

Scheme of Study for BS (4-Years) Program in Zoology

w.e.f. 2023 and Onward (Fall, 2023) 1st Semester

Duration of Program: 8-12 semesters

Total credits: 129

Semester	Course Code	Course Title	Credit Hrs.	Category
1 st	GEN-3101	Functional English	3(3-0)	General
	GEN-3102	Environmental Science	3(2-1)	General
	GEN-3103	Quantitative Reasoning –I	3(3-0)	General
	BOT-3104	Introduction to Plant Sciences	3(2-1)	Interdisciplinary
	ZOO-3105	Principles of Animal Life-I	3(2-1)	Interdisciplinary
	Semester Total Credit Hours			15
2 nd	GEN-3201	Expository Writing	3 (3-0)	General
	GEN-3202	Arabic/Kashmir Studies/Intro to History	2 (2-0)	General
	GEN-3203	Application of Information & Communication Technologies	3 (2-1)	General
	BOT-3204	Plant Systematics, Anatomy & Development	3(2-1)	Interdisciplinary
	ZOO-3205	Animal Diversity-I	3(2-1)	Interdisciplinary
	CHM-3206	Inorganic Chemistry	4(3-1)	Major
	Semester Total Credit Hours			18
3 rd	GEN-4301	Islamic Studies	2 (2-0)	General
	GEN-4302	Entrepreneurship	2 (2-0)	General
	GEN-4303	Quantitative Reasoning –II	3 (2-0)	General
	BOT-4304	Cell Biology Genetics and Evolution	3 (2-1)	Interdisciplinary
	CHM-4305	Physical Chemistry	4 (3-1)	Major
	ZOO-4306	Principle of Animal Life-II	3 (2-1)	Interdisciplinary
	Semester Total Credit Hours			17
4 th	GEN-4401	Introduction to Sociology/Psychology/Management/ Education/Anthropology	2 (2-0)	General
	GEN-4402	Civics & Community Engagement	2 (2-0)	General
	GEN-4403	Ideology & Constitution of Pakistan	2 (2-0)	General
	BOT-4404	Plant Physiology and Ecology	4(3-1)	Interdisciplinary
	CHM-4405	Organic Chemistry	4(3-1)	Major
	ZOO-4406	Animal Form and Function-I	4(3-1)	Interdisciplinary
	Semester Total Credit Hours			18

SEMESTER-V

Course code	Course title	Credits	Category
ZOO-5501	Cell Biology	3 (2-1)	Major
ZOO-5502	Animal Physiology	4 (3-1)	Major
ZOO-5503	Genetics	4 (3-1)	Major
ZOO-5504	Animal Ecology	3 (2-1)	Major
ZOO-5505	Research Methods and Reports	2 (2-0)	Major
	Total Credits	16	

SEMESTER-VI

Course Code	Course title	Credits	Category
ZOO-5601	Chemistry of Biomolecules	3 (2-1)	Major
ZOO-5602	Developmental Biology	4 (3-1)	Major
ZOO-5603	Principles of Animal Taxonomy	2(1-1)	Major
ZOO-5604	Data Analysis	2 (2-0)	Major
ZOO-5605	Paleontology and Evolution	4 (3-1)	Major
ZOO-5606	Molecular Biology	3 (2-1)	Major
	Total Credits	18	

SEMESTER-VII

Course code	Course title	Credits	Category
ZOO-6701	Zoogeography	2 (2-0)	Major
ZOO-6702	Biological Techniques	3(1-2)	Major
ZOO-6703	General Microbiology	3(2-1)	Major
ZOO-6704	Metabolism of Biomolecules	3(3-0)	Major
ZOO-7699	Internship	3(0-3)	Major
	Elective Course	3(2-1)	Major
	Total Credits	17	

SEMESTER-VIII

Course code	Course title	Credits	Category
ZOO- 6801	Economic Zoology	3 (2-1)	Major
	Elective	3	Major
	Elective	3	Major
	Comprehensive Examination (Oral)	Q/NQ	Major
ZOO-6899	Capstone Project	3(0-3)	Major
	Total Credits	12	
Grand Total	17+ 17+16+16+16+18+17+12	129	

COURSE CONTENTS FOR SEMESTER-I

GEN-3101

Functional English

Credit Hours: 3

Course Objectives: The course is developed to enhance the language skills and critical thinking of students by

- Enabling them to correct use of grammar and language structures
- Enabling them to communicate effectively
- Helping them improve their presentation skills by systematic drilling and activities in the areas of reading and speaking
- Guiding them well organized writing

Course Contents:

Grammar:

- Basics of grammar
- Parts of speech and their use in communication
- Sentence structure
- Correct use of Tenses
- Active and passive voice
- Practice in unified sentences (unity and coherence)
- Analysis of Phrase, Clause and sentence structures
- Transitive and Intransitive Verbs
- Punctuation and Spellings

Reading skills:

- Comprehension skills
- Literal understanding of text, reading between lines (interpret text), reading beyond lines (to assimilate, integrate knowledge)
- Answers to the questions on a given text

Discussion:

- General topics and everyday conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of the students)
- Introducing ourselves, describing things, recounting past events, agreeing and disagreeing, compare and contrast

Listening:

- To be improved by showing documentaries/ films carefully selected by subject teacher
- Listening and note taking

Translation Skills:

- Urdu to English

Writing Skills:

- Paragraph Writing

Basic structure of paragraph and guidelines for writing an effective paragraph

Speaking Skills:

- Presentation Skills
- Introduction (types of presentation, structure of presentation)
- Prepared and unprepared talks

Note: Extensive reading is required for vocabulary building

Recommended Books:**1. Functional English****a) Grammar**

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

- 1) Ellen, K. 2002. Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top
- 2) Hargie, O. (ed.) Hand book of Communications Skills
- 3) Mandel, S. 2000. Effective Presentation Skills: A Practical Guide Better Speaking
- 4) Mark, P. 1996. Presenting in English. Language Teaching Publications

GEN-3102

Environmental Sciences

Credit Hours: 3(2-1)

Objectives:

- To understand and provide updated knowledge of environmental problems
- To provide a basic introduction sustainable environmental management.

Course Contents

Unit I. The human environment, the litho, bio and hydrospheres, the nature and composition of natural waters,

Unit II. Pollution: definition, classification and impact on habitats

- i. Air pollution: Sources and effect of various pollutants (inorganic, organic), control, remediation. Photochemical smog. Smog. Acid rain: 1. Theory of acid rain, 2. Adverse effects of acid rains. Chlorofluorocarbons and its effects.
- ii. Water pollution: Major sources of water pollution its impact. Prevention, control remediation, Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters.
 - iii. Soil pollution: major sources of soil pollution and its impact. Prevention, control remediation.
 - iv. Noise pollution.

Unit III. Ozone layer:

- i. Formation
- ii. Mechanism of depletion
- iii. Effects of ozone depletion

Unit VI. Greenhouse effect: causes, impacts.

Practical:

Examination of water for

- i. Total dissolved solids.
- ii. pH and Conductance.
- iii. Alkalinity.

iv. Hardness of water

v. Determination of phosphates and sulphates

Recommended Books:

1. Newman, E.I. 2001. Applied Ecology. Blackwell Science. UK
2. Mooney, H.A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
3. Eugene, E.D. and Smith, B.F. 2000. Environmental Science: A study of interrelationships. McGraw Hill. USA.
4. French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W.W. Norton and Company, NY.
5. Hall, C.A.S. and Perez, C.L. 2000. Quantifying Sustainable Development. Academic Press, UK.
6. Bazzaz, F.A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology

QUANTITATIVE REASONING (I)

UGE Policy V 1.1 : General Education Course

Credits: 03
Pre-Requisite: Nil
Offering: Undergraduate Degrees (including Associate Degrees)
Placement: 1 - 4 Semesters
Type: Mandatory
Fields: All

DESCRIPTION

Quantitative Reasoning (I) is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately;
2. Understanding of fundamental mathematical and statistical concepts;
3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

SYLLABUS

1. **Numerical Literacy**
 - Number system and basic arithmetic operations;
 - Units and their conversions, dimensions, area, perimeter and volume;
 - Rates, ratios, proportions and percentages;
 - Types and sources of data;
 - Measurement scales;
 - Tabular and graphical presentation of data;
 - Quantitative reasoning exercises using number knowledge.
2. **Fundamental Mathematical Concepts**
 - Basics of geometry (lines, angles, circles, polygons etc.);
 - Sets and their operations;
 - Relations, functions, and their graphs;
 - Exponents, factoring and simplifying algebraic expressions;
 - Algebraic and graphical solutions of linear and quadratic equations and inequalities;
 - Quantitative reasoning exercises using fundamental mathematical concepts.
3. **Fundamental Statistical Concepts**
 - Population and sample;
 - Measures of central tendency, dispersion and data interpretation;
 - Rules of counting (multiplicative, permutation and combination);
 - Basic probability theory;
 - Introduction to random variables and their probability distributions;
 - Quantitative reasoning exercises using fundamental statistical concepts.

Arliana Yama

Aims and Objectives

To help participants understand basic plant science fundamentals through a variety of hands-on activities and resources. This course also provides an overview of the past, present and potential uses of plants. Particular emphasis is given to plants used directly, as in food, or indirectly, as products used by humans or those used to enhance the environment in line with sustainable development goals (**SDG s**).

Course Contents

History and the importance of plant sciences. Scope of plant sciences. Renewable and non-renewable resources. Traditional uses and potentials: sources of food (cereals, legumes, root and tuber crops, vegetable crops, fruits), drug discovery and medicinal plants.

Plants and **SDGs**: The need for a focus on plant, **SDG 1** No poverty (Use of plant to end poverty), **SDG 2** Zero hunger (Role of plants to end hunger, achieve food security and improved nutrition and promote sustainable agriculture, **SDG 3** Good health and well-beings (use of plants to ensure healthy life and promote well-being), **SDG 13** Climate action (Role of plants to combat climate change and its impacts), **SDG 15** Life on land (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss).

