Zoology, S. Chand and Company.
8. M . S. Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
9. M. M. Shafique, 2005. Wildlife Acts and Rules of Pakistan. PFI, Peshawar.
10. Miller and Harly, 2007. Zoology (7th Edition). McGraw Hill, New York.
11. Mirza . Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
12. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
13. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
14. Pough, F. H., Janis, C. M. and Heiser, J. B. 2006. Vertebrate Life, 6th Ed. Pearson Prentice Hall.
15. Prasad, S. N. and Kashyap, V. 2011. A textbook of Vertebrate Zoology, New Age International Publishers.
16. Punjab Wildlife Act 1974. Government of the Punjab.
17. Roberts, T. J. 1991. Birds of Pakistan. Vol. I Oxford
18. Roberts, T. J. 1992. Birds of Pakistan. Vol. II. Oxford
19. Roberts, T. J. 1997. Mammals of Pakistan. Vol. II. Oxford
20. Roberts, T. J. 2005. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford
21. Roberts, T. J. 2005. Field Guide to the small Mammals of Pakistan. Oxford
22. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.
23. S. S. Ali, 1999. Zoogeography, Paleontology and Wildlife Management, Naseem Book Depot, Hyderabad.
24. Singh, S. K. 2005. Text Book of Wildlife Management. IBDC
25. Smith, R. L. 1980. Ecology and field biology, Harper and Row.

SEMESTER– VI

Course Code	Title of Course	Credit Hours
HQ- 006	تدریس ترجمہ قرآن	1(1+0)
Z-3601 & 3602	Biochemistry-II	3(2+1)
Z-3603 & 3604	Cell and Molecular Biology-II	3(2+1)
Z-3605 & 3606	Genetics and Biostatistics-II	3(2+1)
Z-3607 & 3608	Physiology-II	3(2+1)
Z-3609 & 3610	Developmental Biology-II	3(2+1)
Z-3611 & 3612	Wildlife	3(2+1)
Total Credit Hours		19

HQ-006

تدریس ترجمہ قرآن
سورة الشعراء تا سورة ص

Cr. 1(0+1)

Z-3601 & Z-3602

BIOCHEMISTRY-II & LAB

Cr. 3(2+1)

Theory

Bioenergetics: Concept of Free Energy; Standard Free Energy change: Energy rich compounds.

Metabolism: description of Glycolysis Regulation and Bioenergetics of Glycolysis. Anabolic role

of Glycolysis; Fate of Pyruvate; Gluconeogenesis, its Regulation and significance in tissues; Utilization of other carbohydrates Glycogen synthesis and degradation; Regulation of Glycogen metabolism;; Pentose phosphate pathway and its major role in the animal tissues.

Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA, Pyruvate dehydrogenase, a multi-enzyme complex; description of citric acid cycle; Bioenergetics of the cycle. Anabolic or Biosynthetic role of citric acid cycle intermediates; Replenishing or Anaplerotic reactions and their role; Regulation of Citric acid cycle; Electron transport chain.

Lipid metabolism: Fate of dietary fat; Activation of Fatty acids and their transportation to mitochondria; Beta-Oxidation; Alpha oxidation; Bioenergetics of Beta-oxidation; Oxidation of unsaturated and Odd chain fatty acids; Omega oxidation pathway; Biosynthesis of Saturated Fatty acid; Biosynthesis of unsaturated Fatty acids. Ketone bodies their biosynthesis, utilization and role in the tissues; Cholesterol metabolism: Cholesterol biosynthesis and its Regulation.

Nitrogen Metabolism: Metabolic fate of amino acids; Catabolism of Amino acids; Deamination and Transamination; Nitrogen Excretion and Urea cycle; Regulation of Urea cycle; Decarboxylation of Amino acids to Biological Amines.; Purine and Pyrimidine synthesis showing the sources of various atoms in both molecules.

Recommended text book

1. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
3. Zubay, G., 1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
4. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York.

Practicals

Preparation of standard curve of proteins by Biuret method. Estimation of blood serum proteins or any unknown concentration of protein using Biuret technique. Biochemical tests for detection of different amino acids. Separation and identification of various amino acids by Paper/Thin layer chromatography. Demonstration of differential solubility of lipids in various solvents. Various Qualitative Tests for detection of Lipids.

Determination of Acid value of Fats. Preparation of standard curve and Estimation of DNA by colorimetric analysis using Diphenylamine method. Preparation of standard curve and Estimation of total RNA by colorimetric analysis using Bial's Orcinol method.

Quantitative analysis of Amylase activity from blood serum or liver. Effect of temperature on the enzymatic rate of reaction.

Books Recommended

1. Plummer, David T., 1990. *An Introduction to Practical Biochemistry*, 4th Ed. McGraw-Hill Book Company, London.
2. Wilson, K and Walker, J., 1994. *Practical Biochemistry: Principles and Techniques*, 4th Ed., Cambridge University Press.
3. Sawhney, S.K and Singh, R., 2008. *Introductory Practical Biochemistry*, Narosa Publishing House, New Delhi, India.

Z-3603 & Z-3604

CELL AND MOLECULAR BIOLOGY-II & LAB

Cr. 3(2+1)

Theory

Recombinant DNA technology

General Principles, molecular tools involved (vectors, enzymes, expression system) DNA sequencing, chromosome walking, PCR techniques.

Role of Genetic Engineering in Economic Development in the areas of

Medicine and Human Health (Therapeutic Drug, Vaccines, Monoclonal antibodies, Gene therapy, Animal Cloning, Human Genome Project, Stem Cells, Transgenics Ethical issues),
Agriculture (Livestock Health, increase in agricultural produce),
Industry (organic solvents, petroleum industry, ore leaching etc.).

Cytoplasmic Organelle: Membrane system (structural and functional commonalities). Ultrastructure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle).

Plasma membrane and its functions: Chemical composition and structure of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments.

Practicals

Isolation and characterization of proteins on polyacrylamide gel electrophoresis; Western blotting; Cloning and transformation; PCR amplification of DNA.

Books Recommended:

Text Book

1. DeRobertis and DeRobertis Cell And Molecular Biology, 8 Ed., Publisher: Lippincott Williams and Williams (2008)

Books Recommended:

2. Albert, B., Bray, D., Lewis, J., Raff, M. et al. 2002. Molecular Biology of the cell 4th Ed. Garland publishing Inc. New York.
3. Karp G. 2009. Cell and Molecular Biology Wiley; 6 Ed., ISBN-10: 0470483377
4. Harvey Lodish et al. 2000. Molecular Cell Biology 4th Ed. W.M. Freeman, New York.
5. Fobert F. Weaver. 2005. Molecular Biology 3rd Ed. The McGraw Hill companies Inc. International Ed.
6. Bernard R. Glick and Jack J. Pasternate. 1994. Molecular Biotechnology: Principles and applications of Recombinant DNA. ASM press, Washington, D.C., USA.

Z-3605 & Z-3606

GENETICS AND BIOSTATISTICS-II & LAB Cr. 3(2+1)

Theory

Genetics Molecular Genetics – Mutation, DNA repair and Recombination, Gene Concept (classical and modern), Genetics of Viruses, Bacteria, Transposons, Molecular Genetic Analysis, The Techniques of Molecular Genetics (elements of genetic engineering), Regulation of Gene Expression in Prokaryotes, Gene Regulation in Eukaryotes The genetic control of the Vertebrate Immune System, Complex Inheritance Patterns.

Population Genetics – Hardy-Wimberg Equilibrium, Systematic and Dispersive Pressures, Inbreeding and Heterosis.

Biostatistics

Probability rules and distribution. Binomial, Poisson and Normal distributions. Hypothesis testing, Z- test, student's 't' test, Chi square test, Analysis of variance and DMRT. Correlation and regression. Experimental designing, Planning of an experiment replication and randomization.

Practicals

Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc) Isolation of DNA from Bacteria, Isolation of Plasmids, PCR.

Books Recommended:

1. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
2. Text Book for Biostatistics: ELEMENTRY STATISTICS A STEP BY STEP APPROACH, By Bluman.A. G Latest available Addition
3. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.

Z-3607 & Z-3608

PHYSIOLOGY-II & LAB

Cr. 3(2+1)

Theory

Cardiovascular Mechanisms: Electrical activity of heart: Automaticity, Rhythmicity, Electrocardiography, Hemodynamics, Blood flow, pressures and resistance and their interrelationships. Nervous and humoral control of cardiac activity (cardiac output) and peripheral circulation.

Exchange of Gases: Physiologic anatomy of lungs, Exchange of O₂ and CO₂ between respiratory surface (the lungs) and body cells. Transport of O₂ and CO₂ in blood. Nervous and chemical regulation of lungs respiration;

Excretion and Osmoregulation: Vertebrate nephron as osmoregulatory organ: Physiological anatomy, Glomerular filtration, Dynamics of glomerular filtration, Factors affecting glomerular filtration, Tubular re-absorption and secretion, Absorptive capabilities of tubular segments, Hypotonic urine formation; Hypertonic urine formation, Autoregulation of glomerular filtration rate, Nervous and hormonal regulation of glomerular filtration

Nutrition: Potentials and Movements in Gastrointestinal tract; Control of Motility and contractility, An overview of digestive secreions in various segments of gastrointestinal tract, Physiological anatomy of digestive tract (mammalian model), Absorption of water, ions and nutrients through highly absorptive surface of small intestine, Absorption in large intestine

Books Recommended:

1. Guyton, A.C. and Hall, J.E., 2016. Textbook of Medical Physiology, 13th Ed.. W.B. Saunders Company, Philadelphia.
2. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
3. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York

Practicals

Cardiovascular Activity: Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure, Calculation of body mass index. Hemolytic responses of erythrocytes in hyper and hypotonic solutions.

Respiration and Exercise: Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.

Endocrine and Reproductive Mechanisms: Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended:

1. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

Z-3609 & Z-3610

DEVELOPMENTAL BIOLOGY-II & LAB

Cr. 3(2+1)

Theory

Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules; Mechanism of

Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes, teratogenesis; Secondary Induction; Organogenesis: A brief account; Origin and Migration of Germ Cells in Vertebrates; Various organs formation from germinal layers, Factors controlling Growth and Oncogenesis. Hormones as Mediators of Development; Regeneration in Vertebrates.

Practicals

Preparation and study of serial sections of mammalian or chick embryos. Application of microsurgical techniques on chick embryos *in vitro*. Preparation and staining of histological slides. Study of fertilization.

Books Recommended:

1. Scott F. Gilbert. 2008-onward. Developmental Biology, Sinauer Associates Inc., Publishers, Massachusetts.
2. Bruce M. Carlson. 2000. Human Embryology and Developmental Biology, Mosby, London.
3. Balinsky, B.I. 1985. An Introduction to Embryology, W.B. Saunders, New York.

Z-3611 & Z-3612

WILDLIFE & LAB

Cr. 3(2+1)

Theory

Introduction to wildlife, Philosophy and significance of wildlife.

Animal distribution in Pakistan and their affinities.

Important wild animals, distribution, status, conservation and management (population estimates and diversity indices).

IUCN categories of wildlife status.

In-situ, ex-situ conservation,

Wildlife benefits, Zoonotic diseases,

Provincial wildlife rules in Pakistan, Zoo rules, National and International organizations involved in conservation and management of wildlife,

National Park, Wildlife Sanctuary, and Game Reserves in Pakistan,

IUCN protected areas, Eco-regions, Ramsar Convention, Ramsar sites of Pakistan, Major threats to wetlands. Threatened species of Pakistan.

Practicals:

Field work and study of species richness, species evenness, relative abundance, Simpson Index, Shannon Weiner Index.

Demonstration of distribution of animal species of Pakistan, (Blank map will be provided),

Individual presentation of threatened wild animal of Pakistan assigned to students.

Books Recommended:

1. Bailey, J.A., 1986. Principles of Wildlife Management, John Wiley.
2. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
3. Grimmett, R. Inskipp, C. and Inskipp, T. 2001, Birds of the Indian Sub-Continent. Helm.
4. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
5. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition). McGraw Hill, New York.
6. Hickman, Roberts, and Larsen, 2004. Integrated principles of Zoology (12th Edition). McGraw Hill, New York.
7. Jordan, E. L. and Verma, P. S. 2011. Invertebrate Zoology, S. Chand and Company.
8. M . S. Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
9. M. M. Shafique, 2005. Wildlife Acts and Rules of Pakistan. PFI, Peshawar.
10. Miller and Harly, 2007. Zoology (7th Edition). McGraw Hill, New York.

11. Mirza . Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
12. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
13. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
14. Pough, F. H., Janis, C. M. and Heiser, J. B. 2006. Vertebrate Life, 6th Ed. Pearson Prentice Hall.
15. Prasad, S. N. and Kashyap, V. 2011. A textbook of Vertebrate Zoology, New Age International Publishers.
16. Punjab Wildlife Act 1974. Government of the Punjab.
17. Roberts, T. J. 1991. Birds of Pakistan. Vol. I Oxford
18. Roberts, T. J. 1992. Birds of Pakistan. Vol. II. Oxford
19. Roberts, T. J. 1997. Mammals of Pakistan. Vol. II. Oxford
20. Roberts, T. J. 2005. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford
21. Roberts, T. J. 2005. Field Guide to the small Mammals of Pakistan. Oxford
22. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.
23. S. S. Ali, 1999. Zoogeography, Paleontology and Wildlife Management, Naseem Book Depot, Hyderabad.
24. Singh, S. K. 2005. Text Book of Wildlife Management. IBDC
25. Smith, R. L. 1980. Ecology and field biology, Harper and Row.

YEAR-II

SEMESTER-VII

Course Code	Title of Course	Credit Hours
Z-701	تدریس ترجمہ قرآن	0(0+0)
Z-702	Environmental Biology-I	4(3+1)
Z-703	Evolution	4(3+1)
Z-704	Zoogeography	4(3+1)
Z-1000	Thesis (Research)	6(6+0)
Z-----	Special Paper A-I	3(2+1)
Z-----	Special Paper B-I	3(2+1)
Z-----	Elective /supporting Paper	3(2+1)
Total Credit Hours		21

Z-701 تدریس ترجمہ قرآن **Cr: 0(0+0)**
سورة الزمر تا سورة ق

Z-702 **ENVIRONMENTAL BIOLOGY-I** **Cr. 4(3+1)**

Theory

Concept of physical environment:

Origin of Solar System and Earth; Climate variation; Origin of Atmosphere; Origin of Oceans

Concept of living environment:

Life in water: History, Hydrologic cycle; Life on land: Biosphere I; Geography of biome; Biosphere II; A microcosm of earth

Global Ecosystems:

Atmosphere; Hydrosphere; freshwater, saltwater and marine; Lithosphere; role in biogeochemical cycle; Ecosphere; impact of industrialization on it; Urban Ecosystem; natural habitat destruction/shelter for endangered species; Disturbance in Ecosystem; modern/mechanized agriculture, industrialization

Interaction in Ecosystem:

Competition; Exploitation; predation, herbivory and parasitism; Mutualism;

Concept of Energy Flow:

Energy sources; Energy limitations; Allocation of energy

Concept of Primary Production:

Aquatic primary production; Terrestrial primary production; Consumer influence; Trophic levels

Concept of Food Web:

Community web; Keystone species; Exotic predators

Biogeochemical Cycles:

Nitrogen, Phosphorus, Sulphur, water, carbon, nutrient cycles

Environmental Resources and Conservation:

Mineral resources; Agriculture and Forestry; Agriculture land use; Range management; Desalination and weather modification

Succession and Stability:

Community change during succession; Ecosystem change during succession; Mechanism of succession; Community and ecosystem stability

Practical

Methods and analysis of population dynamics; Quadrature method; Determining frequency of different species; Determining density of species in habitat;

Books Recommended:

1. M.L. McKinney. 2007. *Environmental Science: System and Solution*. 4th Edition. Jones and Bartlett Publication, Boston, USA
2. G. Tyler Miller, Jr. 2002. *Living in the Environment. Principles, Connections and Solutions*. Book/Cole Thomson Learning, USA
3. Peter Stilling, 2002. *Ecology*. 4th Edition. Prentice Hall Publication, New Jersey, USA
4. Krebs. 2000 *Ecology: The experimental analysis of distribution and application*.
5. J.L. Chapman and M.J. Reiss, 1997. *Ecology*. Cambridge University Press, UK.
6. M.C. Molles. 1999. *Ecology: Concepts and applications* WCB/McGraw Hill, New York
7. C.E. Mason. 1996. *Biology of Freshwater Pollution*. Longman Publication, UK
8. E.P. Odum. 1996. *Ecology: A Bridge between science and society*.
9. R.K. Singh. 1998. *Human Ecology*.
10. R. Lloyd. 1992. *Pollution and Freshwater*. Fishing News Books
11. Smith, 1988. *Ecology and Field Biology*. National Book Foundation, Islamabad.
12. E. P. Odum. 1976. *Fundamentals of Ecology* National Book Foundation, Islamabad.

Z-703 EVOLUTION Cr. 4(3+1)

Theory

Origin of life: Panspermia and Chemical theory; The causes of micro-evolution; Hardy-Weinberg equilibrium, Mutation, Gene flow, Genetic drift, Nonrandom breeding, and natural selection. Types of natural selection, its measurement. Causes of polymorphism in populations. The general selection model: (one locus and two locus), Genetic load, Cost of selection, Hitch-hiking, Linkage disequilibrium and shifting balance theory. Fitness and its measurement, Dependence of fitness on frequency of individual. Concept of phenotypic variation: Polygenic traits and Heritability. Explanation for adaptation, genetics of adaptation, reasons of imperfect adaptation. The Units of selection (allele, cell line, organisms, kin group and group). Sexual selection, Theories of sexual selection; Darwin, Fisher and Zahavi. Macroevolution: Evolutionary developmental biology: allometry, heterochrony, species selection, Evolutionary innovation and origin of higher taxa. Rates of evolution; Evolutionary trends and laws, Gradualism and punctuated equilibrium. Coevolution and co adaptations.

