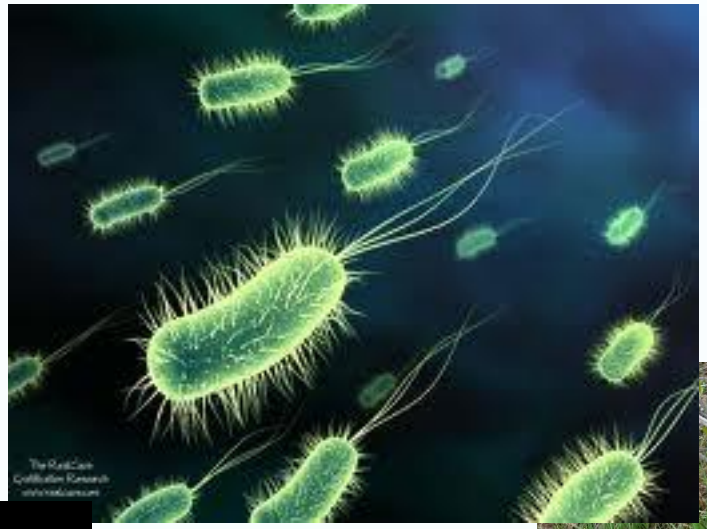
# Classification



# of

# Living Things

Scientists have described and named a total of:

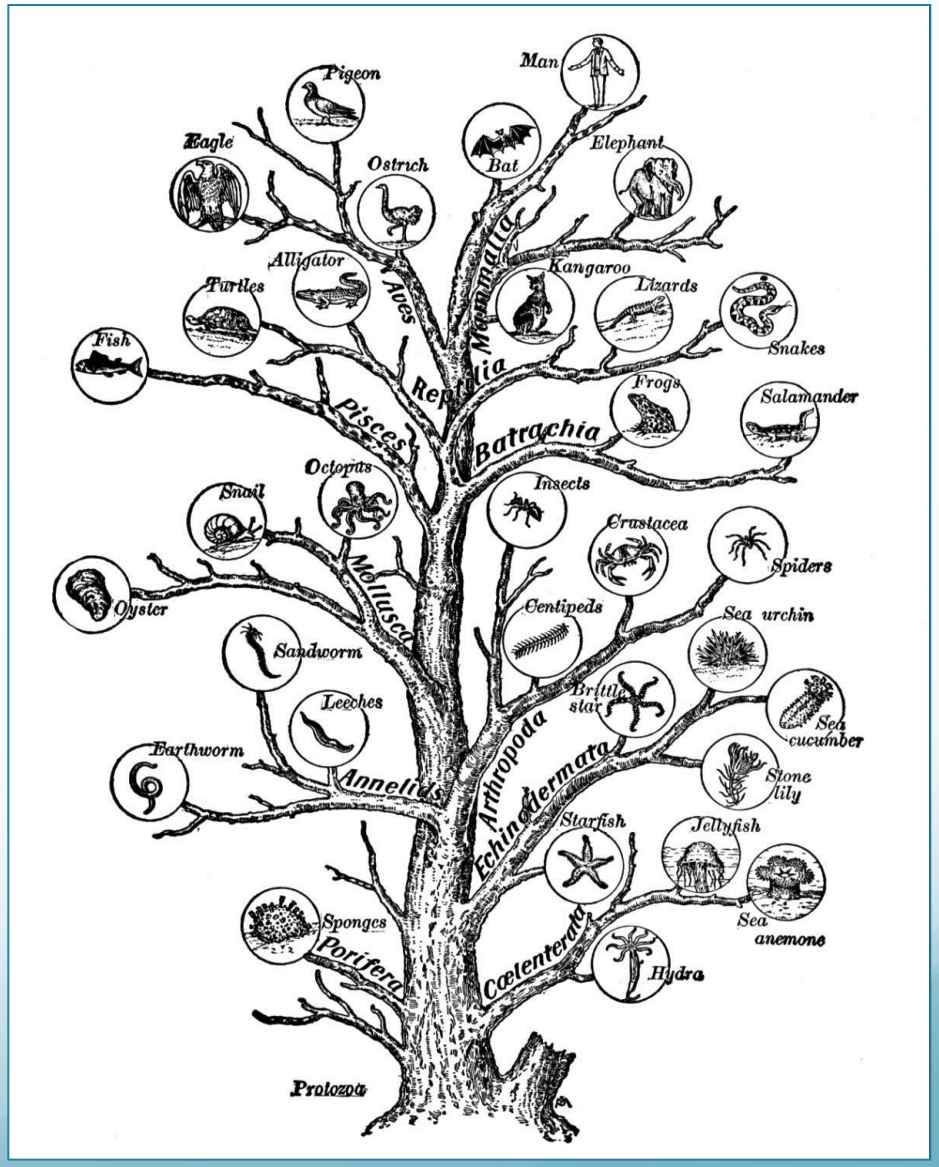
**1.5 million species.**

It is estimated that the total number of species is about:

