Descent with modification:
history of evolutionary thought

Evolution: modern definitions

- a change in the genetic composition of a population from generation to generation
- descent with modification
  - organisms with adaptive traits tend to leave more offspring

Evolution Theory - unifying theory explaining pattern found in a vast array of observations

Example of evolution

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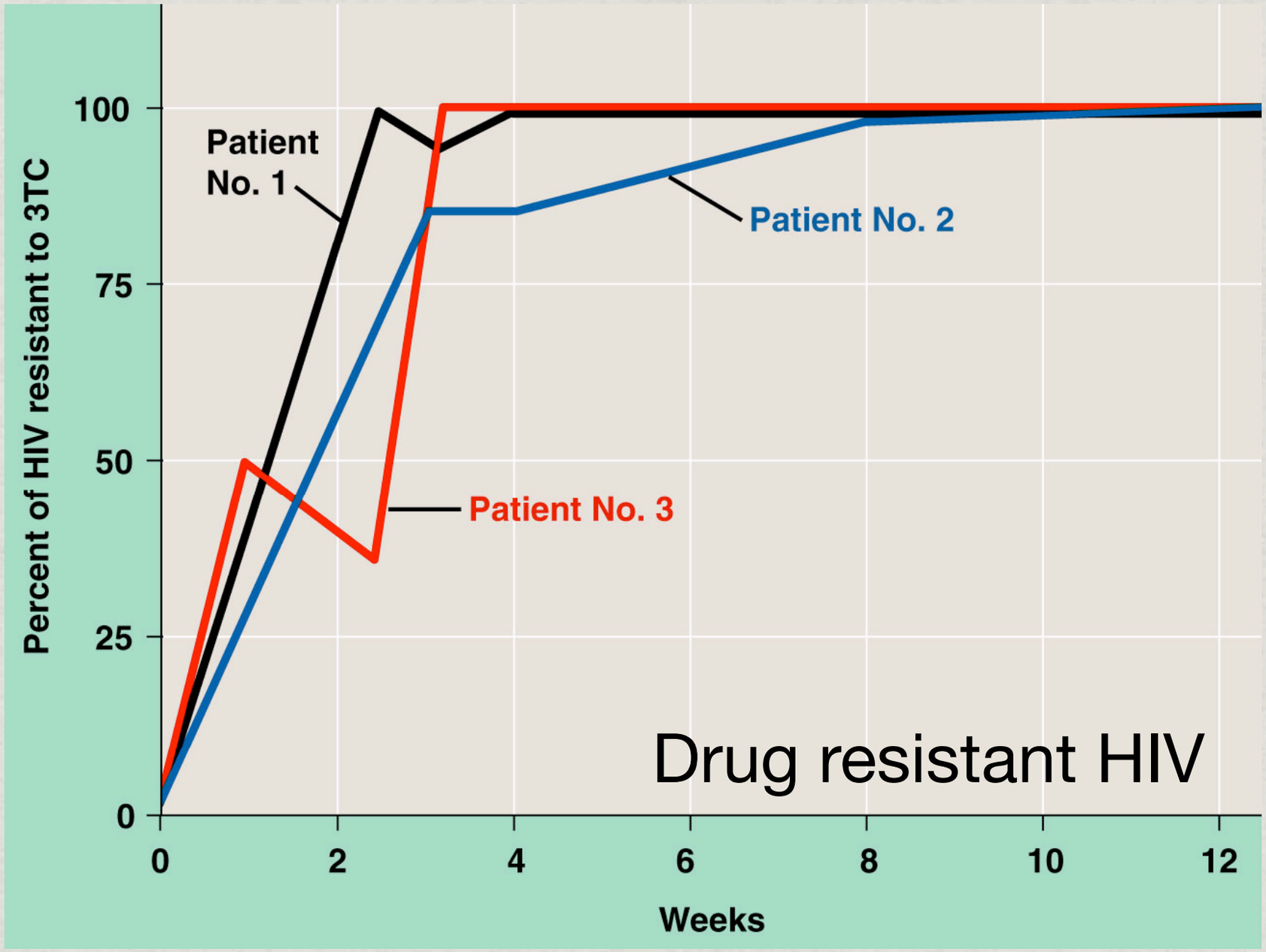
Example of evolution



Descent with modification

Endless forms most beautiful

A quick history of evolutionary thought

Descent with modification

Artificial selection, natural selection and adaptation

A theory is supported by a body of evidence

‘Endless forms most beautiful….’

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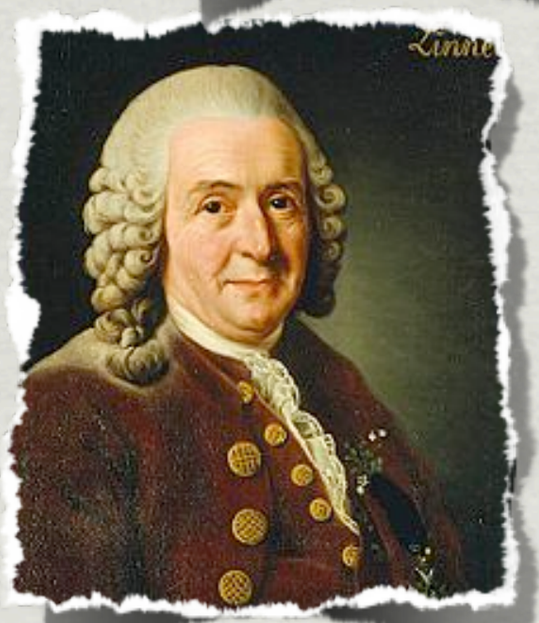
- organisms seem suited for life in their environments
- the unity - and diversity - of life

Roots of evolutionary biology

- Life as unchanging and perfectly suited to environment:
  - Aristotle (4th c. BCE)- *Scala Naturae* linear scale of complexity
  - Linnaeus (1707-1778) - grouped organisms based on likeness



