Evidence for Evolution by Natural Selection

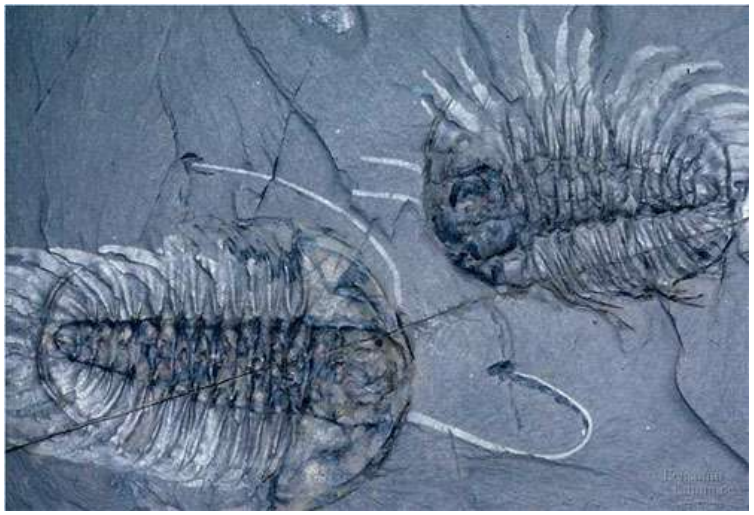
Hunting for evolution clues… Elementary, my dear, Darwin!

Evidence supporting evolution

- **Fossil record**
  - shows change over time
- **Anatomical record**
  - comparing body structures
    - homology & vestigial structures
    - embryology & development
- **Molecular record**
  - comparing protein & DNA sequences
- **Artificial selection**
  - human caused evolution

1. Fossil record

- Layers of rock contain fossils
  - new layers cover older ones
    - creates a record over time
  - fossils show a series of organisms have lived on Earth
    - over a long period of time



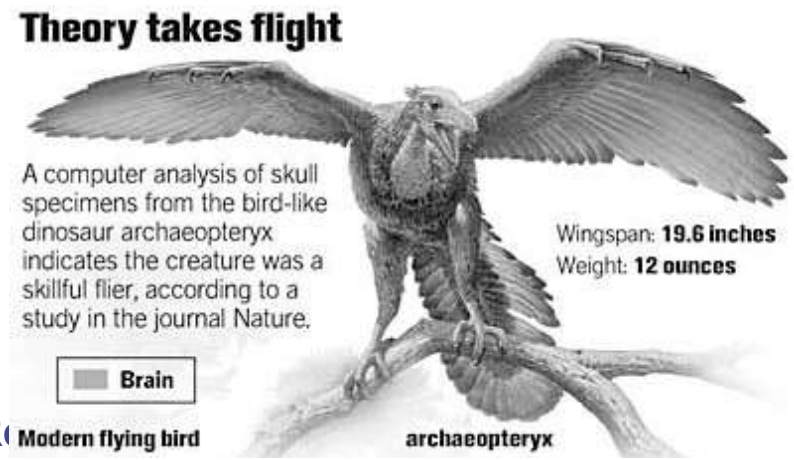
Fossils tell a story…

Evolution of birds

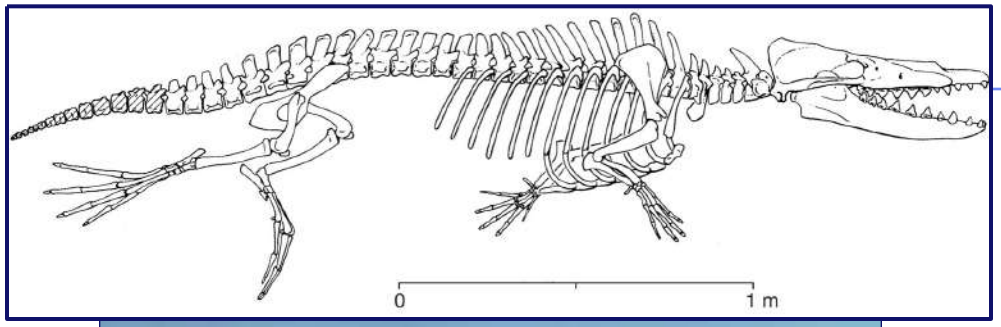
Today's organisms descended from ancestral species