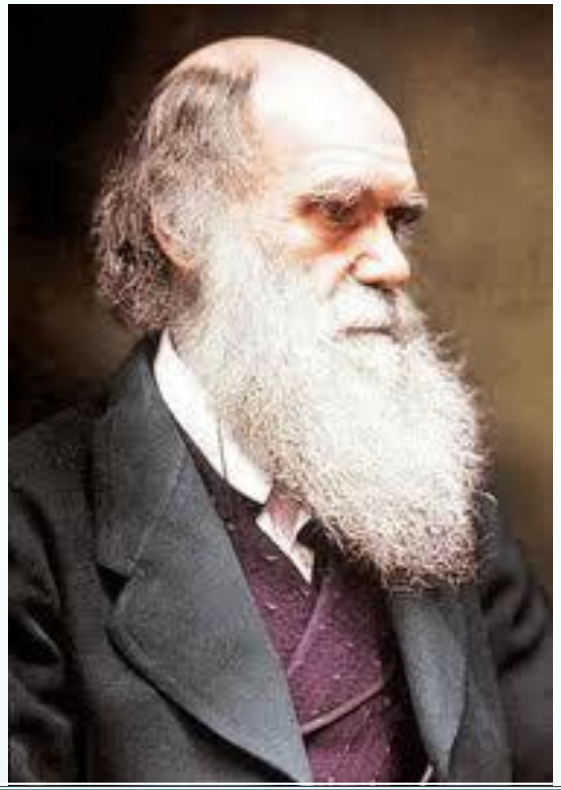
**10 million.**

# Life on earth is constantly evolving and changing slowly over time.

Scientists attempt to order the natural world by <u>grouping and classifying</u> all living organisms. As technologies improve, so have our systems of classification.



# A Summary of Darwin's Theory of Evolution



The species that are alive on Earth today are descended with modification from ancestral species that lived in the past.

1. Organisms produce more offspring than can survive. Of the offspring that do survive, many will never reproduce.

2. Because more organisms are produced than can survive, there is:
   intense competition for limited resources, such as food, water, and shelter.

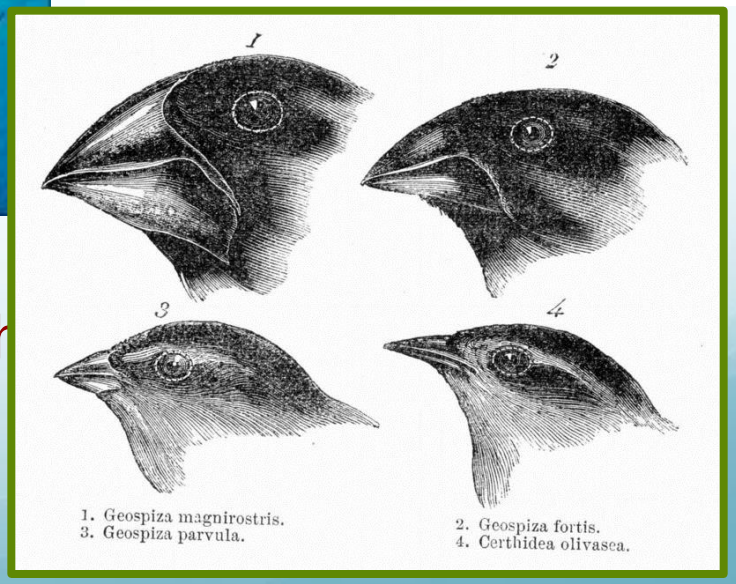
3. Individuals that are best suited to their environment survive, reproduce, and pass their traits on to their offspring.
   Other organisms that are less suited for their environment often die, or will not be reproductively competitive.
   This is the process of "natural selection" and causes the many species of organisms on Earth to change over time.

For 3.5 billion years, life on Earth has been constantly changing.

# Natural Selection

Natural selection has led to a staggering diversity in organisms.

To study this diversity, scientists must give each organism a name and sort them into groups.



