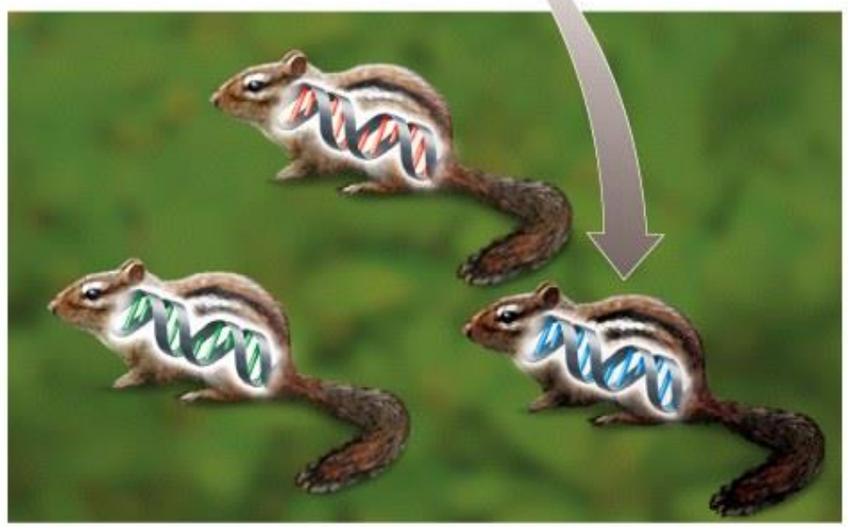
Chapter 5
Evolution of Biodiversity

Earth is home to a tremendous diversity of species

- Ecosystem diversity- the variety of ecosystems within a given region.
- Species diversity- the variety of species in a given ecosystem.
- Genetic diversity- the variety of genes within a given species.

(a) Ecosystem diversity

(b) Species diversity



(c) Genetic diversity

Figure 5.2
Environmental Science

- Species richness- the number of species in a given area.
- Species evenness- the measure of whether a particular ecosystem is numerically dominated by one species or are all represented by similar numbers of individuals.

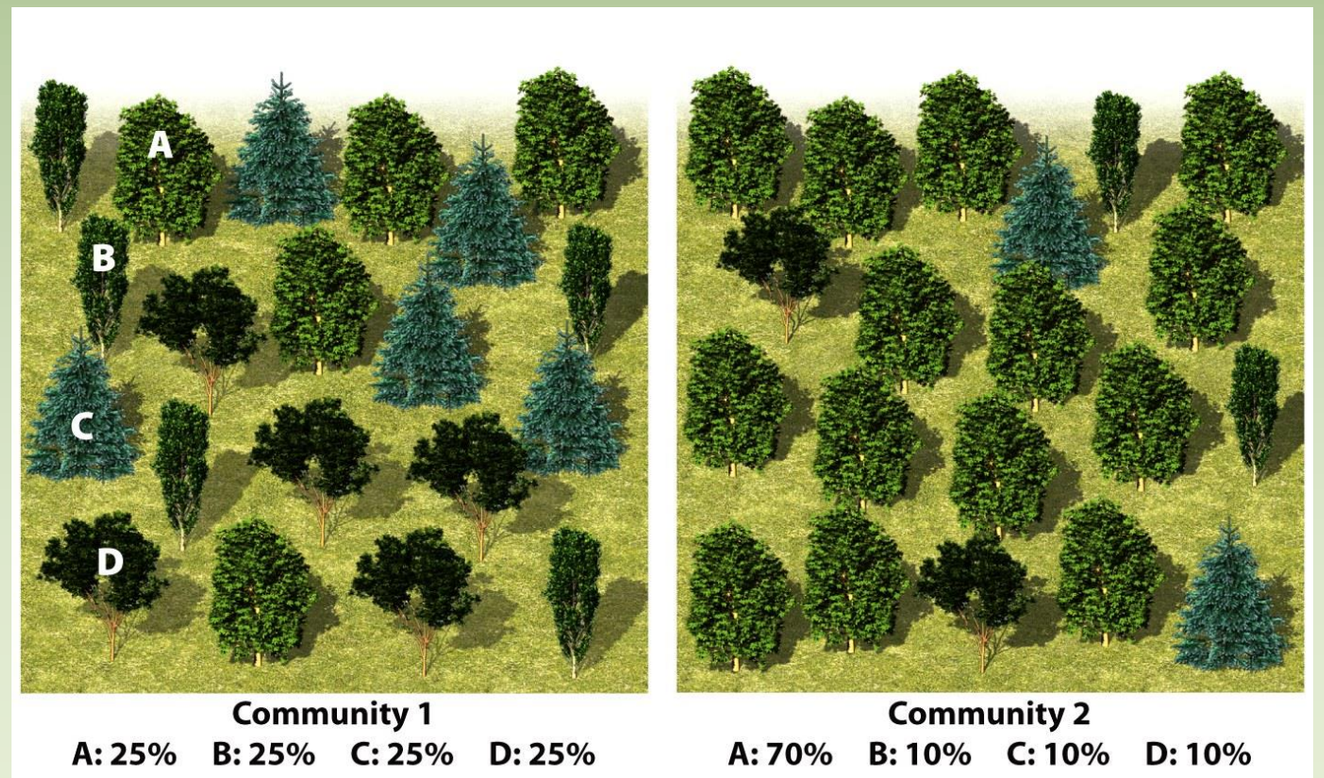


Figure 5.4
Environmental Science

Evolution is the mechanism underlying biodiversity

- Evolution- a change in the genetic composition of a population over time.
- Microevolution- evolution below the species level.
- Macroevolution- Evolution which gives rise to new species or new genera, family, class or phyla.

