

2 nd Semester				
S. No	Course Code	Course Title	Credit Hour	Status
1	ZOO-3201	Cell Biology	3 (2-1)	Major
2	ZOO-3202	Diversity of Chordates	3 (2-1)	Major
3	IDC-3201	Plant Physiology and Ecology	3 (2-1)	Interdisciplinary
4	GEN-3201	Quantitative Reasoning –II	3 (3-0)	General
5	GEN-3202	Expository Writing	3 (3-0)	General
6	GEN-3203	A Science of Society	2 (2-0)	General
7	UOQ-3204	Understanding of the Holy Quran-I	1(0-1)	General
		Total Credit Hours	18	

ZOO-3201 Cell Biology 3(2-1)

Course Title	Cell Biology
Course Code	ZOO-3201
Credit Hours	3(2-1)

Learning Objectives of the Course	
	<ul style="list-style-type: none"> To explain the basic concepts of cell biology. To understand cellular structure, composition of the organelles, cell growth and cellular division. To explain how macromolecules and organelles govern the dynamic organization, function of living
Contents	Theory Introduction; cell structure and function <ul style="list-style-type: none"> Cell theory Comparison of plant and animal cells

- Comparison of prokaryotic and eukaryotic cells

Cell membranes

- Structural models
- Chemical composition and function

Cell Organelles (structure and function)

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

Nucleus

- Structure and function
- Nuclear membrane
- Chromatin

Cytoskeleton

- Structure and types
- Function of cytoskeleton

Cellular transport

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

Cellular reproduction

- Cell cycle
- Mitosis
- Meiosis

Practical:

1. Microscopy
2. Staining techniques (Gram staining)
3. Identification of cell organelles (prepared slides)
4. Study of mitotic and meiotic stages (prepared slides)
5. Preparation and staining of histological slides

Suggested Readings/Reference Book	<ol style="list-style-type: none"> 1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York. 2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc. 3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC. 4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC. 5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea &Febiger, New York. 6. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, INC. 7. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2019
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ZOO-3202 Diversity of Chordates 3(2-1)

Course Title	Diversity of Chordates
Course Code	ZOO-3202
Credit Hours	3(2-1)
Learning Objectives of the Course	
<p>On the completion of the course, the students will:</p> <ul style="list-style-type: none"> • Understand the distinguishing features and classification of major chordate groups. • Explore the evolutionary relationships and phylogeny of chordates. • Examine the anatomical and physiological adaptations of each chordate group. • Investigate the ecological roles and life histories of these organisms. 	
Contents	<p>Theory Hemichordates</p> <ul style="list-style-type: none"> • Introduction to Hemichordates • Characteristics and classification of Enteropneusta, • Characteristics and classification of Pterobranchia • Hemichordates in marine ecosystems

Protochordates

- Introduction to Protochordates
- Characteristics and classification of Urochordata, Cephalochordates
- Protochordates in marine ecosystems
- Evolutionary Significance of Hemichordates and Protochordates

Chordates

- Introduction to Chordates
- General characteristics and classification
- Phylogenetic relationships among chordates

Fishes

- Characteristics and classification of fishes
- Anatomy and physiology of jawless fishes (Agnatha), cartilaginous fishes (Chondrichthyes), and bony fishes (Osteichthyes)
- Reproduction and development in fishes
- Ecological roles of fishes in aquatic ecosystems
- Evolutionary history and adaptive radiation of fishes

Amphibians

- Characteristics and classification of amphibians
- Anatomy and physiology of frogs (Anura), salamanders (Caudata), and caecilians (Gymnophiona)
- Reproduction and development in amphibians
- Ecological roles of amphibians in terrestrial and aquatic ecosystems
- Evolutionary history and adaptive radiation of amphibians

Reptiles

- Characteristics and classification of reptiles
- Anatomy and physiology of turtles (Testudines), lizards and snakes (Squamata), and crocodylians (Crocodylia)
- Reproduction and development in reptiles
- Ecological roles of reptiles in various ecosystems
- Evolutionary history and adaptive radiation of reptiles

Aves

- Characteristics and classification of birds
- Anatomy and physiology of birds

	<ul style="list-style-type: none"> • Reproduction and development in birds • Ecological roles of birds in various ecosystems • Evolutionary history and adaptive radiation of birds <p>Mammals</p> <ul style="list-style-type: none"> • Characteristics and classification of mammals • Anatomy and physiology of mammals • Reproduction and development in mammals • Ecological roles of mammals in various ecosystems • Evolutionary history and adaptive radiation of mammals • Importance of conserving chordates diversity • Captive breeding and reintroduction programs <p>Practical:</p> <ol style="list-style-type: none"> 1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals. 2. Visit to PMNH for the study of diversity of chordates.
Suggested Readings/ Reference Book	<ol style="list-style-type: none"> 1. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc. 2. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill. 3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill. 4. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill. 5. Lecture Notes of Prof. dr. Zulfiqar Ali 2025 <p>Verma P. S. Chordate Zoology 2010 S. Chand Publishing, 2010.</p>

BOT-3201 Plant Physiology and Ecology 3(2-1)

Course Title	Plant Physiology and Ecology
Course Code	IDC-3201
Credit Hours	3(2-1)
Learning Objectives of the Course	

- To provide comprehensive knowledge of functioning of organs, organelles and biomolecules,
- To enable the students to assess the effects of various environmental factors on plant growth and development.

Contents	<p>Theory</p> <p>Plant Physiology</p> <ul style="list-style-type: none"> • Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation. • Mineral nutrition: Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients. • Photosynthesis: Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C3 and C4 plants. Factors affecting this process, Products of photosynthesis. <p>Respiration:</p> <ul style="list-style-type: none"> • Definition and respiratory substrates. Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. <p>Ecology</p> <ul style="list-style-type: none"> • 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 relationships to plants. • Light and Temperature. Quality of light, diurnal and seasonal variations. Eco physiological responses. • Wind: Wind is an ecological factor and its importance. <p>Practical:</p> <ul style="list-style-type: none"> • Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations. • Determination of the temperature at which beet root cells lose their permeability.
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	<ul style="list-style-type: none"> • Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/by cobalt chloride paper method. • Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer. • Measurement of carbon dioxide evolution during respiration of germinating seeds by the titration method. • Effect of light and temperature on seed germination. • Determination of physical and Chemical characteristics of soil. • Field trips to ecologically diverse habitats. • Measurements of wind velocity.
Suggested Readings/ Reference Book	<ol style="list-style-type: none"> 1. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th. Ed. Sinauers Publ. Co. Inc. Calif. 2. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA. 3. Hopkins, W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York 4. Schultz, J.C. 2005. Plant Ecology. Springer-Verlag, Berlin. 5. Ricklefs, R.E. 2000. Ecology. W.H. Freeman and Co., UK.

GEN-3201 Quantitative Reasoning –II 3(3-0)

Course Title	Quantitative Reasoning –II
Course Code	GEN-3201
Credit Hours	3(3-0)
Learning Objectives of the Course	
<ul style="list-style-type: none"> • Summarizing, interpreting, and presenting quantitative data in mathematical forms, such as graphs, charts, tables, or mathematical text. • Construct or compute representations of data using mathematical forms or equations as models and use statistical methods to assess their accuracy. 	

Contents	<p>Logic, Logical and Critical Reasoning:</p> <ul style="list-style-type: none"> • Introduction and importance of logic. • Inductive, deductive and abductive approaches of reasoning.
	<ul style="list-style-type: none"> • Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences. • Logical fallacies. • Venn Diagrams. • Predicates and quantifiers. • Quantitative reasoning exercises using logical reasoning concepts and techniques. <p>Mathematical Modeling and Analyses:</p> <ul style="list-style-type: none"> • 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. <p>Statistical Modeling and Analyses:</p> <ul style="list-style-type: none"> • Introduction to probabilistic models. • Bivariate analysis, scatter plots. • Simple linear regression model and correlation analysis. • Basics of estimation and confidence interval. • Testing of hypothesis (z-test; t-test). • Statistical inference in decision making. • Quantitative reasoning exercises using statistical modeling.

Suggested Readings/Reference Book	<ol style="list-style-type: none"> 1. Using and Understanding Mathematics: A Quantitative Reasoning Approach by Bennett, J.O., Briggs, W. L., & Badalamenti, A. 2. Discrete Mathematics and its Applications by Kenneth H.Rosen. 3. Discrete Mathematics with Applications by Susanna S.Epp. 4. Applied Mathematics for Business, Economics and Social Sciences by Frank S. Budnick. 5. Elementary Statistics: A Step-by-Step Approach by Allan Bluman. 6. Introductory Statistics by PremS.Mann. 7. Applied Statistical Modelling by Salvatore Babones. 8. Barrons SAT by Sharvon Weiner Green,M.A and IraK.Wolf
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GEN- 3202 Expository Writing 3(3-0)

Course Title	Expository Writing
Course Code	GEN-3202
Credit Hours	3(3-0)
Learning Objectives of the Course	
<ul style="list-style-type: none"> • Helping them learn and understand basic concepts of communication process. • Practically implementing theoretical aspects in the real-life situations 	

Contents	<p>What is Communication?</p> <ul style="list-style-type: none"> • Process of communication, effective steps of communication, basic communication skills. <p>Paragraph Writing.</p> <ul style="list-style-type: none"> • Practice in writing a good, unified and coherent paragraphs. • Paragraph writing leading towards the writing of five to seven paragraphs long essay. • Stages of writing (brainstorming, researching, drafting and editing). • Methods of writing (cause and effect, problem solutions, comparison and contrast) <p>Essay Writing.</p> <ul style="list-style-type: none"> • Basic structure of essay, topic sentence, supporting sentence, concluding sentence, thesis statement • Unity and Coherence, Introduction and Conclusion <p>CV and Job Application</p> <ul style="list-style-type: none"> • Preparing a Curriculum Vitae • Writing a formal job application <p>Translation Skills</p> <ul style="list-style-type: none"> • Urdu to English (Practice at advanced level) <p>Study Skills</p> <ul style="list-style-type: none"> • Skimming and scanning, intensive, extensive and speed reading • Summary and precis writing • Comprehension (at advanced level) (sQ3R and SQ4R methods)
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	<p>Academic Writing</p> <ul style="list-style-type: none"> • Letter/Memo writing, Minutes of Meeting, use of Dictionary, Library and Internet <p>Presentation Skills</p> <ul style="list-style-type: none"> • Personality development (emphasis on content, style and pronunciation) • Preparation stage, audience analysis, handling and asking questions, managing time, handling non-verbal means, feedback <p>Academic Writing</p> <ul style="list-style-type: none"> • How to write a research proposal for research paper/term paper? • How to write a research paper/term paper? • (Emphasis on style, content, language, form, clarity, consistency) <p>Report Writing</p> <ul style="list-style-type: none"> • Technical Report writing • Progress report writing • Preparation and planning • Preparing for Interview and Research proposal/research paper defense <p><i>Note: Documentaries to be shown for discussion and review</i></p>
<p>Suggested Readings/ Reference Book</p>	<p>a). Grammar Practical English Grammar by A.J. Thomson and A.V.Martinet. Exercises Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.</p> <p>b). Writing Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking). Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 4354065 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).</p> <p>c). Reading Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991.ISBN0194534030.</p>

