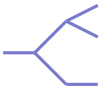
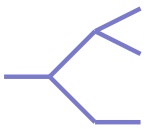
Natural Selection

AP Biology ▪ Unit 7

AP Biology



What we will cover



1 Natural selection

Natural selection

Natural selection 自然选择 (Darwin): helpful traits spread because their carriers reproduce more. It needs three things:

- **variation** 变异 among individuals
- the trait is **heritable** 可遗传的
- **differential reproductive success** 繁殖成功

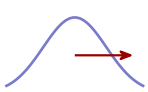
> An individual does not evolve – the **population** 种群 does, as **allele frequencies** 等位基因频率 shift.

Helpful alleles spread; fitness is surviving offspring

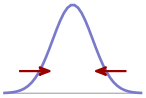
2 Types

Types of selection

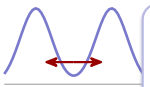
Selection can push a trait three ways:



Directional
one extreme wins



Stabilizing
middle wins



Disruptive
both extremes win

Antibiotics select for resistant bacteria

> **Artificial selection** 人工选择 (breeding) does the same, faster – proof that populations change.

3 Population genetics

Population genetics

The **gene pool** 基因库 is all the alleles in a population. Frequencies shift by more than selection:

- **genetic drift** 遗传漂变 – random, strong when small
- **gene flow** 基因流 – **migration** 迁移 in/out

> **Bottleneck** 瓶颈效应 and **founder effect** 奠基者效应: a few survivors carry only some alleles.

Allele frequencies change across populations and deep time

4 Hardy-Weinberg

Hardy–Weinberg equilibrium

A **null hypothesis** 零假设: a population that is *not* evolving. It holds only with no mutation, no selection, no gene flow, large size, random mating.

$$p + q = 1$$

$$\underbrace{p^2}_{\text{hom. dom.}} + \underbrace{2pq}_{\text{het.}} + \underbrace{q^2}_{\text{hom. rec.}} = 1$$

From one measurement

16% show the recessive trait, so $q^2 = 0.16$.

$$q = \sqrt{0.16} = 0.4, \quad p = 0.6$$

$$p^2 = 0.36, \quad 2pq = 0.48$$

Check: $0.36 + 0.48 + 0.16 = 1.00$. If real data differ, the population is evolving.

5 Evidence

Evidence and common ancestry

Many independent lines all point to **evolution** 进化:

- **Fossils** 化石记录: change over time
- **Homologous structures** 同源结构: same bones
- **Molecular** 分子: shared DNA sequences
- **Biogeography** 生物地理学: where species live

One near-universal genetic code + ATP + ribosomes ⇒ common ancestry.

Fossils record change and shared ancestry

6 Speciation

Speciation and phylogeny

A **species** 物种: members that breed fertile offspring. New species need **reproductive isolation** 生殖隔离:

- **allopatric** 异域物种形成 – a physical barrier splits them
- **sympatric** 同域物种形成 – split in the same place

> A **phylogenetic tree** 系统发育树 shows relatedness; recent branch points = close cousins.

Isolation and extreme habitats can split lineages

7 Recap

Unit 7 – key takeaways

1 Selection

variation + heritable + differential reproduction; the population evolves

2 Drift & flow

gene pool shifts; bottleneck/founder cut variation

3 Hardy–Weinberg

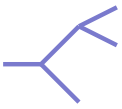
$p + q = 1$; $p^2 + 2pq + q^2 = 1$ as a null model

4 Evidence

fossils, homology, molecules; common ancestry

Check yourself

1. What three conditions does natural selection need?
2. Which selection type favours both extremes?
3. If $q^2 = 0.09$, what are q and p?
4. What kind of barrier drives allopatric speciation?



Answers **1.** variation, heritable, differential reproduction **2.** disruptive **3.** $q = 0.3$, $p = 0.7$ **4.** a physical/geographic barrier