Creating Genetic Diversity

- Genes- physical locations on chromosomes within each cell of an organism.
- Genotype- the complete set of genes in an individual.
- Mutation- a random change in the genetic code.
- Phenotype- the actual set of traits expressed in an individual.

Evolution by artificial and natural selection

- Evolution by artificial selection- when humans determine which individuals breed.
- Evolution by natural selection- the environment determines which individuals are most likely to survive and reproduce.

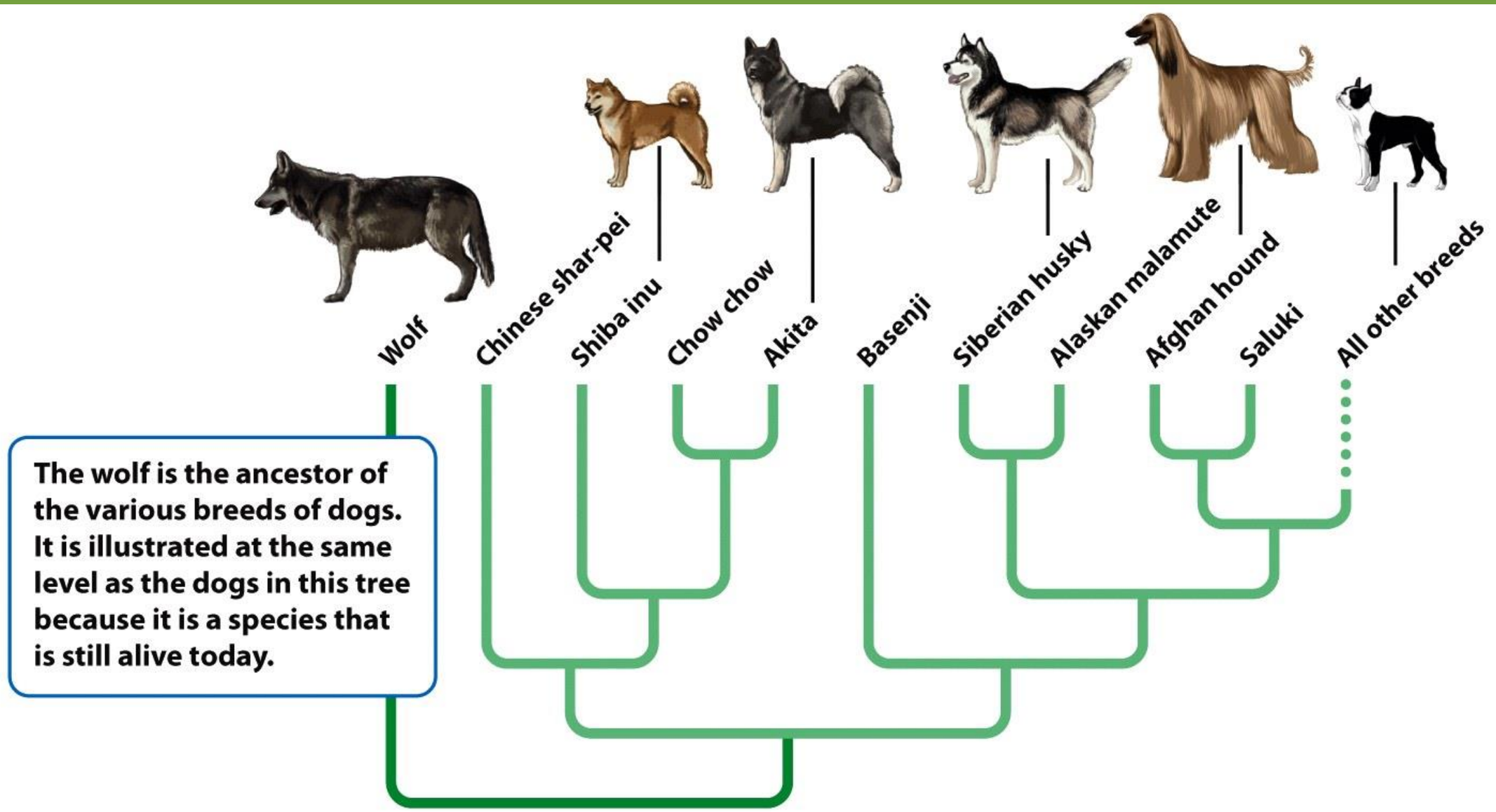


Figure 5.8
Environmental Science

Darwin's theory of evolution by natural selection

- Individuals produce an excess of offspring.
- Not all offspring can survive.
- Individuals differ in their traits.
- Differences in traits can be passed on from parents to offspring.
- Differences in traits are associated with differences in the ability to survive and reproduce.