	<p>Reading and Study Skills by John Langan Study Skills by Richard York.</p> <p>d). Speaking</p> <p>Ellen, K.2002.Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top</p> <p>Hargie,O. (ed.) Handbook of Communications Skills</p> <p>Mandel,S. 2000. Effective Presentation Skills: A Practical Guide Better Speaking</p> <p>Mark, P.1996. Presenting in English. Language Teaching Publications</p>
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GEN-3203 A Science of Society 2(2-0)

Course Title	A Science of Society
Course Code	GEN-3203
Credit Hours	2(2-0)
Learning Objectives of the Course	
<ul style="list-style-type: none"> • The course is designed to introduce the students with sociological concepts and the discipline. • The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes. • The course will provide due foundation for further studies in the field of sociology 	
Contents	<p>Introduction</p> <ul style="list-style-type: none"> • Definition, Scope, and Subject Matter • Sociology as a Science • Historical background of Sociology <p>Basic Concepts</p> <ul style="list-style-type: none"> • Group, Community, Society • Associations: Non-Voluntary: Voluntary • Organization: Informal: Formal • Social Interaction: Levels of Social Interaction; Process of Social Interaction: Cooperation: Competition: Conflict: Accommodation: Acculturation and diffusion: Assimilation: Amalgamation <p>Social Groups</p> <ul style="list-style-type: none"> • Definition & Functions

- Types of social groups
- In and out groups
- Primary and Secondary group
- Reference groups
- Informal and Formal groups
- Pressure groups

Culture

- Definition, aspects and characteristics of Culture
- Material and non-material culture
- Ideal and real culture
- Elements of culture
- Beliefs
- Values
- Norms and social sanctions
- Organizations of culture
- Traits
- Complexes
- Patterns, Ethos, Theme
- Other related concepts, Cultural Relativism, Subcultures, Ethnocentrism and Xenocentrism, Cultural lag

Socialization & Personality

- Personality, Factors in Personality Formation
- Socialization, Agencies of Socialization
- Role & Status

Deviance and Social Control

- Deviance and its types
- Social control and its need
- Forms of Social control
- Methods & Agencies of Social control

Collective Behavior

- Collective behavior, its types
- Crowd behavior

	<ul style="list-style-type: none"> • Public opinion • Propaganda • Social movements • Leadership
Suggested Readings/ Reference Book	<ol style="list-style-type: none"> 1. Anderson, Margaret and Howard F. Taylor. 2001. <i>Sociology the Essentials</i>. Australia: Wadsworth. 2. Brown, Ken 2004. <i>Sociology</i>. UK: Polity Press 3. Gidden, Anthony 2002. <i>Introduction to Sociology</i>. UK: Polity Press. 4. Macionis, John J. 2006. 10th Edition <i>Sociology</i> New Jersey: Prentice-Hall 5. Tischler, Henry L. 2002. <i>Introduction to Sociology</i> 7th ed. New York: The Harcourt Press. 6. Frank N Magill. 2003. <i>International Encyclopedia of Sociology</i>. U.S.A: Fitzroy Dearborn Publishers 7. Macionis, John J. 2005. <i>Sociology</i> 10th ed. South Asia: Pearson Education 8. Kerbo, Harold R. 1989. <i>Sociology: Social Structure and Social Conflict</i>. New York: Macmillan Publishing Company. 9. Koenig Samuel. 1957. <i>Sociology: An Introduction to the Science of Society</i>. New York: Barnes and Nobel. 10. Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. <i>Marriage and the family</i> New York: Barnes and Noble, Inc. 11. Leslie, Gerald et al. 1973. <i>Order and Change: Introductory Sociology</i> Toronto: Oxford University Press. 12. Lenski, Gevbard and Lenski, Jeam. 1982. <i>Human Societies</i>. 4th edition New York: McGraw-Hill Book Company. 13. James M. Henslin. 2004. <i>Sociology: A Down-to-Earth Approach</i>. Toronto: Allen and Bacon.

UOQ-3204

Understanding of the Holy Quran-I 1(0-1)

Week	Units	Lesson	Assignments/home Task	Linguistic Rules
1	1	1-6	پڑھے گئے اسباق کے قرآنی الفاظ کا معنی لکھیں	معرفہ، مذکر مؤنث
	1	9-14	پڑھے گئے اسباق کے قرآنی الفاظ کا معنی لکھیں	جمع کی دو اقسام ، نکرہ اور و کا معنی
2	1	15-17	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ہذا، ہذہ ذالک ، تلک
	1	18-19 and revision of unit 1	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	لام تاکید ، اسم تفضیل
3	2	1-3	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ان ، لام کئی اور فی کی بحث
	2	4-6	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار علی ، من ، الی
4	2	7-9	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار "ب" ، لام نافیہ ، لام نفی جنس ، ما نافیہ اور الا
	2	10-13 and Revision of Unit 2 Assignment	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ان ، کان ، حروف النداء
5	Unit 3	1-2	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	صفت ، موصوف
	3	3-5	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	مضاف ، مضاف الیہ
6	3	6-7	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	مضاف ، مضاف الیہ
	3	8-10 And revision of Unit 3 Quiz	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	اسم فاعل ، اسم مفعول اور مثنیٰ
7				
8	Unit 4	1-2	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر ہو منفصل ، ؤ ضمیر متصل
	4	3-4	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار ، ضمیر متصل

8	4	5-8	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انت، ضمیر متصل "ک" مرکب اضافی اور ضمیر متصل
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9	4	9-12	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل ہی، ضمیر متصل ہا
	4	13-16 Assignment	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انا، ضمیر متصل ی
10	4	17 and revision of unit 4	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	حال
	Unit 5	1-2	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	جمع مذکر سالم، جمع مذکر سالم المسبوق بحرف الجر
11	5	3-4	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	جمع مذکر سالم المسبوق بالاضافۃ
	5	5-6 Quiz	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر ہم منفصل و متصل
12	5	7-8	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	اضافت اور حروف جار
	5	9-11	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انتم اور متصل کم
13	5	12-14	پڑھے گئے ابساق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل نحن، متصل نا
	5	15-16	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	حروف جار کو اضافت کے ساتھ ملانا
14	5	17-18	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	اسما اشارہ ہؤلاء، اولئک
	5	19-23	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	ما/الا، ان/الا، انما، ایس، ما، کان، (الا، ایس، الیوم، یومئذ، سبحان، ما بینہما، قل، اذن، بنس، نعم، کلا، ما، ادراک، حسب، اعلم، مصیر، دینا(تمیز)

15	5	Revision unit 5		
	6	1-3	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع، جملہ فعلیہ، فعل مضارع، صیغہ مفرد
16	6	4-5	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع، صیغہ مفرد یعلم
	6	6	پڑھے گئے ابساق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع صیغہ جمع یعملون
		Terminal		

Semester IV**GEN-4401****Introduction to Sociology****Credit Hours: 2(2-0)**

Objectives: The course is designed to introduce the students with sociological concepts and the discipline. The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes. The course will provide due foundation for further studies in the field of sociology.

Course Outline**Unit I: Introduction**

- a. Definition, Scope, and Subject Matter
- b. Sociology as a Science
- c. Historical back ground of Sociology

Unit II: Basic Concepts

- a. Group, Community, Society
- b. Associations
 - i. Non-Voluntary
 - ii. Voluntary
- c. Organization
 - i. Informal
 - ii. Formal
- d. Social Interaction
 - i. Levels of Social Interaction
 - ii. Process of Social Interaction
 1. Cooperation
 2. Competition
 3. Conflict
 4. Accommodation
 5. Acculturation and diffusion
 6. Assimilation
 7. Amalgamation

Unit III: Social Groups

- a. Definition & Functions
- b. Types of social groups
 - i. In and out groups
 - ii. Primary and Secondary group
 - iii. Reference groups
 - iv. Informal and Formal groups
 - v. Pressure groups

Unit IV: Culture

- a. Definition, aspects and characteristics of Culture
 - i. Material and non-material culture
 - ii. Ideal and real culture
- b. Elements of culture
 - i. Beliefs
 - ii. Values
 - iii. Norms and social sanctions
- c. Organizations of culture

- i. Traits
- ii. Complexes
- iii. Patterns
- iv. Ethos
- v. Theme
- d. Other related concepts
 - i. Cultural Relativism
 - ii. Sub Cultures
 - iii. Ethnocentrism and Xenocentrism
 - iv. Cultural lag

Unit V: Socialization & Personality

- a) Personality, Factors in Personality Formation
- b) Socialization, Agencies of Socialization
- c) Role & Status

Unit VI: Deviance and Social Control

- a) Deviance and its types
- b) Social control and its need
- c) Forms of Social control
- d) Methods & Agencies of Social control

Unit VII: Collective Behavior

- a) Collective behavior, its types
- b) Crowd behavior
- c) Public opinion
- d) Propaganda
- e) Social movements
- f) Leadership

Recommended Books:

1. Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
2. Brown, Ken 2004. *Sociology*. UK: Polity Press
3. Giddens, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
4. Macionis, John J. 2006. 10th Edition *Sociology* New Jersey: Prentice-Hall
5. Tischler, Henry L. 2002. *Introduction to Sociology* 7th ed. New York: The Harcourt Press.
6. Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
7. Macionis, John J. 2005. *Sociology* 10th ed. South Asia: Pearson Education
8. Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict*. New York: Macmillan Publishing Company.
9. Koenig Samuel. 1957. *Sociology: An Introduction to the Science of Society*. New York: Barnes and Nobel..
10. Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. *Marriage and The family*. New York: Barnes and Noble, Inc.
11. Leslie, Gerald et al. 1973. *Order and Change: Introductory Sociology* Toronto: Oxford University Press.
12. Lenski, Gevbard and Lenski, Jeam. 1982. *Human Societies*. 4th edition New York: McGraw-Hill Book Company.
13. James M. Henslin. 2004. *Sociology: A Down to Earth Approach*. Toronto: Allen and Bacon.

