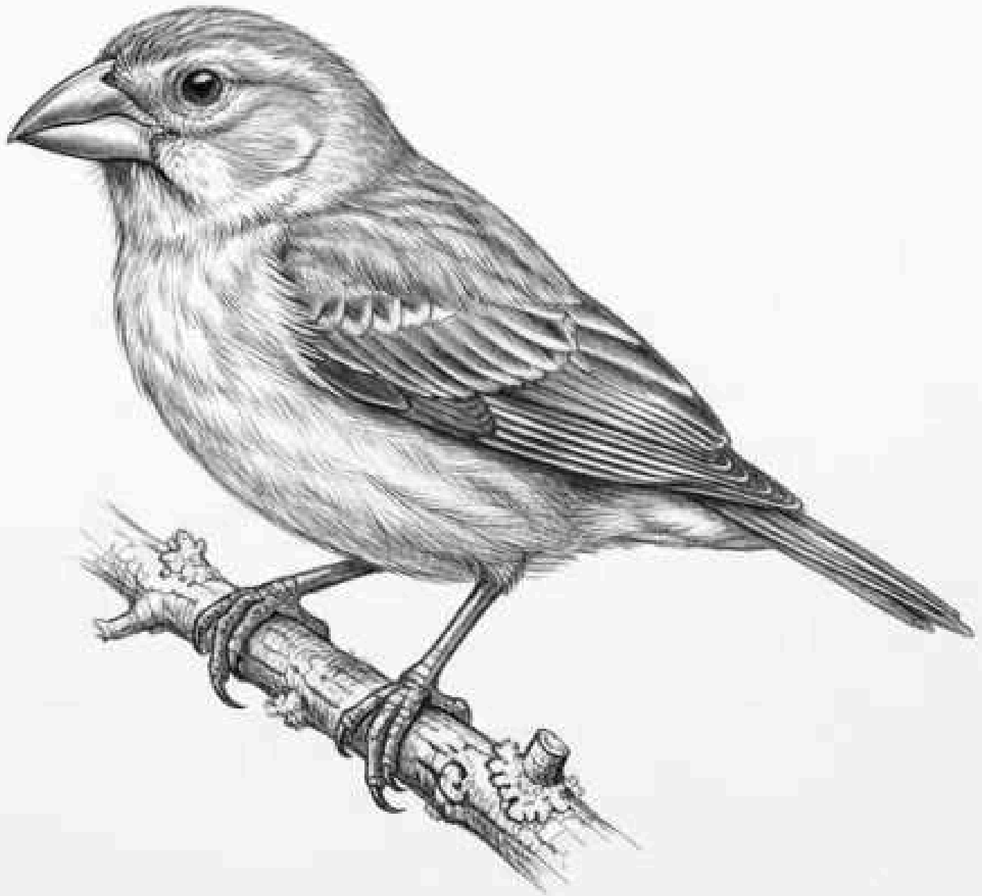
¶ 5.1

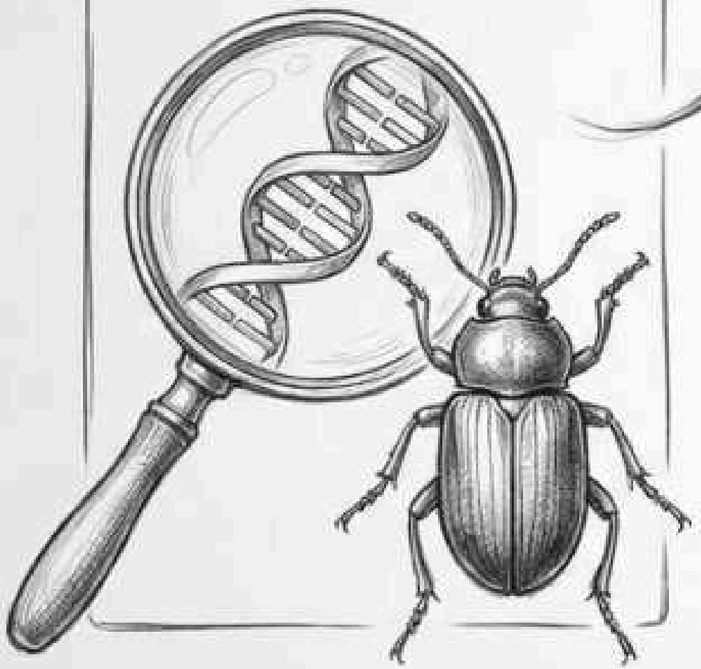


BIO 101 B — Lecture 5

Evolution by Natural Selection

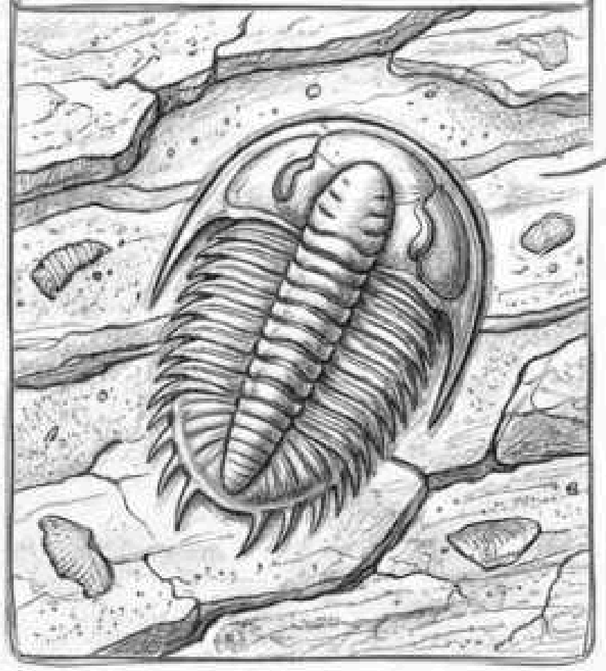
¶ 5.2

How it works



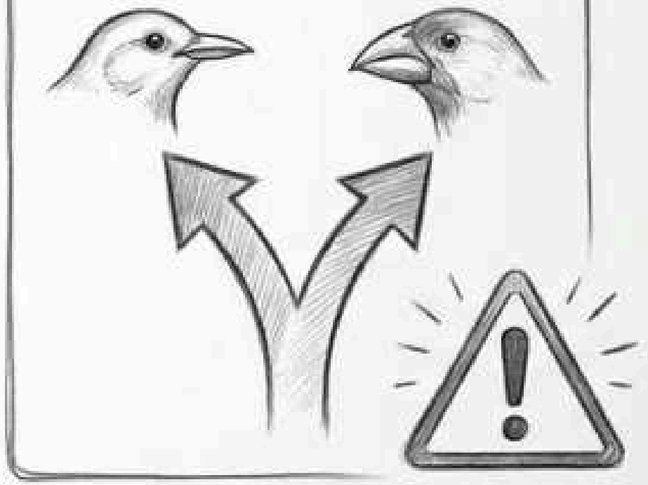
Genetic variation & Inheritance
Mutation & Recombination
Natural Selection acts on phenotypes

The Evidence



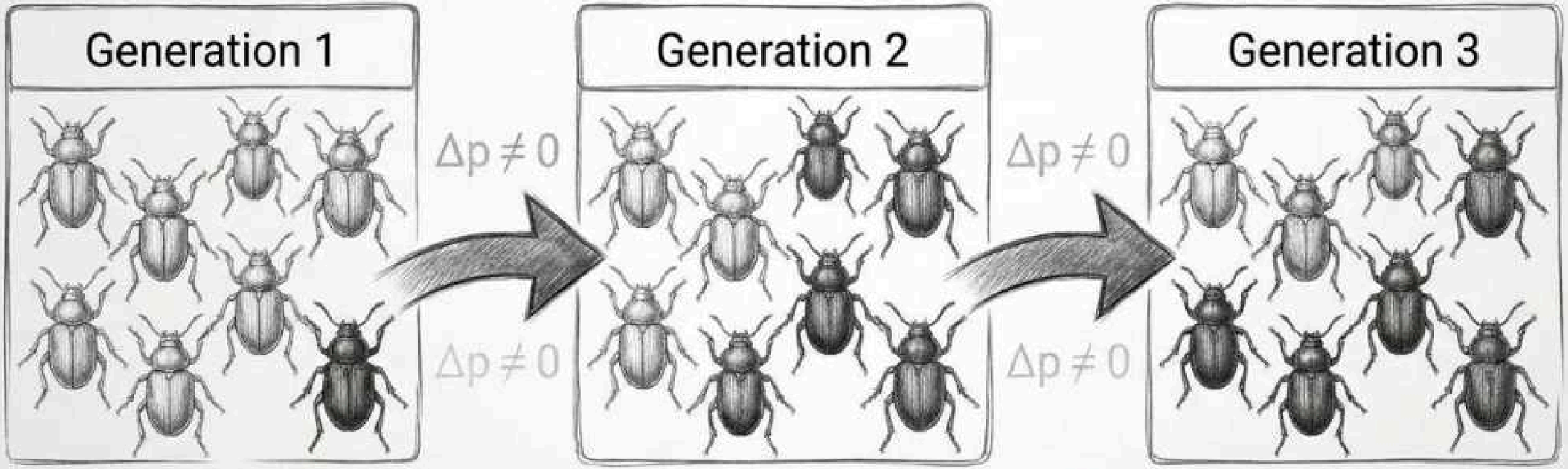
Fossil Record & Stratigraphy
Transitional Forms
Biogeography & Homology
Molecular Evidence

New Species & Misconceptions



Speciation (Allopatric, Sympatric)
Adaptive Radiation
Common Misconceptions
- Evolution is NOT linear
- Individuals don't evolve, populations do

“Nothing in biology makes sense except in the light of evolution.”

