DEPARTMENT OF ZOOLOGY

APPROVAL

CURRICULUM M.Sc (2YEARS) PROGRAM

SESSION 2019 and Onwards

Submitted by:

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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY
SCHEEME OF STUDY M.SC (2YEARS) SESSION: 2019 AND ONWARDS

S.NO	Semester	COURSE TITLE	COURSE CODE	Theory	Practical	CREDIT HOURS
1.	1st	Principles of Biochemistry	BCHM-	2	1	3
2.		Elements of Statistics and Biometry	STAT-501	3	0	3
3.		Functional English-I	FENG-510	2	0	2
4.		Molecular Biology	ZOL-513	2	1	3
4.		Evolutionary Biology	ZOL-514	3	0	3
5.		Animal Behavior	ZOL-515	3	0	3
		Total Credit Hours				**17**
S.NO	**Semester**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
7.	2nd	Research Planning and Report Writing	ZOL-521	2	0	2
8.		Animal Ecology	ZOL-522	2	1	3
9.		Parasitology	ZOL-523	3	1	4
10.		Principles of Genetics	ZOL-524	2	1	3
11.		Wild life Conservation and Management	ZOL-525	2	1	3
12.		Functional English-II	FENG-520	2	0	2
		Total Credit Hours				**17**
S.NO	**Semester**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
13.	3rd	Zoogeography and Paleontology	ZOL-631	3	0	3
		Principles of Animal Systematics	ZOL-632	2	1	3
		Entomology	ZOL-634	2	1	3
14.		Animal Diversity	ZOL-635	3	1	4
16.		Microbiology	ZOL-636	2	1	3
		Total Credit Hours				**16**
S.NO	**Semester**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
18.	4th	Endocrinology	ZOL-641	2	1	3
19.		Developmental Biology	ZOL-642	2	1	3
20.		Animal Physiology	ZOL-643	3	0	3
21.		Research Project OR	ZOL-699/	0	6	6
		Optional Course + internship	ZOL- ZOL-690	2 3	1 3	3 3
		Total Credit Hours				**15**

Total credit hours: 67

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY
COURSES WITH COURSE CODES M.SC (2YEARS)
SESSION: 2019 AND ONWARDS

Course Category	Courses Title	Course Codes	Theory	Practical	Credit hours
COMPULSORY-I	Functional English-I	FENG-510	2	0	2
COMPULSORY-II	Functional English-II	FENG-520	2	0	2

Course Category	Course Title	Course codes	Theory	Practical	Credit Hours
General-I	Elements of Statistics and Biometry	STAT-501	3	0	3

Course Category	Courses Title	Course Code	Theory	Practical	Credit Hours
Foundation-I	Principles of Biochemistry	BCHM-	2	1	3
Foundation -II	Molecular Biology	ZOL-513	2	1	3
Foundation -III	Principles of Genetics	ZOL-524	2	1	3
Foundation -IV	Evolutionary Biology	ZOL-514	3	0	3
Foundation -V	Zoogeography and Paleontology	ZOL-631	3	0	3

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY
COURSES WITH COURSE CODES M.SC (2YEARS)
SESSION: 2019 AND ONWARDS

Course Category	Courses Title	Course Code	Theory	Practical	Credit Hours
Major-I	Animal Ecology	ZOL-522	2	1	3
Major-II	Developmental Biology	ZOL-642	2	1	3
Major-III	Animal Physiology	ZOL-643	3	0	3
Major-IV	Wild life Conservation and Management	ZOL-525	2	1	3
Major-V	Entomology	ZOL-634	2	1	3
Major-VI	Animal Diversity	ZOL-635	3	1	4
Major-VII	Principles of Animal Systematics	ZOL-632	2	1	3
Major-VIII	Endocrinology	ZOL-641	2	1	3
Major-XI	Research Planning and Report Writing	ZOL-521	2	0	2
Major-X	Parasitology	ZOL-523	3	1	4
Major-XI	Microbiology	ZOL-636	2	1	3
Major-XII	Animal Behavior	ZOL-515	3	0	3

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY
COURSES WITH COURSE CODES M.SC (2YEARS)
SESSION: 2019 AND ONWARDS

Serial No.	Optional Courses Title	Course Code	Theory	Practical	Credit Hours
1.	Ichthyology	ZOL- 645	2	1	3
2.	Reproductive Biology	ZOL- 646	2	1	3
3.	Environmental Biology	ZOL- 647	2	1	3
4.	Biomembranes and Signal Transduction	ZOL- 648	2	1	3
5.	Enzymology	ZOL- 649	2	1	3
6.	Principles of Gene Manipulation	ZOL- 650	2	1	3
7.	Clinical Biochemistry	ZOL- 651	2	1	3
8.	Research Techniques and Instrumentation	ZOL- 652	2	1	3
9.	Vitamins and Hormones	ZOL- 653	2	1	3
10.	Medical Microbiology	ZOL- 654	2	1	3
11.	Immunology	ZOL- 655	2	1	3
12.	Protozoology	ZOL- 656	2	1	3
13.	Freshwater fish culture	ZOL- 657	2	1	3

SEMESTER –I

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DETAILS OF COURSES

REVISED CURRICULUM M.SC (2-YEARS) 2019 AND ONWARDS

SEMESTER-I

Course Name: Principles of Biochemistry	**Course Code: BCHM-**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Introduction and Importance, Hydrogen bonding in water, solvent properties of water, chemical equilibrium, pH, acids and bases, buffers, the Henderson-Hesselbach equation, bicarbonate buffer system of blood, Enzymes.

The ATP cycle of bio-energies structure and biological function of carbohydrates, lipids, proteins and nucleic acids. Glycolysis, the citric acid cycle, electron transport, oxidative phosphorylation and regulation of ATP production. Oxidation of fatty acids and amino acids, urea cycle.

Laboratory Work Outline

1. Titration of a strong acid with a strong base.
2. The determination of pKa, preparation of buffers.
3. Titration curves of amino acids, determination of amino acids
4. Identification of an unknown carbohydrate
5. Determination of lipids in a given sample.

Books Recommended

1. Darnell Jr. J., Lodish, H. and Balimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.
2. Voet, D. and Voet, J.G., (1990). Biochemistry, John Wiley & Sons.
3. Zubay, G.L., (1995). Principles of Biochemistry. McMillan Publishing Co.
4. Stryer, L. (1995). Biochemistry, W.H. Freeman & Co., New York.
5. Davlin, J. 1992. Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons.
6. Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemistry. Worth Publishers, N.Y.
7. Wilson, K., and Goulding, K.H. (2000). A Biologist's Guide to Principles and Techniques of Practicals of Biochemistry. Edward Arnold.
8. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3rd Edition. John Wiley Sons, Inc., N.Y.

Course Name: ELEMENTS OF STATISTICS AND BIOMETRY	**Course Code: STAT-501**
Course Structure: Lectures: 3, Lab: 0	**Credit Hours: 3**

COURSE OUTLINE

Course Objectives: To provide knowledge of importance of and its application in Biological Sciences. Understanding of use of statistical techniques to summarize and analyze Biological data.

Learning Outcomes: Upon successful completion of this course the students will be able to:
Understand the applications of statistical tools in biological science.
Demonstrate an understanding of the central concepts of statistical theory in Biological Sciences.
Apply appropriate statistical techniques to Biological data and analyze and communicate the results of statistical analysis effectively.

Course Contents: Introduction to Biostatistics its scope and importance. Data types, variables; Categorical, numerical and censored data. Descriptive Statistics; Measure of central tendency; mean, median, mode. Measure of dispersion; Variance and standard deviation. Simple linear regression; model fitting. Correlation; correlation co-efficient, co-efficient of determination. Chi-square and T-test. Logistic regression. Logit transformations and their analysis, p values and its importance and role. Hypothesis testing.

Course Name: Molecular Biology	**Course Code: ZOL-513**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Introduction: gene theory, structure of DNA, concept of gene, mutation gene structure and function. DNA replication: prokaryotic and eukaryotic, viral, DNA repair, recombination, transonses their insertion sequence, gene expression: and translation: transcription, pro and eukarotic biosynthesis of RNA ad its regulation, initiation, elongation, and termination, RNA polymerase function and modulation of its activity: promoters, operators repressor, terminator, regulation, post transcriptional processing of rtRNA, mRNA, rRNA, Bacterial protein synthesis and regulation; Eukaryotic protein synthesis and regulation, post translational modification, organelles genome.

Laboratory Work Outline

1. Preparation of plasmid DNA
2. Restriction enzymes digestion of DNA
3. Separation of DNA fragments by gel electrophoresis
4. Determination of melting temperature of DNA

Books Recommended

1. Darnell Jr. J., Lodisch, H. and Balimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.
2. Zubay, G.L., (1995). Biochemistry, W.H. Freeman & Co., New York.
3. Griffiths, Anthony J. f., Et. Al. (2002). Modern genetic analysis: Integrating genes and genomes Edition 2nd W.H. Freeman, New York.
4. Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemistry. Worth Publishers, N.Y.
5. Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemsitry. Worth Publishers, N.Y.
6. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3rd Edition. John Wiley Sons, Inc., N.Y.
7. Weaver, Robert F. (1999). Molecular Biology McGraw-Hill, Boston.