Practicals:

Experiments that simulate the effects of natural selection and adaptation in changing environments, genetic drift, and the importance of population size in natural population. Discussion on evidences of evolution and their problems.

Text Books:

1. Ridley, M. 2004. Evolution, 3rd Ed.. Blackwell Science.
2. Mayer, E. and Ashlock, P. D. () Principles of Systematic Zoology. McGraw Hill, New York.

Books Recommended:

1. Bell, G. 1997. Selection: the mechanism of evolution. Chapman and Hall, NY.
2. Dawkins, R. 1986. The blind watchmaker. Longman Scientific and Technical. Essex, England.
3. Dawkins, R.. 1978. The selfish gene. Oxford University Press, NY.
4. Freeman, S. and Herron, J. C. 2004. Evolutionary analysis, 3rd ed. Pearson Prentice Hall.
5. Futuyma, D. J. 1997. Evolutionary Biology, 3rd ed. Sinauer Associates, Inc. Sunderland, Massachusetts.
6. Gould, S. J. 1977. Ever since Darwin. W. W. Norton and Company, NY.
7. Ridley, M. 2000. Genome. New York: Perennial. Great reading.
8. Stearns, S. C. and Hoekstra, R. F. 2000. Evolution, an introduction. Oxford University Press.
9. Strickberger, (3rd or latest Ed.) Evolution. Jones and Barrett Publishers.
10. Freeman Dyson, (1999). Origin of life, Cambridge University press.
11. Simpson, G. G. (latest Ed.). Principle of animal taxonomy. Columbia University Press, New York.
12. Sokal R., and Sneath P.H. A. (latest Ed.). Principles of numerical taxonomy. W.H. Freeman and company, London.

Z-704 ZOOGEOGRAPHY Cr. 4(3+1)

Theory

Branches of zoogeography (Descriptive, chorology, Faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography); Animal distribution (Cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution); Barriers and dispersal (Barriers and means of dispersal in marine, fresh water and terrestrial environments); Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaeartic and Nearctic regions), Oriental, Ethiopian, Australian and New tropical Regions); Insular fauna [Continental islands (British Isles, Borneo, Java, Japan, Formosa and Philippines and Sri Lanka islands)] [Oceanic Islands, (Azores, Bermuda, Galapagos, St. Helena and Karakatau Islands) Ancient Islands (New Zealand and Madagascar Islands)]; Palaeogeography (Theories of permanence of continents, Land bridges, Continental drift and Plate tectonics).

Books Recommended:

1. Darlington, 1963. Zoogeography. John Wiley & Sons, New York.
2. Allee, Schmidth and Hesse, 1951. Ecological Animal Geography. John Wiley & Sons, Ltd., New York.
3. De Beaufort, 1951. Zoogeography of the Land Inland Waters. Sidgwick & Jackson, Ltd., London.
4. Ekman, 1953. Zoogeography of the sea. London, Sedgwick and Jackson, Ltd London.
5. Lillies, 1974. Introduction to Zoogeography. By Joachim lilies. Translated by WD Williams. London: Macmillan.
6. Muller, 1974. Aspects of Zoogeography. Hague, Dr. W. Junk Publishers
7. Jafri, 1977. Land Zoogeography of World.
8. Ali, S.S., 1999. Palaeontology, Zoogeography and Wildlife Management.

Practicals

Zoogeography

The classification of vertebrate animals up to species and their zoogeographical distribution.

Z-1000

THESIS

Cr. 6 (6+0)

SPECIAL SUBJECTS

Z-711 ENTOMOLOGY A (Morphology, Physiology and Ecology)-I Cr. 3(2+1)

Theory

General characteristics of insects. Relationship with other Arthropoda, splitting up into different evolutionary lines. Reasons for success of the insects in diverse environments.

Hard Parts: General segmentation, Tagmatosis and organization.

Cuticle: Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane. Colours of insects. Cuticular outgrowths and appendages sclerotization.

Head: Cephalization, Sclerites, Modifications. Antennae: Different modes of ingestion and types of mouth parts.

Neck: Sclerites.

Thorax: Sclerites: legs, their different modifications and functions.

Wings: Origin: Different regions. Development. Basal attachments. Main veins and their branches (generalized insects). Wing coupling.

Abdomen: Secondary appendages and external genitalia. Flight: types of flight. Aerodynamics. Fuels.

Practicals

Preparation of permanent slides. All the hard parts (terminal segments, wings, antennae, legs, mouth parts and genitalia). Different systems, especially digestive, reproductive of the following insects. American cockroach, Gryllus, grasshopper

Books Recommended

1. GENERAL TEXT BOOK OF ENTOMOLOGY. Imm. Richards and Davies, Vol.1.
2. THE INSECTS: STRUCTURE AND FUNCTION, 2000. Chapman.
3. INSECT PHYSIOLOGY. Wiggles Worth.
4. INSECT PHYSIOLOGY. Pattons.
5. INSECT ECOLOGY. Price.
6. ECOLOGY: THE EXPERIMENTAL ANALYSIS ABUNDANCE. Krebs.
7. MODERN ENTOMOLOGY, 1997. Tembhare.
8. ECOLOGICAL METHODS, 1978. T.R.E. Southood.
9. ELEMENTS OF INSECT ECOLOGY, 1997. S.S. Yasbani and M.L. Agarwal.

Z-712 ENTOMOLOGY B (Classification of Insects and Pest Management) -I Cr. 3(2+1)

Theory

A general account including classification of insect orders: Collembola, Orthoptera, Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders: Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata, Thysanoptera, Neuroptera, Mecoptera, Tricoptera, Siphonaptera, Strepsiptera, Insects of economic importance.

Practicals

Collection, preservation and identification of insects upto families (except for the identification upto species of a few pests of great economic importance), with the help of keys/literature.

Books Recommended:

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.
2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

Z-713 ENDOCRINOLOGY A (General & Comparative Endocrinology)-I Cr. 3(2+1)

Theory

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feed back, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

Hypothalamus and pituitary: Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary and hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.

Thyroid gland: Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.

Calcitrophic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Practicals

Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc; Histological and ultrastructure features of endocrine glands;

Books Recommended:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol.I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed.. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-714 ENDOCRINOLOGY B (Molecular and Clinical Endocrinology) -I Cr. 3(2+1)

Theory

General Mechanisms in Molecular Endocrinology: Subcellular structure of cells secreting protein hormones; Process of hormone secretion; Transcription factors in developmental organisms in endocrine systems. Recombinant DNA technology and molecular genetics in diagnosis and treatment of endocrine diseases. Measurements of hormones: Radioimmunoassay, immunoradiometric, immunochemiluminometric and radioreceptor assays and their statistical procedures.

Mechanisms of Action of Hormones: Hormone systems and intracellular communication; Hormones acting at cell surface: Properties of hormone receptor interaction, structure, biosynthesis

and turnover of membrane receptors; Hormones acting in transcription regulation: Biochemistry and molecular interaction of steroid receptor, gene expression, messenger RNA stability and metabolism in hormone action.

Functional Pathology in Endocrine Glands: Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, corticotrophin regulation; Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity;

Practicals

Studies on recognition and response of receptors; Studies of disorders of pituitary by observing anatomical and histological features; Studies of thyroid status in deficient and excess hormone functions;

Books Recommended:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol. I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-715 PHYSIOLOGY A (Physiology of Coordination) -I Cr. 3(2+1)

Theory

Physiological Mechanisms at Cell: Cellular membrane and transmembrane transport; resting membrane potentials; Generation and conduction of action potentials; synaptic transmission; Membrane receptors, Second messenger and signal-transduction pathways.

Nervous System: Organization of nervous system; General sensory system; Visual, Auditory, Vestibular and Chemical sensory system; Motor system with brainstem, Cortical, Cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning, memory.

Muscle and Movements: Molecular basis of contraction; Muscles activity on skeleton; Adaptation of muscles for various activities; Muscles in the walls of hollow organs.

Practicals

Recording of action potentials on oscilloscope and effects of various factors on its characters; Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.

5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Ed.. Prentice Hall, London.

Z-716 PHYSIOLOGY B (Physiological Systems and Adaptations) -I Cr. 3(2+1)

Theory

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

Respiratory System: Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbondioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

Renal System: Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostais; Role of kidney in acid-base balance.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors; Demonstration of respiratory volume and pulmonary function tests.

Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Liouis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

Z-717 PARASITOLOGY A-I Cr. 3(2+1)

Theory

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of dmestic and wild animals. Camers in parasitology. Some basic definitions.

Basic principles and concepts. Parasite ecology and evolution.

Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship.

Parasitic protozoa, form, function and classification.

Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae.

Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida,

order Opalinida.

The Amoebas. Order Amoebida, order Schizopyrenida.

Books Recommended:

1. FOUNDATION OF PARASITOLOGY, 2000, 6th ed. Roberts, L.S. and Janovy, J. McGraw Hill Book Co.
2. PROTOZOOLOGY, 1996, 2nd ed. Hausman, K. and Hulsmann, N. Thieme Medical Publishers, Inc. New York.

Practical

- 1 Study of the prepared slides of Protozoan Parasites
 1. *Giardia lamblia* (Cyst and trophozoite)
 2. *Eimeria tenella* (Cyst and trophozoite)
 3. *Endolimax nana* (Cyst)
 4. *Entamoeba histolytica*
 5. *Histomonas meliagridis*
 6. *Leishmania*
 7. *Opalina*
 8. *Plasmodium falciparum*
 9. *Plasmodium vivax*
 10. *Schistosoma mansoni*
 11. Trophozoite of *Giardia lamblia*
 12. *Trypanosoma cruzi*
 13. *Trypanosoma gambiense*
 14. *Neglaria fowleri*
 15. *Monocystis lumbrici*
- 2 Culturing of protozoa (*Entamoeba*, *Histomonas meliagridis*)

Books Recommended:

1. Chaudhri SS and Gupta SK. 2003. *Manual of General Veterinary Parasitology*. International Book Distr. Co.
2. Sterling CR. and Adam RD. 2004. *The Pathogenic Enteric Protozoa*. Kluwer Academic Press.
3. Durr P & Gatrell A. 2004. *GIS and Spatial Analysis in Veterinary Science*. CABI. Ministry of Agriculture, Fisheries and Food (MAFF). 1986. *Manual of Veterinary Parasitological Laboratory Techniques*. 3rd Ed. Tech. Bull. 18, HMSO.
4. Rathore VS & Sengar YS. 2005. *Diagnostic Parasitology*. Pointer Publ.

Z-718 PARASITOLOGY B-I Cr. 3(2+1)

Theory:

Systematics, biology, pathology, host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

Practicals

Methods of collection, preservation and transportation of parasitic material. Qualitative and quantitative faecal examination for helminth ova.

Books Recommended:

1. Noble and Noble, 1982. *Parasitology. The Biology of animal parasites*. 5th Ed.. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. *Medical parasitology*. 3rd Ed.. The C.V. Mosby Company, Toronto, London.

3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J. Jr., 2001. Foundations of Parasitology. 5th Ed.. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitology. Longman Scientific and Technical publications, Longman Group, U.K.

Z-719 MICROBIOLOGY A (General Microbiology) -I Cr. 3(2+1)

Theory

History and Introduction of Microbiology: The beginnings of Microbiology; Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology. **Characterization, Classification, and Identification of Microorganisms:** Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. **Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material. **The Cultivation of Bacteria:** Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation. **Viruses:** Bacteriophages; Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

Practicals

Study of bacteria, yeasts, molds and protozoa. Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic granule stain, Acid fast stain.

Books Recommended:

1. MICROBIAL APPLICATIONS (complete version) LABORATORY MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.
2. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 1986. Microbiology, McGraw Hill, London.
3. Madigan, M.T., Martinko, J.M. and Parker. 1997. Brock's Biology of Microorganisms, J. Prentice-Hall, London.
4. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter. 1986. The Microbial World, R.R. Prentice Hall, London.

Z-720 MICROBIOLOGY B (Applied Microbiology) -I Cr. 3(2+1)

Theory

Control of microorganisms: Control by physical agents: High Temperatures, Low Temperatures, Desiccation, Osmotic Pressure, Radiations, Filtration. **Control by chemical agents:** Characteristics of an ideal antimicrobial chemical agent, Selection of a chemical agent for practical applications, Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Quaternary ammonium compounds, Aldehydes, Gaseous agents, Evaluation of Antimicrobial Chemical Agents, **Antibiotics and other chemotherapeutic agents:** Antibiotics, Fleming and Penicillin, Modes of Action of Antibiotics, Antifungal antibiotics, Antiviral Chemotherapeutic agents, Synthetic chemotherapeutic agents, Development of resistance to antibiotics, Microbiological assay of antibiotics, Microbial susceptibility to chemotherapeutic agents, Nonmedical uses of antibiotics, **Microorganisms and diseases: Microbial Flora of the Healthy Human Host:** Origin of the normal flora, Normal flora and the human host, distribution and occurrence of the normal flora, **Host-microbe interactions: The Process of Infection:**

Pathogenicity virulence and infection, Microbial adherence, Penetration of epithelial cell layers, Events in infection following penetration, Microbial virulence factors, **Resistance and Immunity: Natural Resistance and Nonspecific Defense mechanisms:** Natural resistance, Internal defense mechanisms, Nonspecific defense mechanisms. **Basic and Theoretical Aspects of the Immune Response:** The immune response, The immune system, Hypersensitivity.

Practicals

Bacteriological examination of water. Isolation and identification of coliform bacteria and enteric pathogens. Isolation of pathogenic *Staphylococci*. Normal throat flora and reaction on blood agar. Enumeration and identification of microorganisms in urinary tract infections.

Books Recommended:

1. MICROBIOLOGY: A HUMAN PERSPECTIVE , 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education.
2. MICROBIOLOGY PRINCIPLES AND EXPLORATIONS, 2001. Jacquelyn, G.G. Wiley John and Sons Inc.
3. MICROBIOLOGY, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., 1986. Mc-Graw Hill, London.
4. MICROBIAL APPLICATIONS: LAB MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.

Z-721 FISHERIES A (Principles of Fish Biology) -I Cr. 3(2+1)

Theory

What fish are. How and where fish live. Major groups of living fishes. Characterization of living fish groups, major groups of extinct fishes. Relationships of the major groups of fishes, primitive fishes, early jawed fishes, sharks and their relatives bony fishes. Representative of families of living fishes.

Systematics and nomenclature; Introduction. Suitability of fishes to systematic studies. Historical background, taxonomic concepts. The data of classification. Study of collections, zoological nomenclature.

Fish morphology; Fish body form, body covering, appendages, openings. Head and mouth, upper lip lower lip, barbules. Scale, its types, arrangement, colour, scalesless fishes. Fin rays, fin spines (Pectoral, Pelvic, Dorsal, and caudal and Anal fin).

Practicals

Identification of freshwater fish species with the help of key. Collection and preservation of freshwater fish (optional)..

Textbook:

1. Ichthyology (2nd Ed.) By Lagler et al., 2003. John Wiley and Sons (Text Book).

Books Recommended:

2. Textbook of Fish and Fisheries. 2005. Sandhu, G.S. 1st Ed. Dominant publishers, New Delhi.
3. Textbook of Fish culture: Breeding and Cultivation. 1986. By M. Hute. Fishing News Books, UK.
4. Catfishes of India 2006. Jayram K.C. Narendra Publishing House, Delhi.
5. A Hatchery Manual for the Common Chinese and Indian Major carps. Jhingran and Rullin 1986. Asian Development Bank, Manila, Philippines.
6. A key to the fishes of the Punjab by Mirza and Sharif. 1996. Ilmi Kitab Khana, Lahore.

Z-722 FISHERIES B (Fish Physiology and Breeding) -I Cr. 3(2+1)

Theory

Fish nutrition: Digestive system, Stomach less fishes, Stomach fishes, Digestion and absorption; Fish food of plant and animal origin; Feeding; Fresh food, dry concentrates and pelleted food

Transportation: Blood composition, Blood cells (Erythrocytes, differential leukocytes and plasma). Circulation; Arterial and venous systems, blood capillaries, Transport of food material

Respiration: Gills, Lungs, Skin, Swimbladder, Homeostasis

Excretion: Kidneys, structure and function of teleost's kidney, osmoregulation

Practical

Study of gut contents, Study of feeding modification and adaptation in fish, Study of respiratory adaptation in fish, Study of blood cells and their counts in normal and diseased fish,

Books Recommended

1. A. N. Shukla, 2009. **Physiology of Fishes**. Discovery Publishing House Pvt. Ltd. New Delhi, India.
2. S. M. Hadi Alvi et al., 2008. **Fish Spermatology**. Alpha Science International, Oxford Business Park, Oxford, UK
3. G. S. Sandhu, 2001. **An Introduction to Fishes**. Campus Book International, New Delhi, India.
4. Keshav Kumar Jha, 2010. **Aquaculture**. Daya Publishing House, New Delhi, India
5. Brenabe. 1992. **Aquaculture vol. II**. Blackwell Scientific Publications Ltd. London
6. Maseke, C. 1987. **Fish Aquaculture**. Pergamon Press, Oxford, England
7. Huet, M., 1986. **Text Book of Fish Culture: Breeding and Cultivation**. Blackwell Scientific Publications Ltd. London
8. Lagler et al. 2003. **Ichthyology**. 2nd Edition. John Wiley & Sons. Inc. Pvt. Ltd., Singapore
9. Matty. 1983. **Fish Endocrinology**
10. Hoar, et al., 1983. **Fish Physiology: Reproduction**. Academic Press, New York

Z-723 ENVIRONMENTAL HEALTH AND ECOSYSTEMS A-I Cr. 3(2+1) (Principles of Environmental Health)

Theory

Human impact on the environment, Environment-animal interaction, Environmental impact on animals, Environmental toxicology: Environmental Hazards, Toxicology and Chemical Hazards, The nature of Chemical Hazards, Sources of Chemical Entering, The threat from Toxic Chemicals Involvement with Food Chains, Municipal, industrial, and hazardous waste, Indoor and outdoor air pollution,.

