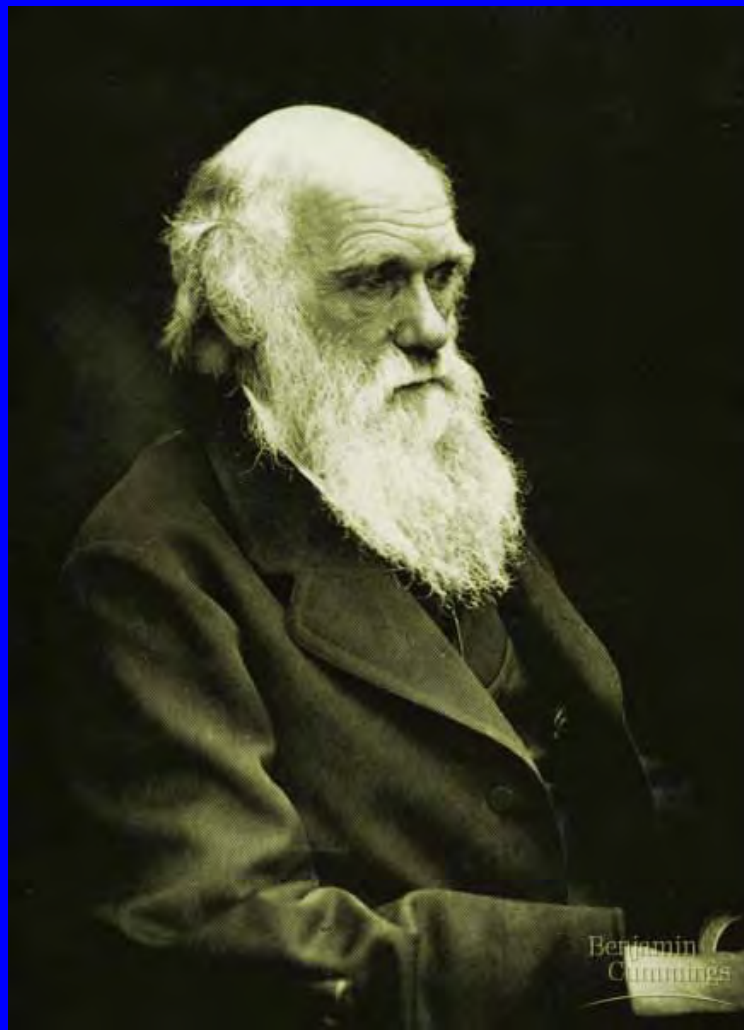
Do Now

- Why is evolutionary theory controversial?

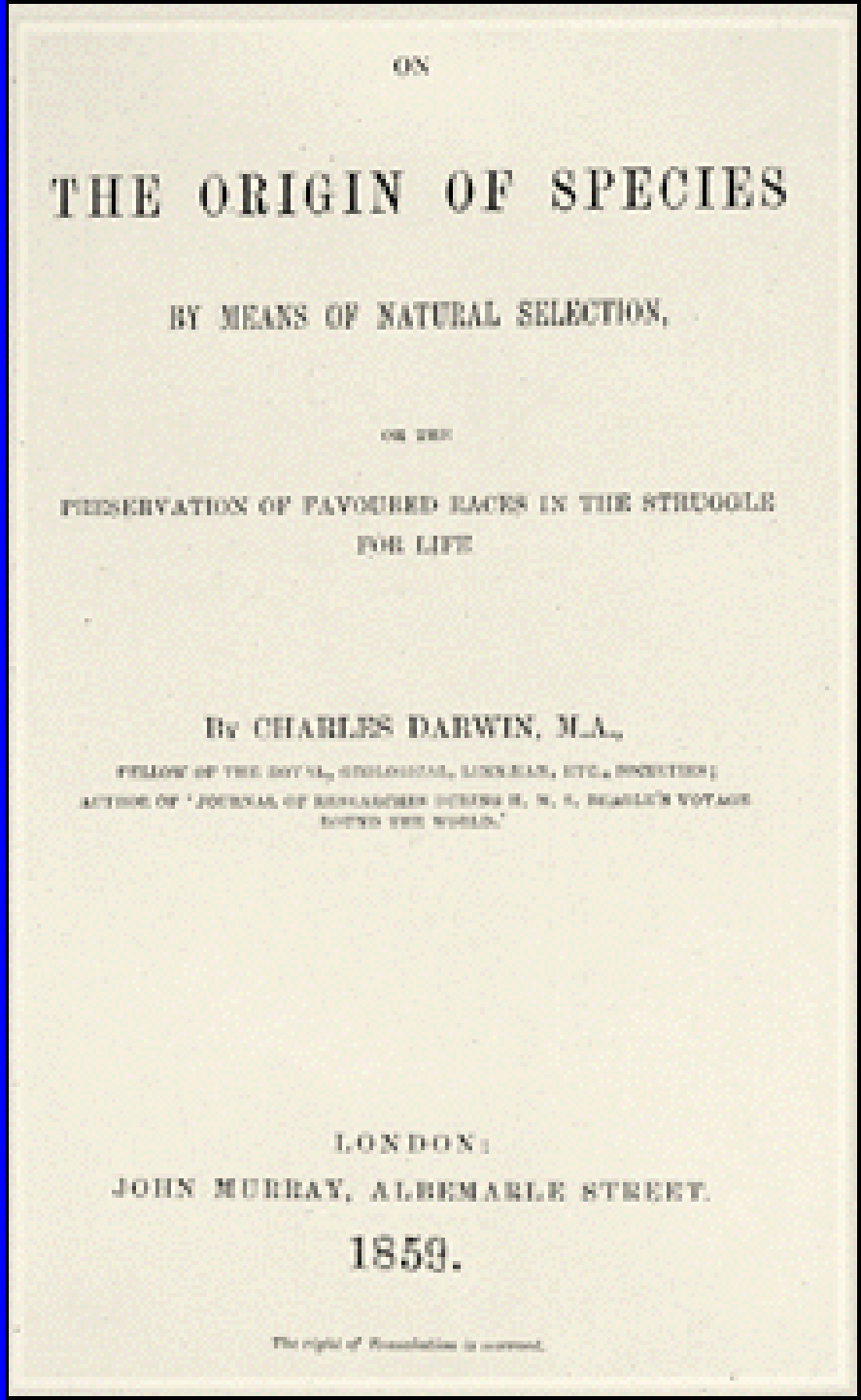
Charles Darwin (1809-1882)

- Born in England
- Attended medical school, HATED IT, and dropped out to become a priest
- Liked to stuff birds instead of dissect humans
- Didn't like grave robbing for bodies
- Boarded the *H.M.S. Beagle* for a 5 year UNPAID journey as a naturalist



Charles Darwin

- "Descent with modification" from an ancestral species
- *November 24th 1859*



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC. SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

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The Origin of Species

Occurrence of Evolution

Descent with Modification

all organisms related through descent from some unknown ancestral population

diverse modifications (adaptations) accumulated over time

Mechanism of Evolution

Natural Selection and Adaptation

natural selection is the differential success in reproduction

natural selection occurs from the interaction between the environment and the inherit variability in a population

variations in a population arise by chance

Can selection actually cause substantial change in a population?

dis. luigi volonté

Journey of the *H.M.S. Beagle*

Darwin's Field Research

- South American flora/fauna distinct from European flora/fauna

- S. American temperate species were more closely related to S. American tropical species than European temperate species

- S. American fossils were distinctly S. American

Tropical Rainforest of South America

Alfred Russel Wallace (1823-1913)

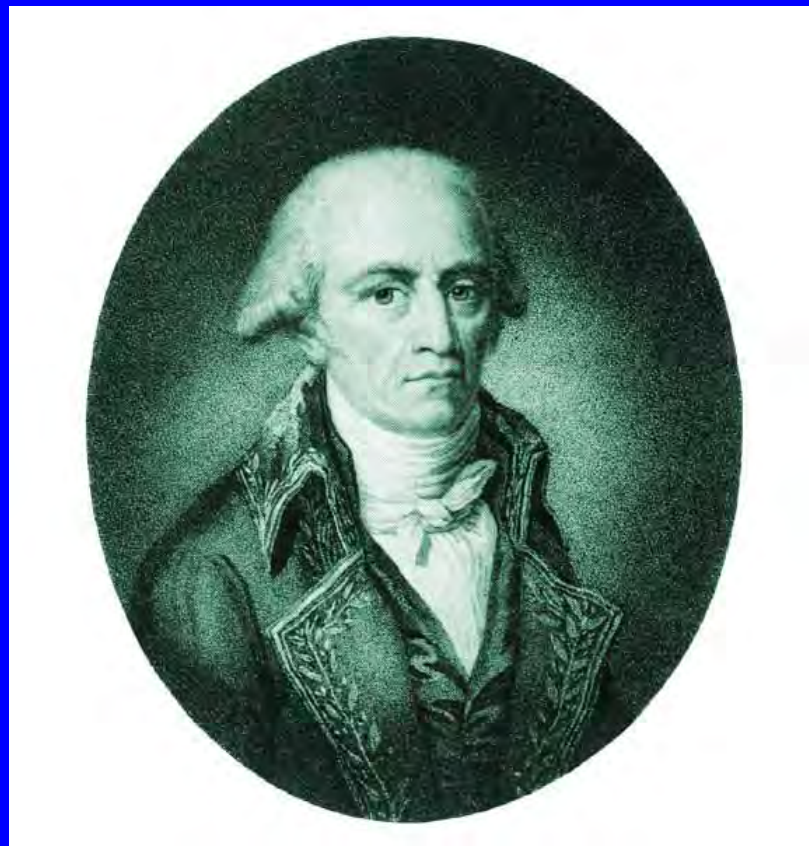
Presented a paper with identical ideas as Darwin on July 1, 1858 at the Linnaean Society meeting

Was a botanist who came up with virtually the same concept of natural selection more or less independently through his studies on the Malay archipelago. Darwin panicked because he was not ready with his book yet!

Where did Darwin and Wallace get the idea of evolution?

Jean Baptiste Lamarck (1744-1829)

- Lamarck claimed that evolution was driven by "use vs. disuse"
- A used structure will become larger, stronger and more important.
- A disused structure will atrophy and become VESTIGIAL.
- Evolution occurs because organisms have an innate drive to become more complex



Theory of "Use vs. Disuse"

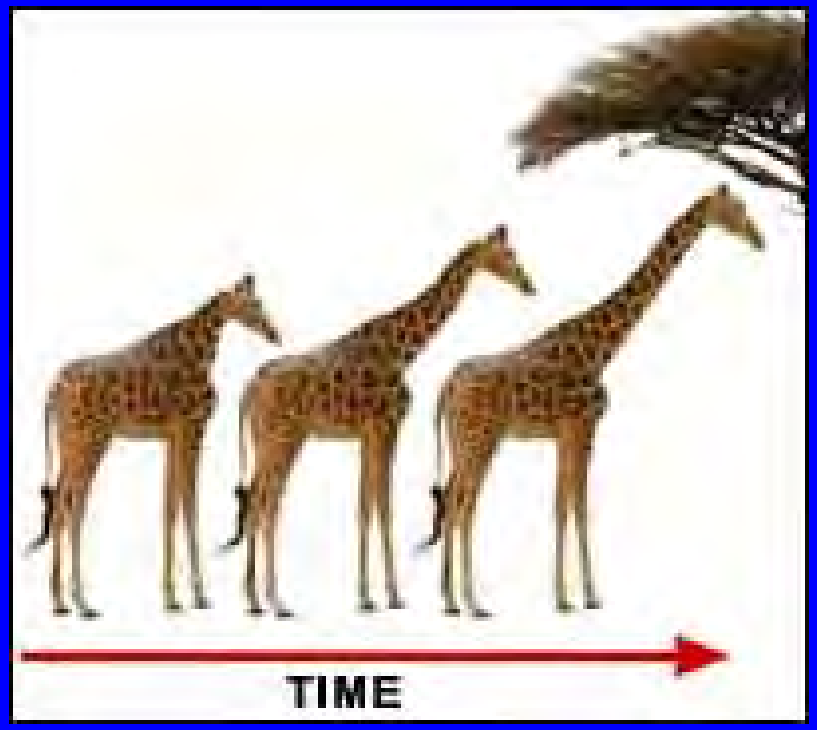
Big, "ripped" muscles developed by the village blacksmith with all his hammering and slinging of heavy metal objects would be expected to be passed on to his offspring.

