

**CURRICULUM
OF
BS ZOOLOGY**

(2026)



**RAWALPINDI WOMEN UNIVERSITY,
RAWALPINDI**

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1. Program Objectives and Outcomes

The objectives of BS program are:

i. **Academic Excellence:**

To provide a comprehensive and innovative curriculum that equips female graduates with in-depth knowledge and practical skills in zoology, particularly in animal physiology, behavior, genetics, evolution, ecology, and conservation science, with a focus on addressing challenges such as biodiversity loss and the impacts of climate change on animal species.

ii. **Research and Innovation:**

To foster and support groundbreaking research initiatives that address global challenges such as species extinction, habitat destruction, climate change, and the sustainable management of wildlife and ecosystems, contributing to the advancement of zoological sciences.

iii. **Professional Development:**

To nurture critical thinking, leadership, and technical skills in female students, preparing them for successful careers in academic research, wildlife conservation, environmental policy, and the zoological industry, with an emphasis on interdisciplinary collaboration and innovation.

iv. **Community Engagement:**

To form strong partnerships with local and international organizations, government agencies, and non-profit entities, translating zoological research into actionable solutions for wildlife conservation, habitat restoration, and the promotion of sustainable practices in human-animal interactions.

v. **Empowerment of Women:**

To create an inclusive and supportive environment that empowers female students to excel in the field of zoology, fostering their personal and professional growth and encouraging their leadership in science, conservation, and innovation to ensure gender equity in the scientific community.

The outcomes of BS program are

The graduates will be able to have a broaden vision of all fields of Zoology. They will be able to get jobs in wide range of professions including Positions in various government and nongovernment organizations, teaching and research, administration and management,

aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, laboratory diagnostics, poultry, plant protection, wildlife, livestock and other areas.

2. Admission Criteria for BS Zoology

As per approved Admission Policy RWU notified vide Notification No. RWU/VC/01/341; dated: 10th Mar, 2023.

3. Vision

To be a vibrant center of zoological learning and discovery, nurturing confident women leaders who contribute to science, sustainability, and societal advancement.

4. Mission

To educate and empower women in zoological sciences through a dynamic blend of knowledge, critical thinking, and hands-on research—fostering innovation, environmental awareness, and academic excellence.

5. Division and Distribution of Courses for BS Zoology

Sr. No.	Categories	No. of Courses	Credit Hour
1.	General Education Courses	13	32
2.	Major Courses	24	72
3.	Interdisciplinary	09	27
4.	Field experience/Internship	01	03
5.	Capstone Project	01	03
6.	Mandatory Courses (Understanding of Quran/ Ethics)	02	02

- Total number of credit hours 139
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course load per semester 15-18 Credit hours

6. Scheme of Studies for BS Zoology (Regular Batch)

SEMESTER-I

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-124	Diversity of Invertebrates	Major	Nil	2
ZOO-124L	Diversity of Invertebrates (Lab)	Major	Nil	1
BOT-124	Diversity of Plants	Interdisciplinary	Nil	2
BOT-124L	Diversity of Plants (Lab)	Interdisciplinary	Nil	1
MTH-110	Quantitative Reasoning – I	General Education	Nil	3
SCI-101	Natural Sciences	General Education	Nil	2
SCI-101L	Natural Science (Lab)	General Education	Nil	1
ENG-110	Functional English	General Education	Nil	3
CS-107	Applications of Information and Communication Technologies (ICT)	General Education	Nil	2
CS-107L	Applications of Information and Communication Technologies (ICT) (Lab)	General Education	Nil	1
UHQ-101/ ETH-103	Understanding of Quran-I/ Ethics-I	Mandatory	Nil	1
Total				19

SEMESTER-II

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-123	Cell Biology	Major	Nil	2
ZOO-123L	Cell Biology (Lab)	Major	Nil	1
ZOO-125	Diversity of Chordates	Major	ZOO-124	2
ZOO-125L	Diversity of Chordates (Lab)	Major	ZOO-124L	1
BOT-102	Plant Physiology and Ecology	Interdisciplinary	Nil	2
BOT-102L	Plant Physiology and Ecology (Lab)	Interdisciplinary	Nil	1
STA-112	Quantitative Reasoning – II	General Education	Nil	3
ENG-111	Expository Writing	General Education	Nil	3
GEO-105/ SOC-104	Fundamentals of Geography/ Introduction to Social Sciences	General Education	Nil	2
UHQ-102/ ETH-104	Understanding of Quran-II/ Ethics-II	Mandatory	Nil	1
Total				18

SEMESTER–III

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-208	Animal Ecology	Major	Nil	2
ZOO-208L	Animal Ecology (Lab)	Major	Nil	1
ZOO-209	Animal Form and Function – I	Major	Nil	2
ZOO-209L	Animal Form and Function – I (Lab)	Major	Nil	1
ZOO-206	Animal Behavior	Major	Nil	3
ISL-101/ ETH-101	Islamic Studies / Ethics	General Education	Nil	2
PAK-104	Pakistan Studies	General Education	Nil	2
BFA-129	Arts and Humanities	General Education	Nil	2
CHM-103	Basic Chemistry	Interdisciplinary	Nil	2
CHM-103L	Basic Chemistry (Lab)	Interdisciplinary	Nil	1
Total				18

SEMESTER–IV

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-210	Evolution	Major	Nil	3
ZOO-211	Animal Form and Function – II	Major	ZOO-209	2
ZOO-211L	Animal Form and Function – II (Lab)	Major	ZOO-209L	1
ZOO-414	Entomology	Major	Nil	2
ZOO-414L	Entomology (Lab)	Major	Nil	1
ZOO-212	Developmental Biology	Major	Nil	2
ZOO-212L	Developmental Biology (Lab)	Major	Nil	1
CCE-497	Civic and Community Engagement	General Education	Nil	2
MGT-108	Entrepreneurship	General Education	Nil	2
PAK-103	Ideology and Constitution of Pakistan	General Education	Nil	2
Total				18

SEMESTER–V

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-444	Zoogeography and Paleontology	Major	Nil	2
ZOO-444L	Zoogeography and Paleontology (Lab)	Major	Nil	1
ZOO-319	Marine Biology	Major	Nil	3
ZOO-320	Principles of Systematic Zoology	Major	Nil	2
ZOO-320L	Principles of Systematic Zoology (Lab)	Major	Nil	1
CHM-324	Principles of Biochemistry	Interdisciplinary	Nil	2
CHM-324L	Principles of Biochemistry (Lab)	Interdisciplinary	Nil	1
ZOO-323	Principles of Genetics	Interdisciplinary	Nil	2
ZOO-323L	Principles of Genetics (Lab)	Interdisciplinary	Nil	1
STA-314	Biostatistics	Interdisciplinary		2
STA-314L	Biostatistics (Lab)	Interdisciplinary	Nil	1
Total				18

SEMESTER–VI

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-321	Fisheries and Aquaculture	Major	Nil	2
ZOO-321L	Fisheries and Aquaculture (Lab)	Major	Nil	1
ZOO-322	Research Methodologies and Bioethics	Major	Nil	2
ZOO-322L	Research Methodologies and Bioethics (Lab)	Major	Nil	1
ZOO-XXX	Elective – I	Major	Nil	3
ZOO-XXX	Elective – I I	Major	Nil	3
ZOO-411	Molecular Biology	Interdisciplinary	Nil	2
ZOO-411L	Molecular Biology (Lab)	Interdisciplinary	Nil	1
Total				15

SEMESTER–VII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-449	Wildlife Conservation and Management	Major	Nil	2
ZOO-449L	Wildlife Conservation and Management (Lab)	Major	Nil	1
ZOO-450	Economic Zoology	Major	Nil	3
ZOO-XXX	Elective – III	Major	Nil	3
ZOO-XXX	Elective – IV	Major	Nil	3
MIC-101	Microbiology and Immunology	Interdisciplinary	Nil	2
MIC-101L	Microbiology and Immunology (Lab)	Interdisciplinary	Nil	1
INT-499	Internship	Mandatory	Nil	3
Total				18

SEMESTER–VIII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-XXX	Elective – V	Major	Nil	3
ZOO-XXX	Elective – VI	Major	Nil	3
ZOO-XXX	Elective – VII	Major	Nil	3
CS-113	Computational Biology	Interdisciplinary	Nil	2
CS-113L	Computational Biology (Lab)	Interdisciplinary	Nil	1
CP-498	Capstone	Capstone	Nil	3
Total				15

Total Cr. Hr: 19+18+18+18+18+15+18+15= 139

7. Scheme of Studies for BS Zoology (Lateral Entry Annual System)

SEMESTER-V

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-444	Zoogeography and Paleontology	Major	Nil	2
ZOO-444L	Zoogeography and Paleontology (Lab)	Major	Nil	1
ZOO-319	Marine Biology	Major	Nil	3
ZOO-320	Principles of Systematic Zoology	Major	Nil	2
ZOO-320L	Principles of Systematic Zoology (Lab)	Major	Nil	1
CHM-324	Principles of Biochemistry	Interdisciplinary	Nil	2
CHM-324L	Principles of Biochemistry (Lab)	Interdisciplinary	Nil	1
ZOO-323	Principles of Genetics	Interdisciplinary	Nil	2
ZOO-323L	Principles of Genetics (Lab)	Interdisciplinary	Nil	1
STA-314	Biostatistics	Interdisciplinary		2
STA-314L	Biostatistics (Lab)	Interdisciplinary	Nil	1
ZOO-206	Animal Behavior	Major	Nil	3
Total				21

SEMESTER-VI

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-321	Fisheries and Aquaculture	Major	Nil	2
ZOO-321L	Fisheries and Aquaculture (Lab)	Major	Nil	1
ZOO-322	Research Methodologies and Bioethics	Major	Nil	2
ZOO-322L	Research Methodologies and Bioethics (Lab)	Major	Nil	1
ZOO-XXX	Elective – I	Major	Nil	3
ZOO-XXX	Elective – I I	Major	Nil	3
ZOO-411	Molecular Biology	Interdisciplinary	Nil	2
ZOO-411L	Molecular Biology (Lab)	Interdisciplinary	Nil	1
ZOO-123	Cell Biology	Major	Nil	2
ZOO-123L	Cell Biology (Lab)	Major	Nil	1
ZOO-210	Evolution	Major	Nil	3
Total				21

SUMMER

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-209	Animal Form and Function - I	Major	Nil	2
ZOO-209L	Animal Form and Function - I (Lab)	Major	Nil	1
ZOO-212	Developmental Biology	Major	Nil	2
ZOO-212L	Developmental Biology (Lab)	Major	Nil	1
Total				6

SEMESTER-VII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-449	Wildlife Conservation and Management	Major	Nil	2
ZOO-449L	Wildlife Conservation and Management (Lab)	Major	Nil	1
ZOO-450	Economic Zoology	Major	Nil	3
ZOO-XXX	Elective – III	Major	Nil	3
ZOO-XXX	Elective – IV	Major	Nil	3
MIC-101	Microbiology and Immunology	Interdisciplinary	Nil	2
MIC-101L	Microbiology and Immunology (Lab)	Interdisciplinary	Nil	1
INT-499	Internship	Mandatory	Nil	3
ZOO-208	Animal Ecology	Major	Nil	2
ZOO-208L	Animal Ecology (Lab)	Major	Nil	1
Total				21

SEMESTER-VIII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-XXX	Elective – V	Major	Nil	3
ZOO-XXX	Elective – VI	Major	Nil	3
ZOO-XXX	Elective – VII	Major	Nil	3
CS-113	Computational Biology	Interdisciplinary	Nil	2
CS-113L	Computational Biology (Lab)	Interdisciplinary	Nil	1
CP-498	Capstone	Capstone	Nil	3
MGT-108	Entrepreneurship	General Education	Nil	2
ZOO-414	Entomology	Major	Nil	2
ZOO-414L	Entomology (Lab)	Major	Nil	1
Total				20

BSc Cr. Hours semesters= 50

21+21+06+21+20=89

Total Cr. Hours= 139

8. Scheme of Studies for BS Zoology (Lateral Entry Semester System)

SEMESTER-V

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-444	Zoogeography and Paleontology	Major	Nil	2
ZOO-444L	Zoogeography and Paleontology (Lab)	Major	Nil	1
ZOO-319	Marine Biology	Major	Nil	3
ZOO-320	Principles of Systematic Zoology	Major	Nil	2
ZOO-320L	Principles of Systematic Zoology (Lab)	Major	Nil	1
CHM-324	Principles of Biochemistry	Interdisciplinary	Nil	2
CHM-324L	Principles of Biochemistry (Lab)	Interdisciplinary	Nil	1
ZOO-323	Principles of Genetics	Interdisciplinary	Nil	2
ZOO-323L	Principles of Genetics (Lab)	Interdisciplinary	Nil	1
STA-314	Biostatistics	Interdisciplinary		2
STA-314L	Biostatistics (Lab)	Interdisciplinary	Nil	1
ZOO-206	Animal Behavior	Major	Nil	3
Total				21

SEMESTER-VI

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-321	Fisheries and Aquaculture	Major	Nil	2
ZOO-321L	Fisheries and Aquaculture (Lab)	Major	Nil	1
ZOO-322	Research Methodologies and Bioethics	Major	Nil	2
ZOO-322L	Research Methodologies and Bioethics (Lab)	Major	Nil	1
ZOO-XXX	Elective – I	Major	Nil	3
ZOO-XXX	Elective – I I	Major	Nil	3
ZOO-411	Molecular Biology	Interdisciplinary	Nil	2
ZOO-411L	Molecular Biology (Lab)	Interdisciplinary	Nil	1
ZOO-210	Evolution	Major	Nil	3
Total				18

SEMESTER-VII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-449	Wildlife Conservation and Management	Major	Nil	2
ZOO-449L	Wildlife Conservation and Management (Lab)	Major	Nil	1
ZOO-450	Economic Zoology	Major	Nil	3
ZOO-XXX	Elective – III	Major	Nil	3
ZOO-XXX	Elective – IV	Major	Nil	3
MIC-101	Microbiology and Immunology	Interdisciplinary	Nil	2
MIC-101L	Microbiology and Immunology (Lab)	Interdisciplinary	Nil	1
INT-499	Internship	Mandatory	Nil	3
Total				18

SEMESTER-VIII

Course Code	Course Title	Course Type	Pre-Requisite	Credit Hours
ZOO-XXX	Elective – V	Major	Nil	3
ZOO-XXX	Elective – VI	Major	Nil	3
ZOO-XXX	Elective – VII	Major	Nil	3
CS-113	Computational Biology	Interdisciplinary	Nil	2
CS-113L	Computational Biology (Lab)	Interdisciplinary	Nil	1
CP-498	Capstone	Capstone	Nil	3
MGT-108	Entrepreneurship	General Education	Nil	2
Total				17

ADP Cr. Hours four semesters= 65

5th -8th Semester= 21+18++18+17=74

Total Cr. Hours= 139

9. List of Major Courses

S.no	Course Code	Course Title	Pre-Requisite	Credit Hours
1.	ZOO-124	Diversity of Invertebrates	Nil	2
2.	ZOO-124L	Diversity of Invertebrates (Lab)	Nil	1
3.	ZOO-123	Cell Biology	Nil	2
4.	ZOO-123L	Cell Biology (Lab)	Nil	1
5.	ZOO-125	Diversity of Chordates	ZOO-124	2
6.	ZOO-125L	Diversity of Chordates (Lab)	ZOO-124L	1
7.	ZOO-206	Animal Behavior	Nil	3
8.	ZOO-208	Animal Ecology	Nil	2
9.	ZOO-208L	Animal Ecology (Lab)	Nil	1
10.	ZOO-209	Animal Form and Function-I	Nil	2
11.	ZOO-209L	Animal Form and Function-I (Lab)	Nil	1
12.	ZOO-210	Evolution	Nil	3
13.	ZOO-211	Animal Form and Function-II	ZOO-209	2
14.	ZOO-211L	Animal Form and Function-II (Lab)	ZOO-209L	1
15.	ZOO-414	Entomology	Nil	2
16.	ZOO-414L	Entomology (Lab)	Nil	1
17.	ZOO-212	Developmental Biology	Nil	2
18.	ZOO-212L	Developmental Biology (Lab)	Nil	1
19.	ZOO-444	Zoogeography and Paleontology	Nil	2
20.	ZOO-444L	Zoogeography and Paleontology (Lab)	Nil	1
21.	ZOO-319	Marine Biology	Nil	3
22.	ZOO-320	Principles of Systematic Zoology	Nil	2
23.	ZOO-320L	Principles of Systematic Zoology (Lab)	Nil	1
24.	ZOO-321	Fisheries and Aquaculture	Nil	2
25.	ZOO-321L	Fisheries and Aquaculture (Lab)	Nil	1
26.	ZOO-322	Research Methodologies and Bioethics	Nil	2

27.	ZOO-322L	Research Methodologies and Bioethics (Lab)	Nil	1
28.	ZOO-449	Wildlife Conservation and Management	Nil	2
29.	ZOO-449L	Wildlife Conservation and Management (Lab)	Nil	1
30.	ZOO-450	Economic Zoology	Nil	3

10. Course Outline for Major Courses

Diversity of Invertebrates

BS-Zoology

Course Code: ZOO-124

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will acquire knowledge of evolutionary/phylogenetic relationships (from simple to complex organisms). Students will be able to know the basic taxonomic characteristics and classification of major invertebrate phyla with anatomical and physiological adaptations and their ecological/economic importance.

Learning Outcomes

By the end of this course, the students will be able to:

- Identify and describe the diversity of invertebrate phyla.
- Analyze the structural and functional adaptations of invertebrates.
- Evaluate the ecological significance and evolutionary history of invertebrates.

Course Outline

Unit 1. Animal-Like Protists

Patterns of organization, Animal-Like Protists, The Protozoa. Evolutionary perspective, Life within a single plasma membrane, Protozoon Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable), Locomotion; Cilia and other pellicular structure, Nutrition; Genetic Control and Reproduction; Multicellular and tissue levels of organization: Evolutionary Perspective.

Unit 2. Classification of Organisms

Classification of Organisms, Evolutionary Relationships and Tree Diagrams.

Unit 3. Animal Phylums

Phylum Porifera, Phylum Cnidaria (Coelenterate), Phylum Ctenophore: Phylum Platyhelminthes: Phylum Nemertea, Phylum Gastrotricha, Pseudocoelomate body plan; Aschelminths: Evolutionary perspective; General Characteristics, Phylum Rotifera, Phylum Nematoda and Phylum Kinorhyncha.: Some Important Nematode Parasites of Humans; Phylum Mollusca, Phylum Annelida.

Unit 4. Phylum Arthropoda

Evolutionary Perspective: Classification and Relationship to other Animals; Metamerism and Tagmatization. The Exoskeleton; Metamorphosis. Classification up to Class.

Unit 5. The Hexapods and Myriapods

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. Insects Behavior, Insect and Human.

Unit 6. Phylum Echinoderms

Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class. Maintenance Functions, Regeneration. Reproduction, and Development in Asteroidea, Ophiuroidea, Echinoidea, Holothuridea and Crinoidea.

Recommended Books/Reference Material

1. Campbell, N. A. (2002). *Biology: 6th Edition*. Benjamin Cummings Publishing Company, Inc.
2. Hanson, E. D. (2021). *Animal Diversity*. Hassell Street Press.
3. Hickman, C. P., Kats, H. L. (2000). *Laboratory Studies in Integrated Principles of Zoology*. McGraw-Hill.
4. Hickman, C. P., Larson, S. K. A., Eisenhour, D., & Roberts, L. (2021). *Animal Diversity: 9th Edition*. McGraw-Hill.
5. Hickman, C. P., Roberts, L. C., & Larson, A. (2007). *Integrated Principles of Zoology: 12th & 13th Edition (International)*. McGraw-Hill.
6. Hickman, C. P., Roberts, L. C., & Larson, A. (2018). *Integrated Principles of Zoology: 15th Edition (International)*. McGraw-Hill.
7. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates*. McGraw-Hill.
8. Miller, A. S., & Harley, J. B. (2016). *Zoology: 10th Edition (International)*. McGraw-Hill.
9. Pechenik, J. A. (2015). *Biology of Invertebrates: 7th Edition (International)*. McGraw-Hill.
10. Piper, R. (2015). *Animal Earth: The Amazing Diversity of Living Creatures*. Thames & Hudson.

Diversity of Invertebrates (Lab)

BS-Zoology

Course Code: ZOO-124L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Students will know about evolutionary/phylogenetic relationships (from simple to complex organisms). They will know the basic taxonomic characteristics and classification of major invertebrate phyla. They will be equipped with the understanding of body organization, and associated organ system.

Learning Outcomes

This course will be based on the following outcomes:

- Understand invertebrate organismal concepts in laboratory and field.
- Understand anatomical and physiological adaptations of animals in relation to evolutionary history
- Analyze economic and ecological importance of invertebrates

Course Outline

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 as representatives of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of Phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of phylum Echinodermata.

Recommended Books/Reference Material

1. Hickman, C. P., Kats, H. L. (2000). *Laboratory Studies in Integrated Principal of Zoology*. McGraw-Hill.
2. Hickman, C. P., Larson, S. K. A., Eisenhour, D., & Roberts, L. (2021). *Animal Diversity: 9th Edition*. McGraw-Hill.
3. Hickman, C. P., Roberts, L. C., & Larson, A. (2007). *Integrated Principles of Zoology: 12th & 13th Edition (International)*. McGraw-Hill.
4. Hickman, C. P., Roberts, L. C., & Larson, A. (2018). *Integrated Principles of Zoology: 15th Edition (International)*. McGraw-Hill.
5. Miller, A. S., & Harley, J. B. (2016). *Zoology: 10th Edition (International)*. McGraw-Hill.
6. Miller, S. A. (2002). *General Zoology Laboratory Manual: 5th Edition (International)*. McGraw-Hill.

7. Pechenik, J. A. (2015). *Biology of Invertebrates: 7th Edition (International)*. McGraw-Hill.
8. Piper, R. (2015). *Animal Earth: The Amazing Diversity of Living Creatures*. Thames & Hudson.

Cell Biology

BS-Zoology

Course Code: ZOO-123

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will acquire knowledge about the basic concepts of cell biology. They will learn about the cellular structure, composition of the organelles, cell growth and cellular division. They will know about how macromolecules and organelles govern the dynamic organization and function of living cells.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the structure, function, and molecular organization of animal cells.
- Explain the mechanisms of cell division and cellular signaling.
- Analyze cellular transport and communication processes.

Course Outline

Unit 1. Cell Structure and Function, Cell Membrane

Cell theory. Comparison of plant and animal cells. Comparison of prokaryotic and eukaryotic cells. Structural models of cell membrane. Chemical composition of cell membrane and its function.

Unit 2. Cell Organelles

Endoplasmic reticulum. Golgi Bodies. Mitochondria. Lysosomes. Peroxisomes. Ribosome

Unit 3. Nucleus

Structure and function. Nuclear membrane. Chromatin

Unit 4. Cytoskeleton

Structure and types. Functions of cytoskeleton

Unit 5. Cellular Transport

Diffusion and osmosis. Facilitated and active transport. Endocytosis and exocytosis

Unit 6. Cellular Reproduction

Cell cycle. Mitosis. Meiosis

Recommended Books/Reference Material

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2017). *Molecular Biology of the Cell* (6th ed.). Garland Science.
2. Alberts, B., Heald, R., Hopkin, K., Johnson, A., Morgan, D., Roberts, K., & Walter, P. (2023). *Essential Cell Biology*. W. W. Norton & Company.
3. Chandar, D. N., & Viselli, D. S. M. (2020). *Cell and Molecular Biology* (2nd ed.). LWW.
4. De Robertis, E. D. P. (2017). *Cell and Molecular Biology* (8th ed.). Lea & Febiger.
5. Geoffrey, M. C., & Robert, E. H. (2007). *The Cell: A Molecular Approach*. Sinauer Associates.
6. Harvey, L., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). *Molecular Cell Biology*. W. H. Freeman Publishers.
7. Karp, J. (2005). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
8. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin, K. C. (2016). *Molecular Cell Biology*. Macmillan Higher Education.
9. Miller, A. S., & Harley, J. B. (2016). *Zoology: 10th Edition (International)*. McGraw-Hill.
10. Stanger, B. (2023). *From One Cell: A Journey into Life's Origins and the Future of Medicine*. W. W. Norton & Company.

Cell Biology (Lab)

BS-Zoology

Course Code: ZOO-123L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Students will acquire knowledge about the basic staining techniques. They will learn about the identification of cell organelles. They will know about the different stages of mitosis and meiosis.

Learning Outcomes

By the end of this course, the students will be able to:

- Students will be able to identify the prepared slides of different cell organelles.
- Students will be able to know the techniques of preparation of whole mount.
- Students will understand the different stages of cell cycle

Course Outline

1. Study of microscope.
2. Study of staining techniques (Gram staining).
3. Study of prepared slides of cell organelles.
4. Preparation of temporary whole mount.
5. Preparation of permanent whole mount.
6. Squash preparation of onion root tip for mitotic stages.
7. Study of mitotic and meiotic stages with the help of prepared slides.

Recommended Books/Reference Material

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2017). *Molecular Biology of the Cell* (6th ed.). Garland Science.
2. Alberts, B., Heald, R., Hopkin, K., Johnson, A., Morgan, D., Roberts, K., & Walter, P. (2023). *Essential Cell Biology*. W. W. Norton & Company.
3. Chandar, D. N., & Viselli, D. S. M. (2020). *Cell and Molecular Biology* (2nd ed.). LWW.
4. De Robertis, E. D. P. (2017). *Cell and Molecular Biology* (8th ed.). Lea & Febiger.
5. Geoffrey, M. C., & Robert, E. H. (2007). *The Cell: A Molecular Approach*. Sinauer Associates.
6. Karp, J. (2005). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
7. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin, K. C. (2016). *Molecular Cell Biology*. Macmillan Higher Education.
8. Miller, A. S., & Harley, J. B. (2016). *Zoology: 10th Edition (International)*. McGraw-Hill.
9. Stanger, B. (2023). *From One Cell: A Journey into Life's Origins and the Future of Medicine*. W. W. Norton & Company.

Diversity of Chordates

BS Zoology

Course Code: ZOO-125

Credit Hours: 02

Pre-requisite: Diversity of Invertebrates (ZOO-124)

Objectives

Students will be able to understand the taxonomic characteristics of protochordates and chordates. They will get knowledge about the phylogenetic relationships of protochordates and various classes of chordates.

Learning Outcomes

By the end of this course, the students will be able to:

- Identify and classify major groups within the phylum Chordata.
- Explain the evolutionary relationships and adaptations of chordates.
- Analyze the ecological roles and physiological characteristics of different chordates.

Course Outline

Unit 1. Fishes

Vertebrate Success in Water, Phylogenetic relationships of Pisces, Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli, Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development.

Unit 2. Amphibians

Characteristics of amphibians, Phylogenetic relationships, Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature

regulation, nervous and sensory functions, excretion and Osmoregulation, reproduction, development, and metamorphosis.

Unit 3. Reptiles

General characteristics of reptiles, 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.

Unit 4. Birds

Classification, Feathers, flight and endothermy, Phylogenetic relationships; ancient birds and the evolution of flight, Diversity of modern birds, Adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development, Migration and navigation.

Unit 5. Mammals

Classification, 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.

Recommended Books/Reference Material

1. Campbell, N. A. (2011). *Biology* (9th ed.). Benjamin Cummings Publishing Company, Inc.
2. Hanson, E. D. (2021). *Animal Diversity*. Hassell Street Press.
3. Hickman, C. P., Larson, S. K. A., Eisenhour, D., & Roberts, L. (2021). *Animal Diversity* (9th ed.). McGraw-Hill.
4. Hickman, C. P., Roberts, L. S., & Larson, A. (2009). *Integrated Principles of Zoology* (14th ed., International ed.). McGraw-Hill.
5. Miller, S. A., & Harley, J. B. (2010). *Zoology* (8th ed., International ed.). McGraw-Hill.
6. Piper, R. (2015). *Animal Earth: The Amazing Diversity of Living Creatures*. Thames & Hudson.

Diversity of Chordates (Lab)

BS Zoology

Course Code: ZOO-125L

Credit Hours: 01

Pre-requisite: Diversity of Invertebrates Lab (ZOO-124L)

Objectives

Students will develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

Learning Outcomes

By the end of this course, the students will be able to:

- Students will be able to acquire the basic knowledge of Taxonomic characteristics of chordates.
- Students will understand the phylogenetic relations and diversity of Pisces, amphibians, reptiles, birds and mammals.

Course Outline

1. Classification and study of lab specimens of fishes, amphibians, reptiles, birds, and mammals.
2. Visit to Pakistan Museum of Natural History (PMNH) for the study of diversity of chordates.

Recommended Books/Reference Material

1. Campbell, N. A. (2011). *Biology* (9th ed.). Benjamin Cummings Publishing Company, Inc.
2. Hanson, E. D. (2021). *Animal Diversity*. Hassell Street Press.
3. Hickman, C. P., Larson, S. K. A., Eisenhour, D., & Roberts, L. (2021). *Animal Diversity* (9th ed.). McGraw-Hill.
4. Hickman, C. P., Roberts, L. S., & Larson, A. (2009). *Integrated Principles of Zoology* (14th ed., International ed.). McGraw-Hill.
5. Miller, S. A. (2002). *General Zoology Laboratory Manual* (5th ed., International ed.). McGraw-Hill.
6. Miller, S. A., & Harley, J. B. (2010). *Zoology* (8th ed., International ed.). McGraw-Hill.
7. Piper, R. (2015). *Animal Earth: The Amazing Diversity of Living Creatures*. Thames & Hudson.

Animal Ecology

BS Zoology

Course Code: ZOO-208

CreditHours:02

Pre-requisites: Nil

Objectives

The course aims to: provide a thorough understanding of ecological principles as they relate specifically to animals and their environments. Students will explore interactions between animals and their biotic and abiotic environments at the individual, population, community, and ecosystem levels and analyze ecological processes such as competition, predation, and symbiosis in animal populations. Moreover, ecological research methods and tools used in studying animal ecology and conservation will be introduced. Lastly, the course will highlight current ecological issues and the role of ecology in wildlife management and environmental sustainability.

Learning Outcomes

By the end of this course, students will be able to:

- Understand the interactions between animals and their environments.

- Analyze population dynamics and community structure within ecosystems.
- Evaluate the impact of environmental changes on animal populations and biodiversity.

Course Outline

Unit 1. Introduction to Animal Ecology and Energy Transfer

Definition, scope, and subfields of ecology, Relationship between ecology and other biological sciences, Basic Concepts of and Types of Ecology, Laws of thermodynamics, primary and secondary productions, Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

Unit 2. Biogeochemical Cycle

Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient.

Unit 3. Limiting Factors: Abiotic and Biotic Factors and Animal Interactions

Light, temperature, water, humidity, soil, and topography, Animal adaptations to abiotic Factors, Interspecific and intraspecific interactions: competition, predation, mutualism, Parasitism, Symbiosis and ecological roles

Unit 4. Global Ecosystems

Atmosphere, Hydrosphere, Lithosphere and Ecosphere. An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types. Major ecosystem of world, Forest, Grassland, Desert, Tundra and Agricultural ecosystems. Marine, Estuarine, Freshwater and Wetlands

Unit 5. Population and Community Ecology

Population characteristics: size, density, growth, and regulation, Life tables, survivorship curves, and reproductive strategies, Community interactions and species diversity indices, Community Analysis, Ecotones.

Unit 6. Applied and Radiation Ecology

Resources and their ecological management, Mineral, Agricultural Desalination, Forest and Range Management, Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).

Recommended Books/Reference Material

1. Chapman, J. L., & Reiss, M. J. (1999). *Ecology: Principles and Applications* (2nd ed.). Cambridge University Press.
2. Krebs, C. J. (2009). *Ecology: The Experimental Analysis of Distribution and Abundance* (6th ed.). Benjamin Cummings.
3. Molles, M. C. (2019). *Ecology: Concepts and Applications* (8th ed.). McGraw-Hill Education.
4. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Brooks/Cole.
5. Ricklefs, R. E. (2008). *The Economy of Nature* (6th ed.). W. H. Freeman.

Animal Ecology (Lab)

BS Zoology
Course Code: ZOO-208L
CreditHours:01
Pre-requisites: Nil

Objectives

Students will know the importance of Ecology and different environmental threats. They will also the ecological management plans of different areas. They will also acquire knowledge about different sampling techniques.

Learning Outcomes

By the end of this course, students will be able to:

- Student will be able to understand and apply the basic concepts of ecology
- Students will acquire theoretical knowledge for rehabilitation of destroyed ecosystems and habitats in the environment.
- Students will be able to solve the ecological problems and their management through scientific approach.