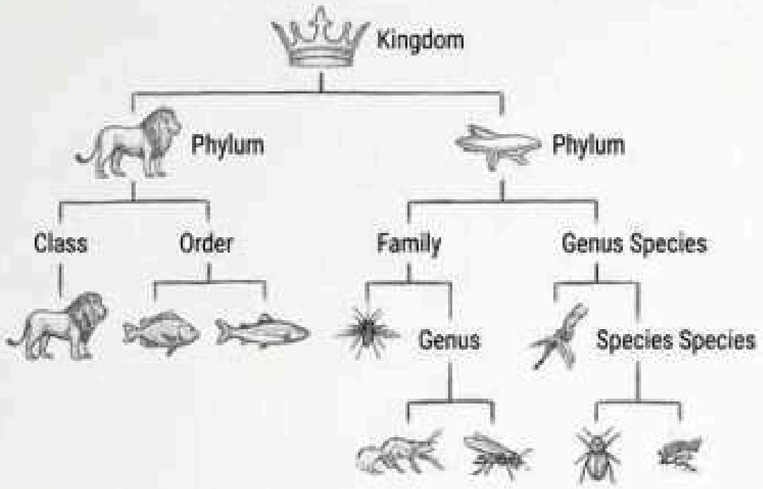


Evolution = Inherited traits shifting in a population over time.

NOT individual animals changing during their lifetimes.

¶ 5.4

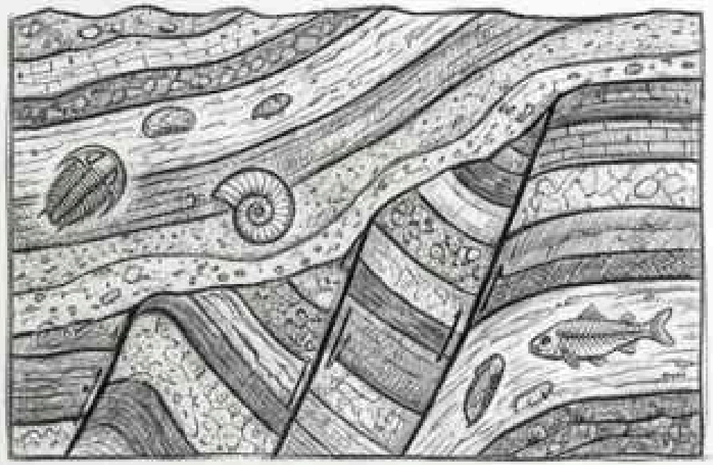
The Foundations of Selection



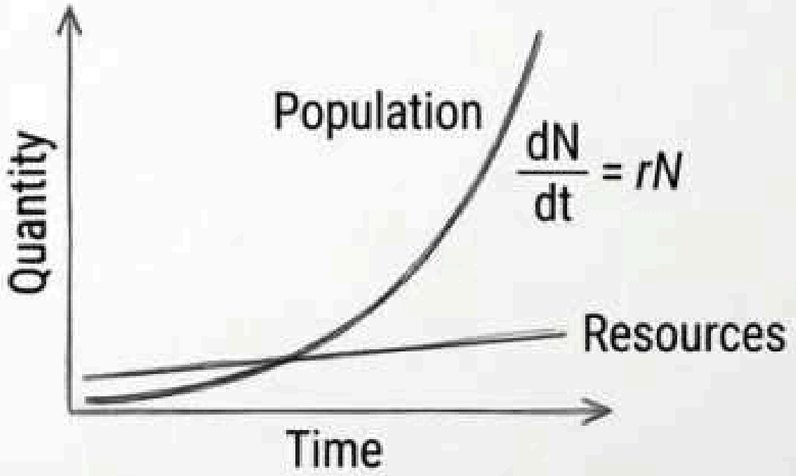
Linnaeus: Nested Classification



Lamarck: Acquired traits (Rejected)



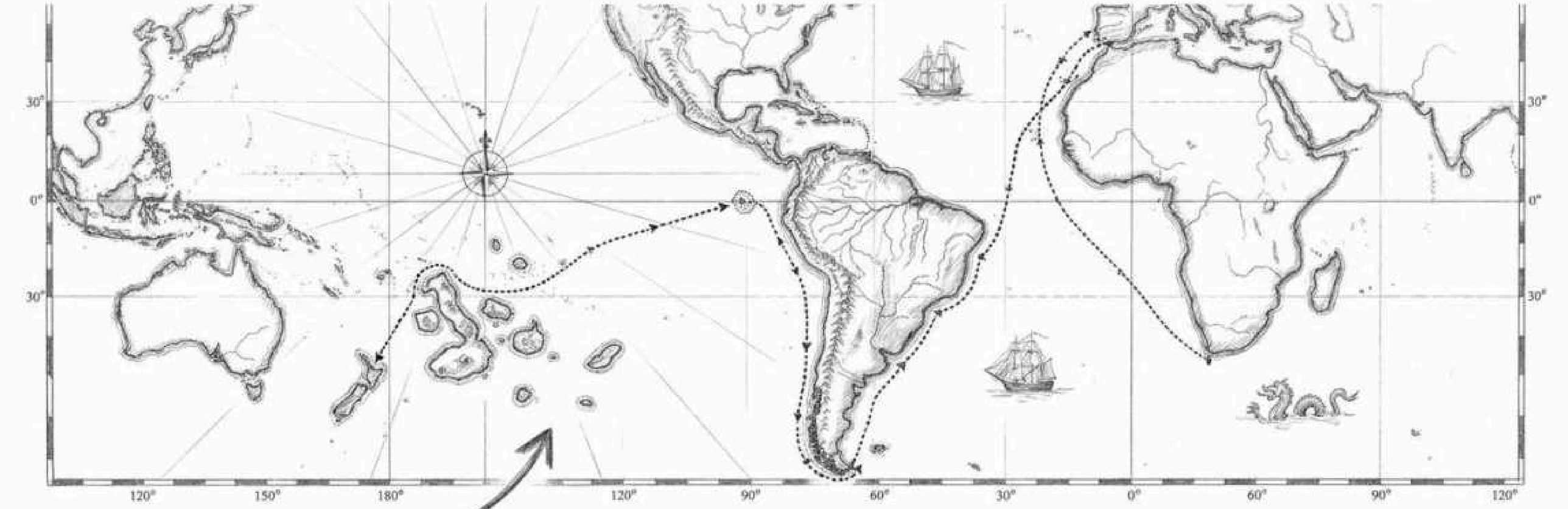
Lyell: Deep Time & Old Earth



Malthus: Population vs. Resources

Naturalist's Whiteboard

¶ 5.5



1831–1836



HMS *Beagle* Voyage
(Island-to-island
variations noted)