Fossil of *Archaeopteryx*

- lived about 150 mya
- links reptiles & birds

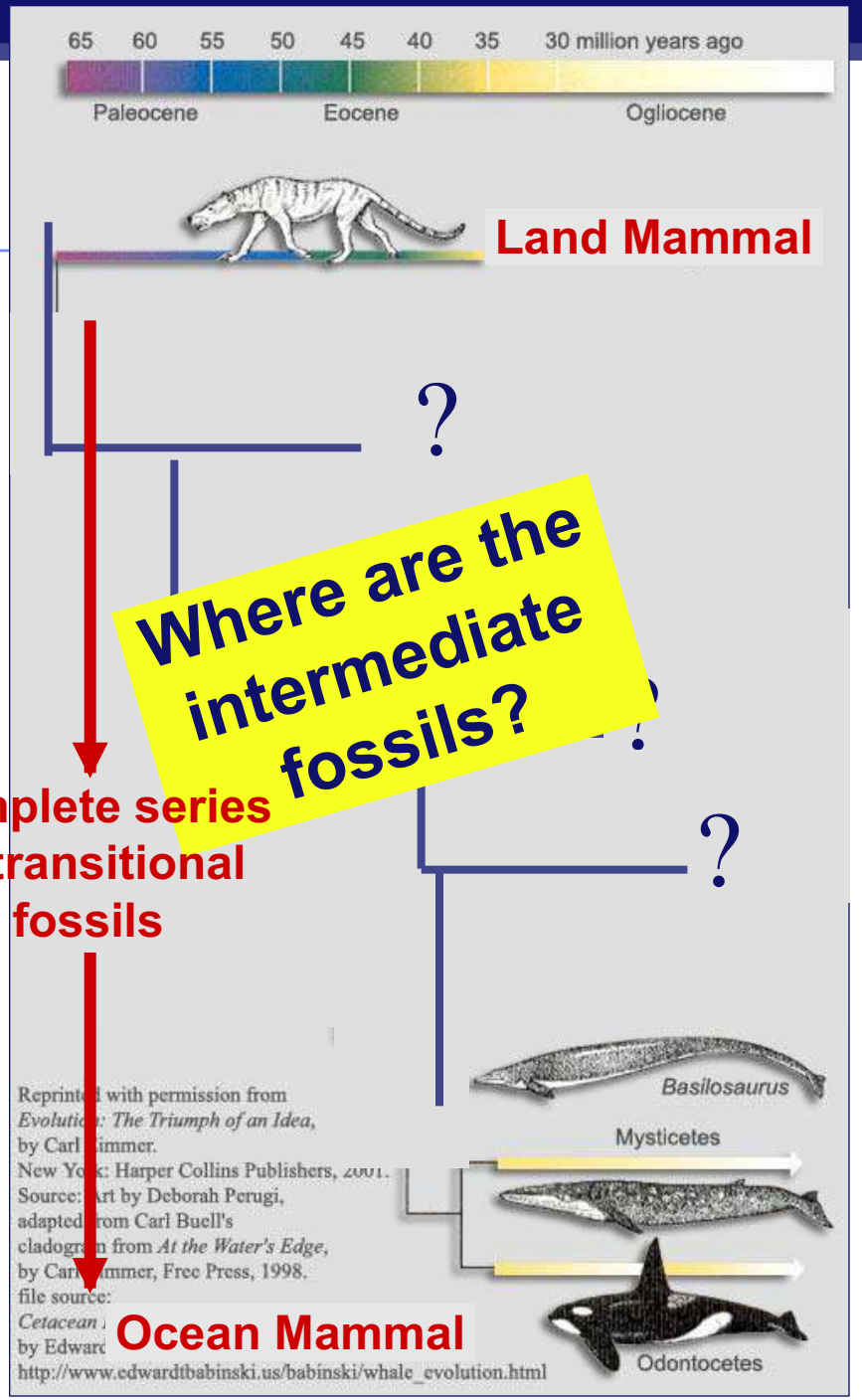


We found the fossil — *no joke!*



Someone's idea of a joke!

But the joke's on them!!



Evolution from sea to land

- 2006 fossil discovery of early tetrapod
  - 4 limbs
- Missing link from sea to land animals