Course Name: Evolutionary Biology	**Course Code: ZOL-514**
Course Structure: Lectures: 3, Lab: 0	**Credit Hours: 3**

COURSE OUTLINE

Pre-Darwinian concept of evolution. Darwin's concept of natural selection, support and challenges for Darwin. The nature of evaluation including evidences for evolution and history of modern evolutionary theory.

The origin of hereditary variation, the genetic structure of populations; races, subspecies; reproductive isolation. Role of mutations, migration, selection, and random genetic drift in evolution.

Gene frequencies and Hardy-Weinberg equilibrium. Origin of universe and earth, geological dating, origin of life.

Books Recommended

1. Strickberger, M. W. (2005). Evolution. Jones and Bartlett, USA
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.W. Valentine. (1977). Evolution, W.H. Freeman and Company, Saw Francisco.
3. Hall BK, Hallgrímsson B, Strickberger MW. (2008). Strickberger's evolution: Jones & Bartlett Learning.
4. Ridley, M. (2004). Evolution. Blackwell Science.
5. Barton NH. (2007). Evolution. CSHL Press, 2007. Hardcover 833 pages.
6. Hedrick PW. (2005). Genetics of populations. Jones & Bartlett Learning, Hardcover. 737 pages
7. Jarman, C. (1972). Evolution of Life. A Bantam Book/published by arrangement with Grosset and Dunlap, Inc.
8. Stebbins, G.L. (1971). Process of Organic Evolution. Prentice-Hall, Inc.
9. Ayala, f.J. (Editor) (1976). Molecular Evolution. Sinauer Associates, Inc.

Course Name:Animal Behavior	**Course Code: ZOL-515**
Course Structure: Lectures: 3, Lab: 0	**Credit Hours: 3**

COURSE OUTLINE

Introduction to animal behavior; foundations of ethology, natural selection, conceptual, theoretical and empirical approaches, learning, imprinting, conditioned behavior; ultimate and proximate causation, control of behavior by nervous system and biochemical factors, biological rhythms, clock genes and zeitgebers; sex determination and sex ratios; description and measurement of behavior; Causes of behavioral change; development of behavior; adaptive significance of behavior; phylogeny of behavior; behavioral genetics; applied ethology; habitat selection, niches, migration, hormones and animal behavior, steroid synthesis ad metabolism; mating, fighting, parenting, signaling, social relationship and organization; dominance, territoriality, development of sexes and types, theories of sexual selection and mate choice, mating systems, monogamy, polygamy and polygyny; parental care, social organization and kinship; cooperation; altruism; coalition; optimal foraging theory, foraging alone and in groups, honeybee foraging; predation; communication and honesty; aggression, agonistic behavior and competition; conflict, migration, orientation navigation; animal play behavior; boldness, shyness; evolutionary change and species differences; life strategies and life histories; examples to explain behaviors should be taken from variety of invertebrates vertebrates and humans, human social behavior and human psychology; facial features, gestures, societies, races, impact of religion on human behavior, social relationships, marriage systems from around the

world.

Laboratory Work Outline

1. Study of aquarium fishes and frogs for courtship, nesting, foraging, egg laying
2. Field study of bird and mammalian behavior through visits to aviaries and zoos, nesting behavior of birds, through binoculars
3. Study of altruistic behavior in rats and related species
4. Small experiments to show kinship and cannibalistic behavior
5. Study of parental care in different vertebrate classes
6. Study of mouse or rat behavior regarding mating, selection and parental care
7. Study of monkey behavior regarding aggression, dominance, grooming
8. Preparation of ethograms and presentation of data
9. Recording bird songs and animal vocalizations
10. Behaviors of large predators, to understand survival strategies
11. Study of human facial expressions and postures

Books Recommended

1. Adkins-Regan, E. 2005. Hormones and animal social behavior. Princeton University Press.
2. John Alcock. 2010. Animal behavior, an evolutionary approach. 9th Edition. Sinauer Publishers.
3. Scott, G. 2009. Essential Animal Behavior. Wiley publishers.
4. Drickamer, L. C; Vessey, S. H; Jakob, E. M. 2002. Animal behavior: mechanisms, ecology, evolution. 5th ed. McGraw Hill Higher Education.
5. Dugatkin, L. A. 2004. Principles of animal behavior. 1st ed. W. W. Norton & Co. Inc.
6. Sherman, P. W; Alcock, J. (Editors). 2001. Exploring animal behavior. 3rd ed. Sinauer Associates, Inc.
7. Huntingford, F. 1984. The study of animal behavior. Chapman and Hall.

SEMESTER-II

COURSE NAME: Research Planning and Report Writing	**COURSE CODE:** ZOL -521
COURSE STRUCTURE: Lectures: 2, Labs: 0	**CREDIT HOURS:** 2

COURSE OUTLINES

Introduction: Research and professions.

- Understanding the research process.
- History and Principles of research ethics.
- Originality of Research
- Conflicts of interest.
- Copyright and Patent Law.
- Aims of research, the research topic.
- Title and research problem.
- Literature review: Search, retrieve and manage information.
- Research design.
- Parametric, non-parametric and semi-parametric methods.
- Qualitative Methodologies and interpretation of results.
- Conclusions and its validity.
- Report writing and the research proposal.
- Community Research.
- Principles of presentation.
- Communication-oral, posters.
- Abstract and manuscript preparation.
- Communicating your own credentials.
- Communicating own work-CV.

Recommended Books

1 Ann Bowling, A. and Ebrahim S., 2005. Handbook of Health Research Methods. Open University Press, Two Penn Plaza, New York, NY.
2. Baumgartner, T. and Hensley, L. 2006. Conducting and Reading Research in Health and Human Performance 4th ed. McGraw-Hill, New York.
3. Kumar, R., 2010.Research Methodology: A Step-by-Step Guide for Beginners. 3rd edition. SAGE Publications, London
4. Flick,U., 2011.Introducing Research Methodology: A Beginner's Guide to Doing a Research Project SAGE Publications London
5. Chilisa, B.,2011.

Course Name: Animal Ecology	**Course Code: ZOL-522**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Introduction: Its meaning and scope. The biosphere: atmosphere, hydrosphere and lithosphere. Ecosystem, biotic and a biotic component. Flow of energy and laws of thermodynamics. Primary productivity and secondary production. Trophic structures: food chains (grazing and detritus) food webs, ecological pyramids and ecological efficiencies. Communities: Biological structure, dominance, richness and evenness, index of diversity and similarity. Patterns in communities and community dynamics.

Population: properties, density, dispersion, age structure and pyramids, population growth, natality, mortality, survivorship curves, population fluctuations, intra specific population regulations, interspecific interactions: herbivory, predation, parasitism, mutualism, human interaction with natural population.

Biogeochemical cycles of C or O, N or P or S, chlorinated hydrocarbons, heavy metals. Global Environmental changes and their effects: Increase in greenhouse gases, ozone hole, acid rain, use of non-biodegradable substances. Pollution, Nuclear Power, Loss of Biodiversity and its conservation.

Laboratory Work Outline

1. Measurement of environmental factors on land, water and air.
2. Study of different ecosystems: pond, agricultural or grassland, forest.
3. Community analysis through different sampling techniques (quadrat, transect).
4. Population dynamic of grasshoppers.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of the gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.
9. Development of an ecological management plan of some selected area.

Books Recommended

1. Krohne, D. T. (2001). General Ecology. 2nd Ed. Books and Cole Thomson Learning
2. Manuel L. Mouls Jr. (2002). Ecology, concepts and applications. 2nd Ed.
3. McGraw Hill Co.
4. Stiting, P. (2002). Ecology: Theories and Applications. 4rth Ed. Prentice Hall of India
5. Towsend, U. R.., Harper, J. L. and Begon, M. (2000). Essentials of Ecology. Ist Ed. Blackwell Science.
6. Smith, R. L. and Smith, T. M. (1998). Elements of Ecology. 4rth Ed. The Benjamin/Cummings Publishing Co.
7. Mackenzie, A., Ball, A. Virde, S. R. (1998). Instant notes in Ecology. Ist Ed. BIOS Scientific Publishers.
8. Odum, E.P., 1994. Fundamentals of Ecology. W.B. Saunders.
9. Moles, M.C., 2002. Ecology: Concepts and Applications. McGraw Hill, Boston.
10. Dodson, 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, Oxford.
11. Singby, D. and Cork, D., 1986. Practical Ecology. McMillan Education Ltd., London.
12. Chapman, J.L. and Reiss, M.J., 1997. Ecology. Principles and Application. Cambridge Univ. Press, Cambridge.
13. Smith, R.L. 1996. *Ecology and Field Biology*, Harper and Row.
14. Southwick, C.H., 1976. *Ecology and Quality of our Environment*. D. Van Norstrand Co, New York.
15. Boyd, C.E. 1981. *Water quality in warm water fish ponds*. Craft Master Printers Incorporation, Alabama.