Course Outline

1. Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).
2. Study of different Ecosystems (Fresh Water, Terrestrial, Marine/Mountain/ Desert).
3. Ecological Notes.
4. Measurements of physical Factors of different Ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.

Recommended Books/Reference Material

1. Anand, M. R., Kommireddy, P., Seenapa, C., & Murthy, K. N. (2023). *Agroecology: Sustainable Ecosystem*. CRC Press.
2. Chapman, J. L., & Reiss, M. J. (1997). *Ecology: Principles and Applications*. Cambridge University Press.
3. Cox, C. B., & Moore, D. (2000). *Biogeography: An Ecological and Evolutionary Approach* (6th ed.). King's College, London: Life Sciences Press.
4. Dodson, S. I., Allen, T. F. H., Carpenter, S. R., Ives, A., Jeanne, R. L., Kitchell, J. F., Langston, N. E., & Turner, M. G. (1998). *Ecology*. Oxford University Press.
5. Molles, M. C. (2005). *Ecology: Concepts and Applications* (6th ed.). McGraw-Hill.
6. Newman, I. (1993). *Applied Ecology*. Blackwell.
7. Odum, E. P. (1994). *Fundamentals of Ecology* (3rd ed.). W. B. Saunders.

Animal Form and Function–I

BS Zoology

Course Code: ZOO-209

Credit Hours: 02

Pre-requisite: Nil

Objectives

To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.

Learning Outcomes

By the end of this course, the students will be able to:

- Describe the anatomical structures of various animal groups.
- Compare the functional adaptations of organ systems across different taxa.
- Evaluate the evolutionary significance of anatomical variations for adaptations.

Course Outline

Unit 1. Protection, Support, and Movement

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

Unit 2. Communication I

Nerves: Neurons: structure and function.

Unit 3. Communication II

Senses: Sensory reception. Senses: Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates. Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

Unit 4. Communication III

The Endocrine System and Chemical Messengers. The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine

system; endocrine systems of vertebrates, endocrine systems of birds and mammals.

Unit 5. Circulation and Immunity

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

Recommended Books/Reference Material

1. Campbell, N. A. (2011). *Biology* (9th ed.). Benjamin Cummings.
2. Hickman, C. P., Roberts, L. S., & Larson, A. (2019). *Integrated Principles of Zoology* (18th ed.). McGraw Hill.
3. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates*. McGraw-Hill.
4. Meloni, S., & Mastenbjork, M. D. (2023). *Anatomy and Physiology*. Medical Creations.
5. Miller, S. A., & Harley, J. B. (2015). *Zoology* (10th ed.). McGraw Hill.
6. Pechenik, J. A. (2013). *Biology of Invertebrates* (4th ed.). McGraw Hill.
7. Saladin, K. (2023). *Anatomy and Physiology: The Unity of Form and Function*. McGraw Hill.

Animal Form and Function–I (Lab)

BS Zoology

Course Code: ZOO-209L

CreditHours:01

Pre-requisite: Nil

Objectives

To understand the organ systems, their specialization and coordination with each other and the constantly changing internal and external environment, inside and outside the animal's body. To embrace the phenomena in the basic structure of each system that determines its function.

Learning Outcomes

By the end of this course, the students will be able to:

- Acquire the concept that for the performance of a function, for example exchange of respiratory gases the different forms are adapted in environments e.g. gills in aquatic and lungs in terrestrial environment.
- Emergence of diversity of forms for the performance of similar function.
- To evaluate the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
- To demonstrate that a form is successfully adapted to perform a function adequately and successfully.

Course Outline

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

Recommended Books/Reference Material

1. Hickman, C. P., Roberts, L. S., & Larson, A. (2019). *Integrated Principles of Zoology* (18th ed.). McGraw Hill.
2. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates*. McGraw Hill.
3. Meloni, S., & Mastenbjork, M. D. (2023). *Anatomy and Physiology*. Medical Creations.
4. Saladin, K. (2023). *Anatomy and Physiology: The Unity of Form and Function*. McGraw Hill.

Animal Behavior

BS Zoology

Course Code: ZOO-206

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will get knowledge about animal responses to external stimuli and their behavioral mechanism. They will also learn about neurophysiology in behavioral development.

Learning Outcomes

By the end of this course, students will be able to:

- Explain the fundamental principles and mechanisms of animal behavior.
- Analyze the influence of genetics, environment, and learning on animal behavior.
- Evaluate the ecological and evolutionary significance of different behavioral patterns.

Course Outline

Unit 1. Introduction

Behavior and its types, Proximate and ultimate causes of behavior. Physiology of behavior in changed environments. Hormones and behavior in animals.

Unit 2. Types of Behavior

Innate behavior and innate releasing mechanisms. Learned behavior and its mechanisms. quick learners' vs slow learners. Concept of animal cognition; key to

understand and develop multiple behavioral choices. Ecological and genetics to maintain animal behavior.

Unit 3. Concept of Territoriality

Concept of territoriality and defense in animals. Circadian rhythms and concept of bio-rhythmicity in animals. Costs and benefit ratios in behavior.

Unit 4. Competition for Resources

Altruism and parental sacrifice to nurture the young. Competition for resources. successful foragers and winners of predator-prey relationships

Unit 5. Social Organization

Social organization in animals and concept of group living. Social organization in insects and mammals. Communication in animals.

Unit 6. Communication in animals

Visual, Bioacoustics, electrical, chemical and tactile. Various types of chemical signals in animals' behavior and their importance in ecosystems.

Recommended Books/Reference Material

1. Alcock, J. (2010). *Animal Behavior: An Evolutionary Approach* (9th ed.). Sinauer Publishers.
2. Breed, M. D., & Moore, J. (2022). *Animal Behavior*. Academic Press.
3. Dugatkin, L. A. (2013). *Principles of Animal Behavior* (3rd ed.). W. W. Norton & Co.
4. Mukherjee, S. (2022). *How Animal Senses Reveal the Hidden Realms Around Us*. Random House.
5. Nelson, R. J., & Kriegsfeld, L. J. (2022). *An Introduction to Behavioral Endocrinology* (6th ed.). Sinauer Associates.
6. Scott, G. (2009). *Essential Animal Behavior*. John Wiley & Sons.

Evolution

BS-Zoology

Course Code: ZOO-210

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will know about the detailed account of the origin of life. They will develop some basic concepts and ideas for causing evolutionary changes and significance of systematics in relation to their nomenclature.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the concept, philosophy and mechanisms of evolution, including natural selection and genetic drift.
- Analyze evolutionary relationships between different animal groups.
- Evaluate the role of evolution in shaping biodiversity, speciation, and adaptation.

Course Outline

Unit 1. Theories of Evolution

Theories to explain diversity of life– modern synthetic theory, factors initiating elementary evolutionary changes (micro-evolution) and change of gene frequencies.

Unit 2. Change of Gene Frequency

Mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.

Unit 3. Role of Isolation in Evolution

Factors of large evolutionary changes (macroevolution). concepts of allometry, orthogenesis, adaptive radiation.

Unit 4. Modern Concept of Natural Selection

Levels of selection, selection patterns, some examples of Natural Selection.

Unit 5. Impacts of Natural Selection

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 and recapitulation theory.

Recommended Books/Reference Material

1. Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sinauer Associates, an imprint of Oxford University Press.
2. Gilbert, S. F. (2013). *Developmental Biology* (10th ed.). Sinauer Associates.
3. Ridley, M. (1993). *Evolution*. Blackwell Scientific Publications.
4. Strickberger, M. W. (2012). *Evolution*. Jones & Bartlett Publishers.
5. Wiley, E. O., & Lieberman, B. S. (2011). *Phylogenetics: Theory and Practical Practice of Phylogenetic Systematics* (2nd ed.). Wiley-Blackwell.

Animal Form and Function–II

BS-Zoology

Course Code: ZOO-211

Credit Hours: 02

Pre-requisite: Animal Form and Function-I (ZOO-209)

Objectives

To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the comparative physiological processes in animals.
- Compare physiological adaptations of animals in response to the environment.
- Analyze the role of homeostasis in maintaining functional stability in animals.

Course Outline

Unit 1. Nutrition and Digestion

Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.

Unit 2. The Mammalian Digestive System

Gastrointestinal motility and its control. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.

Unit 3. Temperature and Body Fluid Regulation

Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals.

Unit 4. Control of Water and Solutes

Osmoregulation and Excretion); Invertebrate and Vertebrate Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions.

Unit 5. Reproduction and Development

Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction; Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes.

Unit 6. The Human Reproductive System

Spermatogenesis, transport and hormonal control, reproductive function; the human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

Recommended Books/Reference Material

1. Campbell, N. A. (2002). *Biology* (6th ed.). Benjamin/Cummings Publishing Company, Inc.
2. Hickman, C. P., Roberts, L. S., & Larson, A. (2004). *Integrated Principles of Zoology* (11th ed., International ed.). McGraw Hill.
3. Miller, S. A., & Harley, J. B. (2002). *Zoology* (5th ed., International ed.). McGraw Hill.
4. Pechenik, J. A. (2013). *Biology of Invertebrates* (4th ed., International ed.). McGraw Hill.
5. Willis, L. M. (2023). *Anatomy and Physiology* (6th ed.). LWW.

Animal Form and Function–II (Lab)

BS-Zoology

Course Code: ZOO-211L

Credit Hours: 01

Pre-requisite: Animal Form and Function–I (Lab) (ZOO-209L)

Objectives

To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body. To embrace the phenomena in basic structure of each system that determines its particular function.

Learning Outcomes

By the end of this course, the students will be able to:

- Solve of emergence of diversity of forms for the performance of similar function.
- Analyze the requirements of diverse forms for the performance of similar function in their past and present needs.
- Evaluate the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
- Demonstrate that a form is successfully adapted to perform a function adequately and successfully.

Course Outline

1. Study of excretory system in an invertebrate.
2. Study of excretory system in a vertebrate representative (Model).
3. Study of digestive system in invertebrate.
4. Study of digestive system in a vertebrate representative (Dissection).
5. Dissection and study of male and female reproductive system in invertebrates.
6. Dissection and study of male and female reproductive system in vertebrates.

Recommended Books/Reference Material

1. Hickman, C. P., & Kats, H. L. (2010). *Laboratory Studies in Integrated Principles of Zoology* (15th ed.). McGraw Hill.
2. Kent, G. C., & Miller, S. (2001). *Comparative Anatomy of Vertebrates* (9th ed.). McGraw Hill.
3. Willis, L. M. (2023). *Anatomy and Physiology* (6th ed.). LWW.

Entomology

BS-Zoology

Course Code: ZOO-414

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will know about the reasons for evolutionary success of insects and the body structure of insects. They will also know about different physiological processes of insects.

Learning Outcomes

By the end of this course, the students will be able to:

- Identify and classify major insect orders and families.
- Analyze the ecological roles of insects and their interactions with other species.
- Evaluate the ecological, economic, medicinal, and agricultural significance of insects.

Course Outline

Unit 1. Introduction: Reason of Success

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

Unit 2. Morphology

Hard Parts: General segmentation, tagmatosis and organization. Integument: Cuticle: Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane, Cuticular outgrowths and appendages sclerotization. Colors of Insects. Head: cephalization, sclerites, modifications. Antennae: Typical Antenna and its types. Mouthparts: Mouthparts and their types. Different modes of ingestion and types of mouthparts. Neck: Sclerites. Thorax: Sclerites: legs, their different modifications and functions. Wings: Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), Modifications of wings and wing coupling. Flight: Types of flight. Abdomen: Secondary appendages and external genitalia.

Unit 3. Physiology

Soft Parts: Muscular system; basic structure, types of muscles; muscle contraction and its energetics. Comparative structure of all the systems, e.g., digestive, excretory, respiratory, incubatory, reproductive and nervous system and their physiology. Sense organs: sound and light producing organs.

Unit 4. Reproduction and Development in Insects

Exocrine and endocrine glands include pheromones and their functions. Development: Embryogenesis, Different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.

Unit 5. Ecology

Population dynamics: Density dependent and density independent factors regulating insect population. Life history and life tables. Carrying capacity r and k selection. Food chains. Predation and competition. Insect defenses and adaptations. Diapause. Insect communication.

Recommended Books/Reference Material

1. Ambrose, D. P. (2015). *The Insects: Structure Functions and Biodiversity*. Kalyani Publishers.
2. Atwal, A. S. (2015). *Agricultural Pests of Southeast Asia and Their Management*. Kalyani Publishers.
3. Chapman, R. F. (2013). *The Insects: Structure and Function* (5th ed.). Cambridge University Press.
4. Grimaldi, D. A. (2023). *The Complete Insect: Anatomy, Physiology, Evolution and Ecology*. Princeton University Press.
5. Gullan, P. J., & Cranston, P. S. (2014). *The Insects: An Outline of Entomology* (4th ed.). Wiley-Blackwell.
6. Miller, S. A. (2002). *General Zoology Laboratory Manual* (5th ed., International). McGraw Hill.
7. Pedigo, L. P., & Rice, M. E. (2009). *Entomology and Pest Management* (6th ed.). Pearson Education.
8. Price, P. W., Denno, R. F., Eubanks, M. D., Finke, D. L., & Kaplan, I. (2011). *Insect Ecology: Behavior, Populations, and Communities*. Cambridge University Press.
9. Richards, O. W., & Davies, R. G. (1977). *Imm's General Textbook of Entomology*. Chapman and Hall.
10. Schowalter, T. D. (2017). *Insect Ecology: An Ecosystem Approach*. Academic Press.

Entomology (Lab)

BS-Zoology

Course Code: ZOO-414L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Students will know about the reasons for the evolutionary success of insects and different developmental stages of insects.

Learning Outcomes

Students will be able to acquire the basic knowledge of the body structure of insects.

- They will understand the role of structures in different life processes of insects.
- They will be able to classify the insects at order level.
- They will be able to associate insect structure, physiology and ecological interactions with their abundance and huge diversity.

Course Outline

1. Preparation of permanent slides. All the hard parts (antennae, mouth parts, wings, legs and genitalia).
2. Dissection of insects to study different systems, especially digestive, reproductive system of the available representative insects preferably following insects. American Cockroach, Grasshopper.
3. Field visits for collection of different developmental stages of insects belonging to different orders.

4. Field visits and reports writing of ecological interactions of different insects.

Recommended Books/Reference Material

1. Ambrose, D. P. (2015). *The Insects: Structure Functions and Biodiversity*. Kalyani Publishers.
2. Atwal, A. S. (2015). *Agricultural Pests of Southeast Asia and Their Management*. Kalyani Publishers.
3. Chapman, R. F. (2013). *The Insects: Structure and Function* (5th ed.). Cambridge University Press.
4. Grimaldi, D. A. (2023). *The Complete Insect: Anatomy, Physiology, Evolution and Ecology*. Princeton University Press.
5. Gullan, P. J., & Cranston, P. S. (2014). *The Insects: An Outline of Entomology* (4th ed.). Wiley-Blackwell.
6. Miller, S. A. (2002). *General Zoology Laboratory Manual* (5th ed., International). McGraw Hill.
7. Pedigo, L. P., & Rice, M. E. (2009). *Entomology and Pest Management* (6th ed.). Pearson Education.
8. Price, P. W., Denno, R. F., Eubanks, M. D., Finke, D. L., & Kaplan, I. (2011). *Insect Ecology: Behavior, Populations, and Communities*. Cambridge University Press.
9. Richards, O. W., & Davies, R. G. (1977). *Imm's General Textbook of Entomology*. Chapman and Hall.
10. Schowalter, T. D. (2017). *Insect Ecology: An Ecosystem Approach*. Academic Press.

Developmental Biology

BS-Zoology

Course Code: ZOO-212

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will acquire knowledge about the transmission of traits from the parents in their gametes, the formation of zygote and its development. They will also know the details of cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the cellular and molecular mechanisms underlying animal development.
- Describe the stages of embryonic development and differentiation in major animal groups.
- Evaluate the genetic regulation of developmental processes and teratology.

Course Outline

Unit 1. History and Basic Concepts of Developmental Biology

Principal features of developmental biology and embryology with special emphasis on

vertebrate models. Origin of sexual reproduction. Developmental patterns.

Unit 2. Gametogenesis

Mammalian spermatogenesis as model for all vertebrates. Spermiogenesis or (spermateliosis). The role of Sertoli and Leydig cells in spermatogenesis. Hormonal control of spermatogenesis.

Oogenesis. Mechanism of oogenesis among various classes of vertebrates. Vitellogenesis. Hormonal control of Vitellogenesis and oogenesis. Overview of the primate menstrual cycle.

Unit 3. Fertilization

External and Internal Fertilization. Species-specific recognition of sperm and egg. Fusion of male and female gametes. Polyspermy: slow and fast blocks to polyspermy. Activation of egg metabolism.

Unit 4. In Vitro Fertilization (IVF)

History, Steps and advantages of IVF. Disadvantages and risk factors.

Unit 5. Cleavage and Early Development

Early development, cleavage and blastulation. Patterns of embryonic cleavage and blastulation among different vertebrate classes. Mechanism of cleavage. Gastrulation. Fate maps. Gastrulation in amphibians, birds and mammals.

Unit 6. Early Vertebrate Development

Neurulation, ectoderm, mesoderm and endoderm formation. Placenta and extraembryonic membranes.

Unit 7. Cellular Basis of Morphogenesis

Differential cell affinity, cell adhesion molecules. Organogenesis. Mechanism of teratogenesis. Aging and Regeneration in vertebrates.

Recommended Books/Reference Material

1. Anger, K., Harzsch, S., & Thiel, M. (2020). *Developmental Biology and Larval Ecology: The Natural History of the Crustacea* (Vol. 7). Oxford University Press.
2. Bruce, M. C., & Carlson, B. M. (2023). *Human Embryology and Developmental Biology* (7th ed.). Elsevier.
3. Gilbert, S. F. (2013). *Developmental Biology* (10th ed.). Sinauer Associates.
4. Gilbert, S. F., & Barresi, M. J. F. (2023). *Developmental Biology* (13th ed.). Oxford University Press.
5. Jamie, A. D. (2014). *Life Unfolding: How the Human Body Creates Itself*. Oxford University Press.
6. Klaus, K. (2001). *Biological Development* (2nd ed.). McGraw-Hill.
- Scott, F. G., & Barresi, M. J. F. (2016). *Developmental Biology*. Sinauer Associates.

Developmental Biology (Lab)

BS-Zoology
Course Code: ZOO-212L
Credit Hours: 01
Pre-requisite: Nil

Objectives

Students will know about different developmental stages of mammals and the cleavage patterns of embryos. They will also know about teratogenesis.

Learning Outcomes

By the end of this course, the students will be able to:

- Students will be able to gain familiarity with different cleavage patterns.
- Students will apprehend the contributions of the sperm and the egg to form zygote and their structures.

Course Outline

1. Study of the structure of gametes in some representative cases, i.e. frog, fish and mammal.
2. Hen's egg internal and external structural details
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.
5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung
7. Semen analysis
8. Dactylography and its uses in developmental biology

Recommended Books/Reference Material

1. Anger, K., Harzsch, S., & Thiel, M. (2020). *Developmental Biology and Larval Ecology: The Natural History of the Crustacea* (Vol. 7). Oxford University Press.
2. Bruce, M., & Carlson, B. M. (2023). *Human Embryology and Developmental Biology* (7th ed.). Elsevier.
3. Carlson, B. M. (2023). *Human Embryology and Developmental Biology* (7th ed.). Elsevier.
4. Gilbert, S. F. (2013). *Developmental Biology*. Sinauer Associates.
5. Gilbert, S. F., & Barresi, M. J. F. (2016). *Developmental Biology*. Sinauer Associates.
6. Jamie, A. D. (2014). *Life Unfolding: How the Human Body Creates Itself*. Oxford University Press.
7. Klaus, K. (2001). *Biological Development* (2nd ed.). McGraw Hill.

Zoogeography and Paleontology

BS-Zoology
Course Code: ZOO-444
Credit Hours: 02
Pre-requisite: Nil

Objectives

Students will be informed about the distribution of animals and their associations in the past and to rationalize their relationship in the present time. Students will gain understanding of the concepts of evolution mainly based on fossil record.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the geographical distribution of animals and its evolutionary significance.
- Analyze the fossil record to understand the history (geological timescale) and evolution of animal life. Evaluate the role of geological and climatic changes in shaping animal diversity.

Course Outline

Unit 1. Paleogeography

Theories of continental drift and plate tectonics. Concept of Pangea.

Unit 2. Animal Distribution

Cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution, endemic distribution, barriers and dispersal.

Unit 3. Zoogeographical Regions

Zoogeographic division and boundaries. Geographic Ranges, Physical Features
Climates. Faunas and Affinities of Palearctic, Nearctic Regions, Oriental, Ethiopian, Australian, and Neotropical Regions. Insular Fauna. Zoogeography of Pakistan.

Unit 4. Paleontology

The planet earth, history of earth, age, shells of earth, atmosphere, hydrosphere, biosphere and lithosphere. Rocks Types; Igneous rocks, sedimentary rocks and metamorphic rocks.

Unit 5. Fossil and Fossilization

Fossil types and uses of fossils, nature of fossils, Fossilization, Invertebrates and Vertebrates Fossil, Biostratigraphy, Fossils of Pakistan, paleontologically important areas of Pakistan. Fossilization. Geological time scale, Pre-Cambrian life, Post Cambrian life, Paleozoic life, Mesozoic life, Cenozoic life.

Unit 6. Paleontological Techniques and Geochronometry

Excavation techniques, Excavation tools and techniques, Transportation and processing of fossils, Presentation of fossils, Prerequisites for paleontological excavation. Uranium/Lead dating, radiocarbon dating, methods, index fossils, evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Recommended Books/Reference Material

Zoogeography:

1. Ali, S. S. (1999). *Palaeontology, Zoogeography and Wildlife Management*. Nasim Book Depot.
2. Beddard, F. E. (2008). *A Text Book of Zoogeography*. Bibliobazar, LLC.
3. Darlington, P. J., Jr. (1963). *Zoogeography*. John Wiley and Sons.
4. Tiwari, S. K. (2006). *Fundamentals of World Zoogeography*. Wedams eBooks Ltd (India) Sarup & Sons.

Paleontology:

1. Ali, S. S. (1999). *Paleontology, Zoogeography and Wildlife Management*. Nasim Book Depot.
2. Brouwer, A. (1977). *General Palaeontology*. Oliver and Boyd.
3. Foote, M., & Millar, A. I. (2007). *Principles of Paleontology* (3rd ed.). W. H. Freeman & Co.
4. Michael, J. B., David, A., & Harper, T. (2009). *Paleobiology and the Fossil Record* (3rd ed.). Wiley Black.

Zoogeography and Paleontology (Lab)

BS-Zoology

Course Code: ZOO-444L

Credit Hours: 01

Pre-requisite: Nil

Objectives

The students will acquire an understanding of fossil records. They will also know about the distribution of animals in the past eras.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the geographical distribution of animals and its evolutionary significance.
- Analyze the fossil record to understand the history (geological timescale) and evolution of animal life.
- Evaluate the role of geological and climatic changes in shaping animal diversity.

Course Outline

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

Recommended Books/Reference Material

1. Ali, S. S. (1999). *Palaeontology, Zoogeography and Wildlife Management*. Nasim Book Depot.
2. Beddard, F. E. (2008). *A Textbook of Zoogeography*. Bibliobazar, LLC.
3. Foote, M., & Millar, A. I. (2007). *Principles of Paleontology* (3rd ed.). W. H. Freeman & Co.
4. Michael, J. B., David, A., & Harper, T. (2009). *Paleobiology and the Fossil Record* (3rd ed.). Wiley-Blackwell.
5. Tiwari, S. K. (2006). *Fundamentals of World Zoogeography*. Wedams eBooks Ltd (India), Sarup & Sons.

Marine Biology

BS-Zoology

Course Code: ZOO-319

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course aims to provide students with a comprehensive understanding of marine ecosystems, biodiversity, and ecological processes. It introduces the physical and chemical properties of marine environments and the adaptations of marine organisms. The course also emphasizes the importance of marine conservation and the impact of human activities on marine life.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the ecological processes and physical factors that influence marine ecosystems and organisms.
- Analyze the biodiversity and adaptations of marine life across different habitats, such as coral reefs, open oceans, and deep-sea environments.
- Evaluate the impact of human activities, climate change, and pollution on marine ecosystems and propose conservation strategies.

Course Outline

Unit 1. Introduction to Marine Biology

Definition, scope, and history of marine biology, Importance of oceans and marine biodiversity, Overview of marine zones and oceanography basics, Marine zones and marine biodiversity hotspots of Pakistan

Unit 2. Physical and Chemical Features of Marine Environment

Properties of seawater: salinity, temperature, light, and pressure, Ocean currents, waves, and tides (focus on Arabian Sea patterns), Nutrient cycling and productivity in marine waters

Unit 3. Marine Ecosystems and Pakistan

Coastal ecosystems: estuaries, mangroves, coral reefs, rocky shores, sandy beaches, Open Ocean (pelagic) and deep-sea (benthic) ecosystems, Hydrothermal vents and cold

seeps, Mangrove forests (Indus Delta, Miani Hor), Coral reefs (Churna Island, Astola Island), Estuaries and mudflats, Continental shelf and deep-sea habitats in the Arabian Sea

Unit 4. Marine Organisms and Adaptations

Classification and diversity of marine life: plankton, nekton, benthos, Adaptations to salinity, pressure, temperature, and locomotion, Marine mammals, reptiles, birds, and invertebrates, Marine biodiversity of Pakistan (fish, crustaceans, mollusks, turtles, whales)

Unit 5. Marine Food Webs and Ecology

Primary productivity and nutrient dynamics, Food chains and trophic interactions in marine systems, Marine symbiosis, predation, and competition

Unit 6. Human Impacts and Marine Conservation

Marine pollution (oil spills, plastics, heavy metals), Overfishing and habitat destruction, Climate change, ocean acidification, and coral bleaching, Marine protected areas and international conservation efforts, Overview of Pakistan's marine fisheries and their economic importance, Role of organizations like WWF-Pakistan and Marine Fisheries Department

Recommended Books/ Reference Materials

1. Barnes, R. S. K., & Hughes, R. N. (1999). *An Introduction to Marine Ecology* (3rd ed.). Wiley-Blackwell.
2. Castro, P., & Huber, M. E. (2019). *Marine Biology* (11th ed.). McGraw-Hill Education.
3. Duxbury, A. C., Duxbury, A. B., & Sverdrup, K. A. (2002). *Fundamentals of Oceanography* (4th ed.). McGraw-Hill.
4. Government of Pakistan. (n.d.). *Reports from the Marine Fisheries Department, Ministry of Maritime Affairs*.
5. Levinton, J. S. (2020). *Marine Biology: Function, Biodiversity, Ecology* (5th ed.). Oxford University Press.
6. Memon, S. H., & Shah, G. Q. (2016). *A Handbook on Pakistan's Coastal and Marine Resources*. MFF Pakistan.
7. Nybakken, J. W., & Bertness, M. D. (2005). *Marine Biology: An Ecological Approach* (6th ed.). Pearson Education.
8. Pirzada, J. A. S., Farooq, S., Shafique, S., Burhan, Z. N., & Farooqi, Z. (2008). Conservation and management of biodiversity in Pakistan through the establishment of marine protected areas. *Ocean & Coastal Management*, 51(5), 377–382. <https://doi.org/10.1016/j.ocecoaman.2008.01.006>
9. Qureshi, R. M., & Saher, N. U. (n.d.). *Studies on Marine Biodiversity of Sindh and Balochistan Coasts* [Local research articles].
10. WWF-Pakistan. (n.d.). *Conservation Initiatives in Coastal and Marine Areas of Pakistan*.

Principles of Systematic Zoology

BS-Zoology

Course Code: ZOO-320

Credit Hours: 02

Pre-requisite: Nil

Objectives

Provide in-depth knowledge of taxonomy in animal sciences. Develop concepts about the importance of systematics. Study the history of systematics with basic rules. Demonstrate about identifications and naming of the organisms according to international code of zoological nomenclature.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles and methods of animal classification.
- Analyze evolutionary relationships among animals using phylogenetic methods.
- Apply systematic approaches to classify and identify animal taxa.

Course Outline

Unit 1. Importance and Applications of Systematics

Taxonomy in Animal science, systematics as a profession and its future perspectives.

Unit 2. History of Taxonomy and Taxonomic Characters

Basic terminology of systematics, theories of biological classifications, Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.

Unit 3. Typological Species Concept

Nominalist species concept, biological species concept, Evolutionary concept. Kinds of different species, Speciation

Unit 4. Taxonomic Procedures

taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Unit 5. Formation of Specific Names

brief concept of cladistics, phylogenetics. Theory and practice of cladistics and phylogenetic systematics.

Unit 6. 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.

Recommended Books/Reference Material

1. Heywood, V. H. (1975). *Taxonomy and Ecology*. Academic Press, London.
2. Mayr, E. (1985). *Animal Species and Evolution*. Harvard University Press.

3. Mayer, E., & Asblock, P. D. (1991). *Principles of Systematic Zoology*. McGraw Hill, New York.
4. Rekadwad, B. (2022). *Microbial Systematics, Taxonomy, Microbial Ecology, Diversity*. CRC Press.
5. Whili, M. J. D. (1978). *Modes of Speciation*. W. H. Freeman and Co., San Francisco.
6. Wiley, E. O., & Lieberman, B. S. (2011). *Phylogenetics: Theory and Practice of Phylogenetic Systematics* (2nd ed.). Wiley-Blackwell, New York.

Principles of Systematic Zoology (Lab)

BS-Zoology

Course Code: ZOO-320L

Credit Hours: 01

Pre-requisite: Nil

Objectives

To know about different animal species. To know the use of different keys for specie identification To know about the methods of statistical analysis.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles and methods of animal classification.
- Analyze evolutionary relationships among animals using phylogenetic methods.
- Apply systematic approaches to classify and identify animal taxa.

Course Outline

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.

Recommended Books/Reference Material

1. Heywood, V. H. (1975). *Taxonomy and Ecology*. Academic Press.
2. Mayr, E. (1985). *Animal Species and Evolution*. Harvard University Press.
3. Mayer, E., & Asblock, P. D. (1991). *Principles of Systematic Zoology*. McGraw Hill.
4. Rekadwad, B. (2022). *Microbial Systematics, Taxonomy, Microbial Ecology, Diversity*. CRC Press.
5. Whili, M. J. D. (1978). *Modes of Speciation*. W. H. Freeman and Co.
6. Wiley, E. O., & Lieberman, B. S. (2011). *Phylogenetics: Theory and Practice of Phylogenetic Systematics* (2nd ed.). Wiley-Blackwell.

Fisheries and Aquaculture

BS-Zoology

Course Code: ZOO-321

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will know about the history, needs and importance of fisheries and aquaculture. They will be able to describe the culturable fish species and their biology. They will also learn about the fish culture and aquaculture facilities.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles of fisheries management and aquaculture practices.
- Analyze the ecological and economic importance of various aquatic species.
- Evaluate sustainable practices in the fisheries and development of aquaculture industry.

Course Outline

Unit 1. Introduction to Fisheries and Aquaculture

Introduction to fish, fishery and aquaculture, History and present status of aquaculture (National and International), Introduction and biology of cultivable fin and shell fishes, Introduction to aquatic resources of Pakistan (Lentic and lotic environment). national and international trends. Fish morphology and diversity in size and shape. Distribution of fishes in Pakistan, commercial fishes, marine and freshwater.

Unit 2. Types of Culture Systems

Ponds, Types of ponds, planning construction and pond preparation. Pond fertilization, dosage and methods of application. Raceways, cages, pen, raft and line culture.

Unit 3. Food and Feeding Habits of Fishes

feed types, artificial and natural fish feeds, feeding strategies of artificial fish feeds.

Unit 4. Aquatic Habitats, Ecology and Extant of Distribution

Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity etc.) and their effects on fish health and production.

Unit 5. Impact of Biotic Parameters on Fish Health

Biotic parameters (plankton, insects, aquatic vegetation etc.) of ponds, lakes, rivers, and impacts on fish growth.

Unit 6. Induced Breeding Techniques

Fish diseases and their control. Fishing gears, fishing techniques, fishing communities.

Unit 7. Fisheries Co-management.

