ACE Biology (3 Semester Credits) - Course Syllabus

Description:
Biology provides comprehensive coverage of foundational research and core biology concepts through an evolutionary lens. *Biology* includes rich features that engage students in scientific inquiry, highlights careers in the biological sciences, and offers everyday applications.

Textbook: *Biology* – Open Stax – Clark, et al., ISBN-10: 1-947172-52-2
(This text is provided to students as part of their enrollment.)

Prerequisites: No prerequisites

Course objectives:
Throughout the course, you will meet the following goals:

- Apply the processes of scientific inquiry including experimental design.
- Explain the essential elements of life, major hypotheses for life's history, mechanisms for the diversification of life, and macroevolution.
- Apply the tools of evolutionary biology to the analysis and evaluation of historical relationships among organisms.
- Evaluate the ecological relationships of organisms at the population, community, and ecosystem level.
- Describe flow of energy within an ecosystem and the role of nutrient cycling in maintaining ecosystem integrity.
- Explain fundamental prokaryotic replication, metabolism, and cellular structure in relationship to evolution of diversity.
- Compare and contrast differences in animal and plant development and their life cycles.
- Describe how plants and animals maintain homeostasis: water and ion balance, gas exchange, energy and nutrient acquisition, temperature regulation.
- Identify major groups and arrange them within currently recognized taxa.
- Compare and evaluate different phylogenies in terms of relationships amongst taxa.
- Describe structural organization/morphology.
- Identify and describe structures and relate them to their functions.
- Classify individual representative specimens to phylum.

Course Evaluation Criteria
A passing percentage is **70%** or higher.

(Continued)

Grading Scale
A = 95-100%
B = 88-94.9%
C = 80-87.9%
D = 70-79.9%
F = below 70%

ACE Course Retake Policy
2 (two) attempts are allowed on every quiz, and 2 (two) attempts are allowed on every final exam.

***Proctorio* – Video Proctoring**
All Final Exams are video proctored with Proctorio. (www.proctorio.com)

ADA Policy
Excel Education Systems is committed to maintaining an inclusive and accessible environment to all students, across all of its schools, in accordance with the 1990 Federal Americans with Disabilities Act (ADA).

There is a **total of 390 points** in this course:

Grade Weighting

Chapter Quizzes	70%
Final Exam	30%
	100%

Assessment	Points Available	Percentage of Final Grade
Unit 1 Quiz	40	8.75
Unit 2 Quiz	40	8.75
Unit 3 Quiz	40	8.75
Unit 4 Quiz	40	8.75
Unit 5 Quiz	40	8.75
Unit 6 Quiz	40	8.75
Unit 7 Quiz	40	8.75
Unit 8 Quiz	40	8.75
Final Exam	70	30
Total	**390**	**100**

Course Contents and Objectives

Unit 1 – The Chemistry of Life (Chapters 1-3)	
Lessons	1.1 The Science of Biology 1.2 Themes and Concepts of Biology 2.1 Atoms, Isotopes, Ions, and Molecules: The Building Blocks 2.2 Water 2.3 Carbon

	3.1 Synthesis of Biological Macromolecules 3.2 Carbohydrates 3.3 Lipids 3.4 Proteins 3.5 Nucleic Acid
Objectives	• Identify the shared characteristics of the natural sciences. • Summarize the steps of the scientific method. • Compare inductive reasoning with deductive reasoning. • Describe the goals of basic science and applied science. • Identify and describe the properties of life. • Describe the levels of organization among living things. • Recognize and interpret a phylogenetic tree. • List examples of different sub disciplines in biology. • Define matter and elements. • Describe the interrelationship between protons, neutrons, and electrons. • Compare the ways in which electrons can be donated or shared between atoms. • Explain the ways in which naturally occurring elements combine to create molecules, cells, tissues, organ systems, and organisms. • Describe the properties of water that are critical to maintaining life. • Explain why water is an excellent solvent. • Provide examples of water's cohesive and adhesive properties. • Discuss the role of acids, bases, and buffers in homeostasis. • Explain why carbon is important for life. • Describe the role of functional groups in biological molecules. • Understand the synthesis of macromolecules. • Explain dehydration (or condensation) and hydrolysis reactions. • Discuss the role of carbohydrates in cells and in the extracellular materials of animals and plants. • Explain the classifications of carbohydrates. • List common monosaccharides, disaccharides, and polysaccharides. • Describe the four major types of lipids. • Explain the role of fats in storing energy. • Differentiate between saturated and unsaturated fatty acids. • Describe phospholipids and their role in cells. • Define the basic structure of a steroid and some functions of steroids. • Explain the how cholesterol helps to maintain the fluid nature of the plasma membrane.

	• Describe the functions proteins perform in the cell and in tissues. • Discuss the relationship between amino acids and proteins. • Explain the four levels of protein organization. • Describe the ways in which protein shape and function are linked. • Describe the structure of nucleic acids and define the two types of nucleic acids. • Explain the structure and role of DNA. • Explain the structure and roles of RNA.