Course Contents:

1. Civics and Citizenship:
 - Concepts of civics, citizenship, and civic engagement.
 - Foundations of modern society and citizenship.
 - Types of citizenship: active, participatory, digital, etc.
2. State, Government and Civil Society:
 - Structure and functions of government in Pakistan.
 - The relationship between democracy and civil society.
 - Right to vote and importance of political participation and representation.
3. Rights and Responsibilities:
 - Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.
 - Civic responsibilities and duties.
 - Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)
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.
5. Advocacy and Activism:
 - Public discourse and public opinion.
 - Role of advocacy in addressing social issues.
 - Social action movements.
6. Digital Citizenship and Technology:
 - The use of digital platforms for civic engagement.
 - Cyber ethics and responsible use of social media.
 - Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.
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 societal harmony and peaceful co-existence.

Suggested Reading

1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education.
2. "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
3. "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
4. "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
5. "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and

Susan M. Omilian.

GEN-4403

Ideology and Constitution of Pakistan

Credit Hours: 2(2-0)

Course Objectives

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

1. Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding father of Pakistan.
2. Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
3. Explain about the guiding principles on rights and responsibilities of Pakistan citizens as enshrined in the Constitution of Pakistan 1973.

Course Contents

1. Introduction to the Ideology of Pakistan:

- Definition and significance of ideology.
- Historical contest 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 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 for separate homeland for Muslims of British India.

2. Two-Nation Theory:

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

3. Introduction to the Constitution of Pakistan:

- Definition and importance of a constitution.
- Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).

4. Constitution and State Structure:

- Structure of Government (executive, legislature, and judiciary).
- Distribution of powers between federal and provincial governments.
- 18th Amendment and its impact on federalism.

5. Fundamental Right, Principles of Policy and Responsibilities:

- Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
- Overview of Principles of Policy (Articles 29-40).
- Responsibilities of the Pakistan citizens (Article 5).

6. Constitutional Amendments:

- Procedures for amending the Constitution.
- Notable Constitutional amendments and their implications

Recommended Books

segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.

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

c) Evolution

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

Practical

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

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

Genetics

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

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.

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

GEN-4405**Organic Chemistry****Credit Hours: 4(3-1)****Course Contents:**

1. Basic Concepts in Organic Chemistry Hybridization of orbitals of carbon atoms in alkanes, alkenes, alkynes and arenes. Hybridization of orbitals of nitrogen, oxygen and sulphur atoms in various functional groups. Localized and delocalized chemical bonding. Conjugation and hyper conjugation. Resonance, rules of resonance, resonance energy, resonance hybrid, factor effecting the resonance; inductive effect, Applications of inductive effect and resonance on various properties of organic compounds; Steric effect and its applications, Hydrogen bonding and its effect on various properties of organic compounds, Tautomerism.
2. Nomenclature of Organic Compounds: Nomenclature of alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, spiroalkanes, monofunctional and polyfunctional derivatives of open chain and cyclic compounds, polysubstituted benzenes, polycyclic hydrocarbons such as naphthalene, anthracene, phenanthrene and their derivatives and heterocyclic compounds.
3. Aromatic Hydrocarbons: Structure of benzene, Resonance energy of benzene, Aromaticity, Criteria for aromaticity, Evidences of aromaticity, Natural sources of aromatic hydrocarbons; Preparation of aromatic hydrocarbons by different methods. Reactions of aromatic hydrocarbons: electrophilic aromatic substitution reactions i.e. nitration, halogenation, Friedal-Crafts reaction and its limitations, sulfonation; Orientation and reactivity of substituted benzenes; Nucleophilic aromatic substitution reactions; reaction such as addition, hydrogenation, Birch reduction, and oxidation reactions of side chain. Polycyclic aromatic hydrocarbons like naphthalene, anthracene and phenantharene, their resonance structures and realtive stabilities. Synthesis of naphthalene, Electrophilic substitution reactons of naphthalene, Oxidation and reduction reactions, Brief description of orientation and reactivity of naphthalenes.

4. Isomerism Conformational Isomerism: conformational analysis of ethane, n-butane, cyclohexane, mono- and di-substituted cyclohexanes. Optical isomerism: optical activity, chirality and optical activity; enantiomers, diastereomers; racemates and their resolution; D, L and R, S conventions; Optical isomerism in cyclohexanes, biphenyls and allenes. Geometrical isomerism: cis and trans isomers; E-Z convention; determination of configuration of the isomers; inter-conversion of geometrical isomers; geometrical isomerism in cyclic compounds.

5. Alkyl halides: Preparation of alkyl halides from alcohols, carboxylic acids; Chemical reactions: Aliphatic nucleophilic substitution reactions, SN1 and SN2 mechanism, effects of the nature of substrates, attacking nucleophile, leaving group and the nature of solvent. Elimination reactions, E1 and E2 mechanisms, orientation of elimination (Hoffmann and Saytzeff rules). Grignard Reagents; synthesis, structure, and reactions with active hydrogen compounds carbonyl compounds such as aldehydes, ketones, esters, acid halides and CO₂; reaction with nitriles, ethylene oxides, sulphur and oxygen.

6. Chemistry of Phenols and Ethers Phenols: Physical properties; Synthesis of phenols, reactions of phenols such as acylation, Friedel-Crafts reaction, Nitration, Sulphonation, Carbonation, Formylation and Diazo coupling. Ethers: Physical properties, Preparation of ether from alcohols, alkyl halides and alkenes; Reactions of ether, brief introduction of crown ethers and polyethers.

7. Chemistry of Carbonyl Compounds: Preparation of aldehydes and ketones, by pyrolysis of calcium salts of acids, acylation of alkenes and arenes, reduction of acid halides and nitriles. Physical properties of aldehydes and ketones; Structure and reactivity of carbonyl group; Comparison of the reactivity of aldehydes and ketones; Nucleophilic addition of water, alcohols, ammonia and its derivatives, hydrogen cyanide, bisulfite, reduction and oxidation reactions; Aldol condensation and related reactions, Cannizzaro's reaction, Wittig reaction, oxidation reactions, chemical tests of aldehydes and ketones.

8. Chemistry of Carboxylic Acids and their Derivatives: Physical properties of carboxylic acids; Effects of different parameters on the acid strengths of aliphatic and aromatic carboxylic acids. Chemical properties like salt formation nucleophilic acyl substitution, reduction of carboxylic acids, decarboxylation, Hunsdiecker reaction, Kochi reaction, substitution at α -carbon. Preparations, properties and reactions of acid chlorides, acid anhydrides, amides, cyanides and esters; Malonic and acetoacetic esters synthesis.

9. Heterocyclic Compounds: Methods of preparation of pyrrole and pyridine, their aromatic character and comparison with benzene. Important reactions of pyrrole and pyridine.

Recommended Books:

1. M. Younan, A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore. 2. Khairat M. Ibe Rasa, M.A. Rehman and Abdul Rehman, Organic Chemistry, Caravvan Book House, Lahore.

Reference Books:

1. Younas, M., Text Book of Chemistry, Ilmi Kutab Khana, Lahore.

2. Rehman, A., Text Book of organic Chemistry, Karwan Book House, Lahore.
3. Bhatti, H. N. and Rahman, R. 2013. Text Book of Organic Chemistry. Caravan Book House Pakistan.
4. Bahl, A., and B. S. Bhat. "A Text Book of Organic Chemistry, 17th Edn, S."Chand and Company, New Delhi ISBN: 81-219.
5. March, J., Advance Organic chemistry, John Wiley & Sons, New York.
6. I. L. Finar, "Organic chemistry" , Vol. I, Pearson Education, L.P.E.
7. I. L. Finar, , "Organic chemistry" , Vol. II, 5th Edition, L.P.E.
8. Jerry March, "Advanced Organic chemistry, Reaction, Mechanism and Structure" , 5th Edition, Wiley Inter Science.
9. Morison and Boyd, "Organic chemistry" , 6th Edition, Prentice Hall.
10. Seyhan N. Ege, "Organic chemistry Structure and Reactivity", 3rd Edition, The University of Michijan, A.I.T.D.S. Publishers & Distributors (Redg).

Organic Chemistry Practical

1. Compound Analysis: Identification of organic compounds containing only one functional group with special emphasis on compounds containing following functional groups. -COOH, -OH, C=O, -NH₂ and -CONH₂
2. Preparation of organic compounds: Preparation and techniques of purification of tribromophenol, nitrobenzene, aspirin, ethyl benzoate and benzoic acid from toluene, butyl chloride, acetanilide.
3. Basic Experimental techniques used in organic chemistry: Simple distillation, Solvent extraction, Sublimation, Re-Crystallization.
4. Estimation (Volumetric): Determination of molecular weight of carboxylic acid. Estimation of amide group and glucose.

Recommended Book:

Muhammad Abid Khawaja, Practical Chemistry Note Book, Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore.

GEN-4406

Animal Form and Function-I

Credit Hours: 4(3-1)

Course Objectives:

The Objectives of the courses are:

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

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

Course Learning Outcomes:

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

Course Outline:

1. Nutrition and Digestion:
 - a. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
 - b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
 - c. The mammalian digestive system: gastrointestinal motility and its control
 - d. 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.
2. Temperature and Body Fluid Regulation:
 - a. 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
 - b. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate
 - c. Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. Reproduction and Development
3. Reproduction:
 - a. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction;
 - b. Sexual reproduction in invertebrates; advantages and disadvantages of sexual

reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes;

- c. The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function;
- d. 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.

4. Descriptive Embryology:

- a. Fertilization; embryonic development: cleavage, and egg types; the primary germ layers and their derivatives;
- b. Echinoderm embryology;
- c. Vertebrate embryology: the chordate body plan,
- d. Amphibian embryology, development in terrestrial environments,
- e. Avian embryology, and the fate of mesoderm.

Practicals:

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).
2. Study of digestive system in invertebrate and a vertebrate representative (Dissection).
3. Dissection and study of male and female reproductive system in vertebrates and invertebrates.
4. Study of stages in the development of an Echinoderm.
5. Study of early stages in the development of a frog, chick and a mammal.

Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

Books Recommended

1. Pechenik, J.A. 2013. *Biology of Invertebrates*, 4th Ed. (International), Singapore: McGraw-Hill.
2. Arthur, M. M. 2010. *Vertebrate Embryology*.
3. Hickman, C.P., Roberts, L.S., Larson, A. 2004. *Integrated Principles of Zoology*, 11th Ed. (International), Singapore: McGraw-Hill.
4. Miller, S.A., Harley, J.B. 2002. *Zoology*, 5th, 6th, 7th, 8th, 9th, 10th & 11th Ed. (International), Singapore: McGraw-Hill.
5. Campbell, N.A. 2002. *Biology*, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Kent, G.C., Miller, S. 2001. *Comparative Anatomy of Vertebrates*. New York: McGraw-

Hill.

7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.

Semester VI

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

ZOO-5601	Chemistry of BioMolecules	3(2-1)	Compulsory
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Aims and Objectives

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

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation. **Enzymes:** introduction; important characteristics of enzymes; immobilized enzymes; how enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how ph and temperature effect enzyme activity. **Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin formation;

disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides. **Lipids:** fatty acids, their types and major characteristics; storage lipids, acylglycerols; waxes; structural lipids in membranes; major functions of lipids; lipoproteins, their types and major functions. **Vitamins and cofactors:** occurrence, structure and biochemical function of vitamins of b-complex group.

Recommended Books

1. Nelson, D. L. and Cox, M.M. Lehninger Principles Of Biochemistry, 3rd Edition, 2000. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25th Edition, 2000. McGraw Hill, New York.
3. Voet. D., Voet, J.G., and Pratt, C.W. Fundamentals Of Biochemistry, 1999. John Wiley and Sons, Inc., New York.
4. Zubay, G. Biochemistry, 4th Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. Biochemistry, 4th Edition, 1995. W.H. Freeman and Company, New York.
6. McKee, T. and McKee, J.R. Biochemistry, The Molecular Basis Of Life. 3rd Edition, 2003. McGraw Hill.

Practicals

- 1) Preparation of standard curve for glucose by *ortho*-Toluidine method.
- 2) Tests for detection of carbohydrates in alkaline and acidic medium.
- 3) Tests for detection of Disaccharides.
- 4) Detection of Non-Reducing sugars in the presence of Reducing sugars.
- 5) Demonstration of Acid Hydrolysis of Polysaccharide.
- 6) Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).

Recommended Books

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

ZOO-5602	DEVELOPMENTAL BIOLOGY	4(3-1)
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Course Objectives:

The course aims to:

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

Course Learning Outcomes:

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

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

Course Outline:**1. Introduction**

- a. History and Basic Concepts of developmental biology
- b. Principal features of developmental biology and embryology with special emphasis on vertebrate models
- c. Origin of sexual reproduction
- d. Developmental patterns

2. Spermatogenesis

- a. Mammalian spermatogenesis as model for all vertebrates
- b. Spermiogenesis or (spermateliosis)
- c. The role of Sertoli and Leydig cells in spermatogenesis

- d. Hormonal control of spermatogenesis
- 3. **Primates Menstrual cycle**
 - 1. **Oogenesis**
 - a. Mechanism of oogenesis among various classes of vertebrates.
 - b. Vitellogenesis
 - c. Hormonal control of Vitellogenesis and oogenesis
- 4. **Fertilization**
 - a. External & Internal Fertilization
 - b. Species-specific recognition of sperm and egg
 - c. Fusion of male and female gametes
 - d. Polyspermy: slow and fast blocks to polyspermy
 - e. Activation of egg metabolism
- 5. **IN VITRO Fertilization (IVF)**
 - a. History, Steps and advantages of IVF
 - b. Disadvantages and risk factors
- 6. **Cleavage &Blastulation**
 - a. Patterns of embryonic cleavage and blastulation among different vertebrate classes
 - b. Mechanism of cleavage.
- 7. **Gastrulation**
 - a. Fate maps
 - b. Gastrulation in amphibians, birds and mammals
- 8. **Early Vertebrate Development**
 - a. Neurulation, ectoderm, mesoderm and endoderm formation
- 9. **Placenta and extraembryonic membranes**
- 10. **Cellular Basis of Morphogenesis**
 - a. Differential cell affinity, cell adhesion molecules
 - b. Organogenesis
 - c. Mechanism of teratogenesis
- 11. **Aging and Regeneration in vertebrates**

Practical:

- 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. Semen analysis
7. Dactylography and its uses in developmental biology
8. Preparation and staining of histological slides.

Text and Reference Books:

1. Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.
3. [Scott F. Gilbert](#) and Michael J. F. Barres. 2016. [Developmental Biology. Sinauer Associates, Sunderland, MA.](#)
4. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

ZOO-5603	PRINCIPLES OF ANIMAL TAXONOMY	2(1-1)
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Course Objectives:

The course aims to:

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

Course Contents:

1. **Importance and applications of systematics:** Taxonomy in Animal science, systematics as a profession and its future perspectives.
2. **History of taxonomy:** systematics, basic terminology of systematics, theories of biological classifications.
3. **Taxonomic characters:** Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.

4. **Typological species concept:** Nominalist species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation,
5. **Taxonomic procedures,** taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.
6. **Formation of specific names,** brief concept of cladistics, phylogenetics. Theory and practice of cladistics and phylogenetic systematics.
7. **Systematics publications:** International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practicals:

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

Books Recommended:

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

Whili, M.J.D. *Modes of Speciation*, 1978. W.H. Freeman and Co., San Francisco

ZOO-5604	Data Analysis	2(2-0)
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Aims and Objectives

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

Course Contents

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

Recommended Books

1. Geffery, R. Norman, David L. Streiner, Biostatistics: The Bare Essentials. 2000. B.C. Decker Inc.
2. Gerry, P. Quinn, Michael J. Keough, Experimental Design And Data Analysis For Biologists. 2002. Cambridge University Press.
3. Campbell, R. C. Statistics For Biologists. 1989. Cambridge University Press.
4. Simpson, G.G., Roe, A. and Lewontin, R.C. (1960). Quantitative Zoology, Harcourt Bruce and Company.
5. Sokal, R.R. and Rohlf, F.J. (1973). An Introduction to Bio-statistics, Toppan.
6. Mather, K. (1960). Statistical Analysis in Biology. Methuen.
7. Bailey, N.T.J. (1981). Statistical Methods in Biology, English University Press.

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

Z00-5605	Palaeontology and Evolution	4(3-1)
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Course Objectives:

1. To provide detailed account based on origin of life
2. To develop some basic concepts and ideas for causing evolutionary changes.
3. To determine the significance of systematics in relation to their nomenclature.

Course Learning Outcomes:

1. To **acquire** basic knowledge for the factors and theories related to the origin of life.
2. To **understand** the vital concepts proposed by various scientists for the appearance of life on earth. .
3. To **solve** the critical issues for the discrepancies based on origin of life.

4. To **analyze** certain issues regarding the animal phyla, classes, orders till sub-species levels.
5. **EXPLAIN** the distribution of animals on the basis of fossils record.
6. **DEVELOP** understanding regarding process of fossilization and its importance in evolutionary history of an animal and its distribution.

Course Contents:

- Theories of Evolution: theories to explain diversity of life– modern synthetic theory, factors initiating elementary evolutionary changes (micro-evolution) and change of gene frequencies.
- Mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.
- Role of isolation in evolution: factors of large evolutionary changes (macroevolution).concepts of allometry, orthogenesis, adaptive radiation.
- Modern concept of Natural Selection: levels of selection, selection patterns, some examples of Natural Selection.
- Impacts of Natural Selection leading to convergence, radiation, regression and extinction, sexual selection: Darwin’s concept, specie concept, kinds of species.

Action of Natural Selection leading to convergence, radiation, regression and extinction.

1. **Paleontology: The Planet Earth**

- a. History, age, shells of earth
- b. Atmosphere, hydrosphere, biosphere, and lithosphere.

2. **Rocks:**

- a. Types; ligneous rocks, sedimentary rocks and metamorphic rocks.

3. **Fossil and Fossilization**

- a. Fossil types and uses of fossils, nature of fossils.
- b. Fossilization
- c. Invertebrates and Vertebrates Fossil
- d. Biostratigraphy
- e. Fossils of Pakistan
- f. Paleontologically important areas of Pakistan.

4. **Fossilization:**

- a. Geological time scale.

- b. Pre-Cambrian life.
- c. Post Cambrian life,
- d. Paleozoic life
- e. Mesozoic life
- f. Cenozoic life.

5. **Geochronometry:**

- a. radiocarbon dating, methods
- b. index fossils
- c. evolutionary history of man, elephant, horse and camel,
- d. Paleocology, Paleomagnetism.

Practical:

1. Study of preserved invertebrate species and their classification to species levels.
2. Collection, preservation and identification of common species with taxonomic keys.
3. Study of molds and casts, pseudomorphs, petrified fossils.
4. Study of vertebrates fossils of evolutionary importance e.g. horse, elephant, camels and primates
5. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
6. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
7. Study and identification of Igneous, Sedimentary and Metamorphic rocks

Text and Reference Books:

1. Strickberger. M.W. 2012. *Evolution*. Jones & Barrett Publishers. Gower Street, London, England.
2. Ridley, M. 1993. *Evolution*. Blackwell Scientific Publications, New York, USA..
3. Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row, Publishers, New York
4. Wiley, E. O. and Lieberman, B. S. 2011. *Phylogenetics: Theory and Practical Practice of Phylogenetic systematics*. 2nd Ed. Wiley-Blackwell.
5. Strickberger. M.W. *Evolution*. 2000. Jones and Barrett Publishers.
Michael, J. B. David, A and Haper, T. 2009. *Paleobiology and the fossil record*. 3rd Ed. Wiley Black, UK.
6. Foote, M and Millar, A. I. 2007. *Principles of paleontology*. 3rd Ed. W. H. Freeman & Co. USA.
7. Andrew, H. *Life on a Young Planet: The First Three Billion Years of Evolution on Earth - Updated Edition*, March 22, 2015

ZOO-5606	Molecular Biology	3(2-1)
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Course 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.

Course Learning Outcomes:

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

1. **EXPLAIN** how the structure and chemistry of nucleic acids relate to their functions, relative stability and interactions with proteins.
2. **UNDERSTAND** the regulation of proteins and nucleic acids interaction
3. **COMPARE & CONTRAST** mechanisms of DNA replication, transcription, translation, repair, recombination and gene regulation.
4. **APPLY** molecular knowledge to identify human genetic disorders and to understand underlying molecular mechanism

Course Outline:**1. Introduction**

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

2. Replication

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

3. Transcription

- a. Types of RNA polymerases in prokaryotes and eukaryotes
- b. Transcription in prokaryotes
- c. Genetic Code

4. Translation

- a. Role of Ribosomes
- b. Mechanism of translation in prokaryotes

5. Mutation

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

6. Gene expression and control

- a. Control of gene expression in Prokaryotes.
- b. Lac operon model.
- c. Control of gene expression in eukaryotes.

