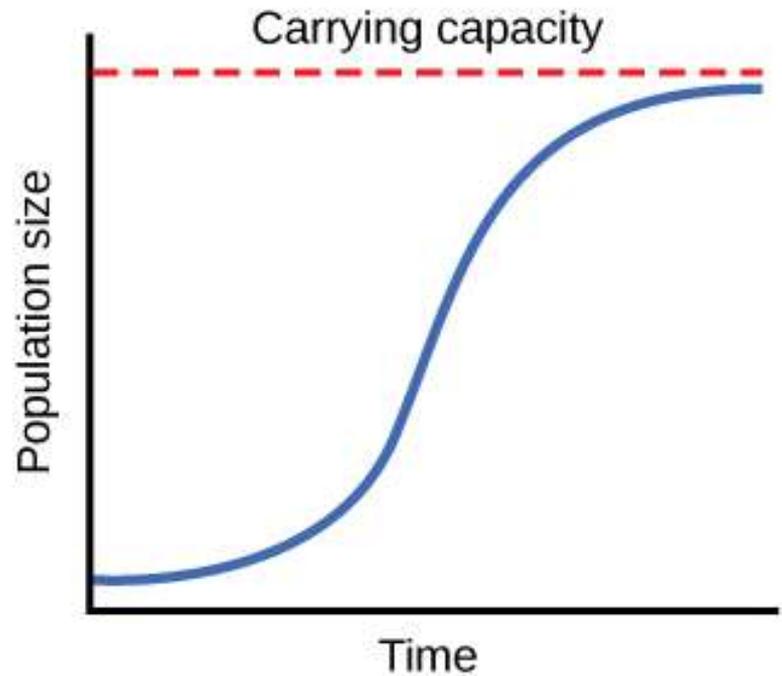
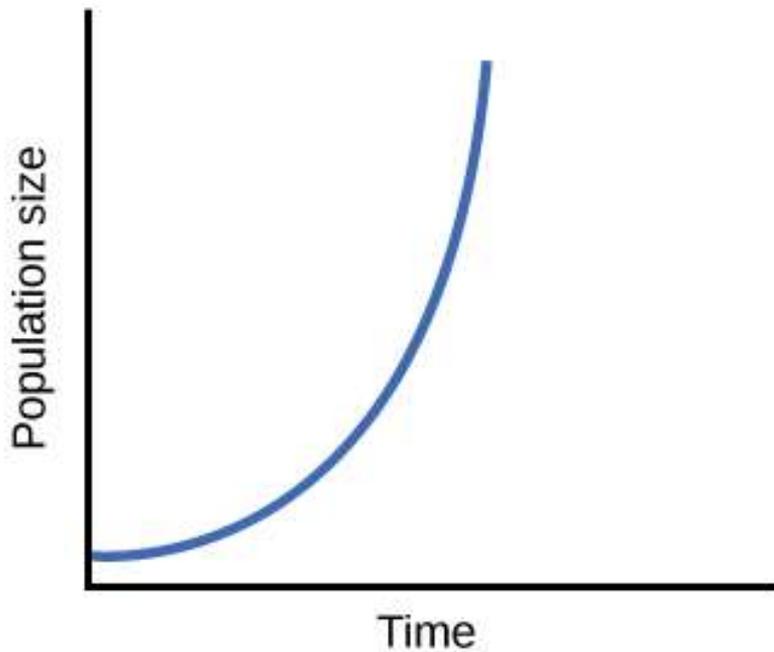


Bellwork

Which growth curve is logistic?

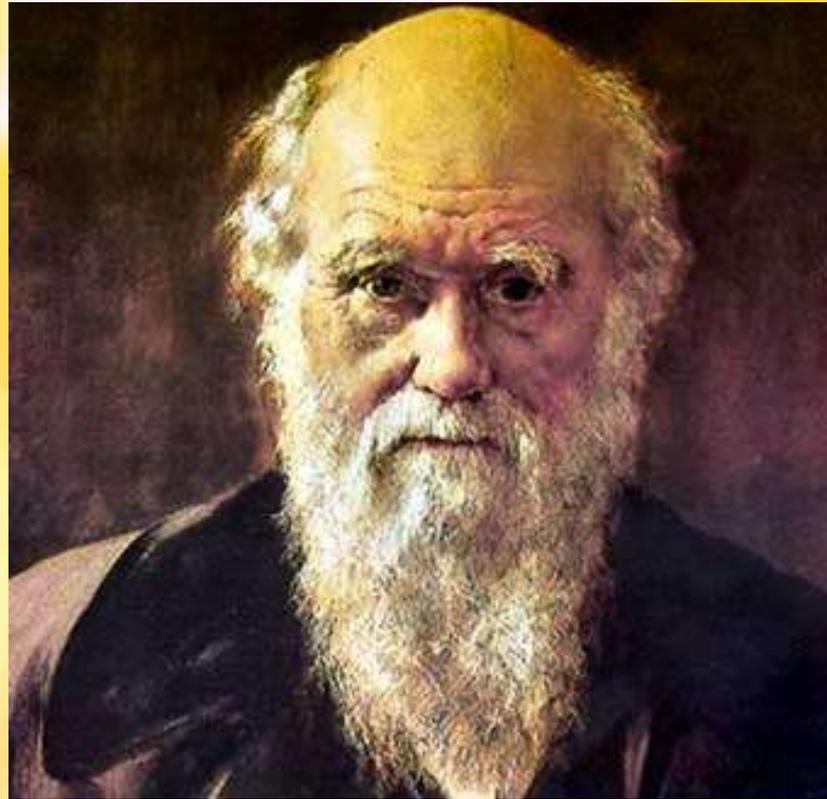
Which growth curve is exponential?



Guided Questions

- Who first suggested evolution?**
- Who first suggested creationism?**
- What's up with all this biodiversity?**

Evolution



The Darwinian View of Life

The Importance of Evolution

- **This is the most important concept we will cover**
- **Links all of biology**
- **Everything we have talked about is a product of evolution**
- **Can explain nearly everything *but* how life began**

A Disclaimer

- **I am not here to argue against anyone's religious beliefs**
- **We will focus on the ideas of evolution and the evidence for evolution- it is up to you to decide your own beliefs**
- **Natural selection and evolution are a model for explaining observations that has failed to be rejected**

Theory of Evolution

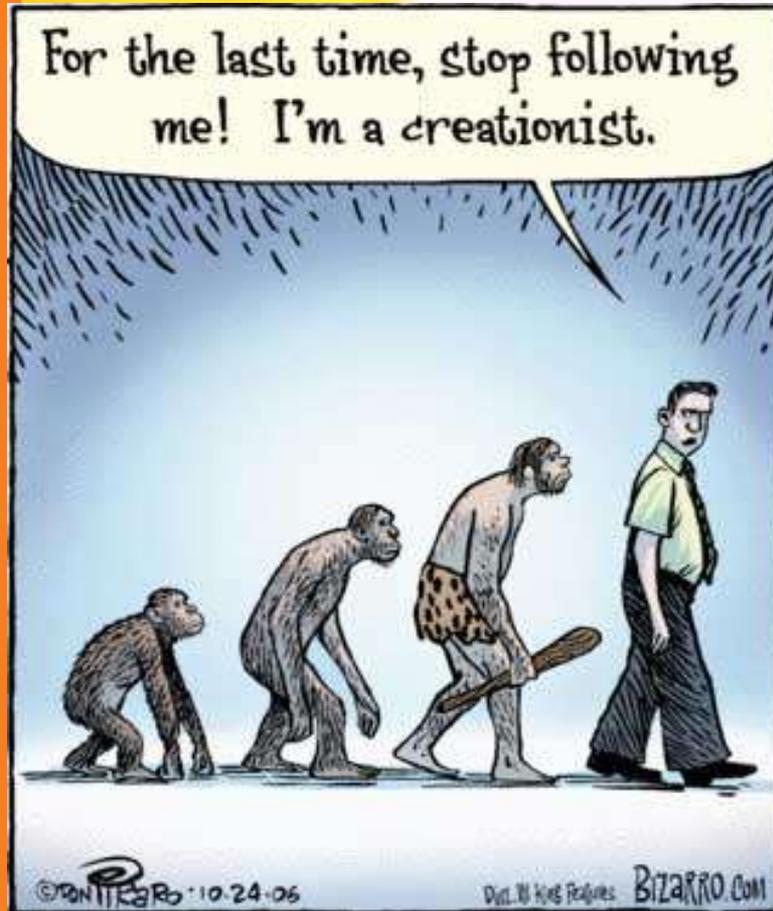
The word theory in science means:

- Hypothesis is broadly accepted worldwide**

The theory of evolution does not or was not meant to hypothesize where life began. This is where many people argue with the evolution theory.

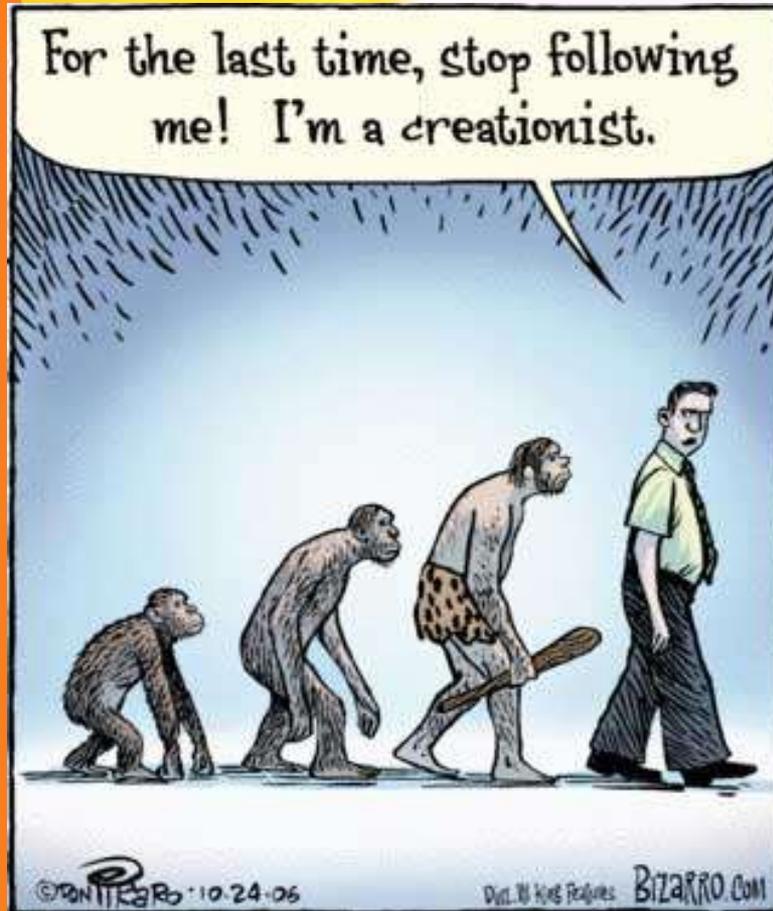
The theory of evolution hypothesizes how life on Earth is so diverse

The Western View



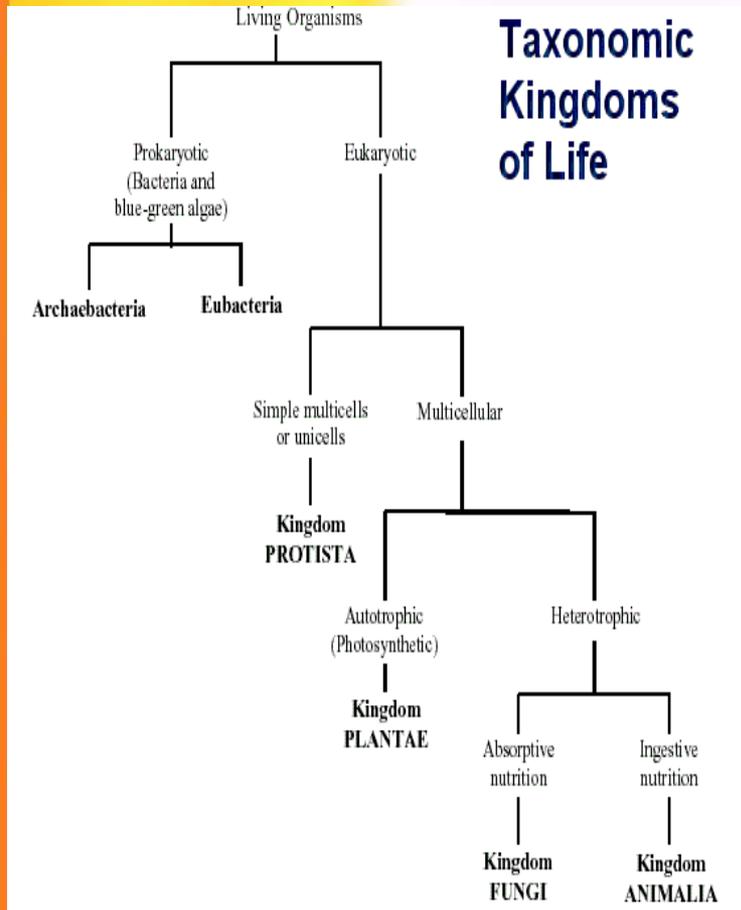
- **Plato and Aristotle viewed species as discrete, perfect and designed**
- **Fit with the Old Testament – that a Creator designed all animals and placed them on Earth**

The Western View



- Plato-saw variation as imperfections
- Aristotle- organisms are diverse and could be arranged in order of increasing complexity became the "*scala naturae*" (sequential ladder)

Linnaeus and Taxonomy



- Linnaeus (1707-1778) believed in fixity of species, but gave us **binomial nomenclature**
- Taxonomy originated before evolution
- Similar species were grouped together

The first scientist to suggest evolution...