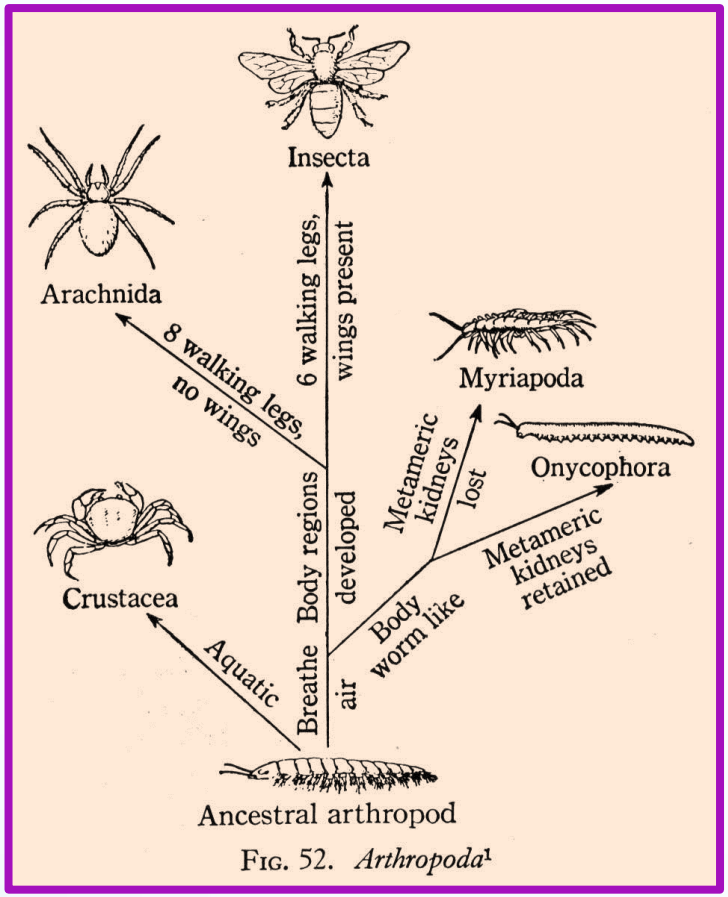


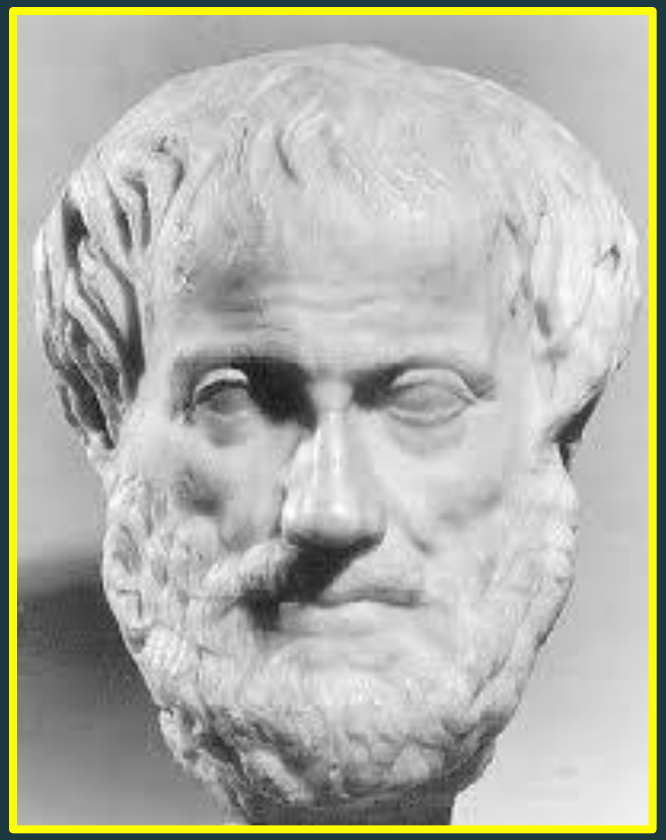
Fig. 52. *Arthropoda*[1]

To study the diversity of life, biologists use a classification system to name organisms and group them in a logical manner.

# TAXONOMY

**The branch of biology that classifies organisms and assigns each organism a universally accepted name.**

# Early Attempts at Classification



Organisms were first classified more than __2000__ years ago by the Greek philosopher, ___Aristotle___.

Aristotle first sorted organisms into two groups:
plants and animals.

# He divided animals into three groups:

Land dwellers

Can you see the problems with this system?????

Water dwellers

Air dwellers

# He divided plants into three groups:

## Herbs

## Shrubs

## Trees

By the 15th and 16th centuries, it became obvious that there were many problems with this system of classification.

Many organisms were placed in groups to which they had no real relationship with the other members of the group.

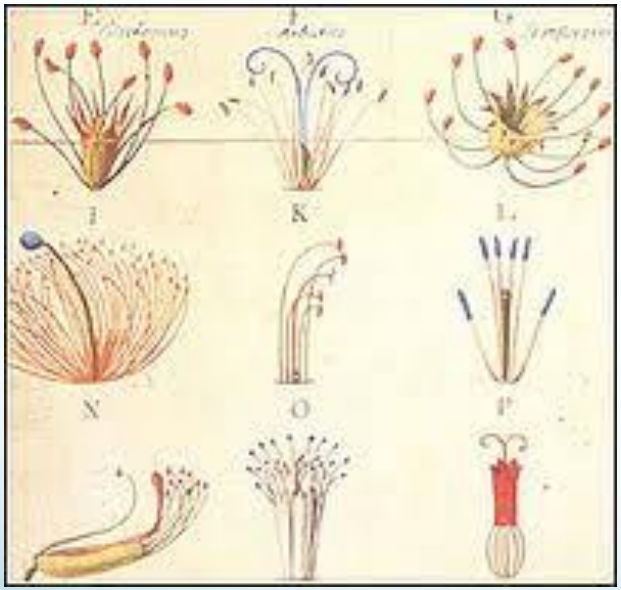
The use of common names was very confusing. For example: catfish, jellyfish, shellfish.

Many new organisms were being discovered and needed to be classified.

In response to the need for a better system of classification, the Swedish naturalist, Carolus Linnaeus _____, developed the system of classification that we still use today.

# Carolus Linnaeus (1707-1778)

Linnaeus set up a classification system based on structural similarity. He thought that the organisms that looked alike were: the most closely related.



Linnaeus developed a system that placed an organism in a particular group and assigned it a scientific name.


CAROLI LINNÆI
EQUITIS AUR. DE STELLA POLARI,
SPECIES
PLANTARUM,
EXHIBENTES
PLANTAS RITE COGNITAS
AD
GENERA RELATAS,
CUM
DIFFERENTIIS SPECIFICIS, NOMINIBUS
TRIVIALIBUS, SYNONYMIS SELECTIS,
LOCIS NATALIBUS,
SECUNDUM
SYSTEMA SEXUALE
DIGESTAE.
TOMUS I.
Editio Tertia.
VINDOBONAE,
Typis JOANNIS THOM. de TRATTNER,
MDCCLXIV.