Practical

Use of Dust Trak to monitor air borne particles, Analysis of PM10, PM2.5, PM1 from different indoor and outdoor environments

Books Recommended

1. Blumenthal, D. S., and Ruttenber, A. J. 1995. Introduction to environmental health. Second Edition. New York: Springer.
2. Lippmann, M. (Ed.). 1992. Environmental toxicants: Human exposures and their health effects. New York: Van Nostrand Reinhold.
3. Moeller, D. W. 1997. Environmental health (Revised ed.). Cambridge: Harvard University Press.
4. Moore, G. S. 1999. Living with the earth: Concepts in environmental health science. Boca Raton: Lewis Publishers.

5. Nadakavukaren, A. 2000. Our global environment: A health perspective (5th ed.) Prospect Heights: Waveland Press, Inc.
6. Philp, R. B. 1995. Environmental hazards and human health. Boca Raton: Lewis Publishers.
7. Yassi, A., Kjellstrom, T., de Kok, T., Guidotti, T. L. 2001. Basic environmental health. New York: Oxford University Press.
8. Bennett, R. and Estell, R. 1991. Global Change and Challenge, Routledge
9. Lazaridis M, and Colbeck Ian, 2010. Human Exposure to Pollutants via Dermal Absorption and Inhalation. Springer.
10. Colbeck I. 2008. Environmental Chemistry of Aerosol, Blackwell Publishing
11. Wright, R.T. 2005. Environmental Science 9th Ed. Pearson Prentice Hall.
12. Purohit, S. S. and Ranjan R. 2003. Ecology Environment and Pollution, Agrobios
13. Ali, Z. Colbeck, I, and Nasir, Z. A. 2009. Basics of air Pollution Monitoring, UVAS, E-links.
14. Tiwary, A, and Colls, J. 2010. Air Pollution: Measurement, Modelling and Mitigation, 3rd edition, Taylor and Francis group.
15. Kowalski, W. J. 2006. Aerobiological Engineering Handbook, McGraw Hill.
16. Patt, A.G., Schroter, D., Klein, R.T.J., and Vega-Leinert, C.D. 2009. Assessing Vulnerability to Global Environmental Change. Making research Useful for Adaptation, Decision Making and Policy, Earthscan, pp. 285.
17. Susskind, L.E., Jain, R. K. and Martyniuk, A. O. 2001. Better Environmental Policy Studies. How to Design and Conduct more Effective Analysis, Island Press, London. Pp. 203.
18. Mozzanti, M. and Montini, A. 2009 Waste and Environmental Policy, Routledge, Taylor and Francis group. Pp.238.

**Z-724 ENVIRONMENTAL HEALTH AND ECOSYSTEMS B-I Cr. 3(2+1)
(Ecosystem Health Dynamics)**

Theory

The Atmosphere and Air Pollution, Air Pollution episodes of the World, Effects of Air Pollution on plants and animals, Inert materials, Human health, Air quality standards, Air Pollution Control, Chemical Hazards-additives, pesticide residues, toxic metals, Pesticides, Route of absorption, Toxicity/Classifications, Biological Effects of Radiation,

Practical

Survey of polluted sites, urban and rural environments, Comparison of data with national and international standards, Microbial and fungal analysis of collected samples from polluted sites.

Books Recommended

1. Blumenthal, D. S., and Ruttenber, A. J. 1995. Introduction to environmental health. Second Edition. New York: Springer.
2. Lippmann, M. (Ed.). 1992. Environmental toxicants: Human exposures and their health effects. New York: Van Nostrand Reinhold.
3. Moeller, D. W. 1997. Environmental health (Revised ed.). Cambridge: Harvard University Press.
4. Moore, G. S. 1999. Living with the earth: Concepts in environmental health science. Boca Raton: Lewis Publishers.
5. Nadakavukaren, A. 2000. Our global environment: A health perspective (5th ed.) Prospect Heights: Waveland Press, Inc.
6. Philp, R. B. 1995. Environmental hazards and human health. Boca Raton: Lewis Publishers.
7. Yassi, A., Kjellstrom, T., de Kok, T., Guidotti, T. L. 2001. Basic environmental health. New York: Oxford University Press.
8. Bennett, R. and Estell, R. 1991. Global Change and Challenge, Routledge
9. Lazaridis M, and Colbeck Ian, 2010. Human Exposure to Pollutants via Dermal Absorption and Inhalation. Springer.
10. Colbeck I. 2008. Environmental Chemistry of Aerosol, Blackwell Publishing
11. Wright, R.T. 2005. Environmental Science 9th Ed. Pearson Prentice Hall.

12. Purohit, S. S. and Ranjan R. 2003. Ecology Environment and Pollution, Agrobios
13. Ali, Z. Colbeck, I, and Nasir, Z. A. 2009. Basics of air Pollution Monitoring, UVAS, E-links.
14. Tiwary, A, and Colls, J. 2010. Air Pollution: Measurement, Modelling and Mitigation, 3rd edition, Taylor and Francis group.
15. Kowalski, W. J. 2006. Aerobiological Engineering Handbook, McGraw Hill.
16. Patt, A.G., Schroter, D., Klein, R.T.J., and Vega-Leinert, C.D. 2009. Assessing Vulnerability to Global Environmental Change. Making research Useful for Adaptation, Decision Making and Policy, Earthscan, pp. 285.
17. Susskind, L.E., Jain, R. K. and Martyniuk, A. O. 2001. Better Environmental Policy Studies. How to Design and Conduct more Effective Analysis, Island Press, London. Pp. 203.
18. Mozzanti, M. and Montini, A. 2009 Waste and Environmental Policy, Routledge, Taylor and Francis group. Pp.238.

SEMESTER–VIII

Course Code	Title of Course	Credit Hours
Z-801	تدریس ترجمہ قرآن	0(0+0)
Z-802	Environmental Biology-II	4(3+1)
Z-803	Principles of Systematic Zoology	4(3+1)
Z-804	Principles of Palaeontology	4(3+1)
Z-1000	Thesis (Research)	6(6+0)
Z-----	Special Paper A-II	3(2+1)
Z-----	Special Paper B-II	3(2+1)
Z-----	Elective /supporting Paper	3(2+1)
Total Credit Hours		21

Z-801 تدریس ترجمہ قرآن **Cr: 0(0+0)**
سورة الزاریات تا سورة الناس

Z-802 **ENVIRONMENTAL BIOLOGY-II** **Cr: 4(3+1)**

Theory

Environmental Pollution:

Primary and secondary pollutants, point and non-point source pollutants, Air Pollution sources: Origin, dispersion. Impact of air pollutants viz. Sulphur oxides; Nitrogen oxides and Volatile organic compounds; Carbon oxides, Ozone, Smog. NH₃, PAN, PAH, smoke, water vapors, pollen grains and fungal spores on human crops and forest; MTBE (methyl tertiary butyl ether) and CFCs (chlorofluorocarbons); Noise pollution; sources, units, health damage from noise, control of noise; Water pollution; Sources of water pollutants; Composition and properties of water pollutants, Fate of water pollutants; Domestic and industrial effluents; Heavy metals and their impact on aquatic life; Water purification in nature; Waste water treatment plants; Wetland sewage treatment plants; cleaner, cheaper, and prettier water; Land Pollution; Pesticides (pollutants made to kill); Inorganic pesticides; Synthetic organic pesticides; Biochemicals (bacterial toxins and synthetic hormones); Chemical pesticides (non-target toxicity); Chlorine, dioxin and PCBs (polychlorinated biphenyls); Advantages and disadvantages of pesticides; Thermal pollution, global warming;; Warm water drainage from nuclear reactor; Radioactive pollution; Radiations, unites, types, causative effects and leakage from nuclear reactor

Population Ecology:

Population dynamics; Pattern of survival and dispersion; Age of distribution, sex ratio; Dispersal; Population growth; Geometric and exponential population growth; Logistic population growth;

Environmental limits on population growth

Population Ecology of man:

Community studies, Environmental management; Ecocrises; Environmental laws; Environmental ethics and politics; Environmental Economics; Chemical and biological warfare

Contemporary environmental themes:

Ozone depletion; Green house gases and their effects; Acid rain; Desertification; Deforestation, Range management.

Practical

Measurement of pollutants levels; In atmosphere (NO₂, SO₂, O₃ and comparison with rural air); In soil (toxic chemical, fertilizer, insecticides, pesticides, herbicides); In plants and animals; Analysis of polluted and freshwater for various pollutants like heavy metals, DO, CO₂, Chloride, -CO₃, -HCO₃, BOD, COD, pH, EC, total soluble and suspended solids, total acidity; Impact of radiation on microbes and plants; Effects of noise on animal behaviour

Books Recommended:

1. M.L. McKinney. 2007. Environmental Science: *System and Solution*. 4th Edition. Jones and Bartlett Publication, Boston, USA
2. G. Tyler Miller, Jr. 2002. Living in the Environment. Principles, Connections and Solutions. Book/Cole Thomson Learning, USA
3. Peter Stilling, 2002. Ecology. 4th Edition. Prentice Hall Publication, New Jersey, USA
4. Krebs. 2000 Ecology: The experimental analysis of distribution and application.
5. J.L. Chapman and M.J. Reiss, 1997. Ecology. Cambridge University Press, UK.
6. M.C. Molles. 1999. Ecology: *Concepts and applications* WCB/McGraw Hill, New York
7. C.E. Mason. 1996. Biology of Freshwater Pollution. Longman Publication, UK
8. E.P. Odum. 1996. Ecology: A Bridge between science and society.
9. R.K. Singh. 1998. Human Ecology.
10. R. Lloyd.1992. Pollution and Freshwater. Fishing News Books
11. Smith, 1988. Ecology and Field Biology. National Book Foundation, Islamabad.
12. E. P. Odum. 1976. Fundamentals of Ecology National Book Foundation, Islamabad.

Z-803 PRINCIPLES OF SYSTEMATIC ZOOLOGY Cr: 4(3+1)

Theory

Systematics:

Contribution of systems ties to biology. Concepts of taxon, phenon and category. Species concepts and its problems (Typological, Nominalistic, Biological, Evolutionary, Mate recognition, Genetic cohesion, Phylogenetic and Phenetic concepts). Subspecies concepts, Clines and hybrid zones, Polytypic species, superspecies. Modes of speciation. Intrapopulational variation. Different kinds of taxonomic characters. Weightage of taxonomic characters. Classification and its types: Phenetic, cladistic and Evolutionary classifications. Difference between types of classification. Taxonomic collections and the process of identification. Types of taxonomic publications, major features of taxonomic articles. The rules of zoological nomenclature (interpretation and application of the code (Stability, priority, first reviser principle), range of authority of code, concept of availability, type method, formation of specific names, synonym, homonym.

Practicals:

The study of a group of organisms while utilizing Key. Collection, preservation, labeling and identification of a group of specimen according to expertise available in the institute. Preparation of bracket and indent key. Biometry Rationale, collection of data, statistical analysis (F test, t test, Z test, analysis of variance, regression and correlation) and interpretation. Phylogeny Reconstruction. Application of phenetic (similarity and dissimilarity matrix and unweighted pair group method) and cladistic (compatibility method) analysis to a group of mock "organisms."

Text Books:

1. Ridley, M. 2004. Evolution, 3rd Ed. Blackwell Science.
2. Mayer, E. and Ashlock, P. D. () Principles of Systematic Zoology. McGraw Hill, New York.

Books Recommended:

1. Bell, G. 1997. Selection: the mechanism of evolution. Chapman and Hall, NY.
2. Dawkins, R. 1986. The blind watchmaker. Longman Scientific and Technical. Essex, England.
3. Dawkins, R.. 1978. The selfish gene. Oxford University Press, NY.
4. Freeman, S. and Herron, J. C. 2004. Evolutionary analysis, 3rd ed. Pearson Prentice Hall.
5. Futuyma, D. J. 1997. Evolutionary Biology, 3rd ed. Sinauer Associates, Inc. Sunderland, Massachusetts.
6. Gould, S. J. 1977. Ever since Darwin. W. W. Norton and Company, NY.
7. Ridley, M. 2000. Genome. New York: Perennial. Great reading.
8. Stearns, S. C. and Hoekstra, R. F. 2000. Evolution, an introduction. Oxford University Press.
9. Strickberger, (3rd or latest Ed.) Evolution. Jones and Barrett Publishers.
10. Freeman Dyson, (1999). Origin of life, Cambridge University press.
11. Simpson, G. G. (latest Ed.). Principle of animal taxonomy. Columbia University Press, New York.
12. Sokal R., and Sneath P.H. A. (latest Ed.). Principles of numerical taxonomy. W.H. Freeman and company, London.

Z-804 PRINCIPLES OF PALAEOLOGY Cr: 4(3+1)

Theory

The history of life; Earth, Shells of earth (Atmosphere, hydrosphere, biosphere and lithosphere); Rock, types of rocks (Igneous rocks, sedimentary rocks and metamorphic rocks); Fossil, types and uses of fossils, Nature of fossils, Processes of fossilization (Study of process of dying and what processes occur to animals after their death, Geological concepts of fossilization); Geological time scale; Pre-Cambrian life, Post-Cambrian life (Paleozoic life, Mesozoic life, Cenozoic life); A brief history of the Siwaliks; Geochronometry (Uranium/Lead dating, radiocarbon dating, Fission track dating and palaeomagnetism); Evolutionary histories of camels, horses, elephants and man.

Books Recommended:

1. Young J.Z., 1950. (3rd edition). Life of vertebrates. London, Oxford Univ. Press.
2. Dunbar C.O., 1960. Historical Geology. John Wiley and Sons Inc. New York.
3. Brouwer, A., 1977. General Palaeontology, Oliver and Boyed, London.
4. Gilbert, Colbert, E.H., 1980. Evolution of vertebrates, John Wiley and Sons Inc. New York.
5. Moore, R.C. Lalicker, G.C., Fisher, A.G., 1952. Invertebrate Fossils. McGraw-Hill, New York.
6. Steven M. Stanley, 2008. Earth system History. 3rd addition.
7. Ali, S.S., 1999. Palaeontology, Zoogeography and Wildlife Management.
8. Michael Foote and Arnold I. Miller, 2007. Principles of Palaeontology (3rd Ed.) Freeman and Company.

Practicals

Principles of Palaeontology

Study of rocks (Igneous, sedimentary and metamorphic rocks); Identification and classification of vertebrates and invertebrate fossils; Study of molds, casts, pseudomorphs, petrified fossils, imprints, foot prints and coprolites; Study of vertebrate fossils of evolutionary importance e.g. Horses, Elephants, Primates and Camels etc;

Z-1000 THESIS Cr. 6 (6+0)

SPECIAL PAPERS

Z-811 ENTOMOLOGY A (Morphology, Physiology and Ecology)-II Cr. 3(2+1)

Theory

Soft Parts: Muscular system: Basic structure. Types of muscles. Muscle contraction and its energetics. Comparative structure of all the systems, e.g., digestive, excretory, respiratory, incubatory, and nervous system and their physiology. Sense organs: sound and light producing organs. Nutritive requirements: Fat body. Exocrine and Endocrine glands including pheromones and their functions.

Reproduction: Reproductive organs and different types of reproduction in insects. Egg fertilization and maturation.

Development: Embryology up to dorsal closure. Different types of metamorphosis. Apolysis and ecdysis and the role of endocrine secretions.

Ecology: Carrying capacity 'r' and k selection. Food chains. Predation and competition. Insect defences and adaptations. Diapause insect population and community studies. Insect communication.

Practicals

Different systems, especially digestive, reproductive of the following insects. housefly, butterfly, mosquito, any common beetle. Red cotton bug. Wasp and honey bee. Sympathetic nervous system of cockroach and gryllus. Salivary glands of cockroach, red cotton bug and honey bee.

Books Recommended

1. GENERAL TEXT BOOK OF ENTOMOLOGY. Imm. Richards and Davies, Vol.1.
2. THE INSECTS: STRUCTURE AND FUNCTION, 2000. Chapman.
3. INSECT PHYSIOLOGY. Wiggles Worth.
4. INSECT PHYSIOLOGY. Pattons.
5. INSECT ECOLOGY. Price.
6. ECOLOGY: THE EXPERIMENTAL ANALYSIS ABUNDANCE. Krebs.
7. MODERN ENTOMOLOGY, 1997. Tembhare.
8. ECOLOGICAL METHODS, 1978. T.R.E. Southood.
9. ELEMENTS OF INSECT ECOLOGY, 1997. S.S. Yasbani and M.L. Agarwal.