Course Name: Parasitology	**Course Code: ZOL-523**
Course Structure: Lectures: 3, Lab: 1	**Credit Hours: 4**
COURSE OUTLINE	
History and origin of parasitism. Science and terminology. Host-parasite relationships: Phoresis, commensalisms, mutualism, parasitism, theory of parasitism, host specificity. Transmission of parasites. Responses: resistance, tolerance, immunity. Effects of parasites on their hosts and pathology. Evolution of parasites: variations, origin, factors affecting evolution, stability of parasitism. Ecology of parasites: variations, origin, factors affecting evolution, stability of parasitism. Ecology of parasites. Biotic potential among parasites. Various theoretical and experimental aspects of parasite physiology: osmoregulation, excretion, oxygen requirements and growth requirements of Protozoa and Helminthes.Classification of relationships between two individuals: symbiosis, commensalism, parasitisms, myiasis, zoonosis, infection and infestation. Evolutionary aspects related to parasites, geographical distribution factors affecting the geographical distribution, patterns of distribution. Habitat within the host. Epidemiology: incidences of occurrence and prevalence. Classification of parasites: Ectoparasites, endoparasites, temporary parasites, permanent parasites, facultative parasites, occasional or accidental parasites, wandering parasites or aberrant parasites (brief account and examples). Classification of hosts: Definitive hosts, intermediate hosts, paratenic hosts. Host susceptibility and specificity. Various types of susceptibilities. Host-parasite relationships. Morphology and physiology of parasites: Adaptions to parasitic mode of life. Effects of parasitism on parasites. Effects of parasites on hosts: Influence of parasites on host populations. Pathological responses, immuno-parasitology: immunity and immune responses of host. Diagnosis, prevention, control treatment, common drugs and anthelmintics. Vector control methods. Animal Parasitology (Protozoology, Helminthology, Veterinary and Medical Entomology) a. Protozoology: Protozoan parasites of man and otheranimals, classification, life cycle, habitat, morphology,epedimiology and immunopathology of infections e.g.,*Entamoeba* spp. Pathogenic amoeba, *Giardia* spp.,Trichomonas, Trypanosoma, Leishmania,	

Coccdia,Plasmodium and other protozoan parasites ofimportance.b. Helminthology: Helminth parasites of man and otheranimals, general account, classification, biology, lifecycle, pathology and symptomology and immunology.Platyhelminthes: e.g. Polysystoma, Trematodes: e.g.,Fasciola, Schistosoma, Diplastomun. Cestodes: e.g.Taenia, Diphyllobothrium, Acanthocephalas (spinyheaded worms). Nematodes: Trichuris, Trichinella,Strongyloides, Ancylostoma, Trichostrongylus,Haemonelm, Toxocara, Filaria worms etc.c. Medical and Veterinary Entomology: Biology andclassification of arthropods of veterinary and medicalimportance. Arthropods as parasites and blood suckers.Biology and life cycle e.g. crustaca, linguatolids, lice,mites, ticks, mosquitoes, fleas, flies, bugs etc. Effects ofbites, allergies, pathology and immunology. Arthropodsas disease transmitters/vectors.

Laboratory Work Outline

1. Study of the prepared slides and preserved specimens of parasites: Protozoan parasites, helminth parasites, Arthropod parasites.
2. Epedimiology of parasitic infections. Survey of incidences of occurrence and prevalence using soil, water (canal drain water samples) and animal population (chicken, goat/sheep, rat, fish etc.), Faecal Egg count Techniques). Survey and study of vectors/intermediate host (population etc.).
3. Preparation of slides for the study of structure of egg larvae of various helminth parasites and staining of cross-section through body regions. Preparation of protozoan parasites slides with various staining techniques. Study and preparation of slides/preservation of arthropod parasites.
4. Study of various host tissues for morphological changes in hosts (prepared slides or diagrams showing comparison) could be used to study the differences.
5. Techniques of collection of parasite samples, preservation and preparation of slides for the study of the morphology.
6. Identification of vector hosts in various habitats and their morphology.
7. Identification of parasites and classification with particular reference to adaptations as parasitic mode of life.
8. Heamatological studies of blood samples of infected/non-infected hosts (sheep/goat, chicken/fish).

Books Recommended

a. 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, U.K.
b. Matthews, E. E. (1998). An introduction to parasirtology. Cambridge Univ. Press.
c. Smyth, J. D. (1994). Introduction to Parasitology. 3rd Ed. Cambridge Univ. Press.
d. Cox, P. E. G., Krcier, J. P. and Wakelin, D. (1998). Parasitology 9th Ed. Oxford Univ. Press.
e. Smyth, J.D., 1994. Introduction to animal parasitology, 3rd Ed. Cambridge Univ. Press, Cambridge, U.K.
f. Roberts, L.S. and Jonovy, J. Jr., 1996. Foundation of Parasitology, 5th Ed. Wan Brown Publishers, Chicago, U.S.A.

g. Beaver, P.C., Jung, R.C. and Cupp, E.W., 1984. Clinical parasitology, 9th Ed. Lea and Febiger, Philadelphia.
h. Cheesbrough, M., 1981. Medical laboratory manual for tropical countries. Stephen, Austen, Hertford.
i. Noble, E.R. and Noble, G.A., 1989. Parasitology: The Biology of Animal Parasites. Lea and Febiger, Philadelphia.
j. Chappell, L.H., 1980. Physiology of Parasites. Blackie, U.K.
k. Lapage, G., 1962. Monning's Veterinary helminthology and Entomology. Bailiers, Tinndall and Company, London.
l. Beck, J.W. and Davies, J.E., 1981. Medical Parasitology, 3rd Ed. The C.V. Mosby Co., London.
m. Barriga, O.O., 1981. The immunology of parasitic infections. University Park Press, Baltimore.
n. Buckle, A.P. and Smith, R.H., 1994. Rodent Pests and their Control. Cab. International, Oxford, U.K.
o. Wakelin, D., 1984. Immunity to parasites. How animals control parasitic infections? Edward Arnold, London.

Course Name: Principles of Genetics	**Course Code: ZOL-524**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Introduction, scope and brief history of genetics. Mendilian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance. Sex linked inheritance, sex linkage in Drosophila and man, XO, XY, WZ mechanism, sex limited and sex linked characters, sex determination. Linkage and crossing over: Definitions, linkage groups, construction of linkage maps, detection of linkage.

Chromosomal aberrations: Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation. Molecular genetics: DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression(e.g lac operon). Transmission of genetic material in Bacteria: Conjugation and gene recombination in E.coli, transduction and transformation. Principles of genetic engineering/biotechnology; basic genetic engineering techniques. Application of genetics in animalimprovement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens.

Laboratory Work Outline

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.
4. Study of Human Chromosomes/models.
5. Polyploidy in plant cells

Books Recommended

1. Hoelzel, A.R. 2001. Conservation Genetics. Kluwar Academic Publishers.
2. Lodish. H. 2001. Molecular Cell Biology. W.H. Freeman and Co.
3. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
4. Strickberger, M.V. (1988). Genetics, MacMillan Press Ltd., London.
5. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity-Molecular Genetics and the Evolution of Animal Design. Blackwell Sciences.
6. Lewin, R. 1997. Principles of Human Evolution. Blackwell Science.
7. Smith, J. (1998). Evolutionary Genetics 2nd edition.
8. Snustad, D.P. (1997). Principles of Genetics. John Wiley & Sons, inc.
9. Griffiths, Anthony J.F., et. al. (2002). Modern genetic analysis: integrating genes and genomes. Editions 2nd W.H. Freeman, New York.
10. Schleif, R. (1993). Genetics and molecular biology. Edition 2nd Johns Hopkins

University Press, Baltimore.
11. Miesfeld, Roger L. (1999). Applied molecular genetics. John Wiley, New York

Course Name: Wild Life Conservation and Management	**Course Code: ZOL-525**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Wildlife of Pakistan, identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan. Philosophy and significance of wildlife conservation. Biodiversity and sustainability of wildlife. Wildlife rules and regulations in Pakistan. National and International agencies involved in conservation and management of wildlife. Sanctuaries, Game Reserves and National Parks in Pakistan. Ramsar convention, wetlands, endangered species of Pakistan.