Unit 2 – The Cell (Chapters 4-10)	
Lessons	4.1 Studying Cells 4.2 Prokaryotic Cells 4.3 Eukaryotic Cells 4.4 The Endomembrane System and Proteins 4.5 The Cytoskeleton 4.6 Connections between Cells and Cellular Activities 5.1 Compounds and Structure 5.2 Passive Transport 5.3 Active Transport 5.4 Bulk Transport 6.1 Energy and Metabolism 6.2 Potential, Kinetic, Free, and Activation Energy 6.3 The Laws of Thermodynamics 6.4 ATP: Adenosine Triphosphate 6.5 Enzymes 7.1 Energy in Living Systems 7.2 Glycolysis 7.3 Oxidation of Pyruvate and the Citric Acid Cycle 7.4 Oxidative Phosphorylation 7.5 Metabolism without Oxygen 7.6 Connections of Carbohydrate, Protein, and Lipid Metabolic Pathways 7.7 Regulation of Cellular Respiration 8.1 Overview of Photosynthesis 8.2 The Light-Dependent Reactions of Photosynthesis 8.3 Using Light Energy to Make Organic Molecules 9.1 Signaling Molecules and Cellular Receptors 9.2 Propagation of the Signal 9.3 Response to the Signal 9.4 Signaling in Single-Celled Organisms 10.1 Cell Division 10.2 The Cell Cycle 10.3 Control of the Cell Cycle 10.4 Cancer and the Cell Cycle

	10.5 Prokaryotic Cell Division
Objectives	• Describe the role of cells in organisms. • Compare and contrast light microscopy and electron microscopy. • Summarize cell theory. • Name examples of prokaryotic and eukaryotic organisms. • Compare and contrast prokaryotic cells and eukaryotic cells. • Describe the relative sizes of different kinds of cells. • Explain why cells must be small. • Describe the structure of eukaryotic cells. • Compare animal cells with plant cells. • State the role of the plasma membrane. • Summarize the functions of the major cell organelles. • List the components of the endomembrane system. • Recognize the relationship between the endomembrane system and its functions. • Describe the cytoskeleton. • Compare the roles of microfilaments, intermediate filaments, and microtubules. • Compare and contrast cilia and flagella. • Summarize the differences among the components of prokaryotic cells, animal cells, and plant cells. • Describe the extracellular matrix. • List examples of the ways that plant cells and animal cells communicate with adjacent cells. • Summarize the roles of tight junctions, desmosomes, gap junctions, and plasmodesmata. • Understand the fluid mosaic model of cell membranes. • Describe the functions of phospholipids, proteins, and carbohydrates in membranes. • Discuss membrane fluidity. • Explain why and how passive transport occurs. • Understand the processes of osmosis and diffusion. • Define tonicity and describe its relevance to passive transport. • Understand how electrochemical gradients affect ions. • Distinguish between primary active transport and secondary active transport. • Describe endocytosis, including phagocytosis, pinocytosis, and receptor-mediated endocytosis. • Understand the process of exocytosis. • Explain what metabolic pathways are and describe the two major types of metabolic pathways. • Discuss how chemical reactions play a role in energy transfer.

	• Define “energy”. • Explain the difference between kinetic and potential energy. • Discuss the concepts of free energy and activation energy. • Describe endergonic and exergonic reactions. • Discuss the concept of entropy. • Explain the first and second laws of thermodynamics. • Explain the role of ATP as the cellular energy currency. • Describe how energy is released through hydrolysis of ATP. • Describe the role of enzymes in metabolic pathways. • Explain how enzymes function as molecular catalysts. • Discuss enzyme regulation by various factors. • Discuss the importance of electrons in the transfer of energy in living systems. • Explain how ATP is used by the cell as an energy source. • Describe the overall result in terms of molecules produced in the breakdown of glucose by glycolysis. • Compare the output of glycolysis in terms of ATP molecules and NADH molecules produced. • Explain how a circular pathway, such as the citric acid cycle, fundamentally differs from a linear pathway, such as glycolysis. • Describe how pyruvate, the product of glycolysis, is prepared for entry into the citric acid cycle. • Describe how electrons move through the electron transport chain and what happens to their energy levels. • Explain how a proton (H+) gradient is established and maintained by the electron transport chain. • Describe how electrons move through the electron transport chain and what happens to their energy levels. • Explain how a proton (H+) gradient is established and maintained by the electron transport chain. • Discuss the ways in which carbohydrate metabolic pathways, glycolysis, and the citric acid cycle interrelate with protein and lipid metabolic pathways. • Explain why metabolic pathways are not considered closed systems. • Describe how feedback inhibition would affect the production of an intermediate or product in a pathway. • Identify the mechanism that controls the rate of the transport of electrons through the electron transport chain. • Explain the relevance of photosynthesis to other living things. • Describe the main structures involved in photosynthesis. • Identify the substrates and products of photosynthesis.

	• Summarize the process of photosynthesis. • Explain how plants absorb energy from sunlight. • Describe short and long wavelengths of light. • Describe how and where photosynthesis takes place within a plant. • Describe the Calvin cycle. • Define carbon fixation. • Explain how photosynthesis works in the energy cycle of all living organisms. • Describe four types of signaling found in multicellular organisms. • Compare internal receptors with cell-surface receptors. • Recognize the relationship between a ligand's structure and its mechanism of action. • Explain how the binding of a ligand initiates signal transduction throughout a cell. • Recognize the role of phosphorylation in the transmission of intracellular signals. • Evaluate the role of second messengers in signal transmission. • Describe how signaling pathways direct protein expression, cellular metabolism, and cell growth. • Identify the function of PKC in signal transduction pathways. • Recognize the role of apoptosis in the development and maintenance of a healthy organism. • Describe how single-celled yeasts use cell signaling to communicate with one another. • Relate the role of quorum sensing to the ability of some bacteria to form biofilms. • Describe the structure of prokaryotic and eukaryotic genomes. • Distinguish between chromosomes, genes, and traits. • Describe the mechanisms of chromosome compaction. • Describe the three stages of interphase. • Discuss the behavior of chromosomes during karyokinesis. • Explain how the cytoplasmic content is divided during cytokinesis. • Define the quiescent G_o phase. • Understand how the cell cycle is controlled by mechanisms both internal and external to the cell. • Explain how the three internal control checkpoints occur at the end of G_1, at the G_2/M transition, and during metaphase. • Describe the molecules that control the cell cycle through positive and negative regulation. • Describe how cancer is caused by uncontrolled cell growth.