Z-812 ENTOMOLOGY B (Classification of Insects and Pest Management) -II Cr. 3(2+1)

Theory

Brief account of biological control, chemical control and integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management.

Practicals

1. Collection, preservation and identification of insects upto families (except for the identification upto species of a few pests of great economic importance), with the help of keys/literature.

Books Recommended:

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.
2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

Z-813 ENDOCRINOLOGY A (General & Comparative Endocrinology) -II Cr. 3(2+1)

Theory

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

Adrenal Medulla and Catecholamines: Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.

Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.

Testes: Androgenic tissue: Structure and chemistry; Transport, metabolism and mechanism of action.

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition.

Endocrinology of Lactation: Hormones in lactation.

Endocrinology of Heart, Kidney, Immune system: Growth and pineal gland.

Functional Diversity of Hormones in Vertebrates.

Overview of Endocrine Mechanisms in Invertebrates.

Practicals

Experiments to demonstrate physiological roles of hormones of different endocrine glands; Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates. Experiments on endocrine mechanism in vertebrates.

Books Recommended:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. et al., 2001. Endocrinology, Vol.I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed.. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-814 ENDOCRINOLOGY B (Molecular and Clinical Endocrinology) -II Cr. 3(2+1)

Theory

Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.

Fuel Homeostasis: Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anorexia nervosa and bulimia nervosa.

Development and Growth: Disorders of growth and puberty.

Endocrine Hypertension

Polyendocrine Syndromes.

Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy.

Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid,

glucose and calcium homeostasis.

Practicals

Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2; Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of hormonal status in puberty and aging.

Books Recommended:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. et al., 2001. Endocrinology, Vol. I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-815 PHYSIOLOGY A (Physiology of Coordination) -II Cr. 3(2+1)

Theory

Endocrine System: General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

Practicals

Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxine on oxygen consumption; Effect of androgen on accessory sex organs and of estrogens on target tissues; Study of estrous cycle and effects of the hormones.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed..

Cambridge University Press, Cambridge.

7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Ed.. Prentice Hall, London.

Z-816 PHYSIOLOGY B (Physiological Systems and Adaptations) -II Cr. 3(2+1)

Theory

Gastrointestinal System: Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

Osmoregulation: Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aquatic and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

Z-817 PARASITOLOGY A -II Cr. 3(2+1)

Theory

Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarina, class Coccidia.

Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida.

Phylum ciliophora, ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea.

Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa.

The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa.

Books Recommended:

1. FOUNDATION OF PARASITOLOGY, 2000, 6th ed. Roberts, L.S. and Janovy, J. McGraw Hill Book Co.

2. PROTOZOOLOGY, 1996, 2nd ed. Hausman, K. and Hulsmann, N. Thieme Medical Publishers, Inc. New York.

Practical

- 1 Establishing infection studies of *Eimeria tenella* in chicken
- 2 Study of malarial parasite in thick and thin blood films.
- 3 Effects of coccidiosis on hematological parameters of chicks
- 4 Macroscopic and microscopic observation of lesions caused by protozoan parasite infection in host tissues (histopathology of infected tissue)

Books Recommended:

1. Chaudhri SS and Gupta SK. 2003. *Manual of General Veterinary Parasitology*. International Book Distr. Co.
2. Sterling CR. and Adam RD. 2004. *The Pathogenic Enteric Protozoa*. Kluwer Academic Press.
3. Durr P & Gatrell A. 2004. *GIS and Spatial Analysis in Veterinary Science*. CABI. Ministry of Agriculture, Fisheries and Food (MAFF). 1986. *Manual of Veterinary Parasitological Laboratory Techniques*. 3rd Ed. Tech. Bull. 18, HMSO.
4. Rathore VS & Sengar YS. 2005. *Diagnostic Parasitology*. Pointer Publ.

Z-818 PARASITOLOGY B-II Cr. 3(2+1)

Theory:

Systematics, morphology and biology of Arthropods causing disease or those responsible for transmission of disease. Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

Practicals

Collection, preservation and preparation of slides of local helminthes and their identification. Identification of insects of medical and veterinary importance.

Books Recommended:

1. Noble and Noble, 1982. Parasitology. The Biology of animal parasites. 5th Ed.. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical parasitology. 3rd Ed.. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J. Jr., 2001. Foundations of Parasitology. 5th Ed.. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitology. Longman Scientific and Technical publications, Longman Group, U.K.

Z-819 MICROBIOLOGY A (General Microbiology) -II Cr. 3(2+1)

Theory

Reproduction and growth of bacteria: Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth. **Pure cultures and cultural characteristics:** Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and

preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures. **Prokaryotic diversity Bacteria:** Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

Eukaryotic Microorganisms: Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

Practicals

The culture of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plate and pour plate methods. Isolation and pure culturing of bacteria. Quantitative plating methods. The turbidimetric estimation of microbial growth. Study of bacterial viruses.

Books Recommended:

1. MICROBIAL APPLICATIONS (complete version) LABORATORY MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.
2. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 1986. Microbiology, McGraw Hill, London.
3. Madigan, M.T., Martinko, J.M. and Parker. 1997. Brock's Biology of Microorganisms, J. Prentice-Hall, London.
4. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter. 1986. The Microbial World, R.R. Prentice Hall, London.

Z-820 MICROBIOLOGY B (Applied Microbiology) -II Cr. 3(2+1)

Theory

Environmental microbiology: Aquatic microbiology: Natural waters, The aquatic environment, Distribution of microorganisms in the aquatic environment, Techniques for the study of aquatic microorganisms, Aquatic microorganisms, The role and importance of aquatic microbial ecosystems, Productivity of aquatic ecosystems, Biogeochemical transformations. **Soil microbiology:** Physical characteristics of soil, Microbial flora of soil, Interactions among soil microorganisms, Biogeochemical role of soil microorganisms, Biochemical transformations of nitrogen and nitrogen compounds, The nitrogen cycle, Biochemical Transformations of carbon and carbon compounds The carbon cycle, Biochemical transformations of sulfur and sulfur compounds The Sulfur cycle. Biodegradation of herbicides and pesticides. **Microbiology of domestic water and sewage:** Water purification, Determining sanitary quality, Swimming pools, Water pollution, Wastewater, Wastewater treatment and disposal, wastewater-treatment processes, Microorganisms and wastewater-treatment procedures, Efficiency of wastewater-treatment procedures, The pollution problem. **Microbiology of foods:** Microbial flora of fresh foods, Microbial spoilage of foods, Microbiological examination of foods, Preservation of foods, fermented foods, Microorganisms as food, single-cell protein. **Industrial Microbiology:** Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

Practicals

Isolation and identification of microorganisms from the diseased ear. Inhibition and destruction of microorganisms by physical agents. Action of disinfectants on bacteria. Bacteriostatic action of

certain dyes and drugs. Bacterial sensitivity tests. Bacterial examination of food and raw milk. Surveys of microorganisms' activities based industries.

Books Recommended:

1. MICROBIOLOGY: A HUMAN PERSPECTIVE , 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education.
2. MICROBIOLOGY PRINCIPLES AND EXPLORATIONS, 2001. Jacquelyn, G.G. Wiley John and Sons Inc.
3. MICROBIOLOGY, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., 1986. Mc-Graw Hill, London.
4. MICROBIAL APPLICATIONS: LAB MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.

Z-821 FISHERIES A (Principles of Fish Biology) -II Cr. 3(2+1)

Theory

Fish Anatomy; (comparative account in three major groups of living fishes, Cyclostomes, chondrichthyes, osteichthyes). Skeleton. Types of skeleton (membranous, axial, appendicular skeleton). Notochord, Skull, backbone, spines; Brain and spinal cord, cranial nerves, spinal nerves; Olfactory organ, eye, organs of hearing and balance. Gills (no, size, arrangements). Fish blood, vital organs, Heart, Liver, Kidney; Viscera and mesenteries (Swimbladder, stomach, spleen. Pancreas, Intestine, reproductive glands-gonads).

Feeding groups of fishes; Herbivore, planlton eater, larvivore, carnivore, omnivore, voracious

Ecology of fishes; Definitions, organic productivity in aquatic ecosystem. Ecological classifications of fishes, ecological factors, marine ecosystem, estuarine, ecosystem freshwater ecosystem.

Practicals

Identification of freshwater fish species with the help of key. Collection and preservation of freshwater fish (optional). Study of different organs of various fish species. Study and survey of various fish collections present in museums like Natural History Museum at Islamabad; Govt. College University Museum, Lahore and Punjab University Museum, Lahore.

Textbook:

1. Ichthyology (2nd Ed.) By Lagler et al., 2003. John Wiley and Sons (Text Book).

Books Recommended:

2. Textbook of Fish and Fisheries. 2005. Sandhu, G.S. 1st Ed. Dominant publishers, New Delhi.
3. Textbook of Fish culture: Breeding and Cultivation. 1986. By M. Hute. Fishing News Books, UK.
4. Catfishes of India 2006. Jayram K.C. Narendra Publishing House, Delhi.
5. A Hatchery Manual for the Common Chinese and Indian Major carps. Jhingran and Rullin 1986. Asian Development Bank, Manila, Philippines.
6. A key to the fishes of the Punjab by Mirza and Sharif. 1996. Ilmi Kitab Khana, Lahore.

Z-822 FISHERIES B (Fish Physiology and Breeding) -II Cr. 3(2+1)

Theory

Reproduction: Gonads, maturation, oogenesis, spermatogenesis, reproductive cells.

Endocrine glands: Pituitary, thyroid, adrenal and pancreas in fishes, endocrine hormone regulation in reproduction.

Breeding: Natural (seasonal), Artificial, Hormonal induced breeding, Temperature and photoperiod control induced breeding

Development: Fertilization, cleavage, gastrulation and organogenesis.

Growth: Extensive culture (due to the consumption of natural food), Semi-intensive culture (due to natural and artificial food), Intensive culture (due to only dry concentrates)

Fish migration and behaviour: Anadromous, Catadromous, Amphidromous, Oceanodromous, potamodromous and diadromous fishes. Learning and memory, Courtship and feeding behaviour, Aquarium fish behaviour

Practical

Study of water quality parameters (DO, NH₃, hardness, alkalinity, turbidity, transparency, temperature, salinity), Study of various forms of swimbladder as hydrostatic organ, Study fecundity of various fish species, Study the effects of reproductive hormone on fish maturation, Visit to various fish seed hatcheries during breeding seasons

Books Recommended

1. A. N. Shukla, 2009. **Physiology of Fishes**. Discovery Publishing House Pvt. Ltd. New Delhi, India.
2. S. M. Hadi Alvi et al., 2008. **Fish Spermatology**. Alpha Science International, Oxford Business Park, Oxford, UK
3. G. S. Sandhu, 2001. **An Introduction to Fishes**. Campus Book International, New Delhi, India.
4. Keshav Kumar Jha, 2010. **Aquaculture**. Daya Publishing House, New Delhi, India
5. Brenabe. 1992. **Aquaculture vol. II**. Blackwell Scientific Publications Ltd. London
6. Maseke, C. 1987. **Fish Aquaculture**. Pergamon Press, Oxford, England
7. Huet, M., 1986. **Text Book of Fish Culture: Breeding and Cultivation**. Blackwell Scientific Publications Ltd. London
8. Lagler et al. 2003. **Ichthyology**. 2nd Edition. John Wiley & Sons. Inc. Pvt. Ltd., Singapore
9. Matty. 1983. **Fish Endocrinology**
10. Hoar, et al., 1983. **Fish Physiology: Reproduction**. Academic Press, New York

Z-823 ENVIRONMENTAL HEALTH AND ECOSYSTEMS A-II Cr. 3(2+1) (Principles of Environmental Health)

Theory

Physical and Chemical properties of Atmospheric Aerosol, Organic Aerosol, Bio-aerosols, Metals in aerosol, Chemical Reactions among Indoor pollutants, Sources and Health Effects of different Indoor Air pollutants, Air Quality Management and Personal Exposure, Thermodynamics of aqueous system, Environmental justice and policy, Risk communication, Ecosystem Sustainability, Value of Ecosystem Capital, Predator-Prey Dynamics, Ecosystem Response to Disturbance, Consequences of losing Biodiversity, Pollution Prevention for a sustainable Society.

Practical

Use of Dust Trak to monitor air borne particles, Analysis of PM₁₀, PM_{2.5}, PM₁ from different indoor and outdoor environments

Books Recommended

1. Blumenthal, D. S., and Ruttenber, A. J. 1995. Introduction to environmental health. Second Edition. New York: Springer.
2. Lippmann, M. (Ed.). 1992. Environmental toxicants: Human exposures and their health effects. New York: Van Nostrand Reinhold.
3. Moeller, D. W. 1997. Environmental health (Revised ed.). Cambridge: Harvard University Press.
4. Moore, G. S. 1999. Living with the earth: Concepts in environmental health science. Boca Raton: Lewis Publishers.

5. Nadakavukaren, A. 2000. Our global environment: A health perspective (5th ed.) Prospect Heights: Waveland Press, Inc.
6. Philp, R. B. 1995. Environmental hazards and human health. Boca Raton: Lewis Publishers.
7. Yassi, A., Kjellstrom, T., de Kok, T., Guidotti, T. L. 2001. Basic environmental health. New York: Oxford University Press.
8. Bennett, R. and Estell, R. 1991. Global Change and Challenge, Routledge
9. Lazaridis M, and Colbeck Ian, 2010. Human Exposure to Pollutants via Dermal Absorption and Inhalation. Springer.
10. Colbeck I. 2008. Environmental Chemistry of Aerosol, Blackwell Publishing
11. Wright, R.T. 2005. Environmental Science 9th Ed. Pearson Prentice Hall.
12. Purohit, S. S. and Ranjan R. 2003. Ecology Environment and Pollution, Agrobios
13. Ali, Z. Colbeck, I, and Nasir, Z. A. 2009. Basics of air Pollution Monitoring, UVAS, E-links.
14. Tiwary, A, and Colls, J. 2010. Air Pollution: Measurement, Modelling and Mitigation, 3rd edition, Taylor and Francis group.
15. Kowalski, W. J. 2006. Aerobiological Engineering Handbook, McGraw Hill.
16. Patt, A.G., Schroter, D., Klein, R.T.J., and Vega-Leinert, C.D. 2009. Assessing Vulnerability to Global Environmental Change. Making research Useful for Adaptation, Decision Making and Policy, Earthscan, pp. 285.
17. Susskind, L.E., Jain, R. K. and Martyniuk, A. O. 2001. Better Environmental Policy Studies. How to Design and Conduct more Effective Analysis, Island Press, London. Pp. 203.
18. Mozzanti, M. and Montini, A. 2009 Waste and Environmental Policy, Routledge, Taylor and Francis group. Pp.238.

**Z-824 ENVIRONMENTAL HEALTH AND ECOSYSTEMS B-II Cr. 3(2+1)
(Ecosystem Health Dynamics)**

Theory

Signs of Aquatic Pollution, Major Water Pollutants, Freshwater Blooms, Prevention and Control of Water Pollution, Water and Animal Diseases, Sources of Noise Pollution, Reasons of noise Pollution, Effect of Noise, Harmful Effects of Pollution, pollution control strategies, Management of Wildlife to reduce Harmful Effects of pollution, Biological and Ecological indicators, Biological markers of Environmental pollution, Resources and Environment

Practical

Survey of polluted sites, urban and rural environments, Comparison of data with national and international standards, Microbial and fungal analysis of collected samples from polluted sites.

Books Recommended

1. Blumenthal, D. S., and Ruttenber, A. J. 1995. Introduction to environmental health. Second Edition. New York: Springer.
2. Lippmann, M. (Ed.). 1992. Environmental toxicants: Human exposures and their health effects. New York: Van Nostrand Reinhold.
3. Moeller, D. W. 1997. Environmental health (Revised ed.). Cambridge: Harvard University Press.
4. Moore, G. S. 1999. Living with the earth: Concepts in environmental health science. Boca Raton: Lewis Publishers.
5. Nadakavukaren, A. 2000. Our global environment: A health perspective (5th ed.) Prospect Heights: Waveland Press, Inc.
6. Philp, R. B. 1995. Environmental hazards and human health. Boca Raton: Lewis Publishers.
7. Yassi, A., Kjellstrom, T., de Kok, T., Guidotti, T. L. 2001. Basic environmental health. New York: Oxford University Press.
8. Bennett, R. and Estell, R. 1991. Global Change and Challenge, Routledge
9. Lazaridis M, and Colbeck Ian, 2010. Human Exposure to Pollutants via Dermal Absorption and Inhalation. Springer.

10. Colbeck I. 2008. Environmental Chemistry of Aerosol, Blackwell Publishing
11. Wright, R.T. 2005. Environmental Science 9th Ed. Pearson Prentice Hall.
12. Purohit, S. S. and Ranjan R. 2003. Ecology Environment and Pollution, Agrobios
13. Ali, Z. Colbeck, I, and Nasir, Z. A. 2009. Basics of air Pollution Monitoring, UVAS, E-links.
14. Tiwary, A, and Colls, J. 2010. Air Pollution: Measurement, Modelling and Mitigation, 3rd edition, Taylor and Francis group.
15. Kowalski, W. J. 2006. Aerobiological Engineering Handbook, McGraw Hill.
16. Patt, A.G., Schroter, D., Klein, R.T.J., and Vega-Leinert, C.D. 2009. Assessing Vulnerability to Global Environmental Change. Making research Useful for Adaptation, Decision Making and Policy, Earthscan, pp. 285.
17. Susskind, L.E., Jain, R. K. and Martyniuk, A. O. 2001. Better Environmental Policy Studies. How to Design and Conduct more Effective Analysis, Island Press, London. Pp. 203.
18. Mozzanti, M. and Montini, A. 2009 Waste and Environmental Policy, Routledge, Taylor and Francis group. Pp.238.