Introducation to wildlife and their relationship with population. Concepts of wildlife conservation, sustainable development and ecosystem. Effects of Industrial and Agricultural development and urbanization on wildlife. National Parks. Wildlife sancturies and game reserves of Pakistan, their management and environmental problems. Modern techniques for control of environmental pollution in wildlife areas. Endangered species: causes and measures for the conservation. International Conventions. Study of ecosystems. Oceans or inland water bodies, forests, Tundras and deserts. Biological communities: primary producer. Primary, secondary and tertiary consumers of various environments. Interrelationship between components of the different food web. Ecosystem Management, Range management. Conservation methods for animals and plants.

Laboratory Work Outline

1. Visit to National Parks, Wildlife sanctuaries and game reserves.
2. Population studies of some reptiles, birds and small manuals.
3. Report on endangered species.

Books Recommended

1. Bailey, J.A., 1986. *Principles of Wildlife Management*, John Wiley.
2. Ali S. & Ripley S.D., 1973. *A Handbook of Birds of India & Pakistan*, Oxford University Press, London.
3. Roberts, T. J., 1998. *The Birds of Pakistan*, Vol. I. Oxford.

4. Roberts, T. J., 1992. *The Birds of Pakistan*, (Vol. II), Oxford.
5. Roberts, T.J., 1977. *Mammals of Pakistan*. Ernest Benon Ltd, London,
6. Robinson, W.L. and Bolen, E.G., 1984. *Wildlife Ecology and Management*. McMillan, Cambridge.
7. Magon, C.F. 1988. *Biology of freshwater pollution*. Longman and Scientific Publication.
8. Boyd, C.E. 1981. *Water quality in warm water fish ponds*. Craft Master Printers Incorporation, Alabama.
9. John Carius. 1995. Rehabilitating Demaged Ecosystem. Lawis Publishers.
10. M.C., Sharron. 1993 Pollution Ecology and Bio.Treatment. Longman House England.
11. R.G.H. Bunce, 1993.Landscap and Ecology and Agro Ecosystems. Lawis Publishers.
12. R.T.T., Forman and Godron, M. 1986. Landscaps Ecology. John Wiley and Sons, New York.
13. Russ. John. C. 1995. The Image Processing Handbook. Lawis Publisher.
14. Edgar Falkner. 1994. Aerial Mapping Methods & App;ications. Lawis Publisher.
15. Arlinghaus, Sandra Lach. 1994. Practical Handbook of Digital Mapping Terms and Concepts. Lawis Publisher.
16. Stephen Horn. 1993. Snboduetion to PCM Telemetering system. Lawis Publisher
17. Doughlas, Williem J. 1991. Environmental GIS Applications to Industrial Facilities.

SEMESTER-III

Course Name: Zoogeography and Paleontology	**Course Code: ZOL-631**
Course Structure: Lectures: 3, Lab: 0	**Credit Hours: 3**
COURSE OUTLINE	
Zoogeography: Branches of Zoogeography (descriptive, chorology, faunistics, systematic, bioceonotic, causal, ecological, historical experimental and applied zoogeography). Animal distribution (cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution). Barriers and dispersals. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaearctic and Nearctic regions), Oriental, Ethiopian, Australian and Neotropical regions). Paleogeography (theories of continental drift and plate tectonics).	
Principles of Paleontology: Earth, shells of earth (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks (igneous rocks, sedimentary rocks and metamorphic rocks). Fossil, types and uses of fossils. Nature of	

fossils. Processes of fossilization. Geological time scale. Pre-Cambrian life. Post Cambrian life (Paleozoic life, Mesozoic life, Cenozoic life). A brief history of the Siwaliks. Geochronometry (Uranium/Lead dating, radiocarbon dating, Fission track dating and palaeomagnetism).

Books Recommended

ZOOGEOGRAPHY

1. Cox, C.B. and Moore, P.D. 2000. Biogeography. An ecological and evolutionary approach. Blackwell Science. Oxford.
2. Hugget, R.J. 2004. Fundamentals of Biogeography. 2nd edition. Routledge. London, UK.
3. Lomolino, M.V., Riddle, B.R. and Brown, J.H. 2006. Biogeography. 3rd Ed. Sinauer Associates, Inc. Publishers. Sunderland, Massachussets.
4. Lomolino, M.V., Sax, D.V. and Brown, J.H. 2004. Foundations of Biogeography. The University of Chicago Press. Chicago, Illinois, USA.
5. Darlington, P.J., Zoogeography, John Wiley. 1985.
6. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife management.

PRINCIPLES OF PALEONTOLOGY

1. Romer, A. S. 1966. Vertebrate Paleontology. 3rd Ed. University of Chicago Press, Chicago.
2. Gilbert, C.E.H. 1980. Evolution of vertebrates, John Willey and Sons Inc. NY.
3. Benton, M.J. 2005. Vertebrate Palaeontology. 3rd Ed. Wiley-Blackwell.
4. Brouwer, A. 1977 General Palaeontology, Oliver and Boyed London.
5. Yadav, P.R. 2009. Understanding Palaeontology. Discovery Pub. Delhi.
6. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management

Course Name: Principles of Animal Systematics	**Course Code: ZOL-632**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Contribution of systematics to Biology: History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends); Microtaxonomy, phenon, Taxon; Taxonomic categories: specific category, infraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept), species mate recognition concept; non-dimensional species concept; Multidimenstional species concept; Cohesion species concept; Difficulties in the application of biological species concepts; polytypic species, subspecies, super species, sibling species; study of major type of variation within a single population. Speciation and taxonomic decision, various types of characters, cladistic

analysis, Macrotaxonomy; different kinds of taxonomic characters; Taxonomic collection and identification; definitions of Synonym, Homonym, Keys; Evolution of the theory of Nomenclature; interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific names.

PRACTICAL:

Note: Classification of each member of each phylum upto order with adaptions 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 Echinodermta.
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.

Books Recommended

1. Mayer, E. PRINCIPLES OF SYSTEMATIC ZOOLOGY. 1994. McGraw Hill, New York.
2. Mayer, E. and Asblock, P.D. PRINCIPLES OF SYSTEMATIC ZOOLOGY. 1991. McGraw Hill, New York
3. Mayr, E. ANIMAL SPECIES AND EVOLUTION, 1985. Harvard University Press.
4. Heywood, V.H. TAXONOMY AND ECOLOGY. 1975. Academic Press, London.
5. Whili, M.J.D. MODES OF SPECIATION, 1978. W.H. Freeman and Co., San Francisco.

Course Name: Entomology	**Course Code: ZOL-634**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	

A general account including classification of insect order Collembola orthoptera Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata Thysanoptera, Neuroptera Mecoptera, Trichoptera, Siphonaptera strepsiptera ,insects of economic importance.Integument Head of an orthopteroid insect Thorax sclerites of a typical wing bearing segment Hypothetical primitive venation pattern wing regions and modifications. Segmentation and functios of legs .Abdomen. Its segmentation appendages and processes Structure of typical male and female external genitalia .Soft parts Morphology and physiology of various system including embryology (upto dorsal closure) and metamorphosis (excluding organogenesis) Ecology Trophic relationship Competition Social systems and behavior populations under insecticidal stress Biological control strategies in Reproduction.

Laboratory Work Outline

1. Dissection Cockroaclh grasshopper, red cotton bug, Gryllus butterfly honey-bee yellow wasp house fly and mosquito drosophila.
2. Microscopic preparations:Mouth-parts, wings,legs,genitalia of the above insects.
3. WholeMounts: Collembola, silver fish, thrips, birds-louse antlion aphids, whiteflies, fig insects, Head Louse, fleas.

Books Recommended

1. Richards, O.W. and Davies, R.J., (1977). Imm's General Textbook of Entomology.
2. Ross, H.H., (1965). A Textbook of Entomology, John Wiley, N.Y.
3. Patton, R.L., (1963). Introductory Insect Physiology, W.B. Saunders, London.
4. Candy, D.J. and Kilby, B.A., (1975). Insect Biochemistry and Function, Chapman and Hall, London.
5. Price, P.W., (1984). Insect Ecology, John Wiley, N.Y.
6. Snodgrass, R.F. (1935). Principles of Insect Morphology, McGraw Hill, N.Y.
7. Chapman, R.G., (1985). The Insects: Structure and Function, Hodder and Stoughton, London.

Wigglesworth, V.B., (1974). The Principles of Insect Physiology, Chapman and Hall, London.

Course Name: Animal Diversity	**Course Code: ZOL-635**
Course Structure: Lectures: 3, Lab: 1	**Credit Hours: 4**

COURSE OUTLINE

Aims and Objectives:

The course is designed to provide students with:

a. concepts of evolutionary relationship of animal kingdom.

b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

1. Introduction

Classification of organisms; evolutionary relationships and tree diagrams; patterns of organization.

2. Animal-Like Protists: The Protozoa

Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations.

3. Multicellular and Tissue Levels of Organization

Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations.

4. Triploblastics and Acoelomate Body Plan

Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations.

5. Pseudocoelomate Body Plan: Aschelminths

Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations.