3. Anatomical record

Animals with different structures on the surface

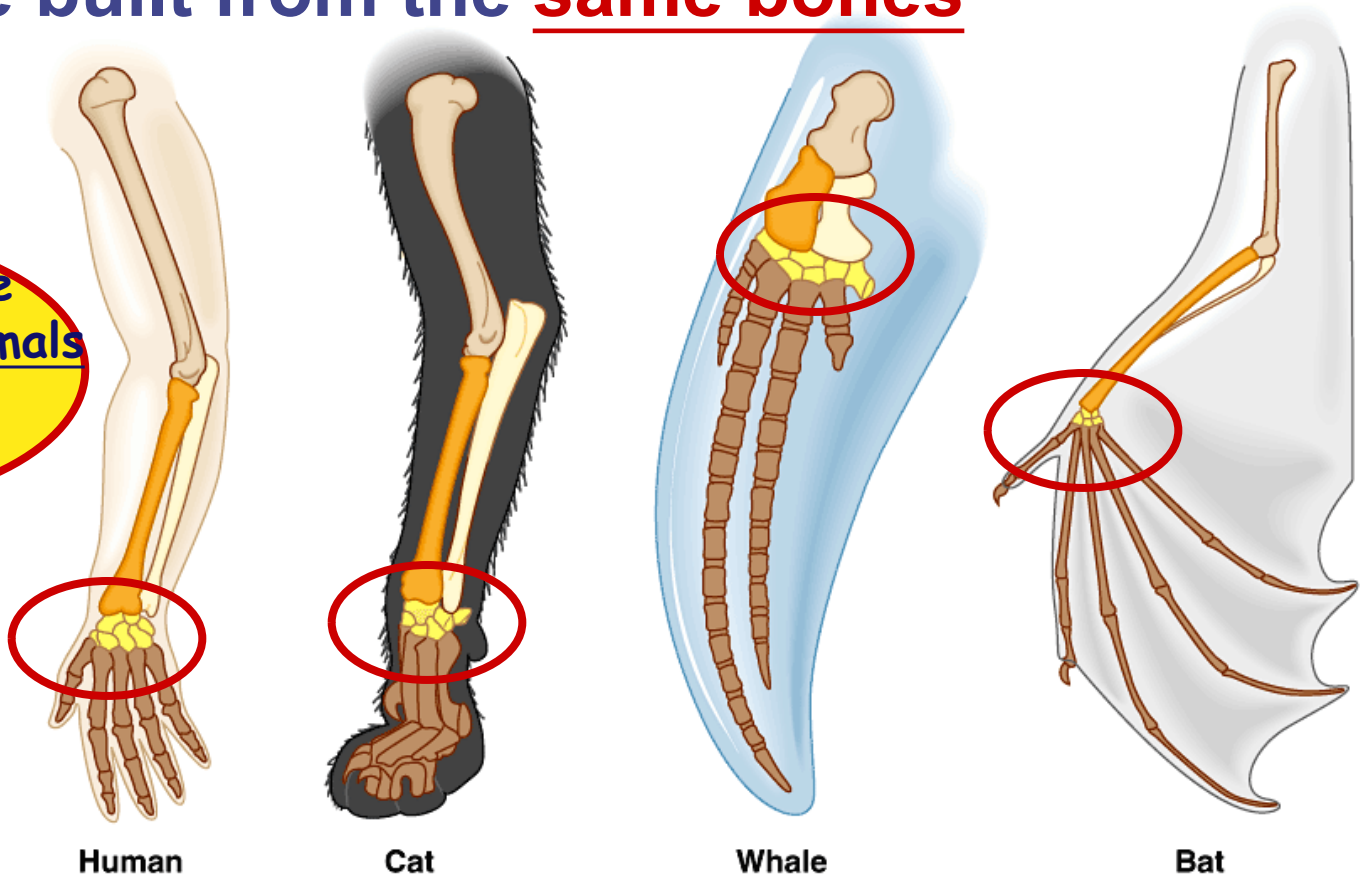
But when you look under the skin…

It tells an evolutionary story of common ancestors

Compare the bones

- **The same bones under the skin**
  - limbs that perform **different functions** are built from the **same bones**

How could these very different animals have the same bones?



Homologous structures

- Structures that come from the same origin
  - homo- = same
  - -logous = information
- Forelimbs of human, cats, whales, & bats
  - same structure
    - on the inside
  - same development in embryo
  - different functions
    - on the outside
  - evidence of common ancestor

But don't be fooled by these…

- Analogous structures
- look similar

on the outside

- same function
- different structure & development

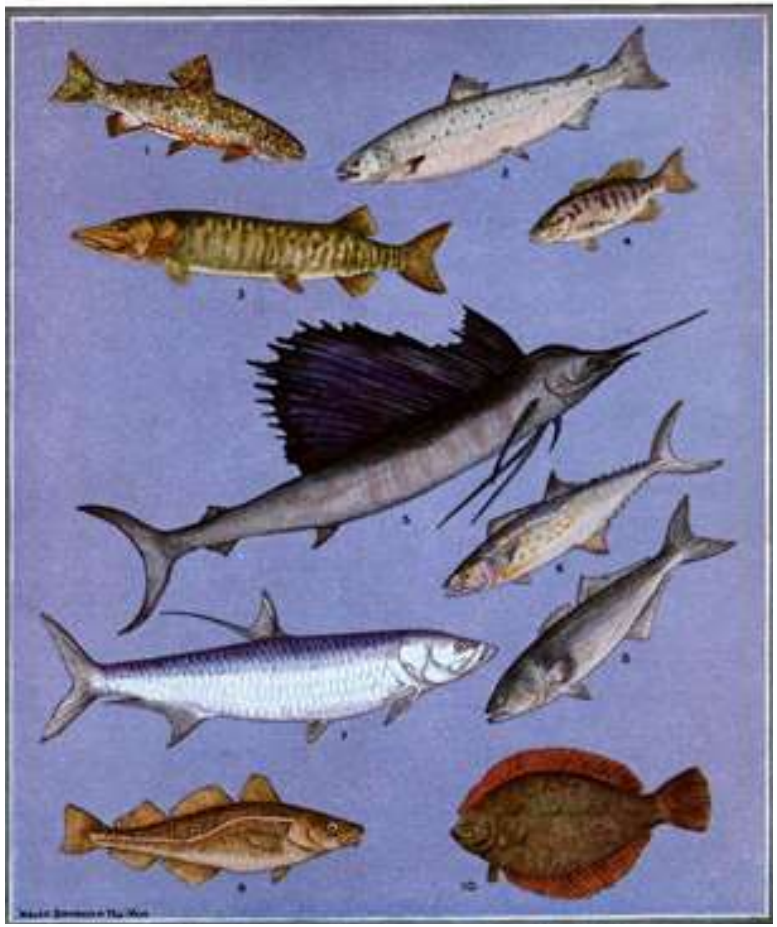
on the inside

- different origin
- evolutionary relationship

Solving a similar problem with a similar solution

Analogous structures

- Dolphins: aquatic mammal
- Fish: aquatic vertebrate
- both adapted to life in the sea
- not closely related

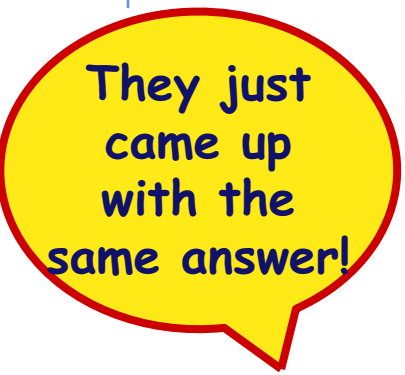


Watch the tail!