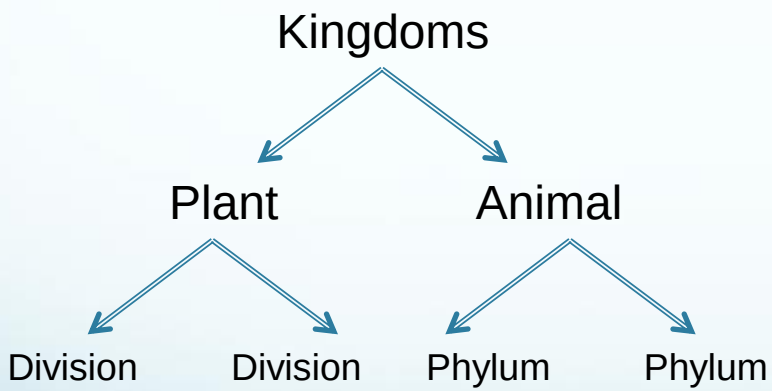
He developed a naming system called binomial nomenclature that is still in use today.

# Binomial Nomenclature:

The system of assigning a scientific name that consists of two parts.

He first divided all organisms into large groups that he called _____kingdoms_____. He based his classification on two kingdoms: plant and animal.

A kingdom would be further subdivided into smaller groups.




Each subdivision of a kingdom is called a _phylum_ in the animal kingdom, or a __division__ in the plant kingdom.

Each subset was further subdivided until he had developed _____ of classification.

7 levels


**List these in your notes!**

Organisms are placed in the same species if:
they can mate and produce fertile offspring.

In the system developed by Linnaeus, the kingdom was the biggest, broadest group. More recently scientists have added an additional level above the kingdom called a "domain".

A species contains:
only one type of organism.


# Rules of Binomial Nomenclature (Linnaeus)

The scientific name always consists of two words: the genus and the species.

All scientific names are in Latin. It is understood by all scientists.

The genus name is always capitalized; the species name is never capitalized.



The two names are always written: in italics or underlined.

No two organisms can have the same name.

**Below is a chart showing the classification of four different animals. Use the chart to answer the questions below.**

| Animal #1 | Animal #2 | Animal #3 | Animal #4 |
|---|---|---|---|
| | | | |
| Animalia | Animalia | Animalia | Animalia |
| Arthropoda | Arthropoda | Arthropoda | Arthropoda |
| Hexapoda | Hexapoda | Hexapoda | Hexapoda |
| Lepidoptera | Lepidoptera | Lepidoptera | Lepidoptera |
| Nymphalidae | Nymphalidae | Papilionidae | Nymphalidae |
| Danaus | Vanessa | Papilio | Danaus |
| plexippus | atalanta | rutulus | gilippus |

**What is the scientific name of Animal #1?** **Danaus plexippus**

**Which of these animals belong to the same phylum?** **1, 2, 3, and 4**

**Which of these animals belong to the same order?** **1, 2, 3, and 4**

Below is a chart showing the classification of four different animals. Use the chart to answer the questions below.

| Animal #1 | Animal #2 | Animal #3 | Animal #4 |
|---|---|---|---|
| | | | |
| Animalia | Animalia | Animalia | Animalia |
| Arthropoda | Arthropoda | Arthropoda | Arthropoda |
| Hexapoda | Hexapoda | Hexapoda | Hexapoda |
| Lepidoptera | Lepidoptera | Lepidoptera | Lepidoptera |
| Nymphalidae | Nymphalidae | Papilionidae | Nymphalidae |
| Danaus | Vanessa | Papilio | Danaus |
| plexippus | atalanta | rutulus | gilippus |

**Which of these animals is the most distantly related to the others?** **Animal #3**

**Which of these animals belong to the same family?** **1, 2, and 4**

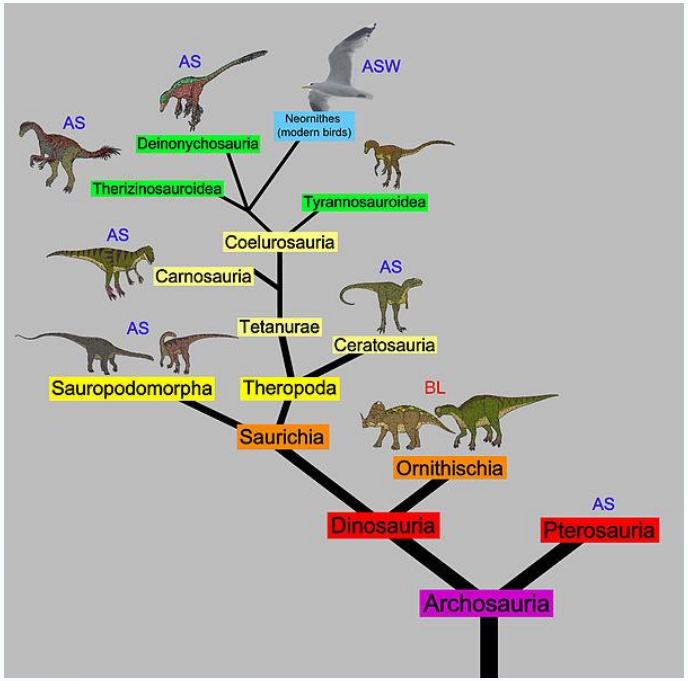
Below is a chart showing the classification of four different animals. Use the chart to answer the questions below.




| Animal #1 | Animal #2 | Animal #3 | Animal #4 |
|---|---|---|---|
| | | | |
| Animalia | Animalia | Animalia | Animalia |
| Arthropoda | Arthropoda | Arthropoda | Arthropoda |
| Hexapoda | Hexapoda | Hexapoda | Hexapoda |
| Lepidoptera | Lepidoptera | Lepidoptera | Lepidoptera |
| Nymphalidae | Nymphalidae | Papilionidae | Nymphalidae |
| Danaus | Vanessa | Papilio | Danaus |
| plexippus | atalanta | rutulus | gilippus |

