Chapter 4: Biodiversity and Evolution
Life on Earth

**biodiversity**: (=biological diversity) variety of different genes, species, or ecosystems.

There are 3 main branches of life: __________________________

2 main types of cells:

• **prokaryotes**: (means "before nucleus") organisms (bacteria + archaea) whose cells do not have a distinct nucleus or other internal parts enclosed in membranes.

• _______________ and _______________ are prokaryotes

• **eukaryotes**: (means "true nucleus") organisms whose cells have a distinct nucleus and various internal parts enclosed in membranes.
THE TREE OF LIFE

Bacteria
- Gram-positive
- Purple bacteria
- Cyanobacteria
- Flavobacteria
- Thermotogales

Prokaryotes

Archaea
- Methanobacterium
- Methanosarcina
- T. celer

Halophiles
- Entamoebae

Eukaryotes
- Slime molds
- Fungi
- Plants
- Ciliates
- Flagellates
- Trichomonads

Microsporidia

Animals
Taxonomic Levels

The taxonomic levels (from most diverse to most specific) are:

Domain – Kingdom – Phylum – Class – Order – Family – Genus – Species

A mnemonic device to remember this order is:

King Phillip Cooked Old Fashioned Good Spaghetti

(or D_______ K________
P_________ C_________
o__ F_________________
G__ S_______________.)
Six Kingdoms of Living Things

Eubacteria
Archaebacteria
Protists
Plants
Fungi
Animals

Figure 4-3
What is a Species?

**Species**: a distinct kind of organism & in cases of sexually reproducing organisms, a group of organisms that can potentially interbreed to _________________.

**Hybrids**: Some cases where different species are similar enough genetically that they can produce offspring, but the offspring is generally infertile. Example: horses and donkeys can interbreed to produce infertile ________.
Biologist estimate that 10% of __________ and 25% of __________ may occasionally interbreed. These hybrid offspring are generally infertile because the two species have different __________________ and lengths. So the hybrids are reproductive/evolutionary dead-ends.

Most species have mechanisms to prevent interspecies mating: such as ____________________(including courtship rituals) or distinct coloration patterns. However, genetically compatible hybrids may occasionally be a source of genetic diversity.
Each known species is assigned a **scientific name** consisting of two parts (genus + species names), the genus name is capitalized and the species name is lower case.

**Examples:**

*Ursus horribilis* is the grizzly bear.

*Taraxacum officinale* is the dandelion.
Adaptation and Evolution

**evolution**: the change in a population's genetic makeup through successive generations.

- **microevolution**: change in ______________ within a population (__________________ evolutionary changes);

- **macroevolution**: the formation of ______________ from ancestral species (__________________ evolutionary changes).
Four processes drive Microevolution:

**Mutation**: _________________in the sequence of _________________ that serve as the ultimate source of genetic variation;

**Natural Selection**: the process by which some individuals of a population have genetically based characteristics that cause them to _________________ & _________________ than other individuals;
Four processes drive evolution (Cont.):

- **Gene flow**: the movement of genes between populations (______________________________);

Immigration = movement into an area

Emigration = movement away from an area (exit)
Four processes drive evolution:

- **Genetic drift**: change in genetic composition that results by ____________, especially in ___________ populations.

Unlike natural selection, genetic drift does NOT necessarily result in a population better suited to its environment.

A type of genetic drift is the **Founder Effect**: loss/change in genetic variation when a colony is settled by a smaller population.

Example: Polydactyly is more common for the PA Amish.

**Video**: achromatopsia on the island of Pinglelap: [https://www.youtube.com/watch?v=CM06G26X-rQ](https://www.youtube.com/watch?v=CM06G26X-rQ)
Natural Selection

Three conditions required for natural selection:

• ____________: there must be natural variation for a trait within a population

• ____________: there has to be a genetic basis for the trait to be passed from generation to generation;

• __________________: the trait must enable individuals with the trait to leave more offspring than other members of the population.
Natural selection leads to adaptation

**Adaptation**: a heritable trait that enables organisms to better survive & reproduce within a
Sexual Selection

Sexual selection is a mode of natural selection in which some individuals in the population outproduce others not due to differences in survival but because they are better at attracting mates.
Limitations to Adaptation

Adaptations can only occur if ___________________________ in the gene pool.

Because organisms must do many things, adaptations are usually ____________________.
Limitations to Natural Selection

- A population’s ability to adapt is **limited by its** 
  _____________________________. A species with a faster 
  reproductive rate may be able to adapt more_________ 
  because more generations occur in a given period.

- A group of bacteria, including genetically resistant ones, are 
  exposed to an antibiotic

- Most of the normal bacteria die

- The genetically resistant bacteria start multiplying

- Eventually the resistant strain replaces the strain affected by 
  the antibiotic
Directional Selection favors individuals with traits that are at ____________________________(such as the peppered moth example).

"It pays to be different."
Natural Selection

Stabilizing Selection eliminates individuals at the extremes of variation; the average remains the same.

"It pays to be average."
Diversifying (or disruptive) selection eliminates ________________, but favors individuals at ________________ of the spectrum of variation.