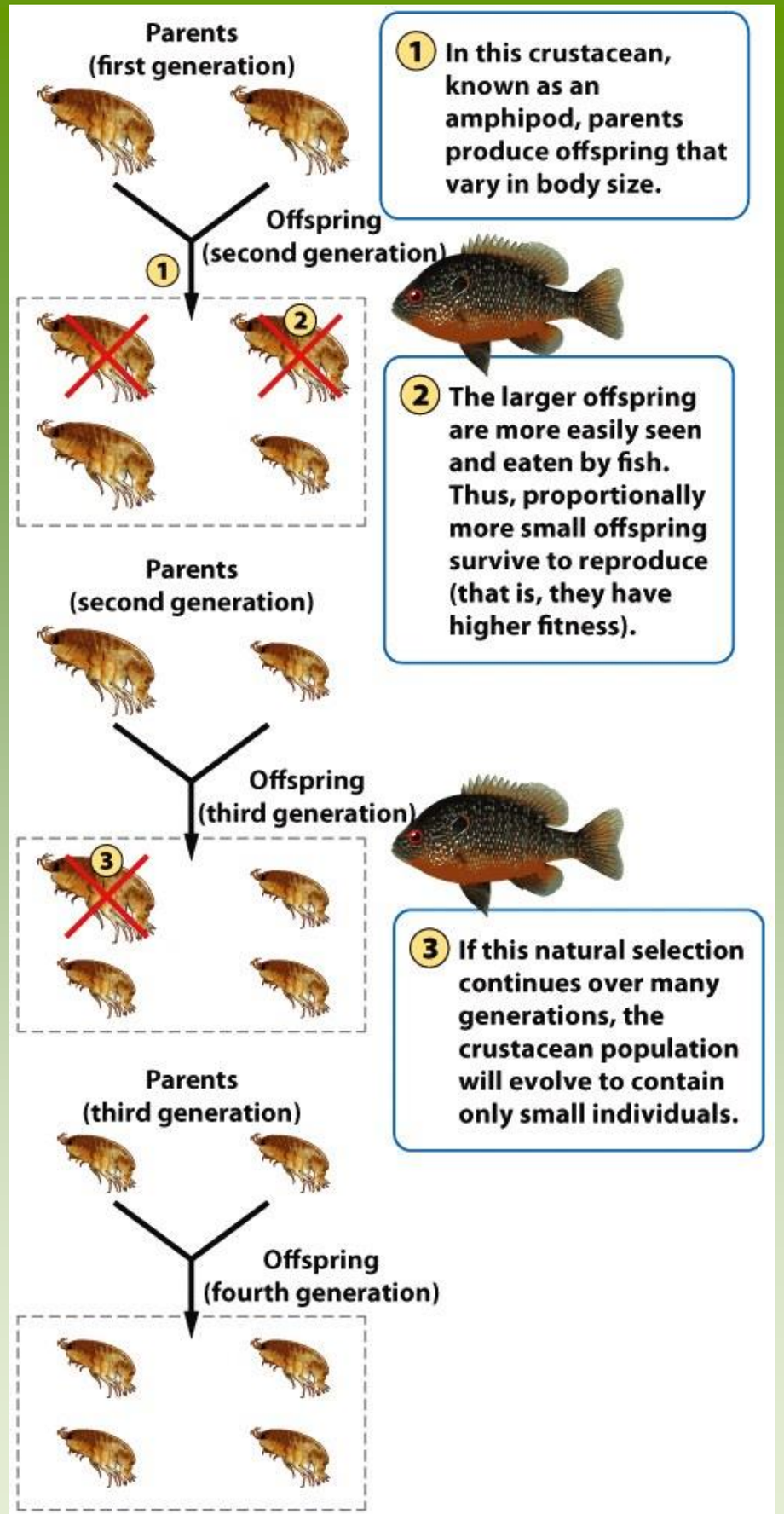
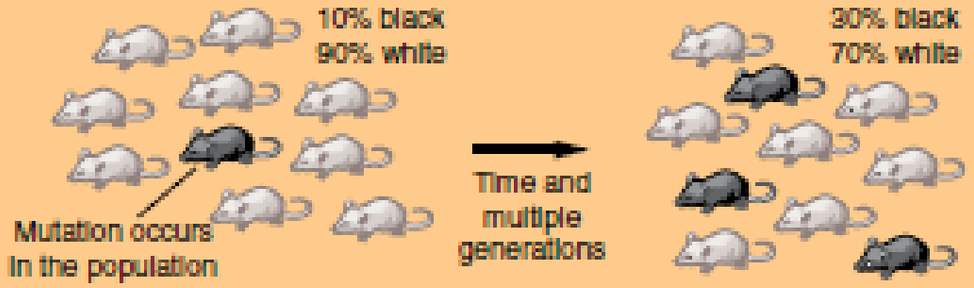


Figure 5.10
Environmental Science

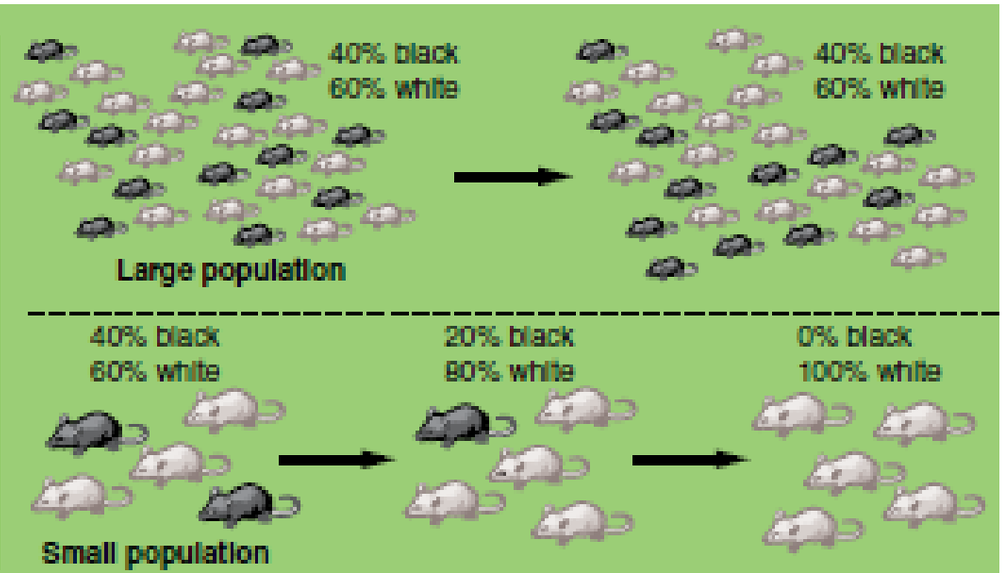
Evolution by Random Processes

- Mutation- occur randomly and can add to the genetic variation of a population.
- Genetic drift- change in the genetic composition of a population over time as a result of random mating.
- Bottleneck effect- a reduction in the genetic diversity of a population caused by a reduction in its size.
- Founder effect- a change in a population descended from a small number of colonizing individuals.