Fish preservation, processing, transportation and marketing

Recommended Books/Reference Material

1. Ali, S. S. (1999). *An Introduction to Freshwater Fishery Biology*. University Grants Commission.

2. Fitzsimmons, K., Janjua, R. S. N., & Ashraf, M. (2015). *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan*. Academia Press.
3. Midani, A. R. (2023). *Deep Technology for Sustainable Fisheries and Aquaculture* (1st ed.). Springer.
4. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and Practices*. Blackwell Science Limited.
5. Sharma, O. P. (2009). *Handbook of Fisheries and Aquaculture*. Agrotech Publishing Academy.
6. Stickney, R. R. (2016). *Aquaculture: An Introductory Text*. CABI Publishing.

Fisheries and Aquaculture (Lab)

BS-Zoology

Course Code: ZOO-321L

Credit Hours: 01

Pre-requisite: Nil

Objectives

Students will know about the history, needs and importance of fisheries and aquaculture. They will be able to describe the culturable fish species and their biology. They will also learn about the fish culture and aquaculture facilities.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles of fisheries management and aquaculture practices.
- Analyze the ecological and economic importance of various aquatic species.
- Evaluate sustainable practices in the fisheries and development of aquaculture industry.

Course Outline

1. Morphological characters of a typical fish
2. Identification of commercially important fish species, meristic counts, fin formula, scale formula etc.
3. Dissection of common fish to study its various systems.
4. Practical demonstration of induced fish breeding.
5. Introduction to artificial feed ingredients.
6. Fish disease diagnosis and identification.
7. Demonstration of fishing gears and methods of fish capture.

Recommended Books/Reference Material

1. Ali, S. S. (1999). *An Introduction to Freshwater Fishery Biology*. University Grants Commission.
2. Fitzsimmons, K., Janjua, R. S. N., & Ashraf, M. (2015). *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan*. Academia Press.

3. Midani, A. R. (2023). *Deep Technology for Sustainable Fisheries and Aquaculture* (1st ed.). Springer.
4. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and Practices*. Blackwell Science Limited.
5. Sharma, O. P. (2009). *Handbook of Fisheries and Aquaculture*. Agrotech Publishing Academy.
6. Stickney, R. R. (2016). *Aquaculture: An Introductory Text*. CABI Publishing.

Research Methodologies and Bioethics

BS- Zoology

Course Code: ZOO-322

Credit Hours: 02

Pre-requisite: Nil

Objectives

Develop research skills Provide understanding how to design scientific research, to collect data and its interpretation. Emphasize the importance of ethics in scientific research. Enable students to write a research proposal.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the ethical principles and guidelines governing biological research and experimentation.
- Analyze bioethical issues related to genetics, biotechnology, and animal welfare.
- Apply ethical decision-making frameworks to address ethical dilemmas in scientific research and practice.

Course Outline

Unit 1. Introduction, Research Process

Objectives of Research, Motivations, Research methods vs. research methodology, scientific method Types of research, general steps involved in research. Problems of research in Pakistan.

Unit 2. Topic Selection and Literature Review

Problem identification for research, criteria and evaluation, Importance and sources. Referencing and citation and Bibliography. Plagiarism.

Unit 3. Research Design

Parts, important features, important concepts in research design, Research objectives, qualities of research objectives.

Unit 4. Material and Methods

Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources.

Unit 5. Scientific Writing

Difference between thesis/report/synopsis/research proposals. Parts of synopsis/project proposal, parts of thesis/report.

Unit 6. Introduction to Bioethics

Introduction and principles of bioethics, Brief history of bioethics. Concept of bioethics in different religions, principles of Islamic bioethics, Ethical issues regarding GMOs, Euthanasia, Issues related to Reproductive & Cloning technologies, Patenting, Commercialization and Benefits Sharing, Role of National Bioethics Committees.

Recommended Books/Reference Material

1. Creswell, J. W. (2013). *Research Design: Quantitative, Qualitative and Mixed Methods Approaches*. Sage.
2. Farooq, M. A., Shahzad, W., & Rashid, M. (2022). *Research Methodology: An Introduction*. Academic Press.
3. Hess-Biber, S. N., & Leavy, P. (2004). *Approaches to Qualitative Research: A Reader on Theory and Practice*. Oxford University Press.
4. Khan, J. A. (2008). *Research Methodology*. APH Publishing.
5. Kothari, C. R., & Gaurav, G. (2014). *Research Methodology: Methods and Techniques*. New Age International.
6. Krishna, V. S. (2007). *Bioethics and Biosafety in Biotechnology*. New Age International.
7. Kumar, R. (2011). *Research Methodology: A Step-by-Step Guide for Beginners*. SAGE Publications.
8. Laurel, B. (2003). *Design Research: Methods and Perspectives*. The MIT Press.
9. Leedy, P., & Ormrod, J. E. (2004). *Practical Research: Planning and Design* (8th ed.). Pearson.
10. Walliman, N. (2005). *Your Research Project: A Step-by-Step Guide for the First-Time Researcher* (2nd ed.). Vistaar Publications.

Research Methodologies and Bioethics (Lab)

BS- Zoology

Course Code: ZOO-322L

Credit Hour: 01

Pre-requisite: Nil

Objectives

This course aims to equip students with practical skills in designing and conducting scientific research, including data collection and basic statistical analysis. It fosters an understanding of ethical principles in research involving human and animal subjects. Students will also develop competencies in scientific writing, literature review, and responsible research conduct.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles of fisheries management and aquaculture practices.
- Analyze the ecological and economic importance of various aquatic species.
- Evaluate sustainable practices in the fisheries and development of aquaculture industry.

Course Outline

1. Identification of research problems and formulation of hypotheses
2. Literature search using databases like PubMed and Google Scholar
3. Designing a basic research project with objectives and methodology
4. Sampling techniques and sample size calculation
5. Data collection methods (questionnaire design, observation, experiments)
6. Basic data analysis using Microsoft Excel or SPSS
7. Application of statistical tests (mean, standard deviation, t-test, chi-square)
8. Scientific writing and structuring a research report
9. Understanding research ethics and bioethical principles

Recommended Books/Reference Material

1. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics* (8th ed.). Oxford University Press.
2. Creswell, J. W. (2013). *Research Design: Quantitative, Qualitative and Mixed Methods Approaches*. Sage.
3. Day, R. A., & Gastel, B. (2011). *How to Write and Publish a Scientific Paper*. Greenwood.
4. Farooq, M. A., Shahzad, W., & Rashid, M. (2022). *Research Methodology: An Introduction*. Academic Press.
5. Hess-Biber, S. N., & Leavy, P. (2004). *Approaches to Qualitative Research: A Reader on Theory and Practice*. Oxford University Press.
6. Khan, J. A. (2008). *Research Methodology*. APH Publishing.
7. Kothari, C. R., & Gaurav, G. (2014). *Research Methodology: Methods and Techniques*. New Age International.
8. Krishna, V. S. (2007). *Bioethics and Biosafety in Biotechnology*. New Age International.
9. Kumar, R. (2011). *Research Methodology: A Step-by-Step Guide for Beginners*. SAGE Publications.
10. Laurel, B. (2003). *Design Research: Methods and Perspectives*. The MIT Press.
11. Leedy, P., & Ormrod, J. E. (2004). *Practical Research: Planning and Design* (8th ed.). Pearson.
12. National Institutes of Health (NIH) Office of Research Integrity. Retrieved from <https://ori.hhs.gov>
13. Walliman, N. (2005). *Your Research Project: A Step-by-Step Guide for the First-Time Researcher* (2nd ed.). Vistaar Publications.

Wildlife Conservation and Management

BS- Zoology

Course Code: ZOO-449

Credit Hours: 02

Pre-requisite: Nil

Objectives

To enable the student to understand values and objectives of wildlife conservation and to understand the wildlife management rules and regulations in Pakistan. Students will also gain knowledge about how National and International agencies are involved in conservation and management of wildlife.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles of wildlife, its conservation and management strategies.
- Analyze the impact of human activities on wildlife populations and ecosystems.
- Evaluate conservation programs and practices for biodiversity protection.

Course Outline

Unit 1. Wildlife of Pakistan

Introduction, Important Definitions, Identification, Distribution, Status, Wildlife values, Conservation and Management (population estimate technology) of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan

Unit 2. Objectives of Wildlife Management

Wildlife Management at Wetlands, Terrestrial Wildlife Management, Wildlife Damage Management, Captive Wildlife Management

Unit 3. Wildlife Conservation

Philosophy and significance of wildlife conservation, Essentials of Wildlife Conservation and National Perspectives, Conservation of Amphibians and Reptiles, In-situ conservation and Ex-situ conservation, Problems in wildlife conservation

Unit 4. Wildlife Rules and Regulations in Pakistan

Principles of Reintroduction, IUCN categories of Wildlife, Zoo rules, Laws, Policy and Social issues, Values and Economics of Wildlife

Unit 5. National and International Agencies Involved in Conservation and Management of Wildlife

IUCN (International Union for Conservation of Nature), WWF (Worldwide Fund for Nature), UNEP (United Nations Environment Program), Ministry of Climate Change (MoCC), Pakistan Environmental Protection Agency (Pak-EPA), WWF-Pakistan, IUCN Pakistan, Pakistan Museum of Natural History (PMNH).

Unit 6. Threatened and Endangered Species and Protected Areas in Pakistan

Vulnerable, Endangered, Critically Endangered Species, Causes and Measures for the Conservation Pakistan. Sanctuaries, Game Reserves, National Parks

Recommended Books/Reference Material

1. Ali, S. S. (1999). *Palaeontology, Zoogeography and Wildlife Management*. Nasim Book Depot, Hyderabad, India.
2. Miller, G. T. (2002). *Living in the Environment: Principles, Connections and Solution* (12th ed.). Thomson Learning Inc., Australia.
3. Mills, S. (2007). *Conservation of Wild Population*. Blackwell Publishing & Co., London, UK.
4. Rigger, P. G. (1991). *Long Term Ecological Research: An International Perspective*. John Wiley.
5. Sexena, M. M. (1990). *Applied Environmental Biology*. Agro Botanical Publishers, India.
6. Sinclair, A. R. E., Fryxell, J. M., & Caughley, G. (2006). *Wildlife Ecology, Conservation and Management*. Blackwell Publishing & Co., London, UK.
7. Sutherland, W. J. (2000). *The Conservation Handbook*. Blackwell Science.
8. Wildlife of Pakistan. (2002). *Wildlife of Pakistan*. Punjab Wildlife Department, Lahore. <http://www.wildlifeofpakistan.com>

Wildlife Conservation and Management (Lab)

BS- Zoology

Course Code: ZOO-449L

Credit Hour: 01

Pre-requisite: Nil

Objectives

To enable the student to understand values and objectives of wildlife conservation and to understand the wildlife management rules and regulations in Pakistan. Students will also gain knowledge about how National and International agencies are involved in conservation and management of wildlife.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the principles of wildlife, its conservation and management strategies.
- Analyze the impact of human activities on wildlife populations and ecosystems.
- Evaluate conservation programs and practices for biodiversity protection.

Course Outline

1. Visit to National Parks, Wildlife Sanctuaries, Game Reserves.
2. Population Studies of some Reptiles, Birds and small Mammals.
3. Report on Endangered Species

Recommended Books/Reference Material

1. Ali, S. S. (1999). *Palaeontology, Zoogeography and Wildlife Management*. Nasim Book Depot, Hyderabad, India.

2. Miller, G. T. (2002). *Living in the Environment: Principles, Connections and Solution* (12th ed.). Thomson Learning Inc., Australia.
3. Mills, S. (2007). *Conservation of Wild Population*. Blackwell Publishing & Co., London, UK.
4. Rigger, P. G. (1991). *Long Term Ecological Research: An International Perspective*. John Wiley.
5. Sexena, M. M. (1990). *Applied Environmental Biology*. Agro Botanical Publishers, India.
6. Sinclair, A. R. E., Fryxell, J. M., & Caughley, G. (2006). *Wildlife Ecology, Conservation and Management*. Blackwell Publishing & Co., London, UK.
7. Sutherland, W. J. (2000). *The Conservation Handbook*. Blackwell Science.
8. Wildlife of Pakistan. (2002). *Wildlife of Pakistan*. Punjab Wildlife Department, Lahore.
9. Wildlife of Pakistan. (n.d.). Retrieved from <http://www.wildlifeofpakistan.com>

Economic Zoology

BS-Zoology

Course Code: ZOO-450

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will know about the relationship of commerce with domestic animals, their products, byproducts and associated farming practices. They will know the importance of human and domestic animal diseases and their vital relation to the economy.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the economic importance of animals in agriculture, industry, medicine etc.
- Explain the contributions of animal resources to human welfare and the economy.
- Discuss effective utility of animal resources for commercialization and sustainable economic development.

Course Outline

Unit 1. Introduction to Economic Zoology

Basic concepts and importance

Unit 2. Parasitic Protozoans and Human Disease

Economic importance of protozoa. Vectors of human and domestic animals. Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).

Unit 3. Pests of Crops

Pests of pulse crops. Pests of oil seed crops. Stored grain pests. Pests of cotton. Pests of vegetables. Pests of fruits. Pests of tea.

Unit 4. Insect Culture

Apiculture, and Sericulture, Lac insect culture and Pearl culture.

Unit 5. Aquaculture and Fisheries

Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters. Economic importance of fishes.

Unit 6. Bird Farming

Poultry farming, Quail farming, Turkey farming, Ostrich farming and Pigeon farming.

Recommended Books/Reference Material

1. Akhtar, M., & Muzaffar, N. (2008). *Introduction to Apiculture*. Department of Zoology, Punjab University Press.
2. Bailey, J. A. (1986). *Principles of Wildlife Management*. John Wiley and Sons Inc., USA.
3. Grimaldi, D. A. (2023). *The Complete Insect: Anatomy, Physiology, Evolution and Ecology*. Princeton University Press.
4. Primack, R. B. (2000). *A Primer of Conservation Biology* (2nd ed.). Sinauer Associates Inc., USA.
5. Ravindranathan, K. R. (2003). *Economic Zoology* (1st ed.). Dominant Publishers and Distributors, New Delhi, India.
6. Robinson, W. L., & Bolen, E. G. (1984). *Wildlife Ecology and Management*. McMillan Publishing Company, Cambridge, UK.
7. Shukla, G. S., & Upadhyay, V. B. (1997). *Economic Zoology* (3rd ed.). Rastogi Publications, Meerut, India.

11. List of Mandatory Courses

S. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1	UHQ-101/ ETH-103	Understanding of Quran-I/ Ethics-I	Nil	1
2	UHQ-102/ ETH-104	Understanding of Quran-II/ Ethics-II	Nil	1
3	INT-499	Internship	Nil	3
4	CP-498	Capstone Project	Nil	3

12.Course Outline for Mandatory Courses

Understanding of Quran-I/ Fehm e Quran

Course Code: UHQ-101

Credit Hours: 1

Pre-Requisites: Nil

Objectives

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcomes

This course will enable the students to:

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plurals through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath – based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the Holy Quran.

Course Outline

- Unit 1. Simple Quranic Words**
Muallim ul Quran: Book 1: Unit: Lesson 1-19
- Unit 2. Words that comes before (The simple Quranic words)**
Muallim ul Quran: Book 1: Unit#2: Lesson 1-13
- Unit 3. Quranic words in terms of their relationship and characteristics**
Muallim ul Quran: Book 1: Unit#3: Lesson 1-10
- Unit 4. Singular Pronouns**
Muallim ul Quran: Book 2: Unit#4: Lesson 1-17
- Unit 5. Singular pronouns & Demonstrative Pronouns**
Muallim ul Quran: Book 2: Unit#5: Lesson 1-23
- Unit 6. Present Tense**
Muallim ul Quran: Book 3: Unit#6: Lesson 1-5

Reference Books:

1- بشير، دكتور. عبيد الرحمن - معلم القرآن - اسلام آباد: دار العلم، ٢٠٢٤. جلد ١، ٢ & ٣

Ethics-I (in lieu of Understanding of Quran-I)

Course Code: ETH-103

Credit hours: 1

Pre-Requisites: Nil

Objectives

Upon successful completion of the course, students will be able to know the basics of ethics, & know how to develop an ethical approach. Also, analyze the importance of ethical and ethical values for a human being. And identify the Semitic & Non-Semitic Religions. Moreover, develop the concept of Ethics in Semitic & Non-Semitic religions. Also, analyze the similarities and differences between ethical teachings of various religions.

Learning Outcomes

- Students will be able to demonstrate their understanding about the concept of ethics & ethical approach.
- Analyze the difference between the concept of Ethics in Semitic and Non-Semitic religions.

Course Outline

- Unit 1. Introduction and Importance of Ethics & Basic Ethical Principles**
Definition of Ethics, Importance of Ethics, Beneficence, Non-maleficence, Autonomy, Justice as basic ethical behaviors.
- Unit 2. Theories of Moral Standards**

Moral Standards as Law, Moral Standards as Pleasure, Moral standards as Perfection.
(Theories of Various Philosopher such as Kant, Spencer, John S. Mackenzie etc)

Unit 3. The concept of Ethics in Major Religions- Christianity, Judaism

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

Unit 4. The concept of Ethics in Major Religions- Hinduism & Buddhism

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

Unit 5. The concept of Ethics in Major Religions- Islam

Introduction of the Religion, Its Basic Concepts and major ethical teachings.

References/Recommended Books

1. Davis, N.K. (2023). *Elements of Ethics*, Legare Street Press.
2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). *Introducing Ethics-a Graphic Guide*, Icon Books Ltd. UK.
5. اخلاق اور فلسفہ اخلاق، سیوہاروی، حفظ الرحمن، ندوۃ المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

Websites & Articles:

1. Articles on Ethics www.infotrac-college.com
2. Brown. (2017). The ethical dimensions of Global Environmental Issues. American Academy of Arts and Sciences. Retrieved July 7, 2017 from amacad.org
3. Business Ethics Magazine www.business-ethics.com/annual.htm
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July 2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics www.globalethics.org
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). "Philosophical Foundations for Global Journalism Ethics" *Journal of Mass Media Ethics*:20(1)

Understanding of Quran-II

Course Code: UHQ-102

Credit Hours: 1

Pre-Requisites: Nil

Objectives

This course will enable the students to understand the Holy Quran by learning Arabic in a simple and easy way. Through relating their basic Urdu vocabulary with Quran, and without engaging them in complex Arabic Grammar, Sarf or Balagha. Students will gradually build the skills to read and understand Quranic verses directly—without needing translation. The course focuses on making Arabic accessible for everyone, even those with no prior background.

Learning Outcomes

This course will enable the students to:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Course Outline

Unit 1. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 1: Lesson 1-9

Unit 2. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 2: Lesson 1-7

Unit 3. Past Tense

Muallim ul Quran: Book 4: Unit#7: Chapter 3: Lesson 1-9

Unit 4. Past Tense

Muallim ul Quran: Book 5: Unit#7: Chapter 4: Lesson 1-5

Unit 5. Past Tense & Passive Voice

Muallim ul Quran: Book 5: Unit#7: Chapter 5 - 9

Unit 6. imperative Verbs for Singulars

Muallim ul Quran: Book 6: Unit#8: Lesson 1-8

Reference Books:

- 1- بشیر، دکتور. عبید الرحمن - معلم القرآن - اسلام آباد: دار العلم، ۲۰۲۴ء. جلد ۳، ۴، ۵، ۶

Ethics-II (in lieu of Understanding of Quran-II)

Course Code: ETH-104

Credit hours: 1

Pre-Requisites: Nil

Objectives

Upon successful completion of the course, students will be able to have better understanding of ethics in various walks of life like in workplace, in business, journalism etc. Moreover, they will be able to be familiarize with Contemporary World's Ethical Issues. And, try to develop answers about them.

Learning Outcomes

- Students will be able to demonstrate their understanding about the importance of ethics in their lives today.
- Identify Contemporary World's Ethical Issues.
- Create problem solving for these contemporary Ethical issues.

Course Outline

Unit 1. Professional Ethics & Bioethics

Meaning of Work/Professional Ethics, Professional Ethics and Human Values, Elements of professional Ethics:

Person attitude, Beliefs about work, Positive Attributes (honesty, integrity, dedication, commitment, responsibility, interpersonal relationship), Genetic engineering, Organ Donation, Cloning, Head Transplant

Unit 2. Ethical Conduct in Business Ethics & it's important

Types of Business Ethics, Common Business Ethical Challenges

Conflict of interest, honesty & integrity, whistle blowing, loyalty vs truth

Unit 3. Journalism

Principles of Ethical Journalism:

Truth & Accuracy, Independence, Fairness & Impartiality, Humanity, Public Accountability

Unit 4. Environmental Ethics

Core Principles of environmental ethics:

Justice & sustainability, Sufficiency & compassion, Solidarity & public participation, Pollution prevention.

Current issues of environmental ethics:

Pollution, The depletion of natural resources, Loss of biodiversity, Destruction of ecosystem, Global climate change

Unit 5. Social Inequalities

Meaning of Social Inequalities, Issues related to social inequality

Difference in source of income, Health care, Freedom of speech, Gender inequality, Toxic workplace culture, Education, Political representation & participation

Unit 6. Social Media Ethics

Facebook, YouTube, WhatsApp, Instagram, TikTok, Snapchat, LinkedIn, X

Current Ethical issues in social media:

Plagiarism, Fake news, Harassment, Photo ethics, Post without caution, inappropriate behavior privacy

Reference Books/Recommended Material

Books

1. Davis, N.K. (2023). *Elements of Ethics*, Legare Street Press.
2. Edmonds, D. (2019). *Ethics and the Contemporary World*, Taylor & Francis,
3. Hastings, J. Alexander, J. Gray S.L. (2023). *The Encyclopedia of Religion and Ethics*, Creative Media Partners, LLC
4. Robinson, D. Garratt C. (2008). *Introducing Ethics-a Graphic Guide*, Icon Books Ltd. Uk.
5. اخلاق اور فلسفہ اخلاق، سیویاروی، حفظ الرحمن، ندوة المصنفین، دہلی، ۱۹۷۶
6. دنیا کے بڑے مذاہب، فاروقی، عماد الحسن، مکتبہ جامعہ لمیٹڈ، دہلی، ۱۹۸۶

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3. Business Ethics Magazine www.business-ethics.com/annual.htm
4. Bussmann, J. (2016). Top 9 ethical Issues in artificial intelligence. Retrieved 7 July 2017 from world Economic Forum weforum.org
5. Ethics and Religion, Shefali Narange <http://www.paperpublications.org/>
6. <http://www.jstor.com/stable/resrep12025.7>
7. <http://www.learnwell.org/ethicalproblems.htm>
8. Institute for Global Ethics www.globalethics.org
9. Klimes, Rudolf e. (2000). Ethical Problems.
10. Ten Ethical Problems of the Present World <https://www.lifepersona.com/10-ethical-problems-of-the-present-world>
11. Ward, Stephen J.A (March 2005). "Philosophical Foundations for Global Journalism Ethics" *Journal of Mass Media Ethics*:20(1)

Internship

Course Code: INT-499

Credit Hours: 03

Pre-requisite: Nil

Objectives

The student will be able to learn different techniques and study methods used in the field of Zoology.

Learning Outcomes

- Students will acquire knowledge about the use of equipment in the field of Zoology.
- Students will be able to learn different techniques that are used in different fields of Zoology.

Course Outline

The course of internship will be supervised and graded by a faculty member as per the rules prescribed by the university.

Capstone Project

Course code: CP-498

Credit hours: 3

Pre requisite: Nil

Objectives

It will enable the student to understand the importance and applications of research in the field of Zoology.

Learning Outcomes

- A capstone project allows students to bring together the concepts, principles and methods that they have learned in their course of study.
- Students will be able to apply their knowledge and acquired competencies to address the real-world problems.

Course Outline

The capstone project shall be supervised and graded by a faculty member as per the rules prescribed by the university.

13. List of General Education Courses

S. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1.	ENG-110	Functional English	Nil	3
2.	PAK-103	Ideology and Constitution of Pakistan	Nil	2
3.	CS-107	Application of Information and Communication Technologies	Nil	2
4.	CS-107L	Application of Information and Communication Technologies (Lab)	Nil	1
5.	ENG-111	Expository Writing	Nil	3
6.	CCE-497	Civic and Community Engagement	Nil	2
7.	ISL-101/ ETH101	Islamic Studies / Ethics	Nil	2
8.	MGT-108	Entrepreneurship	Nil	2
9.	MTH-110	Quantitative Reasoning-I	Nil	3
10.	STA-112	Quantitative Reasoning-II	Nil	3
11.	PAK-104	Pakistan Studies	Nil	2
12.	SCI-101	Natural Sciences	Nil	2
13.	SCI-101L	Natural Sciences (Lab)	Nil	1
14.	BFA-129	Art and Humanities	Nil	2
Social Sciences Courses (2)				
15.	GEO-105	Fundamentals of Geography	Nil	2
16.	SOC-104	Introduction to Social Sciences	Nil	2

14. Course Outline for General Education Courses

Functional English

Course Code: ENG-110

Credit Hours: 03

Pre-requisite: Nil

Objectives

This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and communication aspects including professional writing, public speaking, and everyday conversation. Ensuring that students are equipped in both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact on their functional interactions.

Learning Outcomes

- Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure
- Comprehend a variety of literary non-literary written and spoken texts in English.
- Effectively express information, ideas and opinions in written and spoken English.
- Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.

Course Outline

Unit 1. Introduction

Ice breaking Activities. Types and modes of Communication. Intrapersonal, Intra-personal and group Communication.

Unit 2. Rules for Structure of Sentences

Types of sentences. Punctuation and Spelling, Vocabulary. Lexical and functional categories. Structural kind of sentences: simple, compound, complex. Synthesis of sentences.

Unit 3. Concept of Time and Tense (present, past, future).

Discussion: General topics and everyday conversation. Concept of Voice: active and passive voice. Functional use of Voice in different situations. Discussion: General topics and everyday conversation.

Unit 4. Direct and Indirect Reporting.

Discussion: General topics and everyday conversation, describing things persons, places, pictures, events etc. Salutation & Greeting, Introduction, Asking and answering questions. Discussion: General topics and everyday conversation.

Unit 5. Practicing Everyday Conversation

Request and Permission, Agreement and Disagreement. Apologizing, Expressing likes and Dislikes, expressing opinion. Expressing approval, Disapproval, Discussion: General topics and everyday conversation.

Unit 6. Articulating Expression

Expressing appreciation, regret, and indifference. Expressing certainty, uncertainty, and obligation. Expressing suggestion, warning, Expressing possibility, impossibility & logical conclusion. Discussion: General topics and everyday conversation.

Unit 7. Art of Inviting

Accepting, declining invitation. Expressing & inquiring about preferences. Stating intentions and Making Plans. Giving directions. Instructing people how to do things.

Unit 8. Discussing Past and Present

Future prospects. Talking about the past.

Recommended Books/ Reference Material

1. Azar, B. S. (2003). *Fundamentals of English Grammar*. Longman.
2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2010). *Communication: Principles for a Lifetime* (p. 483). Allyn & Bacon.
3. Eastwood, J. (1994). *Oxford Guide to English Grammar*. Oxford University Press.
4. Floyd, K., & Cardon, P. (2023). *Business and Professional Communication*. McGraw-Hill US Higher Ed.
5. Kortmann, B. (2020). *English Linguistics: Essentials*. Springer Nature.
6. Langan, J. (2001). *College Writing Skills with Readings*. McGraw-Hill.
7. Murphy, R. (2003). *English Grammar in Use*. Cambridge University Press.
8. Sharma, G. D. (2023). *A Comprehensive Resource Book of Functional English*. OEP.
9. Thomson, A. J., & Martinet, A. V. (2015). *A Practical English Grammar*. Oxford University Press.
10. Wren, P. C., & Martin, H. (2000). *English Grammar and Composition*. S. Chand & Company Ltd.

Ideology and Constitution of Pakistan

Course Code: PAK-103

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistan citizens to enable them function in a socially responsible manner.

Learning Outcomes

- Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.
- Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
- Explain about the guiding principles on rights and responsibilities of Pakistani citizens are enshrined in the Constitution of Pakistan 1973.

Course Outline

Unit 1. Introduction to the Ideology of Pakistan

Definition and significance of ideology. Historical context of the creation of Pakistan (with emphasis on socio-political. Religious and cultural dynamics of British India between 1857 till 1947). Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah etc. Contributions of women and students in the freedom movement or separate homeland.

Unit 2. Two-Nation Theory

Evolution of the Two-Nation Theory (Urdu-Hindi controversy. Partition of Bengal. Simla Deputation 1906, Allama Iqbal Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940). Role of communalism and religious differences.

Unit 3. Introduction to the Constitution of Pakistan

Definition and importance of a constitution. Ideological factors that shaped the Constitution(s) of Pakistan. Overview of constitutional developments in Pakistan.

Unit 4. Constitution and State Structure

Structure of government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. Eighteenth Amendment and its impact of federalism.

Unit 5. Fundamental Rights, Principles of Policy and Responsibilities

Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles R-28). Overview of Principles of Policy (Articles 29-40). Responsibilities of the Pakistani citizen.

Unit 6. Constitutional Amendments

Procedures for amending the Constitution. Notable constitutional amendments and their implications

Recommended Books/Reference Material

1. Ahmed, A. S. (1997). *Jinnah, Pakistan and Islamic Identity: The Search for Saladin*. Routledge.
2. Aziz, K. K. (2002). *The Making of Pakistan: A Study of Nationalism*. Sang-e-Meel Publishers.
3. Choudhury, G. W. (1969). *Constitution-Making in Pakistan: The Dynamics of Political*. Columbia University Press.
4. Cohen, S. P. (2004). *The Idea of Pakistan*. Brookings Institution Press.
5. Hussain, M. (2020). *The Parliament of Pakistan*. Oxford University Press.
6. Iqbal, J. (2005). *Ideology of Pakistan*. Sang-e-Meel.
7. Jalal, A. (2014). *The Struggle for Pakistan: A Muslim Homeland and Global Politics*. Belknap Press.
8. Khan, H. (2020). *Constitutional and Political Development of Pakistan*. Oxford University Press.
9. Mahmood, S. (2003). *Pakistan: Political Roots and Development*. University of Michigan.
10. Mujahid, S. U. (2001). *Ideology of Pakistan*. Progressive Publishers.
11. Qureshi, I. H. (1965). *The Struggle for Pakistan*. University of Karachi Press.
12. Sayeed, K. B. (1960). *Pakistan: The Formative Phase*. Oxford University Press.
13. Talbot, I. (2015). *Pakistan: A New History*. Oxford University Press.
14. The Constitution of Pakistan. (1973). *Original text*. Retrieved from https://na.gov.pk/uploads/documents/1333523681_951.pdf
15. Ziring, L. (2000). *Pakistan in the Twentieth Century: A Political History*. Oxford University Press.

Application of Information and Communication Technologies

Course Code: CS-107

Credit Hours: 2

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various DOMAINS in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- Define various types and components of computer including input/output devices, memory, storage media.

- Describe different types of software from operating systems to system utilities and productivity apps.
- Describe the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media.

Course Outline

Unit 1. Technology

Types of Computers, Mobile & Game Devices, Data and Information, The Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy, Health Concerns, Environmental Issues, Programs and Apps, Operating Systems, Applications, Installing and Running Programs, Developing Programs and Apps, Communications and Networks, Wired and Wireless Communications, Networks, Technology Uses, Government, Finance, Retail, Entertainment, Health Care, Science, Travel, Publishing, Manufacturing, Technology Users.

Unit 2. Online Web

The Internet, Websites and Media, The Internet, Evolution of the Internet, connecting to the Internet, Internet Service Providers, How Data Travels the Internet, IP & MAC Addresses and Domain Names, The World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Mobile Computers and Desktops, Laptops, Tab and Other Mobile Computers, Handheld Computers, Desktops and All-in-Ones, Servers, Terminals, Point-of-Sale Terminals, Wearable Devices, Game Devices, Embedded Computers. Inside the Case, The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory, Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

Role of the Operating System, Obtaining Software, Installing Software, Categories of Programs and Apps, Multimedia and Interest Applications, Communications Applications, File, Disk, and System Management Tools.

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure.

Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering. What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization. Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended Books/Reference Material

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016). *Shelly Cashman Series Discovering Computers & Microsoft Office 365 & Office 2016: A Fundamental Combined Approach*. Cengage Learning.
2. Hafez, K., Skinner, A., & Grüne, A. (2022). *Foundations of Global Communication: A Conceptual Handbook*. Routledge.
3. Hawkrigde, D. (2022). *New Information Technology in Education*. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2016). *Managing and Using Information Systems: A Strategic Approach*. John Wiley & Sons.
5. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). *Managing and Using Information Systems: A Strategic Approach*. John Wiley & Sons.

