UNIVERSITY OF SARGODHA

Office of the Registrar

Ref: SU/Acad/ 884
November/05/2020

Notification

The Academic Council in its meeting held on 18.06.2020 has approved the following recommendations made by the Board of Faculty of Sciences in its meeting held on 03.06.2020. The Syndicate in its meeting held on 27.07.2020 has also endorsed the decision of Academic Council.

1. Revised Scheme of Studies and Curriculum of BS Zoology under Semester / Term System from session 2020 (Annex-'A')
2. Course contents 'Introduction to Biology' for other departments (Annex-'B')
3. Revised Scheme of Studies of MSc Zoology under Annual System from session 2020 (Annex-'C')
4. Revised Scheme of Studies and Curriculum of MSc Semester / Term System from session 2020 (Annex-'D')
5. Revised Scheme of Studies and Curriculum of MPhil Zoology from session 2020 (Annex-'E')
6. Revised Scheme of Studies and Curriculum of PhD Zoology from session 2020 (Annex-'F')

Muhammad Farooq
Deputy Registrar (Acad)

Distribution:

- Chairman, Department of Zoology
- Director, Sub-Campus Bhakkar
- Controller of Examinations
- Principals of all affiliated colleges (concerned)
- Web-Developer *(for uploading on university web-site)*

C.C:

- Focal Person. Faculty of Sciences
- Deputy Registrar (Affiliation)
- Deputy Registrar (Registration)
- Secretary to the Vice-Chancellor
- P.A to Registrar

SCHEME OF STUDY FOR MSc ZOOLOGY

(ANNUAL SYSTEM)

(Applicable from 2020)

DEPARTMENT OF ZOOLOGY

UNIVERSITY OF SARGODHA

SARGODHA - PAKISTAN

SCHEME OF STUDY -MSc ZOOLOGY 2 YEARS ANNUAL SYSTEM PROGRAM FOR AFFILIATED COLLEGES
(Applicable from 2020)

MSc-Two Years ***Zoology*** program comprises of two parts with 13 courses in total. Six courses have to be studied in Part I and seven courses have to be studied in Part II.

Duration of the Program:

The duration of MSc Zoology is two years (Part I & Part II)

Main Features of MSc Zoology Program/Credit Requirements

Major Subject: Zoology

Duration: 02 years (Part I & Part II)

Degree Requirements: All 13 courses have to be cleared both in theory and practical separately. Each course will have a separate paper of theory (75 marks) and a respective separate paper for practical (25 marks).

Candidate has to pass each subject separately both in theory and practical.

MSc 2 YEARS (ANNUAL) PROGRAM IN ZOOLOGY FOR AFFILIATED COLLEGES
(Applicable from 2020)

Part-I

Paper	Course Title	Marks Theory+ Practical
Paper- I	Biochemistry	75+25=100
Paper -II	Developmental Biology	75+25=100
Paper -III	Biostatistics	75+25=100
Paper -IV	Cell and Molecular Biology	75+25=100
Paper -V	Animal Physiology	75+25=100
Paper -VI	Genetics	75+25=100
Total Marks		**600**

Part-II

Paper- VII	Wild life and Fisheries	75+25=100
Paper -VIII	Animal Ecology	75+25=100
Paper -IX	Evolution & Principles of Systematics	75+25=100
Paper -X	Principles & Kinetics of Toxicology	75+25=100
Paper -XI	Zoogeography & Paleontology	75+25=100
Paper -XY*	*Optional	75+25=100
Paper-XYY*	*Optional	75+25=100
Total Marks		**700**

Total Marks: 1300

Two optional papers has to be opted from the list of the optional papers (Annexure I)

ANNEXURE I **(List of Optional Papers)**

Paper -XII	Animal Behavior	75+25=100
Paper -XIII	Bioinformatics	75+25=100
Paper -XIV	Biodiversity & Wildlife	75+25=100
Paper -XV	Biology of Spiders	75+25=100
Paper -XVI	Comparative Developmental Biology	75+25=100
Paper -XVII	Endocrinology	75+25=100
Paper -XVIII	Entomology-I	75+25=100
Paper -XIX	Entomology-II	75+25=100
Paper -XX	Environmental Issues	75+25=100
Paper -XXI	Fish Culture	75+25=100
Paper -XXII	Fish Physiology & Breeding	75+25=100
Paper -XXIII	Hematology	75+25=100
Paper -XXIV	Immunology	75+25=100
Paper -XXV	Integrated Pest Management	75+25=100
Paper -XXVI	Microbiology-I	75+25=100
Paper -XXVII	Microbiology-II	75+25=100
Paper -XXVII	Molecular & Clinical Endocrinology	75+25=100
Paper -XXIX	Ornithology	75+25=100
Paper -XXX	Physiological Systems & Adaptations	75+25=100
Paper -XXXI	Physiology of Reproduction	75+25=100
Paper -XXXII	Principles of Parasitology	75+25=100

Part I
Paper I **Biochemistry** **(75+25=100)**

The course aims to provide in-depth knowledge about the polymerized organic compounds of life. It will develop an understanding about the dynamism in life as it proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It enables students to know how organisms harvest energy for growth and duplication. This course will help students to understand the principles of bioenergetics and the dietary requirements of man and animals. It will also provide knowledge of metabolism of dietary and endogenous carbohydrate, lipid, and protein as well as the principles and major mechanisms of metabolic control and molecular signaling by hormones. This course will help students in understanding of the principles of bioenergetics and enzyme catalysis and to understand the chemical nature of biological macromolecules, their three-dimensional construction. This course will acquaint students with the principles of molecular recognition and will clarify the understanding of the molecular machinery of living cells.

Contents

1. Amino acids, peptides and proteins, standard amino acids, their structure and classification, acid/base properties of amino acids and their titration curves, peptides, their ionic behavior and amino acid composition, cytochrome C, proteins, level of structural organization, example of structural and functional proteins.
2. Enzymes their Introduction, important characteristics of enzymes, immobilized enzymes, how enzymes work, example of enzymatic reaction, enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect on enzyme activity.
3. Classification, types, important characteristics and structure of carbohydrates, cyclic structure of monosaccharides, cyanohydrin formation, disaccharides their types structure and function,
4. Polysaccharides, storage and structural types, structure and major functions of polysaccharides.
5. Fatty acids, their types and major characteristics, storage lipids, acylglycerols, waxes,
6. Structural lipids in membranes, major functions of lipids, lipoproteins, their types and major functions.
7. Vitamins and cofactors, occurrence, structure and biochemical function of vitamins B complex group.
8. Detailed description of glycolysis and catabolism of other hexoses, regulation and bioenergetics of glycolysis, anabolic role of glycolysis, fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation, alcoholic fermentation, gluconeogenesis, its regulation and significance in the tissues, feeder pathways in glycolysis, utilization of other carbohydrates in glycolysis phosphorolysis and starch, regulation of glycogen metabolism.
9. Citric acid (TCA) cycle: conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex, detailed description of citric acid cycle, bioenergetics and conservation of energy produced in 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 and its components, oxidative phosphorylation, chemiosmosis theory, ATP synthesis, uncouple electron transport and heat generation.
10. Lipid metabolism: oxidation of fatty acids, digestion, mobilization and transport of fats, biosynthesis of triacylglycerol, utilization of triacylglycerol, activation of fatty acids and their transportation to mitochondria, beta-oxidation, biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis, fatty acid synthetase (FAS) multienzyme complex
11. Ketone bodies their biosynthesis, utilization and role in the tissues, cholesterol metabolism: steroid hormones.
12. Nitrogen metabolism: metabolic fate of amino acids, catabolism of amino acids, deamination and transamination, nitrogen excretion and urea cycle, regulation of urea cycle.

Practical

1. Preparation of standard curve for glucose by *ortho*-Toluidine method.
2. Tests for detection of carbohydrates in alkaline and acidic medium.
3. Tests for detection of Disaccharides.
4. Detection of Non-Reducing sugars in the presence of reducing sugars.
5. Demonstration of Acid Hydrolysis of Polysaccharide.
6. Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).
7. Determination of pKa values of an amino acid by preparation of titration curves.
8. Biochemical tests for detection of different amino acids.
9. Separation of various protein fractions by precipitation method.
10. Demonstration of differential solubility of lipids in various solvents.
11. Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
12. Quantitative analysis of Amylase activity from blood serum or liver.
13. Study on the effect of temperature on the enzymatic rate of reaction

Recommended Texts

1. Nelson, D. L., & Cox, M. M. (2012). *Lehninger principles of biochemistry*. New York: McMillan worth publishers.
2. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2011). *Biochemistry* (7th ed.). Palgrave MacMillan.

Suggested Readings

1. Lodish, H. Berk, A. Zipursky, S. L. Paul. M. Baltimore D., & Darnell, J. (2012). *Molecular cell biology*. New York: Freeman.
2. Wilson, K., & Walker, J. (2010). *Practical biochemistry: principles and techniques* (7th ed.). Cambridge: Cambridge University Press.
3. McKee, T., & McKee, J. R. (2003). *Biochemistry: The molecular basis of life* (3rd ed.). McGraw Hill.

Paper II **Developmental Biology** **(75+25=100)**

The course is designed to provide information on transmission of traits from the parents in their offsprings , the formation of zygote and its development, impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction as well as provide understanding of the mechanisms of organogenesis. factors controlling growth and oncogenesis. Students will learn how developmental biology is having a significant impact on understanding of evolution and modern medicine, including the treatment of birth defects, infertility and cancer in humans. The students will be able to understand and compare basic principles of embryology through the understanding of developmental patterns with help of morphology and anatomy of embryos among different vertebrates. The practical section will enable them to go through the structure of gametes (frog, fish and mammal), to study the process of fertilization, early development of frog/fish through induced spawning under laboratory conditions and to know about the dactylography and its uses in developmental biology.

Contents

1. Introduction: Principal features of development, origin of sexual reproduction, developmental patterns, spermatogenesis, oogenesis. fertilization: egg metabolism activation
2. Cleavage: Patterns of embryonic cleavage, mechanism of cleavage, gastrulation, fate maps, gastrulation in sea urchin, amphibians, birds and mammals.
3. Early vertebrate development, neurulation, ectoderm, mesoderm and endoderm.
4. Cellular basis of morphogenesis, differential cell affinity, cell adhesion molecules.
5. 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 and mechanism of teratogenesis, secondary induction.
6. Organogenesis, a brief account, origin and migration of germ cells in vertebrates., factors controlling growth and organogenesis.
7. Post embryonic development and metamorphosis hormones as mediators of development, regeneration in vertebrates.

Practical

1. Study of the structure of gametes in some representative cases, i.e. frog, fish, fowl and mammal.
2. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc.
3. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
4. Preparation and study of serial sections of frog or chick embryos.
5. Application of microsurgical techniques on chick embryos *In vitro*. preparation and staining of histological slides.

Recommended Texts

1. Gilbert, S. F., & Barresi, M. J. (2016). *Developmental biology* (11th ed.). Sunderland (Massachusetts): Sinauer Associates.
2. Gilbert, S. F. (2013). *Developmental biology* (10th ed.). Sunderland (Massachusetts): Sinauer Associates.

Suggested Readings

1. Davies, J. A. (2014). *Life unfolding: how the human body creates itself*. USA: Oxford University Press.
2. Balinsky, B. I. (2012). *An introduction to embryology* (5th ed.). India: Cengage.
3. Klaus, K. (2001). *Biological development* (2nd ed.). New York: McGraw-Hill.

Paper III **Biostatistics** **(75+25=100)**

The course aims to provide knowledge about the importance and use of statistics in life sciences and familiarize students with the methods of data analysis pertaining to their research work and to assess the significance of their experimental designs. Specific topics include tools for describing central tendency and variability in data, methods for performing inference on population means and proportions. After finishing this course, students will be able to recognize the importance of data collection and its role in determining scope of inference, can demonstrate a solid understanding of interval estimation and hypothesis testing, can choose and apply appropriate statistical methods for analyzing one or two variables and can interpret statistical results correctly, effectively, and in context. More specifically, by the end of the course they will be able to identify cases and variables in a dataset, and classify variables as categorical or quantitative and to recognize when it is, and is not, appropriate to use sample data to infer information about a population.