Practical

Identify local ethnobotanically useful species.

Survey of medicinally important plants and their products

Medicinal plant description and processing

Preparation of decoctions, syrups, ointments, and dried plants for domestic medicinal use Field exercises on medicinal plant specimen collection, documentation, storage and gardening

Recommended Readings

Simpson B., Ogorzaly M. (2000). Economic Botany: Plants in our world. McGraw-Hill Education. Plant Science: Growth, Development, and Utilization of Cultivated Plants, 4th edition (McMahon et al., 2007).

Sharrock, S., & Jackson, P. W. (2016). Plant Conservation and the Sustainable Development Goals. Global Partnership for Plant Conservation. Missouri: Botanical Gardens Conservation International.

ZOO-3105

Principles of Animal Life-I

Credit Hours: 3(2-1)

Aims and Objectives

The course aims to impart knowledge and understanding of:

1. The concept and status of Zoology in life sciences.
2. The common processes of life through its chemistry, biochemical and molecular processes.
3. The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
4. Biochemical mechanisms eventually generating energy for animal work.
5. Animals and their relationship with their environment.

Course Contents

1. Scope of Zoology:

- a) Introduction;
- b) Significance and applications of zoology;
- c) Animal diversity;
- d) The scientific method;
- e) Environment and world resources.

2. Chemical Basis of Animal Life:

Brief introduction to bio molecules;

- a) Carbohydrates b) lipids, proteins, c) nucleic acids.

3. Cellular Organization:

- a) Structure of animal cells,
- b) cell membrane,

c) cytoplasm and its organelles:

ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles; ribosomes, endoplasmic reticulum, the nucleus: nuclear envelope, chromosomes and nucleolus.

4. Animal tissues:

- a) Types: epithelial, connective, muscle and nervous tissue;
- b) organs and organ systems.

5. Enzymes:

- a) Structure, b) types; c) function and factors affecting their activity; d) cofactors and coenzymes.

6. Energy Harvesting:

- a) Aerobic and anaerobic respiration: glycolysis, citric acid Cycle and electron transport chain; fermentation, the major source of ATP.

7. Reproduction and Development:

- a) Types; asexual and sexual,
- b) gamete to genesis, fertilization, metamorphosis, zygote and early development.

8. Ecological Concepts:

- a) Individuals and Populations: Animals and their abiotic environment; populations and limiting factors;
- b) Communities and Ecosystems: Community structure and diversity; interspecific interactions. Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles;
- c) Ecological problems; human population growth, pollution, resource depletion and biodiversity.

Practical's

1. Tests for different carbohydrates, proteins and lipids.

Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).

Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.

3. Preparation of blood smears.

4. Plasmolysis and de plasmolysis in blood.

5. Protein digestion by pepsin.

6. Ecological notes on animals of a few model habitats.

7. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Recommended Books

1. Hickman, C.P., Roberts, L.S., Keen L.S., Larson, A., I'Anson, H. and Eisenhour, D.J., Integrated Principles of Zoology, 14th Edition (International), 2004. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. Zoology, 10th Edition (International), 2016. Singapore: McGraw Hill.

3. Campbell, N.A. Biology, 6 th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

4. Miller, S.A. General Zoology Laboratory Manual. 7th Edition(International), 2013. New York: McGraw Hill.

5. Hickman, C.P. and Kats, H.L., Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.

6. Molles, M.C. Ecology: Concepts and Applications. 9th Edition. 2022. McGraw Hill, New York, USA.

7. Odum, E. P. Fundamentals of Ecology. 3 rd Edition. 1994. W.B.Saunders. Philadelphia.

LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY

III SEMESTER (w.e.f. 2022)

SEMESTER-III (Cr. 18)

Course Code	Course title	Credits	Status
ENG-4302	Report writing	3(3-0)	Compulsory
PKS-4301	Pakistan Studies	2(2-0)	Compulsory
BOT-4301	Cell Biology, Genetics and Evolution	3(2-1)	General
CHM-4301	Physical Chemistry	3(3-1)	General
ZOO-4305	Animal Diversity-I	3(2-1)	Foundation
ZOO-4306	Animal Form and Function-I	4(3-1)	Foundation
	Total Credits	18	

Note: The course contents of courses other than zoology will be adopted as prescribed by the relevant departments/University/HEC.

BOT-4301	Cell Biology, Genetics and Evolution	4(3-1)
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Aims and Objectives

To understand

1. Structure and functions of cell.
2. Nature of genetic material and hereditary process.
3. Familiarization with evolutionary processes.

Course Contents

a) Cell biology

1. Structures and Functions of Bio-molecules
Carbohydrates, Lipids, Proteins, Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.
3. Ultra structure of plant cell with a brief description and functions of the following organelles
Cell wall, Endoplasmic reticulum, Plastids, Mitochondria, Ribosome's, Dictyosomes, Vacuole, Micro bodies (Glyoxysomes and Peroxisoms)

4. Nucleus: Nuclear membrane, nucleolus, ultra structure and morphology of chromosomes, cerotype analysis
5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

b) Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.
2. Sex linked inheritance, sex linkage in *Drosophila* and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex linked characters, sex determination.
3. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.
4. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).
5. Transmission of genetic material in Bacteria: Conjugation and gene recombination in *E.coli*, transduction and transformation.
6. Principles of genetic engineering / biotechnology; Basic genetic engineering techniques.
7. Application of genetics in plant improvement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens, selection, hybridization and plant breeding techniques. Development and release of new varieties.
8. Introduction to germplasm conservation

c) Evolution

The nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Practical

Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs

1. Measurement of cell size.
2. Study of mitosis and meiosis by smear/squash method and from prepared slides.
3. Study of chromosome morphology and variation in chromosome number.
4. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources

Genetics

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of DNA in plant material. Carmine/orcein staining.
3. Study of salivary gland chromosomes of *Drosophila*.

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd., New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
5. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.
6. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.

PKS-4301	Pakistan Studies	2(2-0)
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Introduction/Objectives:

Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outlines:**1. Historical Perspective**

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah. Factors leading to Muslim separatism. PEOPLE AND LAND: Indus Civilization, Muslim advent, Location and geo-physical features. GOVERNMENT AND POLITICS IN PAKISTAN: Political and constitutional phases, 1947-58, 1958-71, 1971-77, 1977-88, 1988-99 and 1999 onward, CONTEMPORARY PAKISTAN: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan

Books Recommended:

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.

3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
5. Wilcox, Wayne. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. Pakistan KayyunToota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson& sons Ltd, 1980.
9. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.
15. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.

ENG-4302	Report writing	3(3-0)
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Objectives:

Enhance language skills and develop critical thinking

COURSE CONTENTS: PRESENTATION SKILLS: ESSAY WRITING: Descriptive, narrative, discursive, argumentative, **ACADEMIC WRITING:** How to write a proposal for research paper/term paper. How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency), **TECHNICAL REPORT WRITING: PROGRESS REPORT WRITING.** Extensive reading is required for vocabulary building.

Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

- b) Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

CHM-4301	Physical Chemistry	3(2-1)
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Quantum theory and structure of atom

Bohr's atomic model, defects of Bohr's atomic model, classical mechanics, failure of classical mechanics, quantum mechanics, dual nature of matter, de-Broglie's equation, Heisenberg's uncertainty principle, limitation of Heisenberg's uncertainty principle, concept of atomic orbitals, quantum numbers, Pauli exclusion principle, electronic distribution of elements.

Physical states of matter

1. Gases

General characteristics of gases, Gay Lussac's law, ideal gas equation, kinetic molecular theory of gases, molecular velocities (average velocity, mean square velocity, root mean square velocity, most probable velocity), ideal and real gases, deviation of gas from ideality, derivation of kinetic gas equation, molecular collisions, collision diameter, critical phenomenon of gases, liquefaction of gases, mean free path, Vander Waal's equation for real gases.

2. Liquid

General characteristics of liquids, physical properties like surface tension, viscosity, parachor value, rheochor value and their applications, refractive index, specific and molar refraction and their applications, optical activity, specific rotation, dipole moment and molecular structure.

3. Solids

General characteristics of solids, types of solids, isotropy and anisotropy, habit of a crystal, crystal lattice and unit cell, crystal systems and Bravis lattices.

Chemical Thermodynamics

Introduction, thermodynamic terms like system, surrounding, boundary of system, states and state function, internal energy, extensive and intensive properties, first law of thermodynamics, enthalpy of a system, relationship between free energy change and enthalpy change, heat capacity of gases at constant volume and at constant pressure, , heat capacities relationship, 2nd law of thermodynamics, change in free energy and equilibrium constant.

Chemical Kinetics

Introduction, concept of rate of chemical reaction, rate law, velocity constant, elementary and complex reaction, order and molecularity of reaction, zero, first and second order reactions, derivation of kinetic equation for first order and 2nd order reaction when initial concentration of both reactants is same, various methods for determining the rate of chemical reaction, Arrhenius equation, Lindemann's theory for unimolecular reaction, introduction to transition state theory, transition state theory for bimolecular reaction.

Basic Electrochemistry

Introduction, conductors and insulators, electrolytic and electronic conduction, specific conductance, measurement of specific conductance, cell constant and its determination, Ostwald's dilution law (dependence of degree of dissociation constant on dilution), electrochemical cells, types of cells, EMF and its measurement.

Solutions

Introduction, types of solution, concentration units, ideal and non-ideal solutions, Raoult's law, molecular interactions in solution, colligative properties (lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure and their determination), concept of zeotropic and azeotropic mixture.

Surface Chemistry

Absorption and adsorption, types of adsorption, characteristics and factors which affect adsorption, applications of adsorption, catalysis, types of catalysis, enzyme catalysis, characteristics of catalysis.

Practicals:

- Determination of viscosity and parachor values of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method.
- Determination of heat of neutralization of an acid with a base.