Application of Information and Communication Technologies (Lab)

Course Code: CS-107L

Credit Hours: 1

Pre-requisite: Nil

Objectives

This course provides a very broad range of topics and prepares the students for various DOMAINS in computing that they will face in upcoming semesters. This course is very comprehensive as it provides every student a set of productivity tools that they will be able to use for the rest of their lives. It provides knowledge and skills for use of computing and communication technologies to solve real life problems. This is an introductory course about Information and Communication Technologies that includes ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

Learning Outcomes

- Define various types and components of computer including input/output devices, memory, storage media.
- Describe different types of software from operating systems to system utilities and productivity apps.

- Describe the basic concepts of computer networks, database management and computer security from a user point of view, components of a computer including input/output devices, memory, storage media.

Course Outline

Unit 1. Technology

Introduction to the lab equipment and SOPs of the labs. Introduction to computer hardware and system information. Introduction to the Web, Web Searching, Online Social Networks, Internet Communications. Digital Security and Privacy, Viruses and Other Malware, Privacy.

Unit 2. Online Web

IP & MAC Addresses and Domain Names, The World Wide Web, Navigating the Web, Web Addresses, Web Apps and Mobile Apps. Types of Websites, Digital Media on the Web, Graphics, Audio, Video, Plug-Ins, Other Internet Services, Email, Email Lists, Internet Messaging, Chat Rooms, Online Discussions, VoIP, FTP, Netiquette.

Unit 3. Evaluating Computers and Mobile Devices

Inside world: The Motherboard, Processors, The Control Unit, The Arithmetic Logic Unit, Machine Cycle, Registers, The System Clock, Personal Computer and Mobile Device Processors, Processor Cooling, The Internet of Things, Cloud Computing, Cloud Computing Services. Memory, Bytes and Addressable Memory, Types of Memory, RAM, Cache, ROM, Flash Memory, CMOS, Memory Access Times, Adapters, Adapter Cards, USB Adapters, Buses, Bus Width, Types of Buses, Power Supply and Batteries, Data Representation & Number System.

Unit 4. Programs and Apps

File, Disk, and System Management Tools. MS office

Unit 5. Digital Security Ethics, and Privacy: Threats, Issues, and Defenses

Digital Security Risks, Cybercrime, Internet and Network Attacks Malware, Botnets, Encryption, Digital Signatures and Certificates, Hardware Theft, Vandalism, and Failure. Backing Up — The Ultimate Safeguard, Wireless Security, Ethics and Society, information Accuracy, Intellectual Property Rights, Codes of Conduct, Cookies, Phishing, Spyware and Adware, Social Engineering, Privacy Laws, Employee Monitoring, Content Filtering.

What is data base and data base management system, Evolution of database management, Data Concepts and Characteristics, Data Organization. Operating Systems, Operating System Functions, Starting Computers and Mobile Devices, Shutting Down Computers and Mobile Devices, providing a User Interface, Managing Programs, Managing Memory.

Recommended Books/Reference Material

1. Campbell, J. T., Freund, S. M., Frydenberg, M., Last, M. Z., & Pratt, P. J. (2016). *Shelly Cashman Series Discovering Computers & Microsoft Office 365 & Office 2016: A Fundamental Combined Approach*. Cengage Learning.

2. Hafez, K., Skinner, A., & Grüne, A. (2022). *Foundations of Global Communication: A Conceptual Handbook*. Routledge.
3. Hawkrigde, D. (2022). *New Information Technology in Education*. Taylor & Francis.
4. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2016). *Managing and Using Information Systems: A Strategic Approach*. John Wiley & Sons.
5. Pearlson, K. E., Saunders, C. S., & Galletta, D. F. (2024). *Managing and Using Information Systems: A Strategic Approach*. John Wiley & Sons.

Expository Writing

Course Code: ENG-111

Credit Hours: 03

Pre-requisite: Nil

Objectives

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation building pre-requisite course, Functional English, this course will enhance students' basic skills of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

Learning Outcomes

- Understand the essentials of the writing process integrating pre-working, drafting, editing and proofreading to produce well-structured essays.
- Uphold ethical practices to maintain originality in expository writing.

Course Outline

Unit 1. Introduction to Expository Writing

Understanding expository writing (definition, types, purpose and applications).

Characteristics of effective expository writing (clarity, coherence and organization).

Introduction to paragraph writing.

Unit 2. The Writing Process

Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.). Drafting (three stage process of drafting techniques). Revising and editing (ensuring correct grammar, Clarity, coherence, conciseness etc.). Proofreading (fine-tuning of the draft). Peer review and feedback (providing and receiving critique).

Unit 3. Essay Organization and Structure

Introduction and hook (engaging readers and introducing the topic). Thesis statement (crafting a clear and focused central idea). Body Paragraphs (topic sentences, supporting evidence and transitional devices). Conclusion (types of concluding paragraphs and leaving an impact). Ensuring cohesion and coherence (creating seamless connections between paragraphs)

Unit 4. Types of Expository Writing

Description, Illustration, Classification. Cause and effect (exploring causal relationships and outcomes). Process analysis (explaining step-by-step procedures). Comparative analysis (analyzing similarities and differences)

Unit 5. Writing for Specific Purposes and Audiences

Different types of purposes (to inform, to analyze, to persuade, to entertain etc.). Writing for academic audiences (formality, objectivity, and academic conventions). Writing for public audiences (engaging, informative and persuasive language). Different tones and styles for specific purposes and audiences.

Unit 6. Ethical Considerations

Ensuring original writing (finding credible sources, evaluating information etc.). Proper citation and referencing (APA, MLA, or other citation styles)
Integrating quotes and evidences (quoting, paraphrasing, and summarizing)
Avoiding plagiarism (ethical considerations and best practices)

Recommended Books/ Reference Material

1. Axelrod, R. B., & Cooper, C. R. (2010). *The St. Martin's Guide to Writing*. Macmillan.
2. Faigley, L., Selzer, J., Enoch, J., & Wible, S. (2009). *Good Reasons With Contemporary Arguments*. Pearson Longman.
3. Floyd, K., & Cardon, P. (2023). *Business and Professional Communication*. McGraw-Hill US Higher Ed USE.
4. Graff, G., Birkenstein, C., & Maxwell, C. (2014). *They Say, I Say: The Moves That Matter in Academic Writing* (p. 245). Gildan Media Corp Book Publisher.
5. Johnson-Sheehan, R., Paine, C., & Paine, C. (2010). *Writing Today*. Pearson Education India.
6. Keizer, E. (2015). *A Functional Discourse Grammar for English*. Oxford University Press.
7. Rosenwasser, D., & Stephen, J. (2011). *Writing Analytically*. Cengage Learning Press.
8. Straijjer, R. (2018). Modern English usage from Britain to America: Bryan Garner follows Henry Fowler from *A Dictionary of Modern American English Usage* to *Garner's Modern English Usage*. *English Today*, 34(4), 39–47.
9. Wachal, R. S. (2000). *The Elements of Style*, by William Strunk, Jr., and E. B. White; and *A Dictionary of Modern American Usage*, by Bryan A. Garner. *American Speech*, 75(2), 199–207.
10. Williams, J. M., & Bizup, J. (2022). *Lessons in Clarity and Grace*. Pearson.

Civic and Community Engagement

Course Code: CCE-497

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with fundamental knowledge about civics, citizenship and community engagement. In this course the students will learn about the essential of civil society, government, civic responsibilities, inclusivity and effective ways to participate in shaping the society which will help them apply the theoretical knowledge to the real-world situation to make a positive impact on their communities.

Learning Outcomes

By the end of this course, students will be able to:

- Demonstrate fundamental understanding of civics, government, citizenship and civil society.
- Understand the concept of community and recognize the significance of community engagement for individuals and groups.
- Recognize the importance of diversity and inclusivity for societal harmony and peaceful coexistence.

Course Outline

- Unit 1. Civics and Citizenship**
Concepts of civics, citizenship, and civic engagement. Foundations of modern society and citizenship. Types of citizenship: active, participatory, digital etc.
- Unit 2. State, Government and Civil Society**
Structure and function of government in Pakistan. The relationship between democracy and civil society. Right to vote and importance of political participation and representation.
- Unit 3. Rights and Responsibilities**
Overview of fundamental rights and liberties of citizens under constitution of Pakistan 1973. Civic responsibilities and duties. Ethical consideration in civic engagement (accountability, non-violence, peaceful dialogue, civility etc.).
- Unit 4. Community Engagement**
Concept, nature and characteristics of community. Community development and social cohesion. Approaches to effective community engagement. Case studies of successful community driven initiatives.
- Unit 5. Advocacy and Activism**
Public discourse and public opinion. Role of advocacy in addressing social issues. Social action movements.
- Unit 6. Digital Citizenship and Technology**

The use of digital platform for civic engagement. Cyber ethics and responsible use of social media. Digital divides and disparities (access, usage, socio-economic, geographic etc.) and their impact on citizenship.

Unit 7. Diversity, Inclusion and Social Justice

Understanding diversity in society (ethnic, cultural, economic, political etc.). Youth, women and minorities engagement in social development. Addressing social inequalities and injustices in Pakistan. Promoting inclusive citizenship and equal rights for social harmony and peaceful co-existence.

Suggested Practical Activities (Optional)

Apart of the overall learning requirements, the course may have one or a combination of the following practical activities

1. **Community Storytelling:** Students can collect and share stories from community members. This could be done through oral histories, interviews or multimedia presentations that captured the lived experiences and perspectives of diverse individuals.
2. **Community Event Planning:** Student can organize a community event or workshop that addresses a specific issue or foster community interaction. This could be a health fair, environmental cleanup, cultural festival or educational workshop
3. **Service Learning:** Student can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time, and skills to address a particular community need, such as tutoring, mentoring or supporting vulnerable population.
4. **Cultural Exchange Activities:** Student can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances and presentations that promote cross cultural understanding.

Recommended Books/Reference Material

1. Džankić, J., & Vink, M. P. (2022). *Citizenship & Migration*.
2. Kymlicka, W., & Norman, W. (2010). *Citizenship in Diverse Societies*. University Press.
3. Mackert, J., & Turner, B. S. (2017). *The Transformation of Citizenship, Volume 2: Boundaries of Inclusion and Exclusion*.
4. Mattson, K. (2017). *Digital Citizenship in Action: Empowering Students to Engage in Online Communities*. International Society for Technology in Education.
5. McGraw-Hill Education. (2009). *Civics Today: Citizenship, Economics, & You, Student Edition*.
6. Weinstock, D. (2017). Citizenship and cultural diversity. In A. Shachar, R. Bauböck, I. Bloemraad, & M. Vink (Eds.), *The Oxford Handbook of Citizenship* (pp. [insert page numbers]). Oxford University Press.
7. Youniss, J., & Levine, J. (2009). *Engaging Young People in Civic Life*. Vanderbilt University Press.

Islamic Studies

Course Code: ISL-101

Credit Hours: 02

Pre-Requisites: Nil

Objectives

Students will be able to demonstrate enhanced knowledge of Islamic Fundamentals, beliefs, practices, historical development, spiritual values and Ethical Principles. Describe Basic sources of Islamic Law and their application in daily life. Also, Identify and discuss contemporary issues being faced by the Muslim world Including Social Challenges, Gender Role and Interfaith dialogue.

Learning Outcomes

- Evaluate and discuss their understanding about the beliefs, history and Ethical values of Islam.
- Be able to apply and relate the Articles of faith in their life according to present world.
- Be able to analyze the importance of Quran and Sunnah in their life and also to refute many relating misconceptions
- Engage in Discussions and write about Contemporary issues specifically related to Women.

Course Outline

Unit 1. Introduction to Islam

Definition of Islam and its core Beliefs (Tawheed, Akhirat and Risalat), Pillars of Islam and their significance (Tawheed, Prayers, Fasting, Zakat & Hajj), The Holy Quran (Introduction, Revelation & Compilation), Sunnah & Hadith (Introduction, Revelation & Compilation)

Unit 2. Seerah of the Holy Prophet PBUH

Life of Prophet pbuh in Makkah, Life of Holy Prophet pbuh in Medina, Diverse roles of Holy Prophet pbuh (individual, leader, peacemaker, educator etc)

Unit 3. Islamic History and Civilization

World before Islam, The Rashidun Caliphate and its expansion, Contributions of Muslim Scientists and Philosophers.

Unit 4. Islamic Jurisprudence

Fundamental sources of Islamic Jurisprudence, Major Schools of Islamic Jurisprudence, Significance & principle of Ijtihad

Unit 5. Family & Society in Islam

Status and Rights of Women in Islam, Marriage, Family & Gender roles in Muslim Society, Family values and Structure in Muslim Society

Unit 6. Islam & Modern world

Relevance of Islam in Modern World. (Islamophobia, Interfaith dialogue & Multiculturalism), Islamic viewpoint towards socio-cultural and technological changes.

Recommended Books/Reference Material

1. Ahmed, A. (1996). *Women & Social Justice: An Islamic Paradigm*. The Islamic Foundation UK.
2. Ahmed, K. (1971). *Islami Nazria E Hayat*. Karachi University Press.
3. Ahmed, K. (1980). *Islam, Its Meaning & Message*. The Islamic Foundation UK.
4. Al-Mubarakpuri, M. S. (2002). *Al Raheeq Ul Makhtoom (The Sealed Nectar)*. Darussalam.
5. Al-Suhaym, M. B. A. (2006). *Islam, Its Foundation & Concepts*. Darussalam.
6. Bokhari, A. S., Zafar, M. D., & Shakir, A. S. (2021). *A Textbook of Islamic Education*. Akram Printing Press.
7. Chaudary, M. N., & Malik, M. A. (2022). *Tafheem E Islamiyat*. Qureshi Brothers Publishers.
8. Hussain, M. (n.d.). *The Five Pillars of Islam: A Framework for Islamic Values and Character Building*. Kube Publishing, The Islamic Foundation UK.
9. Maududi, A. A. (2007). *Towards Understanding Islam*. The Islamic Foundation UK.
10. Maududi, A. A. (2008). *Islamic Civilization: Foundations, Beliefs & Principles*. Kube Publishing, The Islamic Foundation UK.
11. Phillip, A. A. B. (2018). *Islamic Studies*. International Islamic Publishing House.
12. Renard, J. (n.d.). *An Introduction to Islamic Theology*.

Ethics (in lieu of Islamic Studies)

Course Code: ETH-101

Course Title: Ethics

Credit Hours: 2

Pre-Requisite: Nil

Objectives

Upon successful completion of the course, students will be able to know the basics of Ethics & Morality and develop Ethical approach, Identify the concept of Ethics in Different Religions & Relate the ethical values with their lives business ethics, journalism ethics etc.

Learning Outcomes

- Students will be able to demonstrate their understanding about the meaning of Ethics and Morality.
- Analyze the Similarities and Differences between ethical teachings of various religions.
- Develop sense of belongingness to the ethical values as a student, being member of the society etc.

Course Outline

Unit 1. Meaning and Scope of Ethics

Meaning and Definition of Ethics and Morality, Difference between Ethics and Morality, Relation of Ethics with: Religion, Science, Law.

Unit 2. Historical development of Morality

Instinctive Moral Life, Customary Morality, Reflective Morality.

Unit 3. Moral Theories, Moral Ethics and Society

Hedonism (Mill), Intuitionism (Butler), Kant's Moral Theory, Freedom and Responsibility, Tolerance, Justice, Punishment.

Unit 4. Moral Teaching of Major Religions

Judaism, Christianity, Islam, Islam and Minorities.

Unit 5. Professional Ethics

Medical Ethics, Ethics of Student, Ethics of Teacher, Business Ethics.

Recommended Books/ Reference Material

1. Blackburn, S. (2021). *Ethics: A Very Short Introduction* (2nd ed.). Very Short Introductions.
2. Cahn, S. M., & Markie, P. (2019). *Ethics: History, Theory, and Contemporary Issues* (7th ed.).
3. Liautaud, S., & Sweetingham, L. (2022). *The Power of Ethics: How to Make Good Choices in a Complicated World*.
4. Shafer-Landau, R. (2020). *The Fundamentals of Ethics* (5th ed.).

Entrepreneurship

Course Code: MGT-108

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge, skills, abilities, enabling them to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting a business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business, market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation.

Learning Outcomes

By the end of this course, students shall have:

- Knowledge of fundamental entrepreneurial concepts, skills and process.
- Understanding on different personal, social and financial aspects associated with entrepreneurial activities.
- Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on export businesses;

- Ability to apply knowledge, skills and competencies acquired in the course to develop a feasible business plan.

Course Outline

Unit 1. The Challenge of Entrepreneurship

The World of the Entrepreneur. What is an Entrepreneur? The Benefits of Entrepreneurship. The Potential Drawbacks of Entrepreneurship. The Power of “Small” Business. Putting Failure into Perspective. The Ten Deadly Mistakes of Entrepreneurship. How to Avoid the Pitfalls. Creativity, Innovation, and Entrepreneurship. Creativity – Essential to Survival. Creative Thinking. Barriers to Creativity. The Creative Process. Techniques for Improving the Creative Process.

Unit 2. Designing a Competitive Business Model and Building a Solid Strategic Plan

Building a Competitive Advantage. The Strategic Management Process. Formulate strategic options and select the appropriate strategies. The Balanced Scorecard

Unit 3. Conducting a Feasibility Analysis, Forms of Business Ownership and Franchising

Conducting a Feasibility Analysis. Why Develop a Business Plan? The Elements of a Business Plan. The Sole Proprietorship. Other Forms of Ownership. Types of Franchises. The Benefits of Buying a Franchise. The Drawbacks of Buying a Franchise. Franchising and the Law. The Right Way to Buy a Franchise. Trends Shaping Franchising

Unit 4. Building a Powerful Marketing Plan

Building a Guerrilla Marketing Plan. Pinpointing the Target Market. Determining Customer Needs and Wants Through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge

Unit 5. Creating a Successful Financial Plan

Basic Financial Statements. Projected Financial Statements. Ratio Analysis. Interpreting Business Ratios. Breakeven Analysis

Unit 6. Sources of Financing: Debt and Equity Phase Discussion

Planning for Capital Needs. Sources of Equity Financing. Corporate Venture Capital. Sources of Debt Capital. Federally Sponsored Programs. Small Business Administration (SBA)

Unit 7. Choosing the Right Location and Layout

Location: A Source of Competitive Advantage. Location Criteria for Retailers and Service Businesses. Location Options for Retail and Service Businesses. The Location Decision for Manufacturers. Layout and Design Considerations. Layout: Maximizing Revenues, Increasing Efficiency, or Reducing Cost

Recommended Books/ Reference Material

1. Abrams, R. (n.d.). *Entrepreneurship: A Real-World Approach*.

2. Scarborough, N. M., & Cornwall, J. R. (n.d.). *Essentials of Entrepreneurship and Small Business Management*.

Quantitative Reasoning-I

Course Code: MTH-110

Pre-requisite: Nil

Credit Hours: 03

Objectives

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

Learning Outcomes

By the end of this course,

- The students shall have fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately.
- Understanding of fundamental mathematical concepts. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

Course Outline

Unit1. Numerical Literacy

Number system and basic arithmetic operations. Units and their conversions, dimensions, area, perimeter and volume. Rates, ratios, proportions and percentages. Types and sources of data; Measurement scales. Tabular and graphical presentation of data. Quantitative reasoning exercises using number knowledge.

Unit 2. Fundamental Mathematical Concepts

Basics of geometry (lines, angles, circles, polygons etc. Relations, functions, and their graphs. Exponents, factoring and simplifying algebraic expressions. Algebraic and graphical solutions of linear and quadratic equations and inequalities. Quantitative reasoning exercises using fundamental mathematical concepts.

Unit 3. Mathematical Modeling and Analyses

Introduction to deterministic models. Use of linear functions for modeling in real-world situations. Modeling with the system of linear equations and their solutions. Elementary introduction to derivatives in mathematical modeling. Linear and exponential growth and decay models. Quantitative reasoning exercises using mathematical modeling.

Unit 4. Introduction to Logic

Introduction and importance of logic. Inductive, deductive and abductive approaches of reasoning. Propositions, arguments (valid, invalid), logical connectives.

Unit 5. Truth Tables and Logical Reasoning Concepts

Truth tables and propositional equivalences. Logical fallacies. Venn Diagrams. Predicates and quantifiers. Quantitative reasoning exercises using logical reasoning concepts and techniques.

Recommended Books/Reference Books

1. Bennett, J., Briggs, W. L., & Badalamenti, A. (2019). *Using and Understanding Mathematics: A Quantitative Reasoning Approach*. Pearson.
2. Mesquita, E. B., & Fowler, A. (2021). *Thinking Clearly With Data: A Guide to Quantitative Reasoning and Analysis*. Princeton University Press.
3. Rosen, K. H. (2007). *Discrete Mathematics and Its Applications*. The McGraw Hill Companies.
4. Schröder, B. (2010). *Fundamentals of Mathematics*. Wiley.
5. Zaslow, E. (2020). *Quantitative Reasoning: Thinking in Numbers*. Cambridge University Press.

Quantitative Reasoning-II

Course Code: STA-112

Credit Hours: 03

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of other sciences. The course focuses on the methods of collection presentation and analysis of data using measures of central tendency and measures of dispersion. The course also focuses on basic principles of probability and distributions, regression and correlation analysis, estimation and testing of hypothesis. It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

Learning Outcomes

- Student will understand the basic statistical concepts and have basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts and equation etc.
- Understand basic quantitative modeling and analyses.
- Ability to critically evaluate quantitative information to make evidence based decision through appropriate statistical tools.

Course Outline

Unit 1. Introduction of Statistic and Data Condensation

Types and sources of data. Measurement scales. Population and sample. Tabular and graphical presentation of data. Quantitative reasoning exercises using fundamental statistical concepts.

Unit 2. Measure of Central Tendency and Dispersion

Measure of central tendency. Measure of dispersion. Data interpretation. Quantitative reasoning exercises using statistical concepts.

Unit 3. Probability and Probability Distributions

Basic probability theory. Rules of counting (multiplicative, permutation, combinations). Introduction to random variables and their probability distributions. Quantitative reasoning exercises using probability theories and distribution concepts.

Unit 4. Regression and Correlation Analysis

Introduction to probabilistic models. Bivariate analysis. Scatter plots. Simple linear regression model. Correlation analysis. Quantitative reasoning exercises using statistical modelling.

Unit 5. Estimation and Testing of Hypothesis

Basics of estimation and confidence interval. Testing of Hypothesis (z-test; t-test). Statistical inference in decision making. Quantitative reasoning exercises using estimation and Statistical inference concepts and techniques.

Recommended Books/Reference Material

1. Chaudhry, S. M., & Kamal, S. (2018). *Introduction to Statistical Theory Part I*. Lahore, Pakistan: Ilmi Kitab Khana.
2. Chaudhry, S. M., & Kamal, S. (2018). *Introduction to Statistical Theory Part II*. Lahore, Pakistan: Ilmi Kitab Khana.
3. Hogg, R., McKean, J., & Craig, A. (2021). *Introduction to Mathematical Statistics* (8th ed.). Boston: Pearson Education.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). *Introduction to Probability and Statistics*. Cengage Learning.
5. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). New York: McGraw Hill.
6. Moore, D. S., McCabe, G. P., & Craig, B. A. (2021). *Introduction to the Practice of Statistics* (10th ed.). New York: W. H. Freeman.
7. Walpole, R. E. (2002). *Introduction to Statistics* (7th ed.). New York: Macmillan Publishing Company.
8. Walpole, R. E., Myers, R. H., & Myers, S. L. (1998). *Probability and Statistics for Engineers and Scientists* (6th ed.). New York: Prentice Hall.

Pakistan Studies

Course Code: PAK-104

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical, and cultural dimensions. It delves into the diverse landscapes, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Learning Outcomes

After studying this course, the student will be able to:

- Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan.
- Understand the society and culture of Pakistan.
- Understand and explain the socio-economic developments in Pakistan.
- Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Course Outline

Unit 1. Introduction to Pakistan

Geographical location and significance. Historical background: Ancient civilizations in the region. Factors leading to the creation of Pakistan.

Unit 2. Political History of Pakistan

Formative phase. Military interventions and democratic transitions.

Unit 3. Geography of Pakistan

Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas. River systems: Indus River and its tributaries. Climatic regions of Pakistan.

Unit 4. Society and Culture of Pakistan

Socio-cultural diversity. Languages and literature of Pakistan

Unit 5. Economic Development of Pakistan

Agriculture and industrial sectors of Pakistan. Economic challenges of Pakistan.

Unit 6. Contemporary Issues

Foreign relations of Pakistan. Security challenges: terrorism, extremism, and regional conflicts. Environmental problems and sustainable development (SDGs). Media and social change.

Recommended Books/Reference Material

1. Burke, S. M. (n.d.). *Pakistan's Foreign Policy: An Historical Analysis*.
2. Hayat, S. (n.d.). *Pakistan Studies: A Book of Readings*.
3. Husain, I. (n.d.). *Economic Development of Pakistan*.
4. Jahangir, U. (n.d.). *Physical Geography of Pakistan*.
5. Jalal, A. (n.d.). *The Sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan*.
6. Khan, F. K. (n.d.). *A Geography of Pakistan: Environment, People, and Economy*.
7. Khan, H. (n.d.). *Constitutional and Political History of Pakistan*.
8. Khan, M. A. J. (Ed.). (n.d.). *Pakistan's Cultural Heritage: Socio-Economic and Technological Aspects*.
9. Kokab, R. U. (n.d.). *Separatism in East Pakistan*.
10. Mansur Sarwar, K., & Saeed, A. (n.d.). *Trek to Pakistan*.
11. Qureshi, I. H. (n.d.). *The Struggle for Pakistan*.
12. Rahman, T. (n.d.). *Language and Politics in Pakistan*.
13. Rumi, R. (n.d.). *Being Pakistani: Society, Culture and the Arts*.
14. Sayeed, K. B. (n.d.). *Pakistan, the Formative Phase, 1857–1948*.
15. Sayeed, K. B. (n.d.). *Politics in Pakistan: The Nature and Direction of Change*.
16. Talbot, I. (n.d.). *Pakistan: A Modern History*.
17. Wolpert, S. (n.d.). *Jinnah of Pakistan*.
18. Zaidi, S. A. (n.d.). *Issues in Pakistan's Economy*.
19. Ziring, L. (n.d.). *Pakistan in the Twentieth Century: A Political History*.

Natural Sciences

Course Code: SCI-101

Credit Hours: 02

Pre-requisite: Nil

Objectives

This course is intended to give students a broad understanding of those sub-disciplines that comprise the natural sciences and to provide students with an understanding of the history, philosophy, and social contributions of science.

Learning Outcomes

The students will be able to understand

- Overview of the philosophical background of natural science development
- Survey of historical events that contributed to the development of natural science

- Description and explanation of the main branches of natural science

Course Outline

Unit 1. Introduction to Natural Sciences

Definition and scope, Categorization of natural sciences: Physics, Chemistry, Biology, Earth Sciences, and Astronomy, Interdisciplinary fields and their importance

Unit 2. Historical Development of Natural Sciences

The scientific method and its evolution. Major historical events that shaped the natural sciences, Significant discoveries and their impact on scientific progress, The role of key figures in the advancement of natural sciences

Unit 3. Main Branches of Natural Science

Detailed exploration of the main branches: Physics, Chemistry, Biology, Earth Sciences, and Astronomy, Key concepts and principles in each branch

Unit 4. Natural Science and Modern Technology

Relationship between natural sciences and technological advancements, Examples of how natural science drives technological innovation, Impact of technology on scientific research and vice versa.

Unit 5. Natural Science in Modern Society

The role and importance of natural sciences in contemporary society, Contributions of natural sciences to societal development, Public perception and understanding of natural sciences. Science and Society Interface: Major issues at the interface between science, technology, and society

Recommended Books/Reference Material

1. Brush, S. G. (1988). *The History of Modern Science: A Guide to the Second Scientific Revolution, 1800–1950*. Iowa State University Press.
2. Bryson, B. (2003). *A Short History of Nearly Everything*. Broadway Books.
3. Cantor, G. N., Christie, J. R. R., Hodge, M. J. S., & Olby, R. C. (Eds.). (2006). *Companion to the History of Modern Science*. Taylor & Francis.
4. Cohen, H. F. (2010). *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*. Amsterdam University Press.
5. Gal, O. (2021). *The Origins of Modern Science: From Antiquity to the Scientific Revolution*. Cambridge University Press.
6. Kuhn, T. S. (1970). *The Structure of Scientific Revolutions*. University of Chicago Press.
7. Zilsel, E., & Zilsel, P. (2013). *The Social Origins of Modern Science*. Springer Netherlands.

Natural Sciences (Lab)

Course Code: SCI-101L

Credit Hours: 01

Pre-requisite: Nil

Objectives

This course is intended to give students a broad understanding of those sub-disciplines that comprise the natural sciences and to provide students with an understanding of the history, philosophy, and social contributions of science.

Learning Outcomes

The students will be able to understand

- Overview of the philosophical background of natural science development
- Survey of historical events that contributed to the development of natural science
- Description and explanation of the main branches of natural science.

Course Outline

1. Lab rules, PPE use, emergency protocols
2. Using balances, rulers, thermometers, graduated cylinders
3. pH testing using indicators and pH meter
4. Introduction to microscope, viewing plant/animal cells
5. Test water turbidity, color, smell, pH
6. Use of vernier caliper and screw gauge

Recommended Books/Reference Material

1. Brush, S. G. (1988). *The History of Modern Science: A Guide to the Second Scientific Revolution, 1800–1950*. Iowa State University Press.
2. Bryson, B. (2003). *A Short History of Nearly Everything*. Broadway Books.
3. Cantor, G. N., Christie, J. R. R., Hodge, M. J. S., & Olby, R. C. (Eds.). (2006). *Companion to the History of Modern Science*. Taylor & Francis.
4. Cohen, H. F. (2010). *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*. Amsterdam University Press.
5. Gal, O. (2021). *The Origins of Modern Science: From Antiquity to the Scientific Revolution*. Cambridge University Press.
6. Kuhn, T. S. (1970). *The Structure of Scientific Revolutions*. University of Chicago Press.
7. Zilsel, E., & Zilsel, P. (2013). *The Social Origins of Modern Science*. Springer Netherlands.

Arts and Humanities

Course Code: BFA-129

Credit Hours: 02

Pre-requisite: Nil

Objectives

Students will develop critical understanding and analysis of art through varied perspectives. They will enhance their knowledge to make informed aesthetic judgments and differentiate between genuine pieces of art and imitations. The course aims to cultivate sensitive perception paired with analytical reasoning about artistic elements.

Learning Outcomes

- Students will develop a systematic understanding of art elements, progressing from basic components (dot, line, shape) to complex compositions enhanced by color.
- Students will acquire the ability to identify and analyze stylistic elements that contribute to artistic individuality.
- Students will demonstrate enhanced perceptual sensitivity paired with logical analysis of artistic components.
- Students will build confidence in making aesthetic judgments based on established critical frameworks.

Course Outline

Unit 1. Foundations of Art Criticism and Appreciation

Explore the distinctions and relationships between criticism, appreciation, and history in approaching artistic works. Examine various forms of artistic expression including visual arts, performing arts, and applied arts with special emphasis on visual arts. Study fundamental frameworks for engaging with art meaningfully and developing a personal critical voice. Students will use AI visual recognition tools to analyze compositional elements in masterworks across different periods, helping them identify critical patterns and approaches used by established art critics throughout history.

Unit 2. The Multi-dimensional Framework of Art Analysis

Investigate the comprehensive framework for art appreciation through six key dimensions: Subject (thematic content), Function (purpose), Medium (materials), Organization (compositional structure), Style (individual expression), and Judgment (critical evaluation). Examine how these dimensions interconnect to create meaningful artistic experiences. Explore varied sources of artistic subject matter including nature, mythology, religion, and history.

Unit 3. Artistic Medium and Technical Execution

Study the intimate relationship between artists and their chosen media, examining how material selection influences artistic expression and technical execution. Analyze how medium-specific techniques develop across artistic movements and how critical judgments must account for medium constraints and possibilities. Students will experiment with AI

tools that simulate different artistic media, allowing them to understand technical challenges and expressive possibilities of various materials without requiring specialized studio equipment. They'll compare their AI-generated experimental works with historical examples to deepen their understanding of medium-specific artistry.

Unit 4. Compositional Organization and Visual Elements

Examine diverse organizational plans in visual composition including symmetrical, pyramidal, vertical, and radial arrangements. Analyze how artists create centers of interest and direct viewer attention through strategic organization of visual elements. Study the fundamental elements of visual arts (line, shape, color, texture, space) and principles of design (balance, rhythm, proportion, emphasis). Students will use AI composition analysis tools to create interactive maps of visual flow in masterworks, revealing hidden structural patterns. They'll then apply these insights to reorganize famous compositions through AI manipulation, exploring how organizational changes impact viewer experience and artistic meaning.

