

**University of Lakki Marwat Khyber Pakhtunkhwa 28420,
Pakistan**



**Course outline
Department of Zoology
Program BS 6th Semester**

| Course Category | Course Title | Credits |
|------------------------|----------------------------------------|----------------|
| Major | Developmental Biology | 4 (3+1) |
| Major | Genetics | 4 (3+1) |
| Major | Biological Techniques | 3 (1+2) |
| Major | Evolution and Principal of Systematics | 3 (2+1) |
| Major | Wild Life | 2 (2+0) |
| | Total Credits | 16 |

Developmental Biology 4 (3+1)

Course Objectives:

The course aims to:

1. Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development.
2. Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.
3. Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

1. **Gain** familiarity with features that make an organism model for the learning of developmental biology *e.g.*, fertilization in sea urchin with mammalian like mechanisms.
2. **Apprehend** the contributions of the sperm and the egg to form zygote.
3. **Elucidate** the problems associated with cell differentiation through fate mapping.
4. **Arrange and investigate** the classical and modern experiments into “find it”, “block it”, and “move it” categories.
5. **Assess** the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode.
6. **Demonstrate** the ability to label macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (*e.g.*, primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm).

Course Outline:

Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis.

Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm.

Cleavage: Patterns of embryonic cleavage, mechanism of cleavage.

Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals.

Early Vertebrate Development: Neurulation, ectoderm, mesoderm and endoderm.

Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules.

Mechanism of Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes and mechanism of teratogenesis; Secondary Induction.

Organogenesis: A brief account; Origin and migration of germ cells in vertebrates. Factors controlling growth and oncogenesis. Post embryonic Development and metamorphosis

Hormones as mediators of Aging, development; Regeneration in vertebrates.

Practicals

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

Books Recommended

1. Gilbert, S. F. 2012. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw Hill.
3. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
4. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
5. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
6. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

GENETICS 4 (3+1)

Course Objectives:

1. To understand the terms and basic concepts of genetics, providing a conceptual framework for future reference.
2. To provide understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc.
3. To develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment.
4. To understand how traits are inherited and to use this understanding in analyses (to solve problems and complete pedigrees).
5. To understand probability concepts and use these concepts to solve problems (including basic statistical problems).
6. To understand how genetic problems may lead to disease or lethality.
7. To understand the molecular basis of genetics (including such topics as replication, transcription, translation, and mutation).
8. To understand mechanism of repair and molecular genetic analysis.
9. To understand the workings and importance of major genetics techniques such as PCR.
10. To understand current issues regarding genetics (e.g., cloning, use of transgenic organisms).
11. To understand Mendelian and non-Mendelian pattern of inheritance in human.
12. To understand the workings and uses of population genetics technique.

Course Learning Outcome

1. Able to define terms of genetics and apply concepts of modern transmission
2. Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.
3. Solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
4. Identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored.
5. Able to accurately draw the diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes.

6. Describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.
7. Describe the processes of gene regulation and predict how a gene will be expressed under specific circumstances.
8. Learn and practice common genetics laboratory techniques.
9. Describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems.
10. Carry out genetics laboratory and research techniques.
11. Identify the human traits and genetic diseases.
12. Describe experimental results in written format both informally and in formal manuscript format
13. Able to solve problem related to population genetics.

Course Contents:

1. Introduction

- a. Classical, molecular and population Genetics: Scope and importance of genetics, Forward and reverse genetics. The basic principles of Inheritance (Mendelism): Monohybrid and Dihybrid crosses (Definition - characteristics criss-cross inheritance).
- b. Multiple Alleles: blood groups and coat color in rabbits.
- c. Genetics of Rh factor and Erythroblastosis Foetalis.

2. Chromosomal Basis of Inheritance:

- a. Chromosomal theory of inheritance
- b. Interaction of genes, Epistasis, Lethality and Pleiotropism.

3. Chromosomal Aberrations

- a. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).
- b. Structural changes, insertion, deletion (Cri du chat syndrome), duplication,
- c. Inversion and translocation

4. Pedigree Analysis:

- a. Normal human chromosome complement; Karyotyping.
- b. Sex-determination and Sex-linkage:
- c. Sex determination in animals and humans,
- d. Sex linked (Hemophilia, muscular dystrophy, color blindness), sex influenced and sex limited traits,
- e. Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics

5. Chromosome mapping

- a. Linkage, recombination (crossing over) and
- b. Chromosome mapping in eukaryotes.

