

Circle of Life: The Greater Yellowstone Ecosystem

Module #	Topic
1	Introduction to the Ecosystem <ul style="list-style-type: none">Module 1 defines the Greater Yellowstone Ecosystem; describes the geological and human history of Grand Teton and Yellowstone National Parks; describes ecosystem structure and types of ecosystems found within the Yellowstone landscape.
1.1	Supplement 1: <ul style="list-style-type: none">This supplement to Module 1 looks in more detail at the zones and characteristics of lake (lentic) ecosystems.
1.2	Supplement 2: <ul style="list-style-type: none">This supplement to Module 1 looks in more detail at the terrestrial biomes we find in the Yellowstone Ecosystem: Aspen forests, the many Coniferous forests, Temperate grasslands, Big Sage Chaparral, and high altitude Tundra.
2	The Nature of Science <ul style="list-style-type: none">Module 2 describes the dual nature of science; an overview of the process of science; characteristics of a controlled study; the products of science including theory; characteristics of quality science and how it differs from pseudoscience or religion; and the public's skepticism with science.
2	Supplement <ul style="list-style-type: none">This supplement to module 1 focuses on anecdotal science (testimonials) and why it is not credible compared to controlled studies; as well as blind studies, double blind studies, and accounting for placebo effect.
3	Basic Chemistry <ul style="list-style-type: none">Module 3 discusses states of matter; atomic structure and the subatomic particles that form them; atomic number and mass; nuclear structure; electron distribution; atomic diagrams; using the Periodic Table of the Elements; ionic and covalent bonds; looking at compatibility and electronegativity to predict bonding; and chemical equations— what they represent and how to recognize whether they are written correctly or not.
3	Supplement <ul style="list-style-type: none">This supplement to Module 3 discusses the characteristics of water and what makes water so unique and important to life.
4	Biochemistry <ul style="list-style-type: none">Module 4 describes organic and inorganic molecules; how monomers form polymers via dehydration synthesis; hydrolysis reactions; important organic groups; and the major organic polymers: carbohydrates, proteins, lipids, and nucleic acids.
4	Supplement <ul style="list-style-type: none">This supplement to Module 4 discusses characteristics of acids and bases; the pH scale; and how the buffer carbonic acid functions to neutralize added acid or base.
5	Cells, Membranes, and Solutions

- Module 8 discusses plasma membrane structure; characteristics of prokaryotic cells and their structures; and characteristics of eukaryotic cells and their structures, contrasting plant and animal cells.

5 Supplement

- This supplement to Module 5 defines solutions; and discusses diffusion, Osmosis, and Dialysis

6 Ecosystem Energetics

- Module 6 introduces energetics with a discussion of the laws of energy; structure and characteristics of ATP; exergonic and endergonic reactions; the flow of energy through nature including fusion, the electromagnetic spectrum, a brief overview of photosynthesis and the cellular oxidation of glucose, producers and consumers, food chains and food webs; ecological roles of organisms in the food web; energy pyramids; and contrasting matter recycling with energy flow.

6.1 Supplement 1

- This supplement to Module 6 looks at portions of energy metabolism to lay a foundation for the discussion of photosynthesis and the cellular oxidation of glucose in later modules. This module discusses oxidation and reduction reactions; the electron carriers NAD^+ , FAD, and NADP^+ and their reduced versions; enzymatic pathways and cycles; substrate level phosphorylation; chemiosmotic/oxidative phosphorylation looking at electron transport systems and ATP synthase functioning in detail; and photosystems.

6.2 Supplement 2

- This second supplement to Module 6 is a detailed look at the light and dark reactions of photosynthesis: Chloroplast structure; photosystems, accessory pigments, and resonance transfer; initiation of photosynthesis and the role of chlorophyll-a and water; photosystem II and photosystem I; ATP production; the Calvin Cycle; the role of glucose; guard cells, stomata, and carbon dioxide; C4 and CAM plants.