Contents

1. Introduction and scope: use of statistics in biology.
2. Population and sample: stages of research
3. Types of data: methods of data collection. data arrangement and presentation, formation of tables and charts.
4. Measures of central tendency: computation of mean, median and mode from grouped and un grouped data.
5. Measures of dispersion: computation of variance, standard deviation, standard error and their coefficients.
6. Probability rules: binomial, poisons and normal distributions. hypothesis testing, student 't' test, chi square test
7. Handling of multiple samples
8. Analysis of variance and LSD.
9. Correlation and regression
10. Experimental designing, planning of an experiment, replication and randomization.

Practical

1. Data collection, arrangement and frequency table.
2. Data presentation in table, graphs (simple bar chart, multiple bar chart, component bar chart).
3. Construction of timeline, pedigree chart, organogram, Gantt chart, info gram.
4. Calculating arithmetic mean, harmonic mean and geometric mean, median and mode from ungrouped and grouped data.
5. Calculating mean deviation, standard deviation and variance from ungrouped and grouped data.
6. Probability distribution.
7. z-test, T-test. ANOVA.
8. Correlation & regression.

Recommended Texts

1. Zar, J. H. (2013). *Biostatistical analysis* (4th ed.). India: Dorling Kindersley Publ. Inc.
2. Field, A. (2013). *Discovering statistics with IBM SPSS statistics.* (4th ed.).UK: SAGE Publication Ltd.

Suggested Readings

1. Forthofer, R. N., Lee E. S., & Hernandez, M. (2011). *Biostatistics: a guide to design, analysis and discovery* (2nd ed.). USA: Elsevier Inc.
2. Rao, K. V. (2009). *Biostatistics: a manual of statistical methods for use in health, nutrition and anthropology*. India: Jaypee Brothers Publishers.
3. Campbell, M. J., & Swinscow, T. D. V. (2011). *Statistics at square one*. (11th ed.). BMJ books.
4. Quinn, G. P., & Keough, M. J. (2002). *Experimental design and data analysis for biologists*. Cambridge: Cambridge University Press.

Paper IV **Cell and Molecular Biology** **(75+25=100)**

The course aims to impart knowledge about the animal cell and its complex external and internal organization and architecture. It enables students to understand various ultra-structural, molecular and functional aspects of the cells. Students will be able to describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function, can relate how cell movement and cell-cell communication occur and discuss mechanisms of signal transduction and the lab work will provide platform to became familiar with various cell types through techniques of slide preparation. Understanding of microscopy to study cell structure and cellular compartmentalization will be provided to learners. Main emphasis of course is to develop familiarity with structure and function of cells at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.

Contents

1. Introduction to prokaryotic and eukaryotic cells: plasma membrane, its chemical composition structure and functions of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.
2. Cytoskeleton, microfilaments, microtubules, intermediate filaments.
3. Cytoplasmic organelles, membrane system, structural and functional commonalities.
4. Ultrastructure, chemical composition and functions of endoplasmic reticulum and their role in protein synthesis and drug metabolism, golgi apparatus its role in synthesis of glycoprotein
5. Mitochondrial respiration and its significance as semi- autonomous organelle,
6. Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, glycoxysome with reference to glyoxylic acid cycle.
7. Nucleus: chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.
8. Replication: mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in eukaryotes with emphasis on DNA polymerases, concept of replicons etc.,
9. 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 Post transcriptional processing, RNA transduction, Genetic code, point mutations.
10. Translation: Specific role of Ribosomes, various factors, and posttranslational processing, control of gene expression in Prokaryotes.

Practical

1. Identification of cell organelles
2. Preparation of temporary whole mount.
3. Preparation of permanent whole mount (demonstration)
4. Preparation of human blood smear and identification of Leucocytes.
5. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).
6. Squash preparation of onion root tip for mitotic stages.
7. Mounting of polytene chromosome (Drosophila/Chironomous.) Demonstration.
8. Detection and quantitative determination of chromosomal DNA and RNA.
9. Cultural and staining of bacteria and yeast.
10. Separation of different sized DNA fragments on agarose gel.
11. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Recommended Texts

1. Cooper, G. M., & Hausman, R. E. (2018). *The cell: a molecular approach* (8th ed.). Massachusetts:

Sinauer Associates.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). *Molecular cell biology* (8th ed.). New York: W. H. Freeman.

Suggested Readings

1. Iwasa, J., & Marshall, W. (2016). *Karp's cell and molecular biology: Concepts and experiments* (8th ed.). New Jersey: John Wiley and Sons.
2. De Robertis, E. D. (2014). *Cell and molecular biology* (8th ed.). New York: Lea & Febiger.
3. Alberts, B. Johnson, A. D. Lewis, J. Morgan, D. Raff, M. Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). Norton & Company.

Paper V **Animal Physiology** **(75+25=100)**

This course will provide an introduction to the basic physiological principles common to humans and other animals. It will include basic physical and chemical processes in animal tissues, detailed consideration of organ systems, and an integrative approach to understand how animals meet the demands in variable conditions. It will not only emphasize human physiology, but also will consider other animal systems for comparison. This course enables the students to understand the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases, removal of nitrogenous wastes, osmosis and other physiological mechanisms underlying animal homeostasis and temperature effects. On the completion of course students will be able to understand mechanisms and adaptations of physiological systems in animals and understand the working of various systems of organisms. The practical portion will let the learners to investigate physiological questions, and collecting, analyzing, interpreting, and reporting experimental data.

Contents

1. Concept of Physiology: Principles of homeostasis and conformity, principles of regulation and adaptation
2. Membrane Physiology: Ionic distribution across membrane, resting membrane potentials: electro genic ion pump, Donnan equilibrium, Ion channels
3. Muscle Physiology: Action potentials in neurons, electrical and chemical synaptic transmission, Neurotransmitters in communications, receptors of neurotransmitters in diverse physiological responses, excitatory and inhibitory postsynaptic potentials, neuronal networks and their role in nervous integration,
4. Muscles: Structure, types, components, muscle proteins, molecular basis of muscle contraction, Sarcoplasmic reticulum and role of calcium, neuromuscular interaction at cell and molecular level muscle, types of muscle contractions and muscle fatigue.
5. Endocrine Physiology: Hormones of invertebrates and specifically of arthropods for the functions in their modes of life, hormones of various vertebrates' endocrine organs and comparison of their roles in adaptability of mode of life, mechanisms of hormone actions, hormone receptors, signal transduction and hormonal coordination.
6. Cardiovascular Physiology: Electrical activity of heart, self-excitability and auto-rhythmicity of myogenic heart, neurogenic heart and their expression, electrocardiography and Kymograph, hemodynamics, relationship between blood flow, pressure and resistance. Their role in performance of the function in variety of vertebrates, control of cardiac activity, cardiac output and peripheral circulation
7. Respiratory Physiology: mechanism of respiratory gases exchange in aquatic and terrestrial respiratory structures, Control of respiration and stimulus factors in various animals, respiration adaptations in hypoxia and percapnia etc, air breathing and respiratory adaptations diver animals.
8. Excretory Physiology: Strategy of mammalian large glomerular filtration and reabsorption in nitrogenous excretion, patterns of nitrogenous excretion in various animals and their phylogenetic significance.
9. Physiology of Nutrition: Adaptation of nutritive canal for digestion and absorption of nutrients in different animals specifically the vertebrates, regulation of digestive secretions, mechanisms of water, ions and nutrients absorptions and their significances in diverse groups, potential and movements in gastrointestinal tract and control of motility.

Practical

1. Respiration and Circulation: Study of respiratory pigments in various animals and hemoglobin in various vertebrates, normal cardiac activity in amphibian model, effect of temperature, effect of drug, heart block, tantalization of heart, measurement and effects of various factors on blood pressure.

2. Blood pressure alteration in exercise, oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer),
3. Nerve and Muscle: Study of salient features of electromyography, study of excitable and contractile properties of a nerve-muscle preparation.
4. Nervous System: Study of brains in different animals in relation to complexity of functions, Study of human brain model and different areas eliciting behaviors, videos study on 1 and 2 studies.
5. Hormones System: Video studies on the effects of hormones in breeding season behaviors of various behaviors, Study through clinics data on the insulin and glycaemia in type1 and type 2 diabetic subjects.

Recommended Texts

1. Moyes, Christopher., Schulte, D., & Patricia, M. (2015). *Principles of animal physiology*. Pearson.
2. Guyton, A. C. & Hall, J. E. (2016). *Textbook of medical physiology*. Philadelphia: W.B. Saunders Company.

Suggested Readings

1. Sherwood, L., Klandorf, H., & Yancey, P. (2012). *Animal physiology: from genes to organisms* (2nd ed.). Brooks/Cole.
2. Hill, R. W., Wyse, G. A., & Anderson, M. (2016). *Animal physiology* (4th ed.). UK: Oxford University press.

Paper VI **Genetics** **(75+25=100)**

This course aims to provide understanding of basic concepts of genetics, providing a conceptual framework for future reference. Students will be able to understand that the continuity of the life from one generation to next generation is based on the mechanisms involving nucleus, chromosomes and genes, develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment, understanding of probability concepts and using these concepts to solve problems. The main goals of this subject are to accurately illustrate and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes, to identify and describe the process and purposes of the cell cycle, meiosis, and mitosis and to describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.

Contents

1. Classical genetics: scope and importance of genetics, gene concept, classical and modern
2. Multiple alleles: blood groups and coat color in rabbits.
3. Chromosomal basis of inheritance: interaction of genes, changes in chromosomal number, euploidy, aneuploidy, polyploidy, structural changes, insertion, deletion (cri du chat syndrome), duplication and translocation
4. Pedigree analysis: normal human chromosome complement, karyotyping. sex-determination and sex-linkage: sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes.
5. Molecular genetics: elements of genetic engineering, genetic basis of diseases, like cancer, genetic control of animal development. human genetics,
6. Single and multifactorial disorders: autosomal anomalies, pseudoautosomal genes, (e.g. down syndrome, edwards syndrome and), single gene disorders gene mutation and disorders, autosomal single gene disorders (sickle cell anemia, brachydactyly, inborn errors of metabolism such as phenylketonuria, alkaptonuria). definition - characteristics criss-cross inheritance. polygenic traits - cleft lip and cleft palate,
7. Sex-linked chromosomal anomalies: klinefelters syndrome, and turner's syndrome.
8. Sex-influenced inheritance: hemophilia, muscular dystrophy, color blindness.
9. Prenatal diagnosis: amniocentesis and chorionvillus sampling - ultrasound scanning and fetoscopy. genetic counselling, eugenics and euthenics.
10. Population genetics: hardy-wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practical

1. Study of mitosis stages (Onion root tips).
2. Study of Meiosis stages (Grass hopper testes).
3. Blood groups.
4. Salivary gland Chromosomes of *Drosophila melanogaster.*
5. General morphology of *Drosophila melanogaster.*
6. Human Pedigree analysis problems.
7. Human Genetics problems.
8. Probability problems. Tossing of coins. X^2 test.

9. Study of transformed bacteria on the basis of antibiotic resistance.

Recommended Texts

1. Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Killian, D. (2018). *Concepts of genetics* (12th ed.). UK: Pearson.
2. Krebs, J. E., Goldstein, E. S., & Kilpatrick , S. T. (2018). *Lewin's gene-XII* (12th ed.). USA: Jones & Bartlett Learning.

Suggested Readings

1. Snustad, D. P., Simmons, M. J., & Gardner, E. J. (2003). *Principles of genetics* (8th ed.). New York: John Wiley and Sons Ltd.
2. Tamarin, R. H. (2001). *Principles of genetics* (7th ed.). New York: McGraw-Hill.

Part II
Paper VII **Wild life &Fisheries** **(75+25=100)**

Wildlife

The objective of this course is to enable the student to understand philosophy and significance of wildlife conservation, understand the wildlife management rules and regulations in Pakistan and to understand how national and international agencies are involved in conservation and management of wildlife. Students will be able to apply knowledge to solve problems related to wildlife conservation and management. They will learn about the conservation and management of threatened species of amphibians, reptiles, birds and mammals along with the contribution of national and international agencies. The major aim of the subject includes to know what type of wildlife exist in Pakistan and what are the threats it is facing, moreover, how wildlife is being secured in Pakistan? After this course students will become able to participate in conservation of wildlife. The practical section will cover the visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas), ecological indices and animal distribution maps.