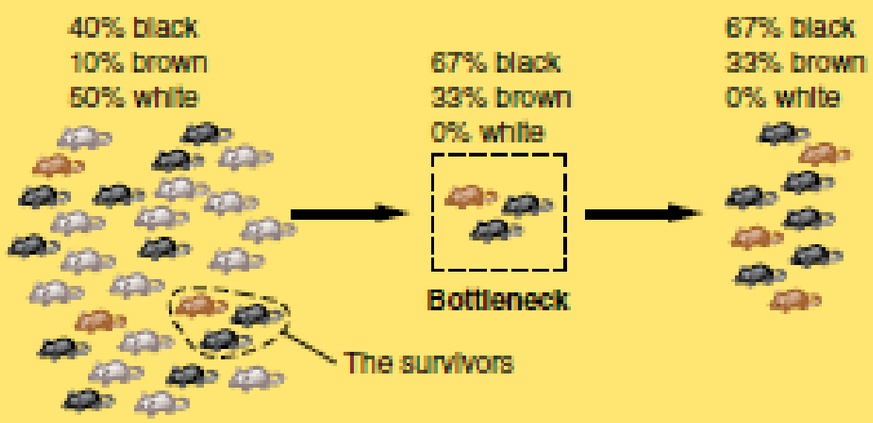
(a) Mutation
A mutation can arise in a population and, if it is not lost, may increase in frequency over time.



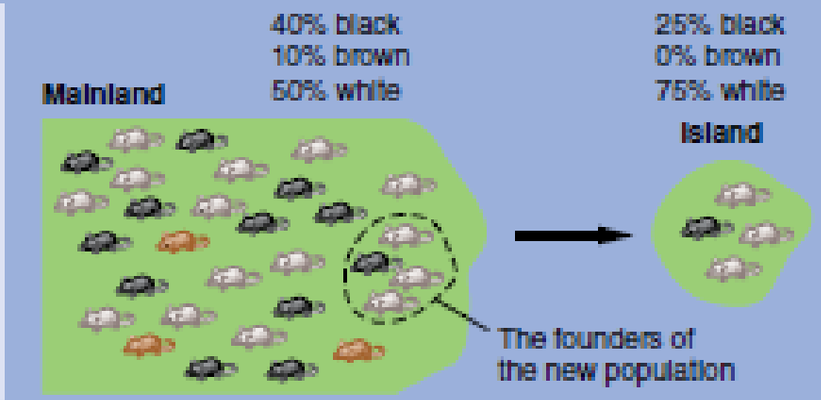
(b) Genetic drift
In a large population, the genetic composition tends to remain the same over time.
In a small population, however, some genotypes can be lost by chance and the genetic composition can change over time.



(c) Bottleneck effect
If a population experiences a drastic decrease in size (goes through a "bottleneck"), some genotypes will be lost, and the genetic composition of the survivors will differ from the composition of the original group.



(d) Founder effect
If a few individuals from a mainland population colonize an island, the genotypes on the island will represent only a subset of the genotypes present in the mainland population. As with the bottleneck effect, some genotypes will not be present in the new population.



Speciation and extinction determine biodiversity

- Allopatric speciation- when new species are created by geographic or reproductive isolation.