1858

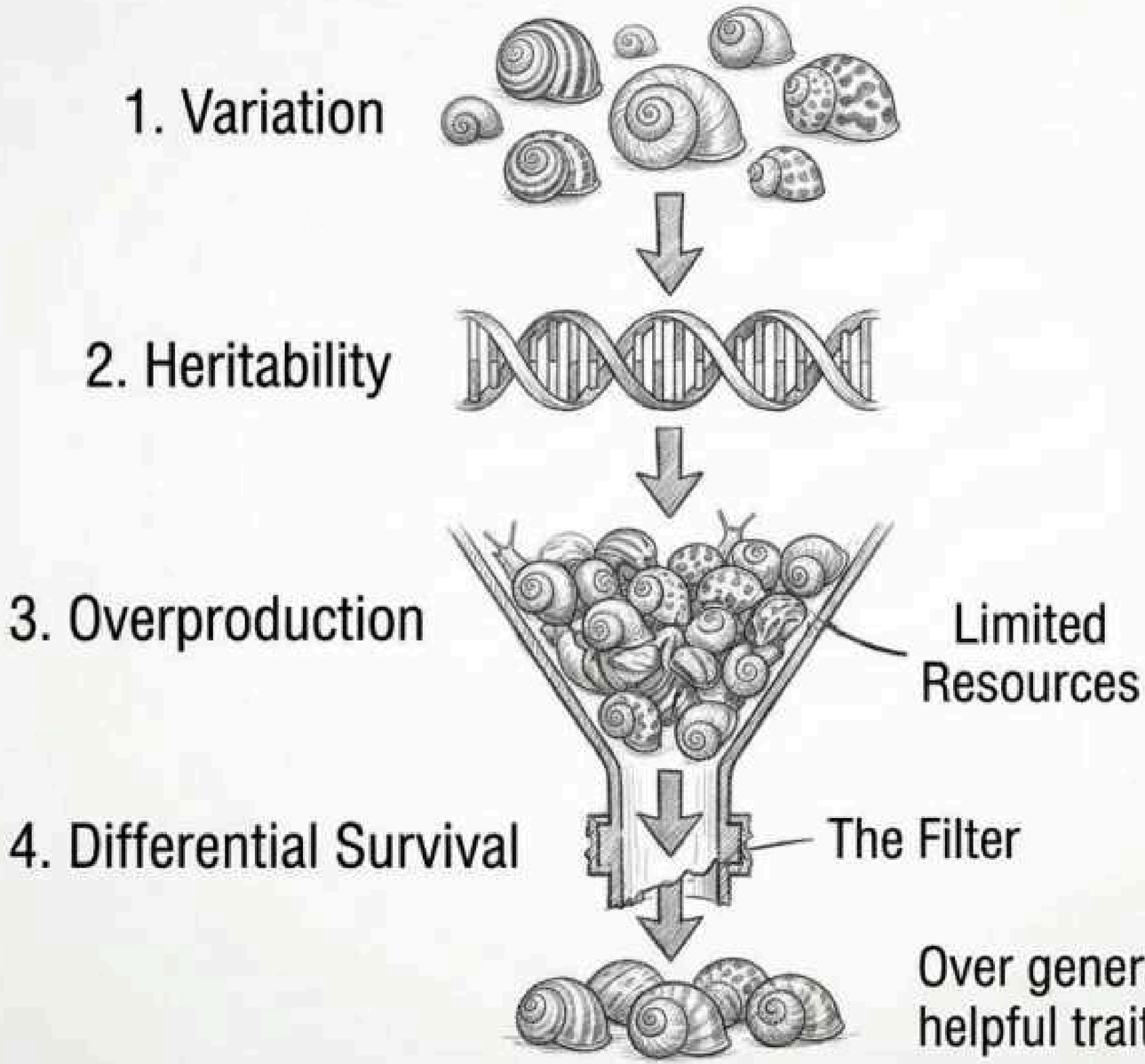
Joint paper with
Alfred Russel Wallace
(Simultaneous discovery)



1859

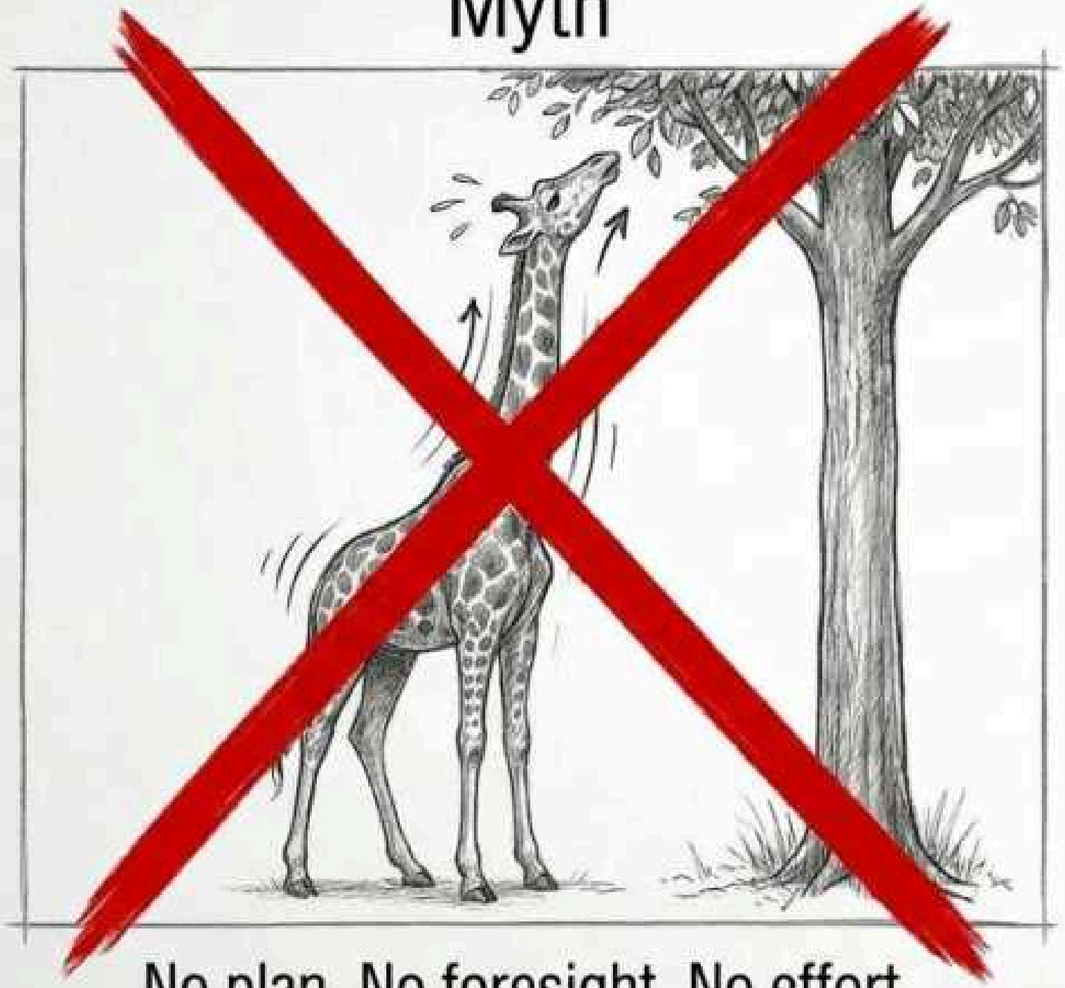
Publication of
On the Origin
of Species




1. Variation
2. Heritability
3. Overproduction
Limited Resources
4. Differential Survival
The Filter
Over generations, helpful traits accumulate.