Practical:

1. Isolation of DNA from human blood.
2. Restriction Fragment Length Polymorphism techniques.
3. DNA amplification through polymerase chain reaction.
4. Separation of different sized DNA fragments on agarose gel.
5. Blotting techniques (Southern ,western and northern)

Text and Reference books:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.
3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.

Semester VIII

Course code	Course title	Credits	Status
ZOO-6801	Animal Behaviour	3(2-1)	Compulsory
	Elective-II	3(2-1)	Elective
	Elective-III	3(2-1)	Elective
	Elective-IV	3(2-1)	Elective
	Elective-V	3(2-1)	Elective
ZOO-6823	Comprehensive examination	P/F	Compulsory
ZOO-6899	Thesis	6(0-6)	Elective
Note: students who will not opt for thesis, will have to opt 5 elective courses			
	Total Credits	15	

ZOO-6801	ANIMAL BEHAVIOUR	3(2-1)
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Aims and Objectives

To teach students:

1. The concept of physiological mechanism.
2. Functional aspects in animal life
3. The designs of mechanisms in nervous and hormonal coordination, muscle and movements, respiratory gas exchange, excretion and osmoregulation, nutrition and thermal regulation.
4. To correlate these mechanisms at biochemical, molecular and cellular levels to the functions at organ system and organism level.
5. Physiological mechanisms in manifestation of behaviour.

Course Contents

The Study of Animal Behaviour: Introduction. History of animal behaviour. Approaches and methods. Mechanisms of behaviour: The nervous system and behaviour. Hormones and behaviour Immunology and behaviour. Biological rhythms. Development of behaviour. Learning behaviour. Communication. Finding Food and shelter: Migration, Orientation and navigation. Habitat selection. Foraging behaviour. Social Organization and Mating systems: Conflict. Sexual reproduction and parental care. Mating systems and parental Care. Social systems.

Practicals

Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments

showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

Recommended Books

1. Drickamer, L. C., Vessey, S. H. and Jacob, E. 2002. Animal behaviour: Mechanism, Ecology Evolution. 5th Edition.
2. Manning, A. and Dawkins, M. S. 1997. An Introduction to Animal Behaviour, 8th edition. Cambridge University Press, Cambridge.
3. Tonap, G. T. 1998. Experimental Entomology an Aid to Laboratory and Field Studies. C. B. S. Publishers Delhi

Course Code	Course Title	Credit Hrs.
ZOO- 6802	Animal Pests and Disease Producing Organisms	3(2-1)
ZOO- 6803	Applied Microbiology	3(2-1)
ZOO-6804	Molecular Biology	3(2-1)
ZOO- 6805	Bioremediation and Environmental Biotechnology	3(2-1)
ZOO- 6806	General Biotechnology	3(2-1)
ZOO- 6807	Clinical Endocrinology	3(2-1)
ZOO- 6808	Environmental Issues	3(2-1)
ZOO- 6809	Fish Biology	3(2-1)
ZOO- 6810	Human Genetics	3(2-1)
ZOO- 6811	Ichthyology (Fish Morphology)	3(2-1)
ZOO- 6812	Limnology-B	3(2-1)
ZOO- 6813	Mammalogy	3(2-1)
ZOO- 6814	Medical Microbiology	3(2-1)
ZOO- 6815	Medical Parasitology	3(2-1)
ZOO- 6816	Molecular Physiology	3(2-1)
ZOO- 6817	Physiological Systems and Adaptations	3(2-1)
ZOO- 6818	Ornithology	3(2-1)
ZOO- 6819	Vector Biology	3(2-1)
ZOO- 6820	Vertebrata	3(2-1)
ZOO- 6821	Wildlife	3(2-1)

ZOO-6802	ANIMAL PESTS AND DISEASE PRODUCING ORGANISMS	3(2-1)
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Aims and Objectives

The course aims to provide knowled and awareness to students about the different invertebrates and invertebrates animal pests and to aquip the student with sufficient knowlege to generate technologies and strategies being used for pest and disease management include testing new pesticides (Chemical and biological) for inclusion in integrated pest management (IPM), to counter this challenge.

Course Contents

Nature and mechanism of damages caused by animals pest injuries to cash crops, vegetables and fruit plants, stored grains and forest plants with brief description of their biology, ecology and control. Role of insects, helminthes, nematodes, protozoans and other pathogens in disease transmission and myiasis. Insects and mites of medical and veterinary importance in Pakistan. Study of mammalian pests of Pakistan.

Practicals

Collection, mounting studying and identification of important animal pests. Endo and ecto-parasite of various animals. Mounting of slides after processing the parasites.

Recommended Books

1. Ahmad, M., 1990. Agricultural Entomology of Pakistan. Nalt. Long Auth, Islamabad.
2. Choudhry, G.U. 1970. Survey of insect fauna of forests of Pakistan.
3. Ghani, M.A. and Cheema, M.A. 1973. Biology, ecology and behaviour of principal natural enemies of major insects pests of forests of Pakistan.
4. USDA, 1956. Year Book of Agriculture, Insects.

ZOO-6803	APPLIED MICROBIOLOGY	3(2-1)
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Aims and Objectives

- Aims of this course to let the students know about the applications of the science of microbiology in the different fields of life.
- The course may initiate their interest in agricultural, industrial and/or environmental microbiology.

Course Learning Outcomes:

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

- **Attain** the sufficient knowledge about the uses and benefits of microorganisms in different aspects of human life
- **Apprehend** the relevant applied scientific knowledgeand impact of microbiology

- **Elucidate** the problems associated with a particular area of microbiology by using the acquired knowledge and practical skills
- **Explore** the microbial world for applications of microorganisms in biotechnology, medicine and industry

Course Contents

Control of microorganisms: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents.

Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. **Environmental microbiology:** Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage.

Microbiology of food, milk and milk products.

Industrial Microbiology: Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

Microbe-microbe interactions and signaling (quorum sensing): Microbial activity measurement in soil, Applications of microbial ecology

Practicals

1. Bacteriological examination of water.
2. Isolation and Identification of enteric pathogen.
3. Selective medium for the isolation of pathogenic Staphylococci. The coagulase test for pathogenic *Staphylococcus*, Sucrose plates.
4. Normal throat flora and reactions on Blood Agar. Slide Agglutination test.
5. Inhibition and destruction of microorganisms by physical agents (temperature, desiccation, light).
6. Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs.
7. Survey of microorganisms' activities-based industries

Recommended Books

1. Prescott's Microbiology, 11th ed. (2019) by [Joanne Willey, Linda Sherwood and Christopher J. Woolverton](#)
2. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora, Berdell R. Funke, Christine L. Case.](#)
3. Alcamo's Fundamentals of Microbiology, 9th ed. (2012) by Jeffrey C Pommerville.
4. [Bergey's Manual of Systematic Bacteriology](#) (2012).
5. Pelczar, Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.
6. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.

ZOO-6804	MOLECULAR BIOLOGY	3(2-1)
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Course Objectives:

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

sCourse Learning Outcomes:

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

1. **EXPLAIN** how the structure and chemistry of nucleic acids relate to their functions, relative stability and interactions with proteins.
2. **UNDERSTAND** the regulation of proteins and nucleic acids interaction
3. **COMPARE & CONTRAST** mechanisms of DNA replication, transcription, translation, repair, recombination, gene regulation, RNA processing in prokaryotes and eukaryotes.
4. **APPLY** molecular knowledge to identify human genetic disorders and to understand underlying molecular mechanism

Course Outline:

1. Introduction

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

2. Replication

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

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

4. Translation

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

5. Gene expression and control.

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

Practicals:

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.

Text and Reference books:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.

3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.

ZOO-6805	Bioremediation and Environmental Biotechnology	3(2-1)
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Aims and Objectives

Biodegradation of various pollutants and also acts as the microbial metabolism to remove pollutants. The purpose of environmental and bioremediation is used to study harmful substances which are contaminating the environment and discovering and inventing such processes which can be beneficial for the environment.

Course Contents

Concept of bioremediation; Bioremediation of heavy metals, xenobiotic compounds and hazardous wastes; techniques used in bioremediation, bioremediation through consortia of microbes and invertebrates; renewable and non-renewable resources; bioleaching and biomining (low grade and sulfide containing ores processing); domestic solid waste and management. Waste water, sludge and sewage management; biological methods of wastes treatment; sample collection and preservation; bioremediation of crude and petroleum oils. Role of yeast in bioremediation. Biological fuel generation; Bioremediations of industrial effluents.

Practicals

Bioremediation of heavy metals through invertebrates, consortia of microorganism, mycoremediation.

Recommended Books

1. Environmental Science (Earth as a living planet). 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000. Pruce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

ZOO-6806	GENERAL BIOTECHNOLOGY	3(2-1)
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Course Objectives:

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

Course outcomes:

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

1. **COMPREHEND** about the introduction and history of biotechnology
2. **UNDERSTANDING** of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution
3. **KNOW** about basic of rDNA technology, concept and principle and application of genetic engineering, transgenic animals, cryopreservation, apoptosis, and animal cloning.