Convergent evolution

- 3 groups with wings
  - *Does this mean they have a recent common ancestor?*

Flight evolved 3 separate times — evolving similar solutions to similar "problems"



Convergent evolution led to mimicry

- Why do these pairs look so similar?

Vestigial organs

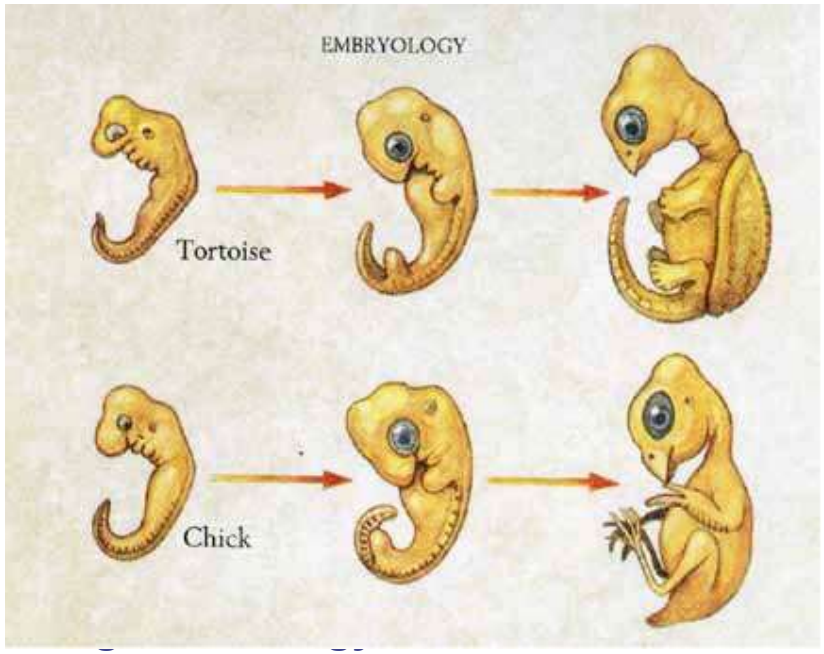
- Hind leg bones on whale fossils

Why would whales have pelvis & leg bones if they were always sea creatures?

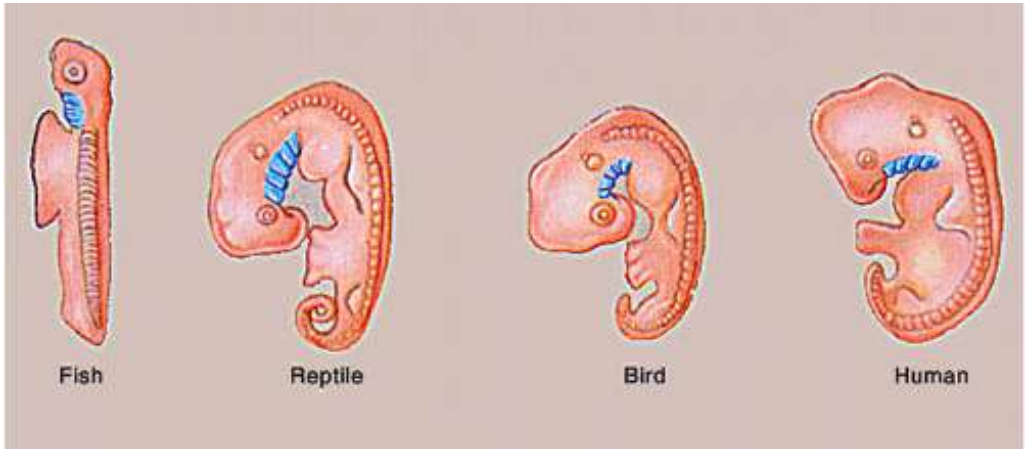
Because they used to walk on land!

Comparative embryology

- Development of embryo tells an evolutionary story
  - similar structures during development