- **Jean Baptiste Lamarck (1744-1829)**
- **Noticed similarities between fossil species and current species and linked diversity with adaptation to the environment.**

Lamarck's Theory

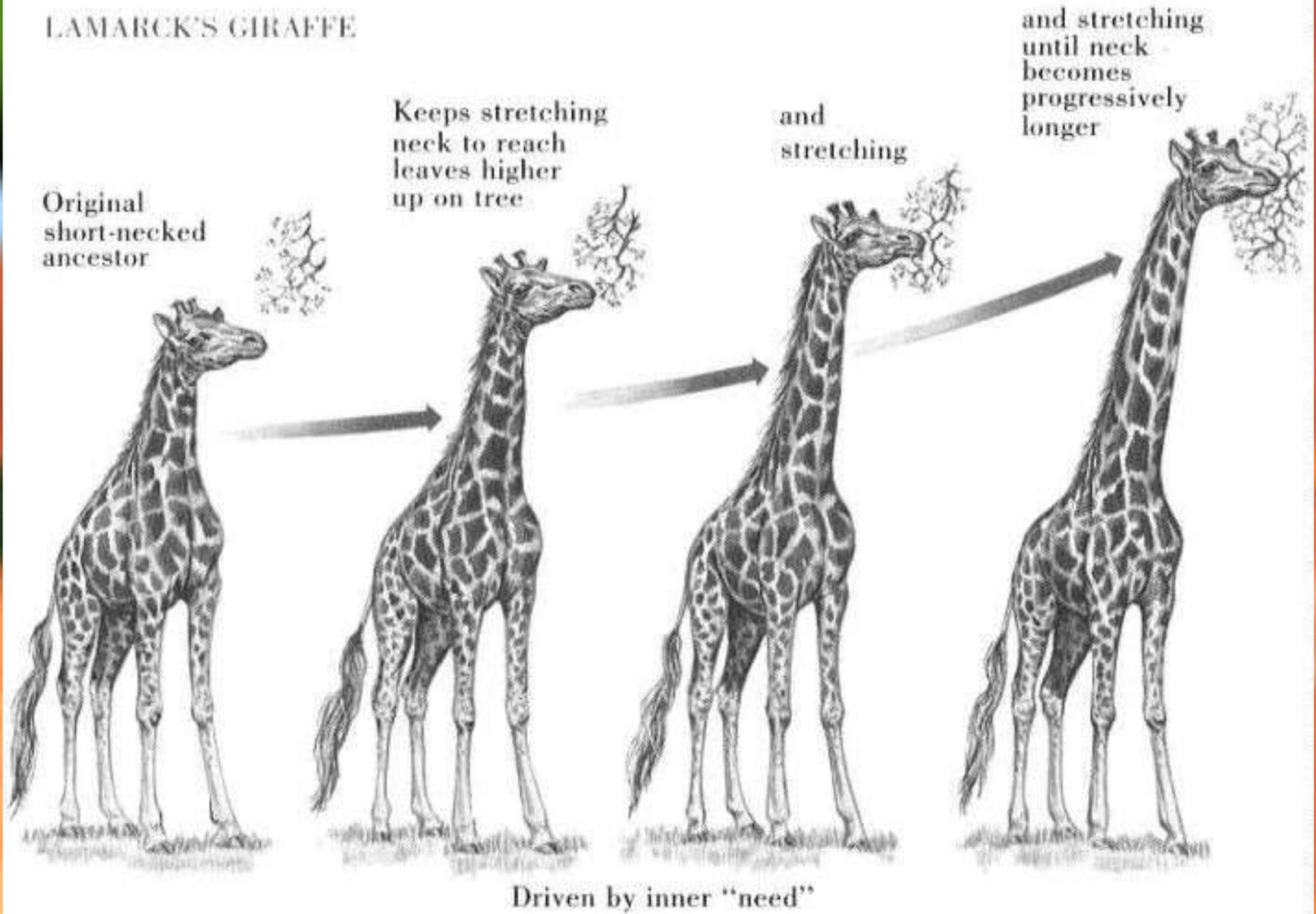
- Evolution was a natural progression towards perfection
- Organisms proceeded up a ladder from simple bacteria to complex organisms
- The parts of an organism that are used grow bigger and bigger, those that are not used disappear or diminish
- These inherited **acquired characteristics or learned behaviors** are passed on to offspring

Example using Lamarck's Giraffe



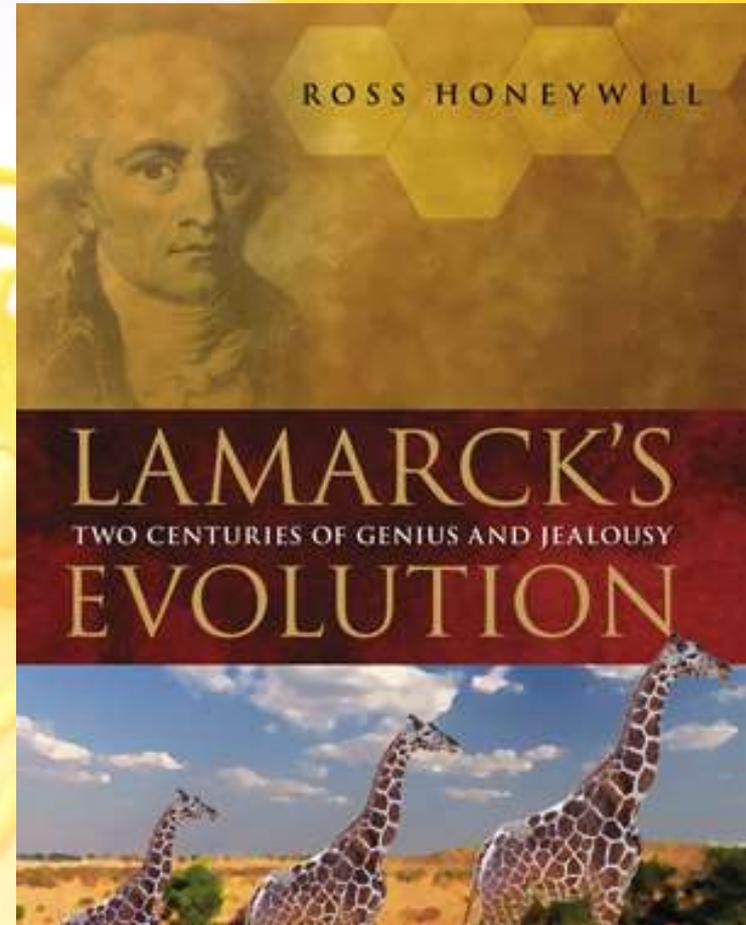
- **Each giraffe stretched, making his or her neck longer**
- **Passed that on to their offspring**
- **All necks became long**

LAMARCK'S GIRAFFE



It Was a Very Good First Guess

- Not really how it works, but important none the less
- He developed the ideas of *adaptation* and *heritability*



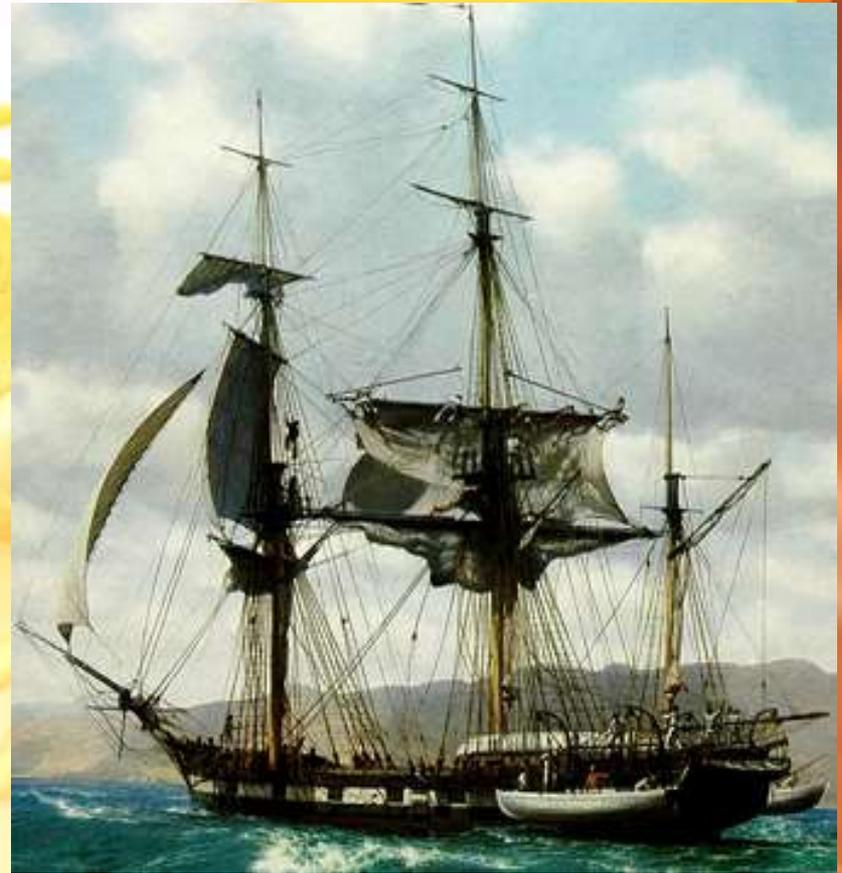
Charles Darwin



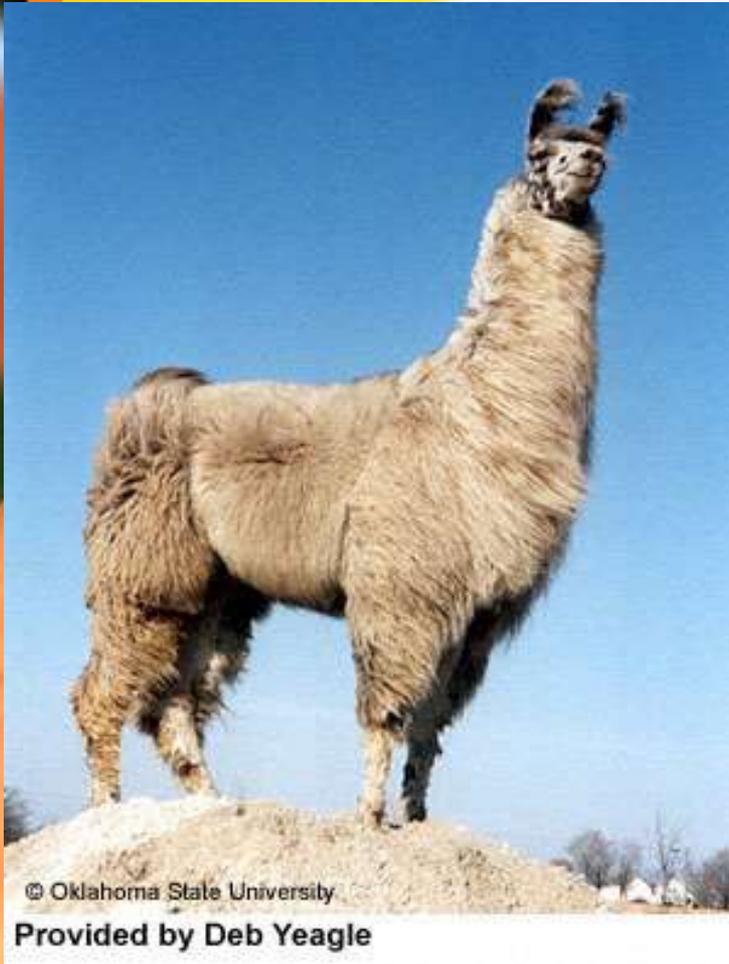
- Darwin went to Med school at 16, but dropped out
- Did what any aspiring scientist at the time would do – tried join the clergy
- A priest got him a job on the HMS Beagle

Darwin's Research on the *Beagle*

- **Traveled to South America and the Galapagos Islands off the western coast**
- **Collected plants and animals from all over the continent, gaining fame as a naturalist**