6.3 Supplement 3

- This third supplement to Module 6 revisits C4 and CAM plants before beginning a detailed look at glycolysis and cellular respiration: aerobic and anaerobic glycolysis; mitochondrial structure; pyruvate to acetyl CoA; Krebs' Cycle; mitochondrial electron transport system; ATP production; the role of oxygen; the metabolic relationship between carbohydrates, proteins, and lipids.

6.4 Supplement 4

- This fourth supplement to Module 6 looks at the major biogeochemical cycles: Nitrogen, phosphorus, carbon-oxygen, and water cycles.

7 Mitosis and Meiosis

- Module 7 looks at ploidy; mitosis and its roles in nature; the roles of mitosis and meiosis in sexual reproduction; and meiosis and its contribution to genetic diversity looking at crossing over and independent assortment.

8 Inheritance

- Module 8 examines Mendelian inheritance of autosomal traits: segregation of alleles, independent assortment, and the basic single trait crosses.
- 9 Protein Synthesis**
- Module 9 looks at the structure of DNA and RNA; the processes of transcription and translation; mutation and its effects; and chromosomal abnormalities.
- 9.1 Supplement 1**
- This supplement to Module 9 describes DNA fingerprinting technology including restriction enzymes; RFLP's; VNTR's; gel electrophoresis; blotting; probes; reading fingerprints; and uses of DNA fingerprinting.
- 9.2 Supplement 2**
- This second supplement to Module 9 describes the process and uses of Polymerase Chain Reaction (PCR).
- 10 Forces of Evolution**
- Module 10 defines biological evolution; examines Darwin's development of evolutionary theory; discusses relevant terminology; and begins a discussion of some of the forces that drive evolution including inheritance, random genetic change, and natural selection. Examples and evidence for these evolutionary forces are emphasized throughout.
- 11 Evolution, Speciation, and More**
- Module 11 continues to look at more forces and evidence of evolution in the form of genetic drift and migration. Genetic drift and natural selection are compared by looking at founder effect and bottlenecks. It also discusses speciation including isolating mechanisms, types of speciation, and examples of speciation.
- 12 Systematics**
- Module 12 defines systematics; examines how organisms are classified comparing traditional and cladistic approaches; lays out the Linnaean hierarchy; and defines characteristics of the three major Domains of life, and how they are related.
- 13 Prokaryotes**
- Module 13 looks at prions and viruses and how they cause disease; characteristics of the Prokaryotic Domains; and examples of some Eubacteria found in the GYE.
- 14 Eubacteria, Archaea, & Simple Eukarya**
- Module 14 discusses Eubacteria and Archaea found in the GYE; describes characteristics of the Protist Kingdoms; and discusses examples of Protists found in the ecosystem.
- 15 Protists and Introduction to Fungi**
- Module 15 continues the discussion of Protists found in the GYE; it continues by introducing characteristics of the Fungi.
- 16 Fungi and Introduction to the Plantae**
- Module 16 discusses the Fungal Divisions Chytridiomycota, Zygomycota, Basidiomycota, and Ascomycota; lichens are also

discussed; and concludes with examination of red algae, green algae, and plant alternations of generations.