Evolution

Evolution and the Theory of Natural Selection

Theory of "Acquired Characteristics"

- Lamarck claimed that traits acquired during an organism's lifetime could be inherited by that organism's offspring.



Georges Cuvier (1769-1832)

- Created Paleontology
  (The study of fossils)

- He noted that deeper layers of sedimentary rock had diversity of organisms far different from present day life found in more recent layers

- Proposed the idea of extinction based on fossils

James Hutton (1726-1797)

- A Scottish geologist who challenged Cuvier's view in 1795 with his idea of GRADUALISM

- Proposed that large changes in the earth's surface could be caused by slow, constant processes

e.g. erosion by a river

Charles Lyell (1797-1875)

- Earth processes had been going on constantly, and could explain the appearance of the earth.

- This theory, uniformitarianism, was a strong basis for Darwin's later theory of natural selection.

Thomas Malthus (1766-1834)

- Suggested that much of humanity's suffering (disease, famine, homelessness and war) was the inevitable result of overpopulation: **humans reproduced more quickly than their food supply could support them.**

- **Malthus showed that populations, if allowed to grow unchecked, increase at a geometric rate.**


PATHWAY TO A THEORY
1 Work of others
Older Earth
Buffon
Geologic change
Lyell
Evolution
Lamarck
VOYAGE OF THE BEAGLE
2 Evidence from observations
Fossils
Earthquakes
Geographic distribution of living organisms
3 Darwin questions prior ideas.
4 Darwin recognizes species change.
RETURN TO ENGLAND
5 How do species adapt to their environment?
6 Observations
Selective breeding of farm plants and animals and pets
7 Darwin seeks a new explanation for adaptation.
8 Malthus influences Darwin's thinking.
9 Darwin formulates his theory in an essay.
10 Darwin publishes his theory.
Origin of Species
Wallace presents similar evidence and inferences.

SO WHAT IS THIS THEORY OF NATURAL SELECTION?

It can be broken down into four basic tenets, or ideas

Theory of Natural Selection

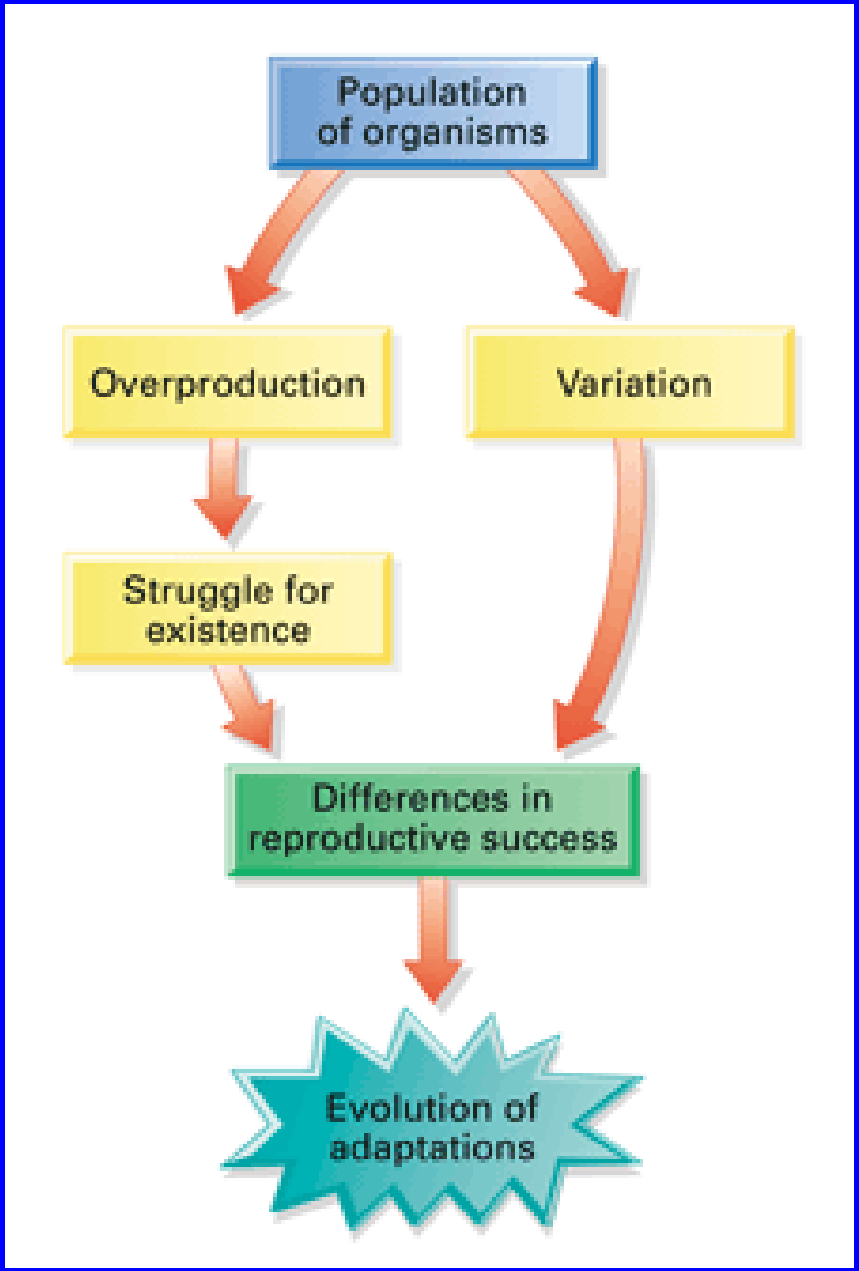
1. Organisms are capable of producing huge numbers of offspring.

2. Those offspring are variable in appearance and function, and some of those variations are heritable.

Theory of Natural Selection

3. Environmental resources are limited, and those varied offspring must compete for their share.

4. Survival and reproduction of the varied offspring is not random. Those individuals whose inherited characteristics make them better able to compete for resources will live longer and leave more offspring than those not as able to compete for those limited resources.



- Natural selection is differential success in reproduction
  - That results from the interaction between individuals that vary in heritable traits and their environment

Objectives

- Discuss evolutionary theory in order to describe its origins and current state.
- Explore the theory of natural selection as the major driving force in evolution.
- Compare/contrast different ideas of evolutionary theory

Do Now

- Why do we give credit to Darwin for the theory of evolution?
- Who influenced Darwin’s thinking?

Objectives

- Explore the theory of natural selection as the major driving force in evolution.
- Compare/contrast homology and analogy in adaptations

Natural Selection Definition

Natural selection

is

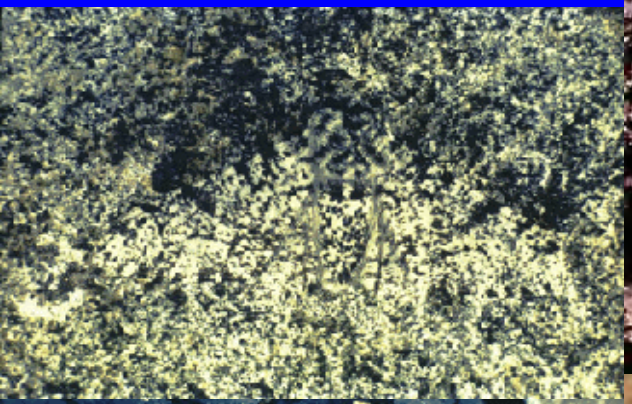
differential success in reproduction

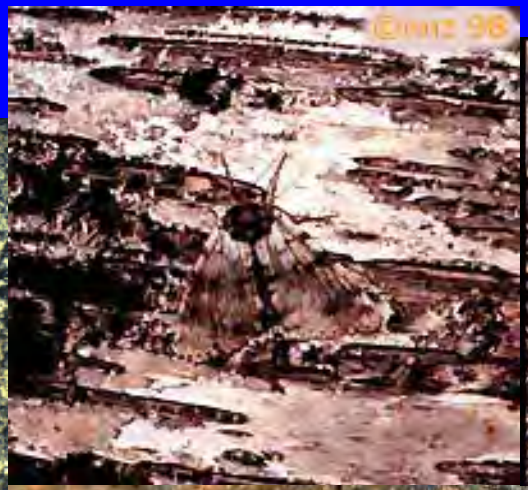
Selection can only edit existing variations

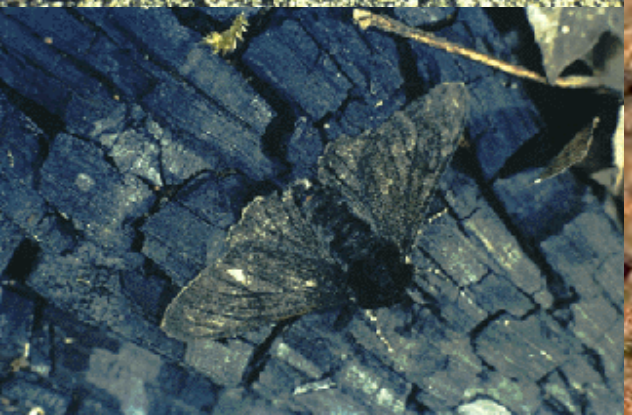
NATURAL SELECTION IN ACTION

- Camouflage

(Cryptic coloration)