Darwin's Observations in South America aka Biogeography

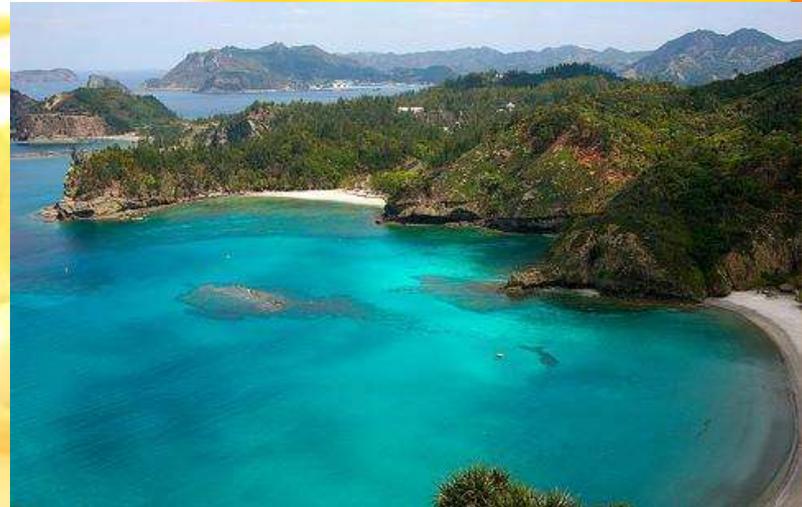


© Oklahoma State University
Provided by Deb Yeagle

- **Species in S. America were related, but distinctly different from European species from which he was familiar**
- **The fossils didn't match European fossils**
- **S. American fossils were related to S. American species, implying some sort of descent**

The Galapagos

- **Small islands off the coast of S. America**
- **Unique species that were related to mainland species**
- **The different islands had different varieties of a species**

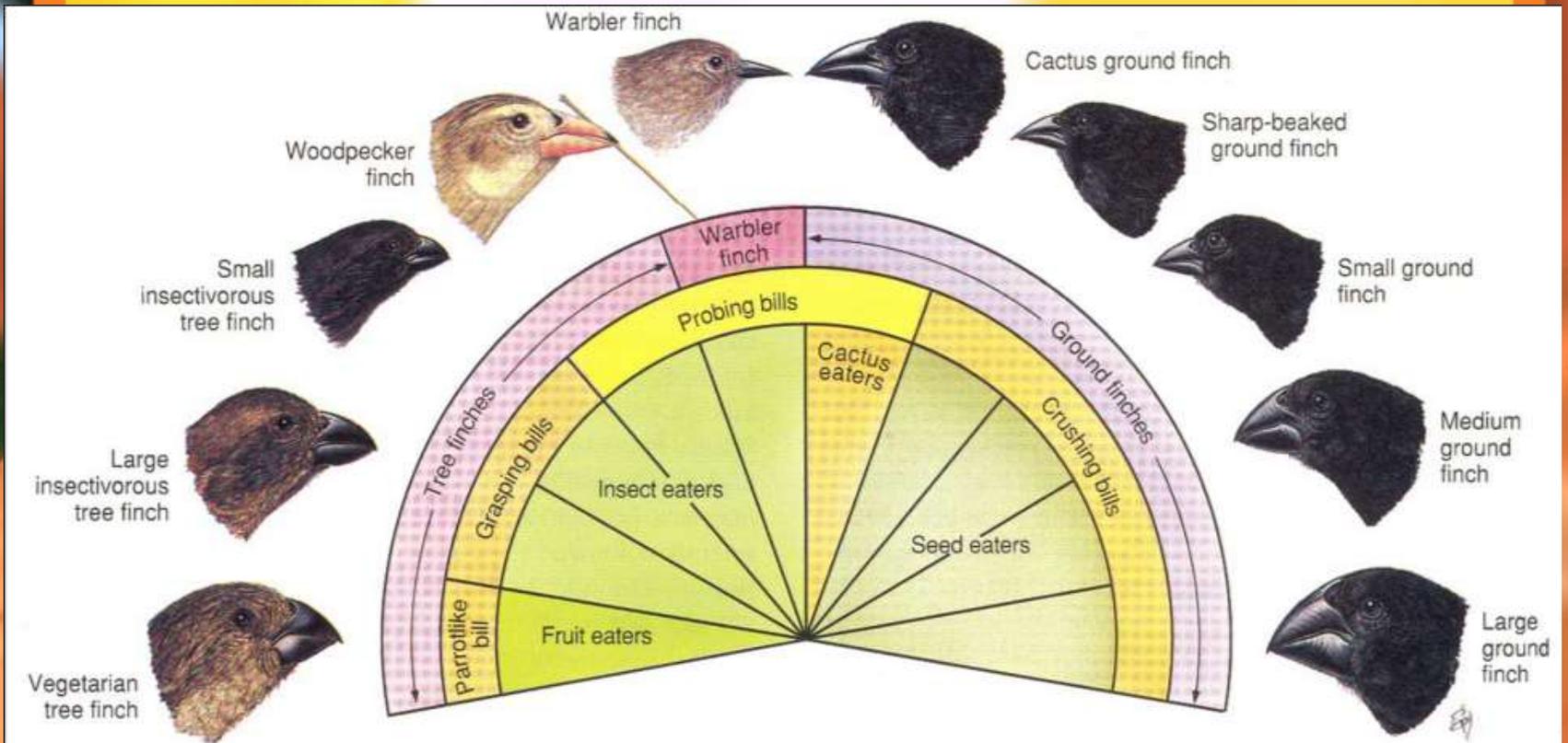


Darwin's Finches

- Darwin noticed each island had unique finches that seemed perfectly suited to its own habitat

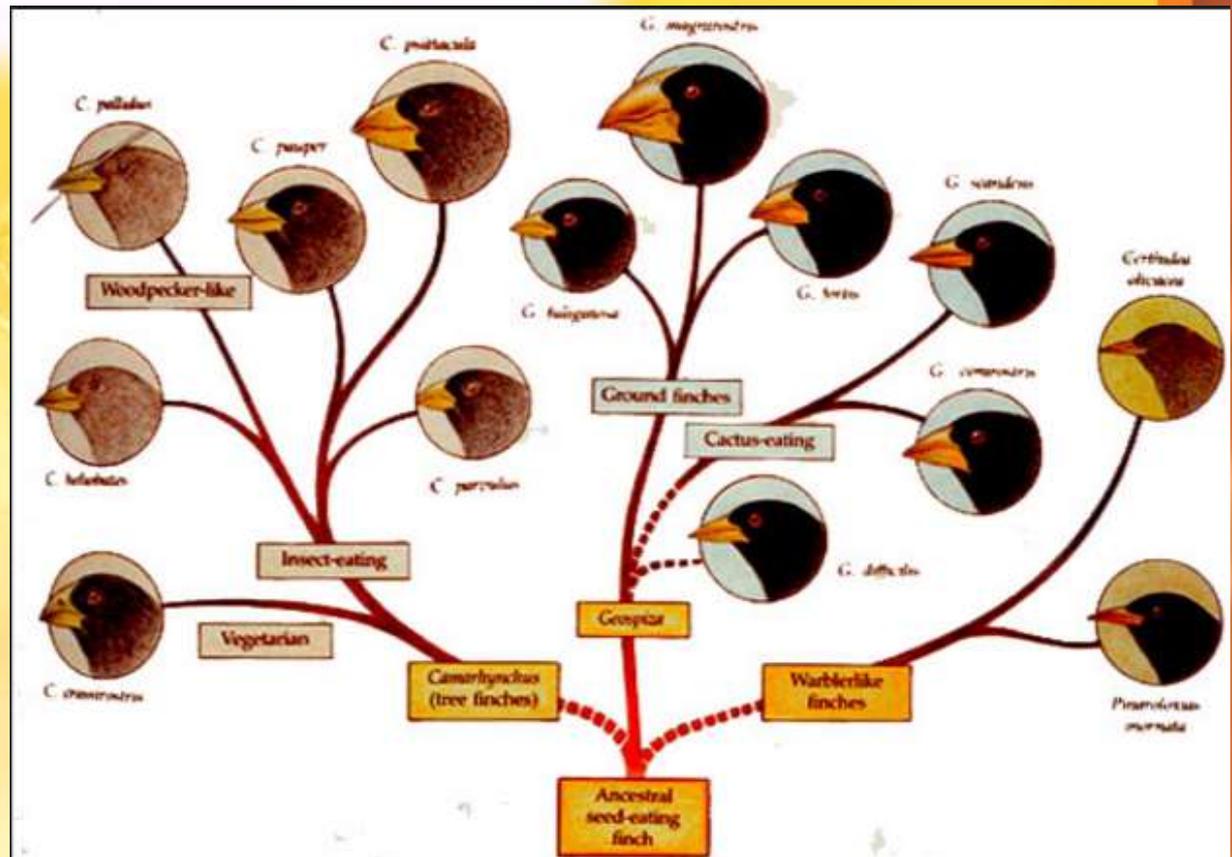


Darwin's Finches

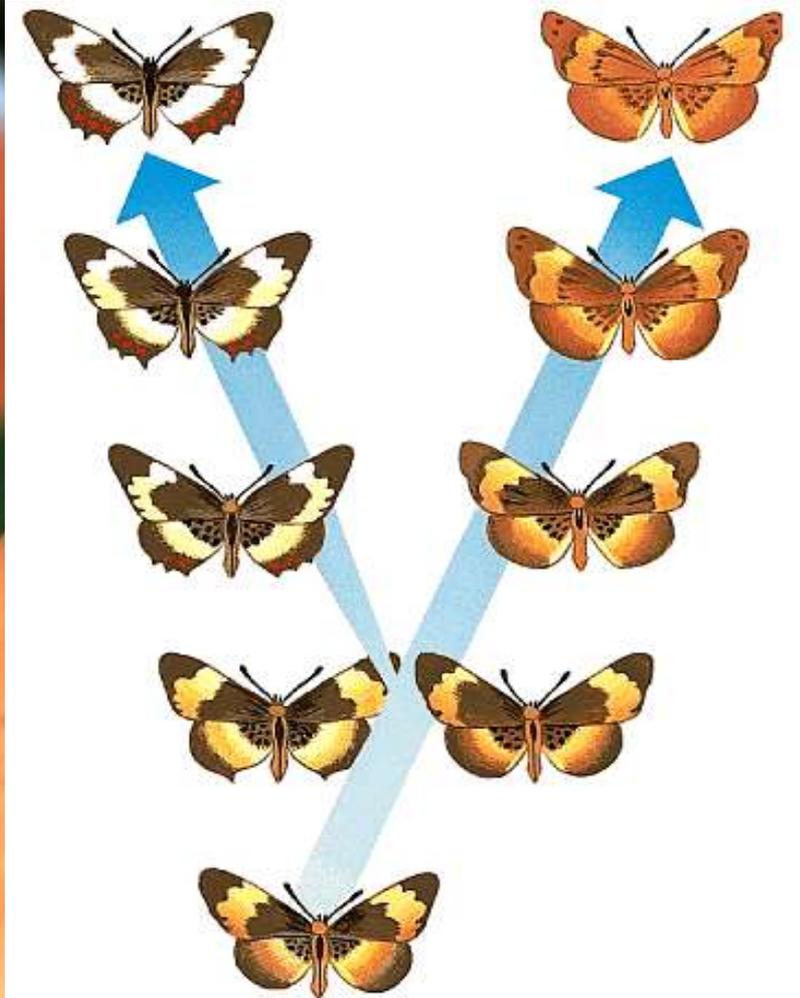


Darwin's Reasoning

- Darwin speculations:
 - Could finches have descend from mainland?
 - Island speciation?

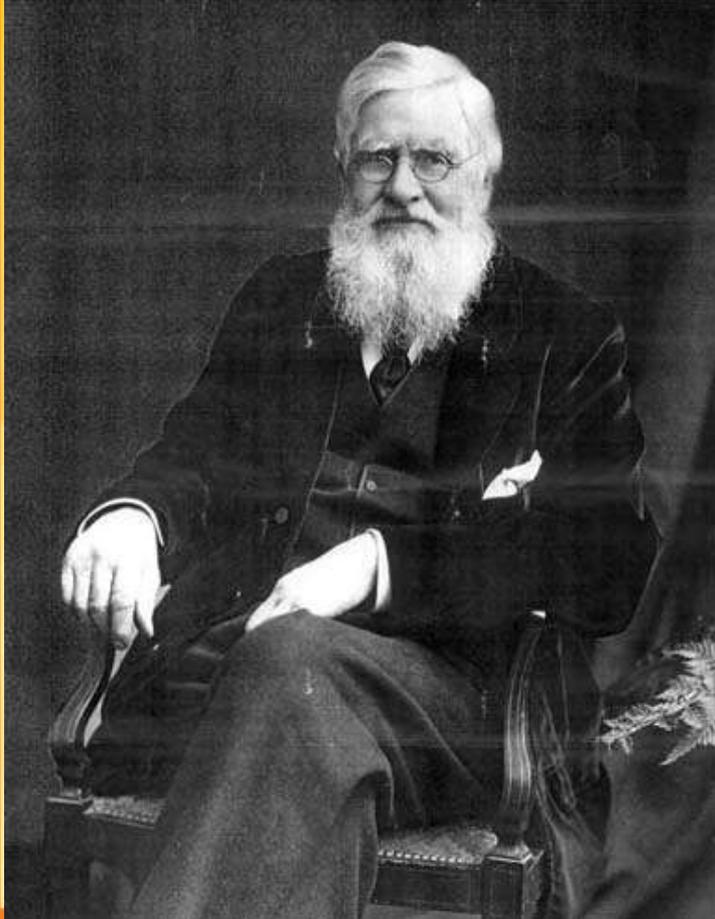


Darwin's Reasoning



• **Gradual accumulation of adaptations to an environment could lead to new species OVER LONG TIME PERIODS**