**Which two of these animals are the most closely related? How do you know?**
**Animals 1 and 4 are the most closely related. They belong to the same genus.**

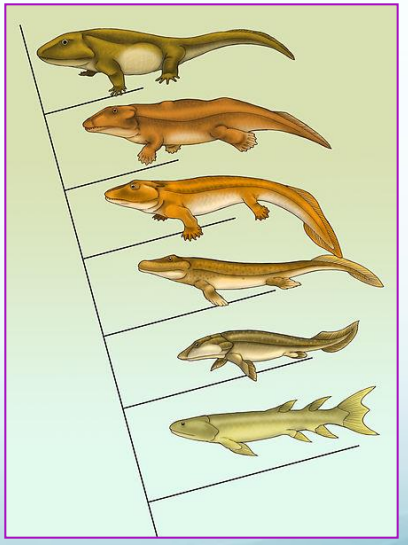
# Modern Taxonomy




Modern taxonomists consider the phylogeny of an organism when attempting to classify it.

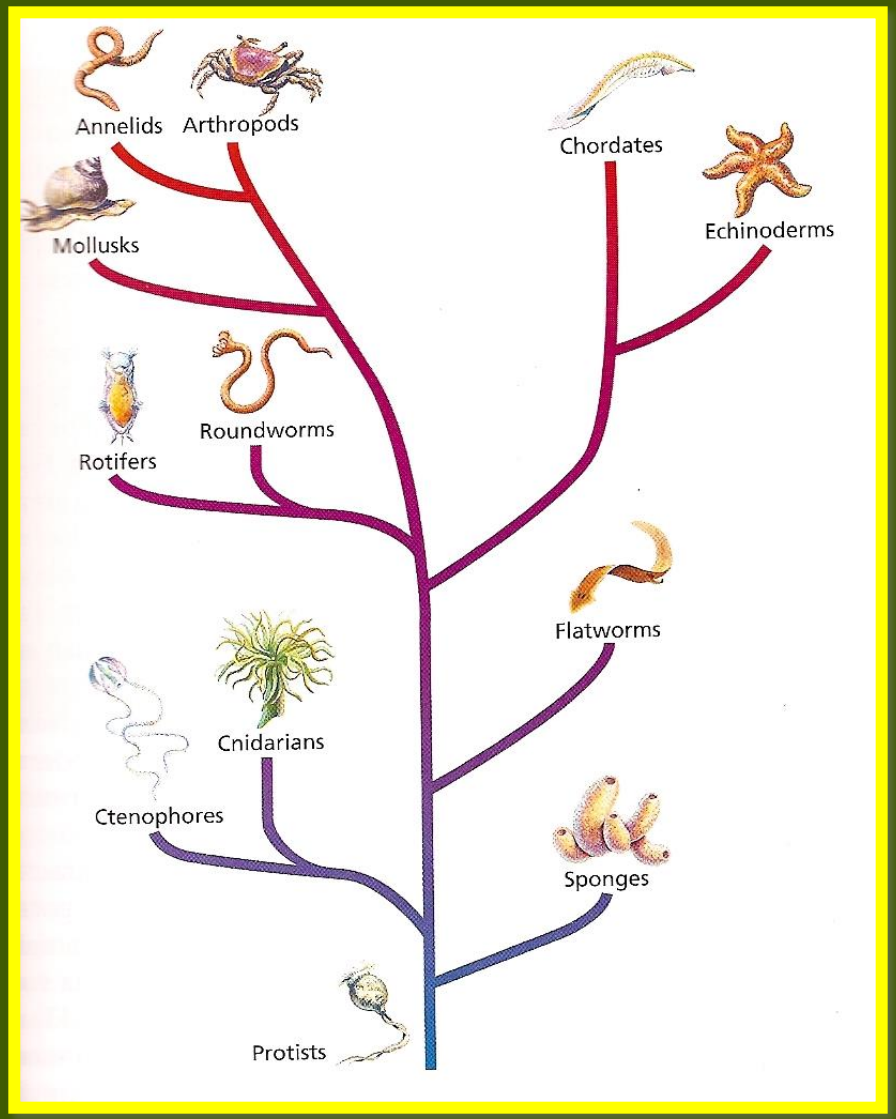
**Phylogeny:** The evolutionary history of an organism.

To show the evolutionary relationship between different groups of organisms, scientists construct phylogenetic trees.



A phylogenetic tree is a family tree that shows:

**the evolutionary relationships thought to exist among different groups of organisms.**




**The phylogenetic tree to the left shows a few of the phyla of the Animal Kingdom.**

What is the common ancestor of all organisms shown on this tree?

Protists

Are the Cnidarians more closely related to the sponges or to the comb jellies (Ctenophores)?