	• Understand how proto-oncogenes are normal cell genes that, when mutated, become oncogenes. • Describe how tumor suppressors function. • Explain how mutant tumor suppressors cause cancer. • Describe the process of binary fission in prokaryotes. • Explain how FtsZ and tubulin proteins are examples of homology.

Unit 3 – Genetics (Chapters 11-17)	
Lessons	11.1 The Process of Meiosis 11.2 Sexual Reproduction 12.1 Mendel's Experiments and the Laws of Probability 12.2 Characteristics and Traits 12.3 Laws of Inheritance 13.1 Chromosomal Theory and Genetic Linkage 13.2 Chromosomal Basis of Inherited Disorders 14.1 Historical Basis of Modern Understanding 14.2 DNA Structure and Sequencing 14.3 Basics of DNA Replication 14.4 DNA Replication in Prokaryotes 14.5 DNA Replication in Eukaryotes 14.6 DNA Repair 15.1 The Genetic Code 15.2 Prokaryotic Transcription 15.3 Eukaryotic Transcription 15.4 RNA Processing in Eukaryotes 15.5 Ribosomes and Protein Synthesis 16.1 Regulation of Gene Expression 16.2 Prokaryotic Gene Regulation 16.3 Eukaryotic Epigenetic Gene Regulation 16.4 Eukaryotic Transcription Gene Regulation 16.5 Eukaryotic Post-transcriptional Gene Regulation 16.6 Eukaryotic Translational and Post-translational Gene Regulation 16.7 Cancer and Gene Regulation 17.1 Biotechnology 17.2 Mapping Genomes 17.3 Whole-Genome Sequencing 17.4 Applying Genomics 17.5 Genomics and Proteomics
Objectives	• Describe the behavior of chromosomes during meiosis. • Describe cellular events during meiosis. • Explain the differences between meiosis and mitosis. • Explain the mechanisms within meiosis that generate genetic variation among the products of meiosis.

	• Explain that meiosis and sexual reproduction are evolved traits. • Identify variation among offspring as a potential. evolutionary advantage to sexual reproduction. • Describe the three different life-cycle types among sexual multicellular organisms and their commonalities. • Describe the scientific reasons for the success of Mendel's experimental work. • Describe the expected outcomes of monohybrid crosses involving dominant and recessive alleles. • Apply the sum and product rules to calculate probabilities. • Explain the relationship between genotypes and phenotypes in dominant and recessive gene systems. • Develop a Punnett square to calculate the expected proportions of genotypes and phenotypes in a monohybrid cross. • Explain the purpose and methods of a test cross. • Identify non-Mendelian inheritance patterns such as incomplete dominance, codominance, recessive lethals, multiple alleles, and sex linkage. • Explain Mendel's law of segregation and independent assortment in terms of genetics and the events of meiosis. • Use the forked-line method and the probability rules to calculate the probability of genotypes and phenotypes from multiple gene crosses. • Explain the effect of linkage and recombination on gamete genotypes. • Explain the phenotypic outcomes of epistatic effects between genes. • Discuss Sutton's Chromosomal Theory of Inheritance. • Describe genetic linkage. • Explain the process of homologous recombination, or crossing over. • Describe how chromosome maps are created. • Calculate the distances between three genes on a chromosome using a three-point test cross. • Describe how a karyogram is created. • Explain how nondisjunction leads to disorders in chromosome number. • Compare disorders caused by aneuploidy. • Describe how errors in chromosome structure occur through inversions and translocations. • Explain transformation of DNA. • Describe the key experiments that helped identify that DNA is the genetic material. • State and explain Chargaff's rules.

	• Describe the structure of DNA. • Explain the Sanger method of DNA sequencing. • Discuss the similarities and differences between eukaryotic and prokaryotic DNA. • Explain how the structure of DNA reveals the replication process. • Describe the Meselson and Stahl experiments. • Explain the process of DNA replication in prokaryotes. • Discuss the role of different enzymes and proteins in supporting this process. • Explain the process of DNA replication in prokaryotes • Discuss the role of different enzymes and proteins in supporting this process • Discuss the similarities and differences between DNA replication in eukaryotes and prokaryotes. • State the role of telomerase in DNA replication. • Discuss the different types of mutations in DNA. • Explain DNA repair mechanisms. • Explain the "central dogma" of protein synthesis. • Describe the genetic code and how the nucleotide sequence prescribes the amino acid and the protein sequence. • List the different steps in prokaryotic transcription. • Discuss the role of promoters in prokaryotic transcription. • Describe how and when transcription is terminated. • List the steps in eukaryotic transcription. • Discuss the role of RNA polymerases in transcription. • Compare and contrast the three RNA polymerases. • Explain the significance of transcription factors. • Describe the different steps in RNA processing. • Understand the significance of exons, introns, and splicing. • Explain how tRNAs and rRNAs are processed. • Describe the different steps in protein synthesis. • Discuss the role of ribosomes in protein synthesis. • Discuss why every cell does not express all of its genes. • Describe how prokaryotic gene regulation occurs at the transcriptional level. • Discuss how eukaryotic gene regulation occurs at the epigenetic, transcriptional, post-transcriptional, translational, and post-translational levels. • Describe the steps involved in prokaryotic gene regulation. • Explain the roles of activators, inducers, and repressors in gene regulation. • Explain the process of epigenetic regulation. • Describe how access to DNA is controlled by histone modification. • Discuss the role of transcription factors in gene regulation.