6. Molluscan Success

Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations.

7. Annelida: The Metameric Body Form

Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations.

8. Arthropods: Blueprint for Success

Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations.

9. Hexapods and Myriapods: Terrestrial Triumphs

Evolutionary perspective; classification up to class. External structure and locomotion, nutrition and the digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, chemical

regulation, reproduction and development in hexapoda; insect behavior; insects and humans; further phylogenetic considerations.

10.Echinoderms

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

11. Hemichordates and Invertebrate Chordates

Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.

12. Fishes: Vertebrate Success in Water

Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

13. Amphibians: The First Terrestrial Vertebrates

Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.

14. Reptiles: The First Amniotes

Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhynchocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

15. Birds: Feathers, Flight, and Endothermy

Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation.

16. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity

Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development

Lab Outline

Practicals

1. Study of a representative of Hemichordate and Invertebrate Chordate.
2. Study of representative groups of class Fishes.
3. Study of representative groups of class Amphibia.
4. Study of representative groups of class Reptilia.
5. Study of representative groups of class Aves.
6. Study of representative groups of class Mammalia.
7. Field trips to study animal diversity in an ecosystem.
8. Study of *Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, Paramecium* as representative of animal like protists. (Prepared slides).
9. Study of sponges and their various body forms.
10. Study of principal representative classes of phylum Coelenterata.
11. Study of principal representative classes of phylum Platyhelminthes.
12. Study of representative of phylum Rotifera, phylum Nematoda.
13. Study of principal representative classes of phylum Mollusca.
14. Study of principal representative classes of phylum Annelida.
15. Study of principal representative classes of groups of phylum Arthropoda.
16. Brief notes on medical/economic importance of the following: *Plasmodium, Entamoeba histolitica, Leishmania*, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
17. Preparation of permanent stained slides of the following: *Obelia, Daphnia*, Cestode, Parapodia of *Nereis.*

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Books Recommended (Practicals)

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A., GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

Course Name: Microbiology	**Course Code: ZOL-636**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

History of Microbiology. Methods of Microbiology, microscopy, Culturing, Identification. Morphology and fine structure of viruses, Bacteria, fungi and Protozoan. Growth of microorganisms: Microbial cultivation (Viruses, Bacteria, Fungi). Microbial nutrition, Microbial reproduction, Growth control. Classification of microorganisms. Bacteria, Fungi, Viruses. Symbiotic relationships of Bacteria and fungi. Microbiology of soil, water and air. Microorganisms and diseases.

Laboratory Work Outline

1. A laboratory studies of the properties of bacteria and relate microorganisms.
2. Techniques of culturing: Media preparation, Sterilization, transfer of culture.
3. Isolation of pure culture: Spread plate method, streak plate method, and pour plate method.
4. Study of Morphology of bacteria, Fungi and Yeast; Staining procedures, Simple staining, Gram,s Staining, Spore staining, Capsule staining, Negative staining, Acid fast staining, Staining of Fungi.
5. Microscopy, light microscopy, Phase contrast microscopy.
6. Estimation of bacterial growth: CFU estimation, Turbidity measurement, Dry cell mass measurement.

Bacterial growth curve.

1. **Books Recommended:**

a. Kathleen, PT, Arthur, T (2010). Foundations in Microbilology, Basic Principles. McGraw Hill Companies.
b. Gerard, JJ, Tortora, Funke, Berbell, R, Funke, Christine, L Case (2006). Microbiology and introduction study guide. Benjamin Cummings Publishing Company.
c. Pelezar Jr. MJ Cham, E.C.S. Krieg, NR (1993). Microbiology, concepts and applications. McGraw hill, Inc. N.Y.
d. Wistrich, GA and Lechtman, MD (1990). Microbiology 5th Ed. McMillan Publishing Company. N.Y.
e. Peltier, G. L. (1998). A Laboratory Manual of Microbiology

SEMESTER-IV

Course Name: Endocrinology	**Course Code: ZOL-641**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine andnervous system relationship; General principles in function, interaction,nature, synthesis, transport of hormones; General concept of feed back,biorhythms, pathology and assessment of endocrine function; Evolution ofendocrine system. Hypothalamus and pituitary: Hypothalamic hormones: Origin,chemistry and actions; hormones of anterior pituitary: Hypothalamic pituitaryregulation, General chemistry, Physiological action and metabolism ofprolactin-growth hormone family, glycoprotein hormone family,corticotiophins and other pro-opiomelanocortin peptides; posterior pituitary:Release, regulation and actions of vasopressin and oxytocin. Thyroid gland: Anatomy and histology; Formation andsecretion of thyroid hormones; Thyroid hormones in peripheral tissues,Regulation and factors affecting thyroid function. Calcitrophic and Mineral Metabolism Hormones: Chemistry,physiological actions and metabolism of parathyroid hormone, metabolism of calcium and phosphate and magnesium; Parathyroid gland, Calcitonin and Cholecalciferol; Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry,physiological roles and mechanism of action of insulin and glucagon;Physiological roles of gut peptides. Adrenal Medulla and Catecholamines: Chromaffin cell andorganization; Structure of adrenal medulla; Biosynthesis, storage, releaseand metabolism; Adrenergic receptors. Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids. Hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress.Energetics of reproduction; functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroids at different stages of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action. Endocrinology of heart Heart, Kidney, pineal gland. Functional Diversity of Hormones in Vertebrates. Overview of Endocrine Mechanisms in Invertebrates. Neuroendocrinology; structural and functional abnormalities in endocrine glands, pharamacoendocrinology.

Laboratory Work Outline

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc.
2. Histological and ultrastructure features of endocrine glands
3. Experiments to demonstrate physiological roles of hormones of different endocrine glands;
4. Experiments to demonstrate regulation of hormones' releases. Experiments to

demonstrate functional diversity of hormones in different vertebrates.

5. Experiments on endocrine mechanism in vertebrates.
6. Radioimmunoassay of hormones.

Books Recommended

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Edition. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. Turner and Bagnara General Endocrinology.
4. Norman, A. W and Litwaik, G. (1997). Hormones. 2nd Ed. Academic Press.

Bentley, P. J. (2000). Comparative Vertebrate Endocrinology

Course Name: Developmental Biology	**Course Code: ZOL-642**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Study of mechanism of development. Historical development, morphogenesis and cell adhesion, fertilization: structure of gametes, sperm, and egg.

An introduction to early developmental process: cleavage, blastulation and gastrulation, patterns of cleavage; cleavage in sea urchin, amphibians, fish, bird and mammals.

Later embryonic development: formation of neural tube, primary and secondary neurolation, neural crest cells, emphasis on morphological, biochemical and physiological factor, induction, evocation and primary organizer concepts, competence, prospective fates and potency, mosaic and regulatory development, and implantation, role of cytoplasm, egg cortex and nuclei in development and differentiation; analysis of mechanisms during organogenesis; Cytodifferentiation and stem cell concept.

Laboratory Work Outline

1. Study of structure of gametes in some representative cases i.e frog, fowl etc.
2. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e chick, fish, frog etc.,
3. preparation of whole mount slides of chick embryo at different developmental stages,
4. early development of frog/toad through induced spawning under laboratory conditions. Application of microsurgical techniques on chick embryos in vitro.
5. Preparation and staining of histological slides.

Books Recommended:

1. Gilbert, S.F., 2004. *Developmental Biology*, Sinauer Associates, Sunderland, MA.

2. Balinsky, B.I., 1985. *An Introduction to Embyrology*, Saunders.
3. Saunders, J.W., 1982. *Development Biology*, McMillan.
4. Oppenheimer, S.S., 1984. *Introduction to Embryonic Development*, Allen and Bacon.
5. Bodemer, C.W.,1968. *Modern embryology*. Holt, Rinehart and Winston.
6. Ham, R.G. and Veomett, M.J., 1980. *Mechanism of development*. C.V. Mosby Co.
7. Berril, N.J. and Karp, G., 1978. *Development*. McGraw Hill.
8. Wilt, F. H. and Hake, S. C. (2004). Principles of Developmental Biology. W. W. Norton and Company, Inc.
9. Sadler, T. W. (2000). Langman's Medical Embryology. 8th Ed. Lippincott Williams and Wilkins.
10. Moore, K. C. and Persaud, T. V. N. (2003). The developing human. 7th Ed. Saunder

Course Name: Animal Physiology	**Course Code: ZOL-643**
Course Structure: Lectures: 3, Lab: 0	**Credit Hours: 3**

COURSE OUTLINE

Central themes in physiology: Methods and tools used in the study of physiology: Structure- function Relationship, Adaptations, Homeostasis,

Membrane physiology, mechanism in Resting Membrane Potential: Donnan equilibrium, ion channels, electrochemical potential difference, Membrane receptors, Action potential generation and propagation innerves and muscles; Structure and function of electrical and chemical synapse. Molecular basis of muscle contraction; myoneural junction; skeletal and smooth muscle, Neurotransmitters;

Receptors Physiology: Mechanoreception, Photoreception, Auditory, Vestibular and Chemical sensory system; Motor system with in brain system, Cortical, Cerebeller and basal ganglia control of posture and movements; Autonomic system and its control; Higher function of nervous system including state of consciousness, learning , memory. Blood and its consumption, transport of oxygen and CO2;

Cardiovascular System: Physiology of cardiac muscles; cardiac cycle action potentials, Electrocardiography, Control of cardiac activity (cardiac out put) and peripheral circulation. Nervous and hormonal regulation of heart activity; Blood and homeostasis; Hemodynamics; Blood flow, pressures and resistance and their interrelationships. Arterial system; Microcirculation and lymphatics;

Overview of respiratory system; Exchange of Gases: Transport of O_2 and CO_2 between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; Regulation of ventilation. Oxygen dissociation; Mechanical aspects of breathing; Respiratory responses in extreme conditions.