Unit 5. Cultural Contexts and Critical Judgment

Explore the complex relationships between art and broader cultural domains including beauty, religion, nature, history, and conceptual thought. Investigate how artistic styles develop within cultural contexts and reflect historical movements. Examine frameworks for critical judgment based on sincerity, scope, levels of meaning, truth, and magnitude. Students will engage with an AI-powered cultural simulation tool that contextualizes artworks within their original environments, demonstrating how cultural factors influenced artistic decisions. Working with this tool, students will develop critical essays that evaluate artworks through historically appropriate critical frameworks, enhanced by AI-generated visual comparisons that illustrate stylistic evolution across cultures and time periods.

Recommended Books/Reference Material

1. D. J. Sporre. *Perceiving the Arts: An Introduction to Humanities*. New Jersey: Prentice Hall, 2015
2. Stephen Davies. *Definitions of Art*. New York: Cornell University Press, 2018
3. Terry Barrett. *Criticizing Art: Understanding the Contemporary*. Mountain View: Mayfield Publishing, 2023
4. Arthur Danto. *After the End of Art: Contemporary Art and the Pale of History*. Princeton University Press, 2022
5. All latest editions of Art Appreciation books.

Social Sciences

Fundamentals of Geography

Course Code: GEO-105

Credit Hours: 02

Pre-requisite: Nil

Objectives

To create awareness about Geography and Geographical knowledge.

Learning Outcomes

By the end of the course, students should be able to:

- Learn basic concepts of geography.
- Learn the role of man in the geographical changes on earth

Course Outline

Unit 1.	Introduction. Definitions, scope and branches of Geography.
Unit 2.	Themes and traditions of Geography.
Unit 3.	The Universe. Galaxies and Solar Systems
Unit 4.	The Earth as a Planet.
Unit 5.	Lithosphere. Atmosphere. Hydrosphere. Biosphere.
Unit 6.	Man - environment interaction. Population.
Unit 7.	Major Environmental activities. Settlements. Pollution

Recommended Books

1. Cristopher, R. W. (2009). *An Introduction to Physical Geography*. Pearson Prentice Hall.
2. Guinness, J. P., & Nagie, G. (2011). *Geography*. Hodder Education.
3. Miller, G. T. (2008). *Living in the Environment: Principles, Connections and Solutions*. Wadsworth.

Introduction to Social Sciences

Course Code: SOC-104

Credit Hours: 02

Pre-requisite: Nil

Objectives

Introduction to Social Sciences offers a comprehensive overview of the various disciplines within social sciences, exploring their origins, scope, methodologies, applications, and interconnectedness. Students will be introduced to anthropology, sociology, psychology, political science, economics, geography, and history, with an emphasis on their relevance to contemporary Pakistani society. The course encourages critical thinking, interdisciplinary understanding, and the application of social sciences in real-world contexts.

Learning Outcomes

Upon completion of this course, students will be able to:

- Understand the origins and development of social sciences as distinct fields of study.
- Recognize the scope, methodologies, and principles of various social science disciplines.
- Analyze social phenomena from interdisciplinary perspectives.
- Apply social science concepts to understand and address issues relevant to Pakistani society.

- Engage in critical discussions, research, and ethical considerations within social sciences.

Course Outline

Unit 1. Introduction to Social Science

Definition and Importance of Social Sciences, Historical Development and Interconnectedness

Unit 2. Anthropology

Scope, Methods, and Key Concepts, Cultural and Biological Anthropology

Unit 3. Sociology

Origin and Scope of Sociology, Key Concepts, Sociological Imagination

Unit 4. Psychology

Introduction to Psychology and its Branches, Human Behavior and Mental Processes

Unit 5. Political Science

Understanding Political Systems and Governance, Politics and International Relations

Unit 6. Social Sciences in Pakistani Society

Application of Social Sciences in Pakistani Context, Social Issues, Policies, and Cultural Insights

Unit 7. Research Methods in Social Sciences

Quantitative and Qualitative Research, Research Ethics

Unit 8. Interdisciplinary Approaches and Future Trends

Integration of Social Science Disciplines, Emerging Trends and Future Challenges

Recommended Books/Reference Material

1. Colander, D., & Hunt, E. (2022). *Social Science: An Introduction to the Study of Society*. Routledge.
2. Gerring, J. (2011). *Social Science Methodology: A Unified Framework*. Cambridge University Press.
3. Habermas, J. (2015). *On the Logic of the Social Sciences*. John Wiley & Sons.
4. Sharpes, D. K. (2009). *The Evolution of the Social Sciences*. Lexington Books.
5. Williams, M. (2012). *Science and Social Science: An Introduction*. Routledge.

15. List of Interdisciplinary Courses

S. No.	Course Code	Course Title	Pre-Requisite	Credit Hours
1.	BOT-124	Diversity of Plants	Nil	2
2.	BOT-124L	Diversity of Plants (Lab)	Nil	1
3.	BOT-102	Plant Physiology and Ecology	Nil	2
4.	BOT-102L	Plant Physiology and Ecology (Lab)	Nil	1
5.	CHM-103	Basic Chemistry	Nil	2
6.	CHM-103L	Basic Chemistry (Lab)	Nil	1
7.	CHM-324	Principles of Biochemistry	Nil	2
8.	CHM-324L	Principles of Biochemistry (Lab)	Nil	1
9.	ZOO-323	Principles of Genetics	Nil	2
10.	ZOO-323L	Principles of Genetics (Lab)	Nil	1
11.	STA-314	Biostatistics	Nil	2
12.	STA-314L	Biostatistics (Lab)	Nil	1
13.	ZOO-411	Molecular Biology	Nil	2
14.	ZOO-411L	Molecular Biology (Lab)	Nil	1
15.	MIC-101	Microbiology and Immunology	Nil	2
16.	MIC-101L	Microbiology and Immunology (Lab)	Nil	1
17.	CS-113	Computational Biology	Nil	2
18.	CS-113L	Computational Biology (Lab)	Nil	1

16. Course Outline for Interdisciplinary Courses

Diversity of Plants

Course Code: BOT-124

Credit Hours: 2

Pre-requisite: N.A

Objectives

To provide the students with adequate knowledge about various plant groups and to provide the students with a practical skills regarding plant identification.

Learning Outcomes

- Students will be made familiarize with the morphological and systematic knowledge about different plant groups.
- Students will be able to learn basic principles of Plant identification and basis of their grouping into lower and higher ranks.
- To enable students to identify different groups of plants in the field.

Course Outline

Unit 1. Algae and Fungi

Structure, reproduction and economic significance of Algae. Major groups and their characteristics. Structure and reproduction of *Spirogyra*, *Chara*, *Pinnularia*. Structure, reproduction and economic significance of Fungi, their implication on crop production and industrial applications. Structure and reproduction of different types of fungi. Structure, reproduction and economic significance of lichens with specific reference to *Physcia*.

Unit 2. Bryophytes

Morphology, reproduction and economic significance of Bryophytes, major groups and their characteristics. Morphology and reproduction of genus *Riccia*, *Anthoceros* and *Funaria*.

Unit 3. Pteridophytes

Morphology, reproduction and economic significance of Pteridophytes. Morphology and reproduction of genus *Psilotum*, *Selaginella*, *Equisetum* and Ferns.

Unit 4. Gymnosperms

Morphology, reproduction and economic significance of Gymnosperms, *Cycas*, *Pinus* and *Ephedra*.

Unit 5. Angiosperms

Morphology, reproduction and economic significance of Angiosperms.

Recommended Books/Reference Material

1. Antonelli, A., Smith, R. J., Fry, C., Simmonds, M. S., Kersey, P. J., Pritchard, H. W., & Qi, Y. D. (2022). *State of the World's Plants and Fungi* (Doctoral dissertation, Royal Botanic Gardens (Kew); Sfumato Foundation).
2. Christenhusz, M. J., Fay, M. F., & Chase, M. W. (2023). *Plants of the World: an Illustrated Encyclopedia of Vascular Plants*. University of Chicago Press.
3. Dehgan, B. (2023). Gymnosperms. In *Garden Plants Taxonomy: Volume 1: Ferns, Gymnosperms, and Angiosperms (Monocots)* (pp. 57-171). Cham: Springer International Publishing.
4. Kunhikannan, C., Anju, M. V., Prasanna, R. (2025). *Taxonomy: Importance, Relevance and Application*. In Textbook of Forest Science (pp. 65-85). Singapore: Springer Nature Singapore.
5. Mauseth, J. D. 2023. *Botany: An Introduction to Plant Biology*. Jones & Bartlett Publishers, UK.
6. Prescott, L.M., Harley, J.P. and Klein, A. D. 2004. *Microbiology*. W. M. C. Brown Publishers.
7. Tietje, M., Antonelli, A., Forest, F., Govaerts, R., Smith, S. A., Sun, M., & Eiserhardt, W. L. (2023). *Global Hotspots of Plant Phylogenetic Diversity*. New Phytologist, 240(4), 1636-1646.

Diversity of Plants (Lab)

Course Code: BOT-124L

Credit Hours: 1

Pre-requisite: N.A

Objectives

To provide the students with adequate knowledge about various plant groups and to provide the students with practical skills regarding plant identification.

Learning Outcomes

- Students will be familiarized with morphological and systematic knowledge about different plant groups.
- Students will be able to learn basic principles of Plant identification and the basis of their grouping into lower and higher ranks.
- To enable students to identify different groups of plants in the field.

Course Outline

1. Introduction of microbial and plant diversity,
2. Culturing and staining of microorganisms.
3. Study of morphology and reproductive structures of the Bacteria and *Cyanobacteria* from prepared slides and fresh collections.
4. Study of morphology and reproductive structures of available algae, fungi and lichens from prepared slides and fresh collections.
5. Study of morphology and reproductive structures of different species of bryophytes from prepared slides and fresh collections.
6. Study of morphology and reproductive structures of different species of pteridophytes from prepared slides and fresh collections.
7. Study of morphology and reproductive structures of different species of gymnosperms and angiosperms from prepared slides and fresh collections.

Recommended Books/Reference Material

8. Antonelli, A., Smith, R. J., Fry, C., Simmonds, M. S., Kersey, P. J., Pritchard, H. W., & Qi, Y. D. (2022). *State of the World's Plants and Fungi (Doctoral dissertation, Royal Botanic Gardens (Kew); Sfumato Foundation)*.
9. Christenhusz, M. J., Fay, M. F., & Chase, M. W. (2023). *Plants of the World: an Illustrated Encyclopedia of Vascular Plants*. University of Chicago Press.
10. Dehgan, B. (2023). Gymnosperms. In *Garden Plants Taxonomy: Volume 1: Ferns, Gymnosperms, and Angiosperms (Monocots)* (pp. 57-171). Cham: Springer International Publishing.
11. Kunhikannan, C., Anju, M. V., Prasanna, R. (2025). *Taxonomy: Importance, Relevance and Application*. In Textbook of Forest Science (pp. 65-85). Singapore: Springer Nature Singapore.
12. Mauseth, J. D. 2023. *Botany: An Introduction to Plant Biology*. Jones & Bartlett Publishers, UK.
13. Prescott, L.M., Harley, J.P. and Klein, A. D. 2004. *Microbiology*. W. M. C. Brown Publishers.
14. Tietje, M., Antonelli, A., Forest, F., Govaerts, R., Smith, S. A., Sun, M., & Eiserhardt, W. L. (2023). *Global Hotspots of Plant Phylogenetic Diversity*. New Phytologist, 240(4), 1636-1646.

Plant Physiology and Ecology

Course Code: BOT-102

Credit Hours: 2

Pre-requisite: N.A

Objectives

This course will provide basic knowledge of different metabolic processes occurring in plants in addition to the relationships of plants with their environment. The course also aims to enable the students to assess the effects of various environmental factors and stresses on plant growth and development.

Learning Outcomes

- Students will be familiarized with the different metabolic processes occurring in plants, as well as the relationships of plants with their environment.
- Students will be able to know the effects of various environmental factors on plant growth and development.

Course Outline

Unit 1. Water Relations and Mineral Nutrition

Water potential, osmotic potential, pressure potential and matric potential. Absorption and translocation of water. Stomatal regulation. Soil as source of minerals. Passive and active transport of nutrients. Essential mineral elements. Role and deficiency symptoms of Macronutrients.

Unit 2. Photosynthesis and Respiration

Introduction, oxygenic and non-oxygenic photosynthesis, mechanism of light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Definition and respiratory substrates, mechanism of glycolysis. Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration. Respiratory quotients.

Unit 3. Growth, Dormancy and Plant Movements

Introduction, role of auxin and abscisic acid. Photoperiodism: definition, classification of plants based on photoperiodic response. Dormancy: introduction, causes and importance of seed dormancy. Plant movements' classification, tropic movements-Photoperiodism and Gravitropism. Introduction aims and application of ecology, field capacity & water holding capacity of soil. Characteristics of xerophytes and hydrophytes.

Unit 4. Ecological Factors

Introduction, aims and applications of ecology. Soil: physical and chemical properties of soil (soil formation, texture pH, EC, organism and organic matter etc.) and their relationship to plants. Quality of light, diurnal and seasonal variations, Eco- physiological responses. Field capacity and soil water holding capacity.

Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants. Wind: wind as an ecological factor and its importance.

Unit 5. Population and Ecosystem Ecology

Introduction. A brief description of seed dispersal and seed bank. Community ecology. Ecological characteristics of plant community. Methods of sampling vegetation (quadrat and line intercept). Major vegetation types of the local area. Definition, types and components of ecosystem. Food chain and food web. Applied ecology: causes, effects and control of water logging and salinity with respect to Pakistan. Soil salinity and water logging identification. Effects on plants and reclamation strategies. Biological succession.

Recommended Books/Reference Material

1. Ambasht, R.S. & Ambasht, N.K. (2022). *A Text Book of Ecology*. (16th Ed.) CBS Publishers & Distributors.
2. Andrew, L. (2022). *Plant Ecology and Conservation*. CRC Press.
3. Ricklefs, R. E. (2020). *Ecology*. W. H. Freeman and Co., UK
4. Schultz, J. C. (2005). *Plant Ecology*. Springer-Verlag, Berlin.
5. Salisbury, F. B. & Ross, C. B. (1992). *Plant Physiology*. (5th Ed.) Wadsworth Publishing Co. Belmont CA.
6. Taiz, L. & Zeiger, E. (2006). *Plant Physiology*. (4th Ed.) Sinauers.

Plant Physiology and Ecology (Lab)

BS-Botany

Course Code: BOT-102L

Credit Hours: 1

Pre-requisite: N.A

Objectives

This course will provide basic knowledge of different metabolic processes occurring in plants in addition to the relationships of plants with their environment. The course also aims to enable the students to assess the effects of various environmental factors and stresses on plant growth and development.

Learning Outcomes

- Students will be familiarized with the different metabolic processes occurring in plants, as well as the relationships of plants with their environment.
- Students will be able to know the effects of various environmental factors on plant growth and development.

Course Outline

1. Preparation of solutions of specific normality of acids/bases, salts, sugars. Molal and Molar solutions and their standardization.

2. Determination of uptake of water by swollen seeds when placed in Sodium Chloride solution of different concentrations. Measurement of leaf water potential by the dye method.
3. Determination of the temperature at which beetroot cells lose permeability. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot.
4. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
5. Estimation of oxygen utilized by a respiring plant by Winkler's method. Effect of light on seed germination. Effect of pH on seed germination.
6. Determination of physical characteristics of soil. Determination of chemical characteristics of soil.
7. Measurement of vegetation by line intercept methods. Measurement of vegetation by Quadrat methods.

Recommended Books/Reference Material

1. Ambasht, R.S. & Ambasht, N.K. (2022). *A Text Book of Ecology*. (16th Ed.) CBS Publishers & Distributors.
2. Andrew, L. (2022). *Plant Ecology and Conservation*. CRC Press.
3. Ricklefs, R. E. (2020). *Ecology*. W. H. Freeman and Co., UK
4. Schultz, J. C. (2005). *Plant Ecology*. Springer-Verlag, Berlin.
5. Salisbury, F. B. & Ross, C. B. (1992). *Plant Physiology*. (5th Ed.) Wadsworth Publishing Co. Belmont CA.
6. Taiz, L. & Zeiger, E. (2006). *Plant Physiology*. (4th Ed.) Sinauers.

Basic Chemistry

Course Code: CHM-103

Credit Hour: 02

Pre-requisite: Nil

Objectives

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

- Understand the basic principles of chemistry and their applications in biological systems.
- Describe the structure of atoms, molecules, and chemical bonds.
- Perform basic chemical calculations and experiments.
- Relate chemical properties to biological functions, especially in physiological and cellular contexts.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the fundamental concepts of inorganic and organic chemistry.

- Apply principles of stoichiometry, chemical reactions, and thermodynamics to solve basic chemistry problems.
- Explain the properties of gases, liquids, and solids, and their behavior in various chemical systems

Course Outline

Unit 1. Introduction to Chemistry

Importance of chemistry in biological sciences, Branches of chemistry: inorganic, organic, physical, analytical, biochemistry

Unit 2. Atomic Structure

Structure of atom: subatomic particles, Atomic number, mass number, isotopes, Electronic configuration and periodic table

Unit 3. Chemical Bonding

Ionic and covalent bonds, Polar and non-polar molecules, Hydrogen bonding and Van der Waals forces, Molecular geometry and VSEPR theory

Unit 4. States of Matter

Solids, liquids, and gases, Gas laws: Boyle's law, Charles' law, Ideal gas law, Properties of liquids and solids: viscosity, surface tension

Unit 5. Solutions and Concentrations

Types of solutions (true, colloidal, suspension), Concentration units: molarity, molality, % solutions, Preparation and dilution of solutions, Solubility and factors affecting it

Unit 6. Chemical Reactions and Stoichiometry

Types of chemical reactions, Balancing chemical equations, Mole concept and Avogadro's number, Stoichiometric calculations

Unit 7. Acids, Bases, and pH

Properties of acids and bases, pH scale and pKa, Buffers and their biological significance

Recommended Books/Reference Material

1. Atkins, P., & de Paula, J. (2018). *Atkins' Physical Chemistry* (11th ed.). Oxford University Press.
2. Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C. J., & Woodward, P. (2017). *Chemistry: The Central Science* (14th ed.). Pearson Education.
3. Chang, R., & Goldsby, K. (2014). *General Chemistry: The Essential Concepts* (7th ed.). McGraw-Hill Education.
4. Petrucci, R. H., Herring, F. G., Madura, J. D., & Bissonnette, C. (2016). *General Chemistry: Principles and Modern Applications* (11th ed.). Pearson.
5. Zumdahl, S. S., & Zumdahl, S. A. (2017). *Chemistry* (10th ed.). Cengage Learning.

Basic Chemistry (Lab)

Course Code: CHM-103L

Credit Hour: 01

Pre-requisite: Nil

Objectives

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

- Understand the basic principles of chemistry and their applications in biological systems.
- Describe the structure of atoms, molecules, and chemical bonds.
- Perform basic chemical calculations and experiments.
- Relate chemical properties to biological functions, especially in physiological and cellular contexts.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the fundamental concepts of inorganic and organic chemistry.
- Apply principles of stoichiometry, chemical reactions, and thermodynamics to solve basic chemistry problems.
- Explain the properties of gases, liquids, and solids, and their behavior in various chemical systems

Course Outline

1. Safety in chemistry lab
2. Preparation of solutions of known concentrations
3. Acid-base titrations
4. Identification of cations and anions
5. Determination of pH using indicators and pH meter
6. Observing chemical reactions (precipitation, redox)

Recommended Books/Reference Material

1. Atkins, P., & de Paula, J. (2018). *Atkins' Physical Chemistry* (11th ed.). Oxford University Press.
2. Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C. J., & Woodward, P. (2017). *Chemistry: The Central Science* (14th ed.). Pearson Education.
3. Chang, R., & Goldsby, K. (2014). *General Chemistry: The Essential Concepts* (7th ed.). McGraw-Hill Education.
4. Petrucci, R. H., Herring, F. G., Madura, J. D., & Bissonnette, C. (2016). *General Chemistry: Principles and Modern Applications* (11th ed.). Pearson.
5. Zumdahl, S. S., & Zumdahl, S. A. (2017). *Chemistry* (10th ed.). Cengage Learning.

Principles of Biochemistry

Course Code: CHM-324

Credit Hour: 02

Pre-requisite: Nil

Objectives

Students will be able to learn the fundamental concepts of Biochemistry, Acid-Base and Electrolyte Chemistry, Chemistry of Carbohydrates, lipids and proteins, Chemistry of Nucleic Acids.

Learning Outcomes

Student should have knowledge about

- Fundamental concepts of Biochemistry
- Acid-Base and Electrolyte Chemistry
- Chemistry of Carbohydrates, lipids and proteins
- Chemistry of Nucleic Acids

Course Outline

Unit 1. Carbohydrates

Brief introduction, to the scope and history of Biochemistry, Molecular logic of the living organism. Cell structures and their functions. Origin and nature of biomolecules. Definition and classification, Chemistry, physical and chemical properties of various classes of carbohydrates, Biological functions of starch and glycogen. Biological functions of cellulose and cell wall polysaccharides, acid muco polysaccharides and proteoglycans.

Unit 2. Lipids

Definition and classification of lipids, Chemistry and biological importance of fatty acids. Biological importance waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols and prostaglandins, Significance of liquids in biological membranes and transport mechanism.

Unit 3. Proteins and Amino acids

Chemistry and Classification of Amino acids. Physical and chemical properties of amino acids, Biological significance of amino acids, peptides. Proteins; their classification, properties and biological significance, Primary, secondary tertiary and quaternary structure of proteins. Denaturation of proteins. Enzymes. (Introduction, properties, kinetics).

Unit 4. Nucleic Acid

Chemical composition of nucleic acids. Structure and biological significance of nucleic acids, Chemical synthesis of Oligonucleotides. Nucleic acids hydrolysis, Isolation and separation of Nucleic acids.

Unit 5. pH and Homeostasis

Intracellular and extracellular electrolytes, body fluids as electrolyte solutions pH, Henderson-Hasselbalch equation and buffers. Amino acids, peptides and proteins, buffer

capacity. Buffers of body fluids, hemoglobin as an acid-base system. Renal control of acidbase, balance, acid-base disorders: acidosis, alkalosis. Hemoglobin and homeostasis, variation of Na⁺, K⁺, Cl⁻ in acid-base disturbances.

Recommended Books/Reference Material

1. Lehninger, A. L. (2001). *Principles of biochemistry*. Worth Publishers.
2. Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2000). *Harper's biochemistry*. Appleton & Lange.
3. Voet, D., & Voet, J. G. (2000). *Biochemistry*. John Wiley & Sons.

Principles of Biochemistry (Lab)

Course Code: CHM-324

Credit Hour: 01

Pre-requisite: Nil

Objectives

Students will be able to learn the fundamental concepts of Biochemistry, Acid-Base and Electrolyte Chemistry, Chemistry of Carbohydrates, lipids and proteins, Chemistry of Nucleic Acids.

Learning Outcomes

Students should have knowledge about

- Fundamental concepts of Biochemistry
- Acid-Base and Electrolyte Chemistry
- Chemistry of Carbohydrates, lipids and proteins
- Chemistry of Nucleic Acids

Course Outline

1. Qualitative and quantitative analysis of carbohydrates,
2. Qualitative and quantitative analysis of lipids
3. Qualitative and quantitative analysis of proteins
4. Determination of pH 5. Preparation of buffers.
6. Enzyme catalysis
7. Progress curve for enzyme catalyzed reactions
8. To study the effect of different factors on the rate of enzyme catalyzed reactions.

Recommended Books/Reference Material

1. Murray, R. K., Mayes, P. A., Granner, D. K., & Rodwell, V. W. (2000). *Harper's biochemistry*. Appleton & Lange.
2. Ochs, R. S. (2021). *Biochemistry*. CRC Press.

3. Lorch, M. (2021). *Biochemistry: A very short introduction*. Oxford University Press.

Principles of Genetics

Course Code: ZOO-323

Credit Hours: 2

Pre-requisite: N.A

Objectives

- To develop understanding of the principles of genetics among students.
- To develop the ability to analyze genetic data, understand patterns of inheritance and variation, and explain genetic mechanisms.

Learning Outcomes

Students will be able to:

- Explain the principles of genetic variation and Mendelian inheritance.
- Use basic genetic techniques to study plant traits.
- Construct genetic maps from linkage and crossing over data.

Course Outline

Unit 1. Introduction to Genetics

Definition, scope and importance of plant genetics and evolution. Mendelian genetics.

Unit 2. Mendelian, Chromosomal and Molecular Genetics

Mendel's Laws of Inheritance (Segregation, Independent Assortment). Monohybrid and Dihybrid Crosses. Punnett squares and probability. Incomplete Dominance, Codominance.. Multiple alleles and polygenic inheritance. Epistasis and pleiotropy. Sex-linked Inheritance. Chromosomal Genetics (Chromosome Structure and Function. Mitosis and Meiosis.

Unit 3. Chromosomal Genetics

Chromosomal Genetics (Chromosome Structure and Function. Mitosis and Meiosis. Karyotyping and chromosomal abnormalities. Linkage, recombination, and gene mapping). Molecular Genetics: (DNA Structure and Replication. Gene Expression (Transcription and Translation). Genetic Code. Regulation of Gene Expression. Mutations).

Unit 4. Chromosomal Variation and Mutations.

Types of mutation, Mutation on chromosomal number, mutation on the basis of codons, Human genome and inherited traits, Genetic disorders and counseling.

Recommended Books/Reference Material

1. Bujakowska, K. M., & Dryja, T. P. (2021). *Fundamentals of Genetics*. In *Albert and Jakobiec's Principles and Practice of Ophthalmology* (pp. 1–32). Springer International Publishing.

2. Meneely, P. M., Hoang, R. D., Okeke, I. N., & Heston, K. (2017). *Genetics: Genes, Genomes, and Evolution*. Oxford University Press.
3. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics*. John Wiley & Sons.
4. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology*. S. Chand Publishing.
5. Waddington, C. H. (2016). *An Introduction to Modern Genetics*. Routledge.

Principles of Genetics (Lab)

Course Code: ZOO-323

Credit Hours: 1

Pre-requisite: N.A

Objectives

- To develop understanding of the principles of genetics among students.
- To develop the ability to analyze genetic data, understand patterns of inheritance and variation, and explain genetic mechanisms.

Learning Outcomes

Students will be able to:

- Explain the principles of genetic variation and Mendelian inheritance.
- Use basic genetic techniques to study plant traits.
- Construct genetic maps from linkage and crossing over data.

Course Outline

1. Monohybrid and dihybrid crosses Punnett squares. Chi-square test for data interpretation. Study of pedigrees and inheritance patterns. Identification of dominant, recessive, sex-linked traits. Incomplete dominance and codominance (examples and problems). Multiple alleles (e.g., ABO blood groups).
2. Sex-linked inheritance (e.g., Drosophila crosses, human pedigrees).
3. Mitosis and meiosis (microscopic observation of prepared slides). Linkage and crossing over (Drosophila crosses or simulations).
4. Construction of linkage maps. Three-point crosses.
5. Hardy-Weinberg equilibrium: simulation and calculation of allele frequencies.
6. Modeling genetic drift, gene flow, and selection pressures.
7. Phylogenetic tree construction using morphological or molecular data.

Recommended Books/Reference Material

1. Bujakowska, K. M., & Dryja, T. P. (2021). *Fundamentals of Genetics*. In *Albert and Jakobiec's Principles and Practice of Ophthalmology* (pp. 1–32). Springer International Publishing.
2. Meneely, P. M., Hoang, R. D., Okeke, I. N., & Heston, K. (2017). *Genetics: Genes, Genomes, and Evolution*. Oxford University Press.

3. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics*. John Wiley & Sons.
4. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology*. S. Chand Publishing.
5. Waddington, C. H. (2016). *An Introduction to Modern Genetics*. Routledge.

Biostatistics

Course Code: STA-314

Credit Hour: 02

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of biological sciences. It familiarizes students with biological data and how to handle with it. Furthermore, this course aims in analyzing and interpreting the results obtained from the data from various health and biological fields.

Learning Outcomes

- Students will be able to understand the biological concepts and categorical variables.
- Students will be able to apply statistical tools in any biological situation.
- Students will be capable to apply regression and correlation analysis on data and interpret its results.
- Students should be able to design and analyze an experiment for a real-life problem.

Course Outline

- Unit 1. Introduction and basic Concepts**
Definition of biostatistics, types of variables. Observations in biological, health and medical sciences. Uniqueness in terms of behavior of variables their domain and units. Categorical data. Populations, target populations and sample population. Role of sampling in biostatistics.
- Unit 2. Introduction to Probability Distributions**
Distributional behavior of biological variables. Application of binomial and Poisson distributions in biostatistics. Application of normal distribution in biostatistics.
- Unit 3. Inferential Statistics**
Z-test, T-Test, F-Test. Basic idea, Confidence limits of means, significant difference of means, Chi square test, Basic idea, testing goodness of fit to a ratio, testing association (Contingency table).
- Unit 4. Regression**
Introduction to Correlation and Regression. Testing of hypothesis and confidence interval for the coefficients of regression. Regression for categorical response variables.
- Unit 5. Basic Experimental Design**
Basic concept and principles of experiments. Observational studies, planning of experiments, replication and randomization. Basic One-way ANOVA: types of sum of

squares, how ANOVA works, ANOVA table. Two-way ANOVA. Field plot technique, layout and analysis of completely randomized design, randomized completely block design, Latin square, multiple treatment comparison.

Recommended Books/Reference Material

1. Chaudhry S.M., & Kamal. S. (2018). *Introduction to Statistical Theory Part I*. Lahore, Pakistan: Ilmi Kitab Khana.
2. Chaudhry S.M., & Kamal. S. (2018). *Introduction to Statistical Theory Part II*. Lahore, Pakistan: Ilmi Kitab Khana.
3. Dean, A., Morris, M., Stufken, J., & Bingham, D. (2020). *Handbook of Design and Analysis of Experiments*. CRC Press.
4. Glover, T., & Mitchell, K. (2015). *An introduction to biostatistics*, (3rd ed.). Waveland Press.
5. Gurumani, N. (2021). *An Introduction to Biostatistics*. India: MJP Publishers.
6. Kuzma, J. W., & Bohnenblust, S. E. (2004). *Basis Statistics for the Health Sciences* (5th ed.). USA: McGraw Hill.
7. Merrill, R.M. (2021). *Principles and Applications of Biostatistics*. Jones & Bartlett Learning.
8. Rosner, B. (2010). *Fundamentals of Biostatistics*, (7th ed.). John Wiley & Sons.
9. Triola, M. M., Triola, M. F., & Roy, J. (2017). *Biostatistics for Biological and Health Sciences*, (2nd ed.). Pearson Education.
10. Walpole, R. E. (2002). *Introduction to Statistics*, (7th ed.). New York: Macmillan.
11. Weiss, N. A., & Weiss, C.A. (2017). *Introductory Statistics*. London: Pearson.
12. Zar, J. H. (2009). *Biostatistical Analysis*, (5th ed.). Pearson Education India.

Biostatistics (Lab)

Course Code: STA-314L

Credit Hour: 01

Pre-requisite: Nil

Objectives

The main purpose of the course is to enable students to understand the significance of statistics in the real world, particularly in the field of biological sciences. Students will use statistical software such as R and SPSS to apply theoretical concepts to real biological datasets. This hands-on experience will help them in analyzing, interpreting, and drawing meaningful conclusions from data collected in various biological, medical, and health-related studies.

Learning Outcomes

- Students will understand biological concepts, categorize variables, and apply statistical tools using R/SPSS.
- Students will be capable to apply regression, correlation, and experimental design to solve biological problems using R/ SPSS.

Course Outline

- Unit 1.** Introduction to biostatistics and types of variables using R/SPSS, including data entry and variable classification. Explore categorical data, population concepts, and perform basic sampling techniques within R/SPSS.
- Unit 2.** Explore the distributional behavior of biological variables and apply binomial, Poisson, and normal distributions using R/SPSS for real-life biological data modeling. Use built-in functions in R or SPSS procedures to simulate, visualize, and interpret probability distributions in biological contexts.
- Unit 3.** Perform Z-test, T-test, and F-test in R/SPSS to compare means and evaluate confidence limits and significance in biological data. Use Chi-square tests to assess goodness of fit and test associations using contingency tables for categorical biological variables.
- Unit 4.** In R/SPSS, explore correlation and regression analysis to assess relationships between biological variables. Conduct hypothesis testing and compute confidence intervals for regression coefficients, including regression models for categorical response variables.
- Unit 5.** In R/SPSS, learn the basic concepts and principles of experimental design, including observational studies, replication, and randomization. Conduct One-way and Two-way ANOVA, analyze sum of squares, interpret ANOVA tables, and apply experimental designs like completely randomized designs, randomized block designs, and Latin squares for multiple treatment comparisons.