Contents

1. Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat.
2. Techniques: Ground and aerial tracking, GPS, radio telemetry, maps etc. wildlife conservation: Philosophy and significance, Biodiversity and sustainability of wildlife.
3. Wildlife Agencies: National and International agencies involved in conservation and management of wildlife. International conventions, agreements.
4. Wildlife of Pakistan: identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan.
5. Wildlife rules and regulations in Pakistan: sanctuaries, game reserves and national parks in Pakistan. endangered species of Pakistan.

(Note: The teacher is suggested to provide blank maps of Pakistan in the theory class to the students to indicate the distribution of the animals).

Practical

1. Visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas)
2. Ecological Indices
3. Animal Distribution Maps

Recommended Texts

1. Odum, E. P. (2007). *Fundamentals of ecology* (5th ed.). Brooks/Cole Publishing Co.
2. Miller, A. S., & Harley, J. B. (2016). *Zoology* (10th ed.). New York: McGraw Hill.

Suggested Readings

1. Smith, R. L., & Smith, T. M. (2000). *Ecology and field biology* (6th ed.). USA: Benjamin Cummings.
2. Ali, S. S. (1999). *Palaeontology, zoogeography and wildlife management*. Hyderabad, Pakistan: Nasim Book Depot.
3. Roberts, T. J. (1997). *The mammals of Pakistan*. Oxford University Press.

Fisheries

1. Introduction to fisheries and aquaculture, national and international trends.
2. Fish morphology and diversity in size and shape.
3. Distribution of fishes in Pakistan, commercial fishes, marine and freshwater.
4. Types of ponds, planning construction and pond preparation.
5. Pond fertilization, application, food and feeding habits of fishes, feeding types, artificial and natural fish food, artificial fish feeds.
6. Fish habitat, ecology and extant of distribution, water quality parameters (abiotic: temperature, light, salinity, pH, turbidity, etc.) and their effects on fish health and production.
7. Biotic parameters (plankton, insects, aquatic vegetation, etc) of ponds, lakes, rivers, and impacts on fish growth. Induced breeding.
8. Fish diseases and their control.
9. Fishing gears, fishing techniques, fishing communities.
10. Fish preservation, processing transportation and marketing.

Practical

1. Morphological characters of a typical fish,
2. Species identification, fin formula, key to identification of commercial fishes,
3. Dissection of common fish to study its various systems.
4. Practical demonstration of induced breeding,
5. Introduction to artificial feed ingredients.

Recommended Texts

1. Dunham, R. A. (2011). *Aquaculture and fisheries biotechnology: genetic approaches*. UK: CABI.
2. Sharma, O. P. (2009). *Handbook of fisheries and aquaculture*. New Delhi, India: Agrotech Publishing Academy.

Suggested Readings

1. Stickney, R. R. (2009). *Aquaculture: an introductory text*. London: CABI Publishing.
2. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: principles and practices*. New York: Blackwell Science Limited.
3. Ali, S. S. (1999). *An introduction to freshwater fishery biology*. Islamabad: UG Commission, H-9.

Paper VIII **Animal Ecology** **(75+25=100)**

This course will enable students to understand about habitat, ecology, ecosystems and environmental threats. Students will learn about the rehabilitation of destroyed ecosystems. They will also be capable to learn methods to protect and safe environment. The students will be able to study the biogeochemical cycles, applied ecology, population ecology, community ecology and global ecosystems. Upon successful completion of the course Students will develop an appreciation of the modern scope of scientific inquiry in the field of Ecology, become familiar with the variety of ways that organisms interact with both the physical and the biological environment and develop an understanding of the differences in the structure and function of different types of ecosystems. Moreover, this subject imparts knowledge to compare and contrast the relationships among organisms, including predation, parasitism, competition, commensalism, and mutualism. The students will also able to explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature.

Contents

1. Energy: Basic concepts of and types of Ecology, laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.
2. Biogeochemical cycle: Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient.
3. Limiting factors: basic concepts, temperature, soil, water, humidity, light and fire.
4. Global ecosystems: atmosphere, hydrosphere, lithosphere and ecosphere, an overview of ecosystem with special reference to ecological niche, basic concepts and types, major ecosystem of world, forest, grassland, desert, tundra and agricultural ecosystems. marine, estuarine, freshwater and wetlands
5. Population ecology: basic population characters, growth and growth curves, population dynamics and regulations.
6. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions
7. Applied Ecology: Resources and their ecological management, mineral, agricultural desalination, weather modification, forest and range management, landscape and land use
8. Pollution: definition, types, water, air, land and noise, sources and management.
9. Radiation ecology: global environmental changes (ozone depletion, acid rain, greenhouse effect and global warming, koyota protocol, radioactivity leakage, environmental laws).
10. Exotic and Invasive Species: desertification, deforestation, exotic and invasive species

Practical

1. Population Sampling Techniques (quadrate, line transact, point count, focal scan and capture and recapture method).
2. Study of different Ecosystems (fresh water, terrestrial, marine/mountain/ desert).
3. Ecological notes.
4. Measurements of physical factors of different ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.
9. Experimental design and approaches in ecological research, writing a research project
10. Development of an ecological management plan of some selected area

Recommended Texts

1. Molles, M. C. (2005). *Ecology: concepts and applications* (6th ed.). New York, USA: McGraw Hill.

2. Cox, C. B., & Morre, D. (2000). *Biogeography: an ecological and evolutionary approach* (6th ed.). London, UK: Life Sciences King's College.

Suggested Readings

1. Dondson, S. I., Allen, T. F. N., Carpenter, S. R., Ives, A., Jeanne, R. L., Kitchell, J. F., Langston, N. E., & Turner, M. G. (1998). *Ecology*. UK: Oxford Univ. Press.
2. Chapman, J. L., & Reiss, M. J. (1997). *Ecology: principles and applications*. UK: Cambridge Univ. Press.
3. Odum, E. P. (1994). *Fundamentals of ecology* (3rd ed.) Philadelphia: W.B. Saunders.

Paper IX **Evolution & Principles of Systematics** **(75+25=100)**

The course aims to provide extensive knowledge about origin of life and concepts about forces responsible for evolutionary changes. This study covers the importance and history of systematics with basic rules and regulations about the identification and naming of organisms. This course will also provide information about origin, classification and evolution of fauna. The students will be able to understand classification, philosophy of nomenclature, species concepts, phylogenetic inference and evolutionary perspectives of biodiversity. Moreover, the students will be able to understand the basic principles of evolution and systematics, and the inference of evolutionary patterns in the major animal groups. Students will be able to demonstrate evolutionary implications of animal diversity, nature and origin to life, Systematic Zoology, Microtaxonomy and taxonomic categories. The practical section will enable the students to preserve invertebrate species and classify them up to class level, how to identify animal by the help of key and how to make keys of different types for identification of animals.

Contents

Evolution:

1. The causes of micro-evolution; Hardy-Weinberg equilibrium, Mutation, Gene flow, Genetic drift, Nonrandom breeding, and natural selection.
2. Types of natural selection: directional, disruptive and stabilizing selection.
3. Causes of polymorphism in populations: Density dependent selection and Heterozygote advantage.
4. General selection model: one locus and two locus selection model, Genetic load, Cost of selection, Hitch-hiking, Linkage disequilibrium. and shifting balance theory.
5. Units of selection: allele, cell line, organisms, kin group and group.
6. Sexualselection: Theories of sexual selection; Darwin, Fisher and Zahavi.
7. Macroevolution: Evolutionary developmental biology: allometery, heterochrony, Evolutionary innovation and origin of higher taxa.
8. Rates of evolution; Evolutionary trends and laws, Gradualism and punctuated equilibrium.

Principles of Systematics:

1. Concepts of taxon, phenon and category.
2. Species concepts and its problems: Typological; Nominalistic, Biological, Evolutionary.
3. Subspecies, Polytypic species and Superspecies: concept and problems
4. Modes of speciation: Allopatric, Sympatric, Parapatric
5. Intrapopulation variation: Types and application
6. Taxonomic characters: Different kinds of taxonomic characters. Weightage of taxonomic characters.
7. Classification and its types; Phenetic, Cladistic and evolutionary classification.
8. Taxonomic collections and the process of identification.
9. The rules of zoological nomenclature: interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific names, synonym, homonym.

Practical

1. Calculation of gene and genotype frequency for generations.
2. To calculate deviation of genotype from Hardy Weinberg equilibrium.
3. Simulate to check the effects of natural selection and genetic drift in changing environments. Simulation of assess the role population size in evolution.

4. Discussion on the evidences of evolution, role of biodiversity in evolution.
5. Simulation experiment to show the process of coevolution.
6. The study of a group of organisms while utilizing key.
7. Collection, preservation, labelling and identification of a group of specimen according to expertise available in the institute.
8. Preparation of bracket and indent key.
9. Phylogeny Reconstruction using phenetic (Similarity and dissimilarity matrix and unweighted pair group method) and cladistic (compatibility method) analysis to a group of mock "organisms".

Evolution:

Recommended Texts

1. Strickberger, M. W. (2012). *Evolution.* Jones & Barrett Publisher.
2. Ridley, M. (1993). *Evolution.* Blackwell Scientific Publications.

Suggested Readings

1. Moody, P. A. (1989). *Introduction to evolution.* New York: Harper and Row Publishers.
2. Dobzhansky, T., Ayala, F. J., Stebbins, G. L., & Valentine, J. W. *Evolution.* New York: W.H. Freeman and Company.

Systematics:

Recommended Texts

1. Wiley, E. O., & Lieberman, B. S. (2011). *Phylogenetics: Theory and practice of phylogenetic systematic.* Wiley-Blackwell.
2. Mayer, E. (1994). *Principles of systematic zoology.* New York: McGraw-Hill.

Suggested Readings

1. Heywood, V. H. (1975). *Taxonomy and ecology.* London: Academic Press.
2. Whili, M. J. D. (1978). *Modes of speciation.* San Francisco: W.H. Freeman and Co.

Paper X **Principles and Kinetics of Toxicology** **(75+25=100)**

The course objectives are to provide knowledge about the nature and mode of action of different categories of toxicants and to provide knowledge about the procedural protocols used in toxicological studies. The major contents of the course include measuring toxicity and assessing risk, chemistry of toxicants, toxicity testing methods, routes of exposure, responses to varying doses of substances and LD50 experiments. Toxicokinetics aims to empower the students with the understanding of absorption and bioavailability and contrasting kinetics of lipophilic substances, routes of absorption (the oral, respiratory and dermal) and elimination. In addition, students will learn about biotransformation (phase I reaction and phase II reaction), cellular sites of action, effect of toxicants on enzymes and mechanism of cell death (apoptosis, necrosis, stress, repair) and recovery. The aim of this subject is to train high-quality scientists in applied toxicology with a heightened respect for the environment. Graduates will develop a broad range of skills, knowledge and experience required for successful careers.

Contents

1. Measuring toxicity and assessing risk: Introduction, chemistry of toxicants
2. Toxicity testing methods, routes of exposure, responses to varying doses of substances, time of exposure, the ld50 experiments, toxicity, hazards and risks.
3. Toxicokinetics: Introduction, pharmacokinetics and toxickinetics, absorption: the oral, respiratory and dermal route of exposure, distribution, elimination
4. Toxicokinetic models: mathematical models of elimination, absorption and bioavailability, contrasting kinetics of lipophilic substances.
5. Biotransformation: Introduction, primary biotransformation (phase I reaction & secondary metabolism (phase II reaction), cellular sites of action: introduction, interaction of toxicants with proteins
6. Effect of toxicants on enzymes, effects of toxicants on lipids and nucleic acids, mechanism of cell death, apoptosis, necrosis, stress, repair and recovery.