Excretion and Osmoregulation: in aquatic and terrestrial environment. Problems of osmoregulation; Obligatory exchange of ions and water; Vertibrate nephron asosmoregulatory organ: Physiological anatomy of kidney and nephron; Glomerular filteration, Tubular absorption and secretion; water and electrolyte balance,urine formation; Control of body fluid volume and osmolality; Potassium, Calcium and

Phosphate homeostasis; Role of kidney in acid-base balance. Nitrogeous waste products; Patterns of nitrogenous excretion and their phylogenetic development. **Nutrition and physiology of digestion:** Regulation of digestive secretions; Physiology anatomy of digestive tract (mammalian model), Absorption of water, ions and nutrients; Potential and movements in Gastrointestinal tract; Control of Motility. Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments. **Temperature relations of heterotherms and endothermes;** Dormancy: Sleep, Torpor, Hibernation, Estivation. Environmental Challenges: Temperature and animal energetic; Temperature relation of Ectotherms, Heterotherms and Endotherms.

Laboratory Work Outline

1. Recording of action potentials on oscilloscope and effects of various factors on its characters;
2. Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential.
3. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves.
4. Experiments on sensory organs study.
5. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs.
6. Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxine on oxygen consumption; Effect of androgen on accessory sex organs and of estrogens on target tissues; Study of estrous cycle and effects of the hormones.
7. Experiments on the study of heart in prepared frogs
8. Study of blood pressure in various physiological states
9. Study of electrocardiograms
10. Blood coagulation study
11. Determination of oxygen consumption in fish and mouse and effects of factors

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

Books Recommended:

1. Schmidt-Nielsen, K. (2002). Animal Physiology. 5th Ed. Cambridge Univ. Press.
2. Randall, D., Burggren, W and French, K. (2001). Animal Physiology. 5th Ed. W. H. Freeman and Co.
3. Sherwood, L. (2004). Human Physiology. 5th Ed. Thomson Learning, Inc.
4. Costanzo, L. S. (2002). Physiology. 2nd Ed. Elsevier Science. USA.
5. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal

Physiology: Mechanisms and Adaptations, 6th ed. W.H. Freeman and Company, New York.

6. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mosby.
7. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
8. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
9. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th edition. Cambridge University Press, Cambridge.
10. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

DETAIL OF COURSE CONTENTS OF OPTIONAL COURSES

Course Name: Ichthyology	**Course Code: ZOL-645**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Biology of commercial food fishes of Pakistan, their morphology, anatomy, systematic, ecology and distribution. Physiology of digestion (food, feeding habits, factor affecting food consumption, digestion, absorption, conservation) body composition (water, protein, fats, carbohydrates and minerals in freshwater and marine fishes), nutrition and growth (dietary requirement, measurement of growth, factors affecting growth rates) reproductive physiology & endocrinology (types, reproductive system, development of ovary and testes, sex differences, sexual maturity, fecundity, fish migration.

Laboratory Work Outline

1. Dissection of a common fish to study systems physiology; blood circulation excretion etc.
2. Measurement of oxygen consumption by fishes.
3. Study of fish respiratory system, gill breathing and swim bladder
4. Determination of length- weight relationship.
5. Condition factor and proximate analysis of a fish.
6. Fish movements and study of movement mechanics.

Books Recommended:

1. Lagler, K.F. *et al*. 1977. Icthyology (Second Edition).
2. Norman, J.R. & Greenwood, P.H. 1975. A history of fishes (Third Ed).
3. Hoar, W.S. *et al*. 1979. Fish Physiology. Vol-VIII.
4. Mirza, M.R. 1975. Freshwater fishes and Zoogeography of Pakistan. Bijdr. Dierk. (Amsterdam), 45: 143-180.
5. Weatherly, A.H. 1972. Growth and Ecology of Fish Populations.
6. Nikolsky, G.V. 1978. The Ecology of Fishes.
7. Wootton, R.J. 1990. Ecology of Teleost Fishes. Chapman & Hall, London.
8. Jobling, M. 1995. Environmental Biology of Fishes. Chapman & Hall, U.K.
9. Weatherly, A.H. and Gill, H.S. 1987. The Biology of Fish growth. Chapman & Hall, U.K.
10. Talwar, P.K. and Jhingran, A.G. 1991. Inland Fishes of India & Adjacent Countries. Vol. I & 11. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
11. Mirza, M.R. and Bhatti, M.N. 1993. Pakistan Ki Machlian aur Mahi Parwari Part-I. Ferozesons (Pvt.) Ltd., Lahore, Pakistan
12. Evans, D.H. 1998. The physiology of fishes, 2nd ed. CRC Press, Boca Raton, New York.

Course Name: Reproductive Biology	**Course Code: ZOL-646**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**

COURSE OUTLINE

Introduction: Overview of Mode of Reproduction in living organisms; general structure of male & female reproductive system. Sex determination and Differentiation of testis,

ovary and accessory reproductive organs. Testicular function: formation of the adult testis, compartment of testis and blood testes barriers, testicular hormones, androgens, organization of spermatogenesis. Ovarian function: growth of follicular development, ovulation corpus luteum. Reproductive cycles: estrus cycle, menstrual cycle. Hypothelamic-Hypophysical-Gonadal axis in Reproduction: Hormonal and neuronal factors and their interactions in ovarian, testicular andother reproductive targets functions, cytokines in follicalogenesis and spermatogenesis; The interactions in developments in estrous and menstrual cycles; The interactions in transitions from childhood to reproductive and post reproductive states. Rhythms in Reproduction. Peripheral Actions of Steroids in the Adult male and female. Pregnancy: Hormonal mechanism in fertilization, zygote transport and type of implantation, growth factors in implantation. Placentalsteroid and polypeptide hormones; Recognition and maintenance of pregnancy; Maternal metabolism in gestation, Hormonal mechanism I parturition. Lacatation: Hormonal mechanism in lactation; Lactogenesis, Galactopoeisis, Milk ejection. Reproductive Senescence: Hormonal and Metabolic aspects in menopause; Mechanisms in males. Fertility Control Mechanisms.

Laboratory Work Outline

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

1. **Books Recommended:**

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

Course Name: Environmental Biology	**Course Code: ZOL-647**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Environment: Introduction, scope, pressure. Pollution: definition, classification and impact	

on habitats. Air pollution: sources, prevention, control, remediation. Photochemical smog. Acid rain, theory and its effects. Chlorofluorocarbons and their effects; Water pollution: sources, impact, prevention, remediation. Eutrophication, thermal pollution. Sediments pollution: fungicides, pesticides, herbicides, prevention, control remediation. Heavy metal pollution. Noise pollution, radiation protection. Forests: importance, deforestation, desertification and conservation. Ozone layer, effects of ozone depletion. Greenhouse effect. Human population explosion. Brief review of major environmental problems of Pakistan and their solutions. Wetland and sanctuaries protection. Range management.

Books Recommended

1. Chiras DD. 2010. Environmental Science. 8th Ed. Jones and Bartlett Publishers, LLC.
2. Wright, R. T., Nebel, B. J. 2002. Environmental Science: Toward a Sustainable Future, 8th Ed. Prentice Hall.
3. Odum, E., Brewer, R., Barrett, G. W. 2004. Fundamentals of Ecology. 5th ed. Brooks Cole.
4. Additional Reading:
5. Newman, E.I. 2001. Applied Ecology, Blackwell publishers.
6. Moony, H. G. A., Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
7. Eugene, E.D., Smith, B.F. Environmental Science: A study of interrelationships, McGraw, USA
8. Marsh,M.W., Grosa, Jr., J.M.,1996. Environmental geography: Science, land use and earth system. John Wiley and Sons.
9. Robert L. McConnell, Daniel C. Abel 2002. Environmental Issues Measuring, Analyzing, Evaluating (2nd Edition) Prentice Hall.
10. France, H. 2000. Vanishing Borders: Protecting the planet in the age of globalization. W.W.Norton and Company, NY.
11. Hall, C.C.S., Perez, C.L. 2000. Quantifying Sustainable Development. Academic Press, UK.
12. Bazzaz, F.A. 1996. Plants in changing environment: Linking physiological, population, and community ecology. Cambridge Univ. Press.
11. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.