Recommended Books/Reference Material

1. Amork, N. M. (2013). *IBM SPSS Statistics 24 Core System User's Guide*. International Business Machine Corporation.
2. Denis, D. J. (2020). *Univariate, Bivariate, And Multivariate Statistics Using R: Quantitative Tools for Data Analysis and Data Science*. John Wiley & Sons.
3. George, D., & Mallery, P. (2020). *IBM SPSS Statistics 23 Step by Step: A Simple Guide and Reference* (14th ed.). Routledge.
4. Gray, C. D., & Kinnear, P. R. (2012). *IBM SPSS Statistics 19 Made Simple*. Psychology Press.
5. McNulty, K. (2021). *Handbook of Regression Modeling in People Analytics: With Examples in R and Python*. CRC Press.
6. Thulin, M. (2021). *Modern Statistics With R: From Wrangling and Exploring Data to Inference and Predictive Modelling*. BoD—Books on Demand.
7. Xanthidis, D., Manolas, C., Xanthidou, O. K., & Wang, H. I. (2022). *Handbook of Computer Programming with Python*. CRC Press.

Molecular Biology

Course Code: ZOO-411

Credit Hour: 02

Pre-requisite: Nil

Objectives

- To impart knowledge about chemical, physical and biological properties of nucleic acids.

- To understand different molecular mechanisms and their regulation in prokaryotes and eukaryotes.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the molecular basis of gene structure, expression and regulation in animal cells.
- Analyze the structure and function of nucleic acids and proteins.
- Identify molecular techniques used to study biological processes.

Course Outline

Unit 1. Introduction

a. Introduction to nucleic acids b. Chromosome structure, Chromatin, c. DNA forms, structures and packaging d. RNA types and structures

Unit 2. Replication

a. DNA replication in prokaryotes b. DNA replication in eukaryotes c. Enzymology of replication d. DNA damage and repair

Unit 3. Transcription

a. Types of RNA polymerases in prokaryotes and eukaryotes b. Synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved c. RNA processing d. Split genes, concept of ribozymes c. Genetic Code

Unit 4. Translation

a. Role of Ribosomes b. Mechanism of translation in prokaryotes and eukaryotes c. Various factors, and posttranslational processing

Unit 5. Mutation

a. Types of Mutations b. Base-Analogue Mutagens c. Chemical Mutagens

Unit 6. Gene expression and control

a. Control of gene expression in Prokaryotes. b. Inducible and repressible operons. c. Control of gene expression in eukaryotes.

Recommended Books/Reference Material

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2017). *Molecular Biology of the Cell* (6th ed.). Garland Science.
2. Cooper, G. M., & Hausman, R. E. (2007). *The Cell: A Molecular Approach* (4th ed.). Sinauer Associates, Inc.
3. De Robertis, E. D. P. (2017). *Cell and Molecular Biology* (8th ed.). Lea & Febiger.
4. Karp, G. (2005). *Cell and Molecular Biology: Concepts and Experiments* (4th ed.). John Wiley & Sons, Inc.
5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). *Molecular Cell Biology* (8th ed.). W. H. Freeman and Scientific American Books.

Molecular Biology (Lab)

Course Code: ZOO-411L

Credit Hour: 01

Pre-requisite: Nil

Objectives

- To impart knowledge about chemical, physical and biological properties of nucleic acids.
- To understand different molecular mechanisms and their regulation in prokaryotes and eukaryotes.

Learning Outcomes

By the end of this course, the students will be able to:

- Understand the molecular basis of gene structure, expression and regulation in animal cells.
- Analyze the structure and function of nucleic acids and proteins.
- Identify molecular techniques used to study biological processes.

Course Outline

1. Preparation of different stock solutions used in molecular biology (solution used in PCR, electrophoresis, DNA isolation, RNA isolation and Protein isolation).
2. Isolation of DNA from human blood.
3. Quantification of DNA and RNA through spectrophotometer.
4. DNA amplification through polymerase chain reaction.
5. Separation of different sized DNA fragments on agarose gel.

Recommended Books/Reference Material

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2017). *Molecular Biology of the Cell* (6th ed.). Garland Science.
2. Cooper, G. M., & Hausman, R. E. (2007). *The Cell: A Molecular Approach* (4th ed.). Sinauer Associates, Inc.
3. De Robertis, E. D. P. (2017). *Cell and Molecular Biology* (8th ed.). Lea & Febiger.
4. Karp, G. (2005). *Cell and Molecular Biology: Concepts and Experiments* (4th ed.). John Wiley & Sons, Inc.
5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). *Molecular Cell Biology* (8th ed.). W. H. Freeman and Scientific American Books.

Microbiology and Immunology

Course Code: MIC-101

Credit Hour: 02

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To provide first-hand knowledge to students in the fundamental aspects of basic microbiology
- To impart the practical know-how about the morphology and microbial activities
- To acquaint the students with basic techniques of sterilization, culturing and isolation of microorganisms
- To be able to clearly state the role of the immune system and a foundation in immunological processes
- The students will be able to describe immunological response and how it is triggered and regulated.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the structure and function of microorganisms and their interactions with hosts.
- Analyze immune system mechanisms in animals and their role in defense.
- Evaluate the impact of microorganisms on animal health and disease.

Course Outline

Unit 1. The Beginnings of Microbiology

a. Discovery of the microbial world b. Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods c. The scope of microbiology d. Microbial evolution, systematics and taxonomy e. Characterization and identification of microorganisms

Unit 2. Viruses

a. History, structure and composition b. Structure of virus, Characteristics of virus, Virus-host cell interaction c. Viral replication, Transformation, Transmission of transforming viruses d. Mechanism of pathogenicity, e. Bacteriophages f. Replication of bacteriophages g. Viruses of animals and plants

Unit 3. Morphology and Fine Structure of Bacteria

a. Size, shape and arrangement of bacterial cells b. Flagella and motility, Pili, Capsules, sheaths c. Structure and chemical composition of cell wall d. Cytoplasmic membrane e. the cytoplasm, nuclear material

Unit 4. Cultivation of Bacteria

a. Nutritional requirements and nutritional types of bacteria b. Physical conditions required for growth c. Bacteriological media d. Choice of media and conditions of incubation

Unit 5. Reproduction and Growth of Bacteria

a. Growth of microbial population, measurement of microbial growth, growth rate, growth curve b. Determination of number of cells by direct microscopic count, Plate count method, membrane filter count, Turbidimetric method

Unit 6. Introduction of Immunity

a. Introduction to immunity. b. Immune response c. Infectious agents

Unit 7. Innate Immunity and Inflammation

- a. Sentinel cells and circulating leukocytes b. Inflammatory events and signaling c. The formation of pus, d. Pattern recognition receptors e. Innate immune signaling f. The complement system

Unit 8. Antibodies and Helper T Cells

- a. B lymphocytes b. Antibody structure and function
- c. Helper T cell functions d. The role of helper T cells in disease

Recommended Books/Reference Material

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2017). *Cellular and Molecular Immunology* (9th ed.). Elsevier.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th ed.). Garland Science.
3. Bergey's Manual Trust. (2012). *Bergey's Manual of Systematic Bacteriology*. Springer.
4. Bertrand, J.-C., Matheron, R., Caumette, P., Lebaron, P., & Sime-Ngando, T. (2015). *Environmental Microbiology: Fundamentals and Applications: Microbial Ecology*. Springer.
5. Black, J. G. (2001). *Microbiology: Principles and Explorations* (5th ed.). Wiley.
6. Burmester, G. R., & Pezzutto, A. (2006). *Color Atlas of Immunology*. Thieme.
7. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2012). *Roitt's Essential Immunology* (12th ed.). Wiley-Blackwell.
8. Detrick, B., McKerrow, J. H., Hobden, J. A., Sakanari, J. A., Carroll, K. C., Morse, S. A., Miller, S., Mitchell, T. G., & Mietzner, T. A. (2015). *Jawetz, Melnick & Adelberg's Medical Microbiology*. McGraw-Hill Education.
9. Johnson, T. R., & Case, C. L. (2015). *Laboratory Experiments in Microbiology* (11th ed.). Pearson.
10. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2003). *Immunology*. W. H. Freeman.
11. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., Stahl, D. A., & Brock, T. (2014). *Brock Biology of Microorganisms* (14th ed.). Pearson.
12. Pommerville, J. C. (2012). *Alcamo's Fundamentals of Microbiology* (9th ed.). Jones & Bartlett Learning.
13. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction* (12th ed.). Pearson.
14. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). *Prescott's Microbiology* (10th ed.). McGraw-Hill Education.

Microbiology and Immunology (Lab)

Course Code: MIC-101L

Credit Hour: 01

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To provide first-hand knowledge to students in the fundamental aspects of basic microbiology
- To impart the practical know-how about the morphology and microbial activities
- To acquaint the students with basic techniques of sterilization, culturing and isolation of microorganisms
- To be able to clearly state the role of the immune system and a foundation in immunological processes
- The students will be able to describe immunological response and how it is triggered and regulated.

Learning Outcomes

By the end of this course, the students will be able to:

- Explain the structure and function of microorganisms and their interactions with hosts.
- Analyze immune system mechanisms in animals and their role in defense.
- Evaluate the impact of microorganisms on animal health and disease.

Course Outline

1. Sterilization Techniques (Dry/Wet)
2. Media Preparation
3. Gram Staining
4. Endospore, flagellar and capsular staining
5. Microbial Count
6. Antibody Purification and Conjugation
7. ELISA
8. Differential leukocyte count.
9. Blood grouping (ABO & Rh).

Recommended Books/Reference Material

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2017). *Cellular and Molecular Immunology* (9th ed.). Elsevier.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th ed.). Garland Science.
3. Bergey's Manual Trust. (2012). *Bergey's Manual of Systematic Bacteriology*. Springer.
4. Bertrand, J.-C., Matheron, R., Caumette, P., Lebaron, P., & Sime-Ngando, T. (2015). *Environmental Microbiology: Fundamentals and Applications: Microbial Ecology*. Springer.
5. Black, J. G. (2001). *Microbiology: Principles and Explorations* (5th ed.). Wiley.
6. Burmester, G. R., & Pezzutto, A. (2006). *Color Atlas of Immunology*. Thieme.
7. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2012). *Roitt's Essential Immunology* (12th ed.). Wiley-Blackwell.
8. Detrick, B., McKerrow, J. H., Hobden, J. A., Sakanari, J. A., Carroll, K. C., Morse, S. A., Miller, S., Mitchell, T. G., & Mietzner, T. A. (2015). *Jawetz, Melnick & Adelberg's Medical Microbiology*. McGraw-Hill Education.

9. Johnson, T. R., & Case, C. L. (2015). *Laboratory Experiments in Microbiology* (11th ed.). Pearson.
10. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2003). *Immunology*. W. H. Freeman.
11. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., Stahl, D. A., & Brock, T. (2014). *Brock Biology of Microorganisms* (14th ed.). Pearson.
12. Pommerville, J. C. (2012). *Alcamo's Fundamentals of Microbiology* (9th ed.). Jones & Bartlett Learning.
13. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction* (12th ed.). Pearson.
14. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). *Prescott's Microbiology* (10th ed.). McGraw-Hill Education.

Computational Biology

Course Code: CS-113

Credit Hour: 02

Pre-requisite: Nil

Objectives

The course will provide:

- An introduction to bioinformatics.
- To develop awareness about fundamental bioinformatics databases.
- Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

Learning Outcomes

By the end of this course, the students will be able to:

- Identify computational tools to solve biological problems and analyze large datasets.
- Use bioinformatics techniques to model and interpret biological processes.
- Evaluate computational approaches for studying molecular and evolutionary biology.

Course Outline

Unit 1. Introduction

a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites b. Aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools c. Human genome project

Unit 2. Biological Databases

a. Data and types of data, data acquisition b. Major DNA databases around the world, NCBI, BOLD, DDBJ c. Major protein databases in the world, protein sequence databases, protein structure databases d. Specialized databases, genome and organism databases h. Non sequence databases, pubmed, pubmed health, OMIM

Unit 3. Genome mapping

- a. Genetic and linkage mapping, physical mapping
- Unit 4. Primer Designing and Sequence Alignment**
- a. Primer and probe, qualities of primer, general rules for primer designing b. Websites used for primer designing c. Importance and significance of alignment, methods for sequence alignment d. Local and global alignment, pair-wise local alignment e. BLAST: Introduction, types, uses, algorithm, BLAST Scores f. Multiple Sequence Alignment: tools for MSA, uses and importance
- Unit 5. Phylogenetic Analysis**
- a. Introduction, interpretation, rooted and unrooted tree, b. phylogenetic methods, tree terminology, comparison of methods, software
- Unit 6. Artificial Intelligence (AI) in Zoology**
- a. Definition of AI, Machine Learning (ML), and Deep Learning (DL), b. Relevance of AI to biological sciences, The need for AI in large-scale data analysis, c. Gene expression analysis using ML algorithms, Protein structure prediction (e.g., AlphaFold by DeepMind), d. AI in drug design and personalized medicine, e. Limitations of AI models in biological systems

Recommended Books/Reference Material

1. Baxevanis, A. D., & Ouellette, B. F. F. (2011). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). John Wiley & Sons, Inc.
2. Gibas, C., & Jambeck, P. (2001). *Developing Bioinformatics Computer Skills*. O'Reilly Media.
3. Krane, D. E., & Raymer, M. L. (2002). *Fundamental Concepts of Bioinformatics*. Benjamin Cummings.
4. Lesk, A. M. (2014). *Introduction to Bioinformatics* (4th ed.). Oxford University Press.
5. Pevsner, J. (2015). *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell.
6. Primrose, S. B. (2004). *Genomics: Applications in Human Biology*. Wiley-Blackwell.
7. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2011). *Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery* (2nd ed.). PHI Learning Pvt. Ltd.
8. Selzer, P. M., Marhöfer, R. J., & Rohwer, A. (2008). *Applied Bioinformatics: An Introduction*. Springer.
9. Westhead, D. R., Parish, J. H., & Twyman, R. M. (2003). *Instant Notes: Bioinformatics*. Viva Books Private Limited.

Computational Biology (Lab)

Course Code: CS-113L

Credit Hour: 01

Pre-requisite: Nil

Objectives

The course will provide:

- An introduction to bioinformatics.
- To develop awareness about fundamental bioinformatics databases.

- Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

Learning Outcomes

By the end of this course, the students will be able to:

- Identify computational tools to solve biological problems and analyze large datasets.
- Use bioinformatics techniques to model and interpret biological processes.
- Evaluate computational approaches for studying molecular and evolutionary biology.

Course Outline

1. Introduction to NCBI
2. Retrieving Literature from NCBI
3. Classification of an organism using NCBI
4. Retrieving FASTA sequence for nucleotide and protein
5. Retrieving disease gene information
6. Searching gene families
7. Primer Designing
8. BLASTing a nucleotide / amino acid sequence
9. Multiple Sequence Alignment using different amino acids / nucleotide sequences
10. Phylogenetic Analysis of different nucleotide / amino acid sequences
11. Microarrays data retrieval from the web
12. Use of Orange or Google Teachable Machine to classify DNA/protein sequences
13. Protein Structure Prediction Demo, Walkthrough of AlphaFold Protein Structure Database

Recommended Books/Reference Material

1. Baxevanis, A. D., & Ouellette, B. F. F. (2011). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). John Wiley & Sons, Inc.
2. Gibas, C., & Jambeck, P. (2001). *Developing Bioinformatics Computer Skills*. O'Reilly Media.
3. Krane, D. E., & Raymer, M. L. (2002). *Fundamental Concepts of Bioinformatics*. Benjamin Cummings.
4. Lesk, A. M. (2014). *Introduction to Bioinformatics* (4th ed.). Oxford University Press.
5. Pevsner, J. (2015). *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell.
6. Primrose, S. B. (2004). *Genomics: Applications in Human Biology*. Wiley-Blackwell.
7. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2011). *Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery* (2nd ed.). PHI Learning Pvt. Ltd.
8. Selzer, P. M., Marhöfer, R. J., & Rohwer, A. (2008). *Applied Bioinformatics: An Introduction*. Springer.
9. Westhead, D. R., Parish, J. H., & Twyman, R. M. (2003). *Instant Notes: Bioinformatics*. Viva Books Private Limited.

17. List Of Elective Courses (Major)

S. No.	Course Code	Course Title	Credit Hours
1.	ZOO-448	Parasitology	3
2.	ZOO-401	Endocrinology	3
3.	ZOO-413	Biotechnology	3
4.	ZOO-414	Environmental Pollution	3
5.	ZOO-415	Bacterial Genetics	3
6.	ZOO-418	Hematology	3
7.	ZOO-419	Basic Human Genetics	3
8.	ZOO-420	Biology of Cancer	3
9.	ZOO-422	Neurobiology	3
10.	ZOO-426	Epidemiology and Public Health	3
11.	ZOO-427	Epidemiology of Parasitic Disease	3
12.	ZOO-428	Vector Biology	3
13.	ZOO-431	Reproductive Biology	3
14.	ZOO-432	Behavioral Ecology	3
15.	ZOO-433	Population Biology	3
16.	ZOO-434	Lab and Biosafety	3
17.	ZOO-435	Mammalogy	3
18.	ZOO-436	Ornithology	3
19.	ZOO-437	Biotechnology in Aquaculture	3
20.	ZOO-438	Microbial Biotechnology	3
21.	ZOO-440	Conservation Biology	3
22.	ZOO-442	Insects of Medical and Veterinary Importance	3
23.	ZOO-443	Principles and Kinetics of Toxicology	3
24.	ZOO-404	Animal Physiology	3
25.	ZOO-445	Biological Techniques	3
26.	ZOO-446	Enzymology	3
27.	ZOO-447	Vitamins and Hormones	3

18. Course Outline Elective Courses

Parasitology

BS-Zoology

Course Code: ZOO-448

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- Describe general principles and concepts of animal parasitology
- Classify major animal parasites of animals and humans.
- Describe many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

Learning Outcomes

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

- Assess general principles and concepts of animal parasitology
- Analyze many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

Course Outline

Unit 1. History and Origin of Parasitism

a. Classification of relationships between two individuals. b. Symbiosis, commensalisms, parasitism, myiasis, zoonosis. c. Infection and infestation.

Unit 2. Classification of Parasites

a. Ectoparasites, endoparasites, temporary parasites, permanent parasites, facultative parasites, accidental parasites, wandering parasites (brief account and examples). b. Classification of hosts: Definitive, intermediate and paratenic hosts.

Unit 3. Host Susceptibility and Specificity

a. Various types of susceptibilities. b. Host-parasite relationships. c. Morphology and physiology of parasites. d. Adaptations to parasitic mode of life. e. Effects of parasitism on parasites.

Unit 4. Effects of Parasites on Hosts

a. Influence of parasites on host populations. b. Pathological responses. c. Immunoparasitology: immunity and immune responses of the host. Diagnosis, prevention, control treatment. a. Common drugs and anthelmintics. b. Vector control methods.

Unit 5. Protozoology

a. Protozoan parasites of man and other animals. b. Classification, life cycle, habitat, morphology, epidemiology and immunopathology of infections e.g., Entamoeba spp.

Pathogenic amoeba, Giardia spp. Trichomonas, Trypanosoma, Leishmania, Plasmodium and Toxoplasma gondii.

Unit 6. Helminthology

a. Helminth parasites of man and other animals. b. General account, classification, biology, life cycle, pathology and symptomatology and immunology. Platyhelminthes: e.g. Trematodes (Fasciola and Schistosoma) Cestodes: Taenia. Nematodes: Trichuris, Strongyloides, Toxocara and Filaria worms.

Unit 7. Medical and Veterinary Entomology

a. Biology and classification of arthropods of veterinary and medical importance. b. Biology and life cycles e.g. lice, Ticks, mites, mosquitoes, fleas, flies, bugs etc. c. Arthropods as disease transmitters/vectors.

Recommended Books/Reference Material

1. Cheesbrough, M. (1987). *Medical Laboratory Manual for Tropical Medicine* (Vol. 1). Cambridge University Press.
2. Hausmann, K., & Hülsmann, N. (1996). *Protozoology* (2nd ed.). Thieme Medical Publishers, Inc.
3. Roberts, L. S., & Janovy, J. (2000). *Foundations of Parasitology* (6th ed.). McGraw-Hill Book Co.
4. Roberts, L. S., & Janovy, J. Jr. (2005). *Foundations of Parasitology* (7th ed.). W.M. Brown Publishers.
5. Urquhart, G. M., Hucan, J. L., Dunn, A. M., & Jennings, F. W. (2000). *Veterinary Parasitology*. Longman Scientific and Technical Publications.

Endocrinology

BS-Zoology

Course Code: ZOO-401

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will be able to know the general properties of hormones and their importance. They will learn about the roles of the endocrine system in maintaining homeostasis, integrating growth and development, responding to environmental insult and promoting successful reproduction. Students will be able to know about the consequences of under and overproduction of hormones to determine the pathophysiological basis and consequences of specific endocrine disorders.

Learning Outcome

- Students will be able to explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction.
- Students will be able to describe different classes and chemical structure of different hormones.

Course Outline

Unit 1. General Concepts and Principles of Endocrinology

The endocrine system; Type of hormones; Endocrine and nervous system relationship, General principles in function, interaction, nature, synthesis, transport of hormones, General concept of feedback, biorhythms, pathology and assessment of endocrine function, Evolution of endocrine system. RIA, RIMA, ELISA, bioassay and receptor assay.

Unit 2. Hypothalamus and Pituitary

Hypothalamic hormones: Origin, chemistry and actions and mechanism of action. Anterior pituitary & hormones: Hypothalamic pituitary regulation. General chemistry, Physiological action, mechanism of action and metabolism of prolactin growth hormone family. Glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; e. posterior pituitary: Release, regulation and actions of vasopressin and oxytocin. f. Causes and effect of over and under production of hypothalamic and pituitary hormones g. Hypothalamic, pituitary and thyroid, adrenocortical, gonadal and other axis.

Unit 3. Thyroid and Parathyroid Gland

Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Functions of thyroid hormone. Mechanism of action; regulation and factors affecting thyroid function. Causes and effect of Hypothyroidism and hyperthyroidism, chemistry, physiological actions, mechanism of action and metabolism of parathyroid hormone. Causes and effect of over and under production of hormone. Calcitonin and calciferols; action and mechanism of action. Homeostasis of calcium, phosphate and magnesium.

Unit 4. 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. Causes and effects of over and under secretion of pancreatic hormones. Glucose homeostasis.

Unit 5. Adrenal Medulla and Catecholamines

Chromaffin cell and organization; Structure of adrenal medulla. Biosynthesis, storage, release and metabolism. Adrenergic receptors and mechanism of action. Disorder of Adrenal medulla (pheochromocytoma)

Unit 6. Adrenal Cortex

Anatomy and Steroid biochemistry. Physiological actions of corticoid hormones and mechanism of action. Regulation and metabolism of glucocorticoids. Mineralocorticoids and adrenal sex steroids. Disorder of adrenal cortex hormones

Unit 7. Testes and Ovaries

Androgenic tissue: Anatomy, structure, chemistry, synthesis and transport of hormone, Metabolism, action and mechanism of action, Testicular disorder. Ovarian Anatomy, hormones. Endocrinology of Pregnancy. Hormones in conception and implantation, Fetus Endocrinology : Growth and Puberty, Disorders of growth and puberty.

Unit 8. Functional Diversity of Vertebrate Hormones

Endocrinology of: Heart, Kidney, Immune system, Growth and pineal gland. Functional diversity of hormones in different vertebrates; Overview of Endocrine Mechanisms in Invertebrates.

Recommended Books/Reference Material

1. Bandeira, F., Gharib, H., Griz, L., & Faria, M. (2022). *Endocrinology and Diabetes* (2nd ed.). Springer.
2. Bentley, P. J. (1998). *Comparative Vertebrate Endocrinology* (3rd ed.). Cambridge University Press.
3. Greenspan, F. S., & Stewler, G. J. (2011). *Basic and Clinical Endocrinology* (9th ed.). Prentice Hall International Inc.
4. Kalyani, R. R. (2023). *Endocrinology of the Aging Patients*. Elsevier.
5. Laycock, J., & Meeran, K. (2013). *Integrative Endocrinology*. Wiley-Blackwell.
6. Sam, A., & Meeran, K. (2009). *Endocrinology and Diabetes: Basic Science and Clinical Context*. Wiley-Blackwell.

Biotechnology

BS-Zoology

Course Code: ZOO-413

Credit Hours: 03

Pre-requisite: Nil

Objectives

To acquaint students of zoology with the basic concepts and significance of biotechnology.

Learning Outcomes

Upon successful completion of the course, the students should be able to:

- comprehend about the introduction and history of biotechnology
- understanding of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution
- know about basic of rDNA technology, concept and principle and application of genetic engineering, transgenic animals, cryopreservation, apoptosis, and animal cloning.

Course Outline

Unit 1. Introduction

a. Definitions, classes, types of modern biotechnology b. Historical perspective, timeline of important events in the field of biotechnology

Unit 2. Genetics and Biotechnology

a. Genome, human genome, types and size of human genome, diversity of human genome b. Short Tandem Repeats, nomenclature, uses of STRs, inheritance of STRs, allele, locus, genotype, phenotype c. Polymerase Chain Reaction, principle, requirements, procedures and applications, Gel electrophoresis, definition, principle, steps/methods involved, DNA ladder

Unit 3. Biotechnology and Justice

a. Sources of DNA, Forensic DNA testing, b. Principles, techniques, types and applications

Unit 4. Animal and Insect Biotechnology

a. Introduction, reasons for producing GM animals, b. Genetic manipulation, mammalian cloning, somatic cell nuclear transfer, procedure and uses, GM hormones and vaccines, GM insects

Unit 5. Biotechnology and Medicine

a. Applications, monoclonal antibodies, importance, steps for production of monoclonal antibodies

Unit 6. Stem Cell Biotechnology

a. Introduction, sources – embryonic stem cells, adult stem cells b. Types of stem cells based on potency, applications of stem cells.

Unit 7. Public Perception of Biotechnology

a. Current issues in bioethics (Autopsy, GMOs, Stem Cells, Euthanasia, Organ Transplant, Human Cloning, IVF, Surrogacy and sperm donor, etc) Bioethics and Islamic Bioethics: a. Introduction and principles of bioethics, b. Concept of bioethics in different religions, principles of Islamic bioethics

Recommended Books/Reference Material

1. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
2. Clark, D. B., & Pazdernik, N. J. (2015). *Biotechnology* (2nd ed.). Academic Cell.
3. Dehlinger, C. A. (2014). *Molecular Biotechnology*. Jones & Bartlett Learning.
4. Freeman, S., Quillin, K., & Allison, L. (2013). *Biological Science* (5th ed.). Pearson.
5. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2009). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th ed.). ASM Press.
6. Schmid, R. D., Schmidt-Dannert, C., & Hammelehle, R. (2016). *Biotechnology: An Illustrated Primer*. Wiley-Blackwell.

Environmental Pollution

BS-Zoology

Course Code: ZOO-414

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To familiarize the students with the types of environmental pollutants
- To introduce the students with the ecosystem related pollutant with their origin and mode of action
- To train the students in tackling the treatments of pollutants

Learning Outcomes

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

- Acquire the basic knowledge of pollutants nature
- Understand the concepts of basic techniques and use them efficiently for control of pollutants with their nature
- Solve the problems of the environment by using different methods

Course Outline

Unit 1. Introduction

a. Pollution, types, water pollution, water pollutants, category and composition of waste water. b. Water quality index. Ground water pollution, Aquifers, Hydraulic gradient, c. Darcy's Law, contaminants in ground water, waste water remediation technologies for surface and ground water. d. Effect of Water pollution on ecosystem and biota

Unit 2. Water Quality Control

a. Introduction, standard qualities for Drinking Water, Water quality standards for irrigation, industry, fishery and other ventures. b. Water treatment systems and waste water treatments technologies c. Hazardous waste in Pakistan water bodies, solid wastes, sewerage, sewage disposal and treatment

Unit 3. Air Pollution

a. Introduction, Pollutant sources, Primary and secondary pollutants and toxic air pollutants. b. Air quality standards, motor vehicle emissions and stationary emissions- composition and control. c. Formation of aerosol and its effects and indoor air quality standards. d. Air pollution assessment technologies and its effect on biota

Unit 4. Soil Pollution and Solid Waste

a. Introduction, sources of soil pollutants-municipal, agriculture, aquaculture, poultry and industrial sources of soil pollutants. b. Classification, characterization of solid waste, hazardous solid waste and biomedical waste. c. Leachate of solid waste, transboundary movement of wastes, physical, chemical and biological treatment of

waste d. Disposal recycling of solid waste, effect of soil pollution on ecosystem and biota.

Unit 5. Noise Pollution

a. Introduction, Noise and vibration, sources of noise pollution, b. Noise, health, permissible levels, sonic boom, impulsive noise c. Anechoic chamber reverberating sound, noise topography and regulations for control of noise

Unit 6. Thermal and light Pollution

a. Introduction, sources of thermal pollution, effect of discharge of heat, effect of thermal pollution and its effect on ecosystem and biota. b. Light Pollution, environmental health, effect of light on pollinators and crop yield

Unit 7. Status of Environmental Pollutions in Pakistan

a. Prevention and control of wastes and National program to control wastes b. Reuse and recycle of waste, Acts and regulation to control pollution.

Recommended Books/Reference Material

1. Khopkar, S. M. (2013). *Environmental Pollution: Monitoring and Control* (2nd ed.). New Age International Publishers.
2. Masters, G. M., & Ela, W. P. (2008). *Introduction to Environmental Engineering and Science* (3rd ed.). Prentice Hall.
3. Nazaroff, W. W., & Cohen, L. A. (2001). *Environmental Engineering Science*. Wiley.

Bacterial Genetics

BS-Zoology

Course Code: ZOO-415

Credit Hours: 03

Pre-requisite: Nil

Objectives

- To learn the continuity of the life from one generation to other generation
- To provide knowledge based on the mechanisms involving nucleus, chromosomes and genes etc.

Learning Outcomes

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

- Acquire the firm knowledge of life stability from one generation to other one.
- Understand the mechanisms involving nucleus, chromosomes and genes etc.

Course Outline

Unit 1. Nucleic Acids

Structure and functions.

Unit 2. DNA Replication

Replicon origins, Events that occur at the replication fork, The structure and functions of DNA polymerases, Replication Strategies; Control of DNA replication: Dichotomous replication in prokaryotes, Control of gene expression in prokaryote, Polycistrons, transcriptional initiation and termination, the operon, catabolite repression and attenuation control.

Unit 3. Protein Synthesis

mRNA translation: Genetic code - non universality, codon usage, Events on ribosomes (c.f. prokaryotes), Ribosome structure-function relationships, Organelle and archaeobacterial systems, Plasmids, episomes and transposons; DNA mutagenesis: Mutagenic agents, Repair and mutation suppression.

Unit 4. DNA Mutagenesis

a. Mutagenic agents b. Repair and mutation suppression

Unit 5. Genetic Recombination

a. Generalized recombination b. Site specific recombination and Illegitimate recombination. c. Gene transfer mechanisms and their role in evolution d. Transformation, transduction, conjugation and cross-phylogenetic transfer. e. Gene mapping by conjugation and transduction. f. Circular chromosomal maps of bacteria. g. Introduction to genetic rearrangements

Recommended Books/Reference Material

1. Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C., Gelbart, W. M., Suzuki, D. T., & Miller, J. H. (2005). *An Introduction to Genetic Analysis* (8th ed.). W. H. Freeman and Company.
2. Hartl, D. L., & Jones, E. W. (2005). *Genetics: Analysis of Genes and Genomes* (6th ed.). Jones and Bartlett Publishers.
3. Ignacimuthu, S. (2005). *Basic Bioinformatics*. Narosa Publishing House.

Hematology

BS-Zoology

Course Code: ZOO-418

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To impart knowledge about hemopoiesis, blood clotting, anemias, allergy, hypersensitivity and immune complexes.
- To develop critical thinking about the mechanisms of autoimmune disorders and changes in hematological parameters in allergy and hypersensitivity reactions.