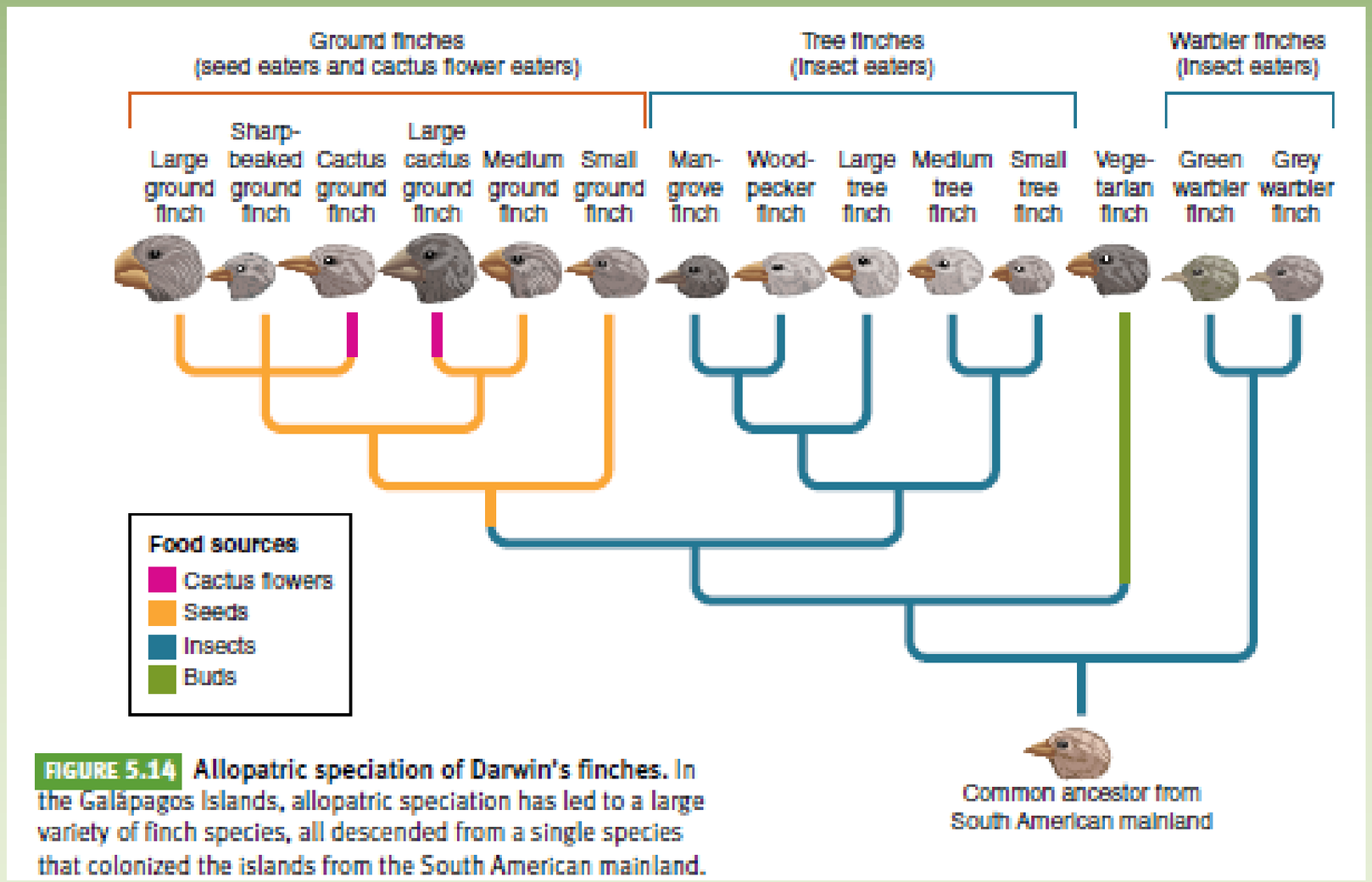
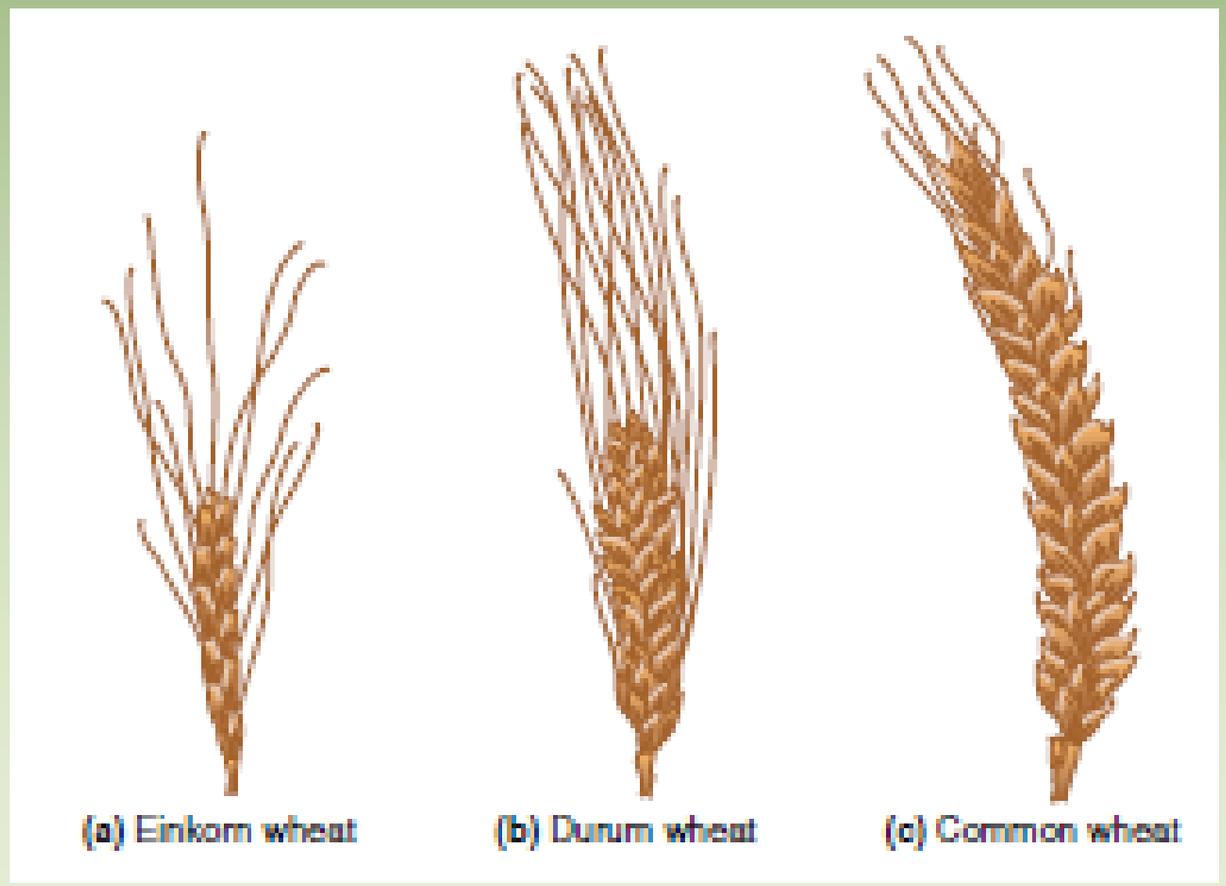