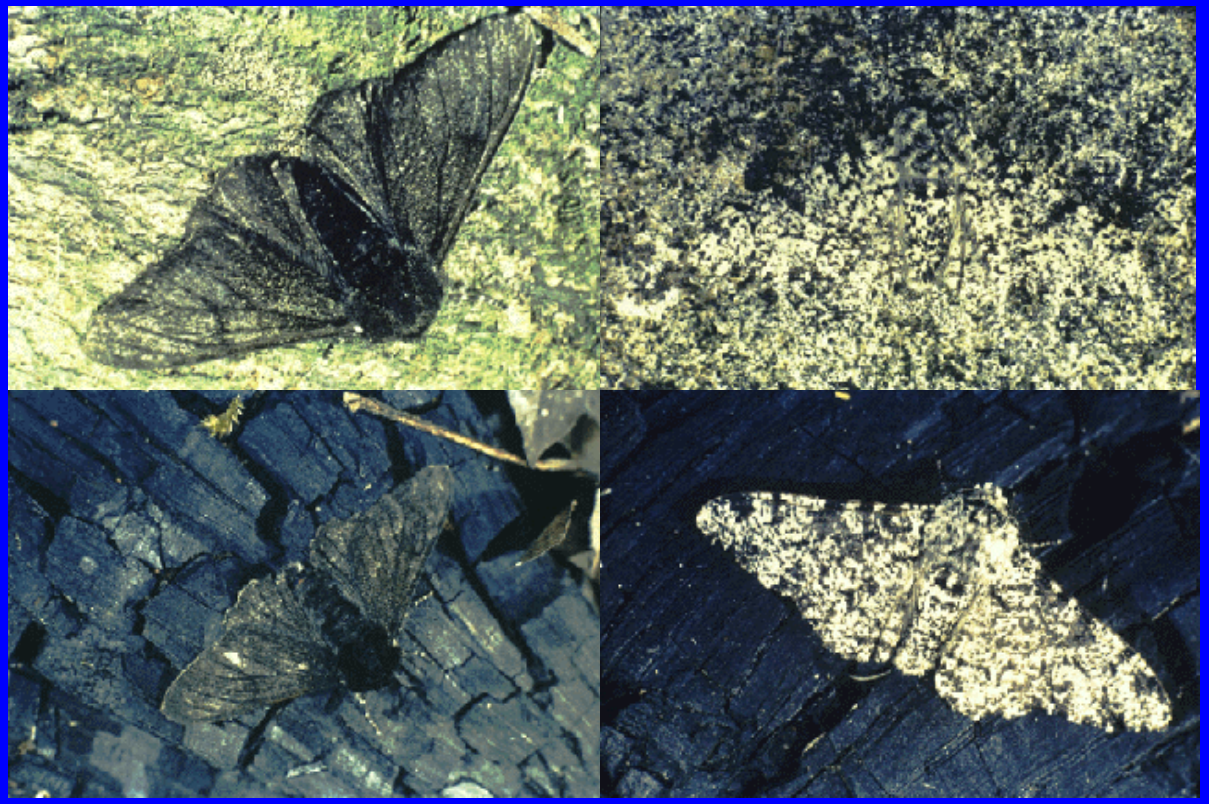






Natural Selection in Action

- Industrial melanism



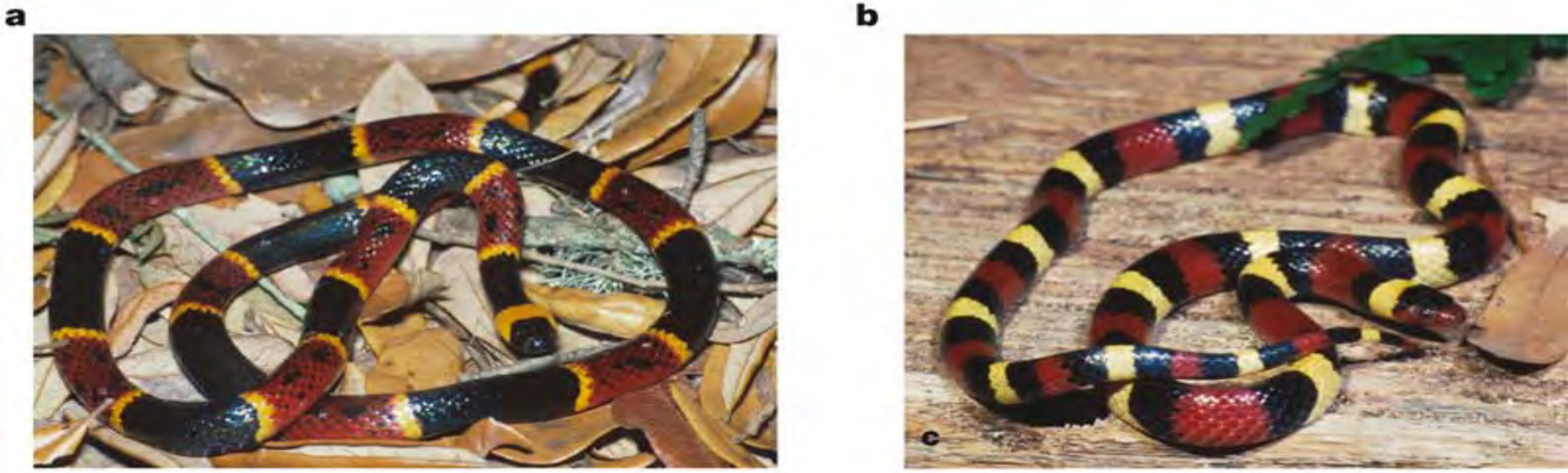
NATURAL SELECTION IN ACTION

- Mullerian Mimicry – Unpalatable mimics unpalatable

- Monarch or Viceroy Butterfly

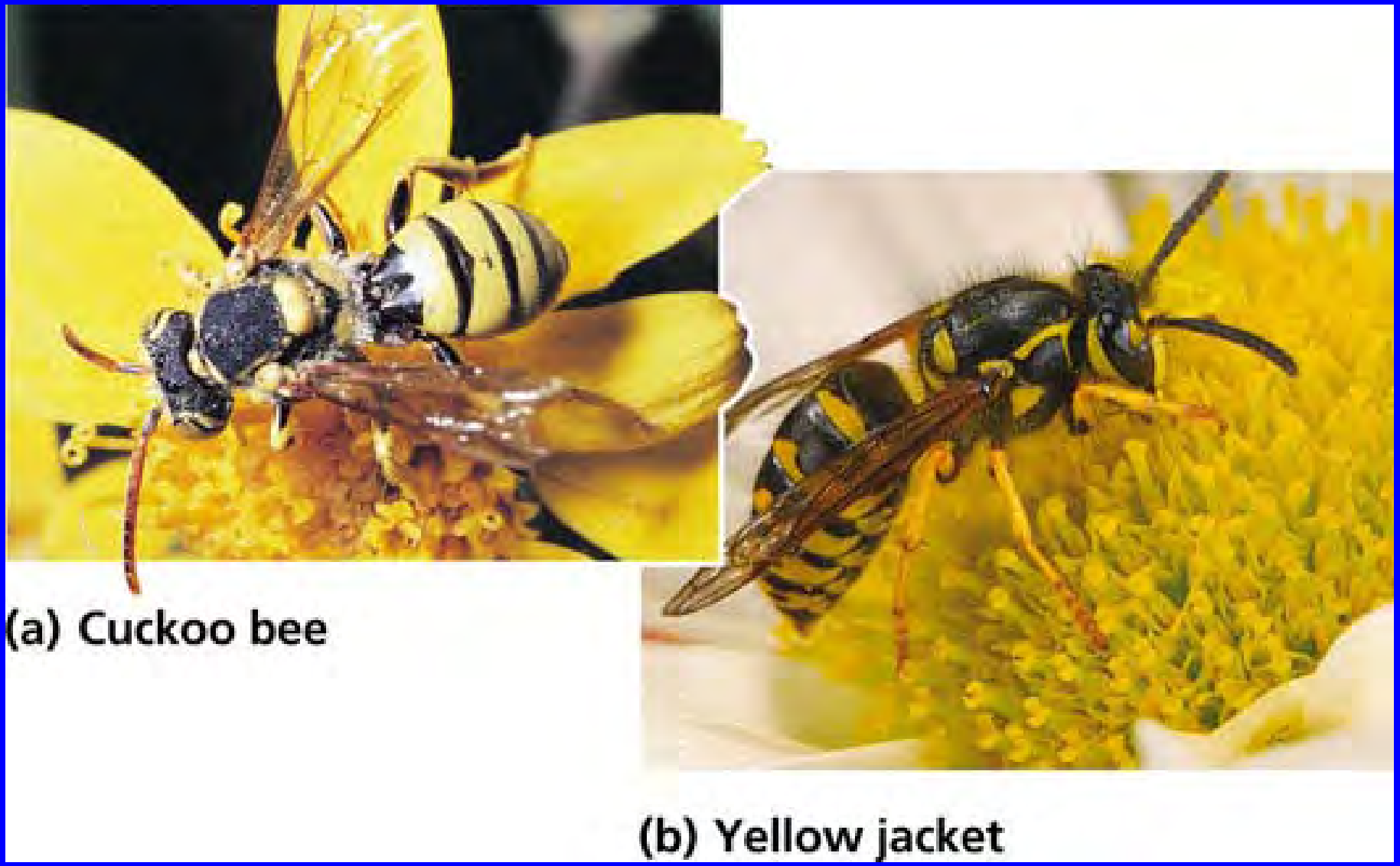
Natural Selection in Action

- Batesian Mimicry – Palatable mimics unpalatable
- Coral vs. King Snakes: Red on yellow, kill a fellow, red on black won't hurt Jack



Which would you rather be stung by?

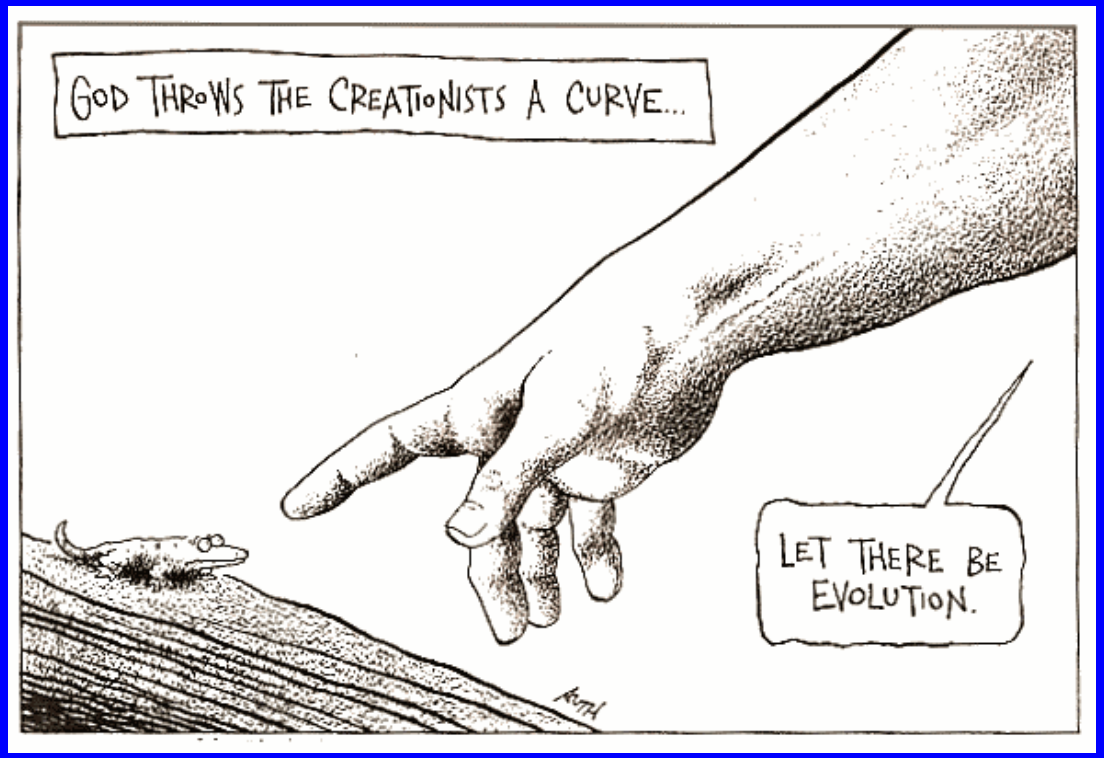
What type of mimicry?


(a) Cuckoo bee
(b) Yellow jacket

- Batesian mimicry is when a harmless species or a species that is prey to predators (some textbooks might use the word 'palatable’) copies a harmful species or a species that is not prey to other predators (unpalatable).
- On the other hand, a Mullerian mimicry is when TWO (or more) harmful or unpalatable species mimic each other.

What is Evolution?

The change in gene frequencies in a population over time



Natural Selection in Action

- Warning Coloration (**Aposematic coloration**)

Questions?

Ask ONE good question to your neighbor about Natural Selection – Get ready to share with the class!

NATURAL SELECTION IN ACTION

- Disruptive Coloration

Natural Selection in Action

- Counter Shading





Natural Selection in Action

- Eye spots

Evolution

Things to remember:

a. Individuals cannot evolve. Populations evolve.

b. Natural selection is the mechanism of evolution.

c. Evolution occurs by chance (NOT GOAL ORIENTED).

What is speciation and who studies it?

- Speciation is the creation of a new species

- Scientists who study the processes and mechanisms that lead to such speciation events are called EVOLUTIONARY BIOLOGISTS.

Species

- have the potential to interbreed in nature and produce viable, fertile offspring but are unable to produce viable fertile offspring with members of other populations