- To develop analytical approach about the clinical investigations of anemia, allergy and hypersensitivity.

Learning Outcomes

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

- acquire the knowledge about hemopoiesis, anemias and changes in blood profile in altered immune response.
- understand the concept of duality of immune response.
- analyze the clinical investigations in allergy and hypersensitivity cases.
- demonstrate individually hemopoiesis and changes in blood profile in anemias, allergies and autoimmune disorders.

Course Outline

Unit 1. Introduction

a. Introduction to Hematology and techniques of hematology. b. Anticoagulants EDTA, heparin, balanced oxalate, calcium citrate and low molecular weight heparin c. Phlebotomy tray and phlebotomy procedure.

Unit 2. Hemopoiesis

a. Normocytic erythropoiesis. b. Megaloctic erythropoiesis and substances required for erythropoiesis. c. Life span of RBC, Structure of RBC and composition of hemoglobin. d. Synthesis of hemoglobin. e. Leukopoiesis, maturation of neutrophils. f. Maturation of basophils and maturation of eosinophils. g. Maturation of lymphocytes AND maturation of monocytes. h. Maturation of plasmacytes and their proliferation. i. kinship between neutrophils and monocytes. j. Maturation of thrombocytes and thrombocytopenia. k. Erythrocyte indices and CBC.

Unit 3. Anemias

a. Hypoproliferative anemia and bone marrow damage. b. Spur cell anemia and Sick cell anemia. c. Hemolytic anemia and mechanism involved in hemolysis of RBC. d. Sideroblastic and nonsideroblastic anemia. e. Macrocytic anemia. f. Coagulation factors.

Unit 4. Immunity

a. Phagocytosis, microphages, macrophages, mast cells and grades of immunity. b. Measurement of immunity. c. Antigens and immune tolerance. d. Major histocompatibility complex I and II. e. Characteristics of antigens. Acquired immunity. Passive acquired immunity. f. Consequences of antigen and antibody binding. g. Humoral immunity and cell mediated immunity.

Unit 5. Allergy and hypersensitivity

a. Atopic allergy and anaphylactic hypersensitivity. b. Immune complex dependent hypersensitivity and hypersensitive response. 169 c. Sensitization of cells. Adaptive immunity. d. Immediate hypersensitivity. Delayed hypersensitivity e. Adjuvants and their types. Complement system and hypersensitivity reactions. f. Cellular basis

of cell mediated hypersensitivity. g. Complement.Antibodies. h. Synthesis of antibodies and stimulatory hypersensitivity. i. j. Interferones and serum sickness. Autoimmune disorders

Recommended Books/Reference Material

1. Bain, B. J., Bates, I., Laffan, M. A., & Lewis, S. M. (2011). *Dacie and Lewis Practical Haematology* (11th ed.). Churchill Livingstone.
2. Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (2006). *Kuby Immunology* (6th ed.). W. H. Freeman and Company.
3. Montanaro, A. (2015). *Primary Immunodeficiency Disorders* (1st ed.). Elsevier.
4. O'Hehir, R. E., Holgate, S. T., & Sheikh, A. (2022). *Allergy Essentials* (2nd ed.). Elsevier.

Basic Human Genetics

BS-Zoology

Course Code: ZOO-419

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To enable the students to understand basic Mendelian inheritance principles
- To enable the students to analyze and predict mode of Inheritance of various genetic disorders.
- To train the students to provide genetic counseling to various families in field.

Learning Outcomes

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

- acquire the basic knowledge of simple mendelian principals and pedigree construction.
- understand the key features involved in different mode of transmission.
- solve the problem by pedigree construction and evaluation
- analyze the pedigree and predict the mode of inheritance of any genetic disorders
- evaluate the pedigree and possible mode of transmission.
- demonstrate the families about the risk factors and probability of affected children in next generation.

Course Outline

Unit 1.

Introduction

a. Pedigree construction by using standard symbols. b. Mode of Inheritance of genetic disorders c. Autosomal dominant and autosomal recessive inheritance d. X

linked dominant and X linked recessive Inheritance. e. Y linked inheritance. f. Mitochondrial Inheritance

Unit 2. Genetic Linkage

a. Linkage Analysis b. Genetic mapping c. Physical mapping d. Genetic linkage and LOD score calculation

Unit 3. Mutations

a. Missense mutations b. Nonsense mutations c. Silent mutations d. Deletion mutation e. Duplication mutations

Unit 4. Prenatal Screening

a. Ultrasonography b. amniocentesis c. Chorionic villi sampling d. Fetoscopy

Unit 5. Introduction to human Genome Project

a. Application and proposed benefits of Human Genome project. b. Ethical, legal and social Issues.

Chromosomal Abnormalities

a Aneuploidy b Euploidy

Recommended Books / Reference Material

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular Biology of the Cell* (4th ed.). Garland Science.
2. Ehrlich, P. R. (2002). *Human Natures: Genes, Cultures, and the Human Prospect* (1st ed.). Penguin Books.
3. Relethford, J. H. (2001). *Genetics and the Search for Modern Human Origins*. Wiley-Liss.
4. Strachan, T., & Read, A. P. (2003). *Human Molecular Genetics* (3rd ed.). Garland Science/Taylor & Francis Group.

Biology of Cancer

BS-Zoology

Course Code: ZOO-420

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To gain the knowledge in the area of Cancer Biology.
- To provide core concepts involved in the transformation of normal cell in to cancer cell.
- To introduce the major signaling circuitry programs contributing towards cancer.

Learning Outcomes

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

- acquire the basic knowledge of cancer biology.
- understand the concepts of transformation of normal cell in to tumor cell.

- analyze the signaling pathways contributing towards cancer.
- evaluate the problems related to genetic mutations and tumor suppressor genes, etc.

Course Outline

Unit 1.

Introduction to cancer and its major types

Definition and characteristics of cancer, Hallmarks of cancer: sustained proliferative signaling, evading growth suppressors, resisting cell death, etc. Difference between benign and malignant tumors, Classification based on tissue origin: Carcinomas (epithelial origin): Sarcomas (connective tissue origin), Leukemias (blood-forming tissues), Lymphomas (immune system origin), Gliomas and other CNS tumors

Unit 2.

Cancer as a Genetic disorder.

Overview of cancer as a multistep genetic disease, Proto-oncogenes and oncogenes: activation mechanisms (point mutations, amplifications, translocations), Tumor suppressor genes (e.g., TP53, RB1): inactivation mechanisms (mutations, deletions), Role of DNA repair genes (e.g., BRCA1/2) in maintaining genomic integrity

Unit 3.

Role of Environmental factors in carcinogenesis; Contribution of genetic mutations in cancer; MicroRNAs and cancer.

Carcinogens and their classification: Physical (e.g., radiation), Chemical (e.g., tobacco smoke, aflatoxins), Biological (e.g., Helicobacter pylori, HPV), Mechanism of action of environmental carcinogens, Interaction between genetic predisposition and environmental exposure, Genetic mutations: Point mutations, Insertions/deletions, Chromosomal translocations, MicroRNAs: Biogenesis and function, OncomiRs and tumor suppressor miRNAs, Diagnostic and therapeutic implications of miRNAs in cancer

Unit 4.

Cancer Genome project; Chromosomal alterations associated with cancer; Viruses associated with some cancers.

Introduction to Cancer Genome Project and The Cancer Genome Atlas (TCGA), Types of chromosomal alterations: Aneuploidy, Translocations (e.g., Philadelphia chromosome), Gene amplifications (e.g., HER2 in breast cancer), Deletions and inversions, Viral oncogenesis: Human Papillomavirus (HPV) and cervical cancer, Hepatitis B and C viruses and liver cancer

Unit 5.

Epigenetics and carcinogenesis; Study of some representative cancers that arise through sequential mutations in number of genes.

Epigenetic mechanisms: DNA methylation, Histone modifications, Non-coding RNAs, Epigenetic alterations in tumor suppressor gene silencing, Use of molecular markers in cancer diagnosis and prognosis

Recommended Books / Reference Material

1. Hejmadi, M. (2009). *Introduction to Cancer Biology*. Bookboon.
2. Pierce, B. A. (2011). *Genetics: A Conceptual Approach* (4th ed.). W.H. Freeman & Co Ltd.
3. Weinberg, R. (2013). *The Biology of Cancer*. Garland Science.

4. Zhang, W., & Fuller, G. N. (Eds.). (2004). *Genomic and Molecular Neuro-Oncology*. Jones & Bartlett Learning.

Neurobiology

BS-Zoology

Course Code: ZOO-422

Credit Hours: 03

Pre-requisite: Nil

Objectives

1. To provide the knowledge about the structure and function of cells that comprise the nervous system.
2. To impart understanding of chemical and electrical signaling in the nervous system.
3. To provide knowledge of sensory and motor systems.
4. To understand the brain development and complex brain functions.
5. To provide knowledge how to develop a hypothesis from a set of observations and then suggest experiments to test the hypothesis.

Learning Outcome

By the end of the course, students should be able to:

- Define the molecular, cellular, and tissue-level organization of the central and peripheral nervous system
- Understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication
- Relate the properties of individual cells to their function in organized neural circuits and systems
- Generate testable scientific hypotheses and develop research plans to test these hypotheses
- Evaluate and discuss primary research literature and evaluate the validity of hypotheses generated by others

Course Outline

Unit 1. Organization of the Nervous System

neurons, types of neurons, nerves, Electrical signals of nerve cells, Membrane permeability, Channels and transporters; Nerve Impulse; Synaptic Transmission: Neurotransmitters, their receptors and effects, Intracellular signal transduction; Sensory somatic system.

Unit 2. The Somatic Sensory System

Pain; Vision : Vision; molecular basis of photoreception, central visual pathways; Neural basis of visual perception, types of eyes, photoreceptor and phototransduction, retinal circuits, visual cortex; Hearing: Nature of Sound, The auditory system; the vestibular system; Lateral line organs and electroreceptor, The mammalian ear, the auditory nerve fibers. Brainstem auditory pathways, Auditory cortex

Unit 3. The Chemical Senses

Taste system, Olfactory system; Motor Neurons/system: lower motor neuron circuits and motor control, upper motor neuron control of the brainstem and spinal cord, modulation of movement by the basal ganglia and the cerebellum, eye movements and sensory motor integration; the visceral motor system.

Unit 4. Brain Development

Brain development; construction of neural circuits; modification of brain circuits as result of experience; plasticity of mature synapses and circuits.

Unit 5. Association Cortices

The association cortices; Language and lateralization; sleep and wakefulness; emotions; sex, sexuality and brain; human memory.

Recommended Books / Reference Material

1. Garrett, B., & Hough, G. (2018). *Brain & Behavior: An Introduction to Behavioral Neuroscience* (5th ed.). SAGE Publications.
2. Haier, R. J. (2016). *The Neuroscience of Intelligence*. Cambridge University Press.
3. Lavine, R. (2017). *Neuroscience ABCs: Human Brain Physiology Guide* [Kindle edition]. National Institute of Mental Health.
4. Shepherd, G. M. (1994). *Neurobiology* (3rd ed.). Oxford University Press.
5. Yuste, R., & Konnerth, A. (2005). *Imaging In Neuroscience and Development: A Laboratory Manual*. Cold Spring Harbor Laboratory Press.

Epidemiology and Public Health

BS-Zoology

Course Code: ZOO-426

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- Describe basic principles of epidemiology, including descriptive/analytical epidemiology
- Elaborate techniques used to conduct disease outbreak investigations and develop disease prevention programs
- Describe causal models, distribution/patterns and control of disease or other health-related events in populations

Learning Outcomes

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

- Discover basic principles of epidemiology, including descriptive/analytical epidemiology
- Demonstrate techniques used to conduct disease outbreak investigations and develop disease prevention programs

- Analyze causal models, distribution/patterns and control of disease or other health-related events in populations

Course Outline

- Unit 1. Introduction To Epidemiology & Public Health**
Disease occurrence, Mapping, Causality.
- Unit 2. Determinants of Disease**
Diagnostic testing, Transmission and maintenance of infection, Descriptive epidemiology, Analytical epidemiology
- Unit 3. Case-Control Studies**
Cohort studies
- Unit 4. Experimental Epidemiology**
Animal disease survey, Types of sampling, Surveillance, Prevention, Control and eradication, Outbreak investigation
- Unit 5. National and International Disease Reporting**
Trans-boundary disease of veterinary importance, TAD distribution, Mapping, Regulatory implications, TAD control, International trade framework

Recommended Books / Reference Material

1. Bonita, R., Beaglehole, R., & Kjellström, T. (2006). *Basic Epidemiology* (2nd ed.). World Health Organization.
2. Gordis, L. (2008). *Epidemiology* (4th ed.). Saunders/Elsevier.
3. Merrill, R. M. (2013). *Introduction to Epidemiology* (6th ed.). Jones & Bartlett Learning.
4. Thrusfield, M. (2007). *Veterinary Epidemiology* (3rd ed.). Wiley-Blackwell.

Epidemiology of Parasitic Disease

BS-Zoology

Course Code: ZOO-427

Credit Hours: 03

Pre-requisite: Nil

Objectives

- To Describe basic principles of epidemiology, including descriptive/analytical epidemiology
- To elaborate techniques used to conduct disease outbreak investigations and develop disease prevention programs
- To describe causal models, distribution/patterns and control of disease or other health-related events in populations.

Learning Outcomes

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

- Learn basic principles of epidemiology, including descriptive/analytical epidemiology
- Demonstrate techniques used to conduct disease outbreak investigations and develop disease prevention programs
- Compute causal models, distribution/patterns and control of disease or other health-related events in populations.

Course Outline

- Unit 1. Introduction of Epidemiology**
Significance, Basis terminology, general concepts.
- Unit 2. Selection of Epidemiological Parameters**
Surveillance study, Host parasite associations
- Unit 3. Population Biology and Genetics**
Genetic variability and parasite transmission, Age- intensity and age prevalence profile of parasite infections.
- Unit 4. Ecological and Evolutionary Dynamics of Parasites**
Parasite prevalence and seasons, Epidemiological approaches for the control of parasites, Application of molecular techniques in Epidemiology of parasitic infections.

Recommended Books / Reference Material

1. Martin, S. W., Meek, A. H., & Willeberg, P. (1993). *Veterinary Epidemiology: Principles and Methods*. Iowa State University Press.
2. Thrusfield, M. (1997). *Veterinary Epidemiology* (2nd ed.). Blackwell Science.
3. Toft, C. A., Aeschlimann, A., & Bolis, L. (Eds.). (1991). *Parasite-Host Associations: Coexistence or Conflict?* Oxford University Press.
4. Urquhart, G. M., Armour, J., Duncan, J. L., Dunn, A. M., & Jennings, F. W. (2000). *Veterinary Parasitology* (3rd ed.). Longman Scientific & Technical.

Vector Biology

BS-Zoology

Course Code: ZOO-428

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To provide in-depth appreciation of diseases transmitted by invertebrate vectors
- To impart knowledge about control of vector-borne disease

Learning Outcomes

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

- Discover the basic knowledge of vector biology
- Illustrate the concepts of disease transmission by invertebrate vectors.
- Analyze knowledge for control of vector-borne disease

Course Outline

Unit 1. Vector Biology and Control

a. Key aspects of vector taxonomy b. Evolution c. Biology and Behavior.

Unit 2. An Introduction to the Life-Cycles of Vectors

a. Ecology b. Role in transmission of various diseases

Unit 3. Major Groups of Arthropod-Borne Pathogens and Vectors

a. Basic components of arthropod-borne disease cycles b. Principles of pathogen transmission dynamics

Unit 4. Emergent Pathogens

a. Vector genetics b. Vaccines for vector-borne disease c. Traditional and modern disease control strategies d. Venomous Arthropods.

Unit 5. Biology and Ecology of Some Vectors of Medical Importance (Order Diptera)

Mosquitoes (*Anopheles culicine*), Black flies and flies, biting midges, horse flies, deer flies and clegs, tsetse flies, house flies, myiasis producing flies (blow flies, blue bottles, green bottles, flesh flies, warble flies and bot flies), Morphology, anatomy, distribution, breeding habits, life-cycle and seasonal prevalence of the species, Brief account of diseases spread by these vectors, Methods of control, Modern trends in their biological and chemical control.

Recommended Books / Reference Material

1. Atkinson, P. W. (Ed.). (2010). *Vector Biology, Ecology and Control*. Springer.
2. Handler, A. M., & James, A. A. (Eds.). (2000). *Insect Transgenesis: Methods and Applications*. CRC Press.
3. Hoy, M. A. (2000). *Insect Transgenesis: Methods and Applications*. CRC Press.
4. Pedigo, L. P. (2001). *Entomology And Pest Management* (4th ed.). Pearson Education.
5. Roy, D. N., & Brown, A. W. A. (2004). *Entomology* (1st ed.). Biotech Books.

Reproductive Biology

BS-Zoology

Course Code: ZOO-431

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To introduce the field of Reproductive Biology, its history and significance
- To impart knowledge about anatomy and physiology of reproduction

Learning Outcomes

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

- understand the fundamental anatomy of male and female reproductive systems in various mammalian species
- acquire knowledge about histology and physiology of the male and female reproductive systems

Course Outline

Unit 1. Introduction

History, Scientists Contributions

Unit 2. Anatomy of Female and Male Reproductive System

Testis, Ovaries, Placenta, and associated structures

Unit 3. Reproductive Endocrinology

Hypothalamic Pituitary Gonadal Axis (HPG Axis), Fertilization and early embryonic development; Implantation and placentation; Parturition & Post-Partum recovery, Role of stimulatory and inhibitory neurotransmitters regulating HPG axis, Reproductive cycles

Unit 4. Folliculogenesis

Spermatogenesis, Oogenesis, Factors affecting folliculogenesis

Unit 5. Fertilization and Early Embryonic Development

Implantation and placentation; Parturition & Post-Partum recovery, Lactation

Unit 6. Aging and Associated Paradigms Affecting Reproduction

Obesity & Reproduction, Reproductive Aging, Addictions & Reproduction, Endocrinology of Stress in Reproduction

Recommended Books / Reference Material

1. Nieschlag, E., Behre, H. M., & Nieschlag, S. (2010). *Andrology: Male Reproductive Health and Dysfunction* (3rd ed.). Springer.
2. Plant, T. M., & Zeleznik, A. J. (Eds.). (2014). *Knobil and Neill's Physiology of Reproduction* (4th ed.). Academic Press.
3. Senger, P. L. (2012). *Pathways To Pregnancy and Parturition* (3rd ed.). Current Conceptions, Inc.

Behavioral Ecology

BS-Zoology

Course Code: ZOO-432

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is

- To enable the student to understand not only behavior of animal but combination of behavior and ecology that contribute to reproductive success
- To understand how animals struggle and survive.
- To understand difference between survival values on function and those concerned with the casual mechanisms.

Learning Outcomes

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

- Acquire theoretical knowledge of animal behavior, natural selection and evolution.
- Understand the struggle for survival, their ecological relationships
- Solve the survival and breeding related problems which are result of anthropogenic activities.
- Interpretation and synthesis of data and other information about animal behavior, competition and ecological relationships.

Course Outline

Unit 1. **Animal Behavior and Ecology**

Introduction, Gene and Behavior, Natural Selection and Behavior, Ecology and Evolution.

Unit 2. **Hypothesis and Testing**

Comparative Approach, Adaptations, Social Organization and Experimental Studies, Economic Decisions Made by Individuals, Marginal Value Theorem and Reproductive Decisions, Economics of Prey Choice, Tradeoff and Optimality Models

Unit 3. **Competition for Resources in Individuals**

Competition by Exploitation, Competition by Resource Defense; Merits and Demerits of living in Groups.

Unit 4. **Fighting Among Individuals**

Role of Resource Values and Fighting Ability, Fighting for Dominance

Unit 5. **Altruism, Kin Selection**

Repository and Manipulation in Animals, Division of Labor and Specialized Helpers.

Recommended Books / Reference Material

1. Dugatkin, L. A. (2001). *Model Systems in Behavioral Ecology: Integrating Conceptual, Theoretical, And Empirical Approaches*. Princeton University Press.
2. Krebs, J. R., & Davies, N. B. (2009). *An Introduction to Behavioural Ecology* (3rd ed.). Wiley-Blackwell.

Population Biology

BS-Zoology

Course Code: ZOO-433

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To familiarize the students with the basic concepts of population diversity & ecology
- To educate the students with the methods of population samplings
- To educate the students with the population dynamics in an ecosystem and their biotic & abiotic factors

Learning Outcomes

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

- Acquire the basic knowledge of biological population and their evolutionary processes
- Understand the concepts of basic methods of population samplings
- Evaluate the population dynamics of biotic and abiotic factors of ecosystem

Course Outline

Unit 1. Population

Population, basic population characters, population dynamics, exponential, logistic, Forms of population growth, density dependent and independent growth, Animal behavior, ecology and evolution, Structural population, population genetics, adaptation and speciation.

Unit 2. Population Ecology

Basic concepts, Population ecology of plants, population simulation, Community ecology, community analysis, succession, ecotones, predator-prey systems, competition, mutualism, commensalism and carrying capacity

Unit 3. Life History

Demographic and life history parameters, evolution of life history parameters: R and K selection, Allometry, aging and sexing, life tables, age and stage structures models

Unit 4. Population Sampling

Preparation of sampling designs for population estimation, Analysis of census data, Studies of various population parameters and use of census techniques.

Unit 5. Population Estimation Methods

Relative and absolute measures, age and sex composition, Methods of estimation of life history parameters

Recommended Books / Reference Material

1. Dodson, S. I., Allen, T. F. H., Carpenter, S. R., Ives, A. R., Jeanne, R. L., Kitchell, J. F., Langston, N. E., & Turner, M. G. (1998). *Ecology*. Oxford University Press.
2. Molles, M. C. (2002). *Ecology: Concepts and Applications*. McGraw-Hill.
3. Townsend, C. R., Begon, M., & Harper, J. L. (2008). *Essentials of Ecology* (3rd ed.). Blackwell Publishing.

Lab and Biosafety

BS-Zoology

Course Code: ZOO-434

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To impart knowledge to the students about biohazards, laboratory associated risks, risk assessment, safety issues, biosafety levels and role of biosafety committees
- To create awareness about the safety involved in handling chemical, radioactive and biohazardous materials in the lab
- To provide guidelines on how students can protect themselves and their workplace from physical, chemical, electrical and bio-hazards
- To demonstrate the proper use of PPE, safety equipment, best lab practices, biological containment, biosafety requirements, storage, transportation and disposal of biohazardous waste

Learning Outcomes

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

- attain the practical knowledge of the safety equipment in the lab and use them efficiently.
- comprehend the concepts of risk groups, risk assessment and biosafety levels.
- apprehend the principles of good lab practices and to ensure that adequate biosafety requirements are in place.
- elucidate the role and responsibilities of biosafety committees in research labs.
- consider the key safety issues and health problems related with lab acquired infections.
- assess the hazards and potential risks associated with the chemicals and laboratory operations.

Course Outline

Unit 1. Introduction and History

a. Introduction to biosafety, biological and biohazardous materials b. History of biosafety, biological warfare, bioterrorism c. Biosafety containment levels and controls d. Classification of Risk groups e. Risk assessment for chemical hazards and biohazards

- Unit 2. Laboratory Associated Risks**
a. Lab Acquired Infections (LAIs) b. Blood borne Pathogens c. Descriptive epidemiology of occupational infections of laboratory workers d. Route of transmission and modes of exposure e. Emergencies: accidents, incidents, chemical/microbial spills and exposures f. Chemical fire and electricity safety
- Unit 3. Lab Safety and Compliance Requirements**
a. Personal Protective Equipment (PPE) b. Lab Facilities and Safety Equipment c. Disinfection, Decontamination and Sterilization d. Contingency plans and emergency procedures e. Practices for handling and disposal of infectious materials f. Packaging, labeling, storage, transportation and disposal of lab waste/infectious agents
- Unit 4. Lab Biosafety Guidelines**
a. Safety management b. General biosafety principles and requirements c. Laboratory permits and registration of biological, chemical and radioactive materials d. Biosafety Policies and Codes e. National Biosafety Guidelines
- Unit 5. Role and Responsibilities of Biosafety Committees**
a. Occupational Safety and Health Administration (OSHA) b. Cartagena Protocol on Biosafety (CPB) c. National Biosafety Committee (NBC) d. Technical Biosafety Committee (TBC) e. Institutional Biosafety Committee (IBC)

Recommended Books / Reference Material

1. Chosewood, L. C., & Wilson, D. E. (Eds.). (2009). *Biosafety in Microbiological and Biomedical Laboratories* (5th ed.). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institutes of Health. HHS Publication No. (CDC) 21-1112.
2. Fleming, D. O., & Hunt, D. L. (2006). *Biological Safety: Principles And Practices* (4th ed.). ASM Press.
3. Oles, A. (2005). *Biosafety Manual*. Department of Health, Safety and Environment, University of Saskatchewan.
4. Pakistan Environmental Protection Agency. (2005). *National Biosafety Guidelines*. Government of Pakistan.
5. Smida, A. (2006). *Lab Safety Manual*. Department of Health, Safety and Environment, University of Saskatchewan.
6. World Health Organization. (2004). *Laboratory Biosafety Manual* (3rd ed.). World Health Organization.

Mammalogy

BS-Zoology

Course Code: ZOO-435

Credit Hours: 03

Pre-requisite: Nil

Objectives

The following will be the objectives of this course to:

- Assess ecological and evolutionary processes which led to the diversification and diversity of mammals.
- Identify factors for mammalian adaptations for survival in a variety of conditions.
- Study mammalian classification up to orders and determine the distribution and abundance of the mammalian species with structure communities for various ecosystems.

Learning Outcomes

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

- acquire the basic knowledge of mammals in diversified ecosystems.
- understand the behavior of the mammals and their relationships to the natural habitats.
- solve the problems in the mammalian study using scientific approaches and methods.
- analyze the impacts of mammals on the ecosystem and likely impacts on economy.
- understanding the role played by mammalogists in the conservation and management of mammals.

Course Outline

- Unit 1. Introduction and History of Mammalogy**
basic characteristics of mammals; diversified habitats for mammals in Pakistan and various continents.
- Unit 2. Mammalian Phylogeny and Concept of Biogeography**
dentition and dental formulae, cranial characteristics, evolution of mammals. Concepts of viviparity and ovo viviparity. mammalian radiations, biogeography of mammals of Pakistan, occurrence, habits and varied habitats, importance to ecosystems and negative values.
- Unit 3. Food and Feeding Strategies**
Preferred food sources of mammals, foraging habits, diurnal and e. nocturnal feeding regimes of mammals; ecological constraints and mammalian adaptations. Concepts of stenophagy and euryphagy.
- Unit 4. Population Dynamics of Mammals.**
Rates of natality, mortality, immigration and emigration, Population modeling concepts in mammals, Mammalian crowding and scuffles with respect to various environments.
- Unit 5. Mammalian Adaptations.**
Concept of torpor formation, aestivation, hibernation, acoustic laterlis systems in mammals. Concept of molecular basis of mammalian adaptations. k. Behavior of mammals; home range, territoriality, predation pressure, evolutionary arms races and competition for resources.
- Unit 6. Communication and Social Organization.**

Chemical signaling in mammals, types and causes of occurrence, communication skills and emergence of mammalian call notes.

Recommended Books and Reference Material

1. Feldhamer, G. A., Drickamer, L. C., Vessey, S. H., Merritt, J. F., & Krajewski, C. (2007). *Mammalogy: Adaptation, Diversity, Ecology* (3rd ed.). Johns Hopkins University Press.
2. Genoways, H. H. (Ed.). (1987). *Current Mammalogy* (Vol. 1). Plenum Press.
3. Vaughan, T. A., Ryan, J. M., & Czaplewski, N. J. (2010). *Mammalogy* (5th ed.). Jones & Bartlett Publishers.

Ornithology

BS-Zoology

Course Code: ZOO-436

Credit Hours: 03

Pre-requisite: Nil

Objectives

Objectives of the proposed course are aimed to:

- Impart knowledge to identify birds and understand their behavior and relationships in their natural habitat.
- Provide vision to understand the factors that cause bird populations to change, and to assess certain bird habitats in relation to climate changes.
- Address both the theoretical and practical knowledge regarding widespread bird diversity in the diversified environments.

Learning Outcomes

On the successful completion of this course, students will be able to:

- acquire the basic knowledge of the birds in the diversified habitats.
- understand their behavior and possible their relationships to the natural habitats.
- solve the issues to detect minute morphological variations by using different high power spotting scopes in the field study for various habitats.
- analyze the likely impacts of changing climatic conditions on variety of birds in different ecosystems to sift in roosting, nesting and behavioral mechanisms.

Course Outline

Unit 1. Introduction to ornithology

basic ecology and themes of study.

Classification and taxonomy of birds up to orders and species

Unit 2. Evolution of birds

evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.

Unit 3. Biology of fossil birds

study of the representative birds viz. Archaeopteryx, Archaeornithes and Neornithes. Comparison with the present existing birds.

Unit 4. Behavior of birds

Courtship behavior in birds, bird foraging, nesting and roosting activities. Learned and imprinting mechanisms in birds; brood parasitism and importance; Predator-Prey relationships, mobbing impacts: foraging and territoriality scuffles; predator avoidance

Unit 5. Physiology of birds

types of food; mastication, digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds; Bird conservation strategies: sanctuaries and importance of urban zoos in bird life.

Recommended Books and Reference Material

1. Cornell Lab of Ornithology. (2014). *Handbook of Bird Biology* (3rd ed.). Princeton University Press.
2. Grimmett, R., Inskipp, C., & Inskipp, T. (2008). *Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives*. Princeton University Press.
3. Howell, S. N. G. (2010). *Peterson Reference Guide to Molt in North American Birds*. Houghton Mifflin Harcourt.
4. Kaiser, G. W. (2008). *The Inner Bird: Anatomy and Evolution*. University of Chicago Press.
5. Urfi, A. J. (2009). *Birds of India: A Literary Companion*. Oxford University Press.

Biotechnology in Aquaculture

BS-Zoology

Course Code: ZOO-437

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To aware students about the past and present status of biotechnology as well as the need for and importance of biotechnology in the current era
- To provide in-depth knowledge on Gynogenesis, Androgenesis, Cloned Populations and Molecular Markers
- To provide an overview of the application of biotechnological tools in Genetic Engineering, Selection, Crossbreeding, Strains, Hybrids, feed and other issues.

Learning Outcomes

After studying this course, the students would be able to:

- identify and develop insight into the application of biotechnological advances in aquaculture.
- conceptualize the principal bases of biotechnology and emerging issues in aquaculture.
- elucidate different aspects of genetic biotechnology with reference to food safety.
- demonstrate various techniques of molecular nature applied for aquaculture development.

Course Outline

Unit 1. Introduction

History of Biotechnology in Aquaculture, Biotechnological approaches in Aquaculture; Gynogenesis.

Unit 2. Androgenesis and Cloned Populations

Induction of Gynogenesis and Androgenesis, Performance of Gynogens and Androgens, Reproduction, Monosex Populations, Cloned Populations

Unit 3. Biochemical and Molecular Markers

Isozymes and Enzymes, Restriction Fragment Length Polymorphism, Single Nucleotide Polymorphisms, Relative Costs of Different Markers, Relative Effectiveness of Markers;

Unit 4. Combining Genetic Enhancement Programs

Sex Reversal and Triploidy, Genetic Engineering and Crossbreeding, Genetic Engineering, Selection, Crossbreeding, Strains and Hybrids.

Unit 5. Food Safety of Transgenic Aquatic Organisms

International Guidelines, Labelling; Environmental Risk of Aquatic Organisms from Genetic Biotechnology: Theoretical Risks, Environmental Risk Data on Transgenic Fish, Common Goals of Aquaculture and Genetic Conservation.

Recommended Books and Reference Material

1. Beaumont, A. R., Boudry, P., & Hoare, K. (2010). *Biotechnology and Genetics in Fisheries and Aquaculture* (2nd ed.). Wiley-Blackwell.
2. Stickney, R. R. (2009). *Aquaculture: An introductory text*. CABI Publishing.