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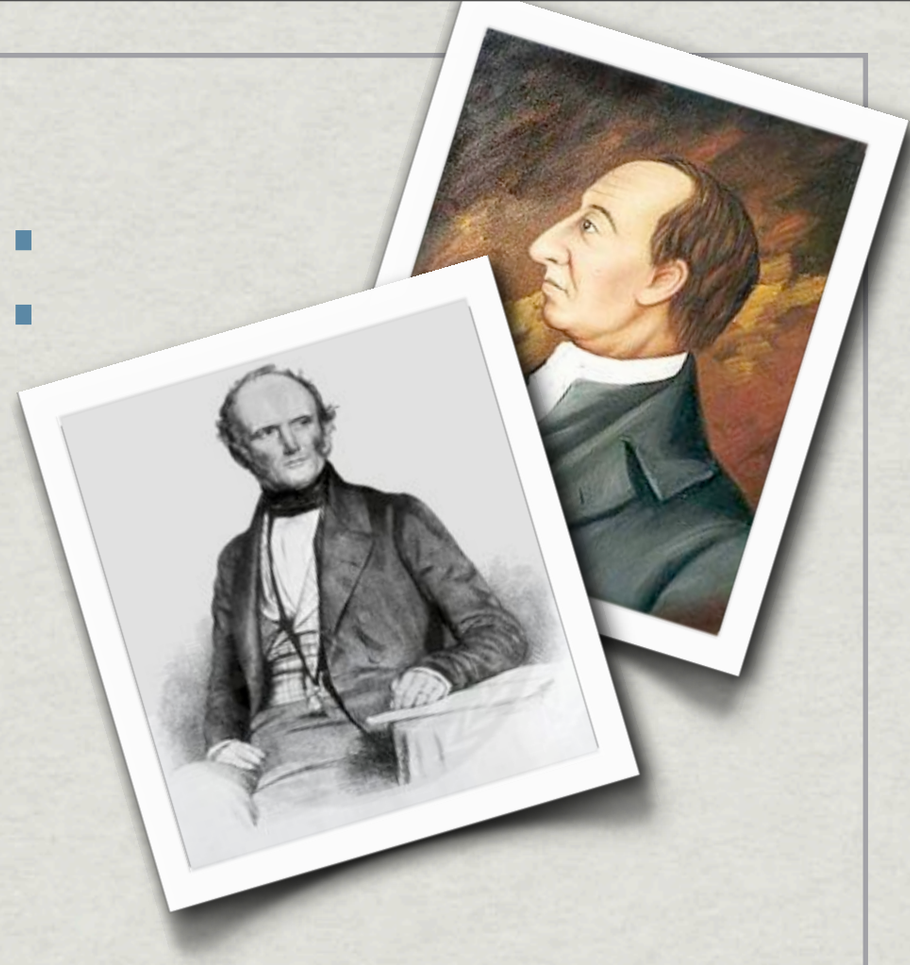
Change over time: Fossils

- Sedimentary rock strata
- Fossils - Georges Cuvier (1769-1832)
- Catastrophism not evolution

Change over time: Geology



- Hutton (1726-1797) and Lyell (1797-1875), geologists

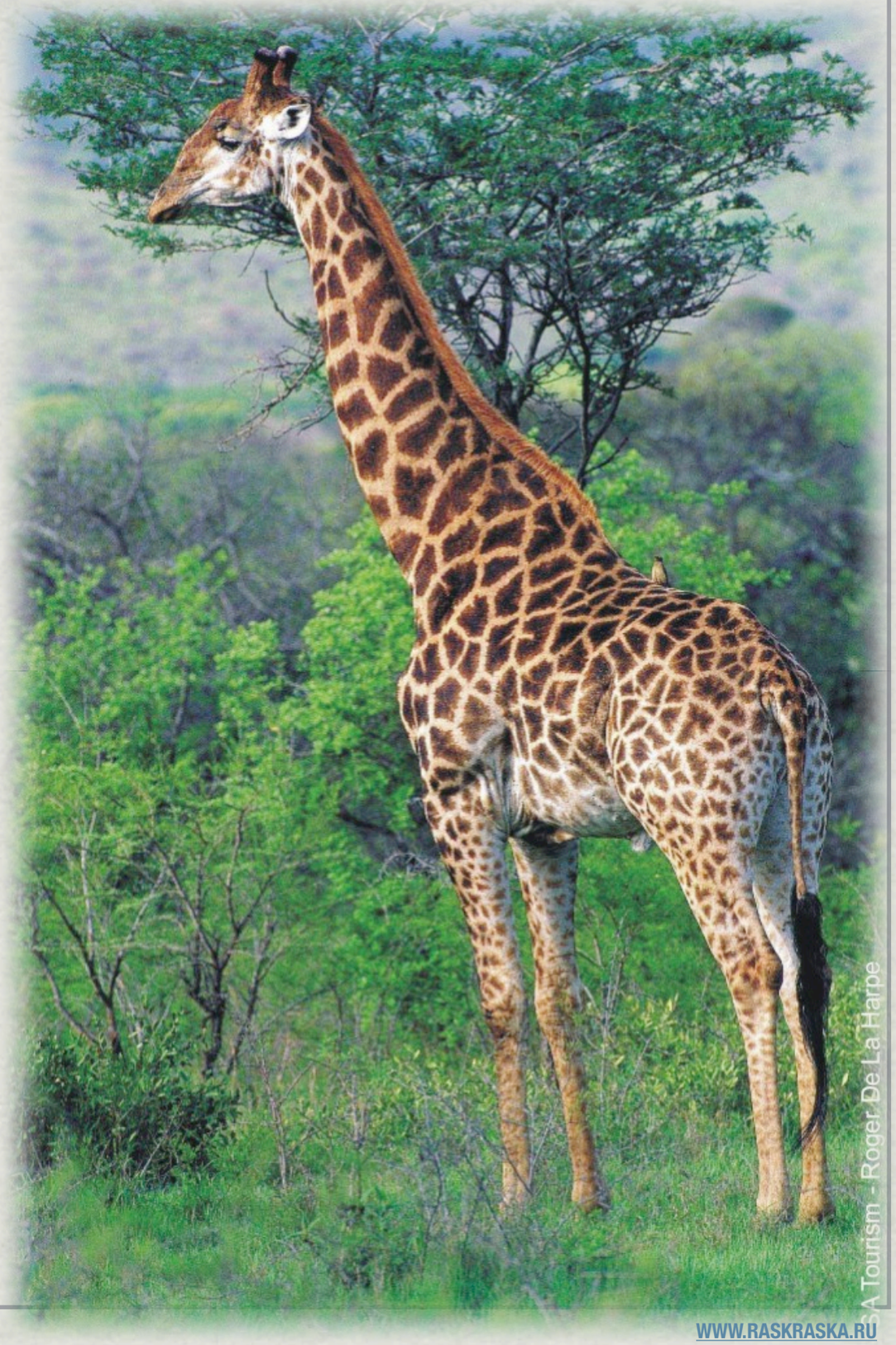
- Geological formations as they appear in the present are the result of slow, but continuous processes (gradualism)