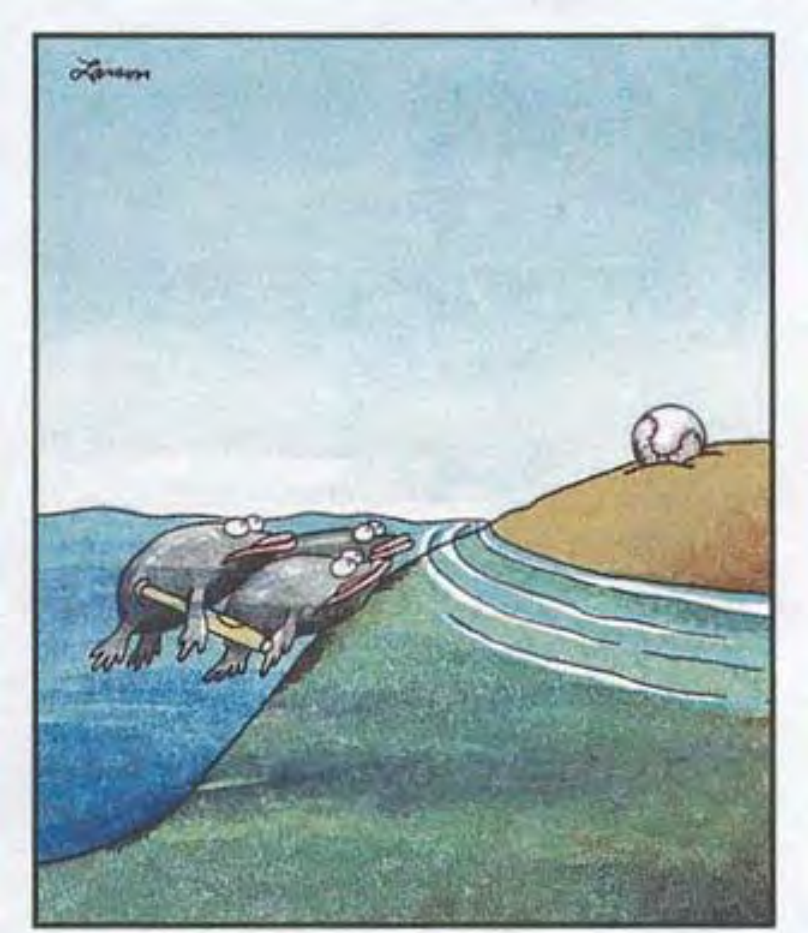
Comparing DNA sequences

- Our friend Mr. Andersen

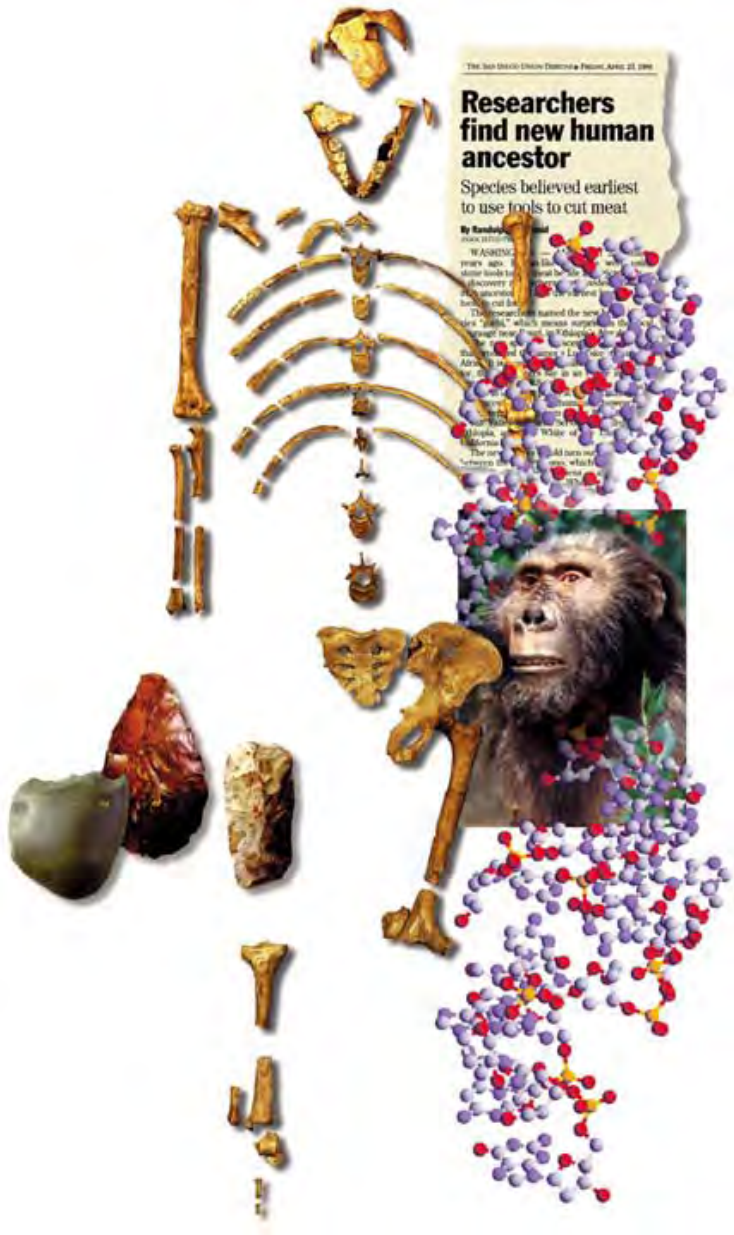
Do Now

- How does one species become 2 distinct species?

Why the controversy?



Great moments in evolution

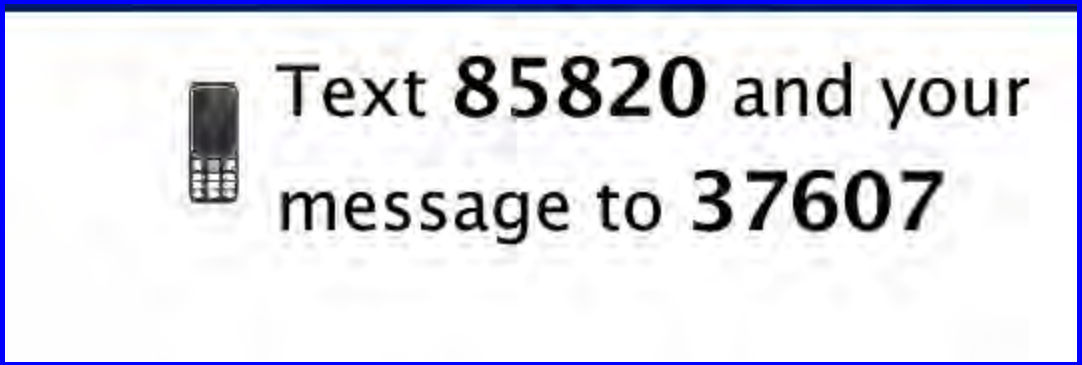


Objectives

- Discuss evolutionary theory in order to describe its origins and current state.
- Explore the theory of natural selection as the major driving force in evolution.
- Compare/contrast different ideas of evolutionary theory

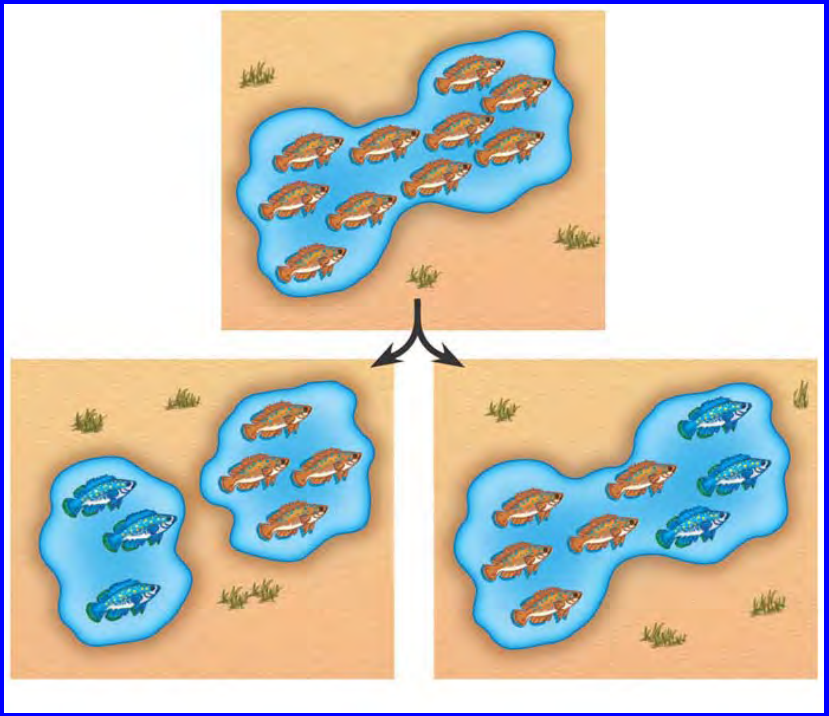
How do you like our AP class so far?

- http://www.polleverywhere.com/free_text_polls/LTczNTYxOTIyMQ



- Use 3 to 5 words to describe this class.

- Speciation can occur in two ways
  - Allopatric speciation
  - Sympatric speciation



Allopatric speciation. A population forms a new species while geographically isolated from its parent population.

Sympatric speciation. A small population becomes a new species without geographic separation.

Allopatric Speciation

- A population becomes physically separated from the rest of the species by a geographical barrier that prevents interbreeding.

- Because gene flow is disrupted by this physical barrier, new species will form.

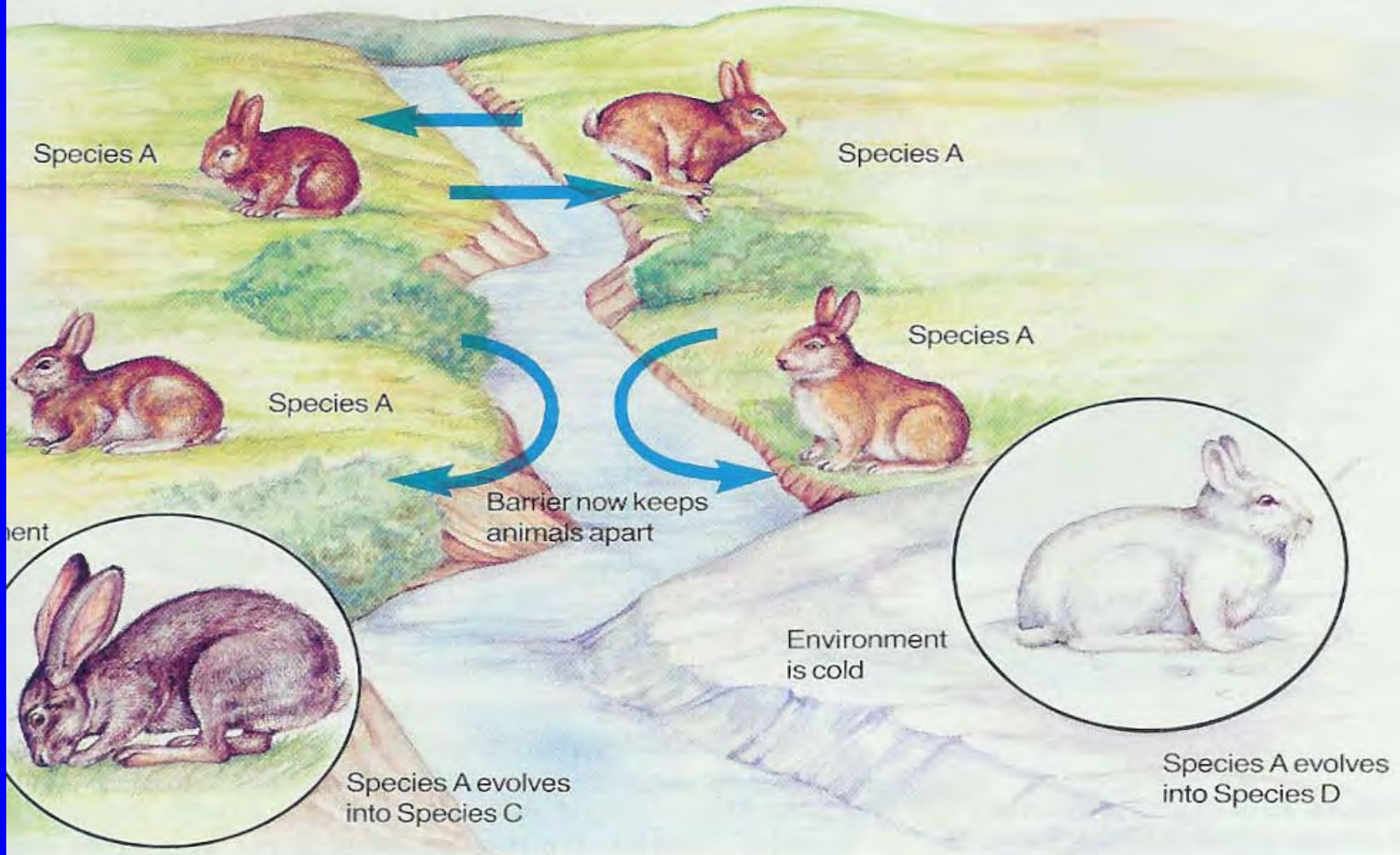


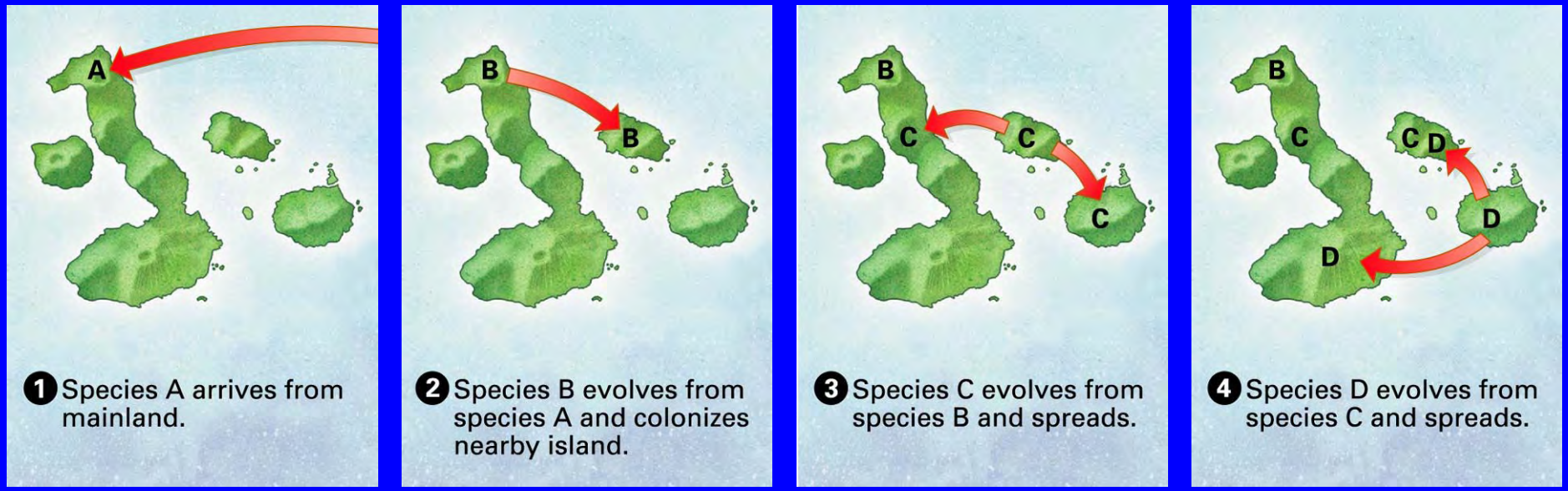
Figure 29-5 A barrier can lead to the formation of new species.