6. Molecular Genetics:

- a. Gene Concept (classical and modern),
- b. Genetics of Viruses and Bacteria,
- c. Transposons,
- d. Mutation and DNA repair
- e. Molecular Genetic Analysis,
- f. Regulation of Gene Expression in Prokaryotes,
- g. Gene Regulation in Eukaryotes,
- h. Genetic basis of diseases, like cancer,
- i. Genetic control of animal development.
- j. The genetic control of the Vertebrate Immune System,

7. Recombinant Technology

- a. The Techniques of Molecular Genetics (elements of genetic engineering),
- b. PCR

8. Human Genetics;

- a. Single and Multifactorial Disorders:
- b. Autosomal anomalies, Pseudoautosomal genes,
- c. Single gene disorders: Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria).
- d. Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate,

9. Population Genetics:

- a. Hardy-Wienberg equilibrium,
- b. Systematic and Dispersive pressures, Inbreeding and heterosis

Practical:

1. Drosophila culture techniques: preparation and maintenance of culture
2. Identification of male and female fruit fly and isolation of virgin females
3. Study of polytene chromosomes from the salivary glands of *Drosophila melanogaster*
4. Mutation induction in *Drosophila*
5. Human karyotyping from photographs prepared slides: paper cut out method
6. Preparation of human metaphase chromosomes from blood lymphocytes
7. Study of mitosis in plants by using onion root tip cells
8. Study of meiosis in the testes of male grasshopper

9. Extraction of genomic DNA from whole blood (lymphocytes)
10. Separation of heterogeneous population of bio-molecules through electrophoresis
11. Study of blood group polymorphisms in local population
12. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
13. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counselling)
14. Study of quantitative traits in humans: finger prints as model of polygenic traits
15. Study of Barr bodies in human cell nucleus
16. Dermatoglyphics in normal and mentally retarded subjects
17. Probability problems. Tossing of coins. X² test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

Books Recommended:

1. Snustad, D.P., Simmons, M.J. 2003. Principles of Genetics. 3rd Ed., John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. 2001. Principles of Genetics. 7th Ed., WCB publishers USA.
3. Lewin, B. 2013. GENE-VIII. Oxford University Press. UK.
4. Gardener, E.J., Simmons, M.J., Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. 2015. Genetics. McMillan, New York. USA.(9780024181206)
PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
6. Concepts of Genetics By Klug, W.S and Cummings M.R.
7. William S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
8. Lewin's Gene XI BY Jocelyn E.Krebs et al. 2013, isbn-13:978-1449659851,ISBN-10:1449659853.
9. Gene- XI by Lewin's,2013,ISBN:978-1449659851.
10. Concepts of genetics 11th edition, William S.Klug,2014,ISBN-13:978-0321948915.

Wild Life 2 (2+0)

Course Objectives:

The objective of this course is

1. To enable the student to understand philosophy and significance of wildlife conservation
2. To understand the wildlife management rules and regulations in Pakistan
3. To understand how National and International agencies are involved in conservation and management of wildlife

Course Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. **ACQUIRE** theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
2. **UNDERSTAND** the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
3. **SOLVE** the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).
4. **ANALYSE**, interpret and synthesize data and other information about the population of wildlife
5. **EVALUATE** the conservation management by government department, National and International organizations.
6. **DEMONSTRATE** the ecological assessment and importance of wildlife to certain area.

Objectives

The students will learn:

- About wildlife, distribution pattern world over
- Regarding wildlife of Pakistan, threatened, endangered species
- Modern techniques used in animal tracking, data collection
- How to protect, maintain, control and preserve the health and environment of wildlife.

Course Contents

Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat.

Techniques: Ground and aerial tracking, GPS, radiotelemetry, maps etc.

Wildlife Conservation: Philosophy and significance, Biodiversity and sustainability of wildlife.

Wildlife Agencies: National and International agencies involved in conservation and management of wildlife. International conventions, agreements.

Wildlife of Pakistan: identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan.

Wildlife rules and regulations in Pakistan: Sanctuaries, Game Reserves and National Parks in Pakistan. Endangered species of Pakistan.

Books Recommended

1. Ali, S.S. 1999. Paleontology, Zoogeography & Wildlife Management. Nasim Book Depot. Hyderabad, India.
2. Roberts, T. J. 1998. *The Birds of Pakistan*, (Vol. II), Oxford University Press.
3. Roberts, T. J. 1992. *The Birds of Pakistan*, (Vol.I). Oxford University Press.
4. Magon, C.F. 1988. *Biology of Freshwater Ponds*. Longman and Scientific Publication.
5. Bailey, J.A. 1986. *Principles of Wild life Management*. John Wiley and Sons.
6. Robinson, W.L., Bolen, E.G. 1984. *Wildlife Ecology and Management*. McMillan, Cambridge.
7. Roberts, T.J. 1977. *Mammals of Pakistan*. Ernest Benon Ltd, London.
8. Ali S., Ripley S. D. 1973. *A Handbook of Birds of India & Pakistan*, Oxford University Press, London.
9. Elirza Z.B, the Birds of Pakistan.

Biological Techniques 3 (1+2)

Course Objectives:

1. To course aim to demonstrate the knowledge of skills
2. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
3. To develop basic understanding of the equipments handling/usage
4. To develop scientific technical expertise, culture and work habits.
5. To know how to collect and preserved animals

Course Learning Outcome:

After successfully completion of this course,

1. Students must be able to identify the instrument
2. Able to use instrument for identification, measurement, fixing and cutting of tissue
3. Able to apply a practical and research skill
4. Able to operate use the lab equipment efficiently.
5. Able to collect and preserved the specimen in dry and wet form.
6. Developed expertise in Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field

Course Contents:

1. Microscopy:

- a. Principles of light microscopy. Magnification, Resolution,
- b. Types of microscopy (Bright field, Dark field, Phase Contrast)
- c. Confocal Microscopy
- d. Electron microscope: Scanning electron microscope and Transmission electron microscope (SEM and TEM).

