WARM UP

• Darwin stated that in order for natural selection to occur, variation must exist in a population. Explain why variation must exist before survival based on natural selection can occur.
Striking gold in Costa Rica

• Golden toads were discovered in 1964, in Monteverde, Chile
• The mountainous cloud forest has a perfect climate for amphibians
• Unfortunately, they became extinct within 25 years
  – Due to global warming’s drying effect on the forest
Evolution: the source of Earth’s biodiversity

- **Biological evolution** = genetic change in populations of organisms across generations
- May be random or directed by natural selection
  - **Natural Selection** = the process by which traits that enhance survival and reproduction are passed on more frequently to future generations than those that do not
Understanding evolution is vital

- It alters the genetic makeup of a population
- It is important for understanding antibiotic and pesticide resistance, agricultural issues, production, medicines, etc.
- Organisms adapt to their environment and change over time
Natural selection shapes organisms

- In 1858, Darwin and Wallace both proposed natural selection as the mechanism of evolution
  - Organisms face a constant struggle to survive and reproduce
  - Organisms tend to produce more offspring than can survive
  - Individuals of a species vary in their characteristics due to genes and the environment
  - Some individuals are better suited to their environment and will survive and pass their genes on in their offspring
Genetic variation

- **Adaptive Trait (Adaptation)** = a trait that promotes reproductive success
- **Mutations** = accidental changes in DNA that may be passed on to the next generation
  - Non-lethal mutations provide the genetic variation on which natural selection acts
- Sexual reproduction also leads to variation
Natural selection acts on genetic variation

- **Directional selection** = drives a feature in one direction
- **Stabilizing selection** = produces intermediate traits, preserving the status quo
- **Disruptive selection** = traits diverge in two or more directions

*If the environment changes, a trait may no longer be adaptive*
Evidence of natural selection is everywhere

- It is evident in every adaptation of every organism
- Evident in bacteria and fruit flies in laboratories
- Selective breeding of animals
Artificial selection

- **Artificial Selection** = the process of selection conducted under human direction
  - For example, artificial selection has led to the great variety of dog breeds
Evolution generates biodiversity

- **Biological Diversity** = An area’s sum total of all organisms
  - The diversity of species
- Their genes
  - Their populations
  - Their communities
- **Species** = a population or group of populations whose members share characteristics and can freely breed with one another and produce fertile offspring
- **Population** = a group of individuals of a species that live in the same area
Speciation produces new types of organisms

- The process of generating new species
  - A single species can generate multiple species
- **Allopatric speciation** = species formation due to physical separation of populations
  - Can be separated by glaciers, rivers, mountains
  - The main mode of species creation
Another type of speciation

- **Sympatric speciation** = species form from populations that become reproductively isolated within the same area
  - Feed in different areas, mate in different seasons
  - Hybridization between two species
  - Mutations
Speciation results in diverse life forms

- Speciation generates complex patterns of diversity above the species level
- **Phylogenetic trees (Cladograms)** = Represents the history of species divergence
Extinction

• Species generally evolve from simple to complex and small to big, but the opposite can occur, and some even disappear

• **Extinction** = the disappearance of a species from Earth
  – Occurs when a species cannot adapt quickly enough to a changing environment
  – Speciation and extinction affect species numbers
Extinction is a natural process

- Extinction is irreversible: once a species is lost, it is lost forever
- Humans profoundly affect rates of extinction
Some species are more vulnerable to extinction

• Extinction occurs when the environment changes too rapidly for natural selection to keep up

• **Endemic species** = a species only exists in a certain, specialized area
  – Very susceptible to extinction
  – These species usually have small populations

• Many other factors also cause extinction
  – Severe weather
  – New species
  – Specialized species
Earth has had several mass extinctions

- **Background extinction rate** = extinction usually occurs one species at a time
- **Mass extinction events** = five events in Earth’s history that killed off massive numbers of species at once
  - 50-95% of all species went extinct at one time
- Humans are causing the sixth mass extinction event
  - Resource depletion
  - Population growth
  - Development
Species’ ranges can be severely restricted

Some U.S. salamander species live on top of single mountains
Ecology is studied at several levels

- Ecology and evolution are tightly intertwined
- **Biosphere** = the total living things on Earth and the areas they inhabit
- **Ecosystem** = communities and the nonliving material and forces they interact with
- **Community** = interacting species that live in the same area

<table>
<thead>
<tr>
<th>Levels of Ecological Organization</th>
<th>Description</th>
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<tbody>
<tr>
<td>Biosphere</td>
<td>The sum total of living things on Earth and the areas they inhabit</td>
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<tr>
<td>Ecosystem</td>
<td>A functional system consisting of a community, its nonliving environment, and the interactions between them</td>
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<td>Community</td>
<td>A set of populations of different species living together in a particular area</td>
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<tr>
<td>Population</td>
<td>A group of individuals of a species that live in a particular area</td>
</tr>
<tr>
<td>Organism</td>
<td>An individual living thing</td>
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Levels of ecological organization

- **Population ecology** = investigates the quantitative dynamics of how individuals within a species interact
- **Community ecology** = focuses on interactions among species
- **Ecosystem ecology** = studies living and nonliving components of systems to reveal patterns
  - Nutrient and energy flows
Organismal ecology: habitat

- **Habitat** = the environment in which an organism lives
  - Includes living and nonliving elements
  - Scale-dependent: from square meters to miles

- **Habitat use** = each organism thrives in certain habitats, but not in others

- **Habitat selection** = the process by which organisms actively select habitats in which to live
  - Availability and quality of habitat are crucial to an organism’s well-being
  - Human developments conflict with this process
Organismal ecology: niche

- **Niche** = an organism’s use of resources and its functional role in a community
  - Habitat use, food selection, role in energy and nutrient flow
  - Interactions with other individuals

- **Specialists** = species with narrow niches and very specific requirements
  - Extremely good at what they do, but vulnerable to change

- **Generalists** = species with broad niches that can use a wide array of habitats and resources
  - Able to live in many different places