ZOO-4305	ANIMAL DIVERSITY-I	3(2-1)
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Course Objectives:

- 1.To provide the knowledge of evolutionary/ phylogenetic relationship (from simple to the complex organisms).
- 2.To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.
- 3.To provide understanding of body organization, Feeding and Digestive system; Other Organ System;
- 4.To provide the description of mode of Reproduction and Development
- 5.To provide the information of their economic and ecological importance

Course Learning Outcomes:

This course will be based on following outcomes:

1. Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
2. Understand invertebrate organismal concepts in laboratory and field.
3. Demonstrate major evolutionary innovations for invertebrates with functional importance.
4. Understand how reproduction and development occurred and able to breed animal in the laboratory/field
5. Analyze economic and ecological importance of invertebrates.

Course Contents:

Note: The minimum details of the titles in the content must be of the principal book Zoology by Miller and Harley. This must be kept in view in teaching and assessments.

INTRODUCTION

- a. Classification of Organisms:
- b. Evolutionary Relationships and Tree Diagrams: Patterns of organization.

ANIMAL-LIKE PROTISTS: THE PROTOZOA

- c. Evolutionary perspective; Life within a single plasma Membrane;
- d. Symbiotic Life-styles.
- e. Protozoan Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable).
- f. Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure;
- g. Nutrition; Genetic Control and Reproduction; Symbiotic ciliates;
- h. Further Phylogenetic Consideration.

MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

- i. Evolutionary Perspective:
- j. Origins of Multicellularity; Animal Origins.

Phylum Porifera

- a. Characteristics and classification. Cell Types, Body Wall, and Skeletons;
- b. Water Current and Body Forms;
- c. Maintenance Functions, Reproduction.

Phylum Cnidaria (Coelenterate)

- a. Characteristics and classification. The body Wall and Nematocysts: Alteration of Generations;
- b. Maintenance Functions; Reproduction and
- c. Classification up to Class.

Phylum Ctenophore;

- a. Characteristics, body organization

THE TRIPLOBLASTIC AND WITH ACOELOMATE BODY PLAN PHYLUM PLATYHELMINTHES

- a. Evolutionary Perspective; Classification up to class;
- b. The Free-Living Flatworms and the Tapeworms, adaptive modification for parasitic life style

Phylum Numerate; Characteristics, body organization

Phylum Gastrotrich; Characteristics, body organization

2. PSEUDOCOELOMATE BODY PLAN

PHYLUM ASCHELMINTHS

a. Evolutionary perspective; General Characteristics; Classification up to order with External Features;

b. Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum **Rotifera**, Phylum **Nematoda** and Phylum **Kinorhyncha**.

c. Some Important Nematode Parasites of Humans;

3. **PHYLUM MOLLUSCA**

a. Evolutionary perspective; Relationship to other animals; Origin of the Coelom;

b. Molluscan Characteristics, Classification up to class. The Characteristics of Shell and Associated Structures,

c. Feeding, Digestion, Gas Exchange, Locomotion,

d. Reproduction and Development, Other maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods:

4. **PHYLUM ANNELIDA**

a. The Metameric Body Form; Evolutionary perspective; Relationship to other animals,

b. Metamerism and Tagmatization, Classification up to Class. External Structure and Locomotion,

c. Feeding and the Digestive system, Gas Exchange and Circulation,

d. Nervous and Sensory Functions, Excretion,

e. Regeneration, Reproduction and Development, in Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.

5. **PHYLUM ARTHROPODA:**

a. Evolutionary Perspective: Classification and Relationship to other Animals;

b. Metamerism and Tagmatization;

c. The Exoskeleton; Metamorphosis;

d. Classification up to Class; Further Phylogenetic Consideration.

The Hexapods and Myriapods:

a. Evolutionary Perspective: Classification up to class. External Structure and Locomotion,

b. Nutrition and the Digestive system, Gas Exchange, Circulation and Temperature Regulation,

c. Nervous and Sensory Functions, Excretion, Chemical Regulation,

d. Reproduction and Development in Hexapoda,

e. Insects Behavior, Insect and Human;

10. **PHYLUM ECHINODERMS**

a. Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class.

b. Maintenance Functions, Regeneration,

c. Reproduction, and Development in Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa;

SOME LESSER-KNOWN INVERTEBRATES;

a. The Lophophorates, Entoprocts, Cycliophores, and Chaetognaths.

Practical:

Note: Classification of each members of each phylum upto order with adaptations in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of phylum Echinodermata.
10. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.
11. Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.
12. How to make grade-wise series for preparation of temporary and permanent slides.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Research project
- Presentation

Assignments & Presentation (10%)

Recommended Principal Reference Book:

1. Miller, A.S. and Harley, J.B. ; 1999 , 2002., 2007, 2009, 2012 & 2016 Zoology, 4th , 5th, 6th, 7th, 8th , 9th& 10th Edition (International), Singapore : McGraw Hill.

Additional Readings:

1. Schierwater, B., &DeSalle, R. (2021). Invertebrate zoology: a tree of life approach. CRC Press.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
3. Mandal, F. B. (2017). Biology of Non-chordates. PHI Learning Pvt. Ltd..
4. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition, (International), Singapore: McGraw-Hill.
5. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2007. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th& 13th Edition (International). Singapore: McGraw-Hill.
6. Sandhu, G. S. (2005). Textbook of invertebrate zoology (Vol. 1). Campus Books International.
7. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin Cummings Publishing Company, Inc.

8. Kent, G. C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES New York: McGraw-Hill.

BOOKS FOR PRACTICAL

9. Verma, P. S. (2010). A Manual of Practical Zoology: Invertebrates. S. Chand Publishing.

10. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), Singapore : McGraw-Hill.

Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw-Hill.

ZOO- 4306	ANIMAL FORMAND FUNCTION- I	4(3-1)
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Course Objectives:

The Objectives of the courses are:

1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

Course Learning Outcomes:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

Course Outline:

1. Protection, Support, and Movement:

- a. Protection: the integumentary system of invertebrates and vertebrates;
- b. Movement and support: the skeletal system of invertebrates and vertebrates;
- c. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

2. **Communication I:**
 - a. Nerves: Neurons: structure and function.

3. **Communication II:**
 - a. Senses: Sensory reception: bar receptors, chemoreceptor, georeceptors, hygrometers, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates
 - b. Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

4. **Communication III:**
 - a. The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
 - b. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemertans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

5. **Circulation and Immunity:**
 - a. Internal transport and circulatory systems in invertebrates
 - b. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
 - c. transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

Practical:

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (*Labeo rohita*), Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis*), fowl (*Gallus gallus domesticus*) and rabbit (*Oryctolagus cuniculus*).
3. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
4. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

5. Study of models or preserved brains of representative animals and notes on adaptations.
6. Study of nervous system of earthworm and a fish.
7. Study of endocrine system in an insect and a rabbit.
8. Study of different types of blood cells in blood smear of rabbit.
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

Books Recommended:

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.
2. E. S Russell, 2010. Form and Function: A contribution to the history of Animal Morphology (Classic reprint)
3. Hickman, C.P., Roberts, L.S., Larson, A. 2014. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
4. Miller, S.A. and Harley, J.B. 2002. Zoology, 5th Ed. (International), Singapore: McGraw-Hill.
5. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing
6. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.
7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.
8. Prof. Dr. M. Khalid Baloch. T.book of Zoology, Animal form & function (A comparative prespective)
9. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Edition (International), Singapore: McGraw Hill.

LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY

V SEMESTER (w.e.f. 2018 and Onward)

YEAR-III

SEMESTER-V (Cr. 17)

Course code	Course title	Credits	Status
ZOO-5501	Cell Biology	3(2-1)	Compulsory
ZOO-5502	Animal Physiology	3(3-1)	Compulsory
ZOO-5503	Basics of Genetics	3(2-1)	Compulsory
ZOO-5504	Environmental Biology	3(2-1)	Compulsory
ZOO-5505	Zoogeography	2(2-0)	Compulsory
ZOO-5506	Chemistry of Bio-Molecules	3(2-1)	Compulsory
	Total Credits	17	

Details

ZOO-5501	Cell Biology	3(2-1)
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Aims and Objectives

The objectives of the course are to impart knowledge about the animal cell and its complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms. The various ultra-structural, molecular and functional aspects of the cells will be communicated in this course.

Course Contents

Introduction to prokaryotic and eukaryotic cells: Plasma membrane, its chemical composition structure and functions: of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis. Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments. **Cytoplasmic Organelles:** Membrane system (structural and functional commonalities). Ultrastructure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle). **Nucleus**, chromatin, heterochromatin,

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

Practicals

1. Detection and quantitative determination of chromosomal DNA and RNA
2. Preparation and staining of histological slides.
3. Identification of different cell organelles on slide

Recommended Books

1. Damnell Jr .J; lodisch, H. and Baltimore, D (1990). Molecular Biology, Scientific American Inc.N.Y.
2. Alberts B., Brary, D., Lewis, j., Raff, M., Roberts, Kand Watson, J.D. (1989). Molecular Biology of Cell.Garland Publishing Inc. New York.
3. De Robertes, E.D.P. And De Robertis Jr, E.N.F. (1987). Cell and Molecular Biology .Laea and febiger New York
4. Karp, J. Cell and Molecular Biology, Concepts and Experiments, 2005. Jhon Wiley and Sons, INC.
5. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, INC.