Practical

1. Study of Biotoxicity assay for LC50.
2. Study the effects of different teratogenic chemicals on the development of human/rat embryo.
3. Study the effect of Ethanol on the development of chick embryo with different doses.
4. Study the effect of Xylene on the development of chick embryo.

Recommended Texts

1. Stine, K. E., & Brown, T. M. (2015). *Principles of toxicology*. UK: CRC press, Taylor and Francis Group.
2. Marquardt, H., Schafer, S. G., Mcclellan, R., & Welsch, F. (2004). *Toxicology*. San Diego, USA: Academic press.

Suggested Readings

1. Barile, F. A. (2013). *Principles of toxicology testing*. UK: CRC Press, Taylor and Francis Group.
2. Wright, D., & Welbourn, P. (2002). *Environmental toxicology*. Cambridge: Cambridge University Press.

Paper XI **Zoogeography and Paleontology** **(75+25=100)**

Main objectives of the course are to provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time, to impart knowledge and concepts of evolution mainly on the basis of fossil record and give understanding that fossil records also provide information about the distribution of animals in the past eras. After completion of this course students will be able to reconstruct the biological traits of extinct organisms, can interpret the modes of life of fossil organisms. The students will learn about paleo geography focusing on theories of continental drift and plate tectonics, zoogeographical regions mainly faunas and affinities of Palearctic, Nearctic regions, oriental, Ethiopian, Australian and Neotropical regions, zoogeography of Pakistan and geochronometry. The practical section will empower students with the knowledge of fauna of various zoogeographical regions and invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.

Contents

Zoogeography

1. Branches of zoogeography: descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography.
2. Animal distribution: cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution, barriers and dispersal.
3. Zoogeographical regions: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palearctic, Nearctic regions, oriental, Ethiopian, Australian, and Neotropical regions, insular fauna
4. Palaeogeography: Theories of continental drift and plate tectonics, Pangea.
5. Zoogeography of Pakistan

Paleontology

1. The Planet Earth: History, age, shells of earth, atmosphere, hydrosphere, biosphere and lithosphere.
2. Rocks: types, igneous rocks, sedimentary rocks and metamorphic rocks. Fossil types and uses of fossils, nature of fossils.
3. Fossilization: Geological time scale, pre-cambrian life, post cambrian life, palaeozoic life, mesozoic life, cenozoic life.
4. Geochronometry: Uranium/Lead dating, radiocarbon dating, methods, index fossils, evolutionary history of man, elephant, horse and camel, Paleoecology, Paleo magnetism.

Practical

1. Study of fauna of various zoogeographical regions.
2. Study of mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals.
3. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
4. Study of vertebrate fossils e.g. horse/elephant/camel/bovid.
5. Study and identification of igneous, Sedimentary and metamorphic rocks
6. Map work for identification of various zoogeographical regions of the world.

Zoogeography

Recommended Texts

1. Beddard, F. E. (2015). *A text book of zoogeography*. United States: Scholar's choice edition.
2. Tiwari, S. K. (2006). *Fundamentals of world zoogeography*. Delhi: Sarup & Sons.

Suggested Readings

1. Ali, S. S. (1999). *Palaeontology, zoogeography and wildlife management*. Hyderabad, Pakistan: Nasim Book Depot.
2. Darlington, P. J. Jr. (1963). *Zoogeography*. United States: John Wiley & Sons.

Paleontology

Recommended Texts

1. Michael, J. B., & Haper, D. A. T. (2009). *Paleobiology and the fossil record*. United States: Wiley-Blackwell.
2. Foote, M., & Millar, A. I. (2006). *Principles of paleontology* (3rd ed.). USA: W. H. Freeman & Co.

Suggested Readings

1. Ali, S. S. (1999). *Paleontology, zoogeography and wildlife management*. Hyderabad, Pakistan: Nasim Book Depot.
2. Brouwer, A. (1977). *General paleontology*. University of Chicago, Chicago

ANNEXURE-I

Paper XII **Animal Behavior** **(75+25=100)**

This course will give the baseline information and knowledge about animal behavior and associate the likely role of external and internal stimuli on various animals during the day, season and year. It also relates daily behavioral rhythms with diurnal and nocturnal periodicities, predicts and anticipates variety of animal actions (costs and benefits) as assessed by innate and learned behavioral displays. The unifying theme of this course will be evolution by means of natural and sexual selection. It includes the scientific study of the mechanistic and evolutionary causes of animal behavior, including communication, foraging and anti-predator behavior, spatial behavior, mating behavior, parental care, and social behaviors. After successful completion of this course, students will be capable of understanding and identify behaviors in a variety of taxa, can competently discuss the evolutionary origins of various behaviors and can design and implement experiments to test hypotheses relating to animal behavior. It will enable them to design animal behavior explorative assignments, independently, and interpret outcomes effectively.

Contents

1. Foundations of animal behavior, ethology, classical ethology
2. Development of behavior: innate mechanisms, imprinting, kinds of behavior: innate, conditioned, complex behavior patterns, habituation.
3. Mechanisms of behavior: nervous system and behavior, hormones and behavior,
4. Social behavior: agonistic, altruistic, kinship, mating, ritualization, dominance, territoriality, biological rhythms: circadian clocks, clock genes.
5. Social organization: conflict, sexual behavior, reproduction and fitness, parental care, social system.
6. Animal Communication: chemical attraction, in moths, honey bees

Practical

1. Locomotory behavior of small animals, earthworm, garden snails.
2. Ear pinna reflex responses in domestic cats.
3. Preparation of skinner box or maze for study of mouse or rat behavior.
4. Mother-pup bond in mice and rats. Infant killing behavior.
5. Pecking behavior of chickens. Hiding behavior of chicks.
6. Observation of birds' nests and study of parental behavior, altruistic behavior in monkeys.

Recommended Texts

1. Dngatkin, L. A. (2012). *Principles of animal behavior*. New York: Nortan & Co.
2. Alcock, J. (2010). *Animal behavior, an evolutionary approach* (9th ed.). Sinauer Publishers.

Suggested Readings

1. Scott, G. (2005). *Essential animal behavior*. New York: Blackwell Publishers.
2. Goodenough, J., McGuire, B., & Wallace, R. A. (2009). *Perspective on animal behavior*. New York: John Wiley & Sons.

Paper XIII **Bioinformatics** **(75+25=100)**

The course will provide an introduction to bioinformatics with a focus on fundamental bioinformatics problems and information on the tools used to compute solutions to those problems, and the theory upon which those tools are based. This involves algorithm, and storage/database development of genomics data. It also describes the different types of data found at the NCBI and EBI resources. This course has three main objectives i.e. to organize vast reams of molecular biology data in an efficient manner, to develop tools that aid in the analysis of such data, and to interpret the results accurately and meaningfully. The advent and rapid rise of bioinformatics has been due to the massive increases in computing power and laboratory technology in recent years. These advances have made it possible to process and analyze the digital information regarding DNA, genes and genomes. A student completing Bioinformatics paper will be able to apply it for problem-solving skills, including the ability to develop new algorithms and analysis methods.

Contents

1. Introduction to bioinformatics: Concept, history, uses, comparison with other experimental tools.
2. Basic principles of computing in bioinformatics: basic acquisition and database: DDBJ, NCBI and EMBL
3. Short introduction to DNA, RNA and protein: amino acids structure & sequence, analyzing protein sequence by the use of bioinformatics tools, sequence-structure-function.
4. Retrieving protein sequences from database (FASTA): alignment of protein\ nucleotide sequences (BLAST, CLUSTALW), computing physico-chemical parameters of proteins (PROTPARAM), Predicting elements of secondary structure of proteins (e.g. PSSP), Retrieval, understanding and predicting 3D structure of protein from sequence, PTMs (e.g NETPHOS etc.)
5. Enzyme classification: retrieval databases
6. Retrieving the DNA sequence from database, computing the sequence, identifying restriction sites, predicting elements of DNA/RNA secondary structure, computing the optimal alignment between two or more DNA sequences
7. PRIMER designing for PCR (PRIMER3+, PRIMER-BLAST, OLIGO-CALC etc.)
8. Short introduction to proteomics and genomics, and the role of bioinformatics in the pharmaceutical industry.

Practical

1. Retrieval of FASTA sequence
2. Determination of proteins physical and chemical parameters
3. Finding similar sequences for protein and DNA
4. Multiple alignment
5. Predicting proteins secondary structure
6. Predicting RNA secondary structure
7. Predicting protein PTM
8. Finding protein families
9. Determination of gene location on chromosome
10. SNPs
11. Primer design

Recommended Texts

1. Selzer, P. M., Marhofer, R. J., & Kock, O. (2018). *Applied bioinformatics: an introduction.* Germany: Springer Publishing.
2. Lesk, A. (2019). *Introduction to bioinformatics* (5thed.). Oxford University Press.

Suggested Readings

1. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). *Bioinformatics: methods and applications: Genomics, proteomics and drug discovery*. PHI Publishing.
2. Primrose, S. B., & Twyman, R. M. (2004). *Genomics: applications in human biology.* Willey-Blackwell.
3. Krane, D. E., & Raymer, M. L. (2002). *Fundamental concepts of bioinformatics.* Benjamin Cummings.

Paper XIV **Biodiversity and Wildlife** **(75+25=100)**

The objective of this course is to enable the student to understand philosophy and significance of wildlife conservation, understand the wildlife management rules and regulations in Pakistan and to understand how national and international agencies are involved in conservation and management of wildlife. Students will be able to apply knowledge to solve problems related to wildlife conservation and management. They will learn about the biodiversity of amphibians, reptiles, birds and mammals, along with the wildlife and its distribution in different major eco zones of Pakistan. The major aims of the subject include knowing what type of wildlife exist in Pakistan and its biodiversity, moreover, how wildlife is being secured in Pakistan. After this course students will become able to participate in wildlife census. The practical section will cover the mammal's population Census Techniques, ecological indices and procedures for studying species richness, simpson index, shannon and wiener function.

Contents

1. Biodiversity: definition, types, levels, status of biodiversity, importance.
2. Natural resources and biodiversity: ecological aspects, impacts, loss of biodiversity, protection/conservation of biodiversity.
3. Wildlife: Introduction, important wild animals of Pakistan, wildlife importance, wildlife management.
4. Eco zones of Pakistan: wildlife and its distribution in different major eco zones of Pakistan.
5. Wildlife census techniques: modern census techniques for mammals and birds, diversity indices.

Practical

1. Procedures for studying species richness, simpson index, shannon and weiner function.
2. Population of some local subterranean animals.
3. Bird's population Census Techniques.
4. Mammal's population Census Techniques.
5. Study of wildlife habitats.

Recommended Texts

1. Kumar, U., & Asija, M. J. (2002). *Biodiversity: principles and conservation.* Crescent News.
2. Starr, C., & Taggart, R. (2005). *Biology: the unit and diversity of life* (11th ed.). Cengage Learning.

Suggested Readings

1. Smith, R. L., & Smith, T. M. (2000). *Ecology and field biology* (6th ed.). USA: Benjamin Cummings.
2. Ali, S. S. (1999). *Palaeontology, zoogeography and wildlife management.* Hyderabad, Pakistan: Nasim Book Depot.
3. Roberts, T. J. (1997). *The mammals of Pakistan.* Oxford University Press.

Paper XV **Biology of Spiders** **(75+25=100)**

This course aims to provide knowledge about spiders, their morphology, anatomy, behavior and physiology along with their role in agro-ecosystem. This course will introduce with the fascinating world of spiders and their relatives. Students will learn about many aspects of their biology, especially their ecology, behavior, and evolution. This one is a comprehensive course highlighting the biology of spiders (Order Araneae) including their functional anatomy, senses and perception, behavior, webs and web-building, identification, classification and relationships, field techniques, and ecology. This course will provide advanced knowledge to students to the study of spiders. After successful completion of the course they will be able to appreciate the diversity and relationships among spiders, understand the functional anatomy of spiders, become proficient in advanced spider identification, learn to conduct field study of spiders using standard techniques, learn to recognize and understand common spider behaviors and can design and conduct their own research project.