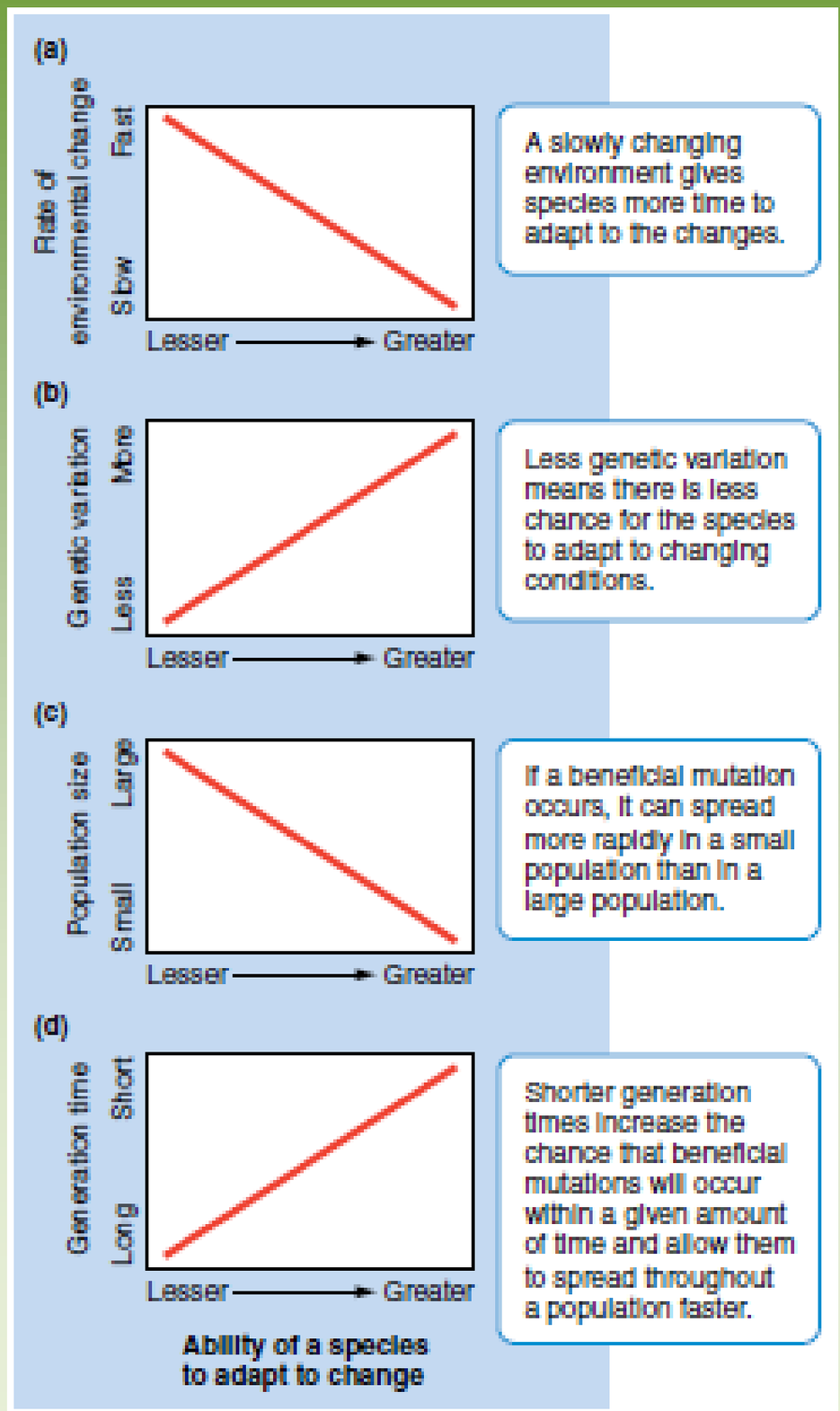