ELECTIVE/SUPPORTING PAPERS

Z-901 INTEGRATED PEST MANAGEMENT Cr. 3(2+1)

Theory

Brief account of integrated pest management. Concept of economic damage and the damage boundary. Economic injury level (EIL), Economic threshold (ET), dynamics of economic injury level, environmental EILs. Pest management history, insecticide era, evolution of pest management. The concept of Pest management : definition, strategies and tactics, kinds of pests (sub economic, occasional, percnial and severe) and likely management strategies. Management with natural enemies. Biological control, numerical and functional response of biocontrol agents; types of biological control agents and their working, practice of biological control (introduction, augmentation and conservation). Ecological management; definition, procedures of ecological management. Role of sanitation, tillage, water management, crop spacing, crop rotation, trap crop, inter cropping and host tolerance in ecological management.

Chemical management: insecticides, classification according to application and chemical composition (Pyretheroids, carbamates, organophosphate, Neonicotinoids, insect growth regulators, fumigants). Types of insecticides formulation, good and bad effects of insecticides; Genetic control: Sterile insect techniques, methods of sterilization and utilization of specimens. Management with resistant plants, insect and host plant relationship, mechanisms of resistance, application in the integration programme. Integration of all these management methods.

Practicals

1. Surveillance and sampling techniques (any five for collection of insect pests).
2. Population estimation of insect pests using different methods.
3. Calculation of economic decision levels (EIL and ET).
4. Development of a pest management programme (using any important Pest of the area).
5. Collection, preservation and identification of insect pest.
6. Effect of insecticide on insect population in the field utilizing any pest and sampling techniques.
7. Effects of tillage and intercrop on insect population in the field.

Textbook:

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.

Additional Readings:

2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

4. De Bach P., 1964. Biological control of insect pests and weeds. Chapman and Hall, London (Latest edition).
5. Flint, M.L. and Gouveia, 2001. IPM in practice principles and methods of Integrated Pest Management.

Z-902 MEDICAL AND VETERINARY ENTOMOLOGY Cr. 3(2+1)

Theory

Life histories, pathogens and control of insects of veterinary and medical importance. Phylum, Arthropoda; Anatomy, Development-Classification. Class, Insecta: Anatomy-Development-Classification. Order, Orthoptera: Cockroaches. Order, Coleoptera; Order, Diptera: Classification – Suborder, Nematocera, Family Ceratopogonidae: Culicoides; Family, Simuliidae: Simulium; Family, Psychodidae: Phlebotomus; Family, Culicidae: Culex-Aedes-Anopheles; Suborder, Brachycera; Family, Tabanidae: Tabanus-Haematopota-Chrysops-Pangonia; Suborder, Cyclorrhapha; Section, Schizophora; Superfamily, Calypteratae; Family, Cestridae: Gastrophilus-Cestrus-Hypoderma-Dermatobia; Family, Anthomyidae: Musca-Stomoxys-Lyperosia-Glossina. Glossina and disease; Family, Tachinidae: Lucilia-Calliphora-Phormia-Chrysomyia-Callitroga. Calliphorine myiasis of sheep. Screw-worms of man, cattle and other animals. Cordylobia-Booponus. Family, Sarcophagidae: Sarcophaga-Wohlfahrtia. Section, Pupipara; Family, Hippoboscidae: Hippobosca-Melophagus-Pseudolynchia. Order, Hemiptera. Family, Cimicidae: Cimex; Family, Triatomidae, Order, Phthiraptera (Lice). Suborder, Anoplura (Siphunculata). Family, Haematopinidae: Haematopinus. Family, Linognathidae: Linognathus-Solenopotes. Family, Hoplopleuridae: Polyplacinae. Family, Pediculidae: Pediculus-Phthirus. Suborder, Mallophaga. Superfamily, Ischnocera. Cuculogaster-Lipeurus-Goniodes-Goniocotes-Chelopistes-Columbicola-Anaticola-Damalinia-Tricodectes-Felicola. Superfamily, Amblycera, Menopon-Menacanthus-Trinoton-Gyropus-Gliricola-Trimenopon-Heterodoxus. Effects of lice on their hosts. Control and treatment of lice. Order, Siphonaptera: Ctenocephalides-Ceratophyllus-Pulex-Xenopsylla-Nosopsyllus-Echidnophaga. Control of fleas. Class, Arachnida. Classification; Order, Acarina, Suborder, Mesostigmata, Dermanyssus-Ornithonyssus-Allodermanyssus-Echinolaelaps-Pneumonyssus. Suborder, Ixodoidea. Family, Argasidae: Argas-Otobius-Ornithodoros. Family, Ixodidae: Ixodes-Boophilus-Margaropus-Hyalomma-Rhipicephalus-Haemaphysalis-Dermacentor-Rhipicentor-Amblyomma-Aponomma: Ticks as parasites. Suborder, Trombidiformes. Family, Trombiculidae: Trombicula-Neoschongastida. Family, Pediculoididae: Pediculoides. Family, Demodicidae: Demodex. Family, Cheyletidae: Psorergates-Syringophilus-Cheyletiella. Family, Myobiidae: Myobia-Harpirhynchus. Suborder, Sarcoptiformes. Family Sarcoptidae: Sarcoptes-Cnemidocoptes-Notoedres. Family, Psoroptidae: Psoroptes-Chorioptes-Otodectes. Family, Cytoditidae: Cytodites. Family, Laminosioptidae: Laminosioptes. Family, Epidermoptidae. Family, Lirophoridae. Feather-Mites: Family, Analgesidae. Family, Dermoglyphidae. Family, Proctophylloidea. Order, Pentastomida. Family, Porcephalidae: Linguatula-Porocephalus. Lujurious Non-parasitic Arthropoda. Myriapoda-Insecta: Piercing or biting species; stinging species; nettling species; cryptotoxic species. Arachnida: Scorpions, Solifuge-Araneide-Acarina: Mites in foodstuffs.

Technique and Diagnosis: Collection and preservation of helminthes. Collection and preservation of arthropod parasites. Making of permanent preparations. Clinical Diagnostic methods. 1. The outside of the body. 2. Excretions. Nasal discharge and vomit. Faeces: (a) Examination for and recovery of, Adult worms and larvae; (b) Microscopical examination and methods for counting worm eggs and worms; (c) cultivation of worm larvae in faeces. 3. Blood examination for larvae. 4. Allergic reactions, (i) Intradermal reactions, (ii) Complement fixation, (iii) Precipitin reaction. Host parasite list. Infective larvae of some nematodes of sheep. Bibliography. Alphabetical index.

Practicals

Collection, preservation and making of permanent preparations of insects of veterinary importance; and their identity.

Books Recommended:

1. Monning's Veterinary Helminthology and Entomology.
2. Bailliere, Tindall and Co. X, London.
3. Metcalf and Flint: Useful and Destructive Insects. McGraw Hill.
4. Chandler and Read: Introduction to Parasitology. Wiley Toppen.
5. Medical Entomology, 2000.

Z-903 CLASSIFICATION OF INSECTS, PEST OF AGRICULTURE AND PEST MANAGEMENT Cr. 3(2+1)

Theory

A general account including classification of insect orders: Collembola, Orthoptera, Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders: Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata, Thysanoptera, Neuroptera, Mecoptera, Tricoptera, Siphonaptera, Strepsiptera, Insects of economic importance.

Brief account of biological control, chemical control and integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management.

Practicals

Collection, preservation and identification of insects upto families (except for the identification upto species of a few pests of great economic importance), with the help of keys/literature.

Books Recommended:

1. Richards, O.W. and Davies, R.J., 1977. *Imms's General Textbook of Entomology*. Vol-2
2. Snodgrass, R.F. 1935. *Principles of Insect Morphology*, McGraw Hill, N.Y.
3. Wigglesworth, V.B., 1974. *The Principles of Insect Physiology*, Chapman and Hall, London.
4. Imms, A.D., 1956. *Insect Natural History*, Collins, London.
5. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

Z-904 STRUCTURE AND FUNCTION OF INSECTS Cr. 3(2+1)

Theory

Structure, Function and Ecology: Primary and secondary segmentation. Integuament: structure, function. Its appendages and colours. Head, neck and antennae. Mouth parts and modes of feeding, regulation of feeding. Digestion and assimilation and absorption. Nutrition. Circulatory system: Haemolymph, Haemocytes, Immunity Fat body.

Thorax: Sclerites, endoskeleton. Legs and locomotion, wings and flight. Modification of legs and wings and mechanism of wing movement. Muscles associated with flight and genes needed. Wing articulation and coupling. Wing veins. Muscles: their basic structure and types.

Abdomen: Appendages and outgrowth. Reproductive system: Anatomy. Spermatozoa, fertilization and oogenesis and oviposition, egg embryology up to dorsal closure. Post embryonic development. Types of larvae and pupae. Respiratory systems in terrestrial, parasitic and aquatic insects. Excretion and water regulation, thermoregulation.

Communication: Nervous system, pheromones and exo- and endocrine organs and their secretions. Sense organs. Types, structure and function, somal and light producing organs.

Ecology: Energy flow. Population growth, dynamics and regulation. Community studies, species packing and diversity.

Practicals

Preparation of hard and soft parts of the following insects: American cockroach, common house

cricket, grasshopper, butterfly, housefly, mosquito, red cotton bug, lady bird beetle or any other common beetle. Honey been and wasp.

Books Recommended:

1. GENERAL TEXT BOOK OF ENTOMOLOGY. Imm. Richards and Davies, Vol.1.
2. THE INSECTS: STRUCTURE AND FUNCTION, 2000. Chapman.
3. INSECT PHYSIOLOGY. Wiggles Worth.
4. INSECT PHYSIOLOGY. Pattons.
5. INSECT ECOLOGY. Price.
6. ECOLOGY: THE EXPERIMENTAL ANALYSIST ABUNDANCE. Krebs.
7. MODERN ENTOMOLOGY, 1997. Tembhare.
8. ECOLOGICAL METHODS, 1978. T.R.E. Southood.
9. ELEMENTS OF INSECT ECOLOGY, 1997. S.S. Yasbani and M.L. Agarwal.

Z-905 PHYSIOLOGY OF REPRODUCTION Cr. 3(2+1)

Theory

Introduction: Overview of structure, at different levels, of reproductive systems and developments in gametes formation.

Sex Determination and Differentiation: Molecular aspects and chemical messengers in differentiation.

Hypothalamic-Hypophysical-Gonadal axis in Reproduction: Hormonal and neuronal factors and their interactions in ovarian, testicular and other reproductive targets functions; The interactions in developments in estrous and menstrual cycles; The interactions in transitions from childhood to reproductive and post-reproductive states.

Reproductive Behaviors: Physiological basis of male and female sexual behavior and maternal behavior; Endocrine basis of communication in reproduction and aggression; Pheromones in mammalian reproduction; Rhythms in Reproduction.

Pregnancy: Hormonal mechanism in fertilization, zygote transport and implantation. Placental steroid and polypeptide hormones; Recognition and maintenance of pregnancy; Maternal metabolism in gestation, Hormonal mechanism in parturition.

Lactation: Hormonal mechanism in lactation; Lactogenesis, Galactopoeisis, Milk ejection.

Reproductive Senescence: Hormonal and metabolic aspects in menopause; Mechanisms in males.

Fertility Control Mechanisks: Hormonal contraceptives; Rhythmic methods, Immunologic techniques and other fertility control procedures in women; complications in their uses; Fertility control in men and search for male contraceptive.

Practicals

Study of male and female reproductive tract; physiological histology of segments of male and female reproductive tracts; Recognition of spermatogonial cells, ovarian follicles and corpus luteum in gonads; study of hormonal mechanisms in superovulation and implantation; Tests for pregnancy recognition; Experiments on role of gonads in maintenance of excessory sex gland in males and target structures in females; Study of fertility control procedures in populations.

Books Recommended

1. Knobil, E. and Neill, J.D., *et al.*, 1994. The Physiology of Reproduction, Vol.1and2; 2nd Ed., Raven Press, New York.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. William's Textbook of Endocrinology, 9th Ed.. W.B. Saunders Company, Philadelphia.
3. Evert, B.J. and Johnson, M.H., 2000. Essential Reproduction, 5th Ed.. Blackwell Science Inc., Oxford.

Theory

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feed back, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

Hypothalamus and pituitary: Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary and hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.

Thyroid gland: Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.

Calcitropic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

Adrenal Medulla and Catecholamines: Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.

Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.

Testes: Androgenic tissue: Structure and chemistry; Transport, metabolism and mechanism of action.

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition.

Endocrinology of Lactation: Hormones in lactation.

Endocrinology of Heart, Kidney, Immune system: Growth and pineal gland.

Functional Diversity of Hormones in Vertebrates.

Overview of Endocrine Mechanisms in Invertebrates.

Practicals

Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc; Histological and ultrastructure features of endocrine glands; Experiments to demonstrate physiological roles of hormones of different endocrine glands; Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates. Experiments on endocrine mechanism in vertebrates.

Books Recommended:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol.I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed.. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-907 MOLECULAR AND CLINICAL ENDOCRINOLOGY Cr. 3(2+1)

Theory

General Mechanisms in Molecular Endocrinology: Subcellular structure of cells secreting protein hormones; Process of hormone secretion; Transcription factors in developmental organisms in endocrine systems. Recombinant DNA technology and molecular genetics in diagnosis and treatment of endocrine diseases. Measurements of hormones: Radioimmunoassay, immunoradiometric, immunochemiluminometric and radioreceptor assays and their statistical procedures.

Mechanisms of Action of Hormones: Hormone systems and intracellular communication; Hormones acting at cell surface: Properties of hormone receptor interaction, structure, biosynthesis and turnover of membrane receptors; Hormones acting in transcription regulation: Biochemistry and molecular interaction of steroid receptor, gene expression, messenger RNA stability and metabolism in hormone action.

Functional Pathology in Endocrine Glands: Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, corticotrophin regulation; Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.

Fuel Homeostasis: Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anorexia nervosa and bulimia nervosa.

Development and Growth: Disorders of growth and puberty.

Endocrine Hypertension

Polyendocrine Syndromes.

Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy.

Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis.

Practicals

Studies on recognition and response of receptors; Studies of disorders of pituitary by observing anatomical and histological features; Studies of thyroid status in deficient and excess hormone functions; Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2; Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of hormonal status in puberty and aging.

Books Recommended:

1. Greenspan, F.S. and Stewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol.I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed.. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

Z-908 PHYSIOLOGY OF COORDINATION Cr. 3(2+1)

Theory

Physiological Mechanisms at Cell: Cellular membrane and transmembrane transport; resting

membrane potentials; Generation and conduction of action potentials; synaptic transmission; Membrane receptors, Second messenger and signal-transduction pathways.

Nervous System: Organization of nervous system; General sensory system; Visual, Auditory, Vestibular and Chemical sensory system; Motor system with brainstem, Cortical, Cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning, memory.

Muscle and Movements: Molecular basis of contraction; Muscles activity on skeleton; Adaptation of muscles for various activities; Muscles in the walls of hollow organs.

Endocrine System: General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

Practicals

Recording of action potentials on oscilloscope and effects of various factors on its characters; Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs. Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxine on oxygen consumption; Effect of androgen on accessory sex organs and of estrogens on target tissues; Study of estrous cycle and effects of the hormones.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Ed.. Prentice Hall, London.

Z-909

PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS Cr. 3(2+1)

Theory

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output;

Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

Respiratory System: Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbondioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

Renal System: Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostais; Role of kidney in acid-base balance.

Gastrointestinal System: Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

Osmoregulation: Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Liouis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Ed.. Prentice Hall, London.

Z-910 MOLECULAR PHYSIOLOGY Cr. 3(2+1)

Theory

Overview of resting membrane, action potential and synaptic transmission; Structure and mechanisms in ion channels; Biosynthesis of neurotransmitters; Neurotransmitters actions at synaptic receptors. Neurosecretions and neurotransmitters in higher nervous system activity.

Molecular mechanisms in transduction of sensory stimuli into impulse; photochemistry and transduction of photoreceptor; Color vision.

Overview of endocrine glands, their hormones and roles; Chemistry and biosynthesis of hormones of adenohipophysis, thyroid, parathyroid, endocrine pancreas, adrenal medulla and steriodogenic tissues; Metabolism of thyroid and steriodogenic tissues; Structure of hormone receptors; Mechanisms of action of a protein/peptide, a steroid and thyroid hormone; Hormonal regulation of

metabolism; Molecular basis of muscular contraction; Molecular interaction at neuromuscular level; Molecular structure of cilia and flagella and mechanisms in movements. Automicity and rythmicity of myogenic heart; Regulation of cardiac activity; Humoral regulation of circulation: Vasoconstriction and vasodilation. Exchange of respiratory gases; Chemical regulation of respiration. Nature and formation of various nitrogenous waste products; Glomerular filtration, reabsorption, and secretion mechanisms; Concentration of urine. Regulation of digestive secretions; Digestion and absorption of nutrients. Molecular mechanisms in adaptation to temperature extremes.