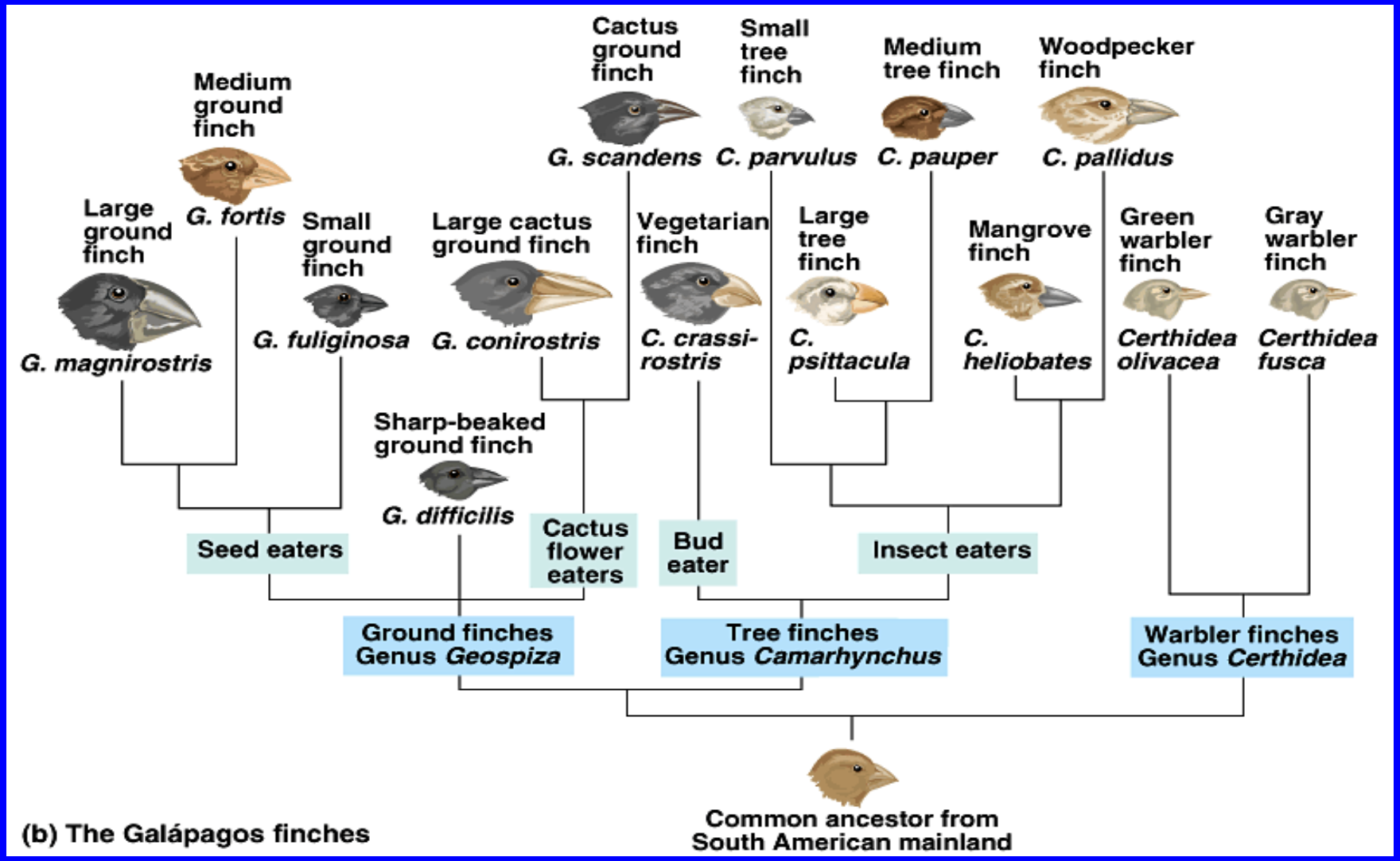

A. harrisi
A. leucurus

Adaptive Radiation

- **Adaptive Radiation** - Evolutionary process in which the original species gives rise to many new species, each of which is adapted to a new habitat and a new way of life.

  E.g. Darwin's Finches


A
1 Species A arrives from mainland.
B
B
2 Species B evolves from species A and colonizes nearby island.
B
C
C
C
3 Species C evolves from species B and spreads.
B
C
C
D
D
D
4 Species D evolves from species C and spreads.

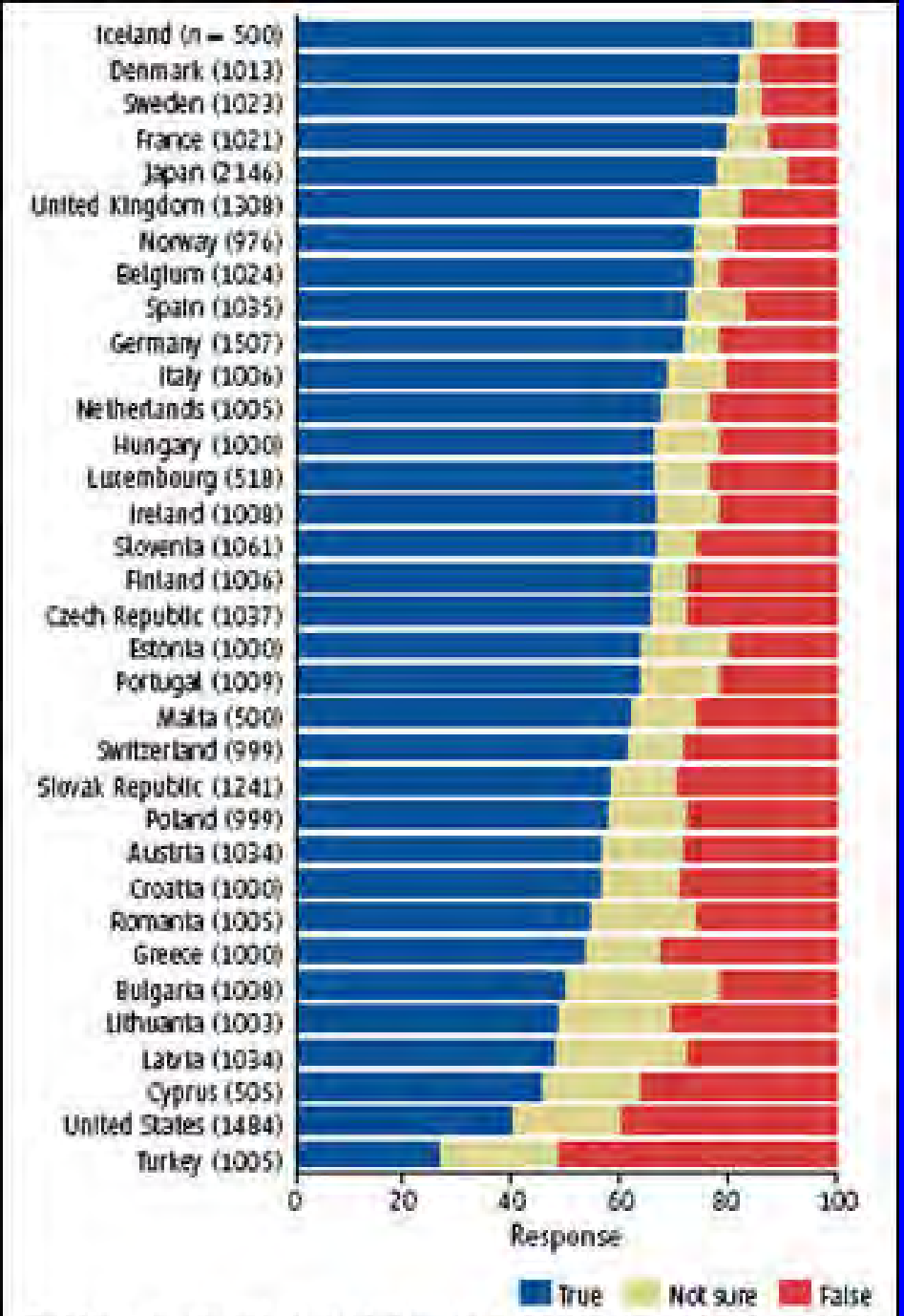


(b) The Galápagos finches

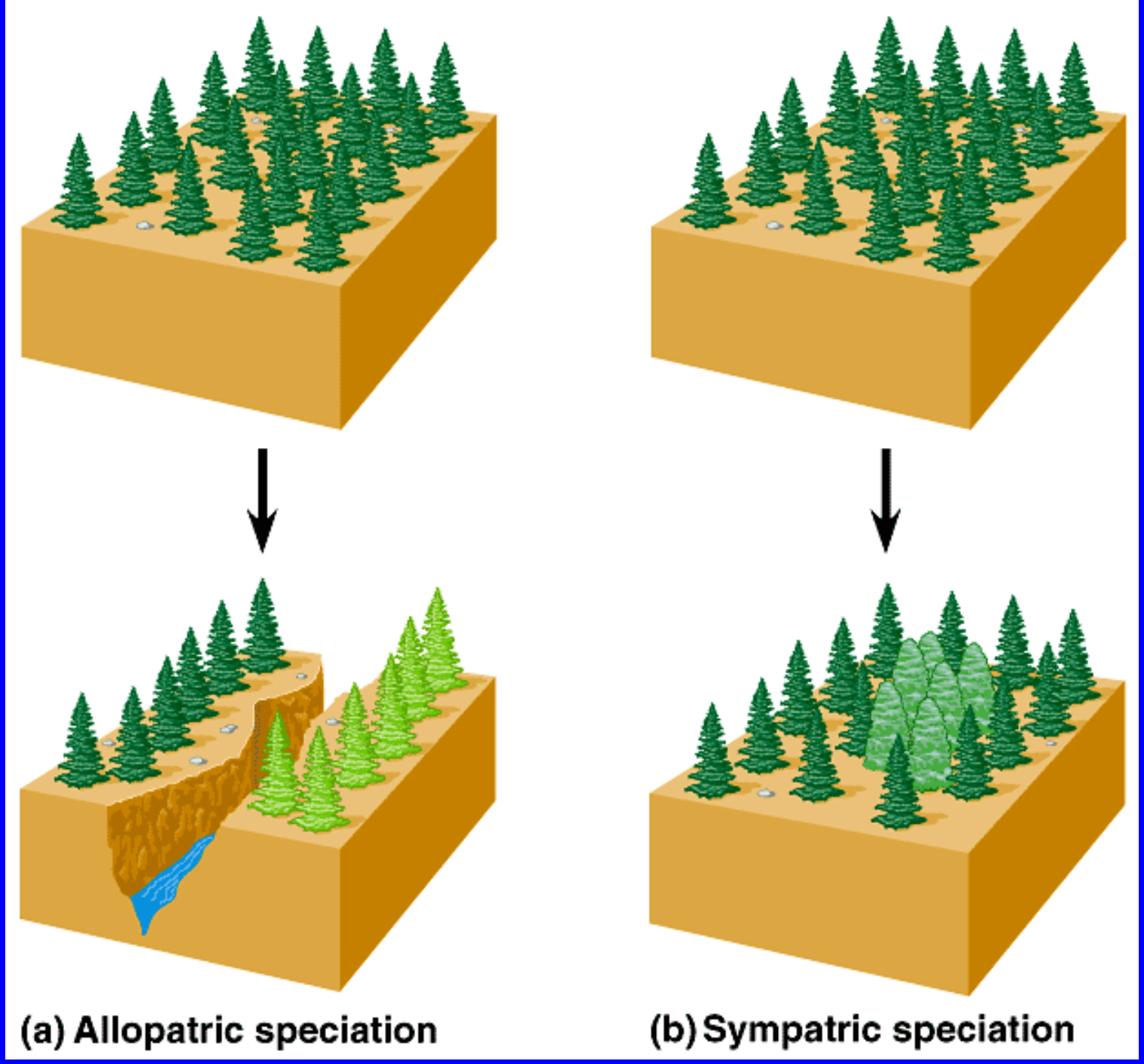
Sympatric Speciation

- Two populations are geographically close to each other, but they are reproductively isolated from each other by different habitats, mating seasons, etc.