FIGURE 5.14 Allopatric speciation of Darwin's finches. In the Galápagos Islands, allopatric speciation has led to a large variety of finch species, all descended from a single species that colonized the islands from the South American mainland.

- Sympatric speciation- the evolution of one species into two species in the absence of geographic isolation, usually through the process of polyploidy, an increase in the number of sets of chromosomes.



The pace of evolution



Evolution shapes ecological niches and determines species distributions

- Range of tolerance- all species have an optimal environment in which it performs well. The limit to the abiotic conditions they can tolerate is known as the range of tolerance.
- Fundamental niche- the ideal conditions for a species.

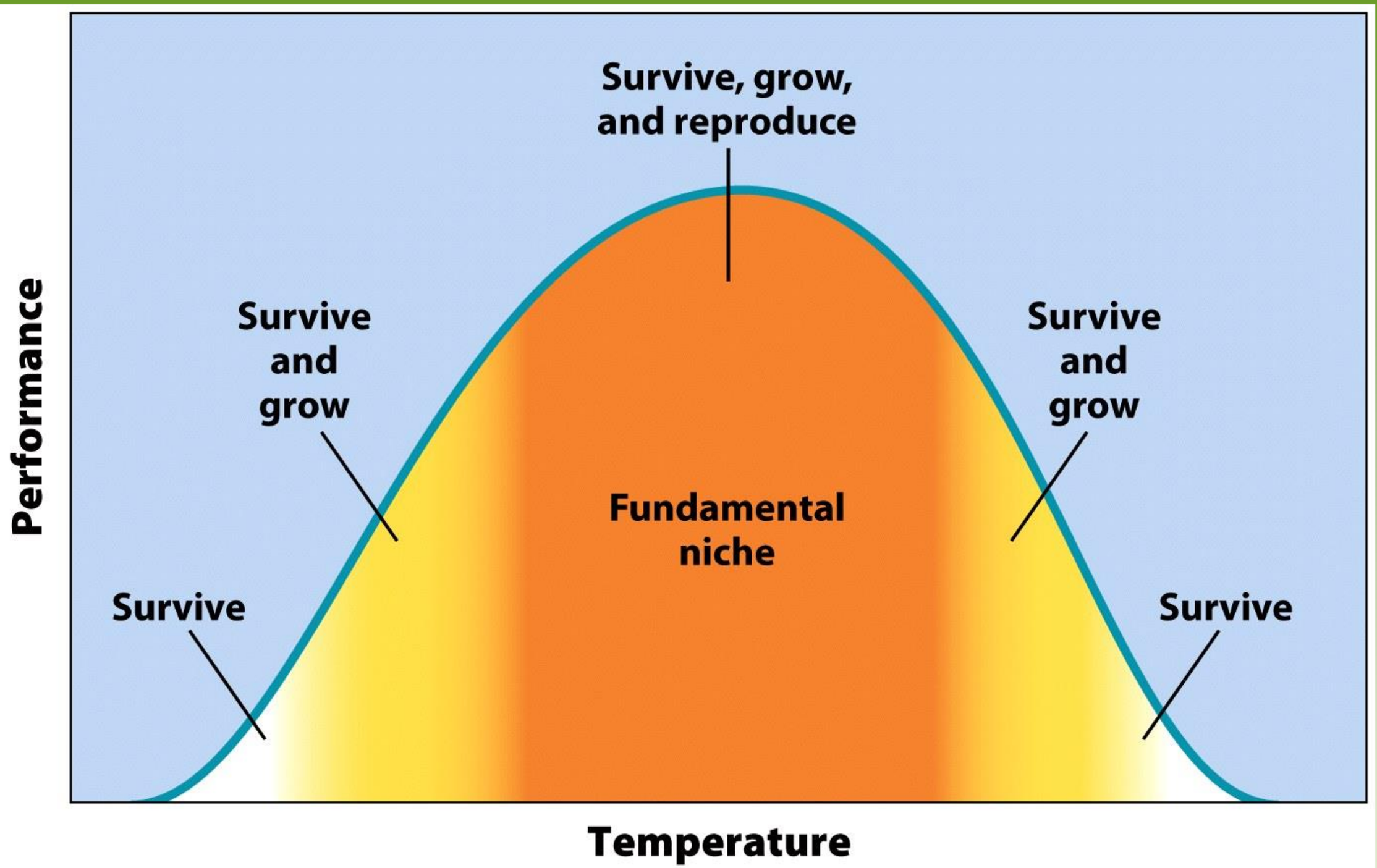


Figure 5.18
Environmental Science

Niches

- Realized niche- the range of abiotic and biotic conditions under which a species lives. This determines the species distribution, or areas of the world where it lives.
- Niche generalist- species that live under a wide range of conditions.
- Niche specialist- species that live only in specific habitats.

Figure 5.19a
Environmental Science

Figure 5.19b
Environmental Science

The Fossil Record

- Fossils- remains of organisms that have been preserved in rock. Much of what we know about evolution comes from the fossil record.