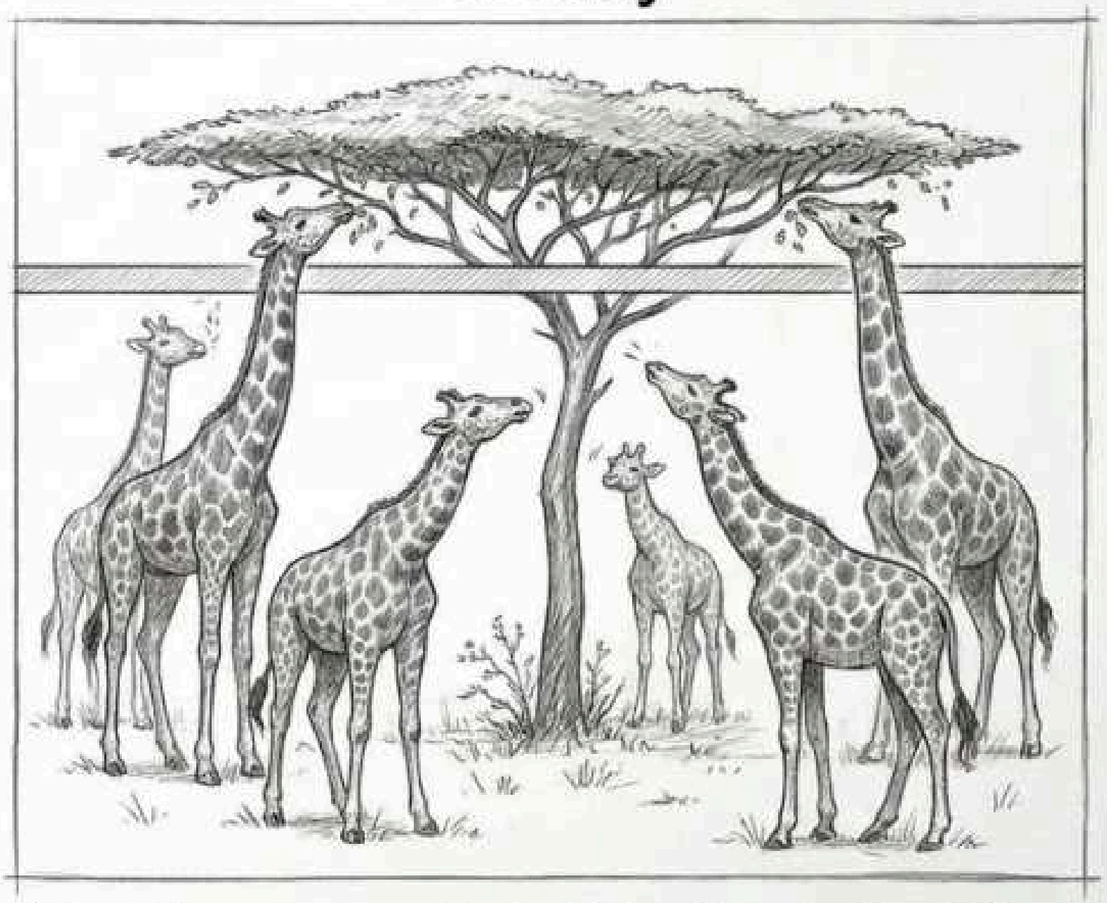
Myth vs. Reality

Myth



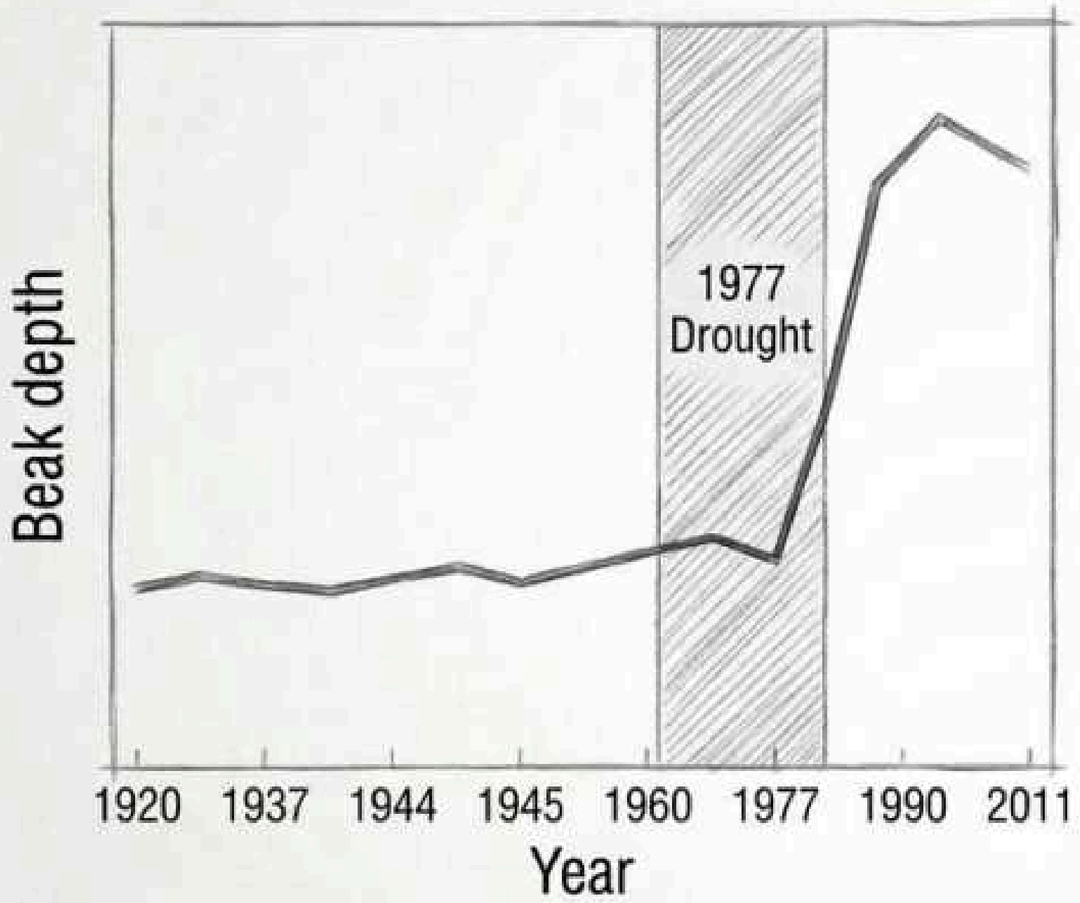
No plan. No foresight. No effort.

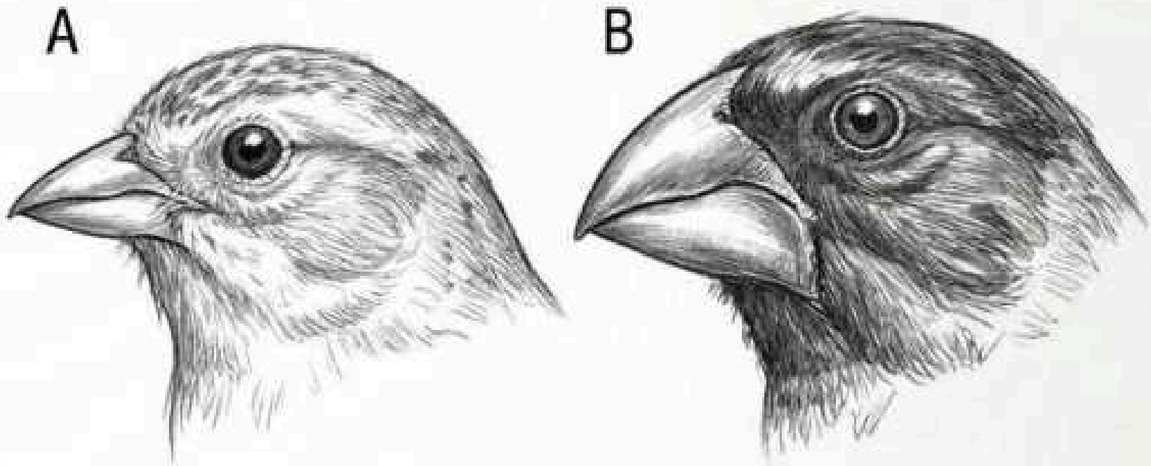
Reality



Variation comes first. Selection is the filter.

¶ 5.8





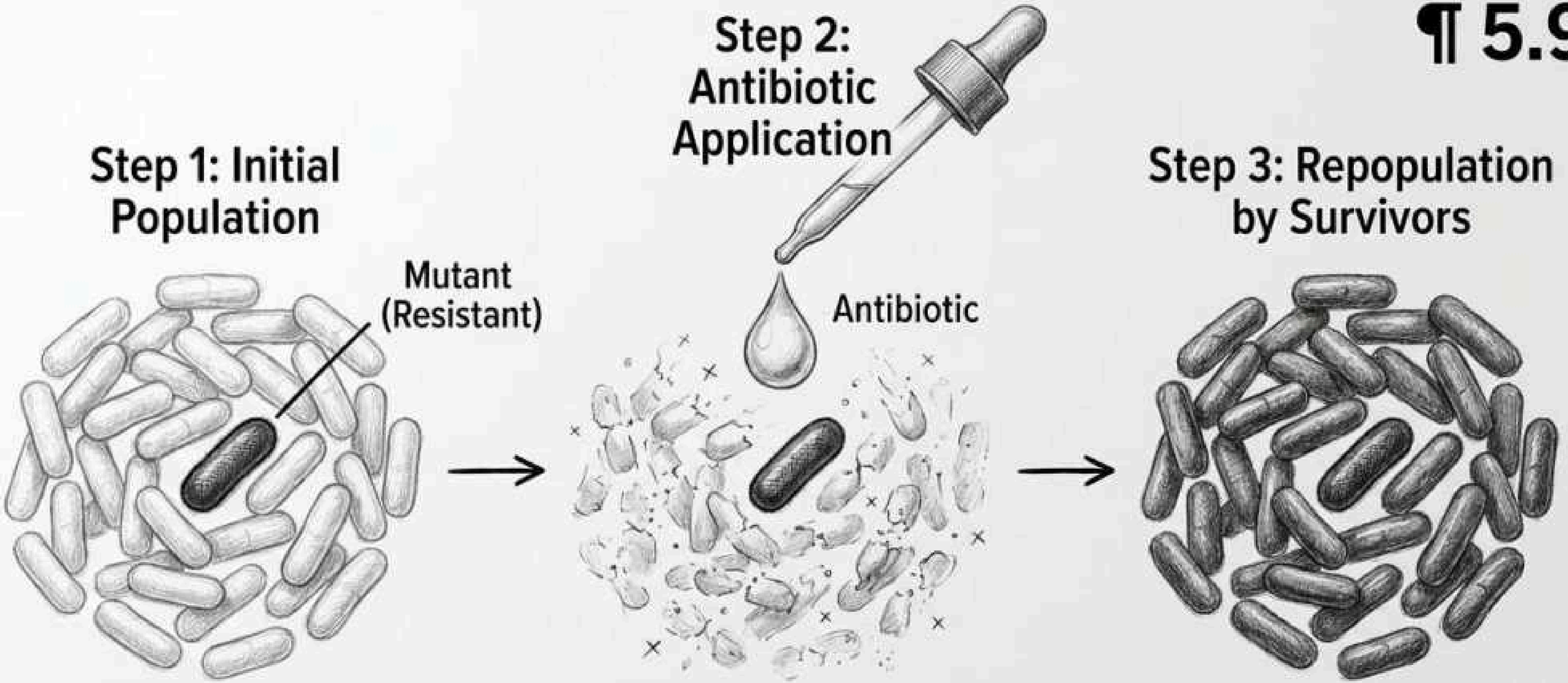
Pre-1977 Norm
(Soft Seeds)

Post-Drought Survivor
(Hard Seeds)

Case Study: Peter & Rosemary Grant

Drought (1977) → Small seeds vanish → Deep beaks crack large seeds → Next generation shifts