The First Published Work on Natural Selection



- Was not by Darwin!
- Alfred Wallace published first
- This led to Darwin's writing of *The Origin of Species*

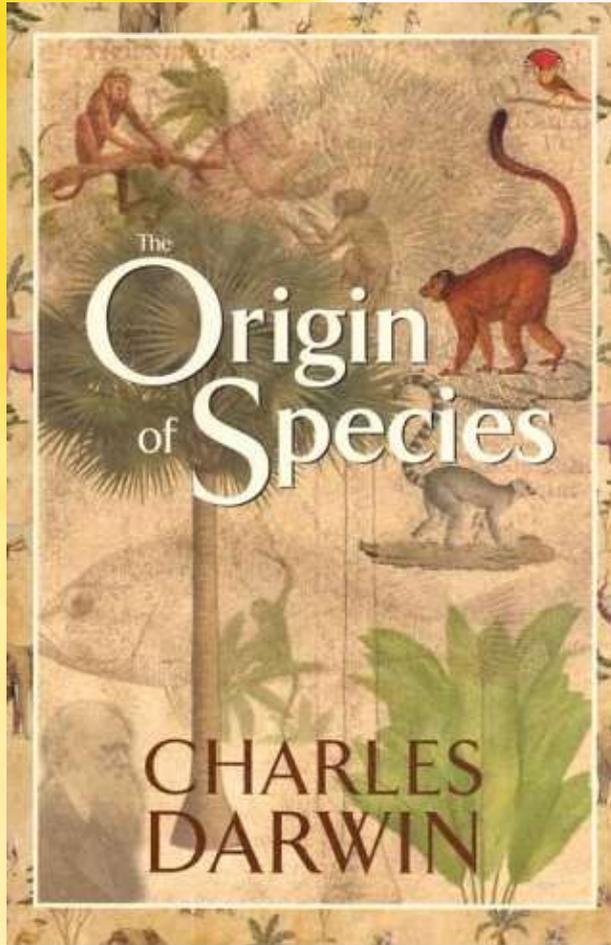
The Importance of Strong Research!

- **Evolution caught on very quickly among biologists**
- **Darwin had incredible amounts of evidence and a very logical and coherent theory**
- **He also was a well respected naturalist**
- **Darwin was much luckier than Copernicus or Galileo**
 - **The importance of strong, well documented research and showing your work!**

A Note On Theory

- **“A scientific theory is an explanation or model used to explain observations or experimental results about an observed phenomenon.”**
- **Not a haphazard guess. A theory must survive scientific scrutiny, experimentation and review. I.e. the Theory of Gravity**
- **Very different from a hypothesis**

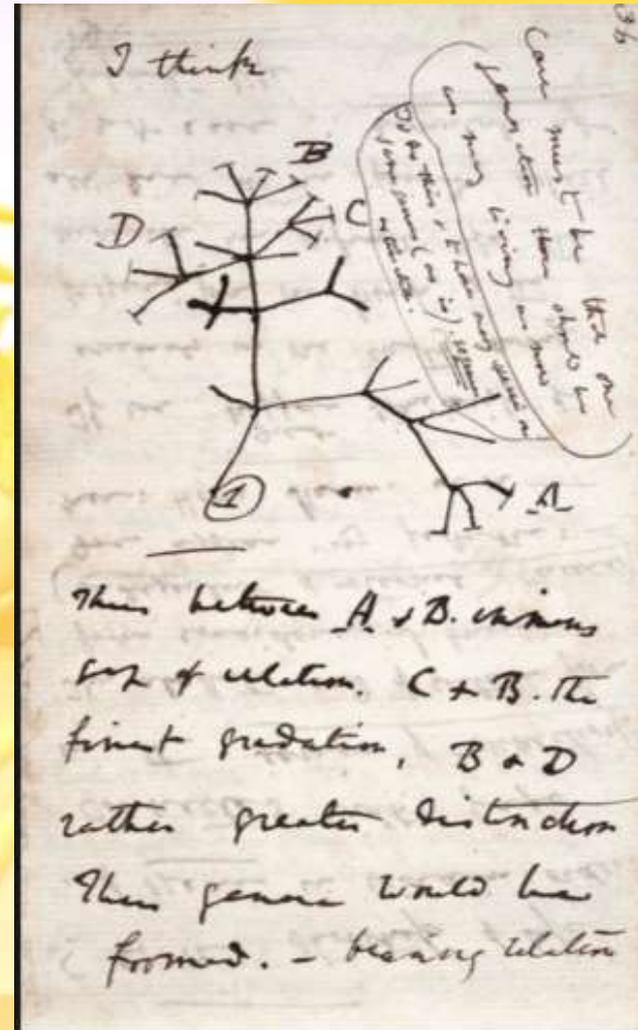
The Two Major Features of *The Origin of Species*



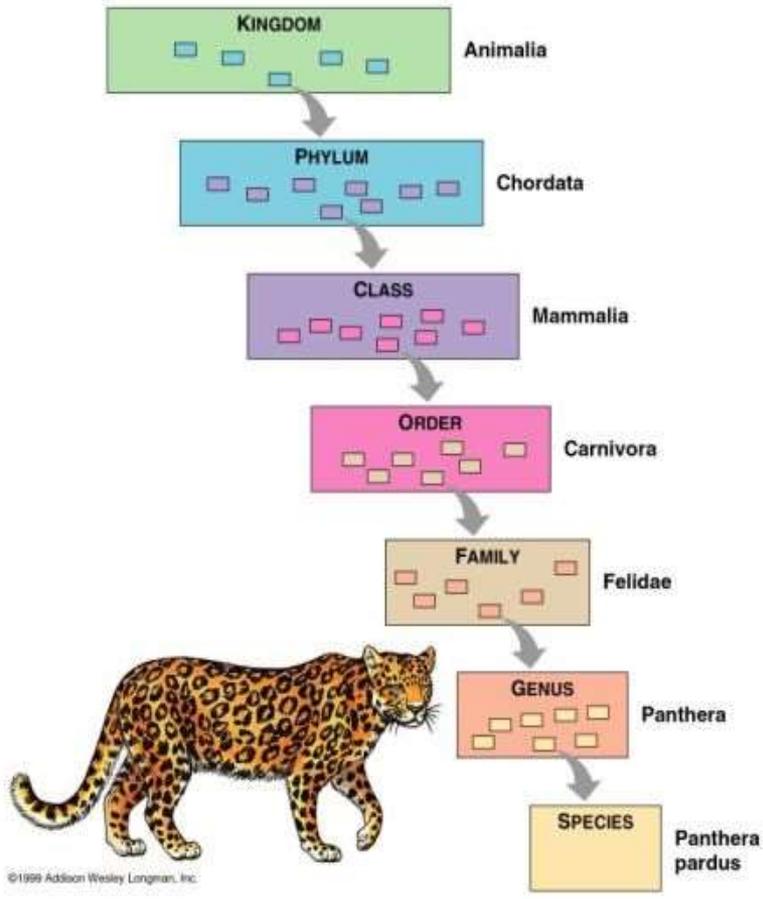
- **Descent with Modification**
- **Natural Selection as the main mechanism**

Descent with Modification

- All species originated from a single species
- Over time slight modifications in offspring lead to all of the diversity found on Earth
- The Tree of Life



Taxonomy Fit Darwin's Theory

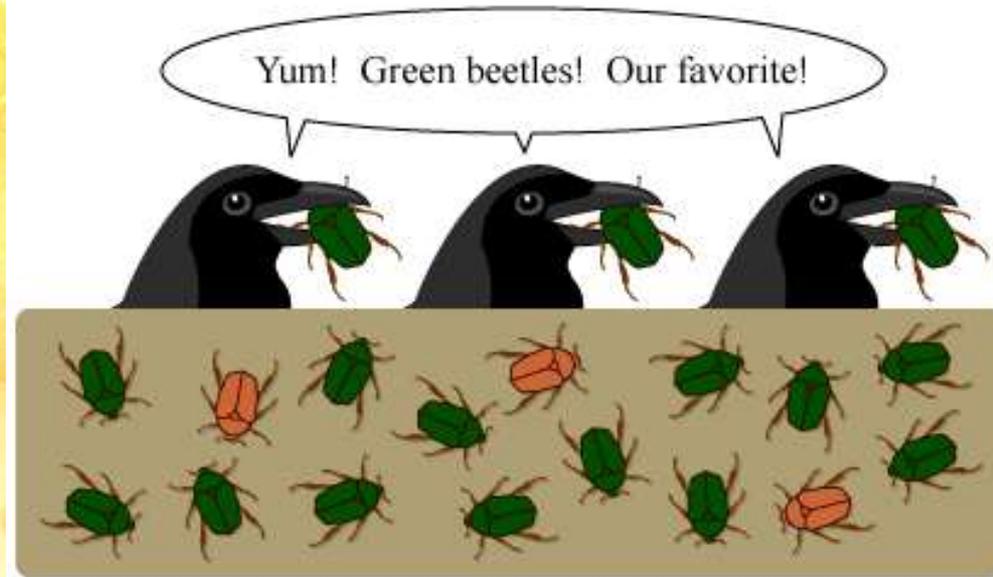


- **Unknowingly, Linnaeus' theories on taxonomy supported Darwin**
- **Organisms can be grouped based on common ancestors**
- **More similar organisms are likely to be more closely related**

Natural Selection

- Darwin's main focus – the mechanism
- In my humble opinion, the most important theory in all of science

Natural selection, in a nutshell:



Observation 1: Species would increase in population exponentially if every individual reproduced successfully

Observation 2: Populations tend to remain relatively stable

Observation 3: Resources in the environment are limited and cannot support unlimited growth

Inference 1: There is a struggle for survival and reproduction –not everyone succeeds aka competition or survival of fittest

Observation 4: Individuals within a population are slightly different and make some more enabled to survive and reproduce

Observation 5: Many of the differences are heritable

Inference 2: Survival and reproduction depends on variations of genetic traits

Inference 3: Traits that help an organisms survive and reproduce are more likely to become common in the population.

NATURE “SELECTS” WHICH GENES/TRAITS BECOME COMMON

My Quick Version

Everyone Wants to Reproduce (fitness)

They Don't

They Can't

There is competition

Everyone is different

The differences are genetic

Survival (and reproduction) depends on genes

Adaptive genes survive and become common

Natural Selection Summarized



- Traits that help organisms survive and reproduce become more common
- Thus the population changes over time

NOTE

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www.CartoonStock.com
WORLD OF COW
By Stik



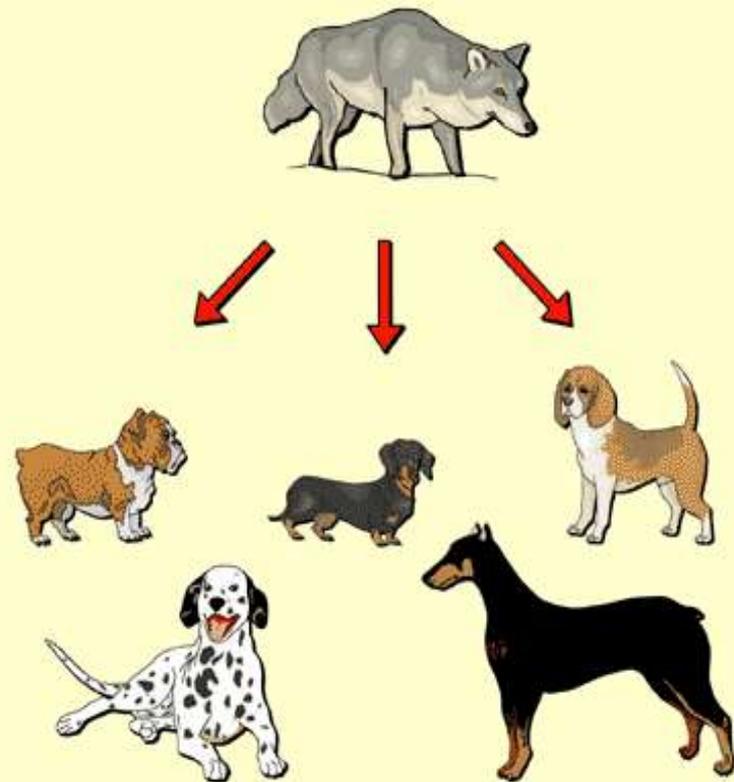
- **ONLY** traits that help survival or reproduction
- **NOT** helpful traits or convenient traits
- **ONLY** acts on traits that are already present

Darwin vs. Lamarck

- 
- **Darwin**
 - **Adaptation to specific environment**
 - **Only heritable traits**
 - **Natural selection (short giraffes don't make as many babies)**
 - **Lamarck**
 - **Progression towards perfection**
 - **Acquired characteristics**
 - **Inner drive by the organism (i.e. giraffe stretches to reach tree)**

Artificial Selection

- We've seen this happen with dog breeding
- It seems reasonable that natural selection can change species over a longer period



Darwin saw Natural Selection as Slow and Gradual

- **Over many thousands of generations small changes lead to significant evolution**
- **Evolution takes millions of years and is constant – species are always evolving at a steady rate**
- **Most debated part of evolution**