Course Content:

1. **Introduction:**
 - a. Definitions, classes, types of modern biotechnology
 - b. Historical perspective, timeline of important events in the field of biotechnology
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, allelic ladder
3. **Biotechnology and Justice:**
 - a. Sources of DNA, Forensic DNA testing,
 - b. Principles, techniques, types and applications
4. **Genetic Engineering**
 - a. Introduction, Steps, Vectors and its types, characteristics of vectors
 - b. Plasmids and its types, pBR322, pUC19, Ti-Plasmid
 - c. Restriction Enzymes, Screening, Blue White Screen, Negative and Positive Control, Competent Cells, Insulin as an example, genetically modified organisms
 - d. Cloning, its types of cloning, cell cloning, molecular cloning, organism cloning, applications and uses
5. **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
6. **Bioprocess Technology:**
 - a. Introduction, requirements of bioreactors, types of bioreactors
 - b. Bacterial and mammalian cell culturing, production of novel antibiotics, steps for production of antibiotics, production of industrially important chemicals
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)
8. **Bioethics and Islamic Bioethics:**

- a. Introduction and principles of bioethics,
- b. Concept of bioethics in different religions, principles of Islamic bioethics

Practicals:

1. DNA Extraction from different sources
2. Quantification of DNA using gel electrophoresis and spectrophotometer
3. Amplification of DNA using PCR
4. PCR product measurement using gel electrophoresis
5. Gender typing of human and animal samples using PCR
6. Restriction fragment length polymorphism of samples
7. Species identification of different animal samples using PCR and RFLP

Text and Reference Books:

1. Clark, D.B., Pazdernik, N.J. (2015) Biotechnology. 2nd Edition. Academic Cell
2. Glick, B., Pasternak, J.J., Patten, C.L. (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press.
3. Freeman, S., Quillin, K., Allison, L. (2013) Biological Science. 5th Edition. Pearson.
4. Schmid, R.D., Schmidt-Dannert, C., Hammelehle, R. (2016) Biotechnology: An Illustrated Primer. Willey-Blackwell.
5. Dehlinger, C.A. (2014) Molecular Biotechnology. Jones & Bartlett Learning
6. Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction. 7th Edition. Willey-Blackwell.
7. Butler, J.M. (2009) Fundamentals of Forensic DNA Typing. Academic Press.
8. Setlow J. K. (2000). Genetic Engineering: Principles and Methods. Kluwer Academic Publishers
9. Krishna.V.S. (2007) Bioethics and Biosafety in Biotechnology. New Age International
10. Furr, A.K. (2008) CRC Handbook of Laboratory Safety. 5th Edition. Boca Raton, FL, CRC Press
- Smith, J. E. (2009). Biotechnology, 5th Edition, Cambridge University Press

Z00 6807	Clinical Endocrinology	3(2-1)
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Course Objectives

The objectives of the course are: -

1. To understand and introduction base of new knowledge building the character of confidence, maturity and full command in expressing his or her ideas
2. To learn more with various directions, critical thinking, ethical resealing, cognitive development.

3. To provide the information of their body hormonal misbalanced and their control

Course Learning Outcomes:

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

1. **ACQUIRE:** To provide a supportive learning environment, supported by different ideas and presentations.
2. **UNDERSTAND:** To provide distinctive modules within appropriate areas of endocrinology.
3. **SOLVE:** To produce graduates well trained in laboratory and research skills and to stand-in the ability to work independently and as part of a group, and to develop presentation skills, both written and oral.
4. **ANALYZE:** To encourage and develop the student's motivation, originality of thought and scope of vision.
5. **EVALUATE:** To provide distinctive modules within appropriate areas of endocrinology, drawing on the expertise and strengths of our academic staff.
6. **DEMONSTRATE:** To produce graduates well trained in laboratory and research skills in major areas of interest in Endocrinology at both the basic science and clinical levels as well as an understanding of state-of-the-art technology that is used to further research in the field and ensure that students are familiar with the fundamental principles of endocrine communication

Course Outline:

INTRODUCTION:

Mechanisms of Action of Hormones: Hormone systems and intracellular communication; Hormones acting at cell surface: Properties of hormone receptor interaction, structure, biosynthesis and turnover of membrane receptors; Hormones acting in transcription regulation: Biochemistry and molecular interaction of steroid receptor, gene expression, messenger RNA stability and metabolism in hormone action.

Functional Pathology in Endocrine Glands: Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, cortiophin regulation.

Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes inspidus, hypo- and hyper-tonic syndromes.

Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and testicular functions.

Fuel Homeostasis: Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anoxia nervosa and bulimia nervosa.

Development and Growth: Disorders of growth and puberty.

Practicals

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

Textbook:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Edition. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol.I, II & III, 4th Edition. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

ZOO-6808	ENVIRONMENTAL ISSUES	3(2-1)
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Aims and Objectives

This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

Course Contents

Life a factor of rapid change in the environment, Population increase of diversified life in an ecosystem, Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance, Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty; integrated approach to alleviate poverty, Life style: Urban sprawl, consequences of ex-urban migration, Health in life style; Environment and health. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and

famine, Soil, irrigation, Stalinization, Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management, Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi-products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution sources and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Green house effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management. Energy resources (Fuel of production and development): energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues).

Practicals

Review, reports, field trips, discussions on current local, national, regional and global issues.

Approaches and strategies, mitigation measures.

Recommended Books

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. 'Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.

9. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology (A text book of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily news papers for current issues.

Z00-6809	Fish Biology	3(2-1)
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Course Objectives:

The objectives of the course are:

1. To enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular.
2. To impart knowledge of morphology, anatomy, classification and understanding of various feeding groups found in different water bodies.

Course Learning Outcomes:

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

1. Classify fishes on the basis of morphological and anatomical characters of freshwater and marine water fish species.
2. Differentiate various groups of fishes on the basis of their feeding habits.
3. Outline various aquatic habitats of fishes on the basis of water quality and characteristics

Course Contents:

1. **Systematic:** Identification of fishes up to; Families; Order; Genus; Species.
2. **Fish morphology:** Head (size, shape, and orientation); Scales (types, arrangements, coloration, scale less fishes); Operculum; Fins, fin rays and fin spine (dorsal, pectoral, caudal, anal); Barbel (upper lip barbels, lower lip barbels).
3. **Anatomy:** Skeleton (skull, backbone, spines); Brain and spinal cord; Gills (Number, size, arrangements); Vital organs (heart, liver, kidney); Viscera and mesenteries (swim bladder, stomach, spleen, pancreas, intestine, gonads).
4. **Feeding groups of fishes;** Herbivore; Plankton eater; Larvivore; Carnivore; Voracious.
5. **Ecology of fishes:** Freshwater; Brackish water; Marine water.

Practicals:

1. Collection, preservation and identification of freshwater fish species.

2. Study of different organs of various fish species.
3. Study and survey of various fish collection present in museums.
4. Studying quality of various water bodies.

Recommended Books

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

Course Objectives:

The objectives of the course are:-

1. To understand the extension to basic genetic laws.
2. To develop understanding of structure of human karyotype and chromosomal disorders
3. To equip the students with skills of genetic counseling and risk calculation of genetic disorders.

Course Learning Outcomes:

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

1. **Illustrate** the key features of human karyotyping and role of certain genes in cancer
2. **Understand** the basic mechanism involved in certain metabolic disorders.
3. **Interpret** certain pedigrees and assess risk calculation and reoccurrence risk of certain genetic disorders.
4. **Identify** certain treatment strategies of inherited disorders.

Course Outline:**1. Exceptions/Extensions to Mendel's laws**

- a. Phenocopy
- b. Lethal Alleles
- c. Genetic heterogeneity
- d. Multiple alleles
- e. Sex limited and sex influenced traits
- f. Incomplete and co dominance
- g. Polygenic inheritance
- h. Penetrance and expressivity

2. Human Karyotyping

- a. Staining
- b. Chromosomal banding
- c. Chromosomal Abnormalities

3. Pedigree analysis

- a. Autosomal recessive
- b. Autosomal dominant
- c. X-linked recessive
- d. X-linked dominant
- e. Y-linked
- f. Mitochondrial

4. Oncogenes and Cancer

- a. Proto-oncogenes
- b. Activation of Oncogenes
- c. Classification of Oncogenes
- d. Telomer, telomerase and cancer

5. **In born Errors of Metabolism**

- a. Disorder of carbohydrate metabolism
- b. Disorder of amino acid metabolism
- c. Disorder of Urea cycle

6. **Twin Studies**

- a. Monozygotic Twins
- b. Dizygotic Twins
- c. Concordance

7. **Prenatal Diagnosis**

- a. Methods of Prenatal Diagnosis
- b. Genetic counselling for Prenatal diagnosis

8. **Population Genetics**

- a. Hardy Weinberg equilibrium
- b. Heterozygote advantage and gene frequency in population
- c. Genetics in Medicine

Practicals

- Pedigree analysis.
- Ability to test PTC.
- Human chromosomes (slides).
- Study of inheritance of some human characteristic- hair color, eye color and tongue rolling.
- Genetic Counseling problems.
- Demonstration of various Cytogenetic techniques, Karyotyping and Banding, DNA extraction and sequencing.

Text and Reference Books:

1. Alberts, B., A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York. 2002.
2. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick.
3. Molecular biology of the gene. Pearson Education. 2004.
4. Snyder, L. and W. Chapness. Molecular Genetics of bacteria. ASM, Press, 2003.
5. Human genetics: concepts and applications, 11th Ed. McGraw-Hill education. 2014

6. Jocelyn E, Elliot S. Goldstein, Stephin T. Lewin's Gene-XII. Jones and Bartlett learning 2018.
7. Nussbaum, McInnes and Willard. Thompson and Thompson Genetics In Medicine 7th Edition 2009.
8. Willam S. Klug, Michael R. Cummings and Charlotte Spencer (2006). Concepts of genetics. Pearson education, Inc

ZOO-6811	ICHTHYOLOGY (FISH MORPHOLOGY)	3(2-1)
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Aims and Objectives

The purpose of this course is to provide students with a thorough introduction to fundamental ichthyology with emphasis on aspects of fish anatomy, biology and form and function.

Course Contents

Basic Morphology, Systematic, Zoogeography of fin fishes, shell fishes and crustaceans with special references to Pakistan. Brief survey of world fisheries and non-fish resources. Fishing Technology, fish preservation, Shelf life of fisheries of various types.

Practicals

Collection and identification of local fishes (fin fishes and shell fishes) and study of anatomy of selected fishes.

Recommended Books

1. Lagler, K.F. (1977). Ichthyology.
2. Norman, J.R. and Greenwood, P.H. (1975). A history of fishes.
3. Kestin, S. C. and Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Huet M. Text Book of Fish Culture: Breeding And Cultivation. 1973. Blackwell Publishing Company.

ZOO-6812	LIMNOLOGY-B	3(2-1)
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Aims and Objectives

Limnology is the study of inland waters – lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater – as ecological systems interacting with their drainage basins and the atmosphere. The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles, and biological productivity with species composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.

Course Contents

Dynamics of lotic and lentic series, Organisms in lotic and lentic environments, Influence of physical and chemical conditions on biota and their adaptations to physical and chemical conditions, Bacteria and other fungi, Nektons, Biological productivity.

Practicals

Collection, preservation and study of fauna and flora of various approachable water bodies; preparation of slides of microfauna and flora, identification, study of adaptive characteristics of animals and plants.

Recommended Books

1. Agrawal, S.C. 1999. Limnology. A.P.H. Publishing Corporation, N. Dehli.
2. Goldman, C.R. and Home, A.J. 1983. Limnology, McGraw Hill, International Book.
3. Welch, P.S. 1968. Limnology 8th Edition, McGraw Hill Book Co.I Inc., New York.
4. Singh, H.R. Advances in Limnology. Narendra. Publishing House, N. Delhi.
5. Allen S.E. 1990. Chemical Analysis of Ecological Materials. Scientific Publishers, London.