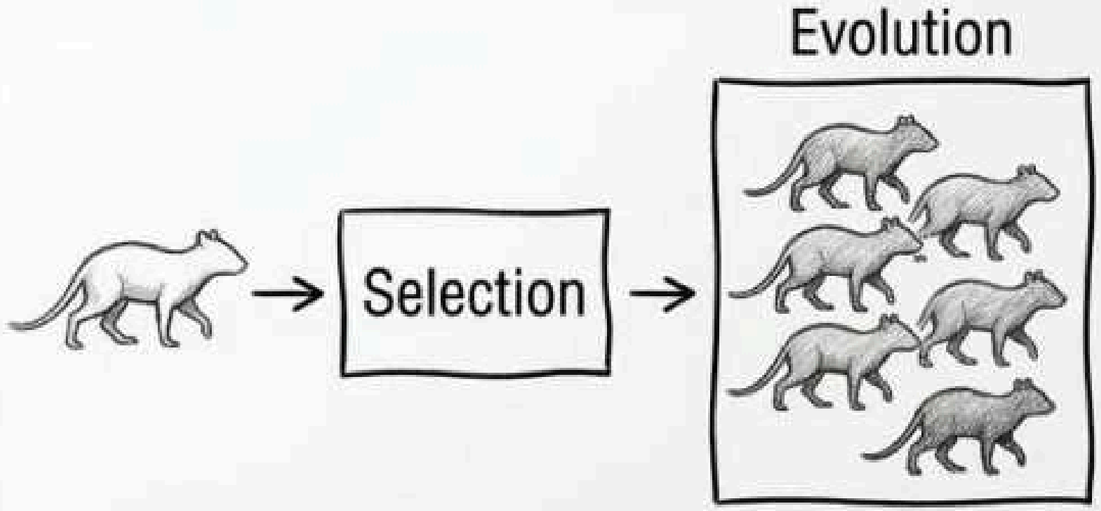
¶ 5.9



Why doctors mandate finishing prescribed courses: Avoid leaving survivors to multiply.

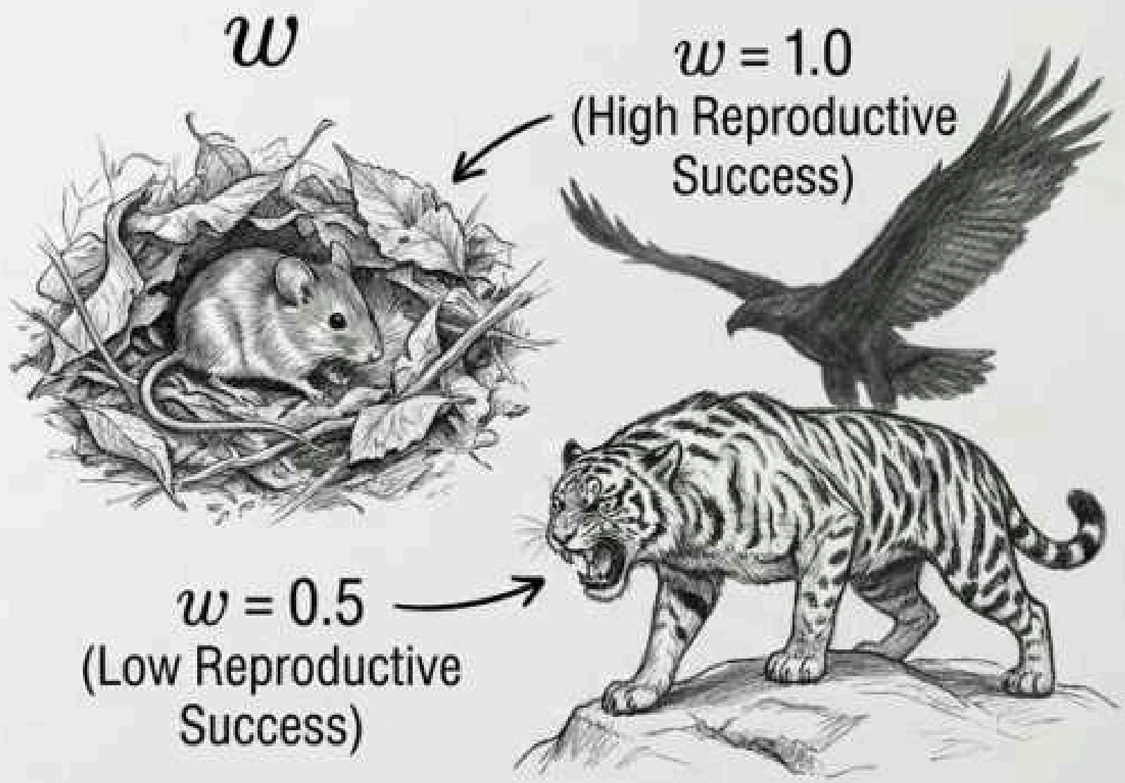
¶ 5.10

The Target vs. Result



Selection acts on individuals.
Evolution happens to populations.

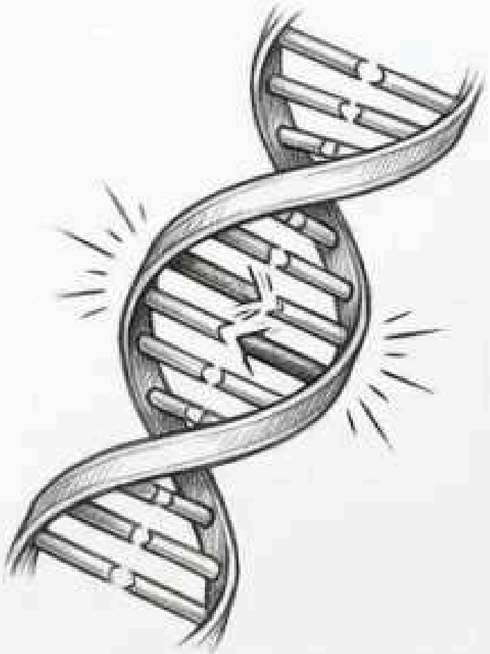
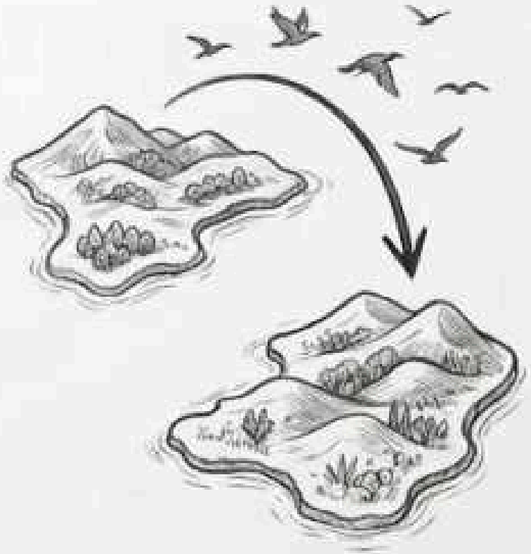
Defining Fitness



Fitness = Reproductive success (surviving to leave offspring).
It does not mean physical strength.

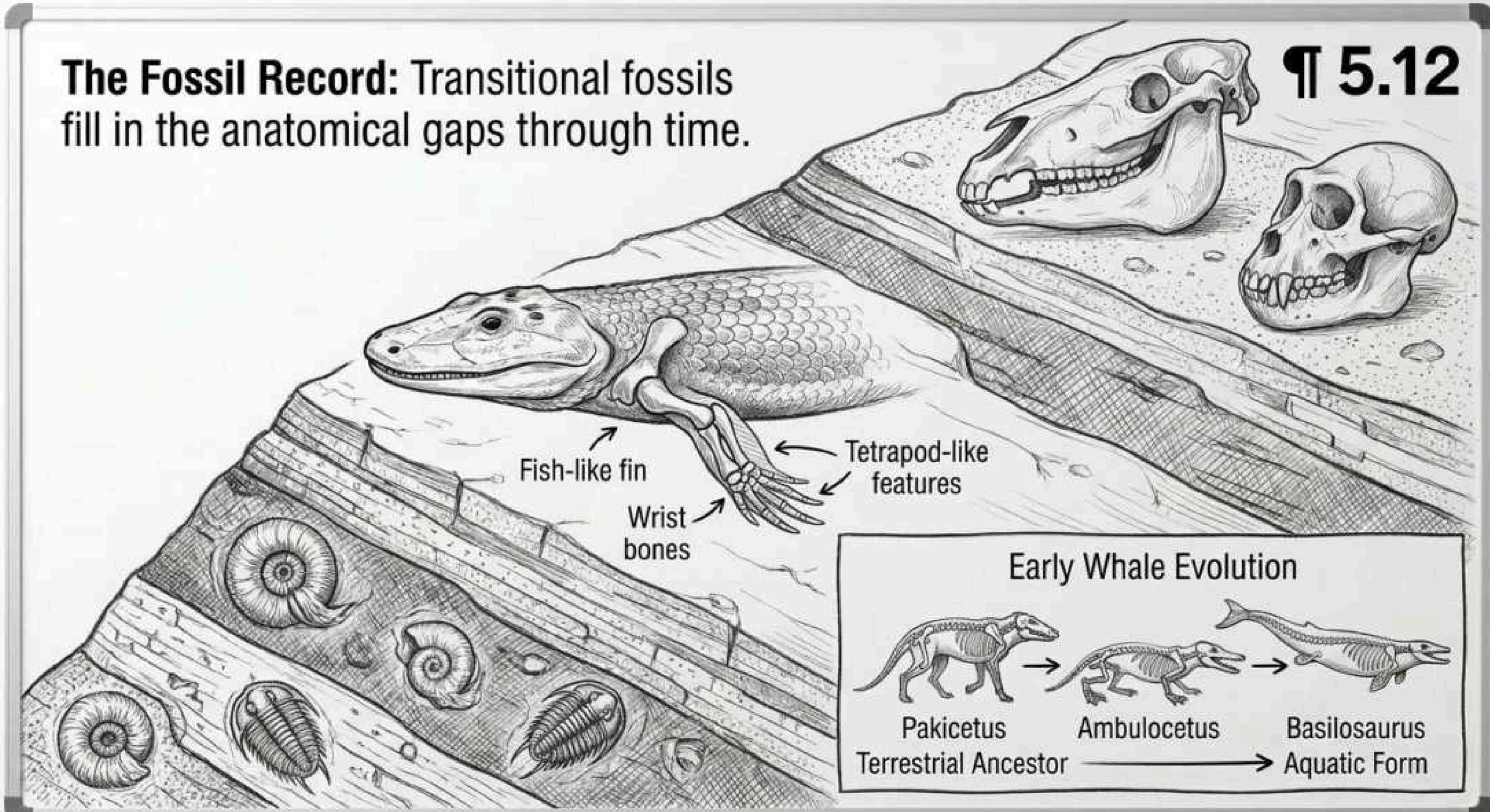
Natural selection is not the only force driving evolution. **¶ 5.11**