Contents

1. An introduction to spiders: mygalomorphea, chelicerae, spinnerets,
2. Functional anatomy: prosoma, opisthosoma,
3. Metabolism: hemolymph, book lungs, hemocyanin,
4. Neurobiology: Sub-esophageal ganglion,
5. Cupiennius,
6. Spider webs: cribellum, linyphiids, spider silk,
7. Locomotion and prey capture: callilepis, bombardier beetles, argiope,
8. Reproduction: palps, haplogynae, cocoon,
9. Development: automized, cheliceral, molting,
10. Ecology: ant mimicry, stridulation,argyrodes,
11. Phylogeny and systematics: synapomorphies, cribellum, mygalomorphae.

Practical

1. collection, preservation and identification of spiders.
2. Preparation of slides of genitalia, measurement, drawings and description.
3. Study of various systems.

Recommended Text

1. Foelix, R. F. (1996). *Biology of spiders.* Oxford University Press
2. Barth, F. G., & Biederman T. A. (2001). *A spider's world: senses and behavior.* New York: Springer Verlog.

Suggested Readings

1. Wise, D. H. (1995). *Spiders in ecological webs.* Cambridge University Press.
2. Sebastian, P. A., & Peter, K. V. (2009). *Spiders of India.* India: University Press Pvt. Ltd.

Paper XVI **Comparative Developmental Biology** **(75+25=100)**

This course is designed to provide information on transmission of traits from the parents into their gametes, to deliver the foundation knowledge of zygote and its development, to impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction and to clear the understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. Students will learn how developmental biology is having a significant impact on our understanding of modern molecular techniques and uses of transgenic animals in developmental biology. The students will be able to understand and compare basic principles of embryology through understanding the embryonic adaptations with help of morphology and anatomy of embryos of different vertebrates. The practical section will enable them to go through study of prepared slides for the development of amphioxus, mammals, frog and chick isolation, identification and culture of various developmental stages of *Ascaris lumbricoides* eggs and to know about the dactylography and its uses in developmental biology.

Contents

1. Historical review of embryology.
2. Uses of modern molecular techniques in developmental biology.
3. Origin of germ cells (gametogenesis).
4. Spermatogenesis & oogenesis, structure and organization of male and female gametes.
5. Fertilization: chemistry of fertilization, molecular biology of fertilization, surface changes in the egg and sperm surface, In vitro fertilization (test tube technology).
6. Mono- & di-zygotic twinning, parthenogenesis, uses of transgenic animals in developmental biology, cleavage, blastulation, fate maps and their preparation, morphogenetic movements and gastrulation in amphioxus, mammals, chick and frog.
7. Stem cells technology and its uses in developmental biology.
8. Embryonic adaptations (fetal extra-embryonic membranes) and placentation, umbilical cord, parturition (birth) and its stages.
9. Regeneration and regenerative powers of vertebrates.
10. Aging

Practical

1. Study of eggs of different invertebrates and vertebrate's representative animals.
2. Dactylography and its uses in embryology.
3. Isolation, identification and culture of various developmental stages of Ascaris lumbricoides eggs from human/ Neoascaris vituolarum eggs from cattle dung (kept for 3 weeks at 240°C in desiccator) by using Tillman's centrifugation technique.
4. Study of prepared slides for the development of amphioxus, mammals, frog and chick.
5. Semen analysis by using improved neubar hemocytmeter

Recommended Texts

1. Scott, F. G. (2010). *Developmental biology* (9th ed.). New York: Sinauer Publishing Co.
2. Patten, B. N. (2004). *Foundation of embryology.* New York: McGraw Hill Books Company, Inc.

Suggested Readings

1. Rao, K. V. (2003). *Developmental biology: a modern synthesis.* Delhi: Oxford publishing Co. Ltd.
2. Oppenheiner, S. B., & Lefevre, G. (1984). *Introduction to embryonic development.* New York: Allen and Bacon Publishers.
3. Saddler, T. W. (1995). *Langmans medical embryology.* USA: Library of congress Cataloguing-in-Publication Data. Williams & Wilkins Publishers.
4. Carlson, B. M. (2001). *Patten's foundations of embryology* (6th ed.). New York: McGraw-Hill, Inc.

Paper XVII **Endocrinology** **(75+25=100)**

Endocrinology course is designed to impart knowledge about endocrine glands, their anatomy, hormonal released from them and the physiological role of these hormones in body. Endocrinology involves the evaluation and management of disorders of the body's glands, hormonal secretions, and resultant changes in body metabolic activity. The course will provide baseline informations about the structures and function of endocrine glands. It will also provide the understanding of the common endocrine disorders, metabolic regulations, and metabolic abnormalities along with their management. Furthermore, it will clarify the knowledge how hormones influence the metabolism of nucleotides, proteins, lipids, carbohydrates, vitamins, water, and therefore, knowledge of endocrinology and metabolism is important. The students will get the perfect idea of the endocrine system in terms of structure, function and its role in regulating metabolism, growth and reproduction in different animals, with reference to some disorders resulting from endocrine dysfunctioning. By the end of this course, the students will be able to examine and describe glands and can determine hormonal impact and syndromes.

Contents

1. 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.
2. Hypothalamic hormones their origin, chemistry and actions, anterior pituitary & 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.
3. Anatomy and histology of thyroid gland, formation and secretion of thyroid hormones, thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.
4. Calciotropic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferol, homeostasis of calcium, phosphate and magnesium.
5 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.
6. Adrenal medulla and catecholamines: chromaffin cell and organization, structure of adrenal medulla, biosynthesis, storage, release and metabolism, adrenergic receptors.
7. Adrenal cortex: steroid biochemistry, physiological actions of corticoid hormones, regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.
8. Testes: androgenic tissue: structure and chemistry, transport, metabolism and mechanism of action.
9. Ovaries: ovarian hormones: steroid biochemistry and biosynthesis, transport, metabolism and mechanism of action.
10. Endocrinology of pregnancy: hormones in conception and implantation, hormonal actions and adaptation in pregnancy and parturition.
11. Endocrinology of lactation: hormones in lactation.
12. Endocrinology of heart, kidney, immune system: growth and pineal gland.
13. Functional diversity of hormones in vertebrates.

14. Overview of endocrine mechanisms in invertebrates.

Practical

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc.
2. Histological and ultra-structure features of endocrine glands,
3. Experiments to demonstrate physiological roles of hormones of different endocrine glands,
4. Experiments to demonstrate regulation of hormones' releases.
5. Experiments to demonstrate functional diversity of hormones in different vertebrates.
6. Experiments on endocrine mechanism in vertebrates.

Recommended Texts

1. Greenspan, F. S., & Strewler, G. J. (2002). *Basic and clinical endocrinology* (5th ed.). London: Prentice Hall International Inc.
2. Wilson, J. D., Foster, D. W., Kronenberg, H. M., & Larsen, P. R. (2008). *William's textbook of endocrinology*. Philadelphia: W.D. Saunders Company.

Suggested Readings

1. DeGroot, L. J., & Jameson, J. L. (2001). *Endocrinology* (4th ed.). Philadelphia: W.B. Saunders.
2. Giffin, J. E., & Ojeda, S. R. (2000). *Textbook of endocrine physiology* (4th ed.). Oxford University Press.

Paper XVIII **Entomology-I** **(75+25=100)**

The course is designed to impart knowledge about morphology and body parts of the insects. The main objective of the entomology course is to provide students with a broad-based education in the science and practice of entomology. This course can establish an understanding about insect identification, structure, and function. It includes general characteristics of insects, their modes of ingestion, relationship with other arthropods and evolutionary study of insects splitting up into different evolutionary lines. This subject also imparts knowledge about ecology of insects by learning carrying capacity 'r' and k selection, food chains, predation and competition, diapause insect population and community studies and insect communication. The practical section will enable the students to prepare permanent slides, distinguish the several body parts (antennae, mouth parts, wings, legs, terminal segments and genitalia) of insects, can study the different systems, especially digestive, reproductive of the insect and be able to address complex problems facing entomology.

Contents

1. General characteristics of insects. relationship with other arthropods, splitting up into different evolutionary lines, reasons for success of the insects in diverse environments.
2. Hard Parts: general segmentation, tagmatosis and organization.
3. Cuticle: detailed structure along with its biochemistry. colors of insects. cuticular outgrowths and appendages sclerotization.
4. Head: cephalization, sclerites, modifications.
5. Antennae: different modes of ingestion and types of mouth parts.
6. Neck: sclerites.
7. Thorax: Sclerites: legs, their different modifications and functions.
8. Wings: origin, different regions. development and basal attachments, main veins and their branches (generalized insects), wing coupling.
9. Abdomen: secondary appendages and external genitalia, flight, types of flight. aerodynamics, fuels, endoskeleton, head, thorax and abdomen.
10. 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.
11. Sense organs: sound and light producing organs.
12. Nutritive requirements: fat body, exocrine and endocrine glands including pheromones and their functions.
13. Reproduction: reproductive organs and different types of reproduction in insects, egg fertilization and maturation.
14. Development: embryology up to dorsal closure, different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.
15. Ecology: carrying capacity 'r' and k selection, food chains, predation and competition, insect defenses and adaptations, diapause insect population and community studies, insect communication.

Practical

1. Preparation of permanent slides.
2. Study of all the hard parts (antennae, mouth parts, wings, legs, terminal segments and genitalia).
3. Study of systems, especially digestive, reproductive of the following insects.

4. American cockroach, gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle.
5. Red cotton bug.
6. Wasp and honey bee.
7. Sympathetic nervous system of cockroach and gryllus.
8. Salivary glands of cockroach, red cotton bug and honey bee.

Recommended Texts

1. Richards. O. W., & Davies, R. G. (1977). *Imm's general textbook of entomology* (10th ed.). London: Chapman & hall.
2. Chapman, R. F. (2013). *The insects: structure and function* (5th ed.). Cambridge University Press.

Suggested Readings

1. Wigglesworth, V. B. (2012). *The principles of insect physiology.* Springer Science & Business Media.
2. Tembhare, D. B. (2002). *Modern entomology.* India: Himalaya Publishing House.
3. Henderson, P. A., & Southhood, T. R. E. (2016). *Ecological methods*. UK: Wiley Blackwell.
4. Peterson, P. G. (2018). *Elements of insect ecology.* Ed- Tech Press.

Paper XIX **Entomology-II** **(75+25=100)**

Entomology is both a basic and an applied science which deals with the study of insects and their effects upon the health, economy, and welfare of humankind. The basic objective of teaching this subject is to acquaint students with the science and practice of entomology. After studying this course, students can classify the insects up to orders level. It also includes diagnostic characters of the insect orders, knowledge about insects of economic importance and brief account of biological control, chemical control and integrated pest management. This subject also imparts knowledge about common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary of insects. Moreover, some brief account on household pests and their management and knowledge of pests of cotton, rice and sugarcane will also be the part of learning. The practical section will enable the students to collect, preserve and identify insects up to families and can have core knowledge of entomology.

Contents

1. A general account including classification of insect orders: collembola, orthoptera, dictyptera, isoptera, hemiptera, lepidoptera, diptera, hymenoptera, coleoptera.
2. Only diagnostic characters of the remaining insect orders: thysanura, diplura, protura, ephemeroptera, odonata, plecoptera, grylloblattoidea, phasmida, dermaptera, embioptera, zoraptera,psocoptera,mallophaga,siphunculata, thysanoptera, neuroptera, meco- ptera, tricoptera, siphonaptera, strepsiptera,
3. Economically important insects
4. Brief account of biological control, chemical control and integrated pest management, common sampling techniques in insect pest management
6. Concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold.
7. Household pests and their management, knowledge of Pests of cotton, rice, sugarcane.

Practical

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

Recommended Texts

1. Pedigo, L. P., & Rice, M. E. (2015). *Entomology and pest management* (6th ed.). Waveland Press.
2. Richards, O. W., & Davies, R. J. (1977). *Imm's general textbook of entomology* (10th ed.). London: Chapman & Hall.

Suggested Readings

1. Metcalf, C. L., & Flint, W. P. (2018). *Destructive and useful insects: their habits and control.* Agri Horti, Press.
2. Richards, O. W., & Davies, R. J. (1977). *Imm's general textbook of entomology* (10th ed.). London: Chapman & Hall.