	• Explain how enhancers and repressors regulate gene expression. • Understand RNA splicing and explain its role in regulating gene expression. • Describe the importance of RNA stability in gene regulation. • Understand the process of translation and discuss its key factors. • Describe how the initiation complex controls translation. • Explain the different ways in which the post-translational control of gene expression takes place. • Describe how changes to gene expression can cause cancer. • Explain how changes to gene expression at different levels can disrupt the cell cycle. • Discuss how understanding regulation of gene expression can lead to better drug design. • Describe gel electrophoresis. • Explain molecular and reproductive cloning. • Describe uses of biotechnology in medicine and agriculture. • Describe gel electrophoresis. • Explain molecular and reproductive cloning. • Describe uses of biotechnology in medicine and agriculture. • Describe three types of sequencing. • Define whole-genome sequencing. • Explain pharmacogenomics. • Define polygenic. • Explain systems biology. • Describe a proteome. • Define protein signature.

Unit 4 – Evolutionary Processes (Chapters 18-20)	
Lessons	18.1 Understanding Evolution 18.2 Formation of New Species 18.3 Reconnection and Rates of Speciation 19.1 Population Evolution 19.2 Population Genetics 19.3 Adaptive Evolution 20.1 Organizing Life on Earth 20.2 Determining Evolutionary Relationships 20.3 Perspectives on the Phylogenetic Tree
Objectives	• Describe how the present-day theory of evolution was developed. • Define adaptation. • Explain convergent and divergent evolution.

	• Describe homologous and vestigial structures. • Discuss misconceptions about the theory of evolution. • Define species and describe how species are identified as different. • Describe genetic variables that lead to speciation. • Identify prezygotic and postzygotic reproductive barriers. • Explain allopatric and sympatric speciation. • Describe adaptive radiation. • Describe pathways of species evolution in hybrid zones. • Explain the two major theories on rates of speciation. • Define population genetics and describe how population genetics is used in the study of the evolution of populations. • Define the Hardy-Weinberg principle and discuss its importance. • Discuss the need for a comprehensive classification system. • List the different levels of the taxonomic classification system. • Describe how systematics and taxonomy relate to phylogeny. • Discuss the components and purpose of a phylogenetic tree. • Compare homologous and analogous traits. • Discuss the purpose of cladistics. • Describe maximum parsimony. • Describe horizontal gene transfer. • Illustrate how prokaryotes and eukaryotes transfer genes horizontally. • Identify the web and ring models of phylogenetic relationships and describe how they differ from the original phylogenetic tree concept.

Unit 5 – Biological Diversity (Chapters 21-29)	
Lessons	21.1 Viral Evolution, Morphology, and Classification 21.2 Virus Infections and Hosts 21.3 Prevention and Treatment of Viral Infections 21.4 Other Acellular Entities: Prions and Viroids 22.1 Prokaryotic Diversity 22.2 Structure of Prokaryotes 22.3 Prokaryotic Metabolism 22.4 Bacterial Diseases in Humans 22.5 Beneficial Prokaryotes 23.1 Eukaryotic Origins 23.2 Characteristics of Protists 23.3 Groups of Protists

	23.4 Ecology of Protists 24.1 Characteristics of Fungi 24.2 Classifications of Fungi 24.3 Ecology of Fungi 24.4 Fungal Parasites and Pathogens 24.5 Importance of Fungi in Human Life 25.1 Early Plant Life 25.2 Green Algae: Precursors of Land Plants 25.3 Bryophytes 25.4 Seedless Vascular Plants 26.1 Evolution of Seed Plants 26.2 Gymnosperms 26.3 Angiosperms 26.4 The Role of Seed Plants 27.1 Features of the Animal Kingdom 27.2 Features Used to Classify Animals 27.3 Animal Phylogeny 27.4 The Evolutionary History of the Animal Kingdom 28.1 Phylum Porifera 28.2 Phylum Cnidaria 28.3 Superphylum Lophotrochozoa 28.4 Superphylum Ecdysozoa 28.5 Superphylum Deuterostomia 29.1 Chordates 29.2 Fishes 29.3 Amphibians 29.4 Reptiles 29.5 Birds 29.6 Mammals 29.7 The Evolution of Primates
Objectives	• Describe how viruses were first discovered and how they are detected. • Discuss three hypotheses about how viruses evolved. • Recognize the basic shapes of viruses. • Understand past and emerging classification systems for viruses. • List the steps of replication and explain what occurs at each step. • Describe the lytic and lysogenic cycles of virus replication. • Explain the transmission and diseases of animal and plant viruses. • Discuss the economic impact of animal and plant viruses. • Identify major viral illnesses that affect humans. • Compare vaccinations and anti-viral drugs as medical approaches to viruses. • Describe prions and their basic properties.

	• Define viroids and their targets of infection. • Describe the evolutionary history of prokaryotes. • Discuss the distinguishing features of extremophiles. • Explain why it is difficult to culture prokaryotes. • Describe the basic structure of a typical prokaryote. • Describe important differences in structure between Archaea and Bacteria. • Identify the macronutrients needed by prokaryotes, and explain their importance. • Describe the ways in which prokaryotes get energy and carbon for life processes. • Describe the roles of prokaryotes in the carbon and nitrogen cycles. • Identify bacterial diseases that caused historically important plagues and epidemics. • Describe the link between biofilms and foodborne diseases. • Explain how overuse of antibiotic may be creating “super bugs”. • Explain the importance of MRSA with respect to the problems of antibiotic resistance. • Explain the need for nitrogen fixation and how it is accomplished. • Identify foods in which prokaryotes are used in the processing. • Describe the use of prokaryotes in bioremediation. • Describe the beneficial effects of bacteria that colonize our skin and digestive tracts. • List the unifying characteristics of eukaryotes. • Describe what scientists know about the origins of eukaryotes based on the last common ancestor. • Explain endosymbiotic theory. • Describe the cell structure characteristics of protists. • Describe the metabolic diversity of protists. • Describe the life cycle diversity of protists. • Describe representative protist organisms from each of the six presently recognized supergroups of eukaryotes. • Identify the evolutionary relationships of plants, animals, and fungi within the six presently recognized supergroups of eukaryotes. • Describe the role that protists play in the ecosystem. • Describe important pathogenic species of protists. • List the characteristics of fungi. • Describe the composition of the mycelium. • Describe the mode of nutrition of fungi. • Explain sexual and asexual reproduction in fungi. • Classify fungi into the five major phyla.