Practicals

Study of post synaptic receptor mechanisms in neuromuscular preparation of frogs; Experiments to study the molecular responses to hormones. Study of hormones receptors in differing hormonal circulation levels; Ultra-structure study of muscle structure for muscle contraction. Effect of chemicals and drugs on cardiac activity of prepared frogs; Study of drugs on reflexes and local circulation models. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse. Study of nature of nitrogenous wastes of animals inhabiting different environment. Urine analysis in different physiological states. Absorption of glucose in inverted intestinal sac, effect of drugs on intestinal movements. Muscular responses to Pyrexia.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th Ed.. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Liouis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Ed.. Prentice Hall, London.

Z-911 COMPARATIVE VERTEBRATE ENDOCRINOLOGY Cr. 3(2+1)

Theory

General concepts in comparative Endocrinology; Comparative Morphology of Endocrine Tissues in Vertebrates; The chemical structure, polymorphism and evolution of hormones; The life history of hormones.

Hormones and Nutrition; Hormones and the Integument; Hormones and Osmoregulation; Hormones and Reproduction.

Practicals

Demonstration of endocrine glands in representative vertebrates; Histological studies of endocrine glands in various vertebrate; Experiments on functional diversity in hormones in vertebrates; Studies in evolution of chemistry of hormones in vertebrates.

Books Recommended

1. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology. Cambridge University Press, Cambridge.

Z-912 ANIMAL BEHAVIOUR Cr. 3(2+1)

Theory

The Study of Animal Behaviour: Introduction. History of Animal Behaviour. Approaches and Methods.

Behaviour Genetics and Evolution: Genes and Evolution. Behavioural Genetics. Evolution of Behaviour Patterns.

Mechanisms of Behaviour: The Nervous System and Behaviour. Hormones and Behaviour and Immunology and Behaviour. Biological Rhythms. Development of Behaviour. Learning Behaviour. Communication.

Finding Food and Shelter: Migration, Orientation and Navigation. Habitat Selection. Foraging Behaviour.

Social Organization and Mating Systems: Conflict. Sexual Reproduction and Parental Care. Mating Systems and Parental Care. Social Systems.

Practicals

Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

Books Recommended:

1. Drickamer, L.C., Vessey, S.H. and Jacob, E., 2002. Animal Behaviour: Mechanism, Ecology, Evolution. 5th Ed..
2. Manning, A. and Dawkins, M.S., 1997. An introduction to animal behaviour, 4th Ed.. Cambridge University Press, Cambridge.

Z-913 EXERCISE PHYSIOLOGY Cr. 3(2+1)

Theory

Physiology in Exercise: Exercise Metabolism, Hormonal Responses to Exercise; Circulatory Responses to Exercise; Respiration during Exercise; Acid-Base Balance during Exercise; Temperature Regulation in Exercise.

Physiology of Health and Fitness: Patterns in health and disease; Body Composition and Nutrition for Health; Cardiorespiratory Fitness; Exercise Prescriptions for Health and Fitness; Exercise for Special Population.

Physiology of Performance: Factors Affecting Performance; Nutrition, Body Composition and Performance; Evaluation of Performance; Training for Performance; Exercise and the Environment.

Practicals

Studies on responses of metabolite in exercise; Experiments on hormonal responses and sensitivity during exercise; Cardiac and Respiratory Indices and their adaptations in exercise; Work tests to evaluate cardiorespiratory fitness; Exercise prescription for health and fitness. Work tests to evaluate performance.

Books Recommended:

1. McArdle, W.D., Katch, F.I. and Katch, V.L., 2001. Exercise Physiology, Nutrition and Human Performance, 5th Ed.. Lippincott, Williams and Wilkins Publishers, Philadelphia.
2. Powers, S.K. and Howley, E.T., 1997. Exercise Physiology: Theory and application to fitness and performance. Brown and Benchmark Publishers, Madison.

Theory

History and General Introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals; Types of Exposure and Exposure responses including exposure characteristics; Spectrum of Undesirable effects; Variation in Toxic Responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity; Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/Disposition of toxicants; Phase-I and Phase II Biotransformation Reactions; Mechanism of Toxicity; Delivery, from the site of Exposure to the Target; Absorption versus prtesytemic Elimination; Distribution to and away from the Target; Excretion versus Re-absorption; Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules; Effects of Toxicant on Target Molecules; Cellular Dysfuntion and Resultant Toxicities; Toxicant-induced Cellular Dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

Books Recommended:

1. KLAASSEN, CURTIS D., (1996). *Casarett and Doull's Toxicology: The Basic Science of Poisons*; 5th Ed. (International), McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J.A., 1995. *Introduction to Toxicology*, 2nd Ed. Taylor and Francis Ltd., London.

Practicals

Determination of LD50 values of some pesticide against any insect pest. Determination of LD50 doses of any toxic compound in mammalian system. Effect of any toxicant on body weights in mice. Toxicity of some toxic compound on relative organ weights in mice. Effect of toxicant on food consumption in mice. Study of toxicity of any chemical on total leukocytic count. Effect of a toxicant on total erythrocytic count in blood of mice. Effects of any toxicant on haemoglobin level in mice. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice. Study of liver function enzyme (Alanine amino transferase) activity following administration of toxic compound to experimental animals. Determination of blood glucose level following toxic exposure.

Books Recommended:

1. Hayes, A. Wallace, 1994. *Principles and Methods of Toxicology*, Third Ed., Raven Press, New York.

Theory

Biochemical aspects of toxicology; Dose response relationship and its measurement; Hazards and Risk assessment; Chronic toxicity; Factors affecting toxic responses; Disposition of Toxic compounds: Absorption; Absorption sites; Distribution and Excretion of toxic compounds; Metabolism; Metabolic changes and their types; Phase-I and Phase-II detoxification reactions; Factors affecting metabolism and disposition; Chemical factors; Biological factors.

Foreign compounds and Toxic responses; Direct toxic action; Tissue lesions and Target organ toxicity; Mechanism and response in cellular injury; Teratogenesis and its various characteristics; Mechanism of teratogenesis, Pharmacological, Physiological and Biochemical effects; Immunotoxicity; Immunosuppression; Genetic toxicity, Chemical Carcinogenesis and mechanism of its induction; Biochemical Mechanisms of toxic action, with specific examples of foreign toxic compounds like pesticides, drugs, industrial pollutants, heavy metals etc.

Practicals

- a. Determinations of LD₅₀ value of malathion (an organophosphate pesticide) against mammalian model (mice).

- b. Determination of LC₅₀ values of phosphine (a fumigant) against stored grain pests *Tribolium castaneum*.
- c. Study of toxic effects of sublethal doses of a pesticide or toxic heavy metal on:
 1. Changes in packed cell volume (haematocrit estimation) in animals.
 2. Changes in haemoglobin concentration in mice.
 3. Estimation of blood glucose level;
 4. Estimation of hepatic GPT activity,
 5. Estimation of hepatic amylase activity,
 6. Estimation of liver /serum proteins, and albumin : globulin ratio,

Preparation of phosphine gas for use as fumigant against any stored grain pest for evaluation of its toxicity.

Application of lab-generated phosphine gas and calculation of its doses for evaluation of LC₅₀.

Determination of amylase activity in mice or stored grain pest following administration of insecticide at sublethal level.

Estimation of serum or hepatic alkaline phosphate activity in mice following feeding on insecticide mixed diet.

Textbook:

1. Timbrel, J., 2000. Principles of Biochemical Toxicology, 3rd Ed. Taylor & Frances, London.

Additional Readings:

1. Hodgson, E., and Guthrie, F. E., 1980. Introduction to Biochemical Toxicology, Blackwell Science Publications Oxford, London.
2. Hayes, A. W., 2001. Principles and Methods in Toxicology, 4th Edition, Raven Press Ltd. New York

Z-916 APPLIED FISHERIES Cr. 3(2+1)

Theory

Basic principles of fish culture: Extensive fish culture, Semi-intensive fish culture, Intensive fish culture

Construction and management of fish farm: Ponds for fingerlings, Ponds for yearlings, Rearing ponds, Nursery ponds, Fattening ponds, Stocking ponds, Farm for large scale fish culture

Construction and maintenance of fish seed hatchery: Hatchery for Salmonids, Hatchery for cyprinids, Hatchery for Catfishes,

Natural food and feeding: Phytoplanktons, Zooplanktons, Crustaceans (cladocera), Arthropods larvae, Annelids, Molluscs

Artificial feed and feeding: Of plant origin, Of animal origin, Feed for Salmonids, Feed for Cyprinids, Feed pelleting, Adaptation of fish on pelleted feed

Breeding and cultivation of Salmonids (rainbow trout and brown trout): Natural breeding, Artificial breeding, Induced spawning, Hormonal induced spawning

Breeding and cultivation of Cyprinids (major carps and Chinese carps): Natural breeding, Artificial breeding, Induced spawning, Hormonal induced spawning

Fish diseases and their control: Viral disease, Bacterial diseases, Fungal diseases, Parasitic (protozoan, helminths, crustaceans, leeches, **Argulus** etc)

Fish enemies and their control: Amphibians, Reptiles, Birds, Mammals, Chemicals and fertilizers

Pond Fertilization and its significance: Varieties of organic and inorganic fertilizers. Doses of fertilizers and its uses.

Common Freshwater aquatic weeds and their control: Biological, Chemical, Mechanical

Fish harvesting and marketing: Netting, Transportation, Maintenance of flesh quality and price control

Practicals

Morphological identification of important culturable fish species; Study of gut contents of culturable fish species; Diagnosis of important bacterial diseases in cyprinids; Study of important parasites of fish; Stripping of mature fish and artificial fertilization of eggs and sperms; Study of early developmental stages; Visit to various fish seed hatcheries during fish breeding season

Books Recommended:

1. Moyle, P.B. and Joseph, J.C. 2004. Fisheries: An Introduction to Ichthyology, Prentice Hall, London.
2. Parker R. O., 2004. Aquaculture Science (4th ed.). Delmar Learning, London.
3. Kestin, 2001. Farmed Fish Quality Multiline Books
4. Ruth, 2000. Freshwater Aquaculture Multiline Books
5. Bromage, 1995. Broodstock Management and Egg and Larval Quality Pak Book Corp.
6. Woo, 1995. Fish Diseases and Disorder: *Protozoan and Metazoan Infections* Pak Book Corp.
7. M. Huet, 1986. Text Book of Fish Culture: *Breeding and Cultivation* Fishing News Books Ltd, England

Z-917 FISH DISEASE AND HEALTH MANAGEMENT Cr. 3(2+1)

Theory

Fish morphology and Biology: Brief account of Fish morphology and Biology; Warm water / cold water culturable fishes; Fish culture practices; Extensive/Semi intensive/intensive fish culture;

Fish Farm management: Brief accounts of fish pond, fish stocking, water quality; manuring, feeding and harvesting.

Fish Health Management: Introduction to fish diseases; disease process; causes of disease. Effects of diseases;

Fish Diseases: A general account of Infectious diseases; (Viral; Bacterial fungal; parasitic diseases) Noninfectious diseases. (Nutritional; Genetics; Pollution; Environmental; Physical damage)

Control of fish diseases: Prevention; Therapy, management; Methods of disease control in fishes; Treatment of fish diseases. Diagnosis to action; Types of treatment; Methods of treatment; Strategies for treatment; Chemicals and drugs for fish health.

Practicals:

Dissection of culturable carp; sampling of fish for diagnostic purpose. Study of fish for parasitic, fungal and bacterial diseases. Preparation of slides of parasites. Visit to a fish farm. Preparing a diagnostic report of diseased fish sample.

Books Recommended:

1. Post, G.W. 1988. Textbook of fish health. T.F.H. publications Inc. USA. (**Textbook**)
2. Bauer, O.N., Musselius, V.A. and Strelkov, Yu.A. 1973. Diseases of pond fishes. Keter press, Jerusalem.
3. Hool, D. et al., 2001. Diseases of carp and other cyprinid fishes. Fishing News Books, UK.
4. Legler, K.E., Bardach, J.E., Miller, R.R. and Maypassino, D.R. 2003. Ichthyology (2nd Ed.) John Wiley, UK.
5. M. Huet, 1986. Text book of Fish culture, breeding and cultivation. Fishing book news Ltd.
6. Woo, 1995. Fishes diseases and disorders, Protozoan and Metazoan infections. Pak Book corporation
7. Noga, E.J. 2010. Fish Diseases. Diagnosis and treatment. 2nd Ed. Wiley and Blackwell, USA.
8. Boyd and Tucker, 1998. Pond Aquaculture and water quality management. Springer, India.

Theory

History and Introduction of Microbiology: The beginnings of Microbiology; Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology.

Characterization, Classification, and Identification of Microorganisms: Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual.

Microbial Diversity: Prokaryotic diversity Bacteria: Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

Eukaryotic Microorganisms: Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

Viruses: Bacteriophages; Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

Morphology and fine structure of bacteria: Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material.

The Cultivation of Bacteria: Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation.

Reproduction and growth of bacteria: Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth.

Pure cultures and cultural characteristics: Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures.

Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Practicals

Study of bacteria, yeasts, molds and protozoa. Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic Granule stain, Acid fast stain. The culture of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plate and pour plate methods. Isolation and pure culturing of bacteria. Quantitative plating methods. The turbidimetric estimation of microbial growth. Study of bacterial viruses.

Books Recommended:

1. MICROBIAL APPLICATIONS (complete version) LABORATORY MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.

2. MICROBIOLOGY, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
3. BROCK'S BIOLOGY OF MICROORGANISMS, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.
4. THE MICROBIAL WORLD, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.

Z-919 BIOREMEDIATION AND ENVIRONMENTAL BIOTECHNOLOGY Cr. 3(2+1)

Theory

Concept of bioremediation; Degradation of natural substances; Biodegradation of xenobiotics; Low grade ores and microorganisms; Waste-water and sewage treatment; Environmental stability; Biological fuel generation; Bioremediation of industrial effluents.

Practicals

Isolation and studies of heavy metals tolerant/resistant microorganisms; Studies on bacterial capable of degrading xenobiotics; production of ethanol from decaying fruits.

Books Recommended:

1. Practical Environmental Bioremediation the field guide. 1997. R. Barry King, Gilbert M. Long, John K. Sheldon, Lewis publishers.
2. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
3. Biotechnology, 1996., Smith, J.E., Cambridge University Press.
4. Environmental Biotechnology Principles and applications, 2000. Bruce R. Hmann, Perry McCarty, McGraw Hills.
5. Biodegradation and bioremediation 1999. Martin Alexander academic press Inc.

Z-920 MAMMALOGY Cr. 3(2+1)

Theory

Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Tritubular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

Practicals

General survey and classification up to species of the following mammals;

Egg-lying mammals (Echidna and Platypus).

Marsupial mammals (Opossum, Australian cat, Numbat kangaroos, Marsupial moles, Bandicoots, Koala, Wombats).

Placental Mammals (Elephants, Giraffes, Rhinoceroses, Tapirs, Blackbuck, Four-horned antelope, *Bos*, *Bison*, *Bubalus*, *Capra*, *Ovis*, *Boselaphus*, Camels).

Skeleton of Mongoose, Cat, Hedgehog and Rabbit.

The skull and teeth.

The vertebral column and appendicular skeleton.

Books Recommended:

1. Davis, D., 1963. Principles in Mammalogy. Reinhold Publishers Corporation, New York.
2. Gelder, 1969. Biology of mammals. Reinhold Publishers Corporation, New York.

3. Miller and Harly, 2005. Zoology (6th Edition). McGraw Hill, New York.
4. Hickman, Roberts, and Larsen, 2005 & 2008. Integrated principles of Zoology (13th & 14th Editions). McGraw Hill, New York.
5. George C. Kent and Robert K. Carr, 2001. Comparative Anatomy of the Vertebrates. (9th Edition.) Boston: McGraw Hill, New York.
6. Vauchan, T.A., Ryan, J.M., Czaplenski, N.J., 2011. Mammalogy. 5th Edition, Johns and Bartlett publisher USA.

Z-921 IMMUNOLOGY Cr. 3(2+1)

Theory

Overview of the immune system Historical perspective, innate and acquired immunity. Cells and organs of immune systems Hematopoiesis, lymphoid cells, Mononuclear cells Dendritic cells, primary lymphoid organs, leukocyte recirculations. Antigens; immunologic properties of Antigens factors affecting antigenicity, epitopes, Haptens, and study of antigenicity, viral and bacterial antigens, mitogens. Immunoglobulin structure and function basics structure, sequencing studies, fine structure, receptor complex, Antigenic determinants, Isotype and super family. Antigen-antibody interactions strength, cross reactivity, precipitant, agglutination reaction RIA and ELISA, western blotting, immuno-fluorescence. Organization and expression of immunoglobulin genes genetic models compatible with immunoglobulin structure. Multigene organization of Ig genes variable region rearrangement, regulation of Ig gene transcription, generation of Ab diversity, class switching among constant region genes. Expression of Ig genes. Major histocompatibility complex (MHC). General organization and inheritance of MHC. Class I MHC molecules and genes. Polymorphism of class I and II MHC genes, class III MHC molecules, mapping of MHC and its expression. Antigen processing and presentation; self MHC restriction of T-cells role of Ag presenting cells. T-cell receptor organization and rearrangement of TCR genes T-cell receptor complex, TCR (i) 3 T-cell accessory membrane molecules TCR-MHC-Antigen interaction. Cytokines; General properties discovery and purification, structure and function, receptors, antagonists, regulation and Biological activity of TH1 and TH2 subsets. Generation of humoral immune responses. Kinetics, experimental systems, identification of cells required for induction of humoral immunity. Cell mediated immunity. Direct and delayed type cytotoxic and hypersensitivity responses. Transplantation immunology graft rejection. Immunodeficiency diseases. Classification, phagocytic humoral, cell mediated and combined humoral and cell mediated deficiencies, complement mediated deficiencies.