ZOO-5502	Animal Physiology	3 (3-1)
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Aims and Objectives

The course aims to:

1. Understand basic physiological mechanisms relating to membrane excitability, nerve and muscle, receptor function.
2. Understand neuro-endocrine coordination and secretions of glands.
3. Know the physiology of heart, hemodynamic system and kidney function.
4. Understand the digestive physiology and nutritive functions of gut.
5. Understand physiological regulation of temperature and its maintenance

Course Contents

Central themes in Physiology: Homeostasis, Concepts of conformity and regulation; physiological adaptations. **Neuro-muscular physiology:** Cellular homeostasis, resting and action potential, synaptic transmission, muscle contraction, general sensory mechanism, cutaneous sensation, audition, vision, tast, olfaction, the motor control system, sleep and consciousness. **Muscles:** Structure, types, components, muscle proteins, molecular basis of muscle contraction: sarcoplasmic reticulum and role of calcium, muscle action potentials, isometric and isotonic contraction, leverage factor, muscle fatigue. **Cardiovascular Physiology:** Vessels, heart,

electrocardiography, cardiac rate, rhythm, and conduction disturbances, heart as a pump, cardiodynamics, hemodynamics, cardiac output and venous return, control of cardiovascular system, responses to stress. **Respiratory physiology:** Respiratory mechanics, gas exchange between atmosphere and the body, gas transport, pulmonary circulation, respiratory control, hypoxia. **Renal Physiology:** Body fluid compartment, renal tubular function, renal clearance, glomerular filtration and GFR, reabsorption and secretion, composition of urine, formation of dilute and concentrated urine, effect of ADH, Aldosterone and Atrial Natriuretic Factor on renal Physiology. **Gastrointestinal Physiology:** Digestive system, the oral cavity, composition of saliva, pharynx, oesophagus, the stomach, regulation of gastric juice, small intestine, liver, regulation of bile, pancreatic and intestinal enzymes and their regulation, the colon, absorption of nutrients. **Endocrine Physiology:** General features of hormones, types of hormone action, basic concepts of endocrine control, endogenous opioid peptides, pituitary gland, thyroid gland, parathyroid hormones, calcitonine, Vitamin D. Adrenal Medulla, Adrenal cortex, Testis, Ovary, Endocrine placenta, Endocrine Pancreas. **Temperature Regulation:** Temperature classification of animals; Temperature relation of ectotherms in freezing and cold and warm and hot environment; Costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation and Estivation.

Practicals

1. **Muscle and Neuromuscular Activity:** Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.
2. **Excitability, Sensation and Behaviour:** Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.
3. **Cardiovascular Activity:** Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
4. **Respiration and Exercise:** Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.
5. **Endocrine and Reproductive Mechanisms:** Effect of insulin on glycemia, study of stages in estrous cycle.

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3rd Edition. 2000. St. Louis, Mosby.

4. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. Animal Physiology, Adaptation and Environment, 5th Edition. 1997. Cambridge University Press, Cambridge.
7. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.

ZOO-5503	Basics of Genetics	3(2-1)	Compulsory
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Aims and Objectives

The continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc. The process of continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment. These concepts will be imparted to the students in this course.

Course Contents

Classical genetics: Scope and importance of genetics, gene concept (classical and modern), **multiple alleles**, blood groups and coat color in rabbits, **Chromosomal basis of inheritance:** interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes), Karyotyping-Normal human chromosome complement. Pedigree Analysis. **Sex-determination and sex-linkage:** Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes, quantitative inheritance. genetics of viruses, bacteria, transposons. **Molecular genetics** – analysis and techniques of molecular genetics (elements of genetic engineering), genetic basis of cancer, genetic control of animal development, the genetic control of the vertebrate immune system, complex inheritance patterns. **Human Genetics:** Autosomal anomalies, Pseudoautosomal genes, (eg. Down syndrome, Edwards syndrome and Cri du chat syndrome), Single gene disorders Gene mutation and disorders (Brief mention) Autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as phenyle ketonuria, alkaptonuria). Definition - characteristics criss-cross inheritance. Multifactorial disorders - Polygenic traits - Cleft lip and cleft palate, Sex-linked and sex-influenced inheritance: Haemophilia and colour blindness. Sex chromosomal anomalies (Kline felters syndrome, and Turners syndrome). **Prenatal Diagnosis:** (Amniocentesis) and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics. **Population genetics** – Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practicals

1. Mitosis (Onion root tips.)

2. Meiosis (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 Books

1. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 3rd Edition, 2003. Johan Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. Principles of Genetics. 7th Edition, 2001. WCB publishers USA.
3. Gardener, E.J., Simmons, M.J. and Snustad, D.P. Principles of Genetics. 1991. John Wiley and Sons Ins. New York, USA.
4. Stickberger, M.W, (1985). Genetics, McMillan, N.Y.
5. Herskowitz, I.H. (1985). Genetics, Little Brown, Boston.
6. White-House, H. L. K. (1965). Towards an understanding of mechanism of hereditary
7. Crow, J.F. (1976). Genetics notes Burgess Publishing Company, Minneapolis.
8. Mays L.L. (1989). Genetics –A Molecular Approach, McMillan and Company N.Y.
9. Lewin, B. (2000). Gene VIII, Oxford University press, UK.

ZOO-5504	Environmental Biology	3 (2-1)
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Aims and Objectives

The main goal of this course is to enable the students to develop strong expertise in contemporaneous themes in ecological research and to be able to discuss these issues in a broad context. The students will be able to think and discuss about advanced topics in population, community and ecosystem ecology as well as in biodiversity research. They will also have the expertise to update their knowledge continuously, and to design their own research in ecology.

Course Contents

An overview of concepts of ecosystem with emphasis on interaction and homeostasis. **Basic global ecosystems:** atmosphere, hydrosphere, lithosphere, ecosphere. An overview of major ecosystem of the world: Marine, Estuarine, Freshwater, Wetlands, Tundra, Forest, Grassland and Desert. **Biogeochemical cycle:** nitrogen, phosphorus, sulphur, water, carbon, nutrient. **Limiting factors:** basic concepts, temperature, soil, water and humidity, light, fire. **Energy:** laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. **Population ecology:** basic population characters, growth and growth curves, population dynamics and regulations. **Community ecology:** basic concepts, community analysis, ecotones, inter-population interactions. **Ecological niche:** basic concepts and types. **Applied Ecology:** Resources and their ecological management (mineral, agricultural and forest, range management, desalination and weather modification, landscape and land use); **Pollution:** (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals, water purification, waste water treatment); air (sulphur dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE and CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution. **Contemporary environmental themes:** (ozone depletion, acid rain, green house effect and global warming, Koyota protocol, desertification, deforestation, exotic and invasive species, radioactivity leakage, environmental laws).

Practicals

Measurement of environmental factors on land, water and air. Study of different ecosystems: pond, agricultural or grassland, forest. Community analysis through different sampling techniques (quadrat, Transect). Population dynamics of grasshoppers. Adaptive features of animals in relation to food and environment. Food chain studies through analysis of gut contents. Analysis of polluted and fresh water for biotic and abiotic variations. Field visits for study of selected protected areas and writing reports. Development of an ecological management plan of some selected area.

Recommended Books

1. Odum, E. P. 1994. Fundamentals of Ecology. 3rd Edition W.B. Saunders. Philadelphia.
2. Molles, M.C. 2005 Ecology: Concepts and Applications. 6th Edition, McGraw Hill, New York, USA.
3. Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. Ecology. Oxford Univ. Press, UK.
4. Slingsby, D. and Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.
5. Chapman, J.L. and Reiss, M.J.1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
6. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
7. Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK.
8. Cox, C.B and Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6th Edition. Life Sciences King's College, London, UK.

ZOO-5505	Zoogeography	2(2-0)	Compulsory
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Aims and Objectives

The course imparts knowledge and concepts of evolution based distribution of animals on the globe. This course provides information on the distribution of animals and their associations in the past; thus, to rationalize their relationship in the present time.

Course Contents

Branches of zoogeography (descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography). Animal distribution (cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution), Factors affecting animal distribution. Barriers and dispersal. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palearctic, Nearctic regions), Oriental, Ethiopian, Australian, and New tropical Regions. Insular fauna; (Continental, Oceanic and Ancient Islands). Palaeogeography (Theories of Continental drift and Plate tectonics). Zoogeography of Pakistan: Fauna of land and sea; ecoregions.

Recommended Books

1. Darlington, P.J. (1963). Zoogeography, the Geographical Distribution of Animals. John Wiley, N. Y.
2. Parker, Hesse, Allee and Schmidt. (1963). Ecological Animal Geography. John Wiley, N.Y.
3. DeBeaufort, L.F. (1951). Zoogeography of the Land and Inland Waters. Sidgwick and Jackson, London.

- Ekman, S. (1967). Zoogeography of the Sea, Sidgwick and Jackson, London.
- Jillies, (1974). Introduction to Zoogeography, London.
- Muller, P. (1974). Aspects of Zoogeography. W. Junk Publishers, Hague.
- Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India.

ZOO-5506	Chemistry of Bio-Molecules	3(2-1)	Compulsory
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Aims and Objectives

- The course will provide in depth knowledge about the polymerized organic compounds of life.
- The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion is performed by various tools called as enzymes.
- Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Contents

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; Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation. **Enzymes:** 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 enzyme activity. **Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides. **Lipids:** fatty acids, their types and major characteristics; storage lipids, acylglycerols; waxes; structural lipids in membranes; major functions of lipids; lipoproteins, their types and major functions. **Vitamins and cofactors:** occurrence, structure and biochemical function of vitamins of b- complex group.

Recommended Books

- Nelson, D. L. and Cox, M.M. Lehninger Principles Of Biochemistry, 3rd Edition, 2000. McMillan Worth Publishers, New York.
- Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25th Edition, 2000. McGraw Hill, New York.

3. Voet, D., Voet, J.G., and Pratt, C.W. Fundamentals Of Biochemistry, 1999. John Wiley and Sons, Inc., New York.
4. Zubay, G. Biochemistry, 4th Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. Biochemistry, 4th Edition, 1995. W.H. Freeman and Company, New York.
6. McKee, T. and McKee, J.R. Biochemistry, The Molecular Basis Of Life. 3rd Edition, 2003. McGraw Hill.

Practicals

- 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).

Recommended Books

- 7) Plummer, David T. An Introduction to Practical Biochemistry, 1990. 4th Edition McGraw-Hill Book Company, London.
- 8) Wilson, K and Walker, J. Practical Biochemistry: Principles and Techniques, 4th Edition, 1994. Cambridge University Press.

LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY

VII SEMESTER (w.e.f. 2018 and Onward)

YEAR-IV

SEMESTER-VII (Cr. 17)

Course code	Course title	Credits	Status
ZOO-6701	Data Analysis	2(1-1)	Compulsory
	Elective-I	3(2-1)	Elective
	Elective-II	3(2-1)	Elective
	Elective-III	3(2-1)	Elective
	Elective-IV	3(2-1)	Elective
	Elective-V	3(2-1)	Elective
	Total Credits	17	

ZOO-6701 Data Analysis

Aims and Objectives

1. The course will provide knowledge about the importance and use of statistics in life sciences. It will help the students to understand the methods to analyze data pertaining to their research work and to assess the significance of their experimental designs.
2. After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

Course Contents

Introduction and scope, use of statistics in biology. Population and sample, Stages of research, **Types of data**: methods of data collection. Data arrangement and presentation, formation of tables and charts. **Measures of central tendency**: computation of mean, median and mode from grouped and ungrouped data. **Measures of dispersion**: computation of variance, standard deviation, standard error and their coefficients. **Probability rules**. Binomial, Poisson and normal distributions. Hypothesis testing, Student 't' test, Chi square test. **Handling of multiple samples**: Analysis of variance and LSD. **Correlation and regression**. Experimental designing, planning of an experiment, replication and randomization.

Recommended Books

1. Geoffrey, R. Norman, David L. Streiner, Biostatistics: The Bare Essentials. 2000. B.C. Decker Inc.

2. Gerry, P. Quinn, Michael J. Keough, Experimental Design And Data Analysis For Biologists. 2002. Cambridge University Press.
3. Campbell, R. C. Statistics For Biologists. 1989. Cambridge University Press.
4. Simpson, G.G., Roe, A. and Lewonhtin, R.C. (1960). Quantitative Zoology, Harcourt Bruce and Company.
5. Sokal, R.R. and Rohlf, F.J. (1973). An Introduction to Bio-statistics, Toppan.
6. Mather, K. (1960). Statistical Analysis in Biology. Methuen.
7. Bailey, N.T.J. (1981). Statistical Methods in Biology, English University Press.

Mishra, B.N. (1982). Introduction to Practical Biostatistics.

LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY

VII SEMESTER (w.e.f. 2018 and Onward)

Course code	Course Title	Credit Hrs.
ZOO-6702	Biological techniques	3(1-2)
ZOO-6703	Immunology	3(2-1)
ZOO-6704	Biodiversity and Wildlife	3(2-1)
ZOO-6705	Basic Human Genetics	3(2-1)
ZOO-6706	Clinical Endocrinology	3(2-1)
ZOO-6707	Fisheries and Aquaculture	3(2-1)
ZOO-6708	General Biotechnology	3(2-1)
ZOO-6709	General Entomology	3(2-1)
ZOO-6710	General Microbiology	3(2-1)
ZOO-6711	General Parasitology	3(2-1)
ZOO-6712	General Toxicology	3(2-1)
ZOO-6713	Helminthology	3(2-1)
ZOO-6714	Hematology	3(2-1)
ZOO-6715	Histology	3(2-1)
ZOO-6716	Industrial and Microbial Biotechnology	3(2-1)
ZOO-6717	Invertebrata	3(2-1)

ZOO-6718	Limnology-A	3(2-1)
ZOO-6719	Neurophysiology	3(2-1)
ZOO-6720	Principles of Fish Biology	3(2-1)
ZOO-6721	Principles of Herpetology	3(2-1)
ZOO-6722	Principles of Parasitology	3(2-1)
ZOO-6723	Reproductive Physiology	3(2-1)
ZOO-6724	Wildlife Parasitology	3(2-1)

ZOO-6702

BIOLOGICAL TECHNIQUES

Aims and Objectives

1. To make aware of the basic philosophy of science, its history, concepts and scope
2. To develop proper scientific mind, culture and work habits
3. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
4. Scientific drawing -Purpose and principle, Basic understanding on principle and uses of the following:

Course Contents (theory and practicals)

Microscopy: Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark field Interference microscope, Electron microscope.

Micrometry and Morphometry: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter). **Standard system for weight, length, volume :** Calculations and related conversions of each:- Metric system- length; surface; weight - Square measures- Cubic measures (volumetric)- Circular or angular measure- Concentrations- percent volume; ppt; ppm - Chemical molarity, normality - Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths. **Specimen preparation for optical microscopy: Microtomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections. **Extraction techniques:** Centrifugation, Ultra centrifugation, cell fractionation, filtration, Distillation, Use of Soxhlet and Rotary evaporator for extraction. **Separation Techniques:** Chromatography: Principle, applications, types, thin layer, paper, column, gas, ion exchange chromatography. Electrophoresis: Principle, applications, types. **Spectrophotometry:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption. **Basic principles of Sampling and Preservation:** Sampling soil organisms, Invertebrates, Aquatic animals, Mammals, Estimation of population

size, Preservation of dry and wet specimens. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field.

Recommended Books

1. Dean, J. R. Extraction methods for environmental analysis. 1999. John Wiley and Sons Ltd. UK.
2. Curos, M. Environmental sampling and analysis: Lab Manual. 1997. Crc Press Llc. USA. 38
3. Curos, M. Environmental sampling and analysis: For Technician. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. District laboratory practice in tropical countries. Part i. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. District laboratory practice in tropical countries. Part ii. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C. Practical ecology. 1986. Mcmillan Education Ltd. London.

ZOO-6703 IMMUNOLOGY

Aims and Objective

The aim of the course is to provide a greater understanding of the role of the immune system in preventing human disease and to focus on how deficiencies in immunity can result in disease susceptibility; in addition, students study the main subject areas in biosciences and medically related research; these subject areas include biochemistry, genetics, cell and molecular biology, anatomy and physiology as related to human health disease and treatment.

Course Contents

Cell mediated and humoral immunity, immunoglobulins, and the synthesis of antibody. Theories of antibodies synthesis. Antigenicity interaction of antigen and antibody. Hypersensitivity and its types with mechanism, classical and alternate compliment sequence, immunology in transplantation, autoimmunity to infections, immune deficiency diseases. Application of immunological phenomena in experimental biology.

Practicals

Antigens and elicitation of immune response. Experiments on methodology that employs immunological procedure such as radioimmuno assay.

Recommended Books

1. Roitt, M., (1979). Essential of Immunology, BlackWell, Oxford.
2. Benecerra, B. and Unanue, F.R. (1979). Text book of Immunology.

3. Bellanti, J.A. (1978). Immunology II, W. B. Saunders Company.
4. Fundehberg. H. Hstites, D.P., Classwel, J. B, and Wells J. O.V. (1980). Basic and Clinical Immunology, Lang Medical Los Angelos, California.
5. Hyde R., Hand Pathod, R.A., (1980). Immunology. Prentice Hall. Reston, Virginia.

ZOO-6704 BIODIVERSITY and WILDLIFE

Aims and Objectives

The aim of this course is to provide basic knowledge to students about the basic concepts of biological diversity, threats to biodiversity and management. It also provides the knowledge about the threatened and endangered species of wild animals and their management principles and efforts being made at global and regional level.

Course Contents

Definition, Types; Levels; Status of Biodiversity; Importance of Biodiversity. Causes of loss of biodiversity, Conservation of biodiversity-in-situ and ex-situ conservation, Introduction to wildlife, Wildlife importance, IUCN Species status category. Endangered and Endemic wildlife species of Pakistan. Protected areas concept and categories, Ramsar sites, captive breeding, biotechnological intervention in biodiversity conservation, International laws/conventions (CBD, CMS, CITES etc.) regarding biodiversity conservation and Pakistan.

Practicals

1. Procedures for studying biodiversity, species richness, Simpson Index, Shannon and Weiner Function.
2. Bird's population Census Techniques.
3. Mammal's population Census Techniques.

Recommended Books

1. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing and Co. London, UK.
2. K. V. Krishnamurthy, 2003. Text Book of Biodiversity, Science Publisher USA
3. B.N. Pandey, A.P. Sharma, P.N. Pandey, P.K. Katiha and K. Jaiswal (editors), 2012. Biodiversity: Issues Threats and Conservation : Narendra Publishing House.
4. Kumar and Asija, 2000. Biodiversity, Principles and Conservation.
5. Mary Jenking and Ann Boyce, 1987. The Diversity of Life.
6. R. Rehmani and Salim Ali: Birds Censing Techniques.
7. Roberts, T. J. The Birds of Pakistan, (Vol. II), 1992. Oxford University Press.
8. Roberts, T. J. The Mammals of Pakistan, 1997. Oxford University Press.
9. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.

10. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley and Sons, Inc.
11. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
12. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
13. Boyd, C.E. and Tucker, C. S. Pond Aquaculture and Water Quality Management. 1998. Boston, Kluwer Publishers Alabama.
14. Ali, S.S. Paleontology, Zoogeography and Wild-Life Management. 1999. Nasim Book Depot. Hyderabad, India.

ZOO-6705 BASIC HUMAN GENETICS

Aims and Objectives

The course aims to help students learn to define basic genetics mechanisms in human inheritance to analyze inherited characteristics and diseases of human to understand genes, genomes, chromosomes and gene expression profiles with relations to phenotypic appearances, to use this knowledge for genetic research and counseling.

Course Contents

Nucleic acids, Genetic linkage: family method, somatic cell hybridization, deletion mapping and duplication mapping. Introduction to human genome. Karyotyping. Patterns of transmission of single gene traits: Pedigree analysis with criteria for identification of various modes of inheritance. Genetic defects in prenatal development; oncogenes and cancer, normal chromosomes, congenital malformations. Introduction to Human genome project.