	• Describe each phylum in terms of major representative species and patterns of reproduction. • Describe the role of fungi in the ecosystem. • Describe mutualistic relationships of fungi with plant roots and photosynthetic organisms. • Describe the beneficial relationship between some fungi and insects. • Describe fungal parasites and pathogens of plants. • Describe the different types of fungal infections in humans. • Explain why antifungal therapy is hampered by the similarity between fungal and animal cells. • Describe the importance of fungi to the balance of the environment. • Summarize the role of fungi in food and beverage preparation. • Describe the importance of fungi in the chemical and pharmaceutical industries. • Discuss the role of fungi as model organisms. • Discuss the challenges to plant life on land. • Describe the adaptations that allowed plants to colonize the land. • Describe the timeline of plant evolution and the impact of land plants on other living things. • Describe the traits shared by green algae and land plants. • Explain the reasons why Charales are considered the closest relative to land plants. • Understand that current phylogenetic relationships are reshaped by comparative analysis of DNA sequences. • Identify the main characteristics of bryophytes. • Describe the distinguishing traits of liverworts, hornworts, and mosses. • Chart the development of land adaptations in the bryophytes. • Describe the events in the bryophyte lifecycle. • Identify the new traits that first appear in tracheophytes. • Discuss the importance of adaptations to life on land. • Describe the classes of seedless tracheophytes. • Describe the lifecycle of a fern. • Explain the role of seedless vascular plants in the ecosystem. • Explain when seed plants first appeared and when gymnosperms became the dominant plant group. • Describe the two major innovations that allowed seed plants to reproduce in the absence of water. • Discuss the purpose of pollen grains and seeds.

	• Describe the significance of angiosperms bearing both flowers and fruit. • Discuss the type of seeds produced by gymnosperms, as well as other characteristics of gymnosperms. • State which period saw the first appearance of gymnosperms and explain when they were the dominant plant life. • List the four groups of modern-day gymnosperms and provide examples of each. • Explain why angiosperms are the dominant form of plant life in most terrestrial ecosystems. • Describe the main parts of a flower and their purpose. • Detail the life cycle of an angiosperm. • Discuss the two main groups of flowering plants. • Explain how angiosperm diversity is due, in part, to multiple interactions with animals. • Describe ways in which pollination occurs. • Discuss the roles that plants play in ecosystems and how deforestation threatens plant biodiversity. • List the features that distinguish the kingdom Animalia from other kingdoms. • Explain the processes of animal reproduction and embryonic development. • Describe the roles that Hox genes play in development. • Explain the differences in animal body plans that support basic animal classification. • Compare and contrast the embryonic development of protostomes and deuterostomes. • Interpret the metazoan phylogenetic tree. • Describe the types of data that scientists use to construct and revise animal phylogeny. • List some of the relationships within the modern phylogenetic tree that have been discovered as a result of modern molecular data. • Describe the features that characterized the earliest animals and when they appeared on earth. • Explain the significance of the Cambrian period for animal evolution and the changes in animal diversity that took place during that time. • Describe some of the unresolved questions surrounding the Cambrian explosion. • Discuss the implications of mass animal extinctions that have occurred in evolutionary history. • Describe the organizational features of the simplest multicellular organisms.

	• Explain the various body forms and bodily functions of sponges. • Compare structural and organization characteristics of Porifera and Cnidaria. • Describe the progressive development of tissues and their relevance to animal complexity. • Describe the unique anatomical and morphological features of flatworms, rotifers, Nemertea, mollusks, and annelids. • Describe the development of an extracoelomic cavity. • Discuss the advantages of true body segmentation. • Explain the key features of Platyhelminthes and their importance as parasites. • Describe the features of animals classified in phylum Annelida. • Describe the structural organization of nematodes. • Understand the importance of Caenorhabditis elegans in research. • Compare the internal systems and appendage specializations of phylum Arthropoda. • Discuss the environmental importance of arthropods. • Discuss the reasons for arthropod success and abundance. • Describe the distinguishing characteristics of echinoderms. • Describe the distinguishing characteristics of chordates. • Identify the derived character of craniates that sets them apart from other chordates. • Describe the developmental fate of the notochord in vertebrates. • Describe the difference between jawless and jawed fishes. • Discuss the distinguishing features of sharks and rays compared to other modern fishes. • Describe the important difference between the life cycle of amphibians and the life cycles of other vertebrates. • Distinguish between the characteristics of Urodela, Anura, and Apoda. • Describe the evolutionary history of amphibians. • Describe the main characteristics of amniotes. • Explain the difference between anapsids, synapsids, and diapsids, and give an example of each. • Identify the characteristics of reptiles. • Discuss the evolution of reptiles. • Describe the evolutionary history of birds. • Describe the derived characteristics in birds that facilitate flight. • Name and describe the distinguishing features of the three main groups of mammals.

	• Describe the proposed line of descent that produced mammals. • List some derived features that may have arisen in response to mammals' need for constant, high-level metabolism. • Describe the derived features that distinguish primates from other animals. • Explain why scientists are having difficulty determining the true lines of descent in hominids.