  - These processes are still at work today

Slow, gradual changes over huge amounts of time can result in significant changes

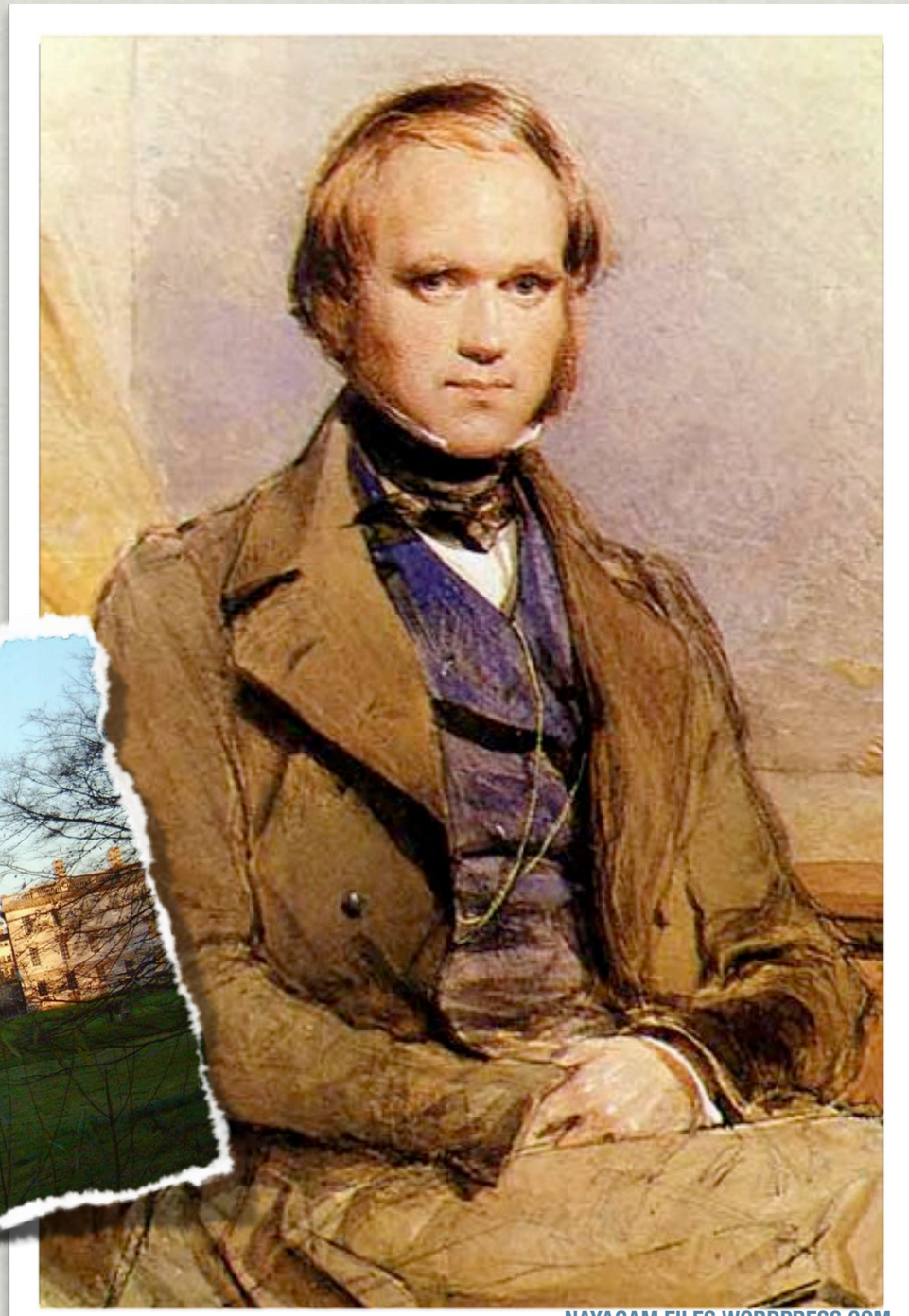
Changes over time: life forms

- Jean-Baptiste de Lamarck (1744-1829)
  - Recognized that life evolves over time
  - Proposed a mechanism
    - Use and disuse
    - Inheritance of acquired traits



Is there another explanation?

- Charles Darwin (1809 - 1882)
  - naturalist
  - budding medical student
  - clergyman



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Darwin's background

- Cambridge
  - Influenced by Rev. John Henslow
    - Botany professor
      - scientific method
      - importance of observation
- *HMS Beagle* in 1831

Voyage of the HMS Beagle (1831 - 1836)

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Darwin returned as a famous man

- Began to work out a mechanism for HOW life changes over time
  - quite different from Lamarck's idea
- Natural selection

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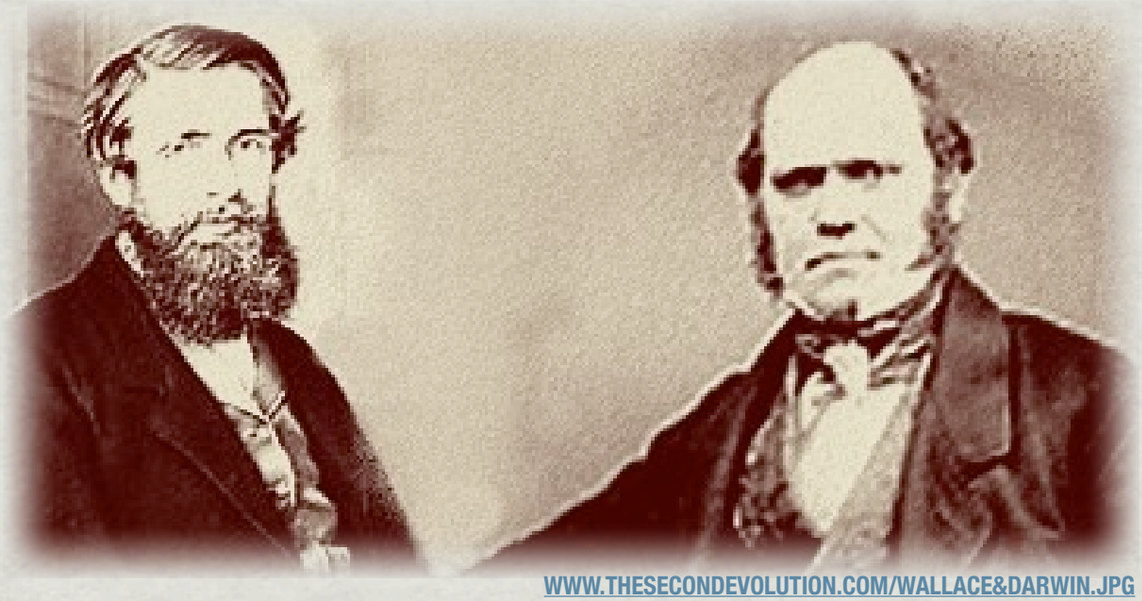
Alfred Wallace