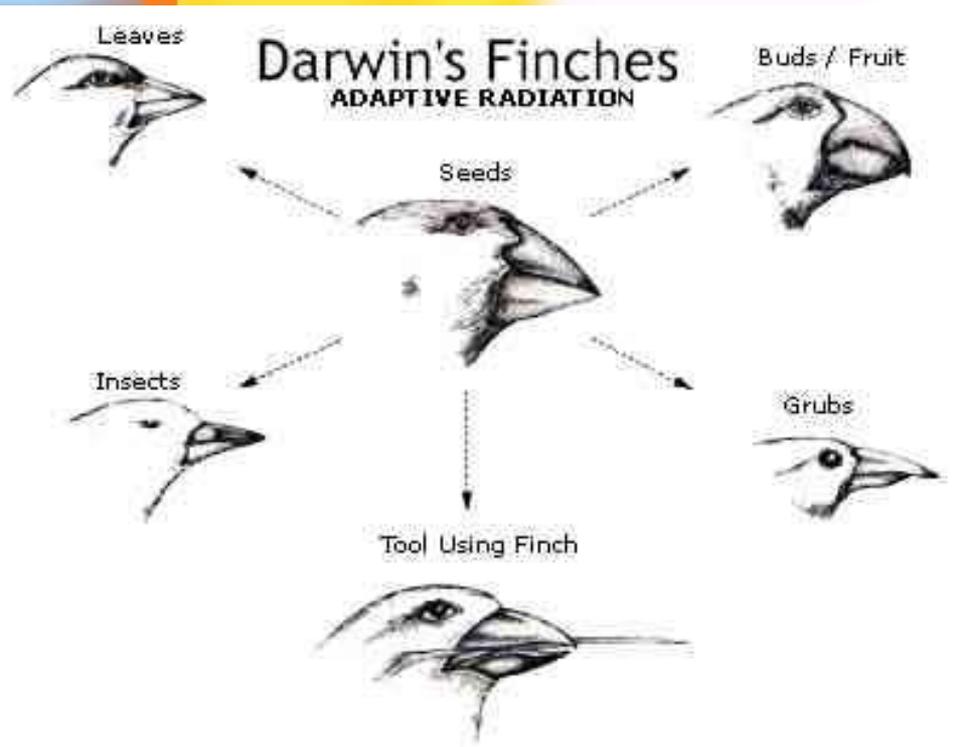
Subtleties of Natural Selection

- **Does not create new traits**
- **Only heritable traits become common**
- **It's not about individuals trying to survive**



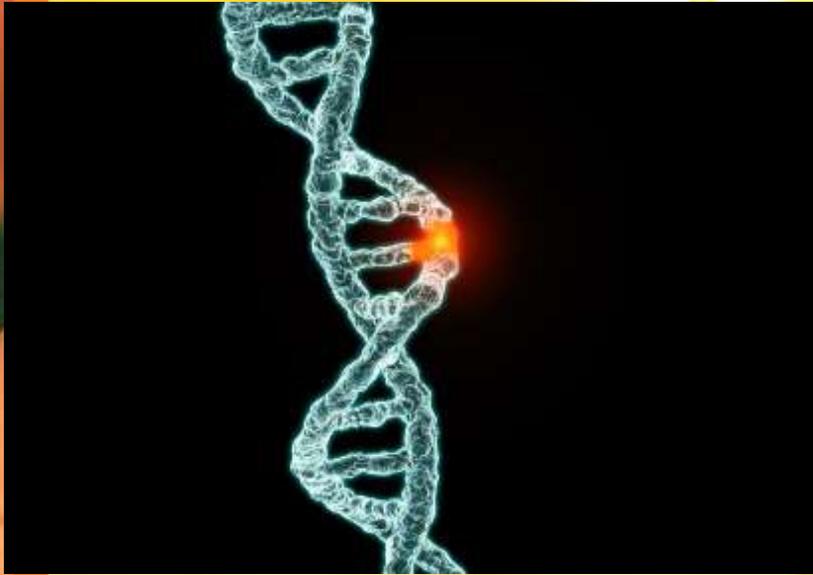
Natural selection does not grant organisms what they "need".

Ex. Natural Selection in Darwin's Finches



- Different beaks are suited for different types of seed
- Each beak type became common in an area where those seeds were found
- Natural selection didn't create the beaks

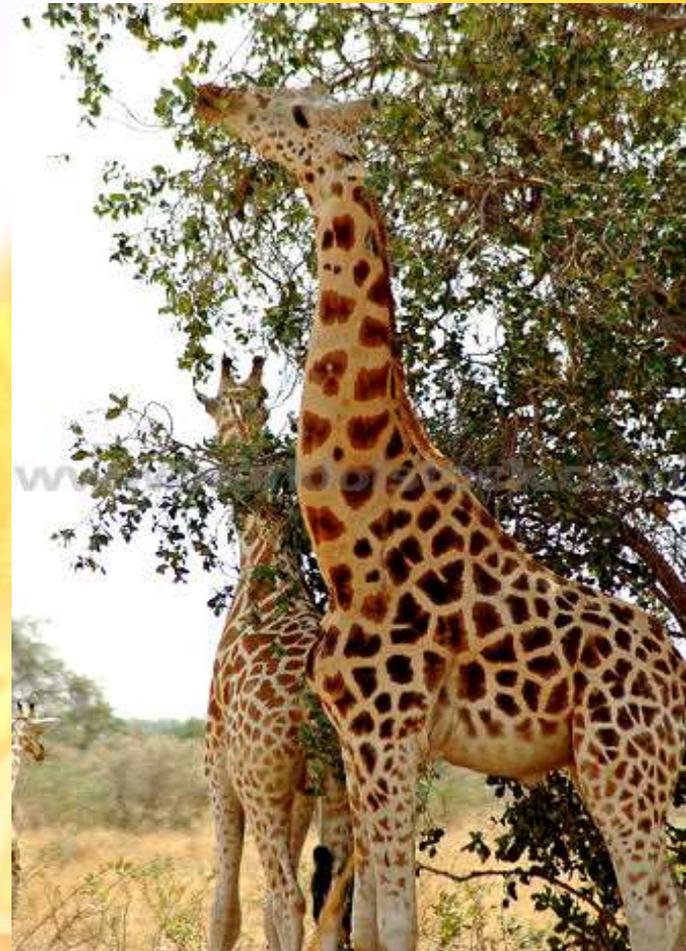
Where Do New Traits Come From?



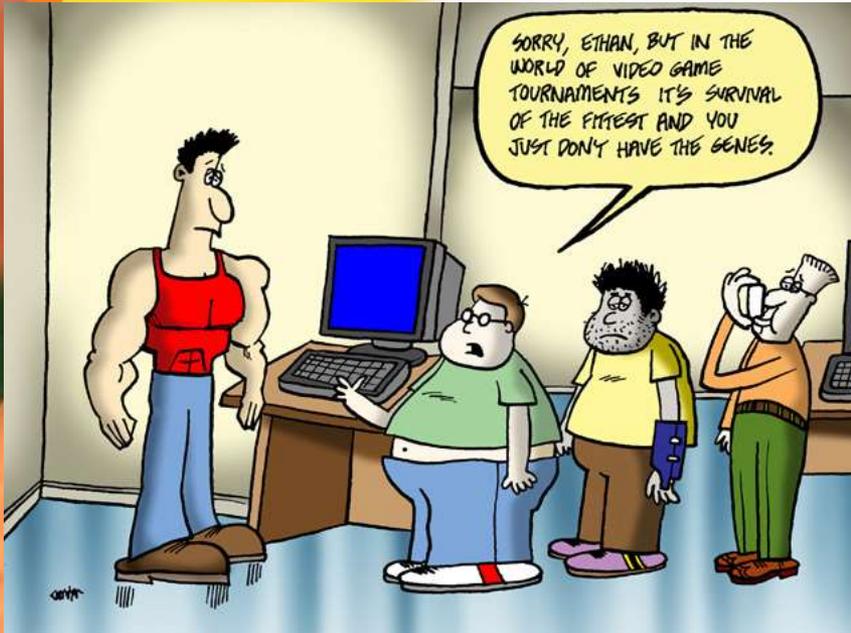
- **Mutations!**
- **Spontaneous accidental changes in an organism's DNA**
- **Very rarely beneficial, but does occur**
- **Or new combinations of existing genes**

Natural Selection is Well-Documented

- There is very little scientific debate that natural selection occurs
- The questions are more on how quickly it occurs and if other mechanisms can cause evolution



Survival of the Fittest?



- “Fit” means most capable of reproduction
- Does not mean bigger, stronger, faster, smarter
- Survival of the most fit *genes/traits*

RAFT Assignment

Role: Charles Darwin

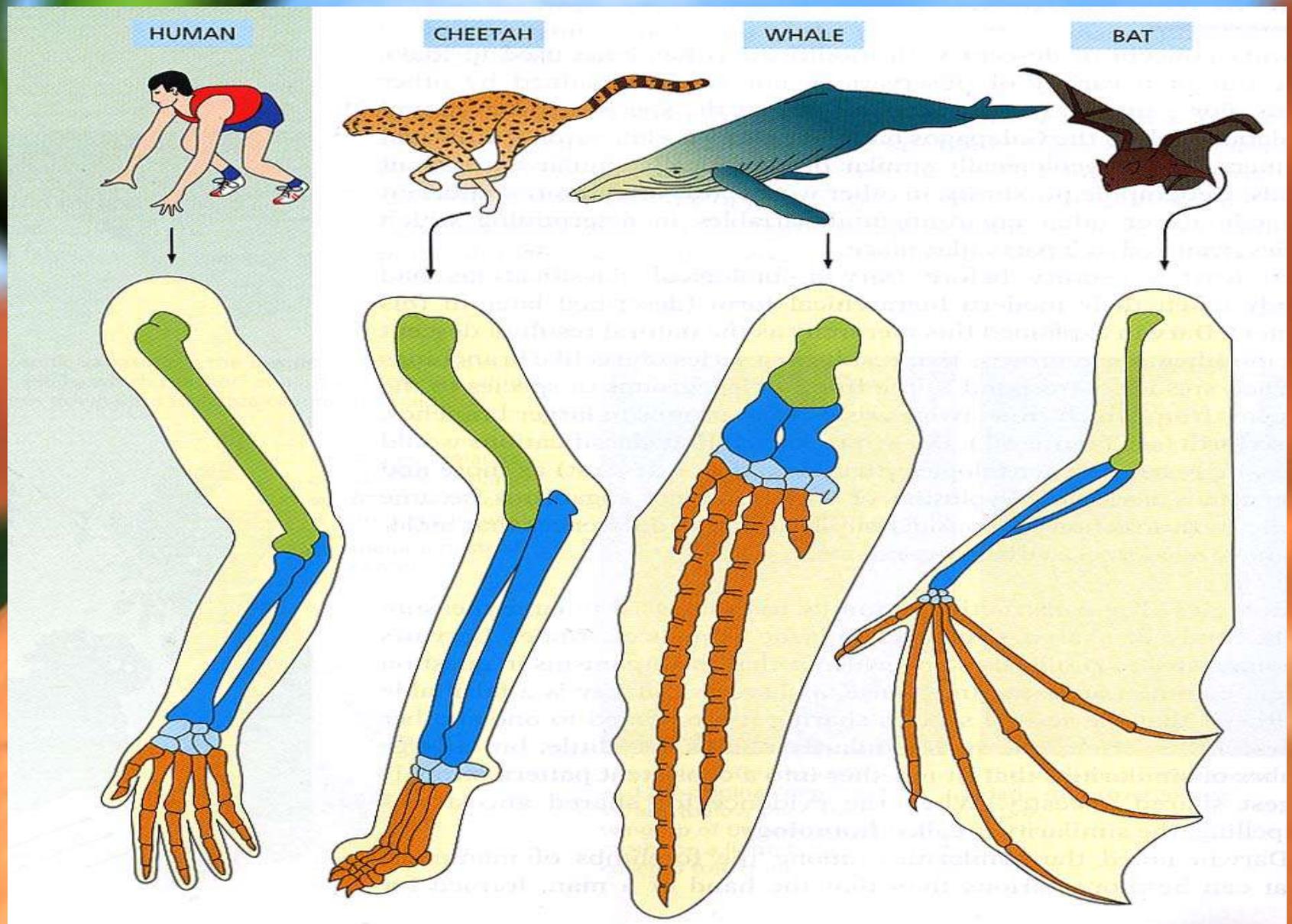
Audience: Jean Baptiste Lamarck

Format: You decide (letter, song, poem, tweet, comic, interpretive dance, video etc.)