Unit 6 – Plant Structure and Function (Chapters 30-32)	
Lessons	30.1 The Plant Body 30.2 Stems 30.3 Roots 30.4 Leaves 30.5 Transport of Water and Solutes in Plants 30.6 Plant Sensory Systems and Responses 31.1 Nutritional Requirements of Plants 31.2 The Soil 31.3 Nutritional Adaptations of Plants 32.1 Reproductive Development and Structure 32.2 Pollination and Fertilization 32.3 Asexual Reproduction
Objectives	• Describe the shoot organ system and the root organ system. • Distinguish between meristematic tissue and permanent tissue. • Identify and describe the three regions where plant growth occurs. • Summarize the roles of dermal tissue, vascular tissue, and ground tissue. • Compare simple plant tissue with complex plant tissue. • Describe the main function and basic structure of stems. • Compare and contrast the roles of dermal tissue, vascular tissue, and ground tissue. • Distinguish between primary growth and secondary growth in stems. • Summarize the origin of annual rings. • List and describe examples of modified stems. • Identify the two types of root systems. • Describe the three zones of the root tip and summarize the role of each zone in root growth. • Describe the structure of the root. • List and describe examples of modified roots. • Identify the parts of a typical leaf. • Describe the internal structure and function of a leaf. • Compare and contrast simple leaves and compound leaves.

	• List and describe examples of modified leaves. • Define water potential and explain how it is influenced by solutes, pressure, gravity, and the matric potential. • Describe how water potential, evapotranspiration, and stomatal regulation influence how water is transported in plants. • Explain how photosynthates are transported in plants. • Describe how red and blue light affect plant growth and metabolic activities. • Discuss gravitropism. • Understand how hormones affect plant growth and development. • Describe thigmotropism, thigmonastism, and thigmogenesis. • Explain how plants defend themselves from predators and respond to wounds. • Describe how plants obtain nutrients. • List the elements and compounds required for proper plant nutrition. • Describe an essential nutrient. • Describe how soils are formed. • Explain soil composition. • Describe a soil profile. • Understand the nutritional adaptations of plants. • Describe mycorrhizae. • Explain nitrogen fixation. • Describe the two stages of a plant's lifecycle. • Compare and contrast male and female gametophytes and explain how they form in angiosperms. • Describe the reproductive structures of a plant. • Describe the components of a complete flower. • Describe the development of microsporangium and megasporangium in gymnosperms. • Describe what must occur for plant fertilization. • Explain cross-pollination and the ways in which it takes place. • Describe the process that leads to the development of a seed. • Define double fertilization. • Compare the mechanisms and methods of natural and artificial asexual reproduction. • Describe the advantages and disadvantages of natural and artificial asexual reproduction. • Discuss plant life spans.

Unit 7 – Animal Structure and Function (Chapters 33-43)

Lessons	33.1 Animal Form and Function 33.2 Animal Primary Tissues 33.3 Homeostasis 34.1 Digestive Systems 34.2 Nutrition and Energy Production 34.3 Digestive System Processes 34.4 Digestive System Regulation 35.1 Neurons and Glial Cells 35.2 How Neurons Communicate 35.3 The Central Nervous System 35.4 The Peripheral Nervous System 35.5 Nervous System Disorders 36.1 Sensory Processes 36.2 Somatosensation 36.3 Taste and Smell 36.4 Hearing and Vestibular Sensation 36.5 Vision 37.1 Types of Hormones 37.2 How Hormones Work 37.3 Regulation of Body Processes 37.4 Regulation of Hormone Production 37.5 Endocrine Glands 38.1 Types of Skeletal Systems 38.2 Bone 38.3 Joints and Skeletal Movement 38.4 Muscle Contraction and Locomotion 39.1 Systems of Gas Exchange 39.2 Gas Exchange across Respiratory Surfaces 39.3 Breathing 39.4 Transport of Gases in Human Bodily Fluids 40.1 Overview of the Circulatory System 40.2 Components of the Blood 40.3 Mammalian Heart and Blood Vessels 40.4 Blood Flow and Blood Pressure Regulation 41.1 Osmoregulation and Osmotic Balance 41.2 The Kidneys and Osmoregulatory Organs 41.3 Excretion Systems 41.4 Nitrogenous Wastes 41.5 Hormonal Control of Osmoregulatory Functions 42.1 Innate Immune Response 42.2 Adaptive Immune Response 42.3 Antibodies 42.4 Disruptions in the Immune System 43.1 Reproduction Methods 43.2 Fertilization 43.3 Human Reproductive Anatomy and Gametogenesis

	43.4 Hormonal Control of Human Reproduction 43.5 Human Pregnancy and Birth 43.6 Fertilization and Early Embryonic Development 43.7 Organogenesis and Vertebrate Formation
Objectives	• Describe the various types of body plans that occur in animals. • Describe limits on animal size and shape. • Relate bioenergetics to body size, levels of activity, and the environment. • Describe epithelial tissues. • Discuss the different types of connective tissues in animals. • Describe three types of muscle tissues. • Describe nervous tissue. • Define homeostasis. • Describe the factors affecting homeostasis. • Discuss positive and negative feedback mechanisms used in homeostasis. • Describe thermoregulation of endothermic and ectothermic animals. • Explain the processes of digestion and absorption. • Compare and contrast different types of digestive systems. • Explain the specialized functions of the organs involved in processing food in the body. • Describe the ways in which organs work together to digest food and absorb nutrients. • Explain why an animal's diet should be balanced and meet the needs of the body. • Define the primary components of food. • Describe the essential nutrients required for cellular function that cannot be synthesized by the animal body. • Explain how energy is produced through diet and digestion. • Describe how excess carbohydrates and energy are stored in the body. • Describe the process of digestion. • Detail the steps involved in digestion and absorption. • Define elimination. • Explain the role of both the small and large intestines in absorption. • List and describe the functions of the structural components of a neuron. • List and describe the four main types of neurons. • Compare the functions of different types of glial cells. • Describe the basis of the resting membrane potential. • Explain the stages of an action potential and how action potentials are propagated.