Paper XX **Environmental Issues** **(75+25=100)**

This course is designed to pinpoint and discuss the different environmental issues including ecological, conservation, pollution, resource maintenance, population and socioeconomic issues of Pakistan. To impart knowledge about management and planning issues using case studies will also be part of this course. The environmental study prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. In this subject students will learn about environmental and social impacts of growing population and affluence by addressing population problems, food production and its distribution, integrated pest management and several types of pollution with their impact on human life and their combating strategies. The students will also have knowledge about major atmospheric changes due to acid deposition, global warming, greenhouse effect and ozone depletion. Energy sources and issues related to fossil fuel usage and nuclear power will also be discussed along with the alternate energy resource identification.

Contents

1. Human population explosion, environmental and social impacts of growing population and affluence, addressing population problems
2. Food production and its distribution: hunger, malnutrition and famine
3. Pest and pest control: need and approach to pest control, integrated pest management.
4. Water pollution: human impact on water resources, eutrophication, combating eutrophication.
5. sewage pollution: sewage hazards and sewage managements.
6. Hazardous chemical pollution: nature of chemical risks, pollution sources and control.
7. Major atmospheric changes: acid deposition, global warming/cooling, greenhouse effect, ozone depletion.
8. Solid waste management: landfills, incineration, management and solutions.
9. Energy resources: Energy sources and uses, issues related to fossil fuel and nuclear power, Alternate energy resources.
10. Environmental issues in Pakistan: ecological issues: soil erosion, deforestation, issues related to irrigation system, natural hazards. issues related to conservation of habitat and biodiversity: major threats to biodiversity in Pakistan, conservation strategies. industrial pollution: sources and remediation.
11. Population issues: socio-economic issues in Pakistan.

Practical

1. Study of the various characteristics of the population with the help of the statistical data (Age profile, family size and educational status, etc.).
2. Study of the types of the commonly used pesticides and their characteristics.
3. Study of the relationship between relative humidity and temperature of Lahore for a particular time period.
4. Estimation of total particulate matter in air by using air sampler.
5. Determination of sodium and potassium in various water samples using flame photometer.
6. Determination of chromium, lead and copper in industrial effluent.
7. To study the urban environment and urban environmental issues.
8. To study the eutrophic conditions in various ponds.

9. To study noise level at different places in city (main road crossings, railway station, hospital) using noise level meter.
10. To study the level of occurrence of various diseases among families of (i) Class students (ii) Low income groups (iii) High income groups.

Recommended Texts

1. Botkin, D. B., & Keller, E. A. (2000). *Environmental science: earth as a living planet* (3rd ed.). New York, USA: John Wiley and Sons Inc.
2. Wright, R. T., & Nebel, B. J. (2008). *Environmental science* (10th ed.). Pearson Prentice Hall

Suggested Readings

1. Bradbury, I. K. *(1999). The biosphere* (2nd ed.). Wiley.
2. Ahmad, R. Z. (2000). *Pakistan- a descriptive atlas: a comprehensive geo-politics course* (1st ed.). Lahore, Pakistan: Feroze sons Pvt. Ltd.
3. Khan, F. K. (1993). *A geography of Pakistan environment (environment, people and economy).* (1st ed.). New York, USA: Oxford University Press.
4. Daily newspapers for current issues.

Paper XXI **Fish Culture** **(75+25=100)**

To disseminate the history, needs and importance of fish culture this course is prepared. It will help to elaborate the basic components of pond fish culture and describe the cultivable fish species and their biology. It imparts knowledge regarding pond fertilization and feeding of fish. This course conveys knowledge about evolution of fish culture, planning and construction of fish pond, water quality criteria, and conditions suitable for fish culture and biological production cycle of fish pond. Moreover, students will have information regarding fertilization of fish pond, organic and inorganic fertilizers used for fish culture. At the end of course students will be able to describe food and feeding habits of fish, integrated fish farming, fish diseases and remedial measures. Research and management in fisheries are highly quantitative endeavors. The practical section will enable the graduates to learn about the Identification of various fishes and induced fish breeding. This course will contribute to fish culture development in Pakistan.

Contents

1. Aims and evolution of fish culture, culturable fishes of Pakistan.
2. Pond fish culture: planning and construction of fish pond, water quality criteria, conditions suitable for fish culture, biological production cycle of fish pond.
3. Fertilization of fish pond: organic and inorganic fertilizers, artificial feeding in fish culture: fish feeding methods, different components of fish feed, composition of commonly available feed ingredients, preparation and feed storage methods.
4. Integrated fish farming: concepts and practices, Fish hatchery management.
5. Fish enemies, fish diseases and remedial measures.
6 Fishing gears, pre- and post-harvesting care of fish, maintenance of fish catch quality during transportation, storage and marketing, fish processing technology.

Practical

1. Uses of different organic and inorganic fertilizers in fish ponds
2. Identification of various fishes
3. Study of morphological characters and identification of culturable fish species
4. Practical demonstration of induced fish breeding

Recommended Text

1. Sharma, O. P. (2009). *Handbook of fisheries and aquaculture.* India: Agrotech Publishing Academy.
2. Hart, P. J. B., & Reynolds. J. D. (2008). *Handbook of fish biology and fisheries* (Volume 2). New York, USA: Blackwell Science Ltd.

Suggested Readings

1. Horvaph, L. G., & Tanes, C. (2002). *Seagrave carp and pond fish culture.* New York, USA: Fishing News Book.
2. Huet, M. (1998). *Textbook of fish culture, breeding and cultivation of fish.* London, UK: Fishing News.

Paper XXII **Fish Physiology and Breeding** **(75+25=100)**

The course presents an introduction to physiological adaptations in fish in relation to their environment. The objective of this course is to provide information about better growth during extensive or semi-intensive culture, to impart knowledge about breeding of most culturable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons. The course offers an introduction to physiological adaptations in fish in relation to their environment. An important part of the course relates to functional physiological regulatory mechanisms. The course is adapted to a focus of fish physiology and breeding. The course focuses on physiological processes in fish including respiration, circulation, acid-base balance, osmoregulation and ionic regulation, swimming and buoyancy, sensory physiology, egg and larval physiology, digestion, energetics and growth, reproduction, fish health and diseases. In the end of the course the students will also have knowledge of fish migration (to nursery ground, to maturation grounds, freshwater to marine water, marine water to freshwater) and fish behavior (learning and memory, light response for maturation, courtship behavior, aquarium fish behavior).

Contents

1. Fish nutrition: digestive system, stomach less fishes, stomach fishes, digestion and absorption, food, plant origin, animal origin, feeding, fresh food, dry concentrates, pelleted food
2. Transportation: blood, blood cells (erythrocytes, leukocytes, platelets and plasma), circulation, arterial system, venous system, capillaries, transport of food material.
3. Respiration: gills, lungs, skin, swim bladder, homeostasis
4. Excretion: kidneys, hypo-osmotic urine, hyper-osmotic urine, osmoregulation
5. Reproduction: gonads, testes and ovaries, maturation, reproductive cells (egg and sperm), artificial fertilization of sex cells.
6. Breeding: natural (seasonal), artificial, hormonal induced breeding, temperature & photoperiod, control induced breeding
7. Growth: extensive culture (due to the consumption of natural food), semi intensive culture (due to natural & artificial food), intensive culture (due to only dry concentrates)
8. Fish health: water quality, hygiene of fish culture facilities, hygiene of equipment used in fish culture
9. Diseases and their control: viral, bacterial, fungal, parasitic, protozoan, helminths (trematodes, cestodes, nematodes, acanthocephalons), crustaceans (cladocera), annelids (leeches), arthropods (water ticks, water flea, water mites)
10. Fish migration: to nursery ground, to maturation grounds, freshwater to marine water, marine water to freshwater
11. Fish behavior: learning and memory, light response for maturation, courtship behavior, aquarium fish behavior

Practical

1. Study of gut contents.
2. Study of feeding modification and adaptation in fish.
3. Study of respiratory adaptation in fish.
4. Study of blood cells and their counts in normal and diseased fish.
5. Study of water quality parameters (DO, NH_3, hardness, alkalinity, turbidity, transparency, temperature, salinity).

6. Study of various forms of swim bladder as hydrostatic organ.
7. Study fecundity of various fish species.
8. Study the effects of reproductive hormone (GnRH) on fish maturation.
9. Diagnosis of bacterial infection in infected fish.
10. Study of fish parasites.
11. Visit to various fish seed hatcheries during breeding seasons.

Recommended Texts

1. Kestin, S. C., & Warris, P. D. (2002). *Kestin farmed fish quality*. UK: Blackwell Science, oxford.
2. Saksena, D. N. (1999). *Ichthyology: recent research advances*. India: Oscar Publications.

Suggested Readings

1. Stickney, R. R. (2016). *Aquaculture* (3rd ed.). CABI.
2. Maseke, C. (1987). *Fish aquaculture*. UK: Pergamon Press, Oxford.
3. Huet, M. (1973). *Text book of fish culture: breeding and cultivation*. Blackwell Publishing Company.
4. Gorbman, A. (1983). *Comparative endocrinology* (1st ed.). UK: John Wiley & Sons.

Paper XXIII **Hematology** **(75+25=100)**

This course provides knowledge about blood formation, morphology, physiology and biochemistry of blood cells, basic mechanisms and types. This course offers detailed knowledge about the functional morphology of blood cells (normal and abnormal), how important blood diseases manifest, and the approaches to diagnosis and treatment of blood and clotting diseases. It conveys knowledge about advanced techniques in studying serological and hematological techniques, blood coagulation. By the end of this course the student will be able to demonstrate an understanding of the components of human blood and characteristics, functions, and abnormalities and disease states of each and can demonstrate proficiency in the skills necessary to perform blood cell counts, and evaluation of blood elements within stated limits of accuracy. After the laboratory practice they will be able to apply principles of safety, quality assurance and quality control in hematology, can compare and contrast hematology values under normal and abnormal conditions and can evaluate normal and abnormal cell morphology with associated diseases.

Contents

1. Blood formed elements and Plasma.
2. Erythropoiesis and general aspects of anemia, hyper chromic anemia and iron overload and Iron deficiency anemia, Vitamin B 12 deficiency anemia
3. Megaloblastic anemia and other meroblastic anemia
4. Blood collection techniques, anticoagulants, hemolytic anemia
5. Structure, types and genetic disorders of hemoglobin, Leukopoiesis
6. General description of leukemias, lymphocytes, monocytes, granulocytes (their benign disorders).
7. Platelets and thrombopoeisis
8. Blood coagulation and hemostasis, bleeding disorders caused by vascular and platelet disorders.

Practical

1. Blood smear of different vertebrates to compare the RBCs morphology.
2. Total erythrocyte and leucocyte counts.
3. Differential leukocytes.
4. Estimation of hemoglobin & study of erythrocytes sedimentation.
5. Comparison of blood counts of diseased (Anemia) and healthy individuals.
6. Morphological alterations in erythrocytes in various disease conditions like sickle cell anemia etc.

Recommended Texts

1. Hoffbrand, A.V., & Hoffbrand, I. E. (2002). *Essential hematology*. Peltit & PAH Moss.
2. Bain, B. J., Bates, I., & Laffan, M. A. (2016). *Dacie & Lewis practical haematology* (12th ed.). Elsevier Health Sciences.

Suggested Readings

1. Seiverd, C. E. (1983). *Hematology for medical technologists*. Philadelphia, PA: Lea & Febiger.
2. Mazza, J. J. (2002). *Manual of clinical hematology*. Lippincott Williams & Wilkins.

Paper XXIV **Immunology** **(75+25=100)**

The course aims to clarify the understanding about the basic concepts of immunology and its importance in biological sciences, to provide information about immunological mechanisms against different diseases and to give understanding of immunization, immunological tolerance. After this course the students will be able to understand immunobiology, immunophysiology and immunopathology. Have brief account on natural and acquired immunity, active and passive immunity, antigens and elicitation of immune responses. The students will be able to describe immunological response and how it is triggered and regulated. This subject also focuses on detection and application of antigen-antibody reactions, antigen antibody interactions and monoclonal antibodies. Cellular basis of immune response will also be discussed in detail along with the immunological tolerance and autoimmunity. The students will be able to describe immunological response and how it is triggered and regulated. Therefore, finally students will be able to demonstrate a capacity for problem-solving about immune responsiveness.