Topic: Correcting Lamarck on his theory of evolution. In the process thoroughly explain natural selection and descent with modification

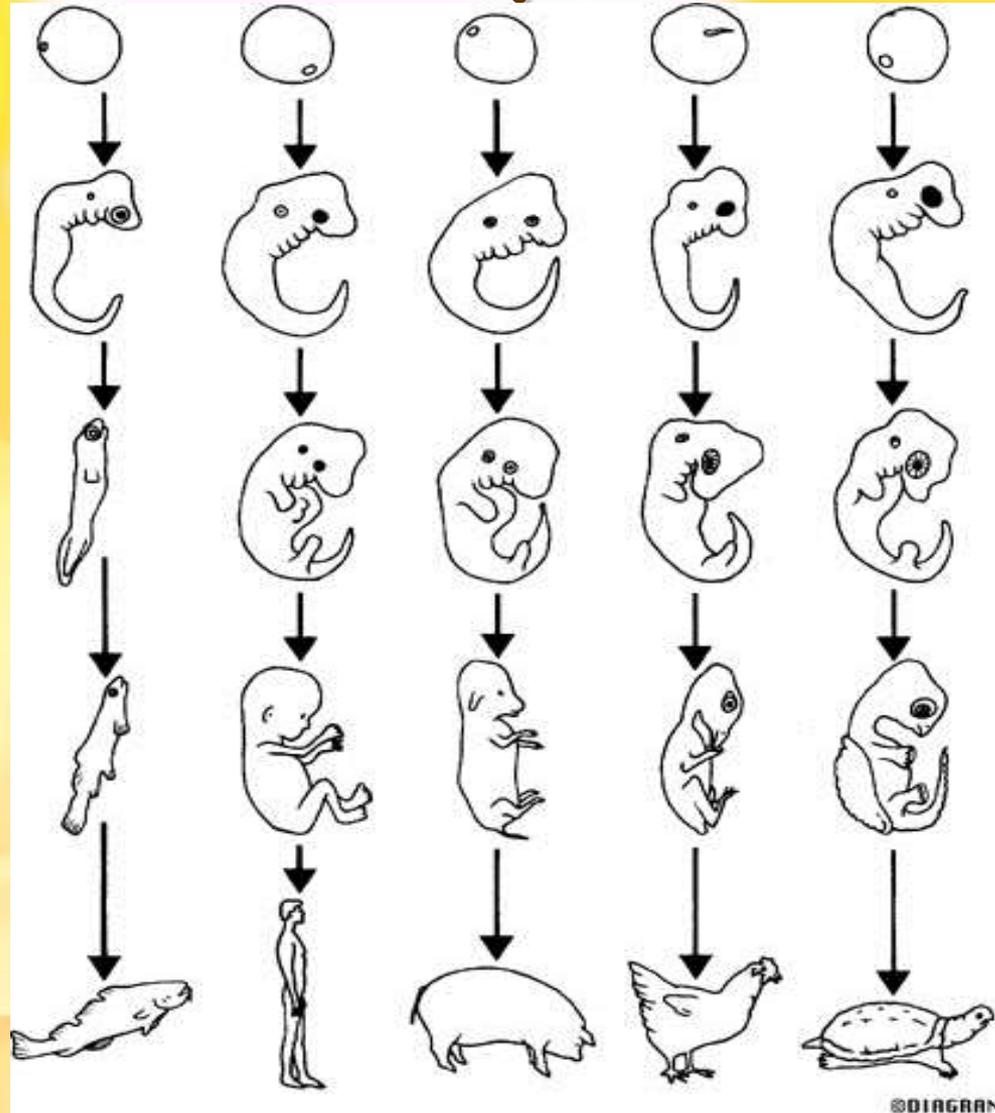
Basis for Modern Taxonomy

- **Homologous structures** (same structure, different function)
- **Similar embryo development**
- **Molecular Similarity in *DNA*, *RNA*, or *amino acid* sequence of Proteins**



Homologous Structures (BONES in the FORELIMBS) shows Similarities in mammals.

Similarities in Vertebrate Embryos



©DIAGRAM

Classification



Species of Organisms

- There are **1.3 million** known species of organisms
- This is **only 5% of all** organisms that ever lived!!!!
- **New organisms** are still being found and identified

What is Classification?

Classification is the arrangement of organisms into orderly **groups** based on their **similarities**

Classification is also known as **taxonomy**

Taxonomists are scientists that identify & name organisms

Benefits of Classifying

- **Accurately & uniformly** names organisms
- Prevents **misnomers** such as starfish & jellyfish that aren't really fish
- Uses **same language (Latin or some Greek)** for all names



Sea "horse"??

Confusion in Using Different Languages for Names

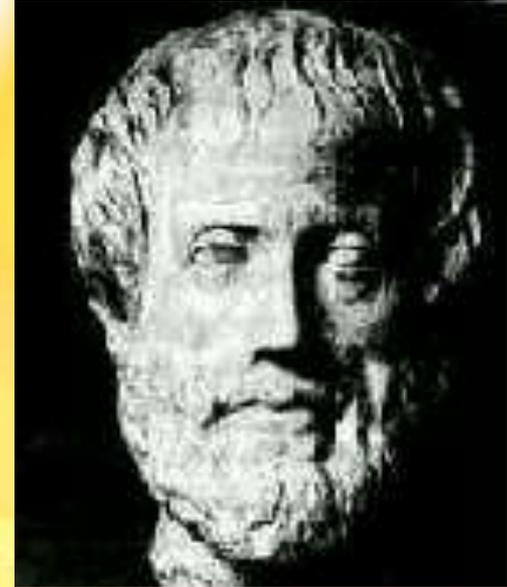


Latin Names are Understood by all Taxonomists



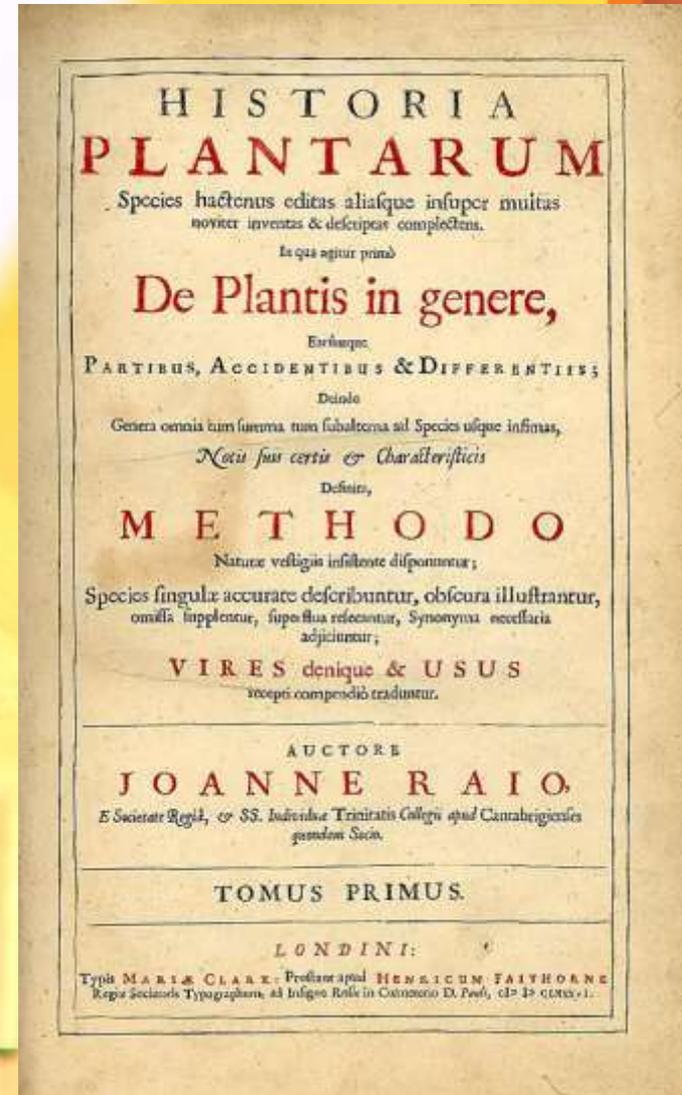
Early Taxonomists

- 2000 years ago, **Aristotle** was the first taxonomist
- Aristotle divided organisms into **plants & animals**
- He **subdivided** them by their **habitat** --- land, sea, or air dwellers



Early Taxonomists

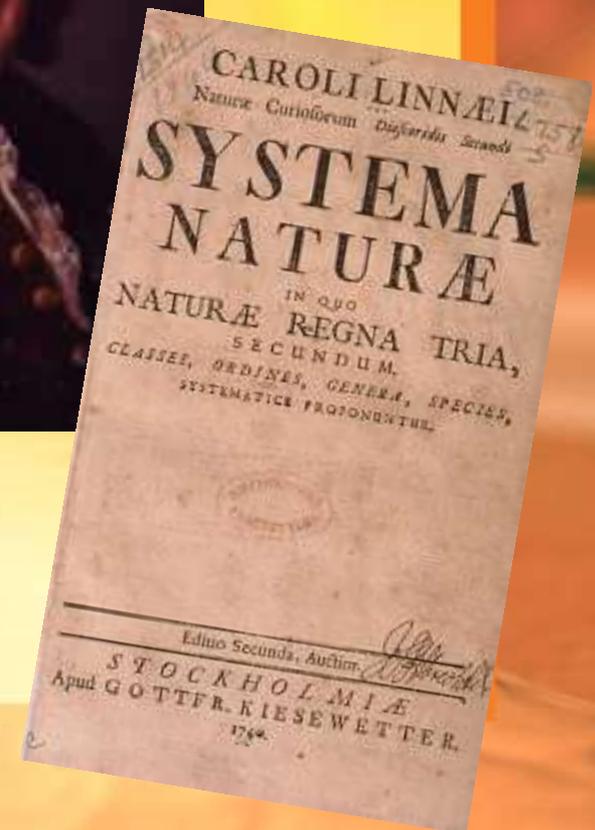
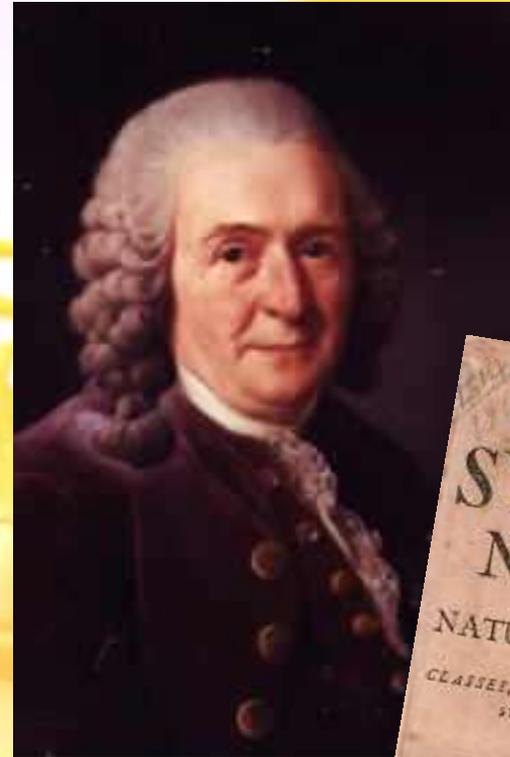
- John Ray, a botanist, was the first to use Latin for naming
- His names were very long descriptions telling everything about the plant



Carolus Linnaeus

1707 - 1778

- 18th century taxonomist
- Classified organisms by their structure
- Developed naming system still used today



Carolus Linnaeus

- Called the “Father of Taxonomy”
- Developed the modern system of naming known as binomial nomenclature
- Two-word name (Genus & species)

Standardized Naming

- Binomial nomenclature used
- *Genus species*
- Latin or Greek
- Italicized in print
- Capitalize genus, but NOT species
- Underline when writing

Turdus migratorius



American Robin

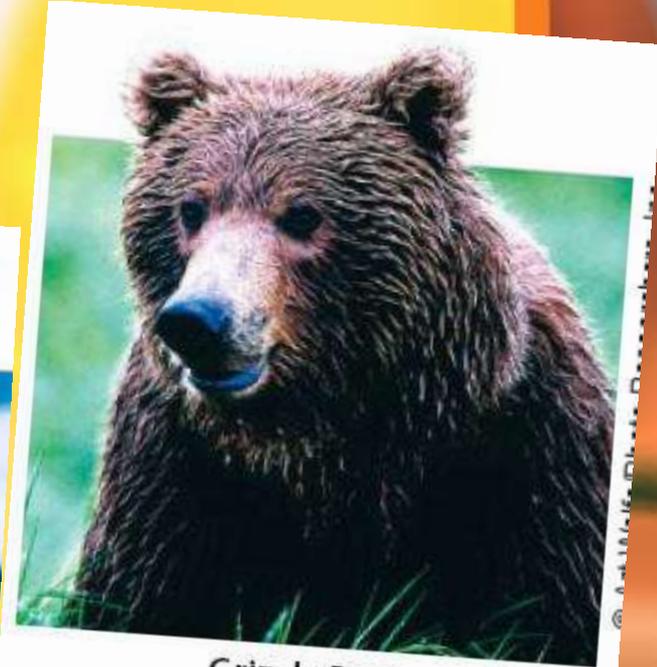
Binomial Nomenclature



Giant Panda
Ailuropoda melanoleuca



Polar Bear
Ursus maritimus



Grizzly Bear
Ursus arctos

Which TWO are more closely related?