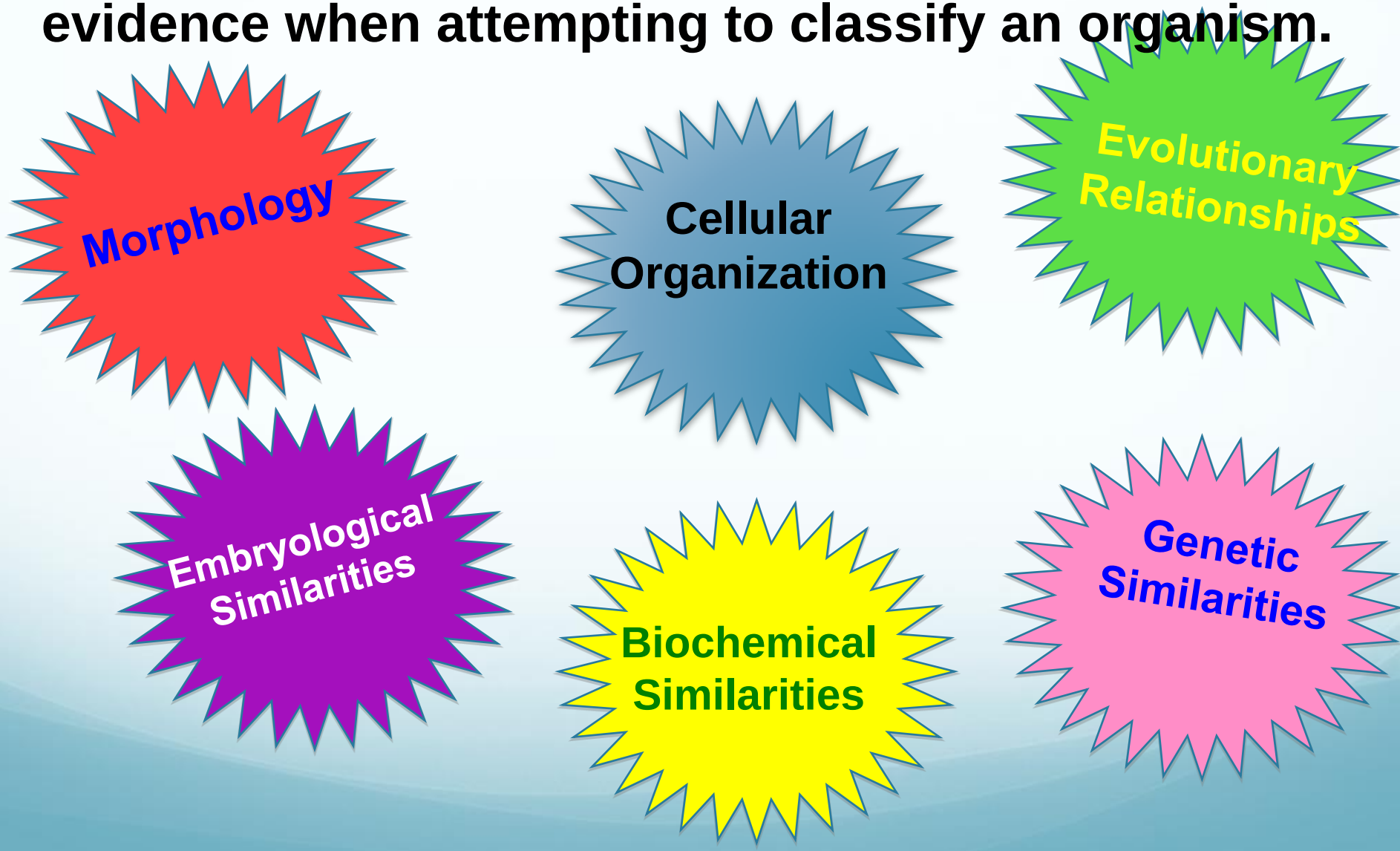
The Ctenophores

What is the closest relative to the Rotifers? Roundworms

What does a branch point represent?

**The last common ancestor shared by two or more organisms.**

**Traditionally, the morphology (__structure__) of the organism was the basis for its classification. Modern taxonomy now takes into account other types of evidence when attempting to classify an organism.**

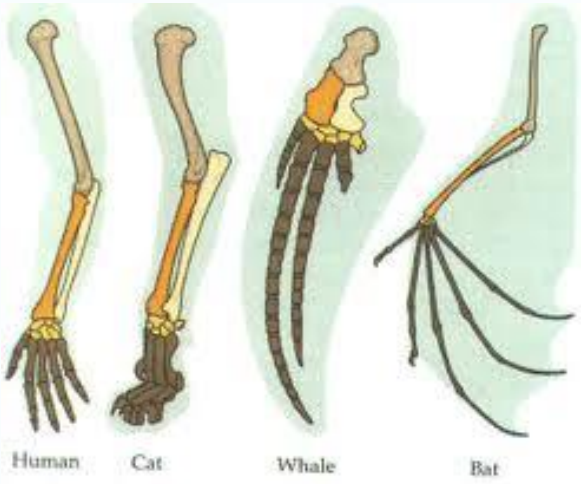


# Morphology

Morphology is classification based on:
the structures possessed by the organism.

This was the basis for Linnaeus' system of classification.

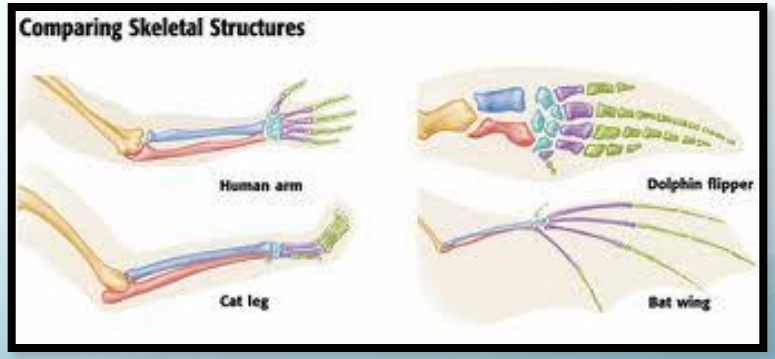
The average person would use color and size, but these are the least important in classification.