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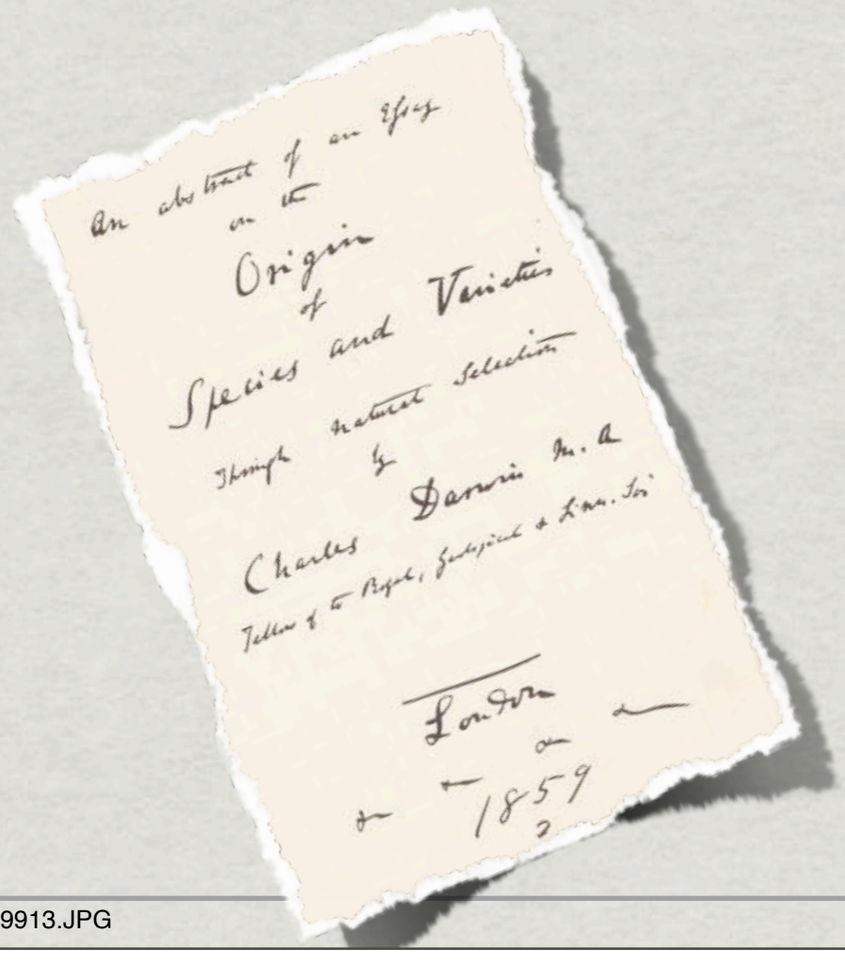
- Great minds think alike
- Working in East Indies, Wallace came to a similar mechanism of evolution - natural selection



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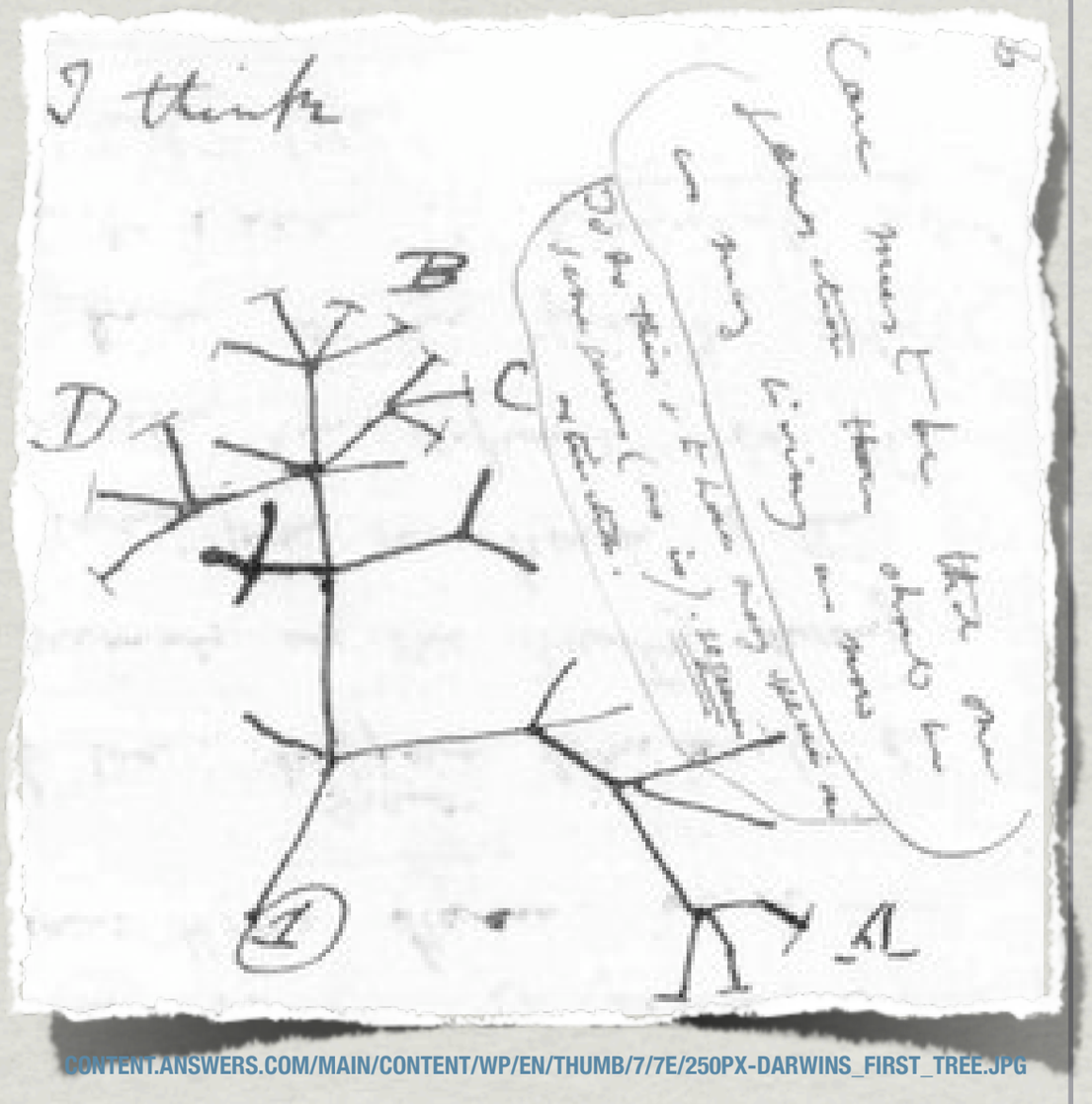
Darwin's theory of evolution