Rules for Naming Organisms

- The *International Code for Binomial Nomenclature* contains the rules for naming organisms
- All names must be approved by *International Naming Congresses* (International Zoological Congress)
- This prevents duplicated names

Classification Groups

- **Taxon** (**taxa**-plural) is a category into which related organisms are placed
- There is a **hierarchy** of groups (taxa) from broadest to most specific
- **Domain, Kingdom, Phylum, Class, Order, Family, *Genus, species***

Hierarchy-Taxonomic Groups

Domain ← BROADEST TAXON

Kingdom

Phylum (Division - used for plants)

Class

Order

Family

Genus

Species ← Most Specific

Grizzly bear Black bear Giant panda Red fox Abert squirrel Coral snake Sea star



KINGDOM Animalia

Dumb
King



PHYLUM Chordata

Phillip



CLASS Mammalia

Came



ORDER Carnivora

Over



FAMILY Ursidae

For



GENUS Ursus

Good



SPECIES *Ursus arctos*

Spaghetti

Table 1.1 Classification of Humans

Classification Category	Characteristics
Domain Eukarya	Cells with nuclei
Kingdom Animalia	Multicellular, motile, ingestion of food
Phylum Chordata	Dorsal supporting rod and nerve cord
Class Mammalia	Hair, mammary glands
Order Primates	Adapted to climb trees
Family Hominidae	Adapted to walk erect
Genus <i>Homo</i>	Large brain, tool use
Species <i>Homo sapiens</i> *	Body proportions of modern humans

Each time we move
 Down a classification
 level notice how the
 characteristics
 (synapomorphies) get
 more and more
 specific

Domains

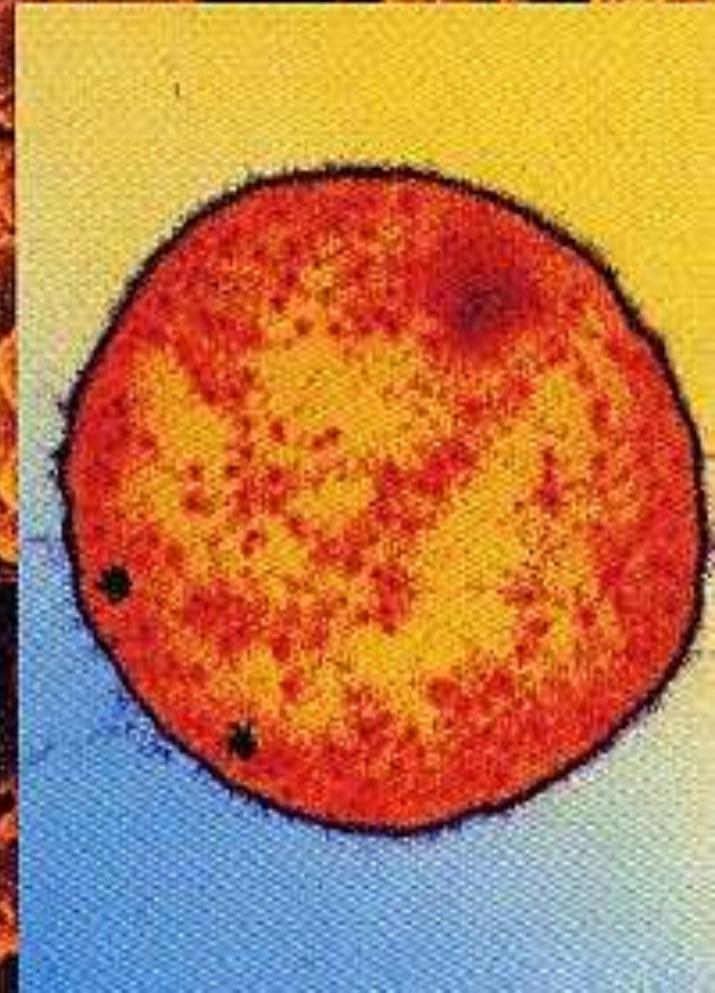
- **Broadest**, most inclusive taxon
- **Three** domains
- **Archaea and Bacteria** are unicellular prokaryotes (no nucleus or membrane-bound organelles)
- **Eukarya** are more complex and have a nucleus and membrane-bound organelles

ARCHAEA

- Kingdom - ARCHAEOBACTERIA
- Probably the 1st cells to evolve
- Live in HARSH environments
- Found in:
 - Sewage Treatment Plants (Methanogens)
 - Thermal or Volcanic Vents (Thermophiles)
 - Hot Springs or Geysers that are acid
 - Very salty water (Dead Sea; Great Salt Lake) - Halophiles

ARCHAEAN

Methanosarcina mazei, an archaean

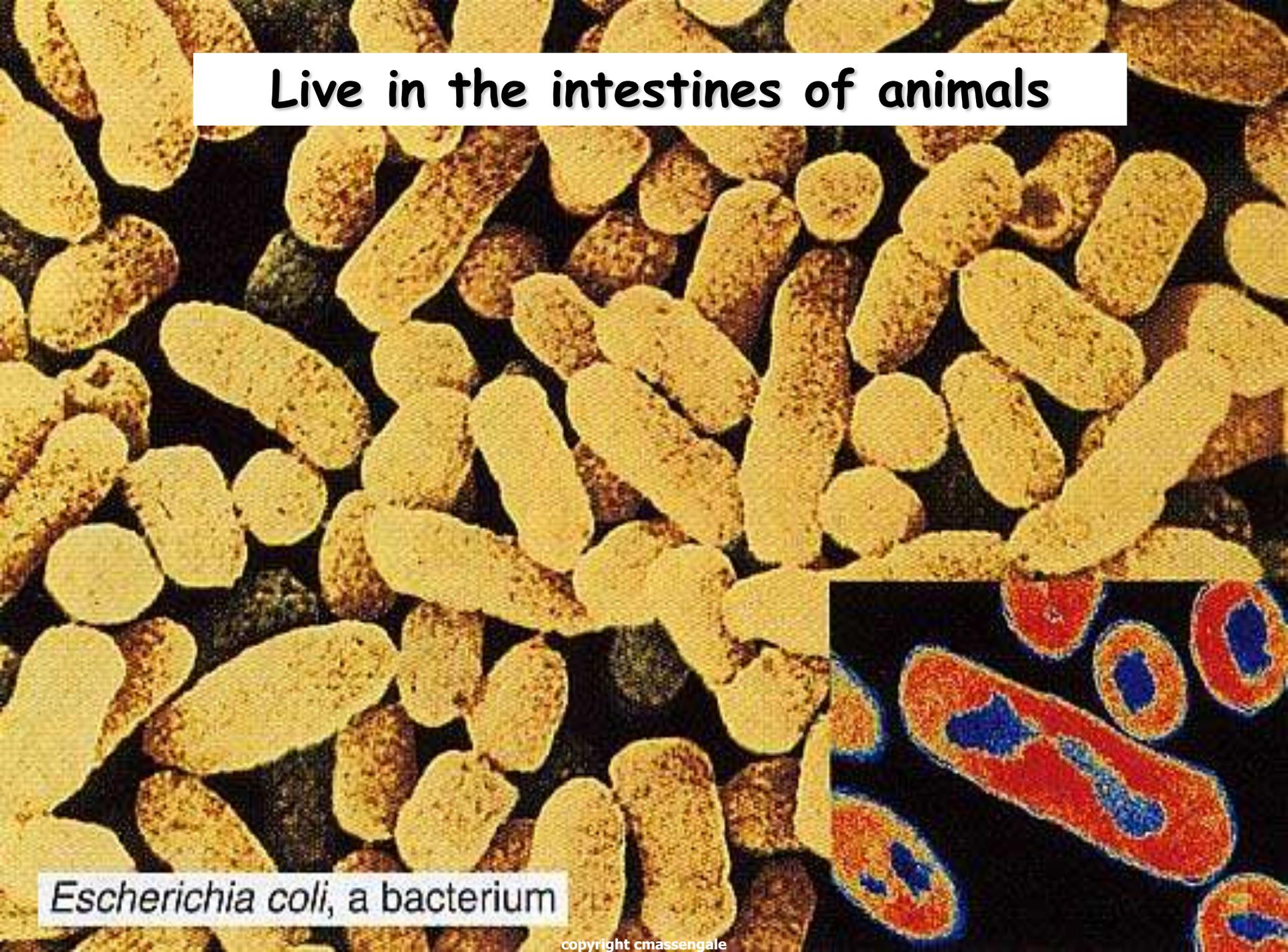


BACTERIA

- Kingdom - EUBACTERIA
- Some may cause DISEASE
- Found in ALL HABITATS except harsh ones
- Important decomposers for environment
- Commercially important in making cottage cheese, yogurt, buttermilk, etc.

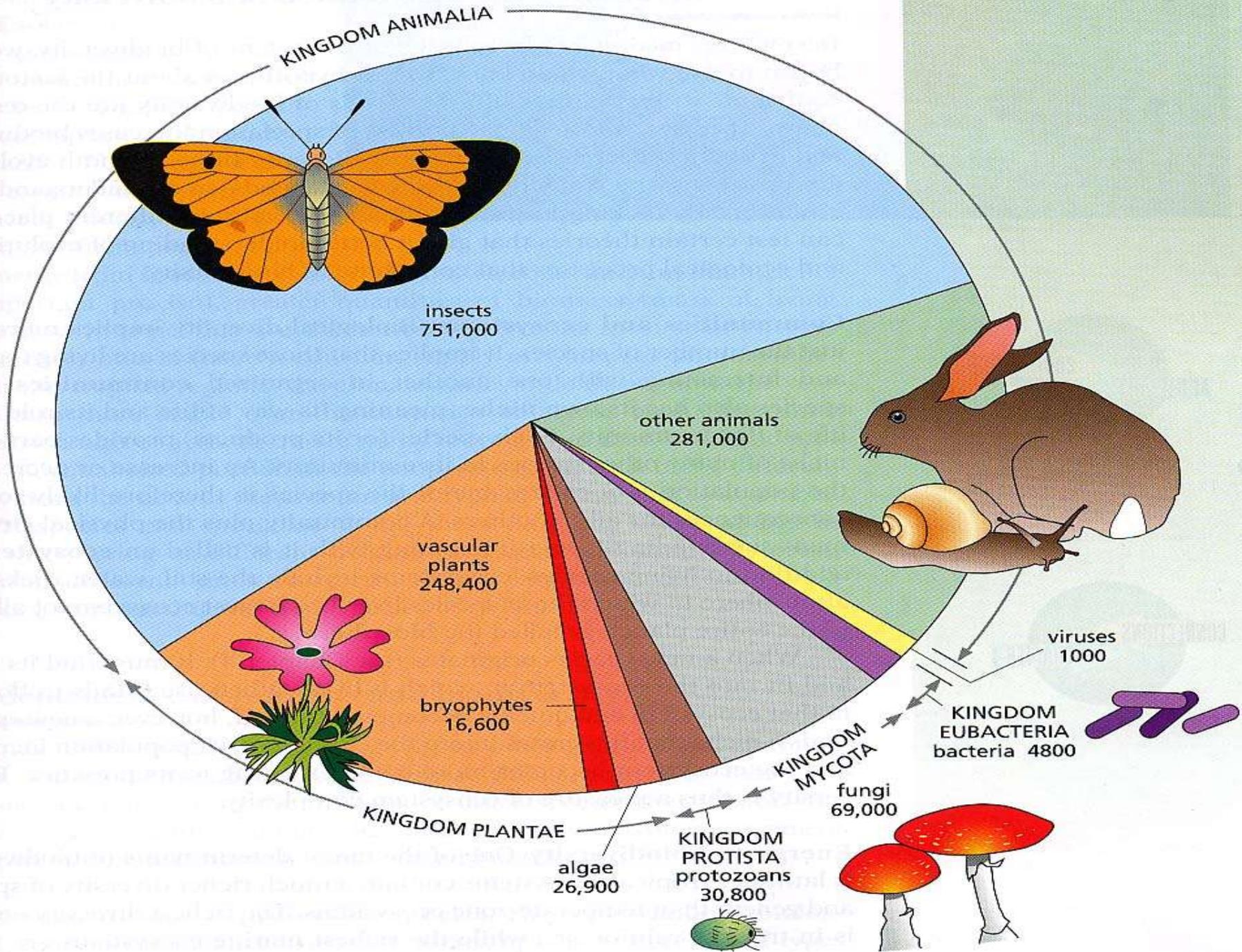
Live in the intestines of animals

Escherichia coli, a bacterium



Domain Eukarya is Divided into Kingdoms

- **Protista** (protozoans, algae...)
- **Fungi** (mushrooms, yeasts ...)
- **Plantae** (multicellular plants)
- **Animalia** (multicellular animals)



Protista

- Most are unicellular
- Some are multicellular
- Some are autotrophic, while others are heterotrophic
- Aquatic