- Polyploidy
  - Is the presence of extra sets of chromosomes in cells due to accidents during cell division
  - Has caused the evolution of some plant species



Public acceptance of evolution in 34 countries, 2005.


(a) Allopatric speciation
(b) Sympatric speciation

Homework site

- On the bottom of our web page!
- www.upegui.weebly.com

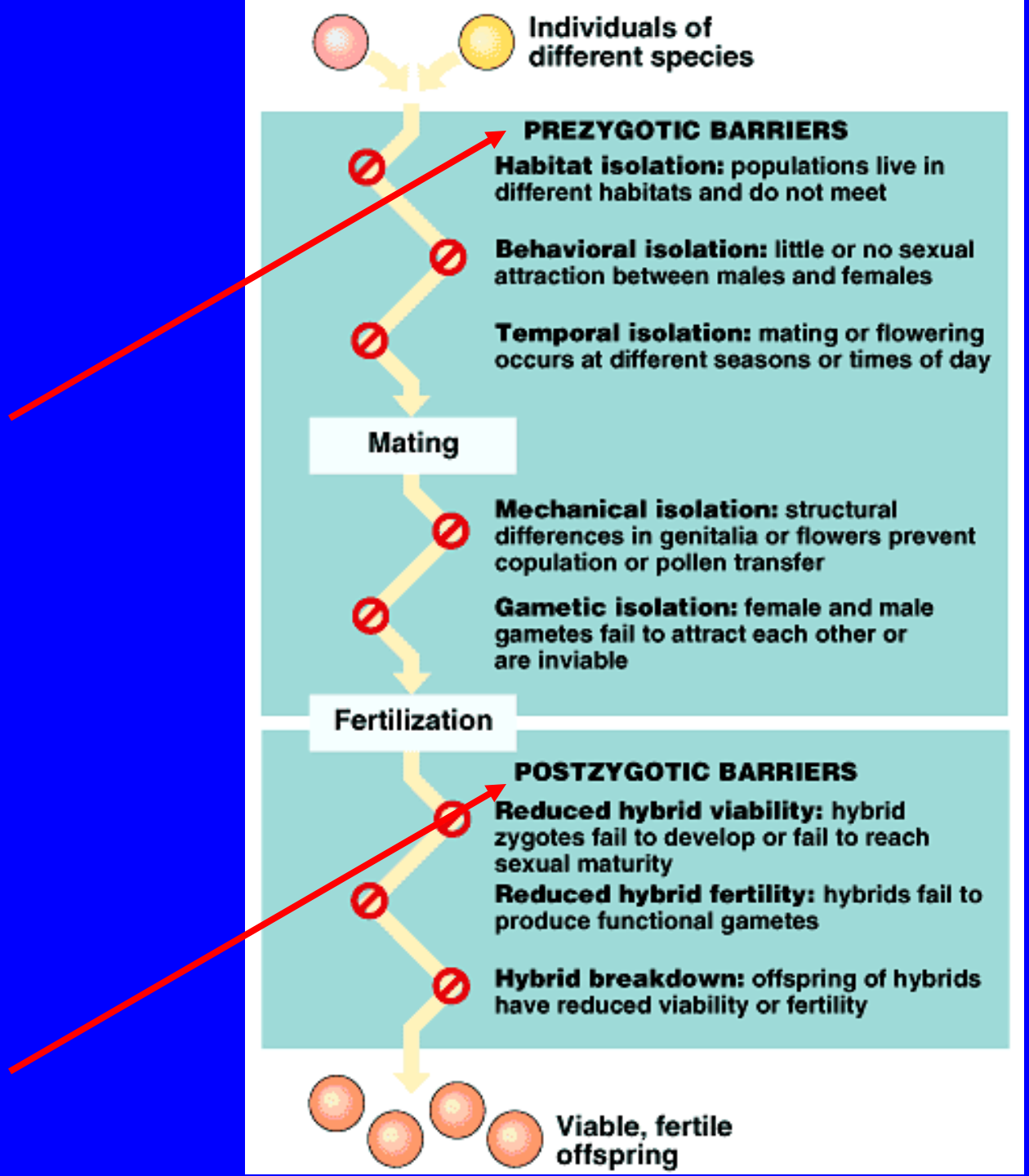
Reproductive Barriers

A reproductive barrier is any factor that prevents two species from producing fertile hybrids, thus contributing to reproductive isolation.

- **Habitat Isolation**
- **Temporal Isolation**
- **Behavioral Isolation**
- **Mechanical Isolation**
- **Gametic Isolation**

Reproductive Barriers

- Prezygotic barriers
  - Impede mating between species or hinder the fertilization of ova if members of different species attempt to mate
- Postzygotic barriers
  - Often prevent the hybrid zygote from developing into a viable, fertile adult


Individuals of different species
PREZYGOTIC BARRIERS
Habitat isolation: populations live in different habitats and do not meet
Behavioral isolation: little or no sexual attraction between males and females
Temporal isolation: mating or flowering occurs at different seasons or times of day
Mating
Mechanical isolation: structural differences in genitalia or flowers prevent copulation or pollen transfer
Gametic isolation: female and male gametes fail to attract each other or are inviable
Fertilization
POSTZYGOTIC BARRIERS
Reduced hybrid viability: hybrid zygotes fail to develop or fail to reach sexual maturity
Reduced hybrid fertility: hybrids fail to produce functional gametes
Hybrid breakdown: offspring of hybrids have reduced viability or fertility
Viable, fertile offspring

Evidence for Evolution

- **Paleontology** - Study of Fossils

  Fossil - preserved evidence of past life

  a. **Relative dating**

  b. Radioactive dating

Evidence for Evolution

- HOMOLOGY is a characteristic shared by two species (or other taxa) that is similar because of **common ancestry**.

- **Artificial Selection** Farmers had been conducting this controlled breeding of livestock and crops for years in order to obtain the most milk from cows or the best cobs from corn plants.

- http://www.pbs.org/wgbh/nova/evolution/intelligent-design-trial.html

Types of homology

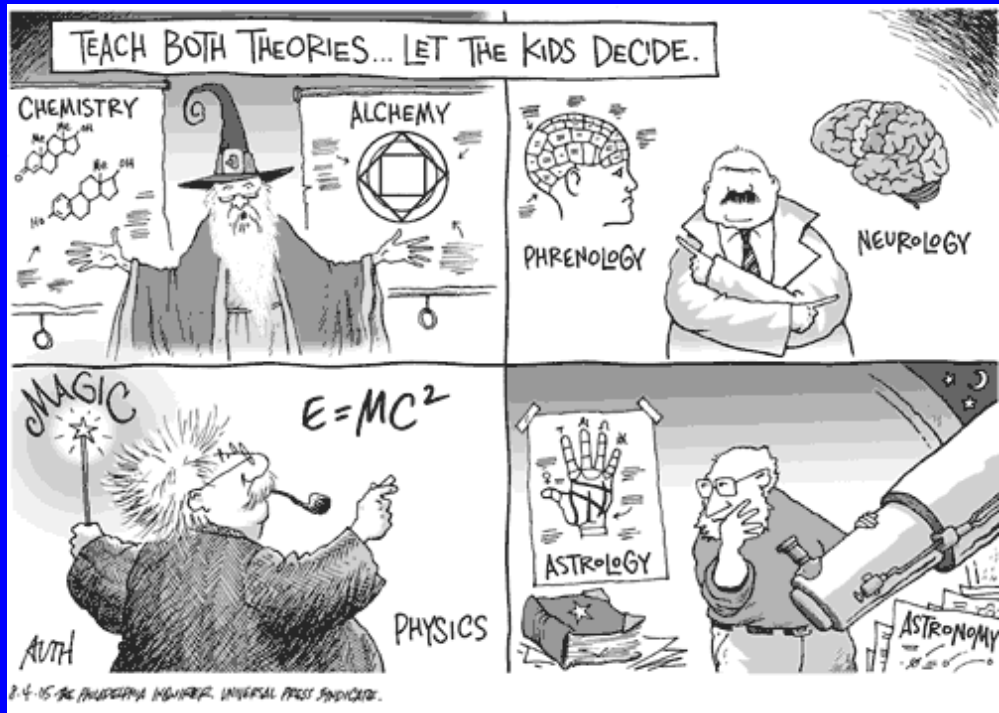
- **morphological homology** – species placed in the same taxonomic category show anatomical similarities.
- **ontogenetic homology** - species placed in the same taxonomic category show developmental (embryological) similarities.
- **molecular homology** - species placed in the same taxonomic category show similarities in DNA and RNA.

MORPHOLOGICAL HOMOLOGY

- Structures derived from a common ancestral structure are called:

HOMOLOGOUS STRUCTURES

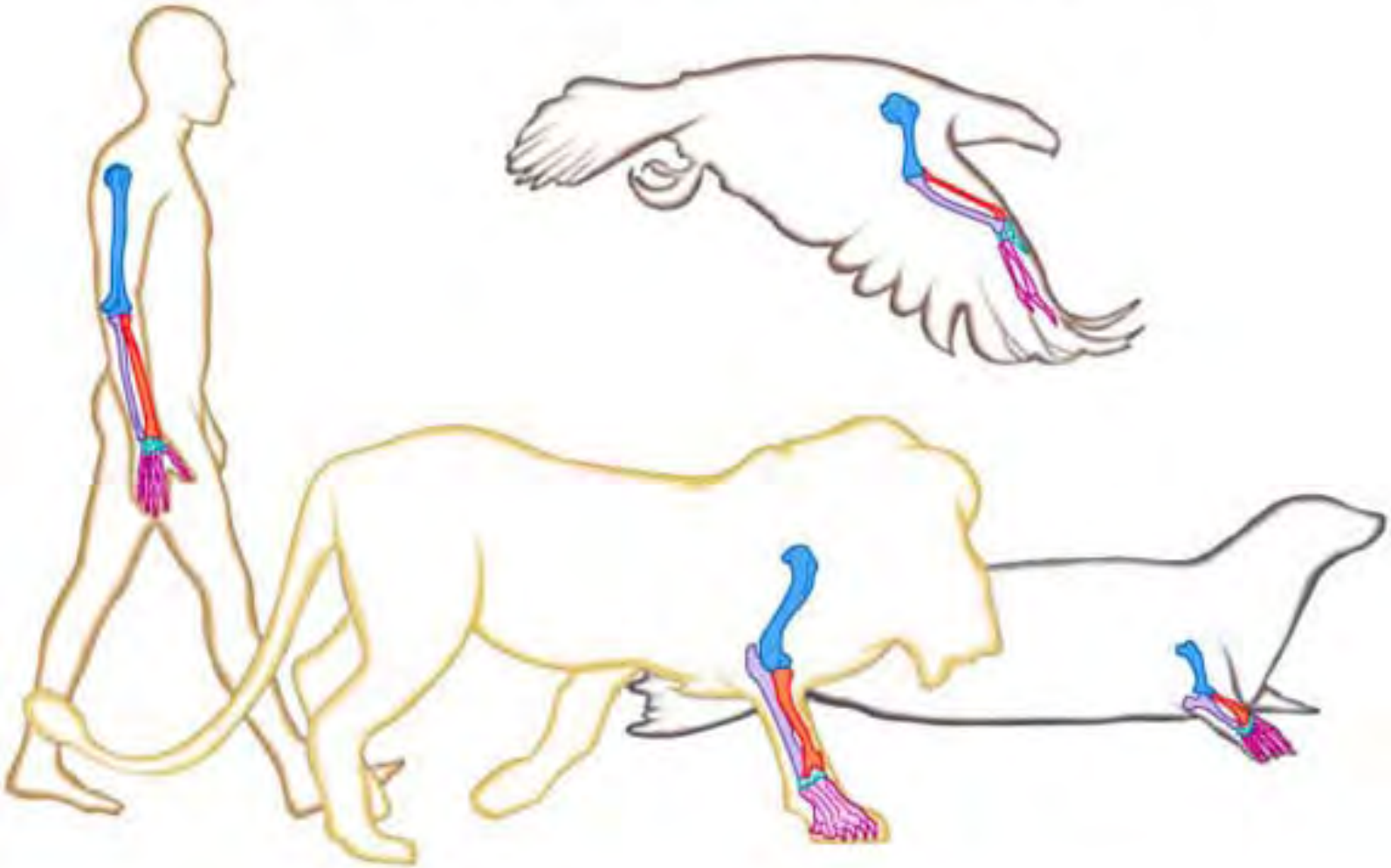
Intelligent Design vs Evolution

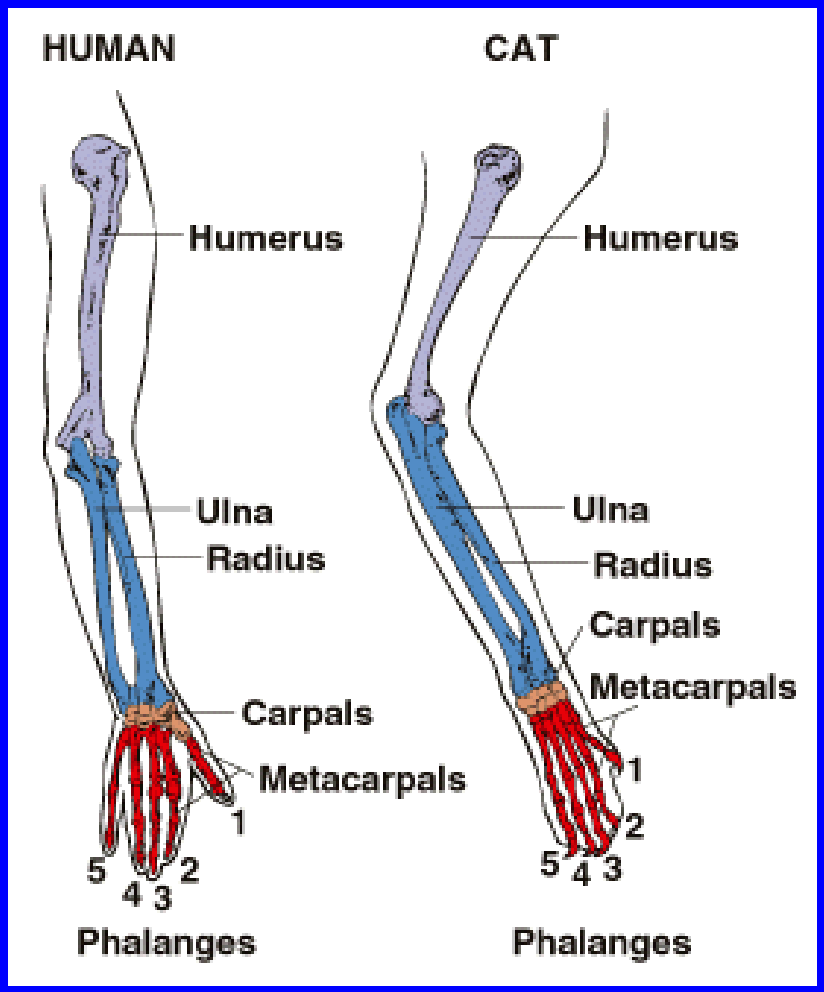


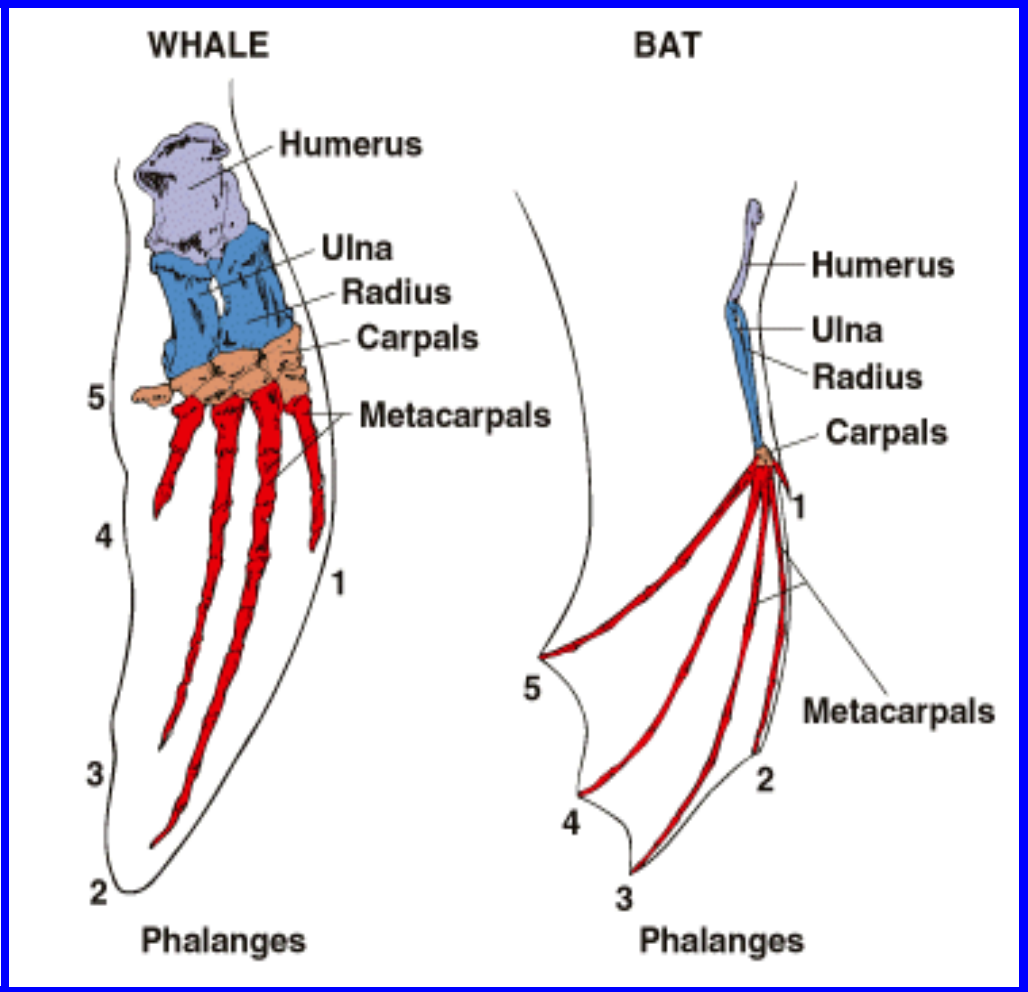
In pairs

- Think of some homologous structures!
- Be creative

Similar skeletal organization



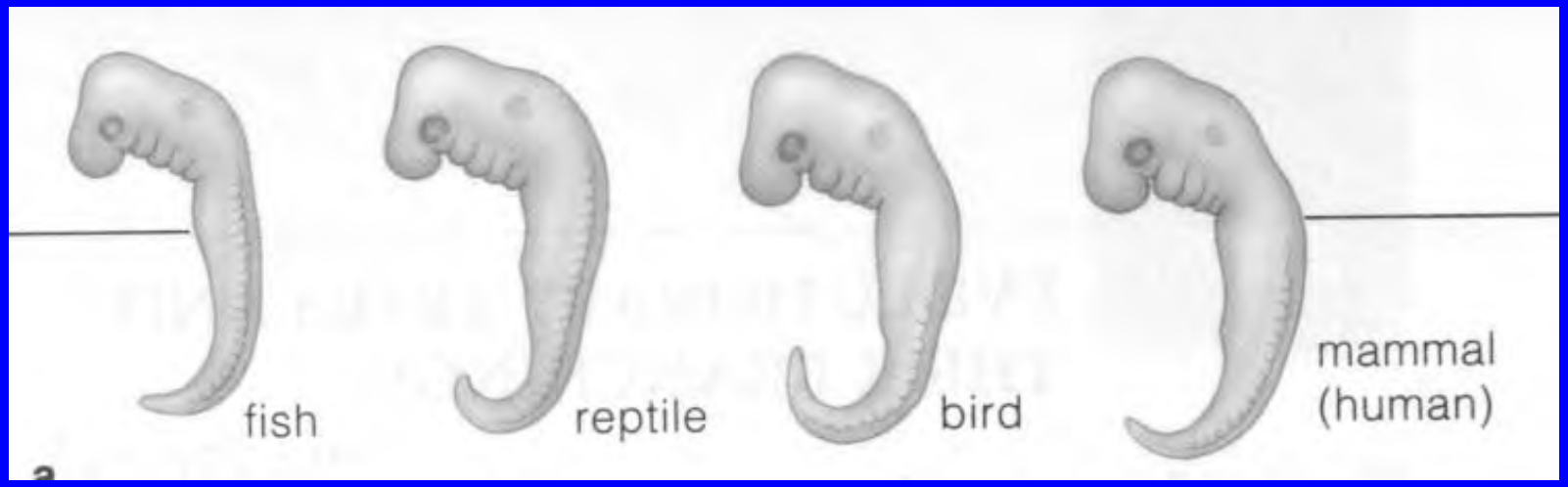

HUMAN
CAT
Humerus
Ulna
Radius
Carpals
Metacarpals
1
2
3
4
5
Phalanges
Humerus
Ulna
Radius
Carpals
Metacarpals
1
2
3
4
5
Phalanges

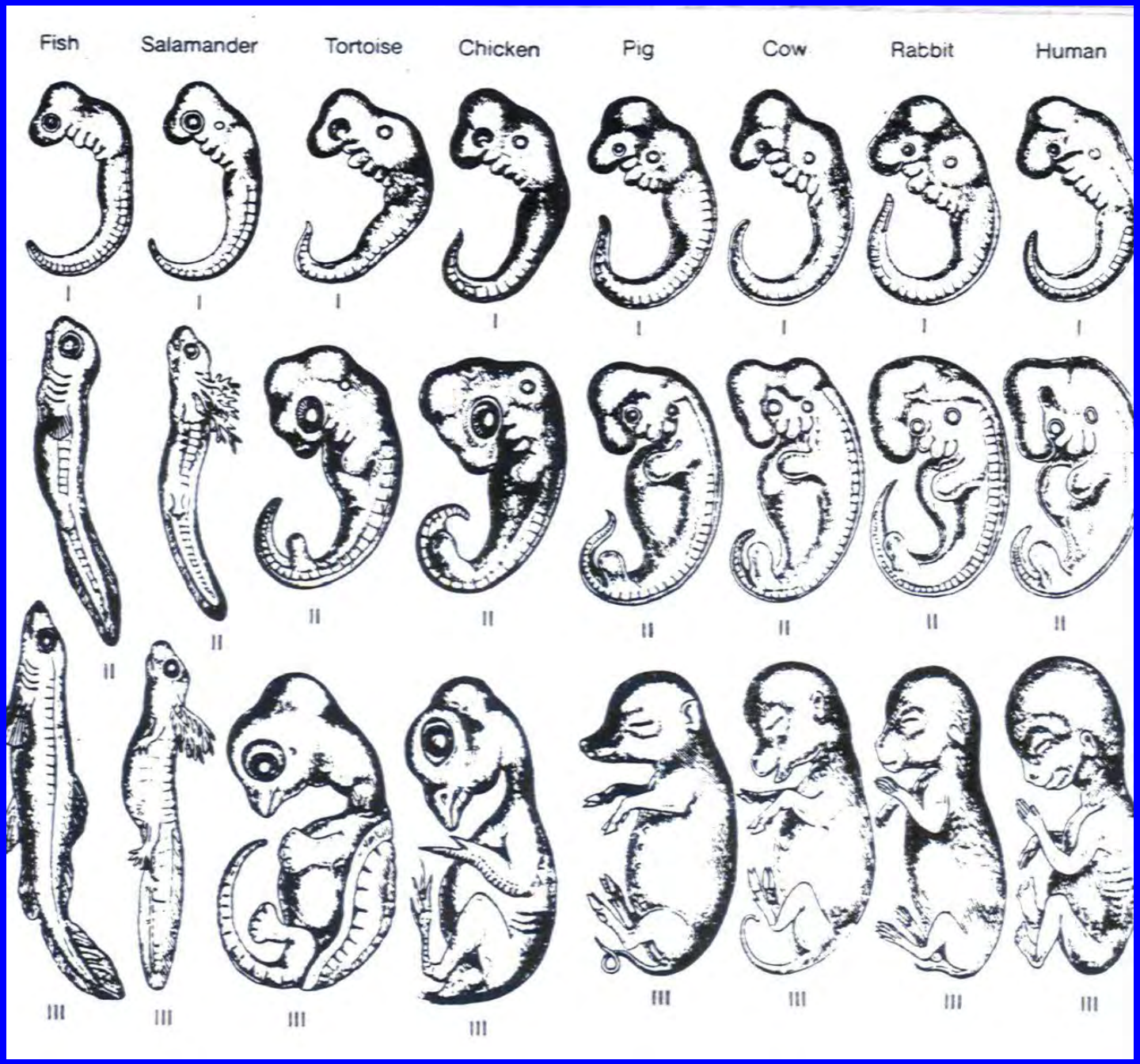

WHALE
BAT
Humerus
Ulna
Radius
Carpals
Metacarpals
1
2
3
4
5
Phalanges
Humerus
Ulna
Radius
Carpals
Metacarpals
1
2
3
4
5
Phalanges

