Evolutionary Patterns, Rates, and Trends
Chapter 17

Learning Objectives

1. Describe how fossils arise, and how they are used to reconstruct the evolution of life.
2. Explain the following lines of scientific evidence used in evolutionary theory: biogeography, comparative morphology, embryonic development, & molecular comparisons.
3. Use the concept of a gene pool and the processes that produce changes in the gene pool (mutation, natural selection, and genetic drift) to explain the process of speciation.
4. Differentiate between sympatric and allopatric speciation, using examples to illustrate your answer.
Fossilization

What is the definition of a species?

- Organism becomes buried in ash or sediments
- Rapid burial and a lack of oxygen aid in preservation
- The organic remains become infused with metal and mineral ions
- As a result of mutations, natural selection, and genetic drift, each species is a mosaic of ancestral and novel traits
- All species that ever evolved are related to one another by way of descent

Radiometric Dating

What is the most abundant isotope of C in cells? How is C¹⁴ incorporated into the molecules of living things?
In some species, like in these chicks, all individuals are identical. I think in all species individuals are identical. Actually, in each species individuals differ in some inherited traits. How can you say that? I cannot see any difference among these chicks.

**CONCEPT OF SPECIES**

With whom do you agree? With whom do you disagree? Why?

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The Origin of Species

- The fossil record chronicles two patterns of speciation (origin of new species).

*How would you describe these two patterns?*

*Which one would increase species diversity?*

*Why?*
Forces of Change & Biogeography

island arc  oceanic crust  oceanic ridge  trench  continental crust

lithosphere (solid layer of mantle)  hot spot  athenosphere (plastic layer of mantle)  subducting plate

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Comparative Morphology

- Comparing body forms and structures of major lineages
- Guiding principle:
  - When it comes to introducing change in morphology, evolution tends to follow the path of least resistance

Differentiate between divergence and convergence in body form. Why does this happen?
Comparative Development

• Each animal or plant proceeds through a series of changes in form
• Similarities in these stages may be clues to evolutionary relationships

Comparative Biochemistry

• Kinds and numbers of biochemical traits that species share is a clue to how closely they are related
• Can compare DNA, RNA, or proteins
• More similarity means species are more closely related
• Mutation rate is relatively constant, therefore counting the number of differences may be used to estimate time of divergence

Example: Human cytochrome c (a protein)
• Identical amino acids in chimpanzee
• Chicken differs by 18 a.a.
Defining “Species”

“Species are groups of interbreeding natural populations that are reproductively isolated from other such groups.”

- Ernst Mayr

Reproductive Isolation

The concept of biological species depends on reproductive isolation; that is, barriers that prevent interbreeding and hence genetic mixing.

What do you think are those barriers? How would you classify them?
Reproductive Isolation

The species is maintained only if offspring reproduce themselves, contributing to the gene pool.

Prezygotic barriers

机械隔离：不同物种的个体因为身体不兼容无法交配。
行为隔离：不同物种的个体因为行为原因无法交配。
时域隔离：不同物种的个体由于不同的繁殖时间而无法交配。
生态隔离：不同物种的个体生活在不同的地方而无法交配。

They interbreed anyway.

Postzygotic barriers

配子不相容：不同物种的配子无法相互结合。

Gamete mortality: Gametes of different species are incompatible, so no fertilization.

精子和卵子不能结合。

 hybrids are inviable: Hybrid embryos die early or the new individuals die before they can reproduce.

Hybrid inviability: Hybrid individuals die early or the new individuals die before they can reproduce.

Hybrid sterility: Hybrid individuals can’t make functional gametes.

No offspring, sterile offspring, or weak offspring that die before reproducing.

Genetic Divergence

• Gradual accumulation of differences in the gene pools of populations

• Natural selection, genetic drift, and mutation can contribute to divergence

• Gene flow counters divergence (makes gene pools more similar)