ZOO-6813	MAMMALOLOGY	3(2-1)
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Aims and Objectives

The purpose of this course is to acquaint students with the origin, evolution, identification, characteristics, systematics, life history, and adaptive strategies of the Mammalia and to expose them to field techniques used in their study.

Course Contents

Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Trituberular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

Practicals

1. General survey and classification up to species of important mammals
2. Skeleton of Mongoose or Cat, Hedgehog and Rabbit.

Recommended Books

1. Terry, A. Vaughan, J.M. Ryan and N.J. Czaplewski, 2009. Mammalogy 5th Ed. Jones and Bartlett Publishers.
2. F. Harvey, Pough, Christine, M. Janis, John, B. Heiser. Vertebrate Life. 2003. Pearson Education.

3. Hickman, Roberts, and Larsen, 2005, Integrated principles of Zoology (13th Edition). McGraw Hill, New York.
4. David, D., 1963. Principles of Mammalogy.
5. Davis. Principles of Mammalogy.
6. Gelder, Biology of Mammals.
7. Miller and Harley, 1999. Zoology (8th Edition).
8. Hickman, Roberts, and Larsen, 2001. Integrated Principles of Zoology (11th Edition).

ZOO-6814	MEDICAL MICROBIOLOGY	3(2-1)
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Aims and Objectives

- Aims of this course are to let the students know about the science of microbiology, To work with microorganisms, their pathogenicity, and various diseases and problems caused by microorganisms.
- The course may also initiate their interest in agricultural, industrial and/or environmental microbiology.

Course Learning Outcomes:

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

- Attain the sufficient knowledge about the microorganisms in different aspects of human life
- Identify specific areas in practical life where the science of microbiology is being applied.
- They can seek different job in various organizations such as clinical, industrial and environmental microbiology sections.

Course Contents

Microbiology and Medicine: antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions.

Bacterial pathogens and associated diseases. *Staphylococcus*, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomeruonephritis. *Pneumococcus*, respiratory infections.

Corynebacteriumdiphtheriae, *Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections. *Salmonella*, *Shigella*, *Escherichia coli*, *Klebsiella proteus*, *Bacillus anthracis*. *Clostridium tetnai*.

Viruses: Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirus

PahtogenicFungi and Protozoa.

Practicals

1. Basic techniques. (Staining of microorganisms: Simple stains, positive staining; negative staining. Culturing of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plates, pour plates method
2. Laboratory diagnosis and control of infections: Streptococcus, Corynebacterium, Listeria, Mycobacterium, Salmonella, Escherichia
3. Widal test
4. Blood tests: TLC, DLC, RBC.

Recommended Books

1. Kenneth Ryan, C. George Ray, Nafees Ahmad, W. Lawrence Drew, James Plorde. (2021). Ryan and Sherris Medical Microbiology, 8th Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology, 9th edition, Philadelphia: Elsevier/Mosby, 2020.
3. Prescott's Microbiology, 11th ed. (2019) by [Joanne Willey, Linda Sherwood and Christopher J. Woolverton](#)
4. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora, Berdell R. Funke, Christine L. Case.](#)
5. Microbial Applications (Complete Version) Laboratory Manual In General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.

ZOO-6815	MEDICAL PARASITOLOGY	3(2-1)
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Aims and Objectives:

To provide an overview of the major parasitic diseases of man and their vectors prevalent in Pakistan. By the end of these course students should be able to:

1. Demonstrate understanding of the biology and the life cycles of the major parasites and of their vectors or intermediate hosts
2. Identify the major parasites, vectors and intermediate hosts
3. Demonstrate understanding of the pathogenesis and pathology of the major parasitic diseases and the immune responses to these parasites
4. Appreciate the epidemiology of the major parasitic infections
5. Appreciate methods available for chemotherapy and control

Course Learning Outcomes:

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

1. Identify important parasites of medical importance.
2. Comprehend how each parasite become involved in the transmission of causative agents of human diseases.
3. Develop methods to control of parasitic diseases based on knowledge of vector biology.

Course Contents:

Introduction to Medical Parasitology (Terminologies used in Medical Parasitology, Medically important parasites in Animal Kingdom, Importance and Scope of Medical Parasitology), Parasitic Adaptations (Morphological and Physiological), Cryptobiosis

- Amoebiasis
- Giardiasis
- Trypanosomiasis
- Leishmaniasis
- Ascariasis
- Echinococcosis
- Schistosomiasis
- Fascioliasis

Study of abovemedically important diseases of Human with following headings

- Introduction about disease (History, parasite and disease name)
- Biology (Life Cycle of Parasite)
- Epidemiology
- Signs and Symptoms
- Diagnosis
- Prevention and Control
- Treatment

Practical:

- Methods of collection of parasites
- Preservation of parasites
- Transportation of parasitic material
- Isolation of these parasites from different sources
- Identification of parasites (Different techniques used for diagnosis of above parasitic diseases)
 - Microscopic Examination of Parasite
 - Staining of parasites
 - ELISA
 - PCR Identification
- Identification of Insects of medical importance

Teaching Methodology:

- Lecturing

- Written Assignments
- Report Writing
- Practical observations

Assessment:

Mid Term (40%)

Theory

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10% Final Term (60%)
- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Recommended Books:

1. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites. 5th edition. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical Parasitology. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M. 1987. Medical Laboratory Manual for Tropical Medicine. Vol. I. University Press Cambridge.
4. Smith, J.D., 1998. Introduction to Animal Parasitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J.Jr., 2001. Foundations of Parasitology. 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitology Longman Scientific and Technical publications, Longman Group, U.K.

ZOO-6816	MOLECULAR PHYSIOLOGY	3(2-1)
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Course Objectives:

Knowledge

At the end of the course the student will be able to:

1. Understand on the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases,

removal of nitrogenous wastes tissue, osmotic and organ physiological mechanisms underlying animal homeostasis and temperature effects.

2. Grasp the development of performing the function developed at molecular and cellular level in the complexity of the animals such as chemical & nervous integration, respiratory and excretory functions.
3. Know the strategy acquired to perform the functions in diverse environment such as in dry & aquatic and cold and hot at molecular and cellular level and regulations to achieve strategy by chemical and nervous regulation at organ levels.
4. Comprehend the concepts in homeostasis and integration in sustaining the life in constantly changing conditions.

Skills:

At the end of the course the student will be able to:

1. Perform experiments designed either primarily for the study of physiological phenomena or for assessment of function.
2. Analyze and interpret experimental/investigative data critically in performance of functions in changed conditions.
3. 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 Learning Outcomes:

Following the completion of this course, each student should have:

1. An understanding of critical concepts, processes, and factual information in the performance of functions and changing conditions.
2. A knowledge of resources for finding the solution for strategies to sustain diverse forms of animal life kept and in wild in normal and abnormal conditions.
3. The ability to utilize knowledge of animal physiology in critical study and for making intelligent decisions in professional life.

Theory:

Concept of Physiology

1. Principles of Homeostasis and conformity
2. Principles of regulation and adaptation

Membrane Physiology:

1. Ionic distribution across membrane
2. Resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Ion channels.

Nerve and Muscle Physiology:

1. Action potentials in neurons
2. Electrical and chemical synaptic transmission
3. Neurotransmitters in communications
4. Receptors of neurotransmitters in diverse physiological responses
5. Excitatory and inhibitory postsynaptic potentials
6. Neuronal networks and their role in nervous integration
7. Muscles: Structure, types, components, muscle proteins
8. Molecular basis of muscle contraction
9. Sarcoplasmic reticulum and role of calcium
10. Neuromuscular interaction at cell and molecular level muscle
11. Types of muscle contractions and muscle fatigue.

Endocrine Physiology:

1. 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.

Respiratory Physiology:

1. Mechanism of respiratory gases exchange in aquatic and terrestrial respiratory structures.
2. Control of respiration and stimulus factors in various animals.
3. Respiration adaptations in hypoxia and percapnia etc.
4. Air breathing and respiratory adaptations diver animals.

Excretory Physiology:

1. Strategy of mammalian large glomerular filtration and reabsorption in nitrogenous excretion.
2. Patterns of nitrogenous excretion in various animals and their phylogenetic significance.

Physiology of Nutrition:

1. Adaptation of nutritive canal for digestion and absorption of nutrients in different animals specifically the vertebrates.
2. Regulation of digestive secretions.
3. Mechanisms of of water, ions and nutrients absorptions and their significances in diverse groups.
4. Potential and Movements in gastrointestinal tract and control of motility.

Practicals:

Nerve and Muscle

1. Study of post synaptic receptor mechanisms in neuromuscular preparation of frogs.
2. Study of excitable and contractile properties of a nerve-muscle preparation.
3. Ultrastructure study of muscle structure for muscle contraction.

Respiration and circulation

1. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse.

Hormones System:

1. Video studies on the effects of hormones in breeding season behaviours of various behaviours.
2. Study through clinics data on the insulin and glycemia in type1 and type 2 diabetic subjects.

Text/Reference Books:

1. Principles of Animal Physiology Third Edition

Moyes, Christopher D. ^Schulte, Patricia M. **Publisher:** Pearson; 3 edition, 2015.

2. Eckert Animal Physiology Fifth Edition

David Randall, Warren Burggren, Kathleen French W. H. Freeman; 2001.

3. Animal Physiology: From Genes to Organisms 2nd Edition Lauralee Sherwood, Hillar Klandorf,

Paul Yancey Brooks Cole; 2012.

4. Animal Physiology 4th Edition

Richard W. Hill, Gordon A. Wyse, Margaret Anderson Sinauer Associates, Oxford University Press, 2016

ZOO-6817	PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS	3(2-1)
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Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to different body organs and systems and their relationship with the surrounding environment.

Course Contents

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; cerebral, fetal. **Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions. **Renal System:** Elements of renal function; tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance. **Gastrointestinal System:** Gastrointestinal secretions and their control: salivary, gastric, pancreatic and hepatic; Digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and

motility in various segments. **Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of ectotherms, Heterotherms and endotherms; Dormancy: Special metabolic state; body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of different factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion of nutrients by enzymes and effects of factors; study of exocrine secretion in stomach and pancreas. Experiments on kidney regulation of osmolarity; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald., R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 8th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Loewy, M.N., 2000. Principles of Physiology, 3rd edition. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E. 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environments, 5th edition. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D. 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

ZOO-6818	ORNITHOLOGY	3(2-1)
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Course objectives:

Objectives of the proposed course are aimed to:

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

Course Learning Outcomes:

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

6. **ACQUIRE** the basic knowledge of the birds in the diversified habitats.
7. **UNDERSTAND** their behavior and possible their relationships to the natural habitats.
8. **SOLVE** the issues to detect minute morphological variations by using different high power spotting scopes in the field study for various habitats.
9. **ANALYZE** the likely impacts of changing climatic conditions on variety of birds in different ecosystems to sift in roosting, nesting and behavioural mechanisms.