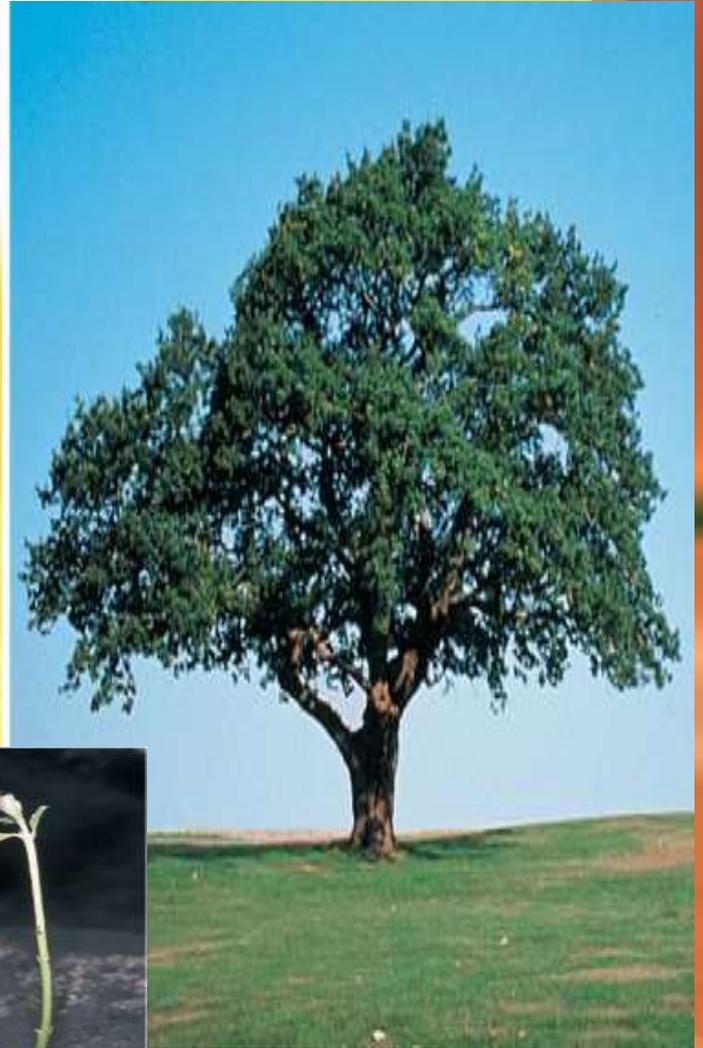
Fungi

- Multicellular, except yeast
- Absorptive heterotrophs (digest food outside their body & then absorb it)
- Cell walls made of **chitin**



Plantae

- Multicellular
- Autotrophic
- Absorb sunlight to make glucose - Photosynthesis
- Cell walls made of cellulose



Animalia

- Multicellular
- **Ingestive heterotrophs** (consume food & digest it inside their bodies)
- Feed on **plants** or **animals**

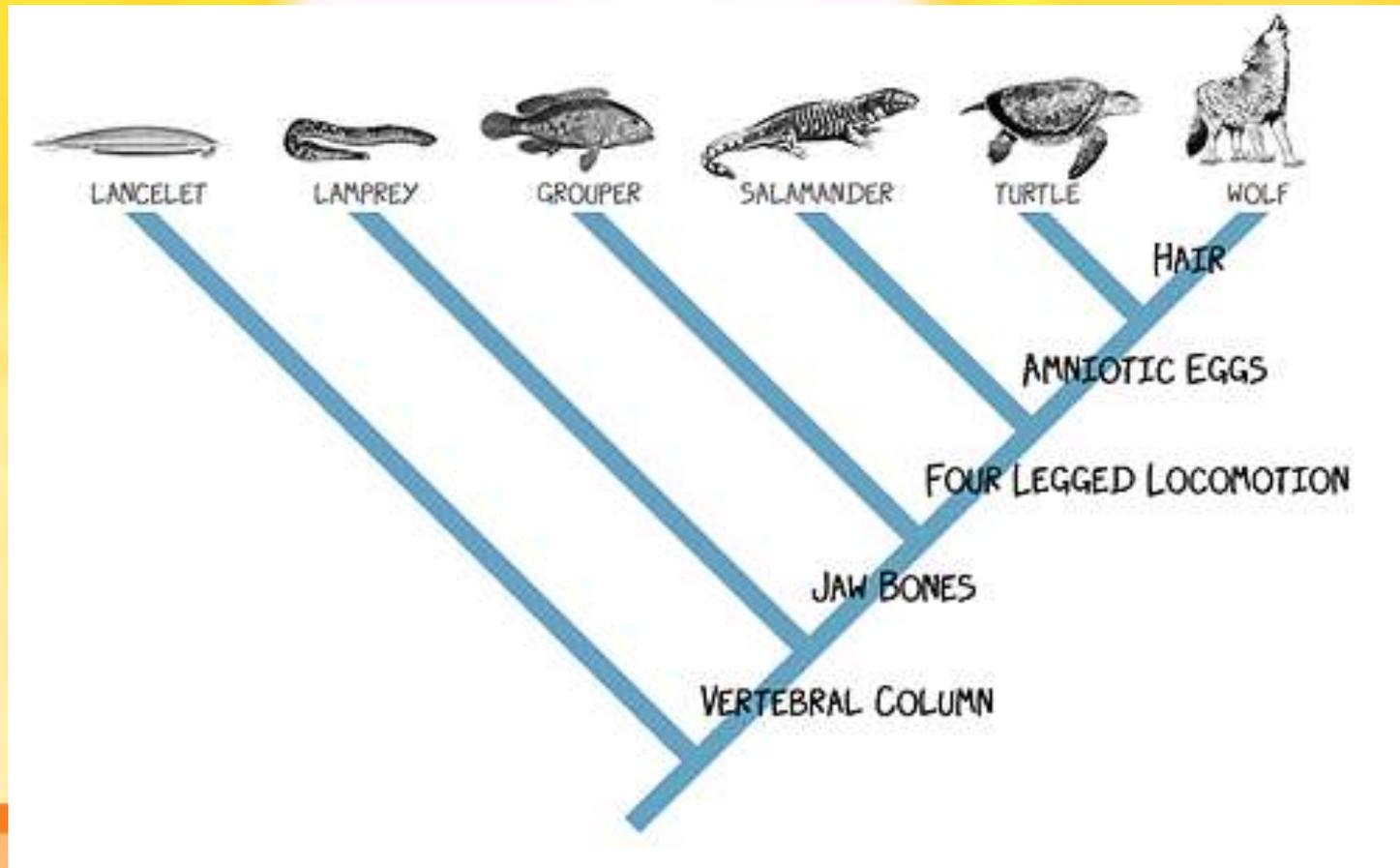


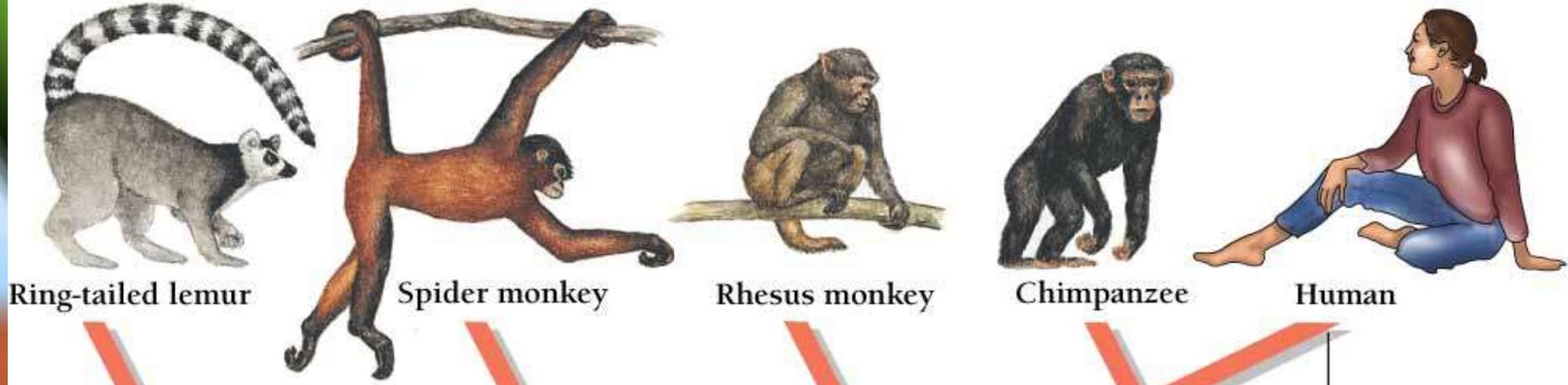
Taxons

- Most **genera** contain a number of similar species
- The genus **Homo** is an exception (only contains modern humans)
- **Classification is based on evolutionary relationships**

Cladogram

Diagram showing how organisms are related based on **shared, derived characteristics** such as feathers, hair, or scales





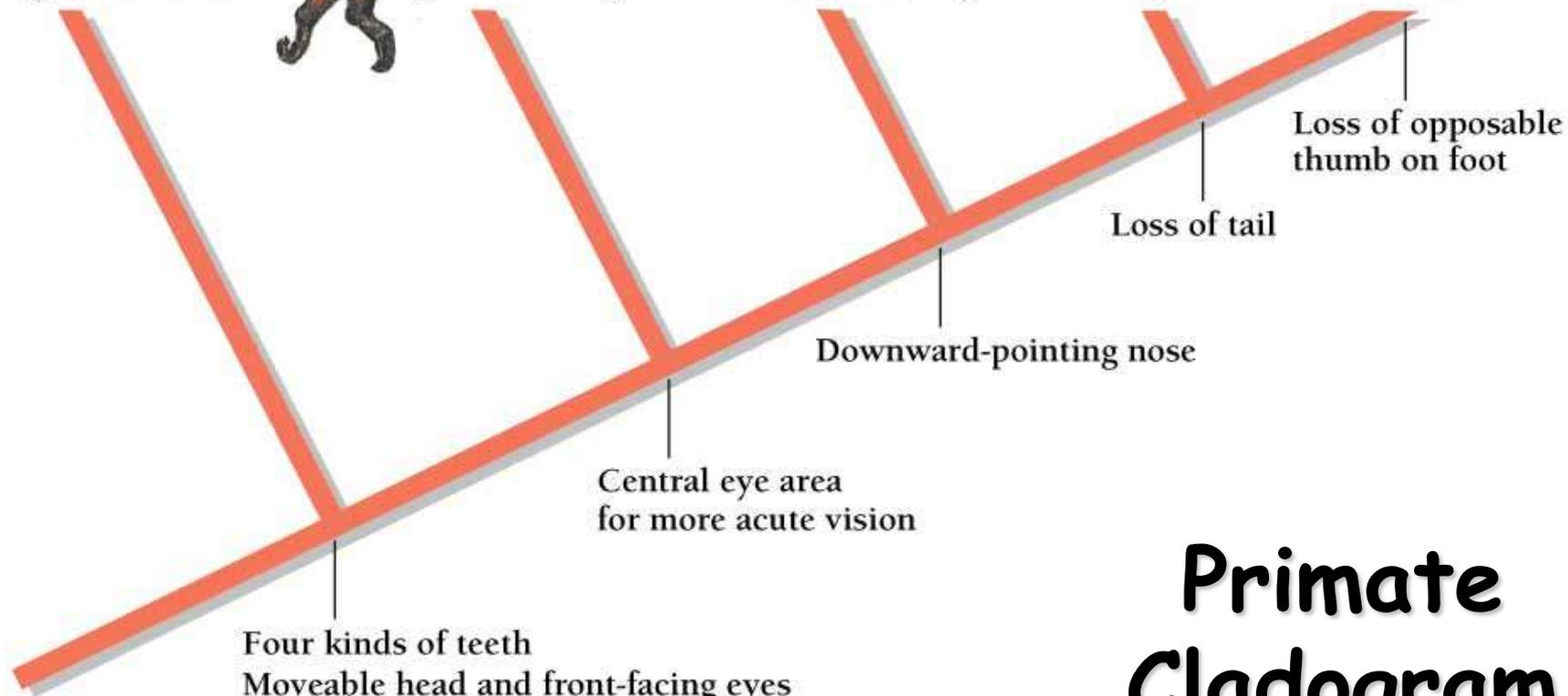
Ring-tailed lemur

Spider monkey

Rhesus monkey

Chimpanzee

Human



Four kinds of teeth
Moveable head and front-facing eyes
Large brain
Omnivorous
Five digits on hand and foot,
with opposable thumbs

Central eye area
for more acute vision

Downward-pointing nose

Loss of tail

Loss of opposable
thumb on foot

Primate Cladogram

Dichotomous Keying

- Used to identify organisms
- Characteristics given in pairs
- Read both characteristics and either go to another set of characteristics **OR** identify the organism

Example of Dichotomous Key

1a Tentacles present - Go to 2

1b Tentacles absent - Go to 3

2a Eight Tentacles - Octopus

2b More than 8 tentacles - 3

3a Tentacles hang down - go to 4

3b Tentacles upright-Sea Anemone

4a Balloon-shaped body-Jellyfish

4b Body NOT balloon-shaped - 5



Taxonomic Key

- 1a Fruits occur singly Go to 3**
- 1b Fruits occur in clusters of two or more Go to 2**
- 2a Fruits are round Grapes**
- 2b Fruits are elongate Bananas**
- 3a Thick skin that separates easily from fleshOranges**
- 3b Thin skin that adheres to flesh Go to 4**
- 4a More than one seed per fruit Apples**
- 4b One seed per fruit Go to 5**
- 5a Skin covered with velvety hairs Peaches**
- 5b Skin smooth, without hairs Plums**

What steps would you use to identify a peach?