"It doesn't pay to be normal."
Discuss with your table partner:

A small group of people establish a new population on an uninhabited island in Micronesia. 90% of the group has blood type A, compared to 20% of the mainland population. What microevolutionary process does this illustrate?
A species of rose has a normal distribution (bell shaped curve) for bloom time with the average flowering time of August. The summer heat begins to cause the pollinators to be less active during August, and therefore fewer successfully reproduce during this time. Which type of selective pressure is this, and how could the distribution graph change?
In cold climates, smaller birds are not able to retain heat as well as larger birds (due to their higher surface area to volume ratio). If a population of birds migrates to a colder climate, which type of selection pressure would be acting on them and how could their distribution change?
A species of dragonflies has an average wing length of 2 inches. A population of these dragonflies lives on an island where strong winds cause the flies with longer wings to be blown out to sea. Which type of selection is this and what could happen to the distribution graph?

Directional selection; the normal distribution could shift to the left (average wingspan would be smaller)
In a chimpanzee population, babies born with too low a birth weight are likely to die, and babies with too high a birth weight could result in the birthing complication that result in the death of the mother and baby. Which type of selection pressure exists on this population, and how will it affect the distribution?
Speciation, Extinction, & Biodiversity

*Macroevolution* involves changes in an evolutionary lineage over much longer periods than *microevolution*. It involves three processes:

- **evolutionary change** of lineage through time;
- _______________: formation of new species;
- _______________: loss of species:

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*Marshall 1998
American Scientist
76: 380-388*
Speciation & Biodiversity

is the accumulation of differences between populations. Divergence can lead to speciation.

new species typically evolve by two processes:

- separation into distinct populations with different evolutionary pressures;
- evolutionary changes in each population that prevent interbreeding when populations come into contact.
Plate Tectonics and Continental Drift

Continental drift (due to plate tectonics), the slow movement of continents, has played a major role in both speciation and extinction.
Why is Earth "just right" for life?

• ___________ : leads to a temperature range favorable to life (between freezing & boiling point of water); energy flow from sun sufficient to drive weather & supply energy for life;

• ______: enough gravitational mass to hold its atmosphere of light molecules (N₂, O₂, CO₂, and H₂O) and to keep its core molten;

• _______: leads to daily patterns (night & day);

• ________________ around sun: leads to seasonal patterns;

• _________________: accumulation of O₂ in lower atmosphere; formation of ozone shield to screen harmful ultraviolet (UV) radiation.
Coevolution involves interactions between two species that result in ________

2 Main types:

- Mutualistic

- “Evolutionary Arms Race” – predator-prey
Coevolution can result in changes that benefit both species in a __________ relationship.

- Flower has the advantage of a specialized pollinator and the bat has the advantage of not having competitors for food.

- Example: An Andean bat has an 8.5 cm tongue to feed on nectar from deep tubular flowers.
Coevolution can also be an evolutionary arms race between ________________.

Examples:
Toxins, thorns, camouflage
coloration, etc.
Videos

Bats and Moths:
http://www.youtube.com/watch?v=irkYP8vxVzE

Hoover Flies and Irises:
http://www.youtube.com/watch?v=MQIq5QtRl90
Discuss with your table partner:

Convergent evolution results in the similarities between species from different taxonomic groups (i.e. more distantly related).

- Anteaters and aardvarks look similar even though their closer relatives don’t have the same long snout.
- Whales have similar shape to fish even though they evolved from land mammals.

What would cause convergent evolution?
Discuss with your table partner:

Review *the difference between coevolution and convergent evolution.* Think of examples of each (besides the ones already discussed).

- Which process could result in symbiotic relationships?
- Which could result in specialists?
- Which could occur in species that are in separate ecosystems?
Extinction

Fossil record shows evidence of extinction as a natural process:

**background extinction**: loss of species at a relatively ______________, often due to changes in ___________ conditions;

**mass extinction**: abrupt increases in extinction rates above the background level.

• mass extinctions believed to result from global climate changes (e.g. ________________, overturning of ___________, catastrophic ________________ releases);

• ________ great mass extinctions during past 500 million years;

• recent extinctions caused by humans at exceptionally high rates = mass extinction???
Adaptive radiation involves splitting of a lineage to form many species in _________________. The adaptive radiation of mammals began about 65 million years ago.

Adaptive radiations are common after ________________because of the many niches left vacant by the extinction.
Misconceptions about Evolution

- Survival of the __________ does not necessarily mean survival of the ________________.

- Fitness to biologist is a measure of _______________ ____________, the fittest are those that leave the most surviving descendants and therefore whose genes are passed down most successfully.
Misconceptions about Evolution

- An individual cannot evolve, only a ___________.
- Natural selection does not always lead to change in one direction. If the environment changes, the natural selection pressure may change. Natural selection is _______________.
Misconceptions Cont.

- Evolution does not involve a grand plan of nature in which species become progressively more _____________. However, adaptation depends on _______________ which are random and can’t be controlled. Also, the compromises concept in evolution.

- There is not some ______________ to be reached in evolution.

Adaptive changes that increase survival in a population’s niche may not be advantageous if the ____________________.
Discuss with your table partner:

Below shows a common mistake people make regarding evolution. Identify what the problem with the definition is.

“Natural selection is the process through which species that are stronger survive and other species may become extinct.”
Functional Diversity
The biological and chemical processes such as energy flow and matter recycling needed for the survival of species, communities, and ecosystems.

Ecological Diversity
The variety of terrestrial and aquatic ecosystems found in an area or on the earth.

Genetic Diversity
The variety of genetic material within a species or a population.

Species Diversity
The number and abundance of species present in different communities.