- Natural selection as a mechanism to explain
  - why species change over time
  - why species are adapted to their surroundings

History of life is like a tree

- Branching pattern of evolution
- common trunk
- tips of twigs - diversity of organisms living in the present
- forks - ancestors of all branches from that point



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Darwin's observations

- Members of population often vary greatly in their traits
  - Traits are inherited from parents to offspring
- All species are capable of producing more offspring than their environment can support
  - Owing to lack of food or other resources, many of these offspring do not survive

Selection of advantageous traits

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Main ideas of natural selection

1. Individuals with inheritable traits that make them more suited to their present environment reproduce at a higher rate

2. Given 1, over time natural selection can increase the match between organisms and their environment

3. If the environment changes, organisms are under new selection pressures, and this may result in new species

Summary of the history of evolutionary thought

- Life is unchanging (Aristotle, Linnaeus)
- Sometimes there are big catastrophes that wipe out life in an area (but life is still unchanging!) (Cuvier)
- Slow, continuous processes can effect geologic change over time (Lyell and Hutton)
- Hey, maybe life evolves over time, slowly and continuously! (Lamarck, Darwin, Wallace)
    - It changes because of inherited acquired characteristics (Lamarck)
    - It changes because of natural selection (Darwin, Wallace)

A theory is supported by a body of evidence

- Direct observations of evolution
- Fossil records
- Homology
- Biogeography

Artificial selection

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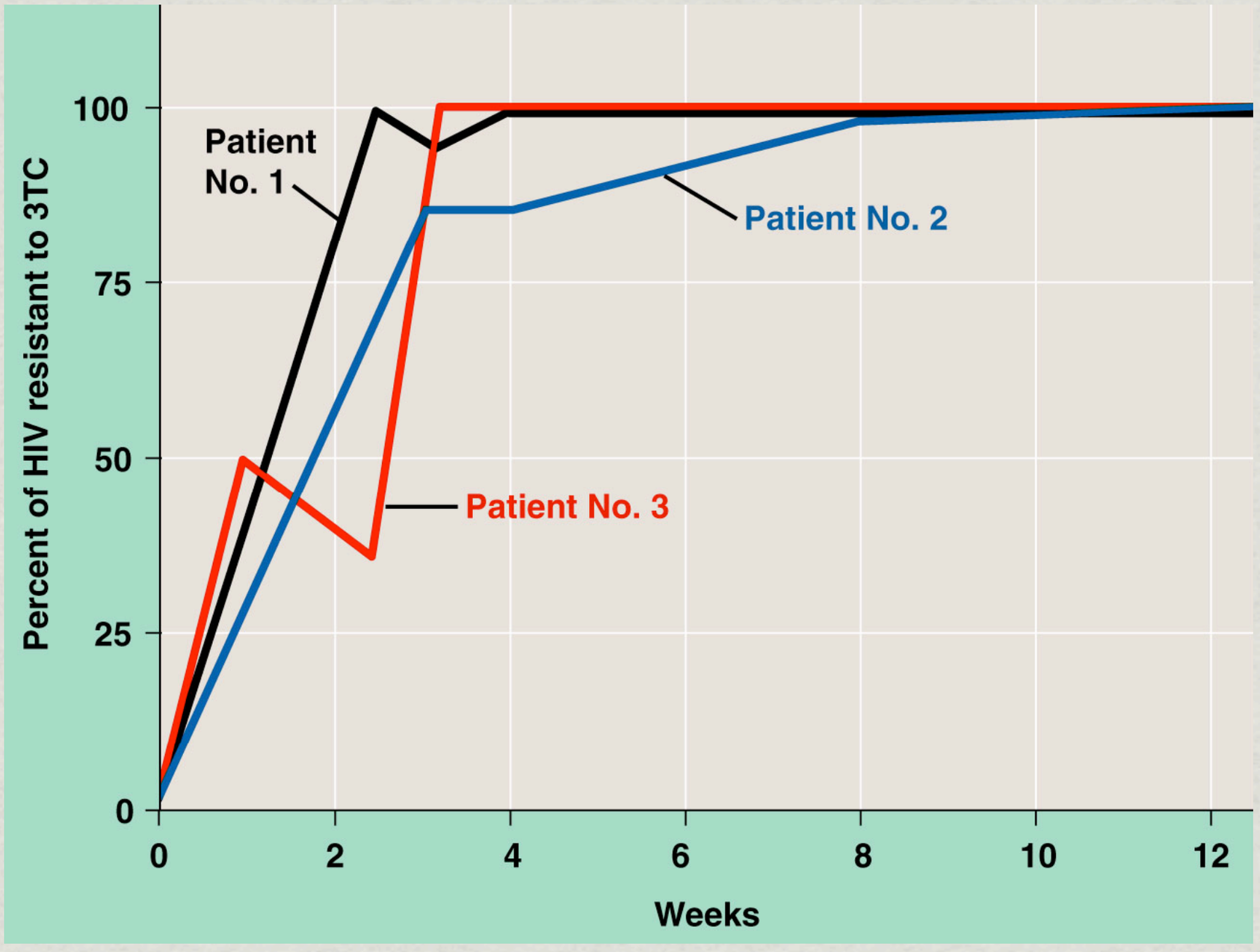
Direct observation