Practicals

Detection of Ab. Primary immune response. Secondary immune response. Demonstration of Ab specificity. Estimation of antibodies. Separation of various types of immunoglobulins. Microscopic study of various organs of immune system. Immune responses in stress. Estimation of globulins. Demonstration of enzyme linked immunosorbent assay. Demonstration of radioimmuno assays.

Books Recommended:

1. KUBY'S IMMUNOLOGY, 2000. 4th ed. Richard, A., Goldsby, Thomas, J. Kindt and Barbara, A. Osborn. W.H. Freeman and Company, New York.
2. CELLULAR AND MOLECULAR IMMUNOLOGY, 1994. 2nd ed. Abbas Lichtman and Pober, W.B. Saunders Co.

Z-922 VECTOR BIOLOGY Cr. 3(2+1)

Theory

Detailed studies of systematic, Biology and Ecology of some vectors of medical importance (order Diptera):
Mosquitoes; Anopheles mosquitoes, culicine mosquitoes, Black flies, sand flies, biting midges,

horse flies, deer flies, and clegs, tsetse flies, house flies, Myiasia producing flies, (blow flies, blue bottles, green bottles, flesh flies, warable flies and bot flies).

The study will cover following aspects: Morphology, anatomy, distribution, breeding habits, Life-cycle, pathogenesis and seasonal prevalence of the species. Brief account of diseases spread by these vectors, methods of control, modern trends in their biological and chemical control.

Practicals

Methods of identification; Dissection of selected vectors i.e. Mosquito, House fly, blue bottles, green bottles, bot flies. Study of prepared slides of parasites. Epidemiological studies of Vector borne diseases (one e.g. malaria) including field studies of control methods and parasite evaluation.

Books Recommended:

1. William A. Riley. Medical Entomology. Mc-Graw Hill book Co., Inc. London.
2. McDonald, G. The Epidemiology and Control of Malaria, London Oxford Press.
3. World Health Organization. Vector Control series, Training and information guide. The House Fly.
4. World Health Organization. Chemical methods for the control of Arthropod Vectors and pests of Public Health Importance Geneva, WHO, 1984.
5. Walker, A. 1994. Arthropods of human and domestic animals. A guide to preliminary identification. Chapman and Hall.
6. Seevick, M.W., 1980. A guide to medical entomology. MacMillan International College Ed..
7. Herms, W.B. and James, M.T. 1960. Medical entomology. The MacMillan Company, New York.

Z-923 HELMINTHOLOGY Cr. 3(2+1)

Theory

Introduction to the phylum platyhelminthes. Trematoda, Aspidogastrea. Trematoda, Form, Function, Life cycle and Classification of digeneans. Digeneans, strigeiformes. *Schistosoma haematobium*, *S. japonicum*, *S. mansoni* (Schistosomiasis); Digeneans Echinostomiformes: *Fasciola hepatica*, *F. gigantica*, *Paramphistomum cervi*, *Megalodiscus temperatus*. Digeneans, Plagiorchiiformes and opisthorchiiformes: *Paragonimus westermani*, *Clonorchis sinensis*, *Heterophyesheterophyes*, *Prosthogonimus macrochis*. Monogenea; *Polystomum integraruum*. Form, function, classification, life cycle. Cestoidea, form function, life cycle and classification of the tapeworms. Cyclophyllidae: *Taenia solium*, *Taeniarhynchus saginata*, *T. pissiformis* (Taeniasis), *Taenia multiceps*, *Echinococcus granulosus*, *E. multilocularis*, *E. vogeli*, *Hymenolepis nana*, *H. diminuta*, *Raillietina* species, *Diphylidium caninum*, *Moniezia* species, *Mesocostoides* species. Phylum Nematoda, Form, Function and Classification. Nematodes, Trichurida and Dioctophymatida, enoplean parasites (*Trichuris trichiura*), *Capillaria hepatica*, *Anatrichosoma ocellaris*, *Dioctophyme renale*, Nematodes, Rhabditida; *Strongyloides stercoralis*, Nematodes, Strongylida, bursate rhabditidians, *Bunostomum*, *Necator americanus*, *Ancylostoma duodenale*, *Synagamus trachea*, *Haemonchus contortus*, *Trichostrongylus* species, *Ostertagia* species, *Prostrongylus rufescens*. Nematodes, Ascaridida, intestinal large round worms; *Ascaris lumbricoides*, *Toxocara canis*, *Lagochilasascaris minor*, *Heterakis gallinarum*, *Ascaridia galli*. Nematodes, oxyurida, the pinworms; *Enterobius vermicularis*. Nematodes, Spirurida, a potporri, *Gnathostoma doloresi*. Nematodes, Filarioidea; the filarial worms, *Wuchereria bancrofti*, *Brugia malayi*, *Loa loa*, *Mansonella perstans*, *M. ozzardi*, *Onchocerca volvulus*, *Dirofilaria immitis*. Nematodes, camallanina, the Guinea worms and others; *Dracunculus mediensis*. Phylum Acanthocephala, Thorny headed worms. Forms, function and classifications; *Macrocanthorhynchus hirudinaceus*. Helminth Zoonoses (Trematode, Cestodes and nematode zoonoses).

Practicals

Methods for collection, transportation, fixation and preservation of flukes, tapeworms and round worms. Methods for collection and examination of faeces, urine and sputum for the presence of eggs/larvae of various helminthes. Methods for examination and staining of blood film for helminthes. Identification of important members of class Trematoda, Cestoda, Nematoda and Acanthocephala. Practical demonstration of helminthes at slaughter houses.

Books Recommended:

1. PRACTICAL EXERCISE IN PARASITOLOGY, 2001. Hatton, D.W., Behinke, M. and Marshal, I. Cambridge University Press, BSP.
2. VETERINARY PARASITOLOGY, 2000. Urquhart, G.M., Duncan, J.L., Qunn, A.M. and Jenniry, F.W. Longman Scientific and Technology, U.K.
3. PARASITIC DIAGNOSIS, 1999. Mayate, S. and Akhtar, M. UGC Govt. of Pakistan.
4. FOUNDATIONS OF PARASITOLOGY, 2000. 5th ed. Robert, L.S. and Janovy, J.Jr. W.C.B. Company, U.K.
5. INTRODUCTION TO ANIMAL PARASITOLOGY, 1994. Smyth, J.D. Cambridge Univ. Press.

Z-924 PROTOZOOLOGY Cr. 3(2+1)

Theory

Introduction to parasitology, basic terminology, basic principles and concepts in parasitic ecology and evolution of parasites. Parasitic protists, forms, functions, nomenclature and classification. Host parasite relationship. Host and organ specificity. Protozoan zoonoses. Kinetoplastida; *Trypanosoma rhodesiense*, *T. gambiense*, *T. brucei*, *T. cruzi*, Trypanosomiasis. *Leishmania donovani*, *L. tropica*, *L. braziliensis*, *L. maxicana*, Leishmaniasis. Flagellated protozoa; *Chilomastix*, *Giardia*. Trichomonas. Subphylum Sarcodina, Amebas; Amoebiasis. Phylum Apicomplexa. *Gregarines*, *Coccidia*, *Toxoplasma*, *Sarcocystis*, *Cryptosporidium*. Phylum Apicomplexa, *Plasmodium falciparum*, *P. ovale*, *P. malariae*, *P. vivax*, Malaria. Phylum, Ciliophora, ciliated protistan parasites; *Balantidium*. Morphology, biology, pathogenesis, immunity and resistance, epidemiology, control and treatment of the diseases caused by above mentioned parasites will be considered.

Practicals

Preparation of solutions used for parasitological examinations. Methods of collection, preservation and transportation of parasitic material. Qualitative and quantitative faecal examination for protozoa. Blood examination for protozoa. Microscopic measurement of protozoa. Identification of important members of protozoa.

Books Recommended:

1. PRACTICAL EXERCISE IN PARASITOLOGY, 2001. Hatton, D.W., Behinke, M. and Marshal, I. Cambridge University Press, BSP.
2. VETERINARY PARASITOLOGY, 2000. Urquhart, G.M., Duncan, J.L., Qunn, A.M. and Jenniry, F.W. Longman Scientific and Technology, U.K.
3. PARASITIC DIAGNOSIS, 1999. Hayate, S. and Akhtar, M. UGC Govt. of Pakistan.
4. FOUNDATIONS OF PARASITOLOGY, 2000. 5th ed. Robert, L.S. and Janovy, J.Jr. W.C.B. Company, U.K.
5. INTRODUCTION TO ANIMAL PARASITOLOGY, 1994. Smyth, J.D. Cambridge Univ. Press.

Z-925 COMPARATIVE ANATOMY AND BIOLOGY OF VERTEBRATES Cr. 3(2+1)

Theory

Origin of vertebrates. Classification (excluding fossil groups) of vertebrates and characteristics of

each group. Comparative anatomy of various body systems in vertebrates.

Practicals

Study of skeleton of Labeo, frog, varanus, fowl and rabbit. Dissection and study of various systems in Rita *rita*, frog, uromastix, pigeon and rabbit. General survey of vertebrates.

Books Recommended:

1. Kardong, K.V. 2002. Vertebrates, Comparative Anatomy, Function Evolution, 3rd Ed. McGraw Hills.
2. Weichert, W.C. Anatomy of the chordates. W.B. Sundres. (Recent Ed.)
3. Young, J.Z.. 1991. LIFE OF VERTEBRATES, Oxford Univ. Press.

Additional Readings

1. Romer, A.S. and Parsons, T.S. 1986. The Vertebrate Body, Saunders.
2. G.C. Kent. Comparative anatomy of vertebrates W.B. Sundres. (Recent Ed.)

Z-926 HUMAN EMBRYOLOGY AND TERATOLOGY Cr. 3(2+1)

Theory

Formation of normal and abnormal gametes and their relation to age, getting ready for pregnancy, transport of gametes and fertilization, cleavage and implantation, formation of germ layers and early derivatives, establishment of basic embryonic body plan. Placenta and extra embryonic membranes, developmental disorders: causes mechanisms and patterns. Brief description of development of various body systems.

Practicals

Study of mammalian gonates and gametes. Study of whole mounts and sections of various mammalian embryos. Experimental manipulations of live embryos.

Books Recommended:

1. Moore, K.L. and Prasad. 2000. THE DEVELOPING HUMAN, Saunders.
2. Sadler, T.W. and Langman, J. 1995. LANGMAN'S MEDICAL EMBRYOLOGY, Williams and Wilkins.
3. Carlson, B.M. 2000. HUMAN EMBRYOLOGY AND DEVELOPMENTAL BIOLOGY, Mosby.

Z-927 CANCER BIOLOGY Cr. 3(2+1)

Theory

Properties of cancerous tissue. Structure and biology of cancer cell. Carcinogens, their structure and mode of action. Types of cancer. Viruses and cancer, oncogenes and cancer, oncogenic DNA viruses, oncogenic RNA viruses, teratocarcinoma.

Practicals

Effect of various chemical carcinogens on different tissues of animals. Study of prepared slides of cancerous tissues.

Books Recommended:

1. Bettar, E.E. 1973. Cell Biology And Medicine, John Wiley.
2. Beck, F. 1975. The Cell In Medical Science, Academic Press, New York.
3. Margaret A., 2005. Knowles, Peter J. Selby Introduction to the Cellular and Molecular Biology of cancer Oxford University Press, USA; 4th Ed.
4. L.M. Franks, N.M. Teich, 1997. Introduction to the Cellular and Molecular Biology of Cancer, Oxford University Press, USA, 3rd Ed.

Z-928 GENERAL PARASITOLOGY Cr. 3(2+1)

Theory

Principles of Parasitology. Various concepts of Parasitism. Systematics, biology, pathology and control of protozoan and helminth parasites of medical and veterinary importance. Ecology of parasites. Host-parasite relationship. Parasitic zoonoses. Immunity and resistance.

Practicals

Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance. Section cutting of the infected tissues and the study of their pathology.

Books Recommended:

1. Noble and Noble, 1982. Parasitology. The Biology of animal parasites. 5th Ed.. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical parasitology. 3rd Ed.. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J. Jr., 2001. Foundations of Parasitology. 5th Ed.. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.

Z-929 MOLECULAR BIOLOGY Cr. 3(2+1)

Theory

Structure and properties of DNA, Molecular Cloning Methods: Molecular tools for studying genes and gene activity. DNA Replication: DNA Polymerases of Prokaryotes and Eukaryotes, the detailed mechanism of replication in Prokaryotes and Eukaryotes. DNA Damage and Repair. Transcription: The detailed mechanism, types of Promoters and RNA Polymerases of Prokaryotes and Eukaryotes; General Transcription factors, Activators and Enhancers in Eukaryotes; Chromatin structure and its effects on transcription, Post-transcriptional events (Splicing, Capping and Polyadenylation); Other RNAs, tRNA and rRNA processing, miRNA and RNAi .Protein synthesis: the detailed mechanism of Initiation, Elongation and Termination in Prokaryotes and Eukaryotes. Post_translational modifications. Gene Regulation: *Lac* operon and *Trp* operon.

Practicals

Quantitative estimation of DNA RNA and Protein by UV spectrophotometer. Method of culturing bacteria. Extraction of plasmid DNA from bacteria. Extraction of genomic DNA from eukaryotic organism. Extraction of RNA and Protein from tissues. Separation of different sized DNA fragments on agarose gel electrophoresis. Separation of protein by SDS- PAGE

Text Book

1. Weaver, R., 2007. *Molecular Biology* 4th Ed. McGraw-Hill.

Additional Reading Material

1. Kornberg, A., 2005. *DNA Replication*, 2 Ed. University Science Books;
2. Waston, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R., 2007. *Molecular Biology of the Gene* (6th Ed.) Benjamin CummingsLewin, B., 2007 . *Genes IX*. 9 Ed. Jones and Barlett Publication.

Z-930 VIROLOGY AND VIRUSES Cr. 3(2+1)

Theory

Fundamental of virology, History of Virology, structure of viruses, characteristic of virus host interaction, viral replication and expression (bacteriophages, RNA viruses DNA viruses), Transmission of viruses, classification of viruses, mechanism of pathogenicity viruses of medical importance, HIV, retrovirus, Hepatitis viruses, viruses, virus cultivation and propagation, viral ontogenesis. Life cycle of HIV, Hepatitis viruses etc.

Practicals

Isolation of bacteriophages; Enumeration of bacteriophages by serial dilution; Extraction of viral nucleic acids; Assays for detection of viral nucleic acids; Assays for detection of antiviral antibodies; Staining of viral inclusion bodies.

Books Recommended:

1. Leslie Collier and John Oxford, Human Virology, Ed 3rd, Oxford University Press Inc., New York. ISBN 13: 978-0-19-856660-1
2. Murray et al., Microbiology, 6th Ed.,
3. Bruce A Voyles (2000) The biology of viruses. 2nd ed. MC Graw Hill companies Inc. New York. NY10020
4. Flint S.J., Enquist L.W., Krug RM, Racaniello, V.R. and Skalka, Principles of Virology. Molecular biology, pathogenesis and control. ASM press Washington D.C.

Z-931 CELL AND TISSUE CULTURE Cr. 3(2+1)

Theory

An overview of background, advantages, limitations, terms and definitions, growth of attachment-dependent and suspended cells; cell lines. Biology of Cultured Cell, Culture environment, cell adhesion, cell proliferation, differentiation and evolution of cell line. Design, Layout and Equipment in Animal Cell Culture Construction, layout; essential, beneficial and useful equipment; consumable items. Aseptic Technique and Safety Objectives, element of aseptic environment, sterile handling, general safety, risk assessment, radiation and biohazard. Media and Serum-free Media Physicochemical properties, complete media, serum, selection, advantages and disadvantages of serum free media, replacement of serum, media development. Primary Culture and Cell Lines Type of primary culture cell. Isolation of tissues. Primary culture. Cloning Selection and Molecular Techniques An overview of suspension cloning, isolation of clones, in situ molecular hybridization, production of monoclonal antibodies. Somatic cell fusion and DNA transfer. Cryopreservation and Quantification Preservation, cell banks, transporting cells. Quantification, Somatic Embryogenesis and Organogenesis, Micro-propagation,

Practicals

Isolation of Liver cells; Cell culture in vitro; Maintaining the cell lines; Primary cell culture

Text Books

1. Freshney, R.I., (2000), Culture of Animal cell: A Manual of Basic Techniques, 4th Ed., Wiley Liss.
2. Dodds, J.H., and Roberts, L.W., (1995), Experiment in Plant Tissue Culture, 3rd Ed., Cambridge University Press.

Books Recommended:

1. Harrison, M.A., and Rae, I.F., (1997), General Techniques of Cell Culture, Cambridge University Press.
2. Dixon, R.A., (1985), Plant Cell Culture: Practical Approach, IRL Press.