	• Explain the similarities and differences between chemical and electrical synapses. • Describe long-term potentiation and long-term depression. • Identify the spinal cord, cerebral lobes, and other brain areas on a diagram of the brain. • Describe the basic functions of the spinal cord, cerebral lobes, and other brain areas. • Describe the organization and functions of the sympathetic and parasympathetic nervous systems. • Describe the organization and function of the sensory-somatic nervous system. • Describe the symptoms, potential causes, and treatment of several examples of nervous system disorders. • Identify the general and special senses in humans. • Describe three important steps in sensory perception. • Explain the concept of just-noticeable difference in sensory perception. • Describe four important mechanoreceptors in human skin. • Describe the topographical distribution of somatosensory receptors between glabrous and hairy skin. • Explain why the perception of pain is subjective. • Explain in what way smell and taste stimuli differ from other sensory stimuli. • Identify the five primary tastes that can be distinguished by humans. • Explain in anatomical terms why a dog's sense of smell is more acute than a human's. • Describe the relationship of amplitude and frequency of a sound wave to attributes of sound. • Trace the path of sound through the auditory system to the site of transduction of sound. • Identify the structures of the vestibular system that respond to gravity. • Explain how electromagnetic waves differs from sound waves. • Trace the path of light through the eye to the point of the optic nerve. • Explain tonic activity as it is manifested in photoreceptors in the retina. • List the different types of hormones. • Explain their role in maintaining homeostasis. • Explain how hormones work. • Discuss the role of different types of hormone receptors. • Explain how hormones regulate the excretory system. • Discuss the role of hormones in the reproductive system. • Describe how hormones regulate metabolism.

	• Explain the role of hormones in different diseases. • Explain how hormone production is regulated. • Discuss the different stimuli that control hormone levels in the body. • Describe the role of different glands in the endocrine system. • Explain how the different glands work together to maintain homeostasis. • Discuss the different types of skeletal systems. • Explain the role of the human skeletal system. • Compare and contrast different skeletal systems. • Classify the different types of bones in the skeleton. • Explain the role of the different cell types in bone. • Explain how bone forms during development. • Classify the different types of joints on the basis of structure. • Explain the role of joints in skeletal movement. • Classify the different types of muscle tissue. • Explain the role of muscles in locomotion. • Describe the passage of air from the outside environment to the lungs. • Explain how the lungs are protected from particulate matter. • Name and describe lung volumes and capacities. • Understand how gas pressure influences how gases move into and out of the body. • Describe how the structures of the lungs and thoracic cavity control the mechanics of breathing. • Explain the importance of compliance and resistance in the lungs. • Discuss problems that may arise due to a V/Q mismatch. • Describe how oxygen is bound to hemoglobin and transported to body tissues. • Explain how carbon dioxide is transported from body tissues to the lungs. • Describe an open and closed circulatory system. • Describe interstitial fluid and hemolymph. • Compare and contrast the organization and evolution of the vertebrate circulatory system. • List the basic components of the blood. • Compare red and white blood cells. • Describe blood plasma and serum. • Describe the structure of the heart and explain how cardiac muscle is different from other muscles. • Describe the cardiac cycle.

	• Explain the structure of arteries, veins, and capillaries, and how blood flows through the body. • Describe the system of blood flow through the body. • Describe how blood pressure is regulated. • Define osmosis and explain its role within molecules. • Explain why osmoregulation and osmotic balance are important body functions. • Describe active transport mechanisms. • Explain osmolarity and the way in which it is measured. • Describe osmoregulators or osmoconformers and how these tools allow animals to adapt to different environments. • Explain how the kidneys serve as the main osmoregulatory organs in mammalian systems. • Describe the structure of the kidneys and the functions of the parts of the kidney. • Describe how the nephron is the functional unit of the kidney and explain how it actively filters blood and generates urine. • Detail the three steps in the formation of urine: glomerular filtration, tubular reabsorption, and tubular secretion. • Explain how vacuoles, present in microorganisms, work to excrete waste. • Describe the way in which flame cells and nephridia in worms perform excretory functions and maintain osmotic balance. • Explain how insects use Malpighian tubules to excrete wastes and maintain osmotic balance. • Compare and contrast the way in which aquatic animals and terrestrial animals can eliminate toxic ammonia from their systems. • Compare the major byproduct of ammonia metabolism in vertebrate animals to that of birds, insects, and reptiles. • Explain how hormonal cues help the kidneys synchronize the osmotic needs of the body • Describe how hormones like epinephrine, norepinephrine, renin-angiotensin, aldosterone, anti-diuretic hormone, and atrial natriuretic peptide help regulate waste elimination, maintain correct osmolarity, and perform other osmoregulatory functions. • Describe physical and chemical immune barriers. • Explain immediate and induced innate immune responses. • Discuss natural killer cells. • Describe major histocompatibility class I molecules. • Summarize how the proteins in a complement system function to destroy extracellular pathogens.