$$\Delta p$$

Mutations	Gene Flow	Genetic Drift	Sexual Selection
			
Fresh variation.	Moving alleles.	Chance changes in small populations.	Traits for finding mates.

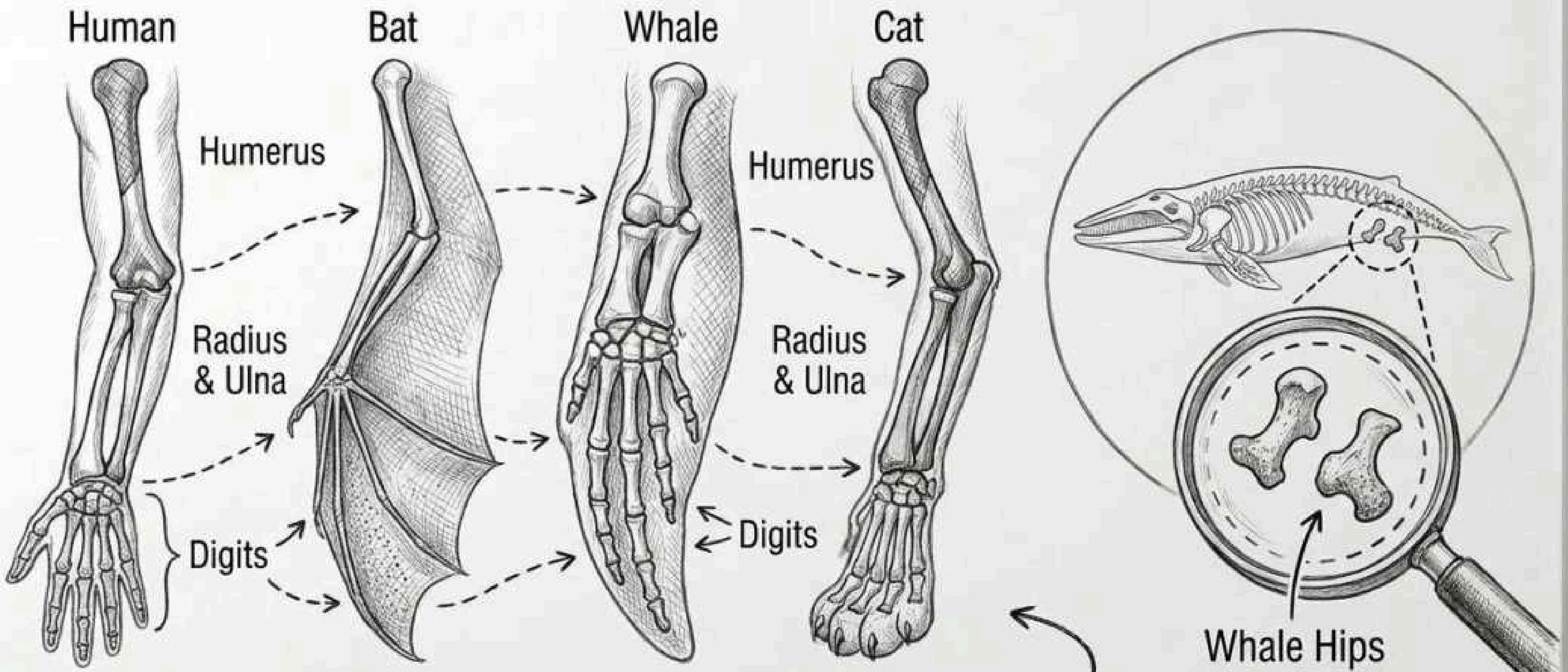
The Fossil Record: Transitional fossils fill in the anatomical gaps through time.

¶ 5.12

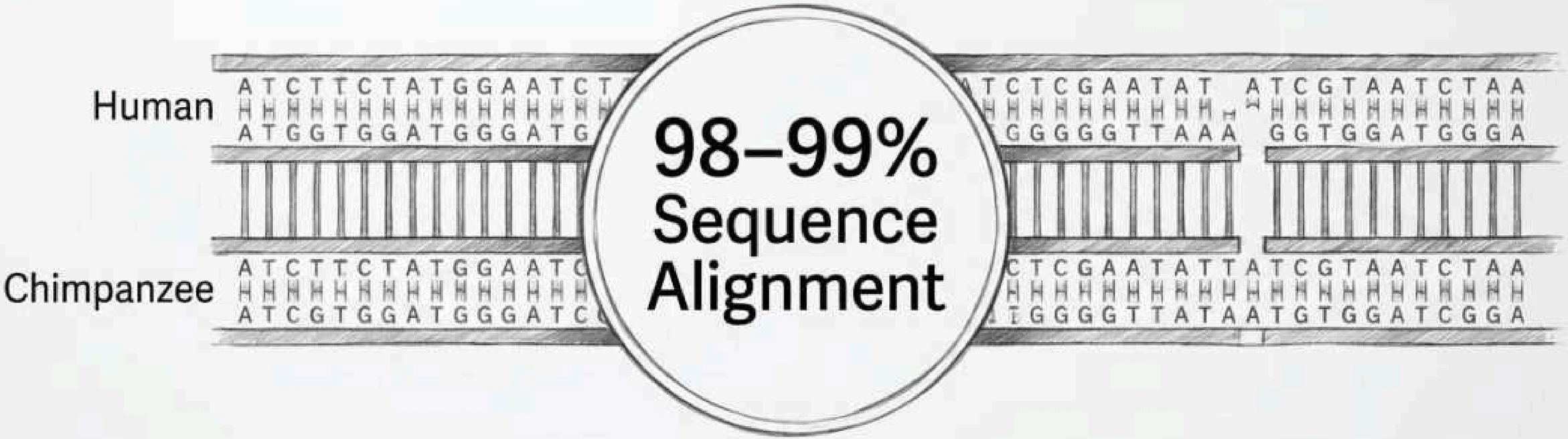


Homologous Structures: Same bone set, different uses.