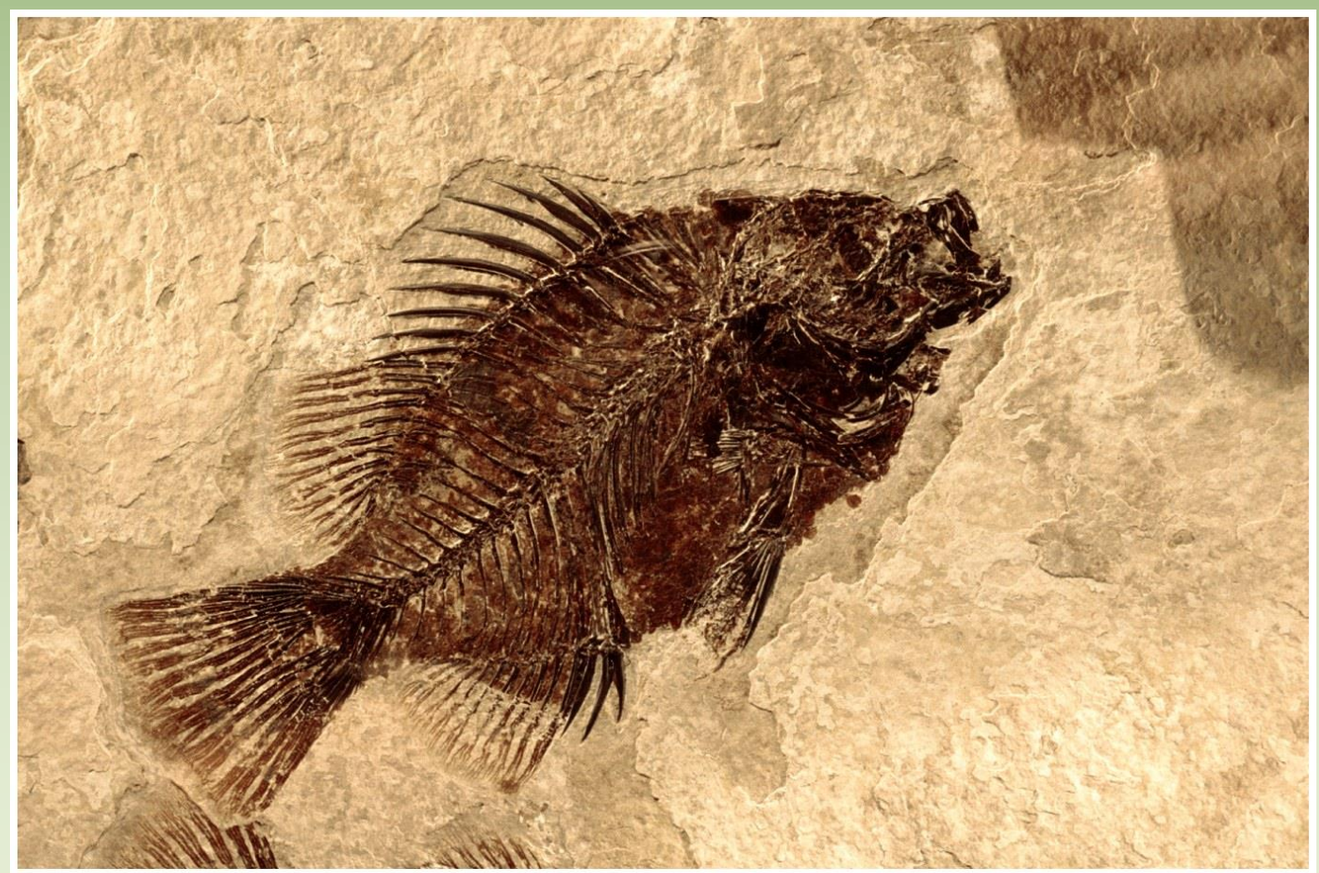


Figure 5.22
Environmental Science

The Five Global Mass Extinctions

- Mass extinction- when large numbers of species went extinct over a relatively short period of time.

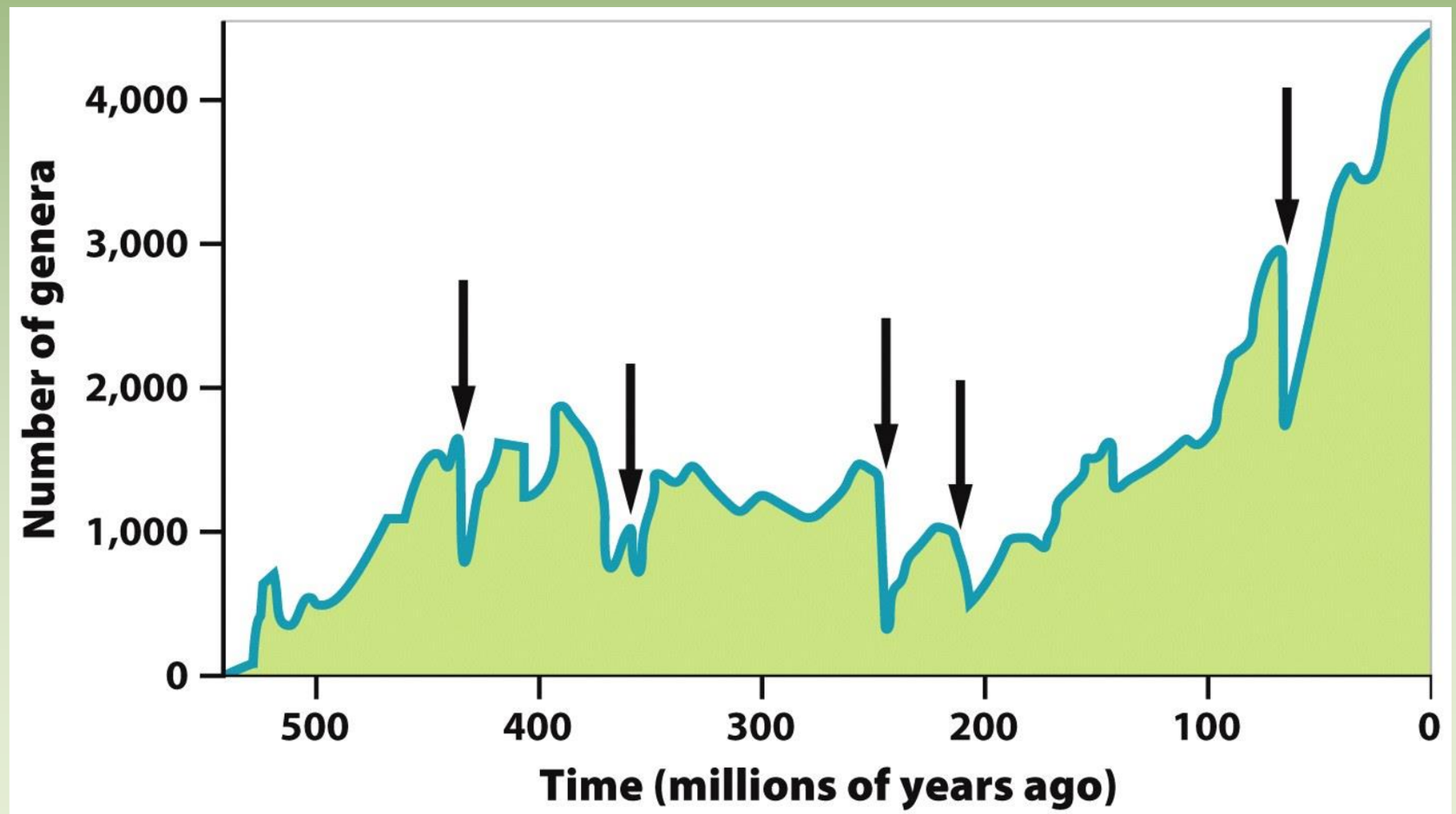


Figure 5.23
Environmental Science

The Sixth Mass Extinction

- Scientists feel that we are in our sixth mass extinction, occurring in the last two decades.
- Estimates of extinction rates vary widely, from 2 % to 25% by 2020.
- In contrast to previous mass extinctions, scientists agree that this one is caused by humans.