	• Explain adaptive immunity. • Compare and contrast adaptive and innate immunity. • Describe cell-mediated immune response and humoral immune response. • Describe immune tolerance. • Explain cross-reactivity. • Describe the structure and function of antibodies. • Discuss antibody production. • Describe hypersensitivity. • Define autoimmunity. • Describe advantages and disadvantages of asexual and sexual reproduction. • Discuss asexual reproduction methods. • Discuss sexual reproduction methods. • Discuss internal and external methods of fertilization. • Describe the methods used by animals for development of offspring during gestation. • Describe the anatomical adaptions that occurred in animals to facilitate reproduction. • Describe human male and female reproductive anatomies. • Discuss the human sexual response. • Describe spermatogenesis and oogenesis and discuss their differences and similarities. • Describe the roles of male and female reproductive hormones. • Discuss the interplay of the ovarian and menstrual cycles. • Describe the process of menopause. • Explain fetal development during the three trimesters of gestation. • Describe labor and delivery. • Compare the efficacy and duration of various types of contraception. • Discuss causes of infertility and the therapeutic options available. • Discuss how fertilization occurs. • Explain how the embryo forms from the zygote. • Discuss the role of cleavage and gastrulation in animal development. • Describe the process of organogenesis. • Identify the anatomical axes formed in vertebrates.

Unit 8 – Ecology (Chapters 44-47)	
Lessons	44.1 The Scope of Ecology 44.2 Biogeography 44.3 Terrestrial Biomes

	44.4 Aquatic Biomes 44.5 Climate and the Effects of Global Climate Change 45.1 Population Demography 45.2 Life Histories and Natural Selection 45.3 Environmental Limits to Population Growth 45.4 Population Dynamics and Regulation 45.5 Human Population Growth 45.6 Community Ecology 45.7 Behavioral Biology: Proximate and Ultimate Causes of Behavior 46.1 Ecology of Ecosystems 46.2 Energy Flow through Ecosystems 46.3 Biogeochemical Cycles 47.1 The Biodiversity Crisis 47.2 The Importance of Biodiversity to Human Life 47.3 Threats to Biodiversity 47.4 Preserving Biodiversity
Objectives	• Define ecology and the four levels of ecological research. • Describe examples of the ways in which ecology requires the integration of different scientific disciplines. • Distinguish between abiotic and biotic components of the environment. • Recognize the relationship between abiotic and biotic components of the environment. • Define biogeography. • List and describe abiotic factors that affect the global distribution of plant and animal species. • Compare the impact of abiotic forces on aquatic and terrestrial environments. • Summarize the affect of abiotic factors on net primary productivity. • Identify the two major abiotic factors that determine terrestrial biomes. • Recognize distinguishing characteristics of each of the eight major terrestrial biomes. • Describe the effects of abiotic factors on the composition of plant and animal communities in aquatic biomes. • Compare and contrast the characteristics of the ocean zones. • Summarize the characteristics of standing water and flowing water freshwater biomes. • Define global climate change. • Summarize the effects of the Industrial Revolution on global atmospheric carbon dioxide concentration. • Describe three natural factors affecting long-term global climate.

	• List two or more greenhouse gases and describe their role in the greenhouse effect. • Describe how ecologists measure population size and density. • Describe three different patterns of population distribution. • Use life tables to calculate mortality rates. • Describe the three types of survivorship curves and relate them to specific populations. • Describe how life history patterns are influenced by natural selection. • Explain different life history patterns and how different reproductive strategies affect species' survival. • Explain the characteristics of and differences between exponential and logistic growth patterns. • Give examples of exponential and logistic growth in natural populations. • Describe how natural selection and environmental adaptation led to the evolution of particular life history patterns. • Give examples of how the carrying capacity of a habitat may change. • Compare and contrast density-dependent growth regulation and density-independent growth regulation, giving examples. • Give examples of exponential and logistic growth in wild animal populations. • Describe how natural selection and environmental adaptation leads to the evolution of particular life-history patterns. • Discuss how human population growth can be exponential. • Explain how humans have expanded the carrying capacity of their habitat. • Relate population growth and age structure to the level of economic development in different countries. • Discuss the long-term implications of unchecked human population growth. • Discuss the predator-prey cycle. • Give examples of defenses against predation and herbivory. • Describe the competitive exclusion principle. • Give examples of symbiotic relationships between species. • Describe community structure and succession. • Compare innate and learned behavior. • Discuss how movement and migration behaviors are a result of natural selection. • Discuss the different ways members of a population communicate with each other.

	• Give examples of how species use energy for mating displays and other courtship behaviors. • Differentiate between various mating systems. • Describe different ways that species learn. • Describe the basic types of ecosystems on Earth. • Explain the methods that ecologists use to study ecosystem structure and dynamics. • Identify the different methods of ecosystem modeling. • Differentiate between food chains and food webs and recognize the importance of each. • Describe how organisms acquire energy in a food web and in associated food chains. • Explain how the efficiency of energy transfers between trophic levels affects ecosystem structure and dynamics. • Discuss trophic levels and how ecological pyramids are used to model them. • Discuss the biogeochemical cycles of water, carbon, nitrogen, phosphorus, and sulfur. • Explain how human activities have impacted these cycles and the potential consequences for Earth. • Define biodiversity. • Describe biodiversity as the equilibrium of naturally fluctuating rates of extinction and speciation. • Identify historical causes of high extinction rates in Earth's history. • Identify chemical diversity benefits to humans. • Identify biodiversity components that support human agriculture. • Describe ecosystem services. • Identify significant threats to biodiversity. • Explain the effects of habitat loss, exotic species, and hunting on biodiversity. • Identify the early and predicted effects of climate change on biodiversity. • Identify new technologies for describing biodiversity. • Explain the legislative framework for conservation. • Describe principles and challenges of conservation preserve design. • Identify examples of the effects of habitat restoration. • Discuss the role of zoos in biodiversity conservation.

ACE Biology (3 Semester Credits)


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