Key points

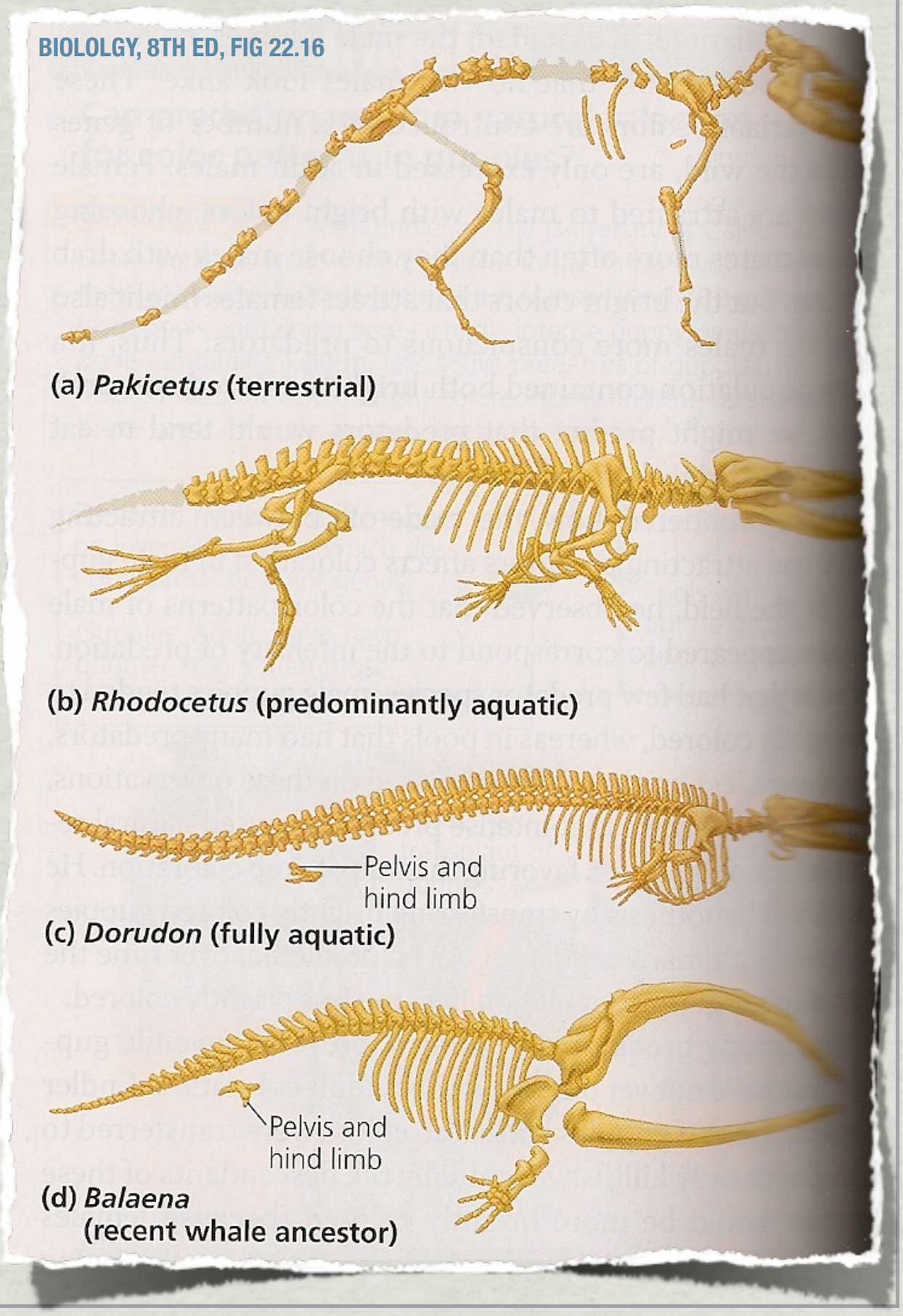
- A drug doesn't create resistant pathogens, it selects for resistant pathogens
- What is adaptive for one environment may be detrimental in another