Practicals:

1. Pedigree analysis.
2. Karyotyping of normal and abnormal human chromosomes.
3. Screening of metabolic and other disorders.
4. Problems solving on genetic counseling.
5. Orientation with different molecular techniques including PCR, RFLP

Recommended Books

1. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd edition, Garland Science/Taylor and Francis. 2003.
2. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, Penguin USA Paper, 2002.
3. Relethford J. H., Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.
4. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York. 2002.

ZOO-6706 CLINICAL ENDOCRINOLOGY

Aims and Objectives

To study that degeneration disease are the results of alterations in biochemical homeostasis regulated by endocrine system.

Course Contents

Functional pathology of Endocrine Glands: Neuroendocrine disorders of gonadotropin, prolactin, growth hormone, corticotrophin regulation; Pituitary disorders: Prolactinomas, Acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper-function; Disorders of Adrenal medullary function; Disorders of Ovarian function and hormonal therapy; Abnormalities of Testicular functions and hormonal therapy. Fuel homeostasis: Glucose homeostasis and Hypoglycemia; Diabetes mellitus; Disorders of lipoprotein metabolism; Eating disorders: Obesity, Anorexia nervosa and Bulimia nervosa. Development and Growth: Disorders of growth and puberty. Endocrine Hypertension. Poly-endocrine Syndromes. Hormones and Cancer: Hormonal effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy. Geriatric Endocrinology: Endocrine and associated metabolism in aging: specifically thyroid, glucose and calcium homeostasis.

Practicals

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

Recommended Books

1. Greenspan, F.S. and Strewaler, G.J. 2002 Basic and Clinical endocrinology, 5th Edition. Prentice Hall International Inc. London.
2. Wilson, J.D., D.W., Kronenberg, H.M. and Larsen, P.R., 2008. Williams Textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. 2001. Endocrinology, Vol. I, II and III, 4th edition. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An Interactive Approach. Blackwell Science Inc. London.

ZOO-6707 FISHRIES AND AQUACULTURE

Aims and Objectives

The aim of this course is to provide knowledge about different requirements for the culture of different cultivable aquatic species. The subject provides practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding and diseases of most culturable freshwater fishes and prawns.

Course Contents

Basic principles of Aquaculture (fish and prawn). Natural food and feeding. Growth and breeding of the important culturable prawns and fishes. Diseases and their control.

Practicals

Study of the gut contents of important fishes. Study of the major parasites of fish. Study of early developmental stages of fishes. Methods of induced spawning.

Recommended Books

1. Auet, M. (1972). Textbook of Fish Culture, Breeding and Cultivation of Fish.
2. Various publications of the Directorate of Fisheries on fish-farming etc.
3. Brenabe, G. Aquaculture, Vol. I. 1992 Blackwell Publishing, Oxford. UK.
4. Maseke C. Fish Aquaculture. 1987. Pergamon Press, Oxford. UK.

ZOO-6708 GENERAL BIOTECHNOLOGY

Aims and Objectives

Biotechnology is a science that uses the method and process for transformation of natural raw materials into useful product by the application of living organism in the industrial process. Thus, it is the biology in service to mankind. Main aims of biotechnology are: 1) To develop industrial processes for production of antibiotics, enzymes etc, 2) To develop gene surgery and gene therapy to cure genetic disease. 3) To create improved varieties of plants and animals through genetic engineering and plant breeding. 4) To develop techniques for tissue culture, cell culture and organ transplantation. 5) To develop bioenergy. 6) To develop biological processes of waste treatment to reduce the impact of pollution. 7) To develop biological process of plant disease control.

Course Contents

Restriction and modification system: Types, Enzyme, classification, Nomenclature, Genetics and applications. Cloning Vectors: Plasmids (Bacterial and yeast), Viruses (Ca, MV, SV40, BPV) phages (Lambda, Mu, M13). Cosmids and phagmids. Cutting and joining of DNA: Isolation and purification of DNA, Ligation of DNA molecules, blunt ends and cohesive termini. Cloning Strategies; selection and characterization molecules, verification and amplification of desired genes, Gene Banks, PCR, RFLP, DNA sequencing techniques, DNA cloning, Southern blotting, Northern blotting, western blotting, site specific mutagenesis. Protein engineering.

Applications of recombinant DNA technology with comprehensive theoretical know-how macromolecules of desired characters for transgenic.

Practicals

1. Isolation of plasmids and chromosomal DNA from bacteria and yeast.
2. Screening of bacteria for plasmids by electrophoresis of total cell lysate.
3. Gel electrophoresis of plasmids DNA chromosomal DNA and RNA.
4. Comparing plasmids of different molecular weights using Molecular Weights markers.

Recommended Books

1. Rehm, J.J. 1998. Fundamentals of Biotechnology, VCH Publishers, N.Y.
2. Lee, B.H. 1996. Fundamentals of Food Biotechnology, VCH Publishers, N.Y.
3. Pirt, J.B. 1975. Microbes and Cell Cultivation, Blackwell Scientific Publishers, London.
4. Bailey, J.E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, McGraw Hills.
5. Watson, J.D., Tooze, J. and Kurta, D.T. 1983. Recombinant DNA-A short Course, Scientific American Books, New York.
6. Old, R.W. and Primrose, S.B. 1989. Principles of gene manipulation. 4th edition, Blackwell Scientific Publishers, London.
7. Molecular cloning, 1989. A Laboratory manual, 2nd edition, Cold spring Harbor Laboratory.
8. Higgins, I.J., Best, D.J. and Jones, J. 1988. Biotechnology Principles and Applications. Blackwell Scientific Publishers, London.
9. Rehm, J.J. 1988. Biotechnology: Special Microbial Process, Vol. 6 (b), VCH Publishers, N.Y.
10. Demain, A.L. and Solomon, N.A. 1986. Manual of Industrial Microbiology.
11. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
12. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
13. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
14. Yount L., Genetic Engineering, Gale group, 2002.
15. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002
16. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001

ZOO-6709 GENERAL ENTOMOLOGY

Aims and Objectives

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

Course Contents

Introduction, Phylum Arthropoda and its classification; external and internal morphology and physiology with particular reference to a typical insect; metamorphosis and its types; insect classification, salient characters of insect orders and families of economic importance with examples of each family.

Practicals

Characters of classes of Arthropoda; collection, identification and preservation of insects; external and internal morphology of typical insects; temporary mounts of different types of appendages of insects; types of metamorphosis

Recommended Books

1. Elzinga, R. T. 2003. Fundamentals of Entomology. Prentice Hall.
2. Gullan, P.I. and P. S. Crauston, 1994. The insects (*an outline of Entomology*) Chapman and Hall New York.
3. Jhonson, N.F., Triplehorn, C.A. Borror and Delong's, 2004. Introduction to the study of Insects. Brooks Cole. 7th Edition.
4. Lohar, M.K. 1998. Introductory Entomology, Kashif Publications, Hyderabad, Pakistan.
5. Main, M.S., 1990. General Entomology (4th Ed). Oxford and IBH publishing Co. Pvt. Ld. New Delhi.
6. Richards, O.W. and R. G. Davies, 1984. Imm's General Text-book of Entomology, Vol. I. and II, 10th ed. Chapman and Hall, London, N.Y.
7. Shahid, M. 1984. Lab Mannual of General Entomology. National Book Foundation, Paksitan.
8. Tonap, G. T., 1994. Experimental Entomology, An Aid to Laboratory and Field Studies. C.B.S. Publishers and Distributors Delhi.
9. Chapman, R.F. The Insects: Structure and Function, 2000. Blackwell Science Inc., London.
10. Krebs, C. J. Ecology: The Experimental Analysist Abundance. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
11. Tembhare, DB. Modern Entomology. 2002. Himalaya Publishing House, India.

ZOO-6710 GENERAL MICROBIOLOGY

Aims and Objectives

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

Course Contents

The beginnings of Microbiology: Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. **Viruses:** Bacteriophages and phages of other protists. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses. **Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material. **The Cultivation of Bacteria:** Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation. **Reproduction and growth of bacteria:** Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth. **Pure cultures and cultural characteristics:** Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures. **Eukaryotic Microorganisms:** Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

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

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

Practicals

The culture of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates. Isolation of a bacterial culture, Quantitative plating methods. The turbidimetric estimation of microbial growth.

Recommended Books

1. Pelczar, Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.
2. Peltler, G.L.A Laboratory Manual of Microbiology.
3. Benson, H.J. Microbial Applications: Laboratory Manual in General Microbiology, 1994. WMC Brown Publishers, England.
4. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.

ZOO-6711 GENERAL PARASITOLOGY

Aims and Objectives

This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure. The goals of the course are to equip students with a fundamental understanding of parasitology science and competence in relevant recent parasitological techniques.

Course Contents

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

Practicals

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

Recommended Books

1. Robberts, L. Sand Janovy John Jr. (2009). Foundation of Parasitology. 8th edition. McGraw Hill, Boston

2. Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jercey USA.
3. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
4. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
5. Olsen, O. W. (1986). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
6. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
7. Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
8. Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.
9. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
10. Walter, J.B. and Israel, M.S. (1979). General Pathology, Charchill Living Stone Edinburgh, London and New York.

ZOO-6712 GENERAL TOXICOLOGY

Aims and Objectives

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants. The will be enabled to understand the differential effects of variety of toxicants on different cellular sites. They will also learn about the procedural protocols used in toxicological studies.

Course Contents

History and general introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals; Types of Exposure and Exposure response including exposure characteristics; Spectrum of undesirable effects; Variation in toxic responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity; Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/Disposition of toxicants; Phase-I and Phase II Biotransformation Reactions; Mechanism of Toxicity; Delivery, form the site of exposure to the target; Absorption versus pre-systemic elimination; Distribution to and away form the target; Excretion versus re-absorption; Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules; Effects of Toxicant on Target Molecules; Cellular dysfunction and resultant toxicities; Toxicant-induced cellular dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

Practicals

1. Determination of LD50 values of some pesticide against any insect pest.
2. Determination of LD50 of any toxic compound in mammalian system.
3. Effect of any toxicant on body weight in mice.
4. Toxicity of some toxic compound on relative organ weight in mice.
5. Effect of toxicant on food consumption in mice.
6. Study of toxicity of any chemical on total leukocytes count.
7. Effect of toxicant on total erythrocyte count in blood of mice.
8. Effect of any toxicant on hemoglobin level in mice.
9. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice.
10. Study of liver function enzyme (Alanine Aminotransferase) activity following administration of toxic compound to experimental animals.
11. Determination of blood glucose level following toxic exposure.