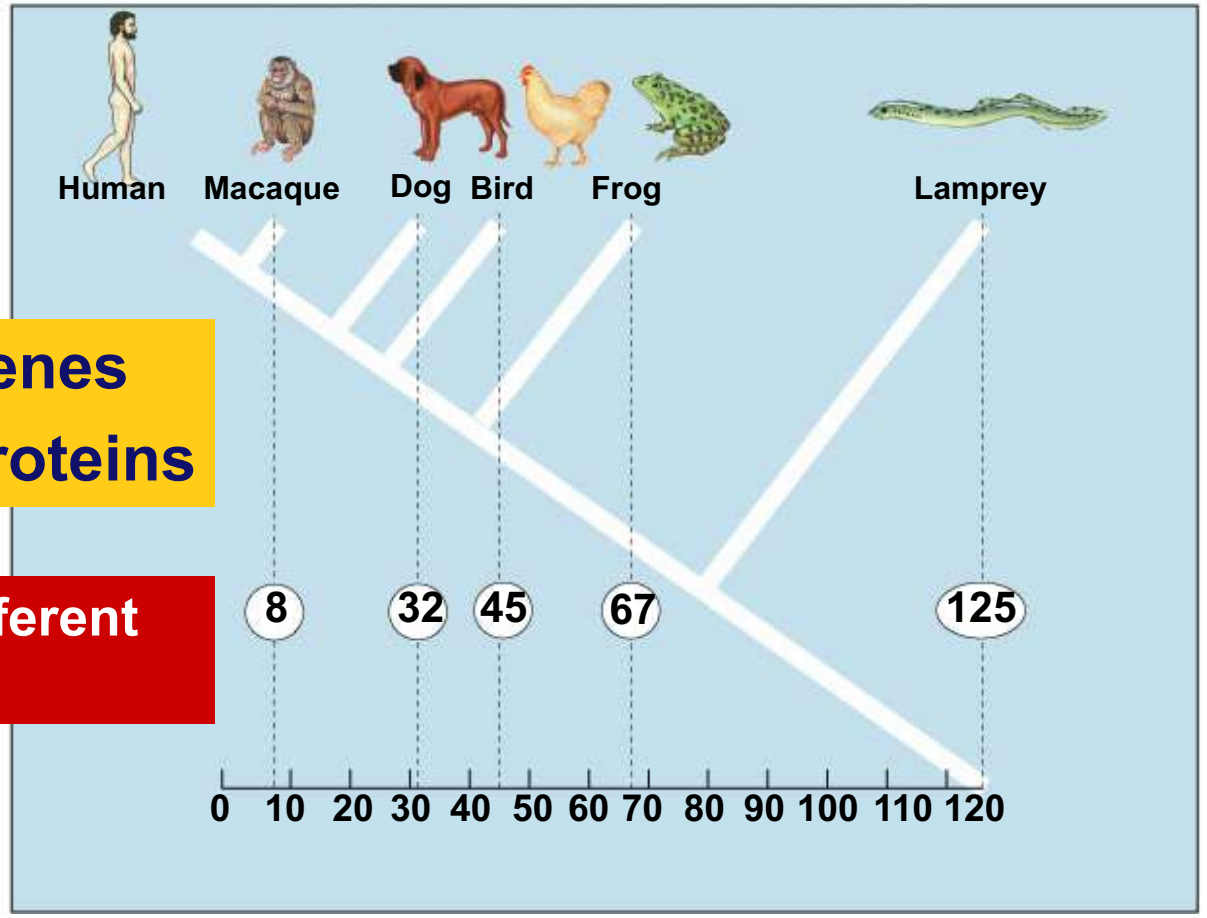


all vertebrate embryos have a “gill pouch” at one stage of development



3. Molecular record

- Comparing DNA & protein structure
  - everyone uses the same genetic code!
    - DNA