Course Name: Biomembranes and Signal Transduction	**Course Code: ZOL-648**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	

Introduction, surfaces and interfaces, chemical compositions; lipid, protein, carbohydrate. Structure of membranes; physiochemical techniques. Isolation of membranes, morphology and function of different biological membranes (plasma membrane, mitochondrion, chloroplast, mesosome, endoplasmic reticulum, Golgi apparatus, lysosomes, tonoplast, nucleus, other membranes). Membrane transport, transport of non-electrolycetes, transport of ions, transport of water. Transport by special mechanism, receptor-ligand interaction.

Signalling through biomembrane, molecular mechanism of signal transduction, signaling receptors,signaling ligands and signaling complexes, signaling cascades, signal transduction in immune system, TCR and BCR signaling, ROS effect on signaling, signal transduction in cancer, signaling through growth factor receptors, thera[eutic intervention involving signaling mechanism.

Books Recommended

1. Karp, G., (2009). Cell and Molecular Biology: Concepts & Experiments. 3rd Edition.
2. John Wiley Sons, Inc., N.Y. Darnell Jr. J., Lodisch, H. and Balimore, D., (2010). Molecular Cell Biology, Scientific American Inc. N.Y.Bruce Alberts, Alexander Johnson, (2002) Molecular Biology of the Cell, 4th Edition, Garland Sciences.
3. Berg, Jeremy M., Tymoczko, John L., (2002) Biochemistry, W. H. Freeman, New York.
4. Albert B, Johnson A. 2007. Molecular biology of the cell. 5th edition. Gerald Sciences UK.
5. Nelson N. 2008. Structure and function in cell signaling. John Wiley sons Inc., USA.
6. Mary Lucky. 2008. Membrane structural biology: Biochemical and biophysical foundations. Cambridge University Press, N.Y.
7. David Sheehan. 2009. Physical biochemistry: Principles and Applications. 2nd edition. John Wiley sons Inc., USA.
8. Peter Jomo Walla. 2009. Modern biophysical chemistry: Detection nad analysis of Biomolecules. John Wiley sons Inc., USA.

Course Name:Enzymology	**Course Code: ZOL-649**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Introduction and basic concepts of Enzymology nomenclature and classification of enzymes the structure of enzyme monomeric and oligomeric enzme kinetics kinetic of single substrate and multi substrate catalyzed reaction and sigmoidal kinetics Mechanism of enzyme activity, enzyme inhibition coenzymes classification and mechanism in enzyme catalysis Enzyme application in medicine and industry Biotechnological application of enzymes immobilization of enzyme immobilization practical application subunit study of enzymes .Isoenzymes structure of isoenzymes formation of isoenzymes identification of isoenzymes functional significance of isoenzymes.	

Laboratory Work Outline

1. Estimation of acid protease
2. Estimation of acid phosphatase
3. Estimation of lactate dehydrogenase
4. Etimation of LDH isozymes
5. Effect of pH temperature metal ions and time on enzyme stability and activity
6. Kinetic studies of enzymes

Books Recommended

1. Fersht, Alan (1999). Structure and mechanism in protein science: a guide to enzyme catalysis and protein folding W.H. Freeman, New York.
2. Wiseman, A. (1995). Handbook of enzyme biotechnology. Edition 3rd Ellis Horwook, London.
3. Zubay, G.L., (1995). Principles of Biochemistry McMillan Publishing Co.
4. Stryer, L. (1995). Biochemistry, W.H. Freeman & Co., New York.
5. Davlin, J. (1992). Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons.

Course Name: Principles Of Gene Manipulation	**Course Code: ZOL-650**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Introduction: Methods of creating recombinant DNA molecules (restriction enzymes). Cloning in *E.coli* plasmid as cloning vehicles, bacteriophage and cosmid vectors, cloning strategies and gene libraries, isolation of clone genes, recombinant selection and screening, expression in *E.coli* , of cloned DNA molecules. Cloning in organisms of other then E. colo: cloning in bacteria other then E. coli, cloning in yeast and other eukaryotes, cloning in plant cells, cloning in mammalian cells in cultures, cDNa, Chromosome walking for isolating long stretches of eukaryotic DNA, split genes. Micro infecting genes into animal oocytes, eggs and embryos. Application of	

recombinant DNA technology in biology and medicine.

Laboratory Work Outline

1. Construction of Restriction Enzyme +Map
2. Amplification of DNA by PCR
3. Preparation of probe for DNA analysis
4. Southern blotting and hybridization
5. Northern blotting and hybridization
6. Heat shock transformation of bacterial cell
7. Agrobacterium medicated transformation of plant cell.

Books Recommended

1. Bernard R. Glick & Jack J. Pasternak. (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA, Third Edition, ASM Press Washington.
2. H. Kreuzer & A. Massey. (2001). Recombinant DNA and Biotechnology, 2nd Edition., ASM Press.
3. Old, R.W. and Primrose S.C. (1995). Principles of gene manipulations. Blackwell Science.
4. Sambrook, Joseph; Russell, David W., (2001). Molecular cloning: a laboratory Edition 3rd Cold Spring Harbor Laboratory Press, new York.
5. Jain, S.K. (2000). Textbook of biotechnology: fundamentals of molecular CBS Publishers, New Delhi.
6. Thiel, Teresa; Bissen, Shirley (2002). Biotechnology DNA to protein: a laboratory project in molecular biology, McGraw-Hill, Boston;
7. Brown, T.A. (2001) Gene Clonning and DNA analysis: an introduction. Blackwell Science Ltd. Oxford.

Course Name: Clinical Biochemistry	**Course Code: ZOL-651**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Biochemistry of blood biochemical aspects of cardiovascular , neurological and endocrine inborn errors of metabolism ,immunology of human diseases immunodiagnostics, biochemical aspects of cancer etiology ,clinical diagnosis and treatment interferon discovery and implication and antibacterial agent, disease due to infection and infestation , diseases due to chemical and physical agents ,genetic and constitutional factors in disease diseases of organs.	

Laboratory Work Outline

1. Analysis of Urine, blood
2. Determination of glycerol and cholesterol/sterols and unsaturated fatty acids.
3. Estimation of Urea, Protein, Cholesterol bilirubin, calcium, phosphorus, uric acid, creatininine and analysis in serum/Urine.
4. Determination of vitamins in serum.
5. Separation of steroids by TLC.

Books Recommended

1. Cumings, J. N and Kremer, M. (1973). Biochemical aspects of Neurological disorders.
2. Hoffman, W. S. (1977).Biochemistry of Clinical Medicine, 4th Ed

Course Name: Research Techniques and Instrumentation	**Course Code: ZOL-652**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Estimation methods for biopolymers. Chromatographies: gel filtration, ion exchange, affinity, chromatofoussing. Isoelectric focussing, HPLC, GLC, electron microscopy, Electrophoresis: polyacrylamide, SDS-polyacrylamide. Immuno-electrophoresis. Double diffusion. Spectrometers; visible, UV, IR, mass, X-ray diffraction and Atomic absorption. Beta and gamma counters.	
Books Recommended 1. Williams, B.L. and Wilson, K.A. 1983. Biologist's guide to principles and techniques of practical biochemistry. Edward ARnold. 2. Oser, B.L. 1965. Haw's physiological chemistry. McGraw Hill Book Co. 3. Work, T.S. and Work, E. 1975. Laboratory techniques in biochemistry and molecular biology. Vols. 1-3 North Holland America	

Course Name: Vitamins and Hormones	**Course Code: ZOL-653**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Vitamins classification, chemical structure and properties: metabolism, function, effect of deficiency and excess. Hormones; structure, structure activity relationship, biosynthesis, regulation, mechanism of action and immunology of: protein and polypeptide hormones, hormones steroids, neurotransmitters, and phytohormone. Hormonal analysis (bioassays, immunoassay). Methods of isolation, purification and physicochemical characterization. Biotechnology (monoclonal antibodies, gene cloning).	
Laboratory Work Outline 1. Determination of vitamins in seum 2. Separation of steroids by TLC 3. Studies on recognition and response of receptors. 4. Studies of disorders of pituitary by observing anatomical and histological features. **5.** Studes of thyroid status in deficient and excess hormone functions.	
Books Recommended: 1. Darnell Jr. J., Lodisch, H. and Balimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y. 2. Zubay, g.L., (1995). Principles of Biochemistry McMillan Publishing Co. 3. Stryer, L. (1995). Biochemistry, W.H. Freeman 7 Co., New York. **4.** Davlin, J. (1992). Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons. **5.** Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemistry. Worth Publishers, N.Y. **6.** Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments.3rd Edition. John Wiley Sons, Inc., N.Y.	