Recommended Books

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

ZOO-6713 HELMINTHOLOGY

Aims and Objectives

This course aims at introducing the common parasites of man and livestock to students with a view to understanding their lifecycles, morphology, pathology, diagnosis, epidemiology and control.

Course Contents

Introduction to the phylum: Platyhelminthes, Trematoda, Aspidothelminthes, Trematoda, Form function, Life cycle and classification of digeneans, Digenians, Strigeiformes, *Schistosoma haematobium*, *S. japonicum*, *S. mansoni* (schistosomiasis); Digenians echinostomiformes; *Fasciola hepatica*, *F. gigantica*, *Paramphistomum cervi*.

Recommended Books

1. Chandler, C. and Read, C.P. 1961. Wiley Toppan. Introduction to Parasitology.
2. Crewe, W.H.K. 1977. A Guide to Human Parasitology, Lowis and Company Ltd.
3. Noble and Noble, 1982. Parasitology, The Biology of Animal Parasites, Lea and Febiger.
4. Beck, J. W. and Davies, J.E. 1981. Medical Parasitology Mosby Company, Toronto, London.

5. Cheesbrough, M. Medical 1987. Laboratory Manual For Tropical Medicine, Vol. I. University Press Cambridge.
6. Sood, R. 1998. Parasitology: Protozoology And Helminthology,
7. Smith, J.D. 1998. Introduction to Animal Parasitology, University Cambridge Press.
8. Roberts, L.S. and Janovy, J. Jr. 2000. Foundations of Parasitology, Brown Publishers, Chicago, London.

ZOO-6714 HAEMATOLOGY

Aims and objectives

Hematology is the study of blood, blood forming tissues and organs, and blood disorders. The aims of the course are to impart the knowledge and practice to the students to specialize them in the diagnosis, treatment, and prevention of blood disorders including anemia, blood clots, bleeding disorders, and blood cancers. Because blood runs through every organ and tissue in the body, hematology has an enormous ripple effect extending to all fields of medicine.

Course Contents

Introduction of blood, Constituents of blood, Function of the cellular elements of blood, Types of blood (Jaundic, Lipemic, Hemolytic, Anemic, Normal), Erythrocytes, Erythropoiesis, Effect of erythropoietin, Erythroblastosis fetalis, Anemia (Nutritional anemia, Pernicious anemia, Aplastic anemia, Renal anemia, Hemorrhagic anemia, Hemolytic anemia, Sickle cell anemia, Hypochromic anemia). Types of Polycythemia (Primary polycythemia / polycythemia vera and Secondary/ Physiological polycythemia) Types of leucocytes, Types of lymphocytes, Typical human cell count, Blood cell production (Hemopoiesis), Plasma, Composition of plasma, Importance of blood group matching before blood transfusion, Factors involved in blood coagulation and clot lysis., Platelets, Formation of a platelet plug, Role of thrombin in hemostasis, Clot pathways, Anticoagulants, Types of hemophilia, Blood doping.

Practicals

Study of erythrocytes. Differential leukocytic counts in normal and immunized animals.

Recommended Books

1. Hoft Brand, A.V. And petit, Je. (1981). Essential of Hematology, Blackwell, Oxford.
2. Essential Haematology. Hoffbrand, A.V. and Hoffbrand, I.E. 2002. Peltit and PAH Moss
3. Haematology. Dacie and Lewis. 2002.

ZOO-6715 HISTOLOGY

Aims and Objectives

The fundamental aim of histology is to determine how tissues are organized at all structural levels, from cells and intercellular substances to organs.

Course Contents

Brief introduction to cells and tissues, study of epithelial tissues, connective tissues, blood cells, lymphatic tissues and the immune system, bone and cartilage, joints, muscles. Anatomy of heart, lungs, liver, kidney, spleen, digestive tract, brain, skin and endocrine glands.

Practicals

Preparation and study of stained slides of different tissues of animals

Recommended Books

1. Eroschenko, Victor, P. (2008). Difioe's Atlas of Histology with Functional Correlations 11th Edition. Wolters Kluwer health (India) Pvt. Ltd. New Delhi.
2. Luiz Carlos Junqueira and Jose Carneiro (2005). Basic Histology Text and Atlas 11th Edition. McGraw Hill Medical Publishing Division New York.
3. Mills, Stacey, E. (2007). Histology for Pathologists 3rd Edition. Lippincott Williams and Wilkins a Wolters Kluwe Business Philadelphia.
4. Ham, Arthur W., Cormack, David, H (1987). Ham's Histology 9th Edition. J.B. Lippincott Company, Philadelphia. London.
5. Arthur Smith and John Bruton (1977). A Colour atlas of Histological Staining Techniques. Wolfe Medical Publication Ltd. London WC2.
6. Copenhaver, Wilred M., and Kelly, Douglas E., and Wood, Richard, L (1978). The Williams and Wilkins Company/Baltimore Tokyo.
7. M. Ahsan Karim, and Khalid M. Khan, (1986). A Guide Histology Practical. Feroz Sons Lahore Pakistan.
8. Ham, Arthur W., (1969). Histology 6th Edition. J.B. Lippincott Company Philadelphia Toronto

ZOO-6716 INDUSTRIAL AND MICROBIAL BIOTECHNOLOGY

Aims and Objectives

Industrial biotechnology (IB) is the use of biological resources (including plant, algae, marine life, fungi and micro-organisms) for producing and processing of materials, chemicals and energy. Microbes are also used to produce high level of industrial products through fermentation processes (e.g. brewing, bakery, industry) and enzyme engineering (as per securing vitamins, antibiotics and various biochemicals); cell and tissue technology (e.g. for increasing an organism's Physiological efficiency).

Course Contents

Application of biotechnology in industry; biotechnology of raw ore processing (bioleaching of sulphides, carbonates, silicates etc.) accumulation of metals by microbial cells, biopulping, biofuels, microbial enhanced oil recovery; application in agriculture, food and livestock products; biofertilization; production of cheese, probiotics, bread, single cell protein, citric acid, amino acid, acetic acid, production in drinks; microbial enzymes in industry, enzyme immobilization. Significance of Industrial Microbiology, Classification of microorganisms, fermentation principles, Culture techniques, Measurement and control of microbial processes, Introduction of probiotics. Introduction to industrial biotechnology, Biotechnology in textile, Chemical, Food, Pharmaceuticals, Agricultural industries, Industrial biocatalysts, Industrial waste, Industrial strain improvement, Screening for new metabolites, Recombinant DNA technology, Substrates for industrial fermentation, Regulation of primary and secondary metabolism, Design and development of industrial bioreactors, Problems and possibilities in fermentation scale up procedure, Bioreactors, Fermentors and controls, Bioenergy and Biofuels, Product recovery and refinement.

Practicals

Screening of enzymes of industrial significance, enzyme immobilization; Production of cheese, yogurt, citric acid, amino acid and acetic acid.

Recommended Books

1. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
2. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
3. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
4. Yount L., Genetic Engineering, Gale group, 2002.
5. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002.
6. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001.

ZOO-6717 INVERTEBRATA

Aims and Objectives

The course is designed to provide students with the concepts of structure, classification biology and evolutionary relationship of invertebrate phyla.

Course Contents

Structure, classification and biology of Protozoa, Mesozoa, Coelenterata, Centiphora, Platyhelminthes, Nematoda, Rotifera, Annelida, Echiurida, Sipunculida, Bryozoa, Branchiopoda, Mollusca and Echinodermata.

Practicals

Preparations of slides, Daphnia, Cyclops, Housefly, Mosquito, Mouth parts of cockroach and butterfly, Honey bee, Museum study of prepared slides.

Recommended Books

1. Parker and Haswell. A Text Book of Zoology (Vol .1) McMillan. London
2. Barrington, E.J.W., (1969) Invertebrates structure and function, the English Language book society, London.
3. Henger and Engelmann. Invertebrate Zoology.
4. Borradiel, L.D., (1963). The Invertebrata Cambridge university press
5. Hyman, L.H. (1940). Invertebrates (Vol 1.VI). McGraw-Hill, New York.

ZOO-6718 LIMNOLOGY-A

Aims and Objectives

To provide information about inland waters, biological productivity and to minimize the pollution of inland water for better aquaculture production. The student will be able to learn about physical and chemical properties of water in order to increase biological production.

Course Contents

Definition, Importance, Inland waters, Sources of bottom materials, Physical features of water, temperature, light, currents, density and water turbidity. Chemical features of water dissolved gasses, dissolved solids, pH, Electrolytes alkalinity, hardness, salinity, brief description of nitrogen and phosphorous cycles.

Practicals

Survey of major water bodies in Azad Kashmir and Pakistan (lotic and lentic waters). Morphometric analysis of rain water, stream water, lake water, pond water and ground water. Preliminary general tests, odour, colour, dissolved gases, dissolved solids, suspended solids, pH, alkalinity, salinity, hardness, micronutrients.

Recommended Books

1. Goldman, C.R. and Horne, A.J. 1983. Limnology. McGraw Hill, International Book Company, Japan.
2. Welch, P.S. 1968. Limnology, 4th Edition, McGraw Hill book. Inc. New York.

3. Allen S. E. 1990. Chemical Analysis of Ecological Materials, Scientific Publishers, London.
4. Robert G. Wetzel. 1983. 2nd Edition. Limnology. Saunder Publishers, New York.
5. Gerald A. Cole. 1983. 3rd Edition. A Text Book of Limnology. Waveland Press Inc. USA.