Microbial Biotechnology

BS-Zoology

Course Code: ZOO-438

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To enable the students to understand what biotechnology is;

- To comprehend the basic role of microorganisms for life
- To highlight the dynamic role of microbes in the entire ecosystem

Learning Outcomes

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

- attain the primary knowledge about microorganisms regarding biotechnology
- recognize the vital role of microbes in relation to diversity
- explore the vibrant talent of microbes for metabolite production
- endorse the realistic connection of microbes with technology
- apply the systematic information in a precise manner

Course Outline

- Unit 1. Microbial Biotechnology and Microbial Diversity**
a. History and scope b. Techniques and examples (e.g. biofertilizers, Bio-pesticides, Bio herbicides, bacterial and fungal Bioinsecticides, Virus-based bioinsecticides), c. Microbial classification (Morphological classification, Nutritional classification, Biochemical classification, Serological/ antigenic classification, Staining reaction) d. Morphological diversity e. Metabolic diversity f. Structural diversity g. Genetic diversity h. Ecosystem and Biomes
- Unit 2. Biomass and Production of Proteins in Bacteria and Yeast**
a. Major components of plant biomass (Cellulose, Hemicelluloses, Lignin) b. Architecture and composition of the wood cell wall c. Biomass degradation, d. Production of proteins in bacteria e. Production of proteins in yeast
- Unit 3. Plant–Microbe Interactions and Recombinant and Synthetic Vaccines**
a. Use of symbionts b. Use of nitrogen-fixing bacteria to improve crop yields c. Production of transgenic plants d. Insect-resistant plants, e. Problems with traditional vaccines f. Impact of biotechnology on vaccine development g. Mechanisms for producing immunity h. DNA vaccines
- Unit 4. Primary and Secondary Metabolites**
a. Citric Acid b. Microbial production of Amino Acids (Lysine, Glutamic acid) c. Enzymatic production of amino acids, d. Antibiotics e. Other biologically active microbial metabolites
- Unit 5. Environmental Applications**
a. Degradative capabilities of microorganisms b. Origins of organic compounds c. Microbiological degradation of xenobiotics d. Microorganisms in mineral recovery e. Microorganisms in the removal of heavy metals from aqueous effluent

Recommended Books and Reference Material

1. Braun, V., & Götz, F. (2002). *Microbial Fundamentals of Biotechnology*. Wiley-VCH.
2. Lee, Y. K. (Ed.). (2006). *Microbial Biotechnology: Principles and Applications* (2nd ed.). World Scientific Publishing.

3. Mosier, N. S., & Ladisch, M. R. (2009). *Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals*. Wiley.
4. Tortora, G. J., Funke, B. R., & Case, C. L. (2016). *Microbiology: An Introduction* (12th ed.). Pearson.
5. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2016). *Prescott's Microbiology* (10th ed.). McGraw-Hill Education.

Conservation Biology

BS-Zoology

Course Code: ZOO-440

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objective of this course is

- To enable the student to understand and investigate the diversity of living world,
- To understand the effect of human activities on species, communities and ecosystems; and
- To develop a practical interdisciplinary approach to protect and restore biological diversity.

Learning Outcomes

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

- acquire theoretical knowledge about the phenomena that affect the maintenance, loss, and restoration of biological diversity.
- understand the ecological and evolutionary principles of biological diversity which influence the conservation of wildlife at spatial and temporal scales in pakistan as well as abroad.
- solve the conservation issue by applying the scientific principles and modern technologies.
- analyse, interpreting and synthesize data and other information about the determinants of the conservation problems.
- evaluate the conservation actions taken by the biologists for solving the conservation problems across biological scales (genes to landscapes) and geographical scales (local to global).
- demonstrate sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

Course Outline

- | | |
|----------------|--|
| Unit 1. | <u>Introduction to Conservation Biology and Biodiversity</u>
a. Definition, b. History, c. Scope, d. Species Diversity; Genetic Diversity; Ecosystem Diversity; e. Measurement of Biological Diversity; f. An Overview of World's Biodiversity; g. The Value of Biodiversity |
| Unit 2. | <u>Threats to Biodiversity</u> |

a. Human Population Growth; b. Habitat Destruction; Habitat Fragmentation; c. Environmental Degradation and Pollution; d. Global Climate Change; e. Overexploitation; f. Invasive Species

Unit 3. Extinctions

a. Extinction and Mass Extinctions; b. Rates of Extinction; Island Biogeography; c. Vulnerability to Extinction; d. Problems of Small Populations; Minimum Viable Population (MVP); e. Loss of Genetic Diversity; Effective Population Size; f. Demographic and Environmental Stochasticity

Unit 4. Conserving Populations and Species

a. Applied Population Biology; Monitoring populations; Population viability analysis; Metapopulations, b. International agreements for conservation of fauna and flora; Role of national and International Laws in Protection of Species; c. Ex Situ Conservation Strategies; Zoos; Aquariums; Botanical gardens; Seed banks. d. Protected Areas and their Establishment and categories; e. Managing Protected Areas; Challenges to Protected Areas Management. f. Unprotected Public and Private Lands g. Ecosystem Management, h. Integration of Local Community in Conservation i. Restoring Damaged Ecosystems

Unit 5. Sustainable Development

a. Challenges Involve in Conservation and Sustainable Development at the Local Level b. International Approaches to Sustainable Development c. Funding for Conservation by the World Bank and international NGOs; d. Conservation Education and the Role of Conservation Biologists

Recommended Books and Reference Material

1. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of Conservation Biology* (3rd ed.). Sinauer Associates.
2. Mills, L. S. (2007). *Conservation Of Wildlife Populations: Demography, Genetics, and Management*. Blackwell Publishing.
3. Primack, R. B. (2002). *Essentials of Conservation Biology* (3rd ed.). Sinauer Associates.
4. Primack, R. B. (2012). *A Primer of Conservation Biology* (5th ed.). Sinauer Associates.

Insects of Medical and Veterinary Importance

BS-Zoology

Course Code: ZOO-442

Credit Hours: 03

Pre-requisite: Nil

Objectives

The objectives of the course are:

- To provide knowledge about insect vectors, disease borne pests of veterinary and human importance

- To impart knowledge about their control
- To understand their life cycles as they carry viruses and other organisms during transmission of diseases

Learning Outcomes

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

- acquire the firm knowledge of important insect vectors and disease borne pests of veterinary and human importance.
- understand their life cycles during transmission of diseases for control.
- analyze their control

Course Outline

Unit 1. Introduction

a. General introduction to medical and veterinary entomology.

Unit 2. Phylum Arthropoda

a. Salient features of insects b. Classification c. General morphology and physiology of insects d. Modifications in mouthparts and appendages of insects e. Metamorphosis and its types

Unit 3. Insects of Medical and Veterinary Importance

a. Mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks b. Life cycles c. Diseases and their control

Unit 4. Insect Venoms

a. Bees, wasps, ants. b. Insect toxins c. Arthropod allergens

Unit 5. Insect Pest Management

a. Definition b. Principles and methods of insects control c. Components of pest management d. Techniques e. General measures to control insects f. Economics of pest management

Recommended Books and Reference Material

1. Pedigo, L. P. (2003). *Entomology and Pest Management* (4th ed.). Pearson Education Singapore Pvt. Ltd.
2. Roy, D. N., & Brown, A. W. A. (2004). *Entomology* (1st ed.). Biotech Books.

Principles and Kinetics of Toxicology

BS-Zoology

Course Code: ZOO-443

Credit Hours: 03

Pre-requisite: Nil

Objectives

The course objectives are:

- To provide knowledge about the nature and mode of action of different categories of toxicants
- To provide knowledge about the procedural protocols used in toxicological studies

Learning Outcomes

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

- examine the differential effects of variety of toxicants on different cellular sites
- discover the nature and mode of action of different categories of toxicants

Course Outline

Unit 1. Introduction to Toxicants and Types

a. Introduction b. chemistry of toxicants; c. Toxicity, d. hazards and risks.

Unit 2. Measuring Toxicity and Assessing Risk

toxicity testing methods; routes of exposure; determining the c. responses to varying doses of substances d. time of exposure; the LD50 experiments

Unit 3. Toxicokinetics

a. Introduction; pharmacokinetics and toxicokinetics b. absorption: the oral, respiratory and dermal route of exposure, distribution, c. elimination, toxicokinetic models: mathematical models of elimination; d. Absorption and bioavailability; contrasting kinetics of lipophilic substances.

Unit 4. Biotransformation

a. Introduction b. Primary biotransformation (phase I reaction) Hydrolysis, oxidation, reduction, c. Secondary metabolism (phase II reaction) Glucuridination, Glutathione conjugation, acetylation and other d. Phase II reactions, factors influencing metabolism.

Unit 5. Cellular Sites of Action

a. Introduction, interaction of toxicants with proteins b. Effect of toxicants on enzymes c. Receptors and ion channels, voltage activated ion channels and transport proteins d. Effects of toxicants on lipids and nucleic acids, e. Mechanism of cell death; apoptosis, necrosis, stress, repair and recovery.

Recommended Books and Reference Material

1. Barile, F. A. (2007). *Principles of Toxicology Testing* (1st ed.). CRC Press.
2. Marquardt, H., Schäfer, S. G., McClellan, R. O., & Welsch, F. (1999). *Toxicology*. Academic Press.
3. Stine, K. E., & Brown, T. M. (2015). *Principles of Toxicology* (3rd ed.). CRC Press.

Animal Physiology

BS-Zoology

Course Code: ZOO-404

Credit Hours: 03

Pre-requisite: Nil

Objectives

Students will understand the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals. They will know the functions developed at molecular and cellular level in the complexity of the animal's physiology. They will also know the strategy acquired to perform the functions in diverse environment such as in dry and aquatic and cold and hot at molecular and cellular level and regulations to achieve strategy by chemical and nervous regulation at organ levels.

Learning Outcomes

- Students will be able to perform experiments designed either primarily for the study of physiological phenomena or for assessment of function.
- Students will also be able to analyze and interpret experimental/investigative data critically in performance of functions in changed conditions.
- They can distinguish between normal and failure of the function in abnormal conditions even through results of experiments/data collections also by the students in laboratory and fields.

Course Outline

Unit 1. Concept of Physiology and Membrane Physiology

Principles of Homeostasis and conformity. Principles of regulation and adaptation
Ionic distribution across membrane. Resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Ion channels.

Unit 2. Nerve and Muscle Physiology

Action potentials in neurons. Electrical and chemical synaptic transmission. Neurotransmitters in communications. Receptors of neurotransmitters in diverse physiological responses. Excitatory and inhibitory postsynaptic potentials. Neuronal networks and their role in nervous integration. Muscles: Structure, types, components, muscle proteins. Molecular basis of muscle contraction. Sarcoplasmic reticulum and role of calcium. Neuromuscular interaction at cell and molecular level muscle. Types of muscle contractions and muscle fatigue.

Unit 3. Endocrine Physiology

Hormones of invertebrates and specifically of arthropods for the functions in their modes of life. 2. Hormones of various vertebrates' endocrine organs and comparison of their roles in adaptability of mode of life. 3. Mechanisms of hormone actions, hormone receptors, signal transduction and hormonal coordination.

Unit 4. Cardiovascular Physiology

Electrical activity of heart; self-excitability and auto-rhythmicity of myogenic heart. Neurogenic heart and their expression. Electrocardiography and Kymography. Hemodynamics, Relationship between blood flow, pressure and resistance. Their role in performance of the function in variety of vertebrates.
Control of cardiac activity, cardiac output and peripheral circulation.

Unit 5. Respiratory Physiology

Mechanism of respiratory gases exchange in aquatic and terrestrial respiratory structures. Control of respiration and stimulus factors in various animals. Respiration adaptations in hypoxia and percapnia etc. Air breathing and respiratory adaptations diver animals.

Unit 6. Excretory Physiology and Physiology of Nutrition

Strategy of mammalian large glomerular filtration and reabsorption in nitrogenous excretion. Patterns of nitrogenous excretion in various animals and their phylogenetic significance. Adaptation of nutritive canal for digestion and absorption of nutrients in different animals specifically the vertebrates. Regulation of digestive secretions. Mechanisms of water, ions and nutrients absorptions and their significances in diverse groups. Potential and Movements in gastrointestinal tract and control of motility.

Recommended Books and Reference Material

1. Hill, R. W., & Wyse, G. A. (2016). *Animal Physiology* (4th ed.). Oxford University Press.
2. Moyes, C. D., & Schulte, P. M. (2021). *Principles of Animal Physiology* (3rd ed.). Pearson Canada.
3. Randall, D., Burggren, W., & French, K. (2001). *Animal Physiology* (5th ed.). W. H. Freeman.
4. Sherwood, L., & Klandorf, H. (2012). *Animal Physiology: From Genes to Organisms* (2nd ed.). Brooks Cole.
5. Willis, L. M. (2023). *Anatomy and Physiology* (6th ed.). Lippincott Williams & Wilkins (LWW).

Biological Techniques

BS-Zoology

Course Code: ZOO-445

Credit Hours: 03

Pre-requisite: Nil

Objectives

- To course aims to demonstrate the knowledge of skills.
- To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences.

Learning Outcome

- Students must be able to identify the instrument
- Able to use instruments for identification, measurement, fixing and cutting of tissue

Course Outline

- Unit 1. Microscopy and Specimen Preparation for Optical Microscopy**
Electron microscope, Micrometry, Introduction to Microtomy and its types, Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section). Hematoxylin and Eosin staining; Separation and purification techniques.
- Unit 2. Filtration and its types**
Chromatography: Chromatography: Principle, applications, types, Paper chromatography and thin layer chromatography, Column chromatography, high pressure liquid chromatography.
- Unit 3. Concentrations and Electrophoresis**
Percent volume; ppt; ppm - molarity, normality, molality. Principle of electrophoresis, applications and types (Agarose and PAGE)
- Unit 4. Spectrophotometry**
Principle, applications, types, Visible/UV spectrophotometry
- Unit 5. Basic Principles of Sampling and Preservation and Preservations Techniques.**
Sampling from soil, water, air, plants and animals, Preservation of dry and wet specimens. Lyophilization, preservation in ethanol, formalin etc.
- Unit 6. DNA Sequencing**
Polymerase chain reaction (PCR), principle and application, DNA sequencing (Sanger and Maxam Gilbert).

Recommended Books and Reference Material

1. Bhat, T. A., & Al-Khayri, J. M. (2023). *Genetic Engineering: Volume 1: Principles, Mechanism, And Expression*. Apple Academic Press.
2. Dean, J. R. (1998). *Extraction Methods for Environmental Analysis*. John Wiley & Sons.
3. Gallagher, S. R., & Wiley, E. A. (2008). *Current Protocols Essential Laboratory Techniques*. John Wiley & Sons.
4. Masoodi, K. Z., Lone, S. M., & Rasool, R. S. (2020). *Advanced Methods in Molecular Biology and Biotechnology: A Practical Lab Manual*. Academic Press.

Enzymology

BS-Zoology

Course Code: ZOO-446

Credit Hours: 03

Pre-requisite: Nil

Objectives

By the end of this course, students will be able to:

- Understand the fundamental principles of enzymology, including enzyme classification, structure, and function.

- Explore enzyme kinetics for single- and multi-substrate reactions, including allosteric behavior.
- Analyze the mechanisms of enzyme catalysis and the role of coenzymes in biochemical reactions.
- Examine different types of enzyme inhibition and their implications.
- Investigate the structural and functional diversity of isoenzymes and enzyme subunits.

Learning Outcomes

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

- Describe enzyme classification, nomenclature, and differentiation between monomeric and oligomeric enzymes.
- Interpret enzyme kinetic data, including Michaelis-Menten and sigmoidal kinetics, for single and multi-substrate systems.
- Explain enzyme catalytic mechanisms and identify factors influencing enzyme activity.
- Distinguish between different types of enzyme inhibition and predict their effects on enzyme kinetics.
- Categorize coenzymes and describe their roles in facilitating enzyme-catalyzed reactions.
- Analyze the structure and function of isoenzymes and their physiological significance.

Course Outline

- | | |
|----------------|---|
| Unit 1. | <u>Introduction and History of Enzymes</u>
Historical aspects, Discovery and chemistry of enzymes, Function and importance, Enzymes in Biotechnology |
| Unit 2. | <u>Classification and Structure of Enzyme</u>
Nomenclature and classification of enzymes, The monomeric and oligomeric enzyme, Active site and regulatory sites, mechanism in enzyme catalysis |
| Unit 3. | <u>Characteristics and Mechanism of Enzyme Activity</u>
Catalytic power and specificity, Enzyme-substrate interactions, Lock and key model, Induce fit model, Enzyme inhibition, Michaelis-Menten equation and other models used to understand kinetics |
| Unit 4. | <u>Enzyme application</u>
Application in medicine and industry in biotechnological application |
| Unit 5. | <u>Isoenzymes</u>
Structure of isoenzymes, Formation of isoenzymes, Identification of isoenzymes, Functional significance of isoenzymes, Coenzymes classification |
| Unit 6. | <u>Enzyme Inhibition</u>
Enzyme Inhibition and types of inhibition, Effect of various factors on rate of reactions, Enzyme assays |

Recommended Books / Reference Material

1. Nelson, D. L., Cox, M. M., & Hoskins, A. A. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W. H. Freeman.

2. Price, N. C., & Stevens, L. (1999). *Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins* (3rd ed.). Oxford University Press.
3. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J., & Weil, P. A. (2022). *Harper's Illustrated Biochemistry* (32nd ed.). McGraw-Hill Education.
4. Stryer, L. (1995). *Biochemistry* (4th ed.). W. H. Freeman.
5. Voet, D. J., Voet, G. J., & Pratt, C. W. (2008). *Fundamentals of Biochemistry* (3rd ed.). J. Wiley & Sons Inc.
6. Voet, D., Voet, J. G., & Pratt, C. W. (2021). *Fundamentals of Biochemistry: Life at the Molecular Level* (6th ed.). Wiley.

Vitamins and Hormones

BS-Zoology

Course Code: ZOO-447

Credit Hours: 03

Pre-requisite: Nil

Objectives

By the end of this course, students will:

- Understand the classification, chemical structure, and biological functions of vitamins and hormones.
- Explore the metabolic pathways, physiological roles, and health implications of vitamin deficiency and toxicity.
- Examine hormone biosynthesis, structure-activity relationships, and mechanisms of hormonal action.
- Understand the immunological aspects of hormone regulation, including peptide, steroid, and plant hormones.
- Gain practical knowledge of hormonal analysis techniques and the methods for isolation, purification, and characterization of biomolecules.

Learning Outcomes

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

- Classify vitamins and hormones and describe their chemical properties and structural features.
- Explain the metabolism, physiological functions, and clinical outcomes of vitamin imbalances.
- Illustrate the biosynthesis and regulatory mechanisms of various hormones.
- Discuss immunological interactions of hormones and their relevance in endocrine function.
- Perform and interpret hormonal assays and apply basic techniques for isolating and characterizing biomolecules.

Course Outline

Unit 1. Vitamins

Vitamins classification, Water-soluble vs. fat-soluble vitamins, Coenzymes and prosthetic groups, Chemical structure and properties

Unit 2. Water- and Fat-Soluble Vitamins

Sources, Structure, Function, Effect of deficiency and excess

Unit 3. Hormones

Chemical nature of hormones: steroids, peptides, amines, Biosynthesis, Regulation

Unit 4. Mechanism of Hormone Action

Receptor binding, Second messengers (cAMP, IP3), Signal transduction pathways

Unit 5. Hormonal Regulation of Physiology

Metabolism, growth and development, Reproduction and puberty, Stress and homeostasis, Hormones in behavior and emotions

Unit 6. Hormonal Analysis

Bioassays, Immunoassay.

Recommended Books and Reference Material

1. Golan, D. E., Tashjian, A. H., Armstrong, E. J., & Armstrong, A. W. (2017). *Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy* (4th ed.). Wolters Kluwer.
2. Goodman, H. M. (2021). *Basic Medical Endocrinology* (4th ed.). Academic Press.
3. Gropper, S. S., Smith, J. L., & Carr, T. P. (2018). *Advanced Nutrition and Human Metabolism* (7th ed.). Cengage Learning.
4. Hall, J. E. (2020). *Guyton And Hall Textbook of Medical Physiology* (14th ed.). Elsevier.
5. Nelson, D. L., Cox, M. M., Lehninger, A. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W.H. Freeman.
6. Ross, A. C., Caballero, B., Cousins, R. J., Tucker, K. L., & Ziegler, T. R. (2020). *Modern Nutrition in Health and Disease* (12th ed.). Wolters Kluwer.

19. List of Allied Courses to be offered to other Departments

S. No.	Course Code	Course Title	Credit Hours
1.	ZOO-101	Biodiversity and Conservation	3
2.	ZOO-102	Fundamentals of Genetics and Evolution	2
3.	ZOO-102L	Fundamentals of Genetics and Evolution (Lab)	1
4.	ZOO-421	Molecular Genetics	2
5.	ZOO-421L	Molecular Genetics (Lab)	1

20. Course Outline

Biodiversity and Conservation

Course Code: ZOO-101

Credit Hours: 3 (3-0)

Pre-requisite: Nil

Objectives

To provide the students with an adequate knowledge of biodiversity, causes and threats to biodiversity decline. To familiarize the students international standards and criteria for species conservation status and protected areas.

Learning Outcomes

By the end of this course, students will be able to understand the basic techniques to assess the factors that influence biodiversity

- Students will learn strategies for conservation of biodiversity
- Students will get knowledge about red list categories and species conservation status
- Students will be familiar regarding importance of conservation policies and actions in Protected Areas

Course Outline

Unit 1. Biodiversity: Introduction, Levels and Significance

Introduction and importance of biodiversity. Ecological, economic, ethical and scientific role of Biodiversity. Sustainable and unsustainable use of biological resources. Levels of Biodiversity. α , β and γ diversity, systematic and functional diversity. Services offered by biodiversity to society. Biodiversity of Pakistan: Phytogeographic regions. Endemic Species of Pakistan

Unit 2. Causes and Threats to Biodiversity

Anthropogenic and natural causes of biodiversity loss. Habitat loss and fragmentation, ecosystem degradation: deforestation, over grazing, erosion and desertification. Pollution and global climate changes, invasive species, over exploitation of species. Biodiversity hot spots of Pakistan and the world.

Unit 3. Measurement of Biodiversity and Conservation Strategies

Measurements of Biodiversity: Conventional and advanced Techniques. Biodiversity indices to measure species richness and evenness. Shannon index, Simpson index. Conservation strategies: major techniques of *In situ* conservation. Conservation vs preservation. Major techniques of *Ex situ* conservation

Unit 4. Global Efforts for Biodiversity Conservation (IUCN Red List and Protected Areas

Global strategy for biodiversity conservation. IUCN: Organizational structure. Red list: categories and transfer. IUCN categories of protected areas. Key Biodiversity Areas (KBA). Biodiversity action plan of Pakistan

Recommended Books/Reference Material

1. Bawa, K., Primack, S., Oommen, R.B. & Anna, M. (2020). *Conservation Biology: A Primer for South Asia*. Orient Black Swan
2. Dyke, F.V. (2021). *Conservation Biology: Foundations, Concepts, Applications*. Springer.
3. Lekevicius, E. (2022). *Biodiversity: Maintenance, Function Origin and Self Organization to Life Support Ecosystems*. Springer
4. Primack, R.B. & Sinauer, P.R.B. (2020). *Essentials of Conservation Biology*. Associates Inc. Publishers USA.

Fundamentals of Genetics and Evolution

Course Code: ZOO-102

Credit Hours: 2

Pre-requisite: N.A

Objectives

- To develop understanding of the principles of genetics and evolution among students.
- To develop the ability to analyze genetic data, understand patterns of inheritance and variation, and explain genetic mechanisms which contribute to the diversity and evolution of life through integrated theoretical and practical approaches.

Learning Outcomes

Students will be able to:

- Explain the principles of genetic variation and Mendelian inheritance.
- Use basic genetic techniques to study plant traits.
- Construct genetic maps from linkage and crossing over data.
- Understand the evolutionary processes in plants.

Course Outline

Unit 1. Introduction to Genetics and Evolution

Definition, scope and importance of plant genetics and evolution. Mendelian genetics and evolutionary theory. Evidence for Evolution (Fossil Record, Comparative Anatomy, Embryology, Molecular Biology).

Unit 2. Mendelian, Chromosomal and Molecular Genetics

Mendel's Laws of Inheritance (Segregation, Independent Assortment). Monohybrid and Dihybrid Crosses. Punnett squares and probability. Incomplete Dominance, Codominance.. Multiple alleles and polygenic inheritance. Epistasis and pleiotropy. Sex-linked Inheritance. Chromosomal Genetics (Chromosome Structure and Function. Mitosis and Meiosis. Chromosomal Variation and Mutations. Karyotyping and chromosomal abnormalities. Linkage, recombination, and gene mapping). Molecular Genetics: (DNA Structure and Replication. Gene Expression (Transcription and Translation). Genetic Code. Regulation of Gene Expression. Mutations).

Unit 3. Population Genetics and Evolutionary Biology

Hardy-Weinberg Equilibrium. Inbreeding. Natural selection and adaptation. Evolutionary mechanisms: mutation, gene flow, genetic drift. Factors Affecting Allele Frequencies (Mutation, Gene Flow, Genetic Drift, Selection).

Unit 4. Speciation, Macroevolution and Evolutionary development

Definition of Species. Modes of Speciation (Allopatric, Sympatric). Speciation and reproductive isolation. Macroevolution: Patterns of Macroevolution. Adaptive Radiation. Extinction. Evolutionary Development (Evo-Devo). Molecular Evolution: Molecular Basis of Variation. Phylogenetics and the Tree of Life.

Unit 5. Human Genetics and Evolution

Primate Evolution. Hominin Evolution. Origin of Modern Humans. Human genome and inherited traits. Genetic disorders and counseling. Evolution of Homo sapiens and genetic diversity

Recommended Books/Reference Material

1. Bujakowska, K. M., & Dryja, T. P. (2021). *Fundamentals of Genetics*. In *Albert and Jakobiec's Principles and Practice of Ophthalmology* (pp. 1-32). Cham: Springer International Publishing.
2. Meneely, P. M., Hoang, R. D., Okeke, I. N., & Heston, K. (2017). *Genetics: Genes, Genomes, And Evolution*. Oxford University Press.
3. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics*. John Wiley & Sons.
4. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology*. S. Chand Publishing.
5. Waddington, C. H. (2016). *An Introduction To Modern Genetics*. Routledge.

Fundamentals of Genetics and Evolution (Lab)

Course Code: ZOO-102L

Credit Hours: 1

Pre-requisite: N.A

Objectives

- To provide hands-on experience in applying fundamental genetic principles through experiments and simulations.

- To develop analytical skills in interpreting genetic data using tools like Punnett squares, pedigree charts, and chi-square analysis.
- To explore evolutionary mechanisms through modeling population genetics and constructing phylogenetic trees.

Learning Outcomes

Students will be able to:

- Solve genetic cross problems (monohybrid, dihybrid, and sex-linked) and interpret inheritance patterns.
- Analyze genetic data using chi-square tests and construct pedigrees to determine modes of inheritance.
- Observe and differentiate stages of mitosis and meiosis using prepared slides.
- Calculate allele frequencies and simulate evolutionary processes such as genetic drift, gene flow, and natural selection.
- Construct and interpret phylogenetic trees based on morphological or molecular data.

Course Outline

1. Monohybrid and dihybrid crosses Punnett squares. Chi-square test for data interpretation.
2. Study of pedigrees and inheritance patterns. Identification of dominant, recessive, sex-linked traits. Incomplete dominance and codominance (examples and problems). Multiple alleles (e.g., ABO blood groups). Sex-linked inheritance (e.g., Drosophila crosses, human pedigrees).
3. Mitosis and meiosis (microscopic observation of prepared slides).
4. Linkage and crossing over (Drosophila crosses or simulations). Construction of linkage maps. Three-point crosses.
5. Hardy-Weinberg equilibrium: simulation and calculation of allele frequencies.
6. Modeling genetic drift, gene flow, and selection pressures.
7. Phylogenetic tree construction using morphological or molecular data.

Recommended Books/Reference Material

6. Bujakowska, K. M., & Dryja, T. P. (2021). *Fundamentals of Genetics*. In *Albert and Jakobiec's Principles and Practice of Ophthalmology* (pp. 1-32). Cham: Springer International Publishing.
7. Meneely, P. M., Hoang, R. D., Okeke, I. N., & Heston, K. (2017). *Genetics: Genes, Genomes, And Evolution*. Oxford University Press.
8. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics*. John Wiley & Sons.
9. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology*. S. Chand Publishing.
10. Waddington, C. H. (2016). *An Introduction To Modern Genetics*. Routledge.

Molecular Genetics

Course Code: ZOO-421

Credit Hours: 2

Pre-requisite: N.A

Objectives

- To provide students with a comprehensive understanding of the molecular basis of genetic processes
- to equip them with laboratory skills essential for studying molecular genetics in plants and other organisms.

Learning Outcomes:

By the end of this course, students will be able to:

- Explain structure of different forms of DNA and RNA.
- Describe gene structure and organization of genomes.
- Understand gene expression and its regulation at various levels.
- Apply molecular techniques to investigate genetic variation and gene function in plants.

Course Outline

Unit 1. Nucleic Acids - Structure and Replication

Molecular structure and chemical composition of DNA and RNA. DNA replication mechanisms in prokaryotes and eukaryotes. DNA damage and repair pathways.

Unit 2. Gene Expression - Transcription and Translation

Transcription process: Initiation, elongation, termination. RNA processing: Capping, polyadenylation, splicing. Translation and the role of ribosomes and tRNAs.

Unit 3. Regulation of Gene Expression

Gene regulation in prokaryotes: lac and trp operons. Gene regulation in eukaryotes: transcription factors, enhancers, silencers. Epigenetic modifications: DNA methylation and histone modifications.

Unit 4. Molecular Techniques and Applications

PCR: Principle and applications. Agarose gel electrophoresis for DNA analysis. Basic principles of recombinant DNA technology.

Unit 5. Advances in Molecular Genetics

CRISPR-Cas9 genome editing. Next-generation sequencing (NGS) technologies. Applications of molecular genetics in biotechnology, agriculture, and medicine.

Recommended Books/Reference Material

1. Lewin, B. (2017). *Genes XII*. Jones & Bartlett Learning.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular Cell Biology* (9th ed.). Macmillan Learning.
3. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics* (7th ed.). Wiley.

4. Stewart, C. N., Jr. (Ed.). (2025). *Plant Biotechnology and Genetics: Principles, Techniques, and Applications* (2nd ed.). John Wiley & Sons.
5. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2017). *Molecular Biology of the gene* (7th ed.). Pearson.

Molecular Genetics (Lab)

BS-Botany

Course Code: ZOO-421L

Credit Hours: 1

Pre-requisite: N.A

Objectives

To equip students with practical skills in fundamental molecular biology techniques, focusing on nucleic acid extraction, PCR, gene expression analysis, and basic bioinformatics applications.

Learning Outcomes

By the end of this course, students will be able to:

- Explain structure of different forms of DNA and RNA.
- Describe gene structure and organization of genomes.
- Understand gene expression and its regulation at various levels.
- Apply molecular techniques to investigate genetic variation and gene function in plants.

Course Outline

1. Laboratory Introduction and Safety, Laboratory safety protocols and aseptic techniques. Introduction to basic molecular biology equipment.
2. Nucleic Acid Extraction and Quantification, Extraction of genomic DNA from plant tissues. RNA extraction and purification methods. Quantification and quality assessment using spectrophotometry/ Nano drop.
3. PCR and Gel Electrophoresis, Principles and protocols of Polymerase Chain Reaction (PCR). Optimization and troubleshooting of PCR reactions. Preparation of agarose gels and electrophoretic analysis of DNA.
4. Gene Cloning and Transformation (Introduction), Basics of plasmid extraction (Mini-prep techniques), DNA ligation and bacterial transformation concepts. Screening of transformed colonies.
5. Bioinformatics and Molecular Data Analysis, Introduction to biological databases (e.g., NCBI, EMBL). Primer designing and sequence alignment. Basics of phylogenetic tree construction and sequence interpretation.
6. Phylogenetic Tree Construction of Plant Species, Compare DNA sequences (e.g., chloroplast genes) of different plants. Objective: Learn evolutionary relationships using molecular data.

Recommended Books/Reference Material

1. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th Ed.). Wiley-Blackwell.
2. Bruce, K., Blackman, R. C., Bourlat, S. J., Hellström, M., Bakker, J., Bista, I., & Deiner, K. (2021). *A Practical Guide To DNA-Based Methods for Biodiversity Assessment*. Pensoft Publishers.

3. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th Ed.). Cold Spring Harbor Laboratory Press.
4. Stewart, C. N., Jr. (Ed.). (2025). *Plant Biotechnology and Genetics: Principles, Techniques, and Applications* (2nd Ed.). John Wiley & Sons.
5. Wilson, K., & Walker, J. (2018). *Principles And Techniques of Biochemistry and Molecular Biology* (8th Ed.). Cambridge University Press.