Contents

1. Immunology: immunobiology, immunophysiology, immunopathology.
2. Immunity: Natural and acquired immunity, active and passive immunity.
3. Antigens and elicitation of immune responses: antigens and their types, antigenicity and immunogenicity, factors important for immunogenicity of an antigen, cell mediated and humoral: nature of antigens, genetic constitution of individuals and route of administration.
4. Immunoglobulins: synthesis of antibodies, theories of antibodies synthesis. types of antibodies
5. Detection and application of antigen-antibody reactions: In vivo and In vitro reactions.
6. Antigen antibody interactions
7. Monoclonal antibodies: importance, synthesis, isolation and applications. major histocompatibility complex: types and importance, diversity in MHC proteins.
8. Cellular basis of immune response: origin of lymphocytes, primary and secondary lymphoid organs, specific response of individual lymphocytes to antigenic stimulation, histological features of immune response.
9. Hypersensitivity: immediate hypersensitivity (anaphylaxis, antibody dependent cytotoxicity, immune-complex mediated disease and stimulatory hypersensitivity), delayed type or cell mediated hypersensitivity.
10. Immunological tolerance and autoimmunity: tolerance, autoimmune diseases and types, factors responsible for autoimmunity. transplantation immunology, tumor immunology, immunity against infectious diseases, immuno deficiency diseases, immunity and malnutrition. immunization, immunization procedures, vaccines and their types.

Practical

1. Study of different types of leucocytes in blood, bone marrow, spleen and thymus in mammals.
2. Estimations of total serum proteins, albumins and globulin concentrations in mammalian blood.
3. Differentiation of globulin proteins in blood serum of mouse by electrophoresis.
4. Diagnosis of immunoglobulin proteins by enzyme linked immunosorbent assay (ELISA).
5. Isolation of lymphocytes and resetting technique.
6. Antigen-antibody reaction by agglutination and precipitation reaction.
7. Antigen antibody reaction by using adjuvant.
8. Diagnosis of typhoid fever by Widal test.

9. Visit to pathological laboratory and report writing.

Recommended Texts

1. Richard, A., Thomas, J., Kindt, T., & Barbara, A. (2013). *Kuby's immunology* (6th ed.). New York: W.H. Freeman & Company.
2. Delves, P., Martin, S. J., Burton, D. R., & Roitt, I. V. (2011). *Roitt's essential immunology* (12th ed.). John Wiley & Sons.

Suggested Readings

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (1994). *Cellular and molecular immunology*. Elsevier Health Sciences.
2. Stites, D. P., Stobo, J. D., Fudnberg, H. H., & Wells, J. V. (1991). *Basic and clinical immunology*. USA: Lange Medical Publications.

Paper XXV **Integrated Pest Management** **(75+25=100)**

The course aims to impart knowledge about approaches to control pest in an integrated manner. It will develop the understanding of multipronged strategies to control various pests of human interest. This course will provide introduction, historical background and geographical distribution of various insect species along factors that makes them pest. Available biological pest control, their identification and distribution will be introduced through this learning's. Students will be given knowledge about biological features and varieties of biological mediators to control insect pests. Theoretical foundation of pest control will be highlighted. Moreover, it includes opportunities and challenges for insect pest control in developing countries, concept of economic threshold level and concept of classical biological control. Understanding about recent strategies which are in practice nationally or internationally to manage pests will be given to students. Several techniques which are commercially used for rearing of biological pest control agents including culturing of bacteria and virus will be familiarized.

Contents

1. Introduction. approaches and objectives, past and present. theoretical foundation of pest control.
2. Opportunities and challenges for insect pest control in developing countries.
3. Concept of economic threshold level, economic injury level, economic damage and boundary.
4. Major threats to the natural enemies, ranking of natural enemies.
5. Concept of classical biological control.
6. Effects of different agronomic practices and habitat structure on the population dynamics of predators. Relationship of biological control to the sustainable agriculture.
7. Augmentation and inoculation of natural enemies, conservation of existing natural enemies.
8. Limitation of biological control and modern trends to overcome this problem.

Practical

1. Collection and identification of important pests and their enemies,
2. Techniques to culture and maintain selected natural enemies of insect pests in the laboratory and in the fields.

Recommended Texts

1. Bradford, A. H., & Howard V. C. (2008). *Theoretical approaches to biological control.* New York: Cambridge University Press.
2. DeBach, P. (1991). *Biological control by natural enemies* (2nd ed.). MA: Cambridge University Press.

Suggested Readings

1. Dent, D. (2005). *Insect pest management* (2nd ed.). UK: CABI.
2. Pedigo, L. P., & Rice, M. E. (2015). *Entomology and pest management* (6th ed.). Waveland Press.
3. Van Driesche, R. G., & Bellows, T. S. Jr. (2012). *Biological control.* Springer Science & Business Media.

Paper XXVI **Microbiology-I** **(75+25=100)**

Microbiology is the study of microorganisms which include: bacteria, viruses, viroid, yeast, molds, protozoans, algae, fungi and other very small organisms. Microbiology is important because it helps us to understand and treat diseases. This course covers basic principles of microbiology and provides an introduction to the characterization and classification of microorganisms and cultivation of bacteria. Students are expected to gain a fundamental understanding of microbes including viruses, bacteria, archaea and eukaryotic microorganisms. After completion of the lecture component of the course, successful students will be able to understand morphology and fine structure of bacteria, cultural characteristics and microbial metabolism processes. It will also help students to appreciate the diversity of microorganisms and microbial communities and recognize how microorganisms solve the fundamental problems their environments present. The laboratory practice can help them to study of bacteria, fungi and protozoa, staining techniques and can apply scientific method to collect, interpret, and present scientific data in microbiology and related fields.

Contents

1. The beginnings of Microbiology.
2. Microscopic examination of microorganisms.
3. Characterization and classification of microorganisms.
4. Morphology and fine structure of bacteria.
5. The cultivation of bacteria. pure cultures and cultural characteristics
6. Reproduction and growth of bacteria. Microbial metabolism.

Practical

1. Study of bacteria, fungi and protozoa.
2. Staining of microorganisms: simple staining, negative staining.
3. Demonstration of special structures by stains, capsular stain, spore stain, metachromatic granule stain, acid fast stain, flagella stain.

Recommended Texts

1. Benson, H. J. (2002). *Microbial applications: laboratory manual in general microbiology* (8th ed.). London: McGraw-Hill.
2. Pelczar Jr., Chan, E. C. S., & Krieg, M. R. (2010). *Microbiology: application based approach.* London: McGraw Hill.

Suggested Readings

1. Madigan, M. T. (2009). *Brock biology of microorganisms* (12th ed.). Pearson/Benjamin Cummings.
2. Stainier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1986). *The microbial world.* London: Prentice Hall.

Paper XXVII **Microbiology-II** **(75+25=100)**

The course aims to develop knowledge about phylogeny of bacteria, their mode of nutrition and their diversity. The course will impart knowledge about phylogenetic relationship of the bacteria with other prokaryotes. Microbiology is important because it clears the understanding about the biology and physiology of microbes that can be helpful in the treatment of diseases. This course covers basic evolutionary linage of bacteria (proteobacteria). Students are expected to gain a fundamental understanding of phototrophic, chemolithotrophic and methanotrophic proteobacteria, aerobic and facultatively aerobic chemoorganotrophic proteobacteria and morphologically unusual proteobacteria. After completion of the lecture component of the course, successful students will be able to understand the structural similarities and differences among delta and epsilon proteobacteria, firmicutes, mollicutes and actinobacteria. It will also help students to appreciate the diversity of cyanobacteria and prochlorophytes and can recognize how microorganisms solve the fundamental problems their environments present. Practical knowledge will equip students with culturing techniques as well.

Contents

1. Bacterial physiology.
2. The phylogeny of bacteria, Phototrophic, chemo lithotrophic and methanotrophic proteobacteria, aerobic and facultatively aerobic chemoorganotrophic proteobacteria, morphologically unusual bacterial classes
3. Cyanobacteria and prochlorophytes, chlamydia, the planctomycetes, verrucomicrobia, flavobacteria and acidobacteria, cytophaga group, green sulfur bacteria, spirochetes, dienococci, the green non sulfur bacteria, hyperthermophillic bacteria, nitrospira and deferribacter,
4. Diversity of archea, euryarchaeota, crenarchaeota.

Practical

1. Culturing of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates.
2. Isolation and stock culturing of bacteria, quantitative plating method.
3. The turbid metric estimation of microbial growth.
4. Study of bacterial viruses & biochemical characterization of bacteria.

Recommended Texts

1. Madigan, M. T. (2009). *Brock biology of microorganisms* (12th ed.). Pearson/Benjamin Cummings.
2. Benson, H. J. (2002). *Microbial applications: laboratory manual in general microbiology* (8th ed.). McGraw-Hill.

Suggested Readings

1. Pelczar Jr., Chan, E. C. S., & Krieg, M. R. (2010). *Microbiology: application based approach.* London: McGraw Hill.
2. Stainier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1986). *The microbial world.* London: Prentice Hall.

Paper XXVIII **Molecular and Clinical Endocrinology** **(75+25=100)**

The course is designed to develop understanding of molecular mechanisms of hormonal action, their molecular assessment and use of molecular techniques to treat endocrine disorders. The course of molecular and clinical endocrinology targets to provide excellence in clinical care for all aspects of health and disease related to endocrine management like from thyroid, adrenal, parathyroid, diabetes, pituitary, bone, obesity and lipid disorders. It also provides an understanding of the general mechanisms in molecular endocrinology, radioimmunoassay, immunoradiometric, immunochemiluminometric and radio receptor assays and their statistical procedures and mechanisms of action of hormones. Furthermore, in all body cells, hormones influence the metabolism of nucleotides, proteins, lipids, carbohydrates, vitamins, water, and therefore, knowledge of endocrinology and metabolism is important. The graduates will study the endocrine system in terms of functional pathology in endocrine glands, disorders of growth and puberty, endocrine hypertension and poly endocrine syndromes. By the end of this course, the students will be able to examine and describe glands and can determine hormonal impact and syndromes.

Contents

1. General mechanisms in molecular endocrinology, subcellular structure of cells secreting protein hormones, process of hormone secretion, transcription factors in developmental organisms in endocrine systems.
2. Recombinant DNA technology and molecular genetics in diagnosis and treatment of endocrine diseases, measurements of hormones, radioimmunoassay, immunoradiometric, immunochemiluminometric and radio receptor assays and their statistical procedures.
3. 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 stability and metabolism in hormone action.
4. 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.
5. Development and growth: disorders of growth and puberty. endocrine hypertension. poly endocrine 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.

Practical

1. Studies on recognition and response of receptors.
2. Studies of disorders of pituitary by observing anatomical and histological features.

3. Studies of thyroid status in deficient and excess hormone functions.
4. Studies of type 1 and type 2 diabetes mellitus.
5. Epidemiology of the types in population, studies of management of the type 2.
6. Model studies of disorders of ovarian and testicular disorders.
7. Model studies of obesity and anorexia.
8. Studies of hormonal status in puberty and aging.

Recommended Texts

1. Greenspan, F. S., & Strewler, G. J. (2002). *Basic and clinical endocrinology* (5th ed.). London: Prentice Hall International Inc.
2. Larsen, P. R., Kronenberg, H. M., Melmed, S., & Plonsky, K. S. (2003). *William's textbook of endocrinology* (10th ed.). Philadelphia: W.B. Saunders Company.

Suggested Readings

1. DeGroot, L. J., & Jameson, J. L. (2001). *Endocrinology* (4th ed.). Philadelphia: W.B. Saunders.
2. Griffin, J. E., & Ojeda, S. R. (2000). *Textbook of endocrine physiology* (4th ed.). Oxford University Press.
3. Neal, J. M. (2000). *Basic endocrinology: an interactive approach.* London: Blackwell Science Inc.