Fossil records

FISHES FOSSILS

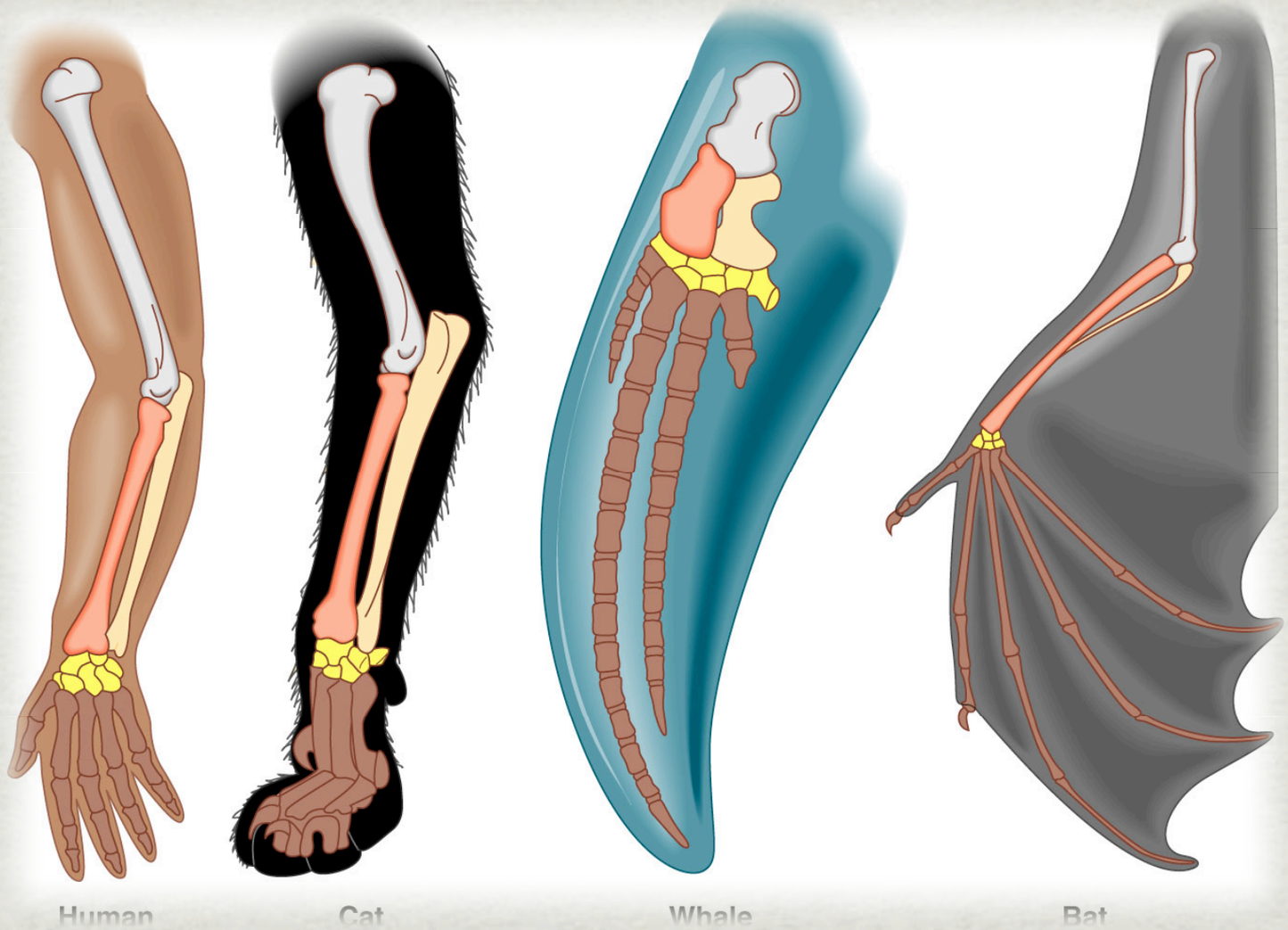
LAND VERTEBRATE FOSSILS

AMPHIBIAN FOSSILS

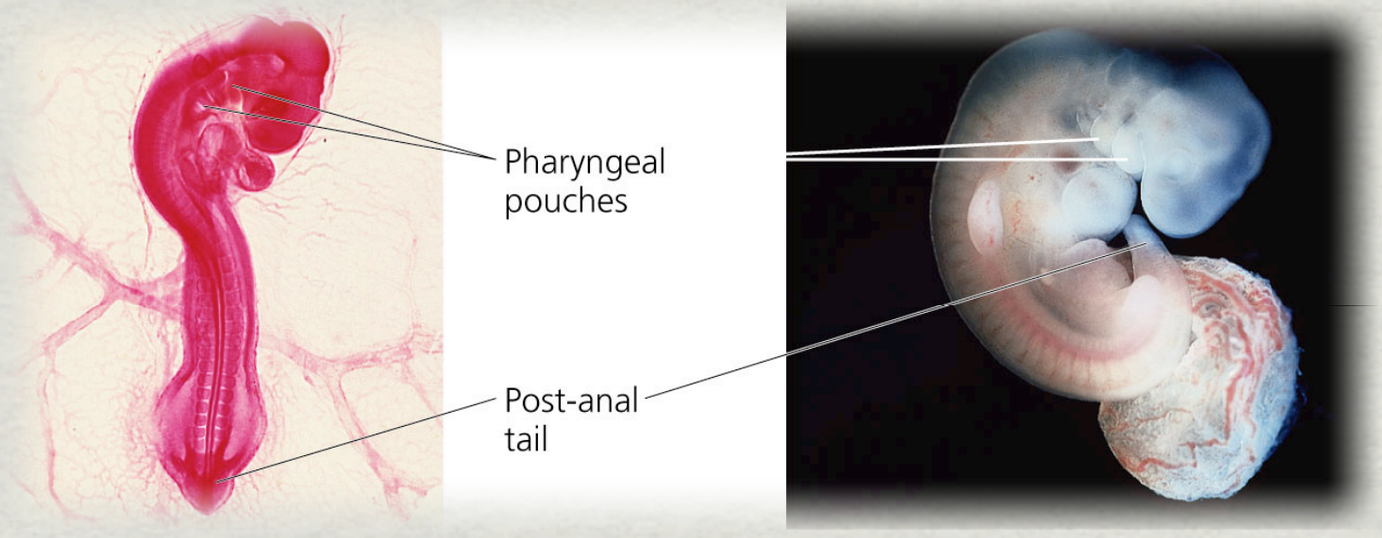


Homology

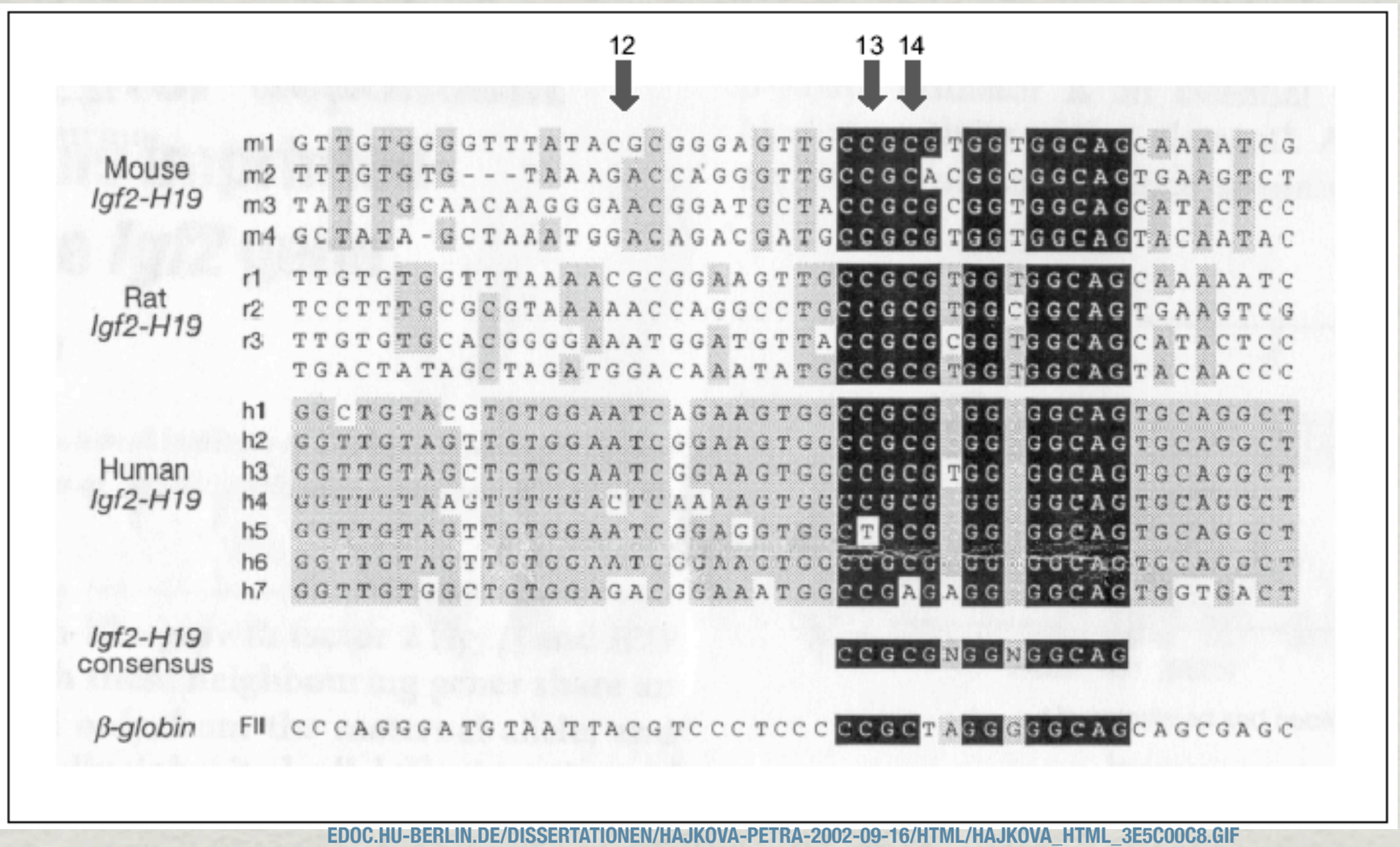
- Anatomical - all mammals have same bone structure in arms, but adapted for different purposes