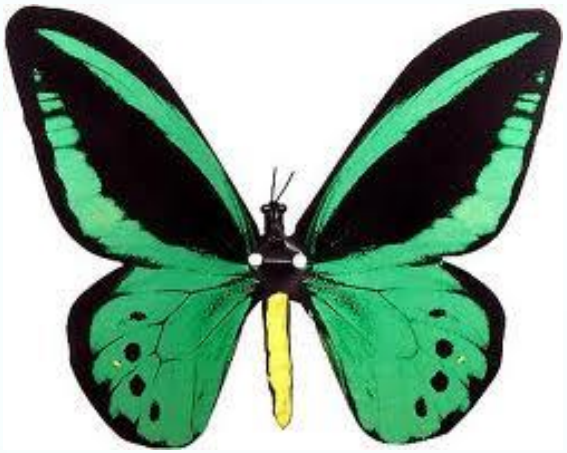

# Homologous Structures

Homologous structures have the same structure, but different functions.

Example: The bones found in the wing of a bird, the wing of a bat, the forearm of a human and the flipper of a whale are homologous to one another.



# Analogous Structures



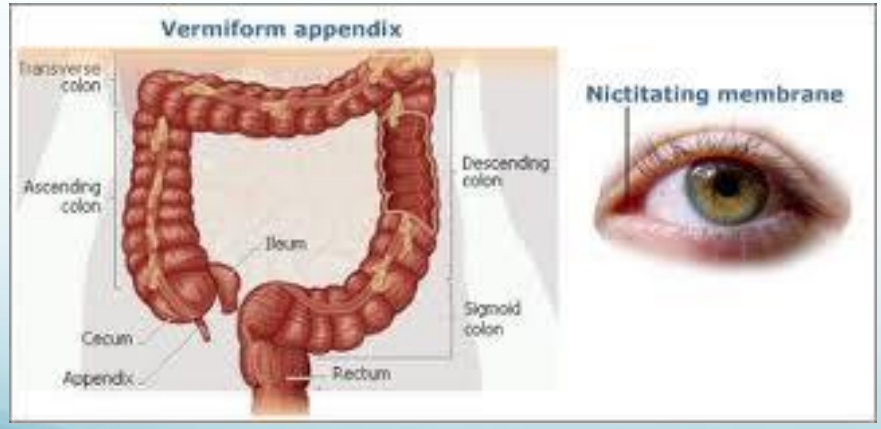
Analogous structures:
Similar in function but not in structure.
Analogous structures are not derived from a common ancestor.

Example: The wing of a bird and the wing of a butterfly have the same function, but there is nothing in common in their structure.

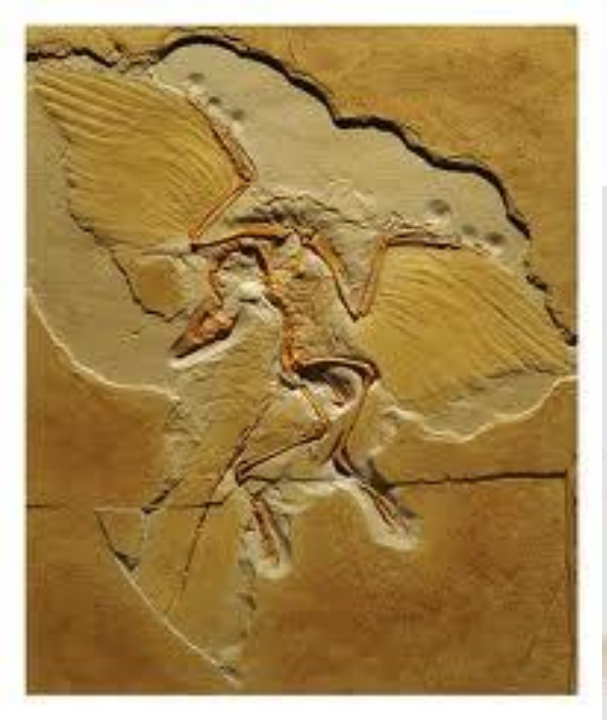
# Vestigial Structures

Vestigial Structure:
A structure that is reduced in size and seems to be "left over" from a previous ancestor.

Examples:
Human Appendix
“Hips” in snakes.




The greater the number of homologous structures two organisms share, the more: <u>closely related they are thought to be</u>.

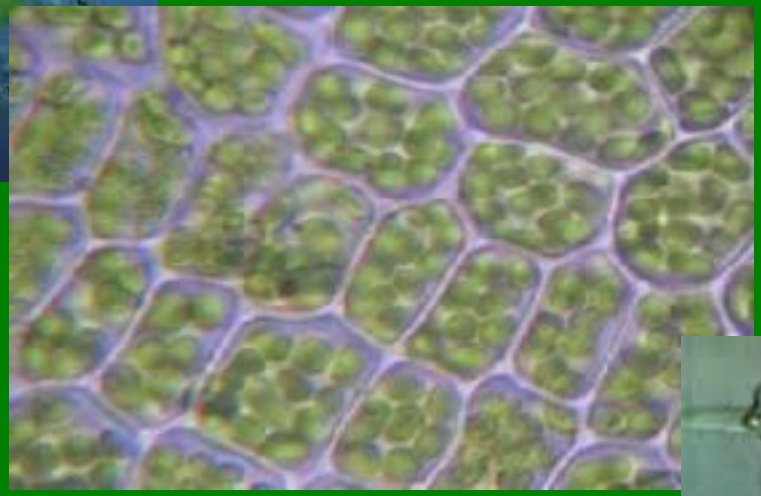


# Archaeopteryx

The fossil record gives us many clues as to the morphology of ancient species, but it is an incomplete record. Other lines of evidence must be considered when classifying an organism. Following are 5 additional areas of consideration.