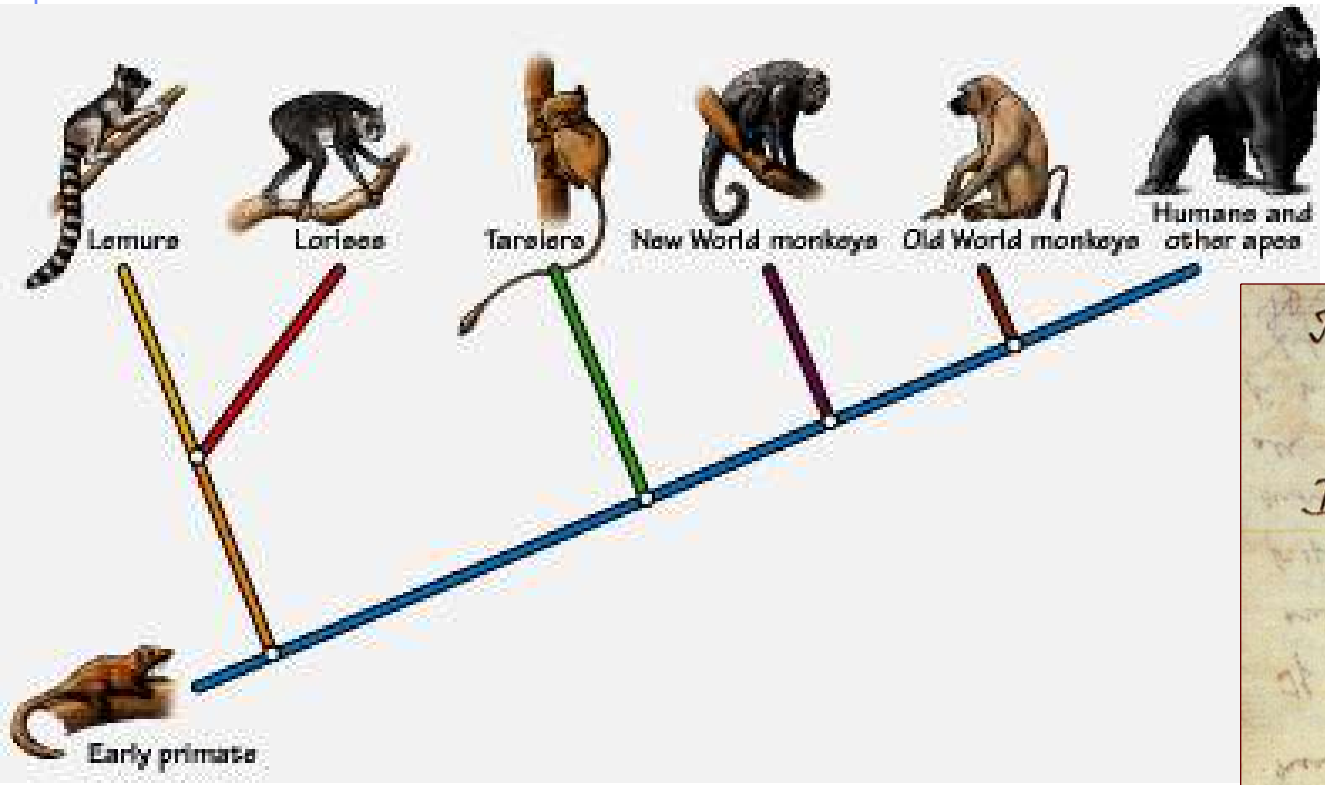


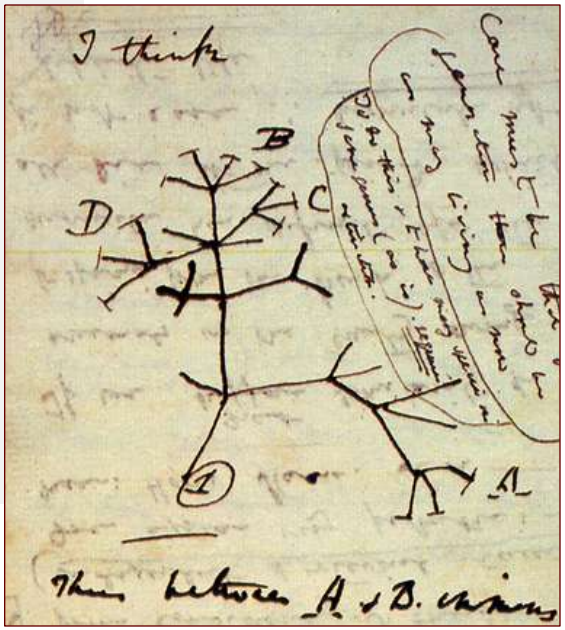
- compare common genes
- compare common proteins

number of amino acids different from human hemoglobin

Building “family” trees

Closely related species are branches on the tree — coming from a common ancestor

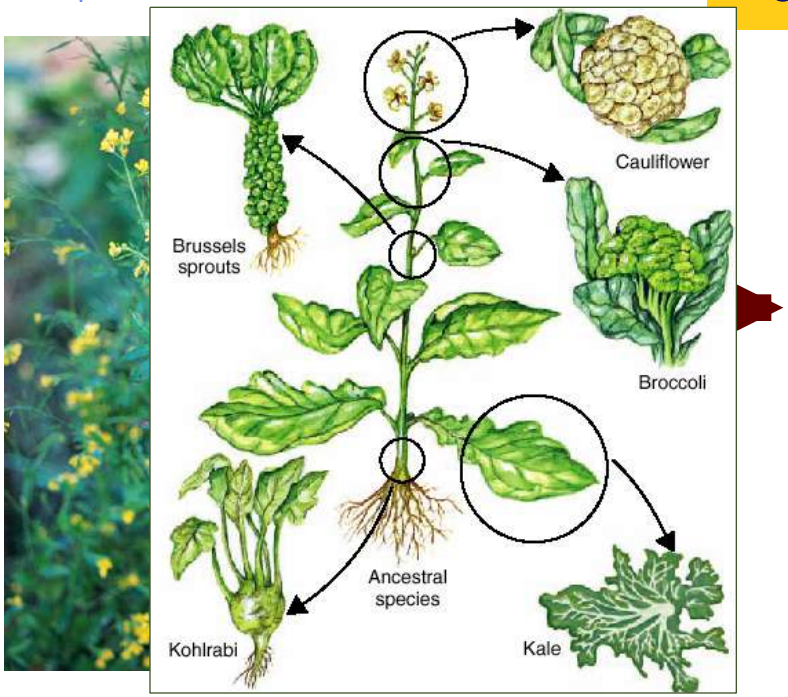




4. Artificial selection

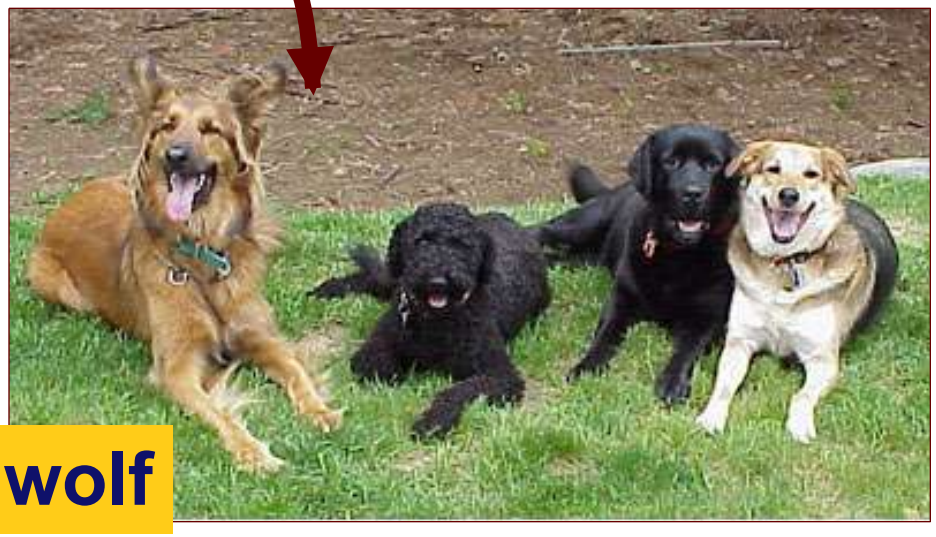
- How do we know natural selection can change a population?
  - we can recreate a similar process
  - "evolution by human selection"