ZOO-6719 NEUROPHYSIOLOGY

Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to the body coordination through cell membran, nerve, muscle excitation and receptor function.

Course Contents

Foundation of excitability at cell membrane level: Membranes, channels and transport. The physical basis of neuronal function: Membrane excitation, resting and action potentials. Communication along and between neurons: Propagation of action potential, synaptic transmission, pre and postsynaptic mechanisms. Neurotransmitters: synthesis, release and their fate. Learning related changes at synapse. Neurochemical basis of behaviour. Organization of sensory receptors. Physiological basis of receptors functions: Mechanoreceptors, photoreceptors, chemoreceptors, Thermoreceptors, Electroreceptors and Nocireceptors.

Practicals

Experiments demonstrating: Nervous organizations in vertebrates (mammals), Potentials particularly the nerve impulse. Nervous regulation of functional system.

Recommended Books

1. Aidley, J. David, 1998. The Physiology of excitable cells. Cambridge University Press, Cambridge, U.K.
2. Ganong, W.F., 2000. Review of Medical Physiology. Prentice-Hall International Inc., London.
3. Randall, D., Burggren, W. And French, Kathleen, 1998. W.F. Freeman and Company, New York.

ZOO-6720 PRINCIPLES OF FISH BIOLOGY

Aims and Objectives

The aim of this course is to enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular. It comprises morphology, anatomy, classification and some understanding about various feeding groups found in different water bodies. After having complete knowledge of above, students will be able to practice independently.

Course Contents

Fish Morphology: Head (Size, shape, and orientation), Scales (types, arrangements, coloration, scaleless fishes), Operculum, fins, fin rays and fin spine (Dorsal, pectoral, caudal, anal), Barbel (upper lip barbels, lower barbels). Anatomy: Skeleton (skull, backbone, spines), Brain and spinal cord, Gills (No, size, arrangements), Vital organs (heart, liver, kidney), Viscera and mesenteries. Swim bladder, stomach, spleen, pancreas, intestine, glands. Systematic: Identification of fishes up to; families, Order, Genus and Species, Feeding groups of fishes, herbivore, Plankton eater, Larvivore, Carnivore, Voracious. Ecology of fishes: Freshwater, Brackish water, Marine.

Practicals

1. Collection, Preservation and identification of freshwater fish species.
2. Study of different organs of various fish species
3. Study and survey of various fish collection present in museum like Natural History Museum at Islamabad, G.C. Lahore and at P.U. Lahore.

Recommended Books

1. Kestin Farmed Fish Quality (2001).
2. Woo. Fish diseases and Disorder: *Protozoan and Metazoan infections* (1995)
3. Brenabe Aquaculture Vol. I and II (1992) Fishing News Books Ltd. England
4. Maseke C. Aquaculture, I and II (1992) Pergamon Press, Oxford.
5. Huet M. Text Book of Fish Culture: *Breeding and cultivation* Fishing News Book Ltd. England.
6. Kestin, S. C. and Warris, P.D. (Edition). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.

ZOO-6721 PRINCIPLES OF HERPETOLOGY

Aims and Objectives

The aim of this course is to provide knowledge about the classification, population and distribution of amphibia and reptiles with reference to their ecological adaptations and interactions.

Course Contents

Classification of amphibians and reptiles. Evolution, geographical distribution, population biology of reptiles and amphibians. Biology, including anatomical, physiological adaptations to their environment, reproduction, foods/feeds, communication (vocal, chemical, behavioural). Mechanism of hibernation in herpeto-fauna (effect of climatic factors). Poisonous species. Sensory mechanisms, predator-prey relationships, chemistry and physiological actions of venoms and patho-physiology and treatment of snake bite.

Practicals

1. Visit of PMNH for study of preserved specimens of herpeto-fauna in relation to their taxonomy and ecosystem.
2. Field visits of different habitats for direct/indirect observations of amphibians and reptiles with respect to their ecologies and weather conditions.
3. Visit to Zoos and wildlife parks.

Recommended Books

1. Daniel, J.C. 1992. The Book of Indian Reptiles. Bombay Natural History Society, India.
2. Girard, C. 1978. Herpetology. Arno Press.
3. Pough, F. H. 2001. Herpetology. Prentice Hall.
4. Zug, G. R. 1993. Herpetology: An introductory biology of Amphibian and Reptiles. Academic Press.
5. Sharif, M. Herpato-Fauna of Pakistan.

ZOO-6722 PRINCIPLES OF PARASITOLOGY

Aims and Objectives

This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure.

Course Contents

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Camers in parasitology. Some basic definitions. Basic principles and concepts. Parasite ecology and evolution. Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship. Parasitic protozoa, form, function and classification: Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae. Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebida, order Schizopyrenida. 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, class Oligohymenophorea. Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa. 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. Pathology of Helminths: Host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

Practicals

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 faecal 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 Books

1. Roberts, L.S. and Janovy, J. Foundation of Parasitology, 6th Edition. 2000. McGraw Hill Book Co.
2. Hausman, K. and Hulsmann, N. T. Protozoology, 2nd Edition. 1996. Medical Publishers, Inc. New York.
3. Noble, E.R. and Noble, G.A. Parasitology. The Biology of Animal Parasites. 5th Edition. 1982. Lea and Febiger Publisher.
4. Beck, J.W. and Davies, J.E. Medical Parasitology. 3rd Edition. 1981. C.V. Mosby Company, Toronto, London.
5. Cheesbrough, M. Medical Laboratory Manual for Tropical Medicine. Vol.I. 1987. University Press Cambridge.
6. Smyth, J.D. Introduction to Animal Parasitology. 1994. Cambridge University Press.
7. Roberts, L.S. and Janovy, J. Jr. Foundations of Parasitology. 7th Edition. 2005. Wm Brown Publishers, USA.
8. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. Veterinary Parasitology. 2000. Longman Scientific and Technical publications, Longman Group, UK.

ZOO-6723 REPRODUCTIVE PHYSIOLOGY

Aims and Objectives

The aim of the subject is to learn about the essential reproductive, histology and physiology of reproductory organs and other relevant organs to integrate this knowledge to study processes that regulate metabolic processes in the body. In addition it includes the study processes of

reproduction and examples of bodily dysfunction and disease that illustrate the basic principles of normal physiology through the absence of normal function.

Course Contents

Note: The emphasis shall be mainly on human being and poultry.

Cytological and genetic basis of sex. Female and male reproductive tracts, morphology and histology. Differentiation of sex and role of hormones. Gonadotropins, their chemistry and physiological characteristics. Mammalian ovary. Mammalian female reproductive cycles and its controlling mechanisms. Oogenesis and Folliculogenesis. Brief study of avian ovary and its functional mechanisms. Mammalian testis. Spermatogenesis in man and domestic animals. Accessory sex organs in male mammals. Fertilization, early development, embryo transfer and implantation. Hormonal mechanisms in pregnancy, parturition. Mammary Gland development, milk synthesis and lactation. Nutrition and reproductive efficiency. Anti-fertility mechanisms in human. Sterility causes in domestic animals.

Practicals

Study of male and female reproductive tracts in a mammal and a bird. Histology of different parts of the tract. Study of Spermatogenesis and folliculogenesis. Study of reproductive cycles in a mammal. Experiments on nutrition and reproductive efficiency in mammals and birds.

Recommended Books

1. Parkes, D.A. Marshalls, Physiology of Reproduction (Vol. I, II and III).
2. Young, W. C. Sex and Internal Secretion (Vol. I and II), Williams and Wilkins Co. London
3. Cole, H.H. and Cupps, P. T. (1977). Reproduction in Domestic Animals, Academic Press, New York.
4. Bearden H.J. and Fuquay, (1980). Applied Animal Reproduction, Reston Publishing Co. Inc. Reston.
5. Finn, C.A. (1979-81). Oxford. Review of Reproductive Biology (Vol. I, II and III), Clarendon Press, Oxford.
6. Hafez, E.S.E. (1982). Reproduction in Farm Animals, Lea and Febiger.

ZOO-6724 WILDLIFE PARASITOLOGY

Aims and Objectives

1. To give knowledge to the students about parasites of wild animals and birds fauna as previously this field of study was ignored.
2. To impart tools of parasites survey of wild fauna and methods of parasites collection to students in field study.

Course Contents

Overview of wildlife: A brief outline of wild-life in Pakistan; introduction and classification. Introduction to wildlife parasitology: Host parasite relationship; Occurrence and prevalence of parasites in Wild animals such as Mammals with exception to Carnivora; Birds; and Reptiles excluding Crocodilla; Pathogenesis of parasitic infection; Diagnosis, Prevention and Treatments. Diseases dissemination: Role of wild animals in spreading of parasitic diseases to Domestic Animals and Man; Control of Ecto and Endo-parasites of wild animals and birds; Zoonotic and Epizootic of wild-wide importance.

Practicals

1. Collection of literature on parasites of wild animals and birds.
2. Collection of parasites, faces / droppings from wild animals and birds.
3. Processing of parasitic material for examination.
4. Preparation of permanent mounts.
5. Identification of parasites

Recommended Books

1. Bush, A. O., Fernandez J. C., Esch, G. W. and Seed, J. R. 2001. Parasitism: The diversity and Ecology of animal Parasites. Cambridge University Press, Cambridge, UK.
2. Fowler, M. E. 1999. Zoo and wild animal medicine: Current Therapy-4 w. b. Saunders Company Philadelphia, USA.
3. Smyth, J. D. 1994. Introduction to animal Parasitology. 3rd Edition Cambridge University Press, Cambridge, UK.
4. Davis, J.W. and Anderson, R. C. 1971. Parasitic diseases of Wild Mammals. The Iowa State University Press, Ames, Iowa, USA.
5. Soluby, E. J. L. 1986. Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Edition Bailliere and Tindal, London.
6. Lavin. N. D. 990. Veterinary Parasitology. The Iowa State University Press. Ames, Iowa,