# Cellular Organization

Similarity in __cell structures__ provides evidence that organisms may be related.



Examples:

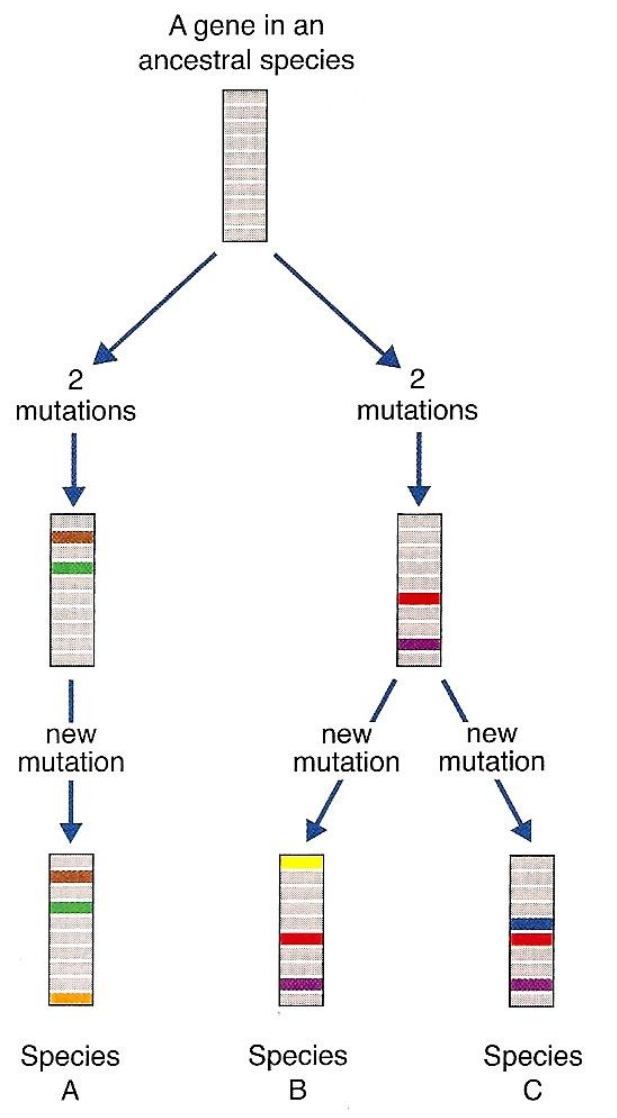
What kinds of plastids are present?
Does the cell possess a nucleus?
Is there a cell wall present?
What is the cell wall composed of?

# Evolutionary Relationships

Fossils show that organisms _alive_ today are similar to organisms that are now _extinct_.

Example: 25 breeds of dogs all came from a wolf-like ancestor

# Biochemical Similarities



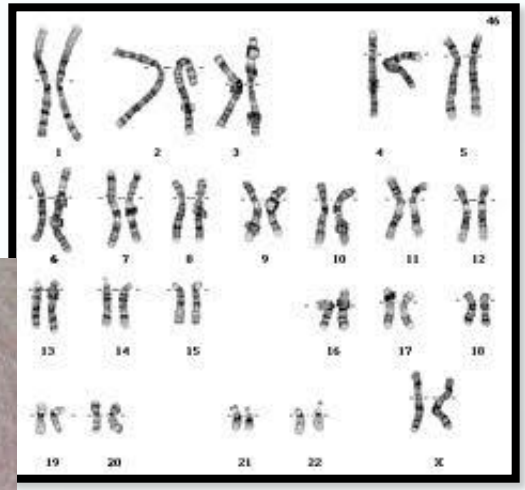

Similarities of chemical compounds found within cells can be used as evidence to show relationships between organisms.

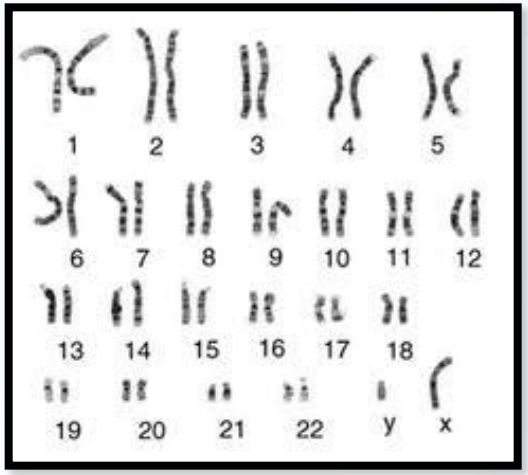
A comparison between the proteins of two organisms serves as a "molecular clock".

Simple mutations occur all the time, causing slight differences in the DNA and the proteins being built.

When the proteins of two different organisms are compared, the number of differences in amino acid sequences is a clue as to how long ago two species diverged from a shared common ancestor.

# Genetic Similarities