¶ 5.13

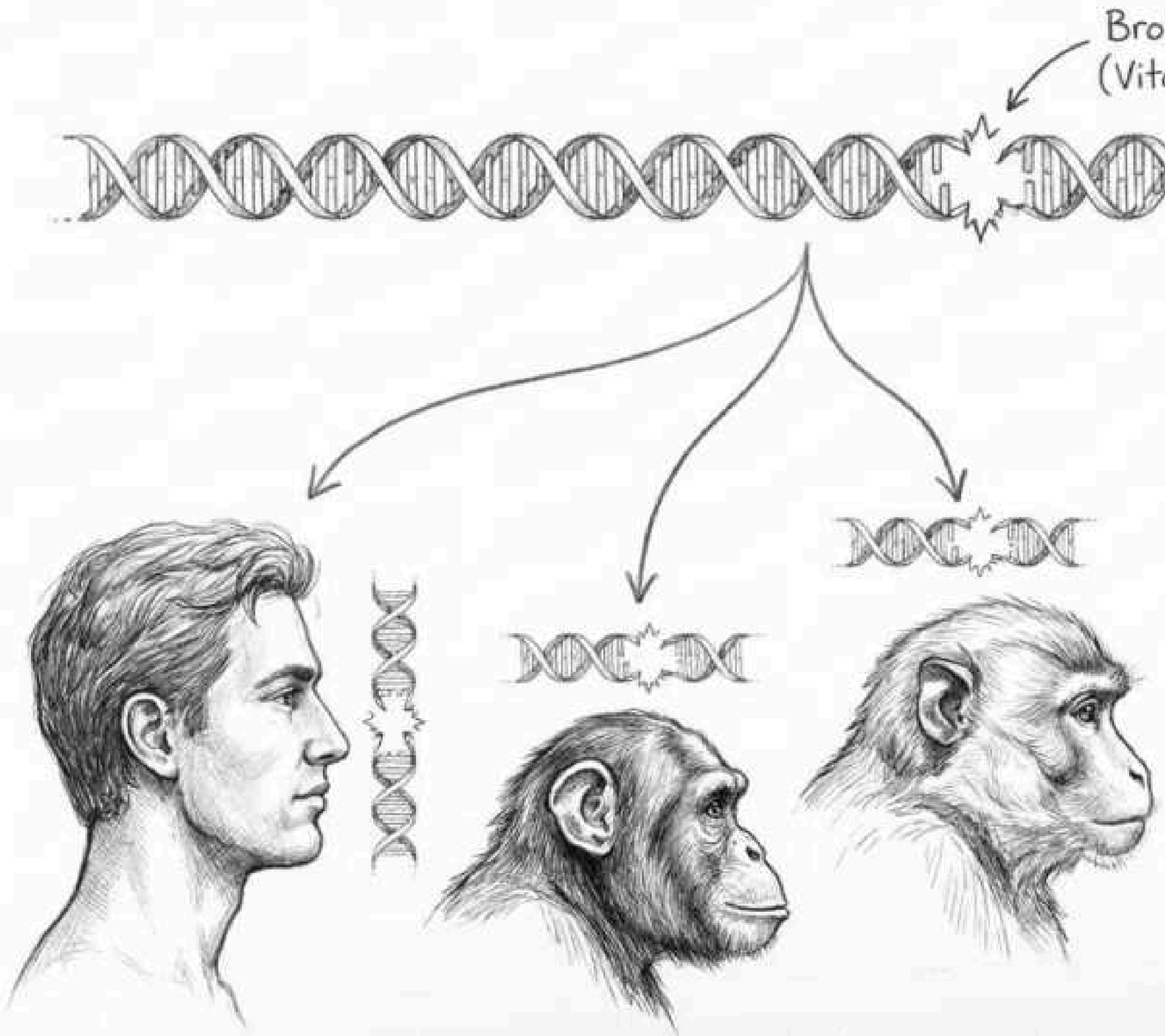


Vestigial Structures: Evolutionary leftovers (e.g., whale hips).



Molecular Biology: All known life uses DNA and nearly the same genetic code. Similarity indicates closeness of relation.

¶ 5.15



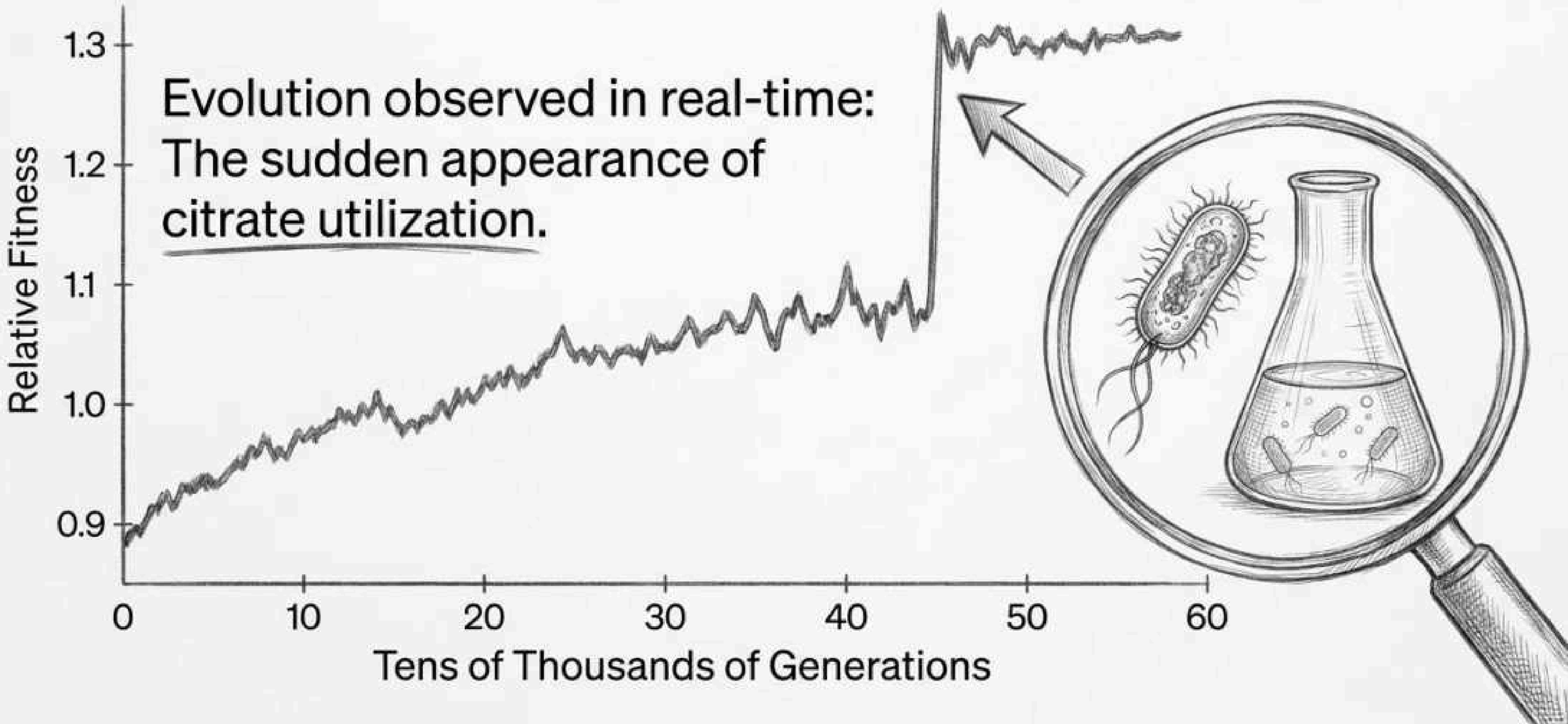
Genetic Fossils:

The broken Vitamin C gene.

Shared molecular errors in the exact same location prove inheritance from a common ancestor.

Since 1988: Richard Lenski's *E. coli* experiment.

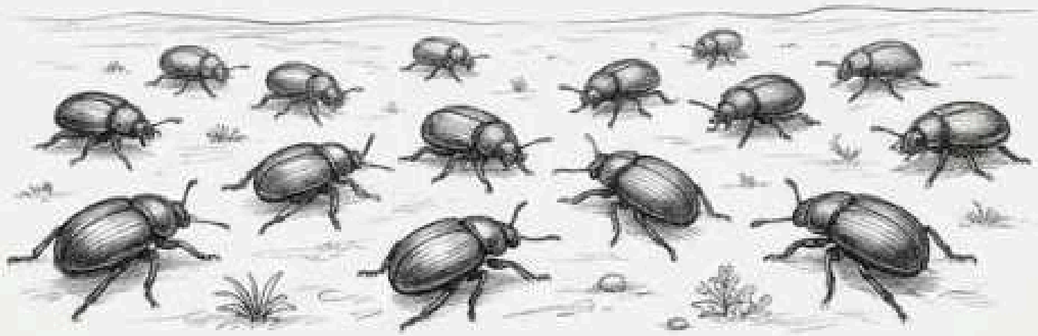
¶ 5.16



Speciation: Divergence requires a splitting barrier and the eventual inability to interbreed.

¶ 5.17

Step 1



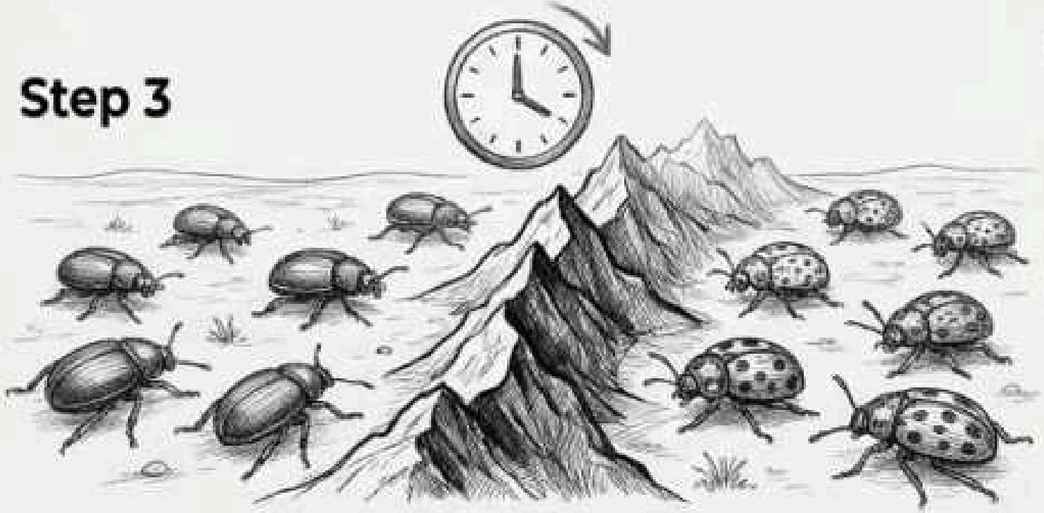
Initial Single Population

Step 2



Geographic Barrier Arises
(e.g., Mountain Range)