Course Name: Medical Microbiology	**Course Code: ZOL-654**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of infection in the community. Immunological principles: antigens, antibodies, and antigen- antibody reactions.Bacterial pathogens and associated diseases. Staphylococcus, skin and wound infections. Streptococcus, sore throat, scarlet fever, glomerulo nephritis. Pneeumococcus, respiratory infections. Cornyebacterium. Erysipelothrix: Listerial, Diphtheria. Mycobacterium tuberculosis: pulmonary and other tuberculosis infections. Actinomyces. Neisseria: Meningitis, Gonorrhoea. Salmonella, Shigella. Escherichia coli, Klesbsiella, Proteus, Providencia. Anthrax bacillus. Clostridum tetani. Poxiviruses. Herpes viruses. Herpes simplex.	

Cytomega-lovirus infections. Adenoviruses. Influenza viruses. Miscellaneous viruses: Rubella Corona, Areana viruses. Hepatisis viruses. Arboviruses. Rickettsia. Pathogenetic Fungi. Protozoa. Infective Syndromes and diagnostic procedures. Stratagy of antimicrobial therapy. Prophylactic immunization.

Laboratory Work Outline

1. Basic techniques. Widal test
2. Laboratory diagnosis and controlof infections: Streptpococcus. Corynebacterium, Erysispelothrix Listeria Mycobacterium. The Entero bacteriaceae: Salmonella. Shigella Escherichia, Klebsiella. Proteus and other Enter bacteria. Clostridium I Clostridium II
3. Protozoa. Blood tests: TLC, DLC, RBC.

Books Recommended

1. Boyd. R. F. (1995). Basic Medical Microbiology. 5th Ed. Little Brown and Co.
2. Ingles, T. S. S. (2003). Microbiology and Infection. 2nd Ed. Churchill livingstone.
3. Wester, E. W., Anderson, D. G., Pearsall, N. (2004). Microbiology: A human perspective. McGraw Hill.
4. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (1975). *Medical Microbiology*, (Vol. 1 & Vol. 2), Churchill Livingstone, N.Y.
5. Turk, D.C. and Poster, I.A., (1978). *A Short Textbook of Medical Microbiology*, Hodder and Stoughton.
6. Vollum, R.L., Jamison, and Cummins C.S. (1970). *Fairbrother's Textbook of Bacteriology*, William Heinemann, London.
7. Collins, C.H. and Lyne P.M. *Microbiological Methods*.

Course Name: Immunology	**Course Code: ZOL-655**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE (3+1)	

The immune system: organs constituting the immune system, their location in the human body and basic architecture, principles and techniques of seriology. The immunnocompetent cells; their origin, surface makers, populations and subpopulations, immuniological characterization and function. Anibody induction and production: antigen and antibody metabolism, cells involved in cellular sequence of events, kinetics of antibody synthesis, Antibody diversity. The role of T-cells and immunoglobulins in the immune response. Immunologic memory: positive and negative phenomena of natural tolerance.Manifestations of antigens antibody reactions including precipitation, agglutination, omplement fixation and neutralization. Basic and applications of ELISA, RIA, Immunoflorescence and Immunoblotting. Role of MHC in antigen presentation.

Immunological disorders: Autoimmunity, Immunnodeficiency, Tissue rejection. Nature of tumor transplantation and immunology and immunogenetics. Resistance and immunonization to infectious diseases.
Laboratory Work Outline 1. Techniques used in serological studies, RBC and WBC count. 2. Differential leukocyte count 3. Blood grouping 4. Agglutination tests and precipitation tests 5. Complement fixation tests 6. ELISA tests 7. Allergy reaction tests **8.** Hypersensitivity
Books Recommended: 1. Abbas, K. Lichtman and Jordan, S. Pober (Latest Edition) Cellular and Molecular Immunology". W.B. Saunders. 2. Janeway-Travers. (Latest Edition) Immunobiology. Current Biology Ltd. UK. 3. Riott, IM, Delves, PJ (2001). Roitt's Essential Immunology. Blackwell Scientific Pub, London. 4. Geo f. brooks, Stephen A. Morse, Janet Butel, Janet S. Butel (2001). Jawetz, Melnick and Adelberg's Medical Microbiology McGraw-Hill Companies. **5.** Kuby, J. (1996). Immunology Immunology 2nd Ed. W.H. Freeman & Co. USA. **6.** Benjamini, E. Immunology. (2001).

Course Name: Protozoology	**Course Code: ZOL-656**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	
Structure, including ultra-structure, taxonomic significance, biology, life cycle and host parasite relationships of parasitic protozoa which will include Mastigophora: *Trypanosoma gambiense; Schizotrypanum cruzi; Leishmania donovani; L. tropica; Giardia intestinalis* and *Trichomonas vaginalis.*Sarcodina: *Entamoeba histolytica; E. coli; E. gingivalis; Endolimax nana* and *Acanathamoeba castellanii.*Sporozoa: Malarial parasites of man, and Coocidia of poultry. Ciliata: *Balantidium coli.*	

Laboratory Work Outline

1. Study of protozoa through prepared microscopic slides
2. Protozoa culturing
3. Isolation of parasitic protozoa from the guts of higher animals, slide preparation and identification
4. Soil protozoa
5. Marine and freshwater protozoa
6. Study of physiological properties of various protozoa

Books Recommended

1. Brusca, R. C. and Brusca, G. J. (2002). Invertebrates. 2nd Ed. Sinauer Associates. Inc., Publishers.
2. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill.
3. Hickman, Jr. C. P; Roberts, L. S and Larson, A. (1998). Biology of Animals. McGraw Hill Co, Inc.
4. Hickman, C.P., Roberts, L.S. and Larson, A., 2001. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
5. Barrington E. J. W. (1977). Invertebrate structure and function.
6. Rupppert, E, D and Barnes, R. D. (1994). Invertebrate zoology. 6th Ed. Saunders College Publishing.
7. Dorit, R. L., Walker, Jr. W. F and Barnes, R. D. (1991). Zoology. Saunders College Publishing, Inc.
8. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
9. Campbell, N.A., 2002. Biology, 6th Edition. Menlo Park, California: The Benjamin/Cummings Publishing Company, Inc.
10. Miller, S.A., 2002. Genral Zoology Laboratory Manual. 5th Edition (International) Singapore: McGraw Hill;
11. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
12. Marshall, A.J. and Williams, W.D., 1972. *A Textbook of Zoology*,Volume I, Invertebrata. McMillan Co., New York.

Course Name: Freshwater Fish Culture	**Course Code: ZOL-657**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours: 3**
COURSE OUTLINE	

Laboratory Work Outline

1. Selection of site, collection of soil and its analysis for fish farm
2. Water analysis for fish culture

3. To calculate the lime requirement for fish pond.
4. Checking fish pond fertility by sacchi disc method.
5. Collection and identification of Common freshwater commercial fishes of Pakistan
6. Assessment of age and growth with the help of scale.
7. To determine the feeding habit of fish by observing their gut contents.
8. Proximate composition of fish feed ingredients and diets.
9. Sampling and identification of zooplankton and phytoplankton from various water bodies.
10. Analyses of water samples from polluted areas for water quality.
11. To determine Food conversion ratio, specific growth rate of commercial fishes of Pakistan
12. Visit of fish farm and submission of report

Books Recommended

Text Books

1. Sarkar, S.K. (2002). Freshwater fish culture. Vol. 1. Daya publishing House, Tri Nagar, Delhi.
2. Stickney, R.R. (2005). Aquaculture: An introductory Text. CABI publishing.

Additional Related Books

1. Nakagawa, H., Sato, M. and Gatlin, D. M. (2010) Dietary Supplements for the Health and Quality of Cultured Fish. CABI publishing.
2. Van der Zijpp, A.J., J., Verreth J.A.J., Tri, L., van Mensvoort, M.E.F,. Bosma R.H. and Beveridge M.C.M. (2008). Fish ponds in farming systems. Wageningen Academic Publishers.
3. Hart, J. B. P. and Reynolds, J. D. (2002). The Handbook of Fish Biology and Fisheries. Vol. 1 & 2. Blackwell publishing
4. Boyd, C.E. and Tucker, C.S. (1998). Pond-Aquaculture Water Quality Management. Boston, Kluwer.
5. Swift, D. (1993).Aquaculture: Training Manual.2nd Ed. Fishing News Books, A division of Blackwell scientific Publishing Ltd.
6. Pillay, T.V.R. (1993). Aquaculture, Principles and Practices, Fishing News Books
7. Ali, S.S. (1993). An introduction to freshwater fishery biology, U.G.C. Islamabad, Pakistan
8. Mirza, M.R. and Bhatti, M.N. (1993). Pakistan Ki Machlian aur Mahi Parwari Part-I. Ferozesons (Pvt.) Ltd., Lahore, Pakistan