"descendants" of wild mustard



Selective Breeding

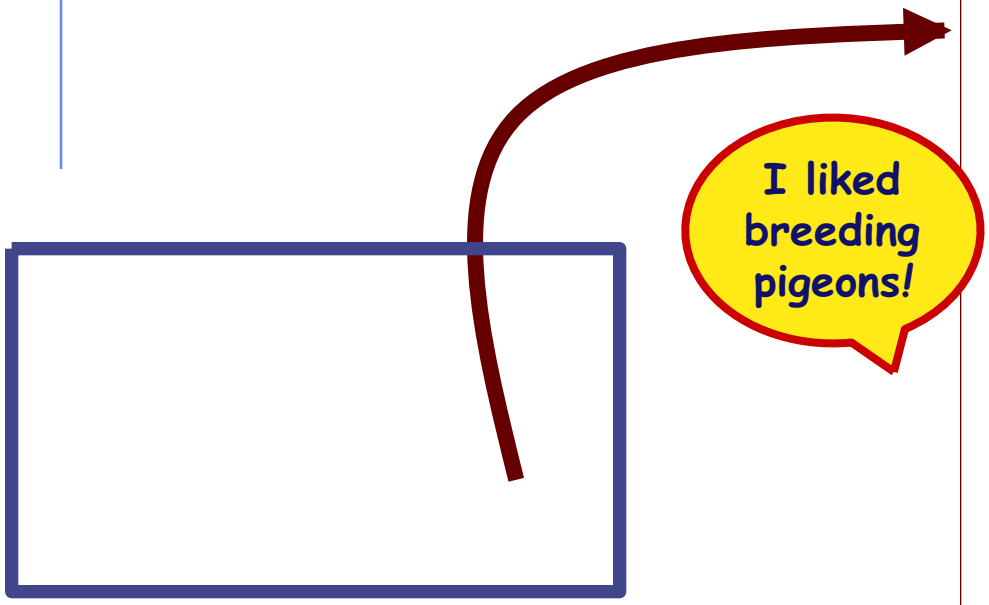
Humans create the change over time



“descendants” of the wolf

Artificial Selection

…and the examples keep coming!

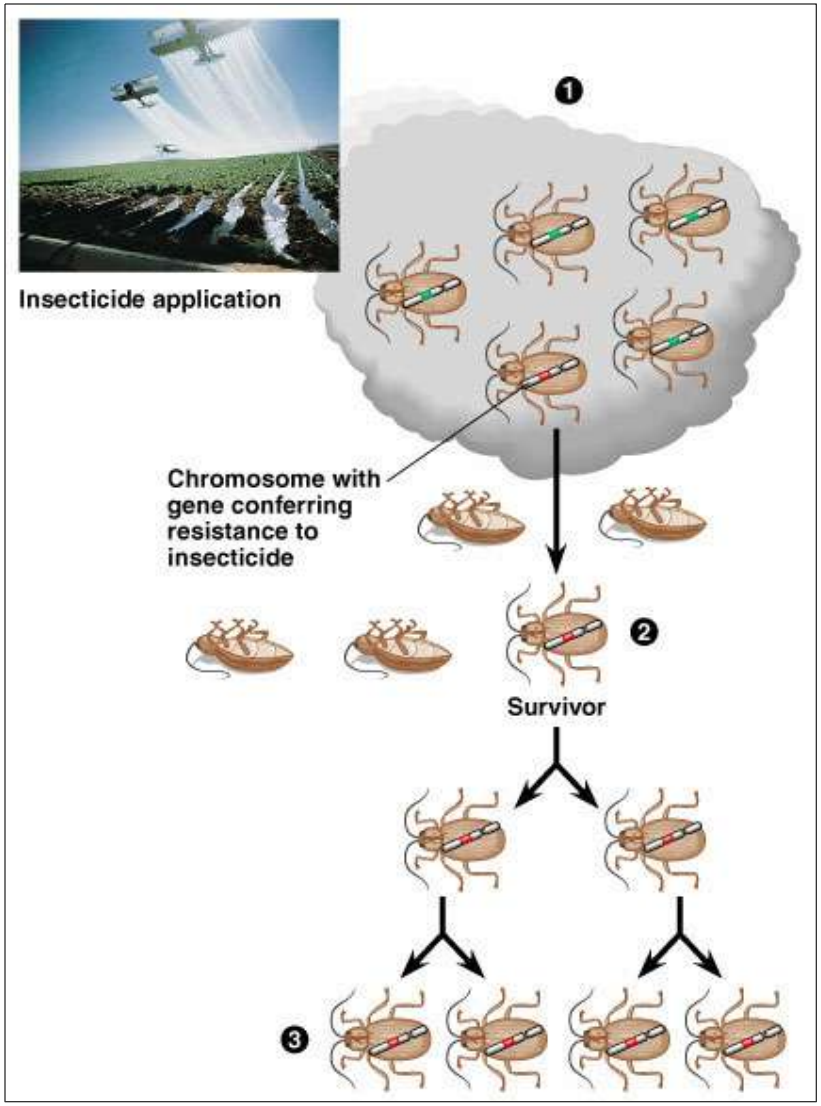


Artificial Selection gone bad!