- 16 Supplement**
- In this supplement to Module 16 Blister Rust (Basidiomycota) is discussed.
- 17 Mosses and Ferns**
- Module 17 looks at plant tissues; transpiration and translocation; moss life cycles and examples within the GYE; and the fern life cycle and examples within the ecosystem.
- 18 Club Mosses, Horsetails, & Gymnosperms**
- Module 18 examines life cycles and examples of GYE club mosses and horsetails; then describes seed structure; and concludes by describing the conifer life cycle and the conifers found in the ecosystem.
- 19 Angiosperms**
- Module 19 revisits how to identify Yellowstone conifers; it then describes the flowering plant life cycle, seeds, fruits, and types of flowers.
- 20 Flowering Plant Families and Metazoa**
- Module 20 looks at flower and leaf characteristics used in identification and classification of plants; a number of flowering plant families and examples of flowers found in the ecosystem; and concludes by examining animal development and other characteristics important in classification.
- 21 Animals**
- Module 21 finishes the discussion of general animal characteristics before looking at life cycles and examples of Sponges, Cnidaria, and Platyhelminthes found in the GYE.
- 22 Flatworms to Arthropods**
- Module 22 continues a discussion of the life cycles and examples of animals found in the GYE. In this module: Platyhelminthes, Nematoda, Acanthocephala, Arthropods (Chelicerates) are considered.
- 23 Insects to Chordates**
- Module 23 continues a discussion of the life cycles and examples of animals found in the GYE. In this module the major insect orders are discussed as well as the Mollusca, Annelida, and Chordate characteristics.
- 24 Fishes and Amphibia**
- Module 24 discusses characteristics and examples of important fishes in the GYE before introducing characteristics of the Amphibia.
- 24.1 Supplement 1**
- This supplement to Module 24 discusses the major contributors to the global amphibian population crash.
- 24.2 Supplement 2**
- This second supplement to Module 24 briefly discusses how Amphibian Chytridiomycosis became a global epidemic.
- 25 Amphibia, Reptiles, and Birds**
- Module 25 discusses common amphibians in the GYE; characteristics and examples of GYE Reptiles; avian characteristics; and the Passeriformes.
- 25.1 Supplement 1**
- This supplement to Module 25 discusses the circulatory anatomy in fishes and Amphibia, and how it relates to ectothermy.

- 25.2 Supplement 2**
- This second supplement to Module 25 looks at the circulatory anatomy in Reptiles, Birds, and Mammals; and how it relates to endothermy and ectothermy.
- 26 Birds: Passeriformes Through Anseriformes**
- Module 26 discusses a number of birds from orders we find in the GYE.
- 26 Supplement**
- This supplement to Module 26 completes the discussion of Greater Yellowstone birds.
- 27 Mammals: Artiodactyla**
- Module 27 discusses mammalian characteristics and begins a discussion of Greater Yellowstone mammalian orders with the Artiodactyla and Elk management.
- 28 Mammals: Artiodactyla and Carnivora**
- Module 28 examines Elk and Bison management including Brucellosis before considering the rest of the GYE Artiodactyla; then begins a discussion of the Greater Yellowstone Carnivora beginning with Grizzly Bears.
- 29 Mammals: Carnivora Through Rodentia**
- Module 29 discusses Grizzly biology and management; then looks at wolf biology, reintroduction, and management; followed by the rest of the Greater Yellowstone Carnivora; and concludes by looking at the native Rodentia.
- 29 Supplement**
- This supplement to Module 29 concludes discussion of the Mammalia by discussing native Lagomorphs and Bats.
- 30 Animal Behavior: Learning, Memory, and Behavior**
- Module 30 discusses instinctual behavior and learning (conditioning, habituation, latent, imprinting, and insight learning); short and long term memory; and behaviors that are very common in animals, particularly vertebrates.
- 30 Supplement**
- This supplement to Module 30 discusses more common animal behaviors and looks at culture and emotions in non human animals.
- 31 Ecosystem Dynamics and Management**
- Module 31 describes ecological succession in the GYE with emphasis on the 1988 fires and fire ecology; positive and negative feedback; synergism; biological magnification; predator-prey population cycles; and methods of monitoring and analyzing ecosystems.
- 31 Supplement 1: Trophic Cascade, Island Ecosystems**
- This supplement to Module 31 describes the trophic cascade in progress resulting from wolf reintroduction; and the effect of “island” or fragmented ecosystems.
- 31 Supplement 2: Slide Lake**
- This second supplement to Module 31 describes the famous Kelly Slide on the Gros Ventre River and its current biological status.
- 32 Endangered Species Act and Global Warming**
- Module 32 looks at the Endangered Species Act; causes of species extinction; greenhouse warming and the consequences to the GYE; and the federal agencies that manage the ecosystem and the federal lands found within the GYE.
- 32.1 Supplement 1: Cattle Grazing in the Ecosystem**
- This supplement to Module 32 discusses cattle grazing in the ecosystem

and the challenges it presents to wolf and grizzly management.

32.2 Supplement 2: Methane

- This second supplement to Module 32 considers an important wild card in greenhouse warming that is often neglected: methane.