Step 3

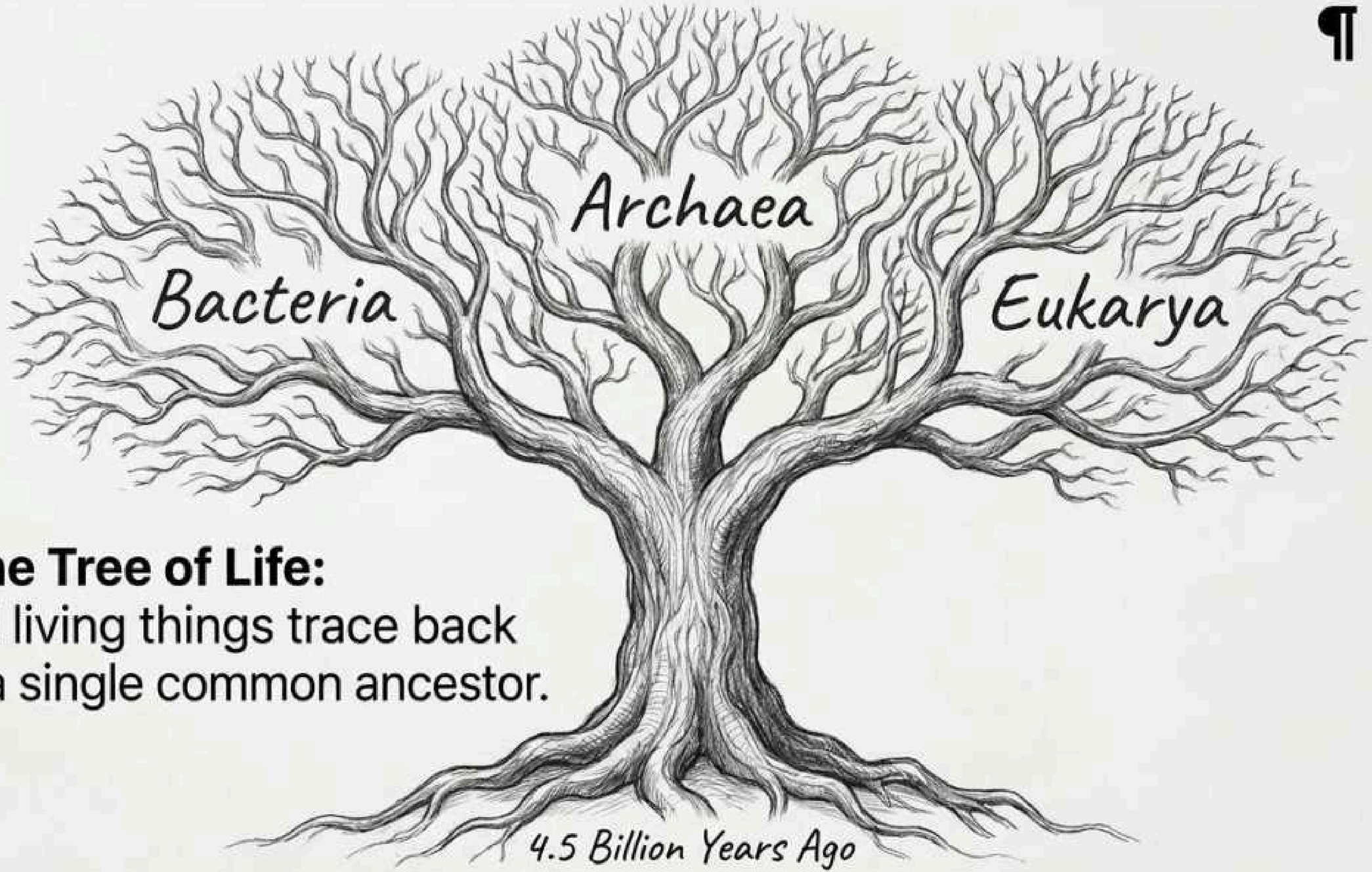


Divergence Over Time *(e.g., Genetic Drift, Selection).*
Left: Original Form. Right: New Variants

Step 4



Secondary Contact & Reproductive Isolation.
Inability to Interbreed



The Tree of Life:
All living things trace back to a single common ancestor.

Common Misunderstandings Corrected.

¶ 5.19

Myth vs. Reality: Theory.

Myth: A mere guess.

→ **Reality:** A well-tested explanation.



Tested & Validated.

Myth vs. Reality: Evolution & Chance.

Myth: Evolution is chance.

→ **Reality:** Mutations are random, but selection is NOT chance.



Selection is Non-Random.

Myth vs. Reality: Purpose.

Myth: A ladder with a goal.

→ **Reality:** No inherent goal or endpoint.

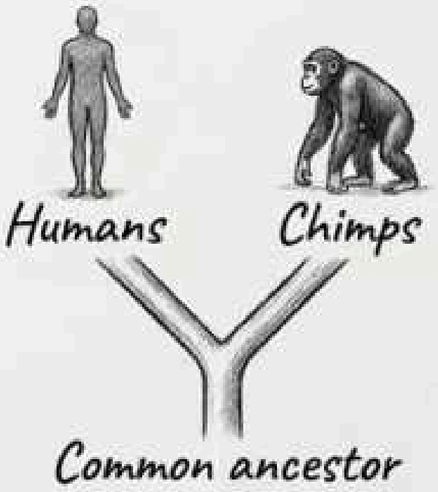


Branching, Not Climbing.

Myth vs. Reality: Ancestry.

Myth: Humans descended from chimps.

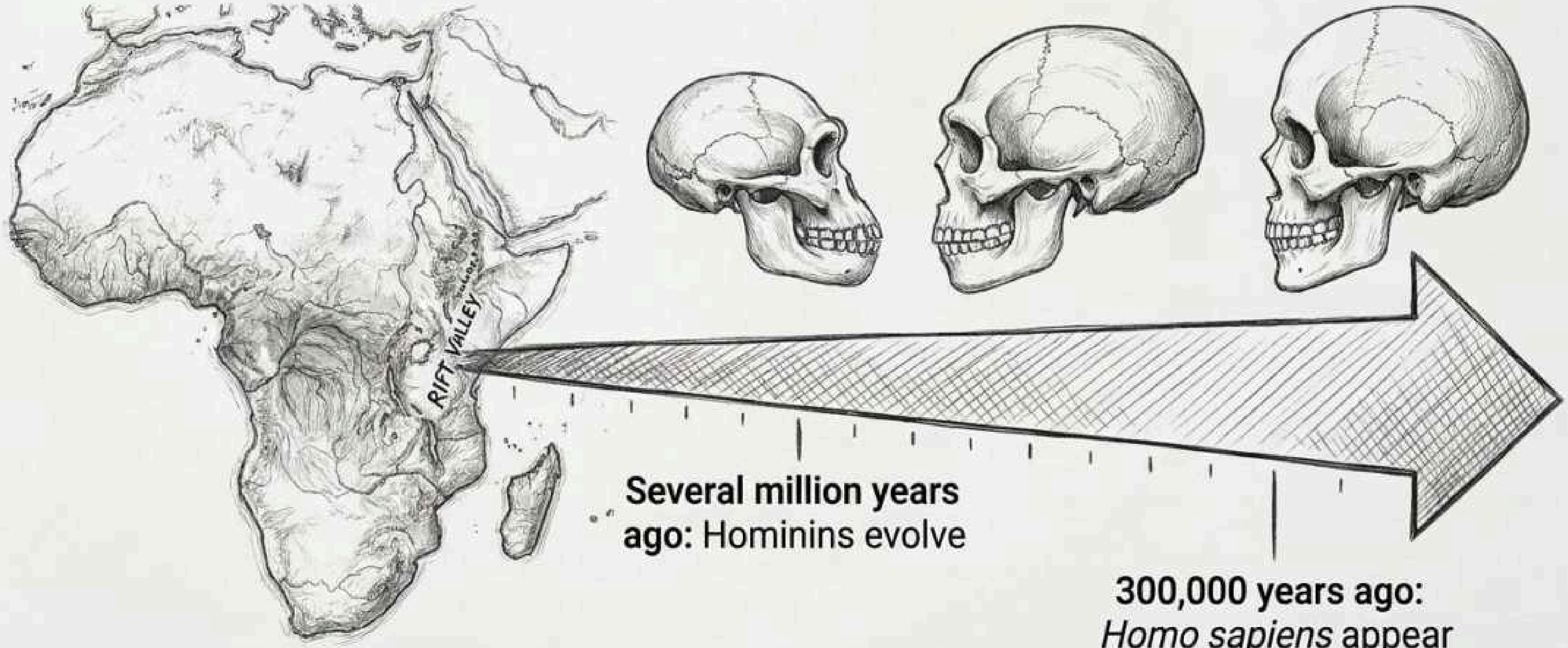
→ **Reality:** We share a common ancestor millions of years ago.



Common Origin, Parallel Paths.

Human Evolution: We are part of the story, sharing ancestors, genes, and features with the rest of the tree.

¶ 5.20



Assignment Prompt.

¶ 5.21



Takeaway Question: Apply the Filter to the Natural World.

1. Pick a well-known organism and a survival trait.
2. Describe how natural selection produced it from an ancestor without it.
3. Identify the evidence you would check to prove it.



¶ 5.22

Next Up: Ecology

Widening the view to living things and the world around them.

End of Lecture 5.