Evidence for Evolution

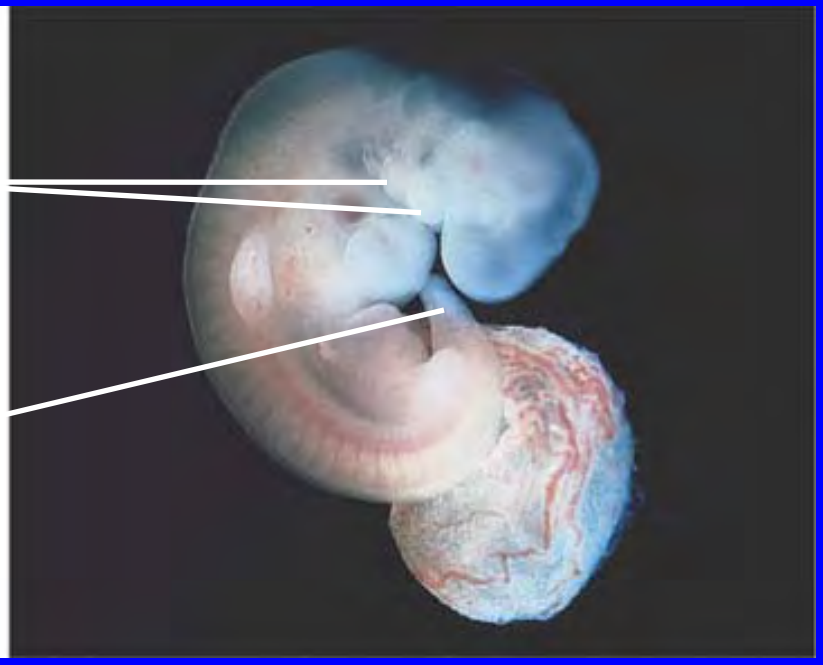
Ontogenetic Homology

The human embryo has gills, a post-anal tail, webbing between the toes & fingers, & spends its entire time floating and developing in amniotic fluid has similar salt concentration as ocean water




Fish
Salamander
Tortoise
Chicken
Pig
Cow
Rabbit
Human
I
II
III

Ontogeny recapitulates phylogeny



Chick embryo

Human embryo

Figure 22.15

MORPHOLOGICAL HOMOLOGY

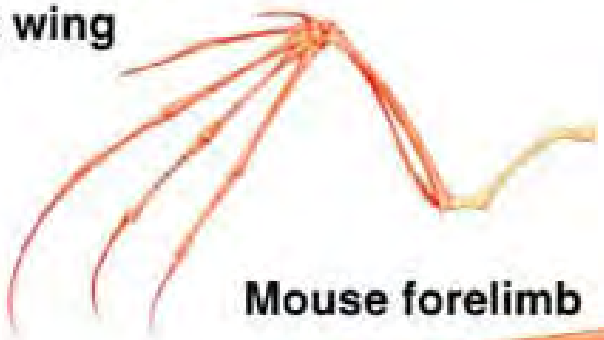
- A structure that serves the same function in two taxa, but is <u>NOT</u> derived from a common ancestral structure is said to be an

ANALOGOUS STRUCTURE

Homology and analogy

Homology

Bat wing



Human arm

Mouse forelimb

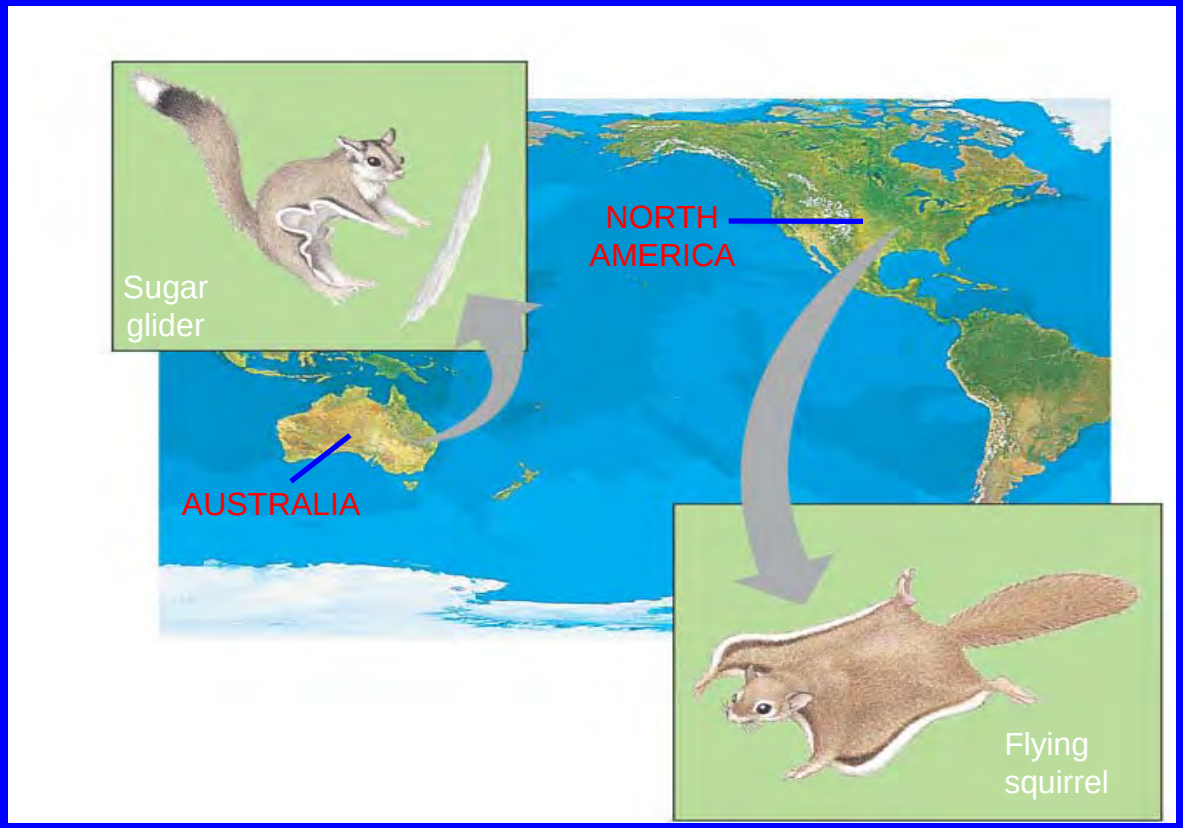
Analogy

Bat wing

Butterfly wing

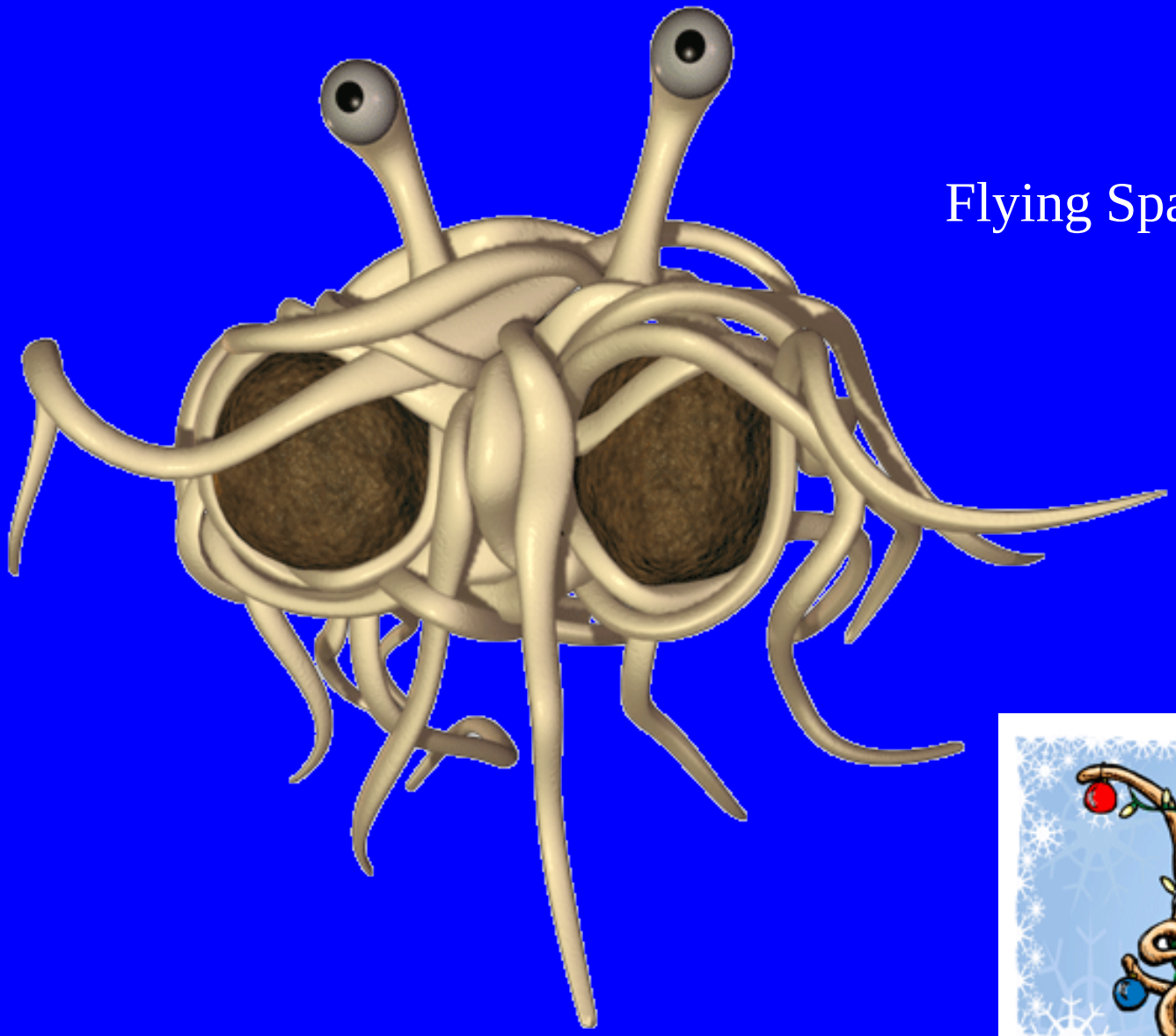
Bird wing

- Some similar mammals that have adapted to similar environments
  - Have evolved independently from different ancestors



Examples of Analogous structures:

- wings of bat, bird, and butterfly
- walking limbs of insects and vertebrates
- cranium of vertebrates and exoskeleton head of insects
- 4 chambered heart in birds & mammals



Flying Spaghetti Monster

Have you been touched by his noodly appendage?

Evidence for Evolution

Molecular Homology

Amino acids reveal evolution

Cytochrome *c* Evolution

Organism	Number of amino acid differences from humans
Chimpanzee	0
Rhesus monkey	1
Rabbit	9
Cow	10
Pigeon	12
Bullfrog	20
Fruit fly	24
Wheat germ	37
Yeast	42

A

- The Greek philosopher Aristotle
  - Viewed species as fixed and unchanging (Scala naturae) Fixed rungs on a ladder of complexity
- The Old Testament of the Bible
  - Holds that species were individually designed by God and therefore perfect
- Carolus Linnaeus
  - Interpreted organismal adaptations as evidence that the Creator had designed each species for a specific purpose
  - Was a founder of taxonomy, classifying life's diversity "for the greater glory of God"