- Embryonic structures are similar between fish and mammals



DNA sequences are similar between related species



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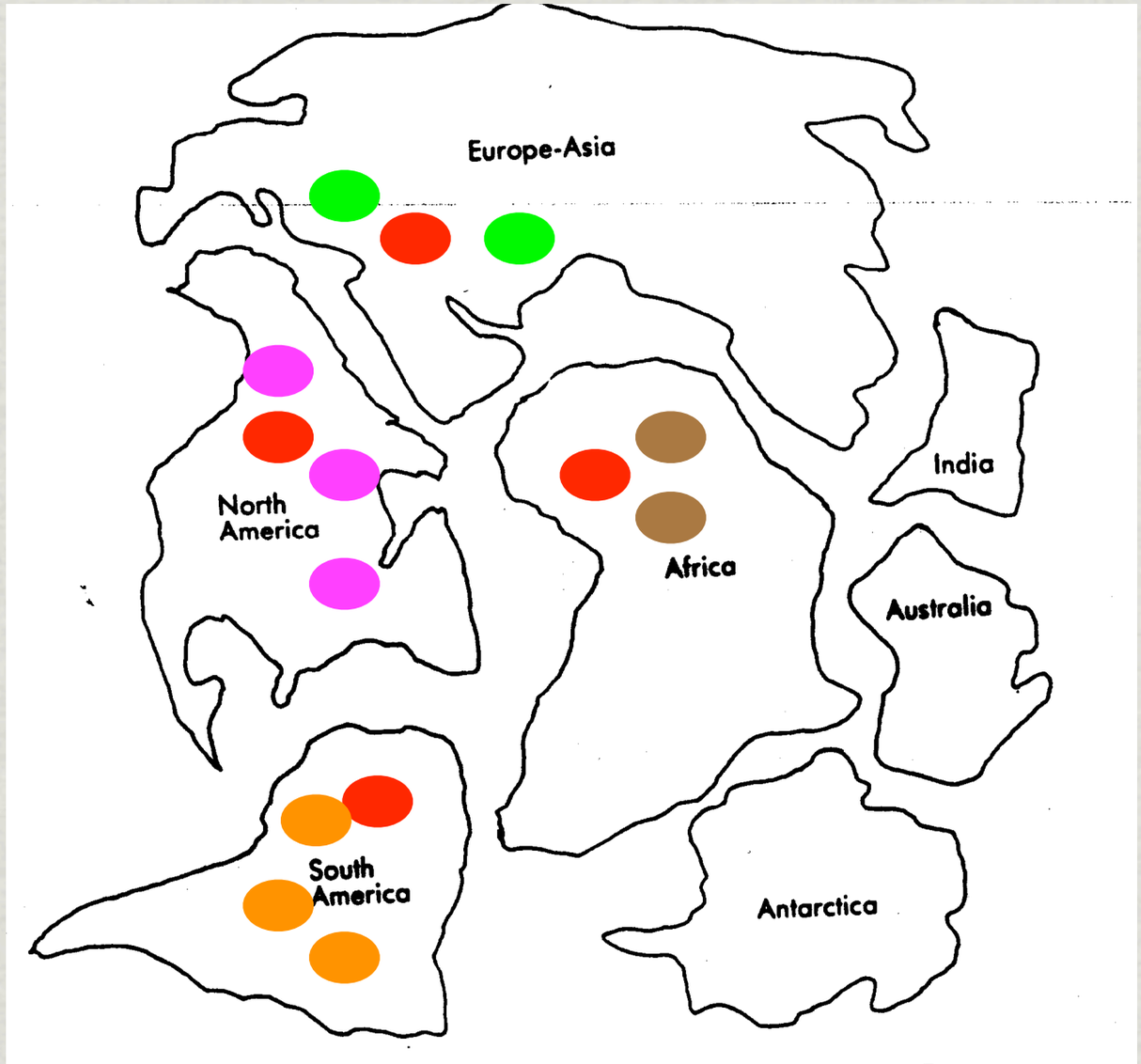
Biogeography - distribution of species



PANGAEA, 250 MYA

Neo-Darwinism

- Darwin's Theory of Evolution unified with Mendel's Theory of Inheritance
- Satisfying mechanism of selection and inheritance of traits
- Traits are coded for by genes!

There is a grandeur in this view of life…[in which] endless forms most beautiful and most wonderful have been, and are being, evolved."

- Charles Darwin, *The Origin of Species*