Paper XXIX **Ornithology** **(75+25=100)**

The course will provide knowledge about bird diversity, avian anatomy, avian physiology and adaptations, bird behavior and socioeconomic and ecological importance of birds This course combines traditional zoology with an emphasis upon avian biology and diversity, and is delivered along with aspects of conservation management and practices. Students will learn about different aspects of birds such as how to identify them, what are the major characteristics and distinguishing features of the major groups of birds, and how birds function in a diversity of environments. However, this course will also cover a modern scientific approach to birds, which has as its goal not just understanding birds, but using birds as a means to uncover general biological principles that may apply to all living things. Students will acquire by the end of the course a new appreciation and knowledge of birds, additional understanding of biological concepts, and an improved ability to be an active scientist.

Contents

1. Introduction to ornithology: class Aves, taxonomy of birds up to orders, families and major species.
2. Evolution of birds: Biology of fossil bird's archaeopteryx, archaeornithes, neoornithes.
3. Morphology and surface anatomy of bird, and development structure of feathers, plumage, Structure of bones.
4. Basic embryology of birds, internal anatomy of birds.
5. Systems physiology, blood circulatory, cardiovascular physiology, heart, blood cells and hemodynamics.
6. Respiratory system, air sacs, ventilation of lungs, metabolic rates, oxygen consumption.
7. Urinary system, kidney physiology and production of solid or semisolid excreta, brain physiology and anatomy, special senses, olfaction, vision, taste.
8. Digestive system, anatomy, guts and feeding strategies.
9. Morphological and physiological adaptations of birds to flying, kinds of flight, mechanisms of aerodynamics.
10. Reproductive organs anatomy and physiology, egg laying and breeding seasons,
11. Bird migration, song production, bird behavior, courtship, mating, egg incubation strategies, brood parasitism, predator-prey relationship, homing behavior, learning, imprinting, nest building, bird parasite.
12. Endangered species of birds, bird conservation and sanctuaries, introduction, evolution, geographical distribution, characteristics of birds, external features, identification of sex and age, reproduction and development, behavior (migration, territoriality), populations and their regulation.
13. Anatomical, physiological adaptations to their environment, reproductive strategies, food/feed, communication (vocal, behavioral), anatomy & physiology of game and predatory species.
14. Birds of Pakistan: aquatic, forest and game birds and birds of prey, birds as pests.

Practical

1. Identification, characteristics and taxonomy of birds up to orders and families.
2. Dissection of sparrow, pigeon, myna, other available birds.
3. Anatomy of bones, skull, girdles, spine, vertebrae, feathers, plumage.
4. Study of gut contents of birds to understand feeding habits.
5. Incubation of chicken eggs to learn avian embryogenesis.

6. Bird stuffing and preservation of eggs.
7. Identification of bird species through feathers and egg shells.
8. Beak and claw structures.
9. Study of bird songs, recording bird songs, fundamental experimentation to understand bird songs in sensitive and sensorimotor phases.
10. Bird watching and preparation of ethograms.
11. Study of predator-prey relationship among birds.
12. Study of brood parasitism.
13. Study of flying mechanics through models.

Recommended Texts

1. Howell, S. N. G. (2010). *Peterson reference guide to molt in North American birds.* Amzaon: Peterson Reference Guides.
2. Urfi, A. J. (2009). *Birds of India: a literary companion.* New Delhi: Oxford University Press.

Suggested Readings

1. Rank, B. (2004). *Ornithology: ecology and evolution of Darwin's finches.* Princeton: W. H. Freeman.
2. Sibley, D. A., & Alfred, A. (2002). *Sibley's birding basics.* New York Press.
3. Ali, S. S., & Ripley, D. (2001). *Handbook of the birds of India and Pakistan: together with those of Bangladesh, Nepal, Bhutan and Sri Lanka.* New Delhi: Oxford University Press.

Paper XXX **Physiological Systems & Adaptations** **(75+25=100)**

This course provides detail insight into physiological systems maintaining the homeostasis of animals. Inter-relations of the systems and regulatory features of each system's function will also be focused. The major goal of the course is to provide detail study in mammalian, principally human, systems physiology, building on knowledge of basic physiological principles. Its contents mainly cover cardiovascular system, respiratory system, renal system, gastrointestinal system and osmoregulation. It also emphases on environmental challenges of temperature regulation like temperature and animal energetics, temperature relation of ectotherms, heterotherms and endotherms. Laboratory practice will enable the students to study of heart in frogs, to study of blood pressure in various physiological states, study of electrocardiograms and to determine the oxygen consumption in fish and mouse and effects of factors. Physiological systems and adaptations also focus on how the metabolic, neuromuscular, cardiovascular, and respiratory systems respond to the demands of varying adaptations and it modifies these systems.

Contents

1. 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.
2. Respiratory system: overview of respiratory system, pulmonary and bronchial circulations, mechanical aspects of breathing, transport of oxygen and carbon dioxide, regulation of ventilation, respiratory responses in extreme conditions.
3. Renal System: elements of renal function, tubular function in nephron, control of body fluid volume and osmolality, potassium, calcium and phosphate homeostasis, role of kidney in acid-base balance.
4. 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.
5. Osmoregulation: problems of osmoregulation, obligatory exchange of ions and water, osmoregulators and osmoconformers, osmoregulation in aqueous and terrestrial environments.
6. 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.

Practical

1. Study of heart functioning in frogs.
2. Study of blood pressure in various physiological states.
3. Study of electrocardiograms.
4. Blood coagulation study.
5. Determination of oxygen consumption in fish and mouse and effects of factors.
6. Demonstration of respiratory volume and pulmonary function tests.
7. Experiments on digestion on nutrients by enzymes and effects of factors
8. Study of exocrine secretion in stomach or pancreas and effects of factors.
9. Experiments on kidney regulation of osmolality.
10. Urine analysis.

11. Study of osmoregulatory adaptations in animals inhabiting various environments
12. Demonstration of effect of temperature on several physiological responses, Study of animals in various types of dormancy.

Recommended Texts

1. Randall, D., Burggren, W., French, K., & Fernald, R. (2002). *Eckert animal physiology: mechanisms and adaptations* (5th ed.). New York: W.H. Freeman and Company.
2. Tharp, G., & Woodman, D. (2002). *Experiments in physiology* (8th ed.). London: Prentice Hall.

Suggested Readings

1. Berne, R. M., & Levy, M. N. (2000). *Principles of physiology* (3rd ed.). St. Lious, Mosby.
2. Guyton, A. C., & Hall, J. E. (2015). *Textbook of medical physiology* (12th ed.). Philadelphia: W.B. Saunders Company.

Paper XXXI **Physiology of Reproduction** **(75+25=100)**

The course aims to provide knowledge about reproductive system and its role in the behavior of the animals. It will enable the students to develop the understanding about the role of sex hormone in sexual behavior and their influence on the process of development. The major objective of this course is to provide students with a sound coverage of human reproductive physiology within the framework of human body. This is achieved by first covering fundamentals of the structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, fetal development and preparation for birth, contraceptive methods and maternal adaptations to pregnancy. It particularly emphasizes on the hormonal control of reproduction. This in turn provides an important foundation to consider sexual differentiation and development, contraception, infertility and current reproductive technologies. Finally, human reproductive behavior and its implications to our future are considered in the light of our evolutionary history, culture and society.

Contents

1. Introduction to sex determination and differentiation: molecular aspects and chemical messengers in differentiation, hypothalamic – hypo physical gonadal axis in reproduction: hormonal and neural factors and their interaction in ovarian, testicular and reproductive targets functions, the interactions in development in estrous and menstrual cycle: the interactions in transitions from childhood to reproductive and post- reproductive states.
2. Reproductive behaviors: physiological basis of male and female sexual behavior and maternal behavior, endocrine basis of communication in reproduction and aggression, pheromone in mammalian reproduction, rhythms in reproduction and pregnancy, hormonal mechanism in fertilization, zygote transport and implantation.
3. Placental steroid and polypeptide hormones, recognition and maintenance of pregnancy, maternal metabolism gestation, hormonal mechanism in parturition.
4. Lactation: Hormonal mechanism in lactation, lacto genesis, galactopoiesios, milk ejection, reproductive senescence, Hormonal and metabolic aspects in menopause, mechanisms in males.
5. Fertility control mechanisms: hormonal contraceptives, rhythmic methods, immunological techniques and fertility control procedures in women, complications in their uses, fertility control in men and search for male contraceptive.

Practical

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

Recommended Texts

1. Evert, B. J., & Johnson, M. H. (2000). *Essential reproduction.* Blackwell Science Inc., Oxford.

2. Larsen, P. R., Kronenberg, H. M., Melmed, S., & Plonsky, K. S. (2003). *William's textbook of endocrinology* (10th ed.). Philadelphia: W.B. Saunders Company.

Suggested Readings

1. Knobil, E., & Neill, J. D. (2006). *The physiology of reproduction* (Vol.2). Gulf Professional Publishing.
2. Larsen, P. R., Kronenberg, H. M., Melmed, S., & Plonsky, K. S. (2003). *William's textbook of endocrinology* (10th ed.). Philadelphia: W.B. Saunders Company.

Paper XXXII **Principles of Parasitology** **(75+25=100)**

This course will introduce the students to general parasitology, will provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance knowledge about their pathology, host parasite relationship and control measures. Overall aim of the course is to acquaint students with knowledge concerning biological, epidemiological and ecological aspects of parasites causing diseases to humans, enable them to understand the pathogenesis, clinical presentations and complications of parasitic diseases, to establish knowledge regarding pathogenesis, clinical presentations and complications of parasitic diseases and to provide students with adequate knowledge about endemic parasites and national parasitic problems as well as re-emerging parasitic infection. By the end of the courses, students will be able to describe the world distribution of important parasitic infections and the epidemiologic principles and the effect of social and demographic patterns on parasitic disease and vulnerability and can describe molecular, biochemical and cellular mechanisms that occur in the body of humans infected with parasites.

Contents

1. Introduction to parasitology its relationship to other sciences, parasitology and human welfare.
2. Parasites of domestic and wild animals.
3. Basic principles and concepts, parasite ecology and evolution. immunology and pathology.
4. Susceptibility and resistance, innate defense mechanisms., acquired immune response.
5. Immunity in invertebrates, immunodiagnosis, pathogenesis of parasitic infections.
6. Accommodation and tolerance in the host-parasite relationship.
7. Parasitic protozoa, form, function and classification, kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae.
8. Other flagellated protozoa, order retortamonadita, order diplomonadida, order trichomonadida, order opalinida. the amoebas. order amoebida, order schizopyrenida.
9. Phylum apicomplexa, gregarines, coccidia and related organisms, the apical complex, class gregarinea, class coccidea. phylum apicomplexa, malana, organisms, and pyroplasms, order haemospondea, order pyroplasmida. phylum ciliophora, ciliated protistan parasites, class spirotoichea, class litostomitea, classoligohymenophorea. phyla microspora and myxozoa.
10. 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.
11. Systematics, morphology and biology of arthropods (causing or responsible for transmission of disease), chemical and non-chemical control of arthropods of medical and veterinary importance.
12. Pathology of Helminths: Host parasite relationships and control of parasitic helminths with particular reference to helminths of medical and veterinary importance.

Practical

1. Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance.
2. Section cutting of the infected tissues and the study of their pathology.
3. Methods of collection, preservation and transportation of parasitic material.
4. Qualitative and quantitative fecal examination for helminth ova.
5. Collection, preservation and preparation of slides of local helminthes and their identification.
6. Identification of insects of medical and veterinary importance.

Recommended Texts

1. Roberts, L. S., & Janovy, J. Jr. (2005). *Foundations of parasitology* (7th ed.). Chicago, London, Tokyo, Toronto: W.M. Brown Publishers.
2. Urquhart, G. M., Hucan, J. L., Dunn, A. M., & Jennings, F. W. (2000). *Veterinary parasitology.* UK: Longman Scientific and Technical publications, Longman Group.

Suggested Readings

1. Watson, J. M. (2014). *Introduction to animal parasitology.* UK: Stenlake Publishing.
2. Cheesbrough, M. (2006). *Laboratory practice in tropical countries* (2nd ed.). Cambridge: University Press Cambridge.