Course Outlines (contents):

- a. **Introduction** to ornithology; basic ecology and themes of study.
- b. **Classification and taxonomy** of birds up to orders and species
- c. **Evolution** of birds; evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.
- d. **Biology of fossil birds**; study of the representative birds viz. *Archaeopteryx*, *Archaeornithes* and *Neoornithes*. Comparison with the present existing birds.
- e. **Behavioural studies of birds**: song and sound dialects in birds; types of songs; preferred season and time for bird pleasure calls; distress calls. Courtship behavior in birds, bird foraging, nesting and roosting activities. Learned and imprinting mechanisms in birds; Birds as pests
- f. **Predator-Prey** relationships, mobbing impacts; foraging and territoriality scuffles; predator avoidance.
- g. **Physiology of birds**: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds.
- h. **Bird conservation strategies**; sanctuaries and importance of urban zoos in bird life.

Practical:

1. Identification characteristics and taxonomy of birds to orders and families.
2. Dissection of sparrow, pigeon or common myna.
3. Study of gut contents of birds to assess their feeding habits.
4. Bird watching and preparation of ethograms
5. Visit of PMNH for study of preserved specimens of different groups of birds in relation to their taxonomy and ecosystem etc.
6. Field visits for bird watching (population estimation, nesting, vocal calls, feeding and other behaviours etc.) in different ecologies.

Text and Reference Books:

1. Gill, F. B, and Prum, R.O. 2019. Ornithology, 4th Ed. Macmillan.
2. Lovette, I. J and Fitzpatrick, J. W. 2016. Handbook of Bird Biology, 3rd Ed. Wiley.
3. Birkhead, T., Wimpenny, J., and Montgomerie, B. 2014. Ten thousand Birds: Ornithology since Darwin. Princeton University Press. Princeton, NJ.
4. Birkhead, T. 2013. Bird Sense: What it's like to be a bird? Bloomsbury, NY.
5. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
6. A.J.Urfi (2009). Birds of India: A Literary Companion, OUP.
7. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.
8. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
9. *Handbook of Bird Biology* (2014). Cornell Lab. Ornithology. Princeton University Press. New Jersey, USA.

ZOO-6819	Vector Biology	3(2-1)
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Course objectives:

The objectives of courses are:

1. To provide in depth appreciation of diseases transmitted by invertebrate vectors.
2. To impart knowledge about vector- parasite interactions relevant to vector epidemiology and control of vector-borne diseases.
3. To provide students with a broad understanding of the key aspects of insect behavior, vector ecology.

Course learning outcomes:

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

1. Discover the basic knowledge of vector biology.
2. Illustrate the concepts of disease transmission by invertebrate vectors.
3. Analyze knowledge for control of vector – borne diseases

Course Outline:

1. Basic Concepts of vector biology
 - a. What are vectors and vector biology
 - b. Detailed studies of systematics
2. Vector biology and Control
 - a. Key aspects of Vector Taxonomy
 - b. Evolution
 - c. Biology and Behaviour
 - d. an introduction to the life cycles of vectors
3. Ecology:
 - Role in transmission of various diseases
4. Major groups of arthrop-borne pathogens and vectors
 - a: Basic components of arthropathogen disease cycles
 - b: Principle of pathogen transmission dynamics
5. Emergent pathogens:
 - a: Vector genetics
 - b: Vaccines for vector borne diseases
 - c: Traditional and modern disease control strategies
 - d: Venomous Arthropods
6. Biology and Ecology of some vectors of medical importance (order diptera)
 - a. Anopheles mosquito, culicine mosquitoes, black flies, sand 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)
 - b. Morphology, anatomy, distribution, breeding habits, life-cycle and Seasonal prevalence of the species
 - c. Brief account of diseases spread by these vectors
 - d. Methods of control
 - e. Modern trends in their biological and chemical control.

Practicals:

1. Demonstration on identification methods.
2. Demonstration of dissection methods.
3. Dissection of selected vectors like mosquitoes, house flies, blue bottles, green bottles and bot flies.
4. Methods of preparation of slides of parasites (available)
5. Study of prepared slides of parasites
6. Epidemiological studies of vector-borne diseases like malaria as well as studies of control methods and parasitic evaluation.

Teaching Methodology:

- . Lecturing
- . Writing Assignments
- . Field visits
- . Report Writing

Text and Reference Books:

1. Vector biology, Ecology and control, Peter W. Atkinson, 2010
2. William A. Riley. Medical Entomology. McGraw Hill Book Co. Inc. London.
3. McDonald, GA. The Epidemiology and Control of Malaria, London Oxford Press.
4. Population biology of Vector – borne diseases. John M. Drake, Michael B. Bonsall and Michael R. Strand. 2020
5. Parasitology and Vector Biology. Cheryl Jose. 2016
6. World Health importance Geneva, WHO, 2018.
7. World health organization. Vector control series. Training and information guide. The House fly.
8. Microbial Control of vector – borne diseases. Brij Kishore Tyagi Dharumadural Dhanasekaran, 2018.

ZOO-6820	VERTEBRATA	3(2-1)
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Course Objectives

The objectives of the course are: -

1. To enable them to understand the Taxonomic characteristics of protochordates and chordates.
2. To impart knowledge about the classification of protochordates and various classes of chordates.
3. To enable them to compare embryological development of different classes of chordates.
4. 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 in chordates.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of Taxonomic characteristics of chordates and the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **UNDERSTAND** that diverse forms adapted to perform the same functions are because of the different past and present conditions in Pisces, amphibians, reptiles and mammals.
3. **ANALYZE** the comparative anatomy and physiology within chordates.
4. **DEMONSTRATE** individually physiological adaptations of chordates.

Course Outline:

1. **Protochordates**

- a. Classification of protochordates (up to orders).
- b. Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates
- c. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in protochordates
- d. Reproduction; life histories and metamorphosis of protochordates.

2. **Fishes:**

- a. Classification of Chondrichthyes, Osteichthyes, Dipnoi and
- b. Holocephalli (up to orders).
- c. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).
- d. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in fishes.

3. **Amphibians:**

- a. The first terrestrial vertebrates. Characteristics of amphibians.
- b. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.
- c. Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperatureregulation, nervous and sensory functions, excretion and
- d. Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
- e. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in amphibians.

4. **Reptiles:**

- a. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
- b. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia
- c. 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 of helonia, squamata, Rhynchocephalia and crocodilian.
- d. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in reptiles.

5. **Birds:**

- a. Classification of birds (up to orders).
- b. Feathers, flight and endothermy.
- c. Ancient birds and the evolution of flight.
- d. 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.
- e. Migration and navigation.
- f. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in birds.

6. **Mammals:**

- a. Classification (up to orders).
- b. Specialized teeth, endothermy, hair and viviparity.
- c. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behaviour, reproduction and development.
- d. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in mammals.

Practicals:

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.
3. whole mount of *Amphioxus* sp. T.S. *Amphioxus* through different regions. Pharynx of an ascidians. Sections of skin of fish, frog and rabbit. Section of mammalian liver, kidney, spleen, thyroid gland, testes, ovary, heart muscle, pancreas, nerve cord, lungs and Intestine etc. Whole mounts and histological sections of different developmental stages of chick.

Teaching Methodology:

- Lecturing
- Written Assignments
- Practical
- Discussion

Text and Reference Books:

1. Pandey, B. N., & Mathur, V. (2018). Biology of chordates. PHI Learning Pvt. Ltd.
2. Salazar, A. (2018). Advanced Chordate Zoology. Scientific e-Resources.
3. Verma, P. S. (2013). Chordate zoology. S. Chand Publishing.
4. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
5. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
6. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
7. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.
8. Verma, P. S., & Agarwal, V. K. (2006). *Chordate Embryology*. S. Chand Publishing

ZOO-6821	WILDLIFE	3(2-1)
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Course Objectives:

The objective of this course is

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

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
2. UNDERSTAND the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
3. SOLVE the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).

4. ANALYSE, interpret and synthesize data and other information about the population of wildlife
5. EVALUATE the conservation management by government department, National and International organisations
6. DEMONSTRATE the ecological assessment and importance of wildlife to certain area.

Course Outline

1. Wildlife of Pakistan

- a) Introduction to wildlife
- b) Existing wildlife of Pakistan,
- c) Identification, classification, distribution, and conservation status of important wildlife species of Pakistan
- d) Introduction to major wildlife habitats in Pakistan/AJK.

2. Philosophy and significance of wildlife conservation

- a) Philosophy and significance of wildlife conservation.
- b) Conservation of wildlife- insito and exsito conservation approaches
- c) Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan
- d) Biodiversity and sustainability of wildlife.
- e) Human-wildlife conflict and its mitigation

3. Wildlife rules and regulations in Pakistan

- a) Wildlife management in Pakistan/AJK.
- b) Wildlife rules and regulations in Pakistan/AJK.

4. National and International agencies involved in conservation and management of wildlife

- a. National Organizations
- b. International Organizations

5. Protected Areas in Pakistan

Protected areas (Sanctuaries, Game Reserves and National Parks) in Pakistan/ AJK.

6. Introduction to some modern techniques used in wildlife conservation

- a) Radio telemetry,
- b) remote camera,
- c) TIR,
- d) GPS,

- e) GIS,
- f) RS,
- g) molecular analysis

Practicals:

1. Study of museum specimens and their classification (Birds and Mammals)
2. Demonstration of distribution of avian and mammalian fauna of Pakistan. (Blank maps may be provided).
3. Study of Birds and mammals census techniques.
4. Use of GPS in field studies.
5. Visit of Zoos, museums and protected areas

Text and Reference Books:

1. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, Latest Edition (International). Singapore: McGraw-Hill.
2. Ali. S.S. 2005 Wildlife of Pakistan.
3. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
4. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
6. Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I and II. Oxford University Press
7. Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press
8. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.
9. Wildlife of the Punjab, Punjab Wildlife Department.
10. Khan M. S. 2011, Amphibian and Reptiles of Pakistan Mirza Z.B. 2011 Biodiversity of Pakistan.