3. Doyle, A., and Griffiths, J.B., (2000), Cell and Tissue Culture for Medical Research, John Wiley and Sons.
4. Chawla, H.S., (2002), Introduction to Plant Biotechnology, 2nd Ed., Science Publisher

Z-932 CELL SIGNALLING SYSTEMS Cr. 3(2+1)

Theory

General Introduction and Introduction to G Protein-Coupled Receptor (GPCR) Signaling, Growth Factor/ Receptor Tyrosine Kinases (RTKs) and Wnt Receptors , Ras to Mitogen-Activated Protein Kinase (MAPK) Pathways, Protein Kinases, Protein Phosphatases, Domains in RTKs: Structural Aspects, Discussion Forum, Structure of GPCRs, G proteins, and GTPases, GPCRs and Their Modulation, G Protein Effectors, Ligand-Gated Channels, Regulation of Ion Channels by G Proteins, Transient Receptor Protein (TRP) Channels, Proteases and Signaling, Apoptosis, Cytokine Receptors , Toll-Like Receptors, Nuclear Transactivators and Repressors, Chromatin Remodeling , Nuclear Receptors, Regulation of Translation, Modeling of Signaling Networks, Assembly and Organization of Macromolecular Complexes, Regulation of Complexes by Cytoskeletal Elements.

Text Book

1. John Hancock, Cell Signalling Ed 3rd, Publisher: Prentice Hall (November 19, 1997), ISBN-10: 0582312671

Books Recommended:

2. Bastien D. Gomperts, Ijsbrand M. Kramer , Peter E.R. Tatham, Signal Transduction, Second Ed., Publisher: Academic Press; 2 Ed. (August 19, 2009), ISBN-10: 0123694418.
3. Friedrich Marks, Cellular Signal Processing: An Introduction to the Molecular Mechanisms of Signal Transduction, Garland Science; 1 Ed. (November 14, 2008), ISBN-10: 0815342152
4. John Nelson, Structure and Function in Cell Signalling. Wiley; 1 Ed. (August 25, 2008), ISBN-10: 0470025514

Z-933 IMMUNE SYSTEM AND IMMUNOCHEMISTRY Cr. 3(2+1)

Theory

Introduction to the immune system, elements of innate and acquired immunity, immunogens and antigens, antibody structure and function, antigen-antibody interactions, genetic basis of antibody structure, monoclonal antibodies, biology of the B lymphocytes, the role of MHC in the immune system, biology of T lymphocyte, activation and function of T and B cells, control mechanisms in immune response, cytokines.

Practicals

Precipitation reactions based assay Agglutination based tests. Enzyme-linked immunosorbent assay (ELISA). Enzyme linked Oligoneucleotide sorbent assay (ELOSA) Immuno fluorescence assay. Immuno enzymatic cytochemical technique Immuno gold technique. Immuno electron microscopy technique

Text Book

1. Medical Immunology 10th Ed. by T.G. Parslow, D.P. Stites, A.I. Terr and J.B. Imboden. Lange.

Books Recommended:

2. Immunology,6th Ed. by I. Riott, J. Brostoff, and D. Male. Publisher: C. V. Mosby.
3. Kuby Immunology,(2006) 6th Ed. by T. J. Kindt, B. Osborne and R.A. Goldsby, W.H. Freeman
4. Principles of Microbiology,(1995) by R.M. Atlas

5. Advance Molecular Biology (1999) by W. Wisden and R. M. Twyman, Springer Verlag GmbH

Z-934 PROTEINS AND PROTEOMICS Cr. 3(2+1)

Theory

Molecular Biology of Proteins (types, structure, synthesis, translation), Posttranslational modifications (glycosylation, phosphorylation, methylation, etc.), Molecular mechanisms of cellular communication/signaling pathways, Bioinformatic tools (genomics, proteomics, metabonomics). Protein-Protein Interactions, receptor identification and characterization, Integral Membrane Proteins and Ion Channels, Peptide Models of Transmembrane, Domains, Membrane Fusion and Membrane Binding Proteins, Apolipoproteins. Advance techniques used in proteomics including, 2D Gel Electrophoresis, Mass Spectrometry, Maldi TOF, MS/MS, LC/MSMS, iTRAQ, Protein arrays etc.

Practicals

Protein Isolation, Purification, Methods for the study of Proteins, Immunohistochemistry, ELISA, Western, 1D, 2D Electrophoresis.,

Text book

1. Principles of Proteomics by R. M. Twyman (2004). BIOS Scientific Publishers

Books Recommended:

2. Proteomics in Practice: A Guide to Successful Experimental Design (2008) 2nd Ed. by R. Westermeier, T. Naven, and Hans-Rudolf. J.Wiley and Sons
3. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter 5th Ed. Garland Sciences, Taylor and Francis
4. Biochemistry (2007) 6th Ed. by J.M. Berg, J.L. Tymoczko and L. Stryer W.H. Freeman and Co.
5. Introduction to Proteomics: Tools for the New Biology (2001) by Daniel C. Liebler

Z-835 SIGNAL TRANSDUCTION AND BIOMEMBRANES Cr. 3(2+1)

Theory

Introduction, surfaces and interfaces, chemical compositions. Structure of membranes. Isolation of membrane bound proteins, morphology and function of different biological membranes (plasma membrane, mitochondrion, chloroplast, mesosome, endoplasmic reticulum, Golgi apparatus, lysosomes, tonoplast, nucleus). Membrane transport: active and passive transport. Membrane receptor-ligand interactions and pathways.

Text book

1. Molecular Cell Biology (2007) 6th Ed.. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, W.H. Freeman.

Books Recommended:

2. Biochemistry (2007) 6th Ed. by J.M. Berg, J.L. Tymoczko and L. Stryer W.H. Freeman and Co.
3. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter 5th Ed. Garland Sciences, Taylor and Francis
4. Molecular Cell Biology (2007) 6th Ed.. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, W.H. Freeman.
5. Cell and Molecular Biology: Concepts and Experiments (2008) by G. Karp John Wiley and Sons

Z-936 BIO-SAFETY AND ETHICS Cr. 3(2+1)

Theory

Lab safety, management and handling of hazardous materials and human protection, environmental pollution and its remedies. Modern biotechnology and its social implications. Biomedical research and bioethics in health policy. Ethical considerations. The uses and abuses of animal research. Safety and benefits of genetic testing, experimentation on human embryos and stem cell research. Genetically modified organisms and foods and their safety. Indigenous knowledge and patenting, commercialization and benefit sharing. national and international bioethics. Regulation of biotechnology for benefit sharing.

Books Recommended:

1. Cross-Cultural Biotechnology (2004). by M. Chalmer, et al Rowma and Littlefield Pulishers.
2. Gene Flow from GM Plants. (2005) by G.M. Poppy and M. J. Wilkinson (Editors) Wiley Blackwell Publications.
3. Cell and Molecular Biology: Concepts and Experiments (2008) by G. Karp John Wiley andSons.
4. Bioethics Yearbook Series

Z-937 GENES AND DISEASE Cr. 3(2+1)

Theory

Introduction to Genes and Disease, Blood and Lymph Diseases, Cancers, The Digestive System, Ear, Nose, and Throat, Diseases of the Eye, Female-Specific Diseases, Glands and Hormones, The Heart and Blood Vessels, Diseases of the Immune System, Male-Specific Diseases, Muscle and Bone, Neonatal Diseases, The Nervous System, Nutritional and Metabolic Diseases, Respiratory Diseases, Skin and Connective Tissue, Chromosome Map

Text book

Genes and Disease, National Center for Biotechnology Information (US). Bethesda (MD): National Center for Biotechnology Information (US); 1998-.

Z-938 INFLAMMATION, CYTOKINES AND CHEMOKINES Cr. 3(2+1)

Theory

Cellular and humoral components of the early inflammatory reaction; Interleukin I as the key factor in the acute-phase response; Purification and biochemical properties of interleukin I; Interleukin I target cells and induced metabolic changes; Response of the brain to interleukin I; Metabolic changes in other organs following intracerebroventricular injection of endogenous pyrogen/interleukin I; Responses of the immune system to interleukin I; Responses of cells other than those of the brain and the immune system to interleukin I; Responses of muscle to interleukin I; Responses of connective and other tissues and cell types to injury-derived factors; Other injury-mediated metabolic changes; Definition and classification of acute-phase proteins; Biological functions of acute-phase proteins; Phylogenetic aspects of the acute-phase response and evolution of some acute-phase proteins; Stimulation of liver by injury-derived factors; Synthesis and secretion of acute-phase proteins from the liver; Hepatocyte stimulating factor and its relationship to interleukin I; Regulation of synthesis of acute-phase proteins; Extrahepatic synthesis of acute-phase proteins; Catabolism and turnover of acute-phase proteins; Diagnostic and prognostic significance of the acute-phase proteins; Acute-phase proteins in chronic inflammation;

Practicals

Assays of monokines; General methods applied to assay of acute-phase proteins in plasma, body fluids and tissue cultures; Specific methods of assay for certain acute-phase proteins;

Books Recommended:

By the expert.

Z-939 APICULTURE Cr. 3(2+1)

Theory

The significance of Apiculture; Types of honeybees and their distribution, endemic and exotic species; Honeybee structure, functions and special organs; The colony and its organization; Biology of the honeybee, life history, placement of colonies, moving and transporting bees; Beekeeping equipment and fundamental tools for bee breeding, honey production and harvesting/ processing of honey and beeswax; Major honey flows in different ecological areas; How to start, installing a bee hive and establishment of an apiary; Inspection techniques, introducing a queen, handling queens; control of robbing; Supplemental feeding for queen breeding and stimulative brooding rearing; sources of nectar and pollen; Products from apiculture; Honey production, harvesting, processing and uses; Beeswax production, extraction, processing and its uses; Swarming, its prevention and control.

Modern and traditional methods for honeybee breeding, merits of frame hive beekeeping and top bar hives; Migratory beekeeping; Seasonal management of colonies; Integrated management of honeybees for higher honey yield; Natural enemies of honeybees, and control; American foulbrood disease of honeybee brood and its remedies; Mite diseases of honeybees and their control; Other diseases of honeybees and cures; Preparation of colonies for honeybee queen breeding, queen management, Commercial queen rearing, improvement of stock and package bees; Conservation of indigenous honeybees and issues facing apiculture; Honeybees as pollinators; Honeybee pollinated crops and fruit trees; Preparation and management of colonies for pollination.

Practicals

1. Watching for the natural nest, contents of the cells, arrangement of the nest, colour of the combs.
2. Preparation of hive with frames and top bars.
3. Wiring frames, fixing foundations.
4. Use of bee veil, smoker, hive tool and other appliances.
5. Handling bees, stings, cleaning hives and ventilation.
6. Inspection of bees: opening bee hives, organization within the colony, removing frames, handling frames, fanning and food transmission.
7. Identification of queens, workers, drones, brood comb formation/ structure, honey and pollen stores, propolis and royal jelly.
8. Transferring bees in Langstroth hives, Observation hives and nuclei.
9. Removing honey crop, uncapping, handling cappings, honey extraction modern and traditional methods and preparation of honey for market.
10. Inspection of colonies: watching for diseases, pests, predators, their diagnosis and control.
11. Supplemental/ emergency feeding and making candy for queen breeding.
12. Moving colonies: Packing hives for transportation.
13. Queen rearing: preparation of colonies and queen cells.
14. Selection an breeding, grafting larvae, dry and wet methods.
15. Requeening of colonies, caging of queens and queen introduction.
16. Uniting colonies, harvesting pollen, propolis and royal jelly.
17. Recognizing robber bees, control of robbing.
18. Production of beeswax, harvesting and processing.

Books Recommended:

1. Ahmad, R. and Muzaffar, N. 1984. Modern beekeeping (Urdu version). Pak. Agric. Res. Council, 350 pp.
2. Atwal, A.S. 2000. Essentials of beekeeping and pollination. Kalyani Publishers, India, 393 pp.

3. Blackiston, 2001. Beekeeping for dummies. Wiley Publishing Inc., USA, 303, pp.
4. Crane, E. 1976. Honey- A comprehensive survey. Inter. Bee Res. Assoe. Heinemann, London, 608 pp.
5. Dadant, C. 1986. The hive and the honeybee. Dadant and Sons, Hamilton, Illinois, USA, 740 pp.
6. Phillips, E.F. 2006. Beekeeping. Ithaca, New York Agrobios Press, India, 490 pp.

Z-940

AIR POLLUTION MONITORING

Cr. 3(2+1)

Theory

Global air pollution and climate, Air pollutants : types, properties and sources, Gaseous air pollutants, Particulate matter and aerosols, Aerosol fundamentals and instrumentation, Definition and classification of aerosol, Tropospheric aerosols, The effects of aerosols, Surface chemistry, Aerosol size, Aerosol optical properties, Aerosol type and sources, Bio-aerosols: types and sources, Air-borne diseases, Testing and remediation, Air pollution and climate change, Bio indicators, Thresholds and injury, Genetic adaptation, Industrial melanism, Sensitivity and tolerance, The nitrogen's cycle, Instrumentation, Global warming, The greenhouse effect, Plant effects, Human implications

Practicals

Study and analysis of PM 10 of ambient and indoor air

Books Recommended

1. Ali. Z. Colbeck, I, and Nasir, Z. A. 2010. Basics of air pollution monitoring, HEC-BC Link publication.
2. Welburn, A. 2007. Air pollution and climate change: 2nd edition; Longman Scientific and Technical

Z-941 COMMUNICABLE DISEASES AND ENVIRONMENTAL HEALTH Cr. 3(2+1)

Theory

The environment in the context of health, Analysis of estimates of the environmental attributable fraction by disease, Respiratory infections, Diarrhoea, Malaria, Intestinal nematode infections, Trachoma, Schistosomiasis, Chagas disease, Lymphatic filariasis, Onchocerciasis, Leishmaniasis, Dengue, Japanese encephalitis, HIV/AIDS, Sexually transmitted diseases, Hepatitis B and hepatitis C, Tuberculosis, Perinatal conditions, Congenital anomalies, Malnutrition, Cancers, Neuropsychiatric disorders, Cataracts, Deafness, Cardiovascular diseases, Chronic obstructive pulmonary disease, Asthma, Musculoskeletal diseases, Road traffic injuries, Unintentional poisonings, Falls, Fires, Drownings, Other unintentional injuries, Suicide, Interpersonal violence, Physical inactivity, Other diseases,

How much disease can be prevented through healthier environments? Which populations suffer the most from environmental hazards to health? Deaths attributable to environmental factors, What can policymakers and the public do about environmental risks to health? Global Environmental diseases statistics, Cost-effective interventions to combat Environmental diseases.

Practicals

Students will get collection of data from different Hospitals and prepare assignments on different environmental health diseases with statistical data, origin, causes, remedies and recommendations.

Books Recommended

1. Pruss-Ustun, A. and Corvalan, C. 2006. Preventing Disease through Healthy Environments, through an estimate of the Environmental Burden of disease. World Health Organization, pp.106

2. Murray, C.J.L., and Smith R. 2001 Diseases of Globalisation. London, Earthscan Publication Ltd.; pp.240
3. Webber .R. 2005. Communicable Diseases Epidemiology and Control: A Global Perspective, CABI. Pp.316.

Z-942 ECOLOGICAL MODELLING AND NATURAL PHOTOGRAPHY Cr. 3(2+1)

Theory

Introduction into the Course, Introduction into Ecological Modelling, Individual-based Models, Models with Temporal Variability, Incorporating Temporal Variability, Environmental Change, Spatial Models, Spatial Models in Ecology, Metapopulation Models & Viability Analysis, Equation-based Population Models, Limited & Unlimited Growth, Stochastic Limited Growth , Bridging between Bottom-up and Top-down Approaches.

Photography Basics: Understanding the Basic Principals of Photography, Understanding the Camera and lenses, Ecology and Photography: Importance and understanding of the different components of the ecology, Natural ecosystems, and its presentation in Photography. Photography as a tool for conservation: Studying and learning the use of photography practices as a tool for conservation and research.

Practicals

Ecological Modeling exercises and assignments, Practical use of photography, Practical use, understanding and in depth study of the ecological photography during the field visits. Research Project Preparation:, Selecting the research subject and preparation of the project assignments

Books Recommended

1. Fath, B., and Jorgensen, S. E. 2001. Fundamentals of Ecological Modelling (Developments in Environmental Modelling, 21).
2. Fath, B., and Jorgensen, S. E. 2011. Fundamentals of Ecological Modelling (4th Edition) 2011
3. Fath, B., and Jorgensen, S. E. Fundamentals of Ecological Modelling, Fourth Edition: Applications in Environmental Management and Research (Developments in Environmental Modelling).
4. Jorgensen, S. E., and Endoricchio, G. Fundamentals of Ecological Modelling.
5. Jeroen C. J. M. A at Barendregt, B., and Gilbert, A. J. 2004. Spatial Ecological-Economic Analysis for Wetland Management: Modelling and Scenario Evaluation of Land Use.
6. Jopp, Fred Reuter, Hauke Breckling. 2011. Broder Modelling Complex Ecological Dynamics: An Introduction into Ecological Modelling.
7. Soetaert, K. and Herman, P. M. J. 2008. A Practical Guide to Ecological Modelling: Using R as a Simulation Platform.
8. Derrida, J. 2010. Copy, Archive, Signature: A Conversation on Photography.
9. Miotke, J. 2007. The Better photo Guide to Digital Nature Photography.
10. Gerlach, J and Gerlach, B. 2007. Digital Nature Photography: The Art and the Science.
11. Kieffer, J. 2004. Mastering Nature Photography: Shooting and Selling in the Digital Age.
12. Shaw, J. 2000. John Shaw's Nature Photography Field Guide.
13. Moss, K. 2006. K. Moss. Digital Nature Photography and Adobe Photoshop 2006
14. Walden, S. 2008. Photography and Philosophy: Essays on the Pencil of Nature.