- Unexpected consequences of artificial selection

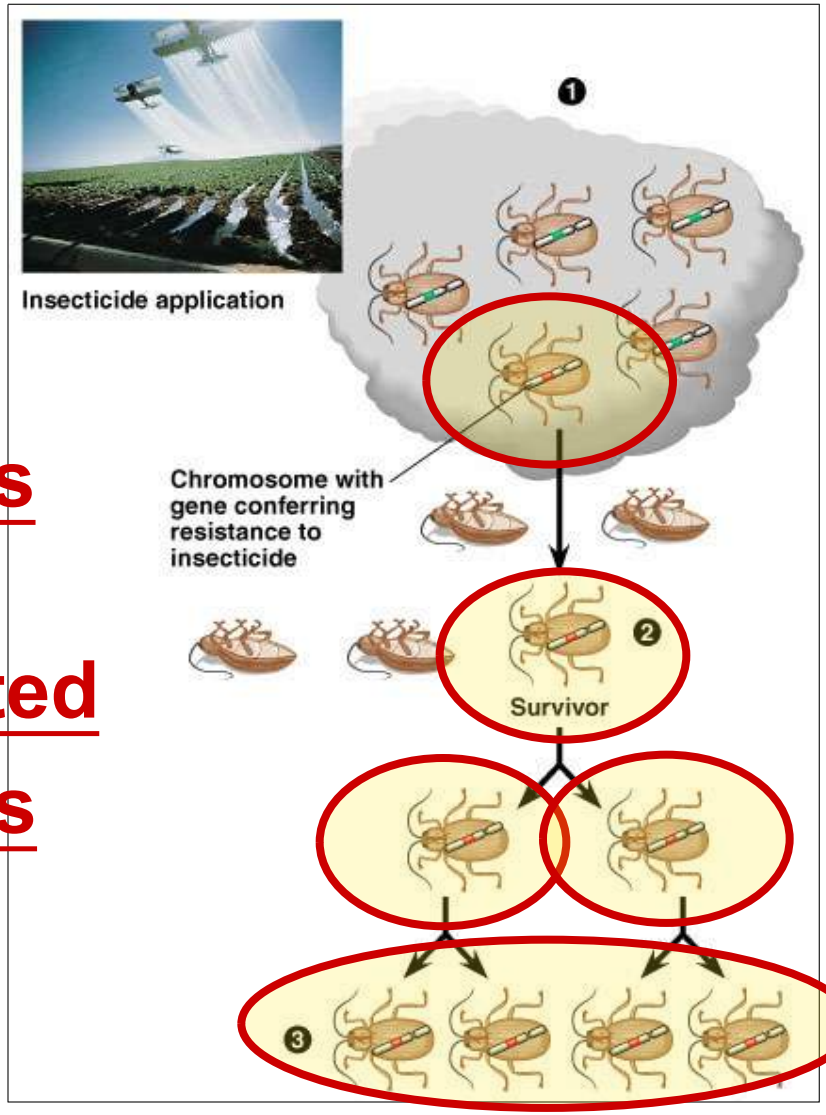
Pesticide resistance

Antibiotic resistance



Insecticide resistance

- Spray the field, but…
  - insecticide didn't kill all individuals
  - variation
    - resistant survivors reproduce
  - resistance is inherited
  - insecticide becomes less & less effective



Any Questions??

Natural Selection of Strawfish

⑩How does natural selection affect genes?

⑩How do genes affect evolution?

1. No Predator Preferences

	FISH			ALLELES	
	blue	green	yellow	blue	yellow
Gen. 1	25%	50%	25%	50%	50%
Gen. 4	27%	55%	18%	55%	45%

No selection force in one specific direction.
No clear pattern of change.

2. Predator Prefers BLUE

	FISH			ALLELES	
	blue	green	yellow	blue	yellow
Gen. 1	25%	50%	25%	50%	50%
Gen. 4	13%	50%	37%	38%	62%

Selection against blue.

Fewer blue fish and fewer blue alleles.

3. Predator Prefers GREEN

	FISH			ALLELES	
	blue	green	yellow	blue	yellow
Gen. 1	25%	50%	25%	50%	50%
Gen. 4	36%	28%	36%	50%	50%

Selection against green.

Fewer green fish but same variation in alleles.

4. GREEN is Camouflaged

	FISH			ALLELES	
	blue	green	yellow	blue	yellow
Gen. 1	25%	50%	25%	50%	50%
Gen. 4	20%	60%	20%	50%	50%

Selection against blue & yellow.
More green fish but same variation in alleles.

Parallel Evolution

Niche	Placental Mammals	Australian Marsupials
Chasin predato		

not closely related

marsupial mammal

placental mammal

filling similar roles in nature, so have similar adaptations

wolf"

Vestigial organs

- **Structures on modern animals that have no function**
  - **remains of structures that were functional in ancestors**
  - **evidence of change over time**
    - some snakes & whales have pelvis bones & leg bones of walking ancestors
    - eyes on blind cave fish
    - human tail bone