2. Standard unit system for weight, length, volume and Micrometry:

- a. Different Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions
- b. Concentrations- percent volume; ppt; ppm - molarity, normality, molality
- c. Preparation of stock solutions of various strengths
- d. Use of stage and ocular micrometers
- e. Calibration of ocular micrometer and measurement of size animal and plant cell and nuclei

3. Specimen preparation for optical microscopy:

- a. Introduction to Microtomy and its types
- b. Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section)

- c. Tissue mounting (dry mount, wet mount)
- d. Staining: Hematoxylin and Eosin staining

4. Separation and purification techniques:

- a. Cell fractionation
- b. Centrifugation and its types
- c. Filtration and its types,

5. Chromatography:

- a. Chromatography: Principle, applications, types,
- b. Paper chromatography and thin layer chromatography
- c. Column chromatography
- d. High pressure liquid chromatography.
- e. Electrophoresis: Principle, applications and types (Agarose and PAGE).

6. Spectrophotometry:

- a. Principle, applications, types
- b. Visible/UV spectrophotometry

7. Basic principles of Sampling and Preservation:

- a. Sampling from soil, water, air, plants and animals
- b. Preservation of dry and wet specimens.
- c. Preservation techniques. lyophilization, preservation in ethanol, formalin etc.

8. DNA sequencing

- a. Polymerase chain reaction (PCR), principle and application
- b. DNA sequencing (Sanger and Maxam Gilbert).

Practicals:

1. Preparation of slides (dry mount and wet mount)
2. Observation of wet mounts of human cheek cells employing bright and dark field microscopy
3. Measurement of cell size: bacterial and eukaryotic Cell
4. Recording of microscopic observations with the help of camera lucida
5. Liquid handling: proper use of pipettes and micropettes
6. Hematoxylin and eosin staining
7. Gram's staining,
8. Handling of centrifuge machines
9. Paper Chromatography
10. Thin layer chromatography of amino acids
11. Spectrophotometric estimation of glucose
12. Collection and Preservation of representative animals of various phyla

Books Recommended:

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
2. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part II. Cambridge University Press, UK.
4. Curoso, M. 1997. Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
5. Curoso, M. 1997. Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA.
6. Slingsby, D., Cock, C. 1986. Practical Ecology. McMillan Education Ltd. London.
7. Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson, Practical skill in bio-molecular sciences.
8. Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.
9. Jones, A. Reed, R and Weyers, J. 1994. Practical skills in Biology. Longman Singapore Publishers (Pte) Ltd.

Evolution and Principal of Systematics 3 (2+1)

Objectives

The course aims to:

- Provide in-depth knowledge of origin of life
- Develop concepts about forces responsible for evolutionary changes
- Study the importance and history of systematics with basic rules and regulations about the identification and naming of organisms

Course Contents

(i). Evolution

The nature and origin to life: Evidences of evolution (molecular, embryological & paleontological).

Theories of Evolution: Theories to explain the diversity of life – Modern synthetic theory, factors initiating elementary evolutionary changes (micro-evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.

Role of isolation in evolution: Factors of large evolutionary changes (macro/mega evolution) - allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of selection, selection patterns, laboratory and field example regarding action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry, Sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory, Recapitulation theory, Trend and rates in evolution.

(ii). Systematic Zoology

Importance and applications of systematics: Taxonomy in Animal science, systematics as a profession and its future perspectives.

History of taxonomy: systematics, basic terminology of systematics, theories of biological classifications.

Taxonomic characters: Kinds and weightage, microtaxonomy, taxonomic categories: specific category, infraspecific category, higher categories;
Species concept.

Typological species concept: Nominalistic species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation, Taxonomic procedures, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Systematics publications: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practicals

1. Study of preserved invertebrate species and their classification up to class level.
2. Collection, preservation and identification of common species with the help of keys.
3. Preparation of keys for the identification of specimens.
4. Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Books Recommended

Evolution

1. Strickberger. M.W. 2012.*Evolution*. Jones & Barrett Publishers.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications.
3. Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row Publishers, New York.
4. Dobzhansky, T., Ayala, F.J., Stebbins, G.L., Valentine, J.W. 1973. Evolution. W.H. Freeman and Company.
5. Mayr, E. 1965.*Populations, Species and Evolution*, Harvard University Press.
6. Dobzhansky, T. 1951. *Genetics and the origin of species*. Columbia University Press, New York.

Systematic Zoology

1. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
2. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.
3. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw Hill, New York
4. Mayr, E. *Animal Species and Evolution*, 1985. Harvard University Press.
5. Heywood, V.H. *Taxonomy and Ecology*. 1975. Academic Press, London.
6. Whili, M.J.D. *Modes of Speciation*, 1978. W.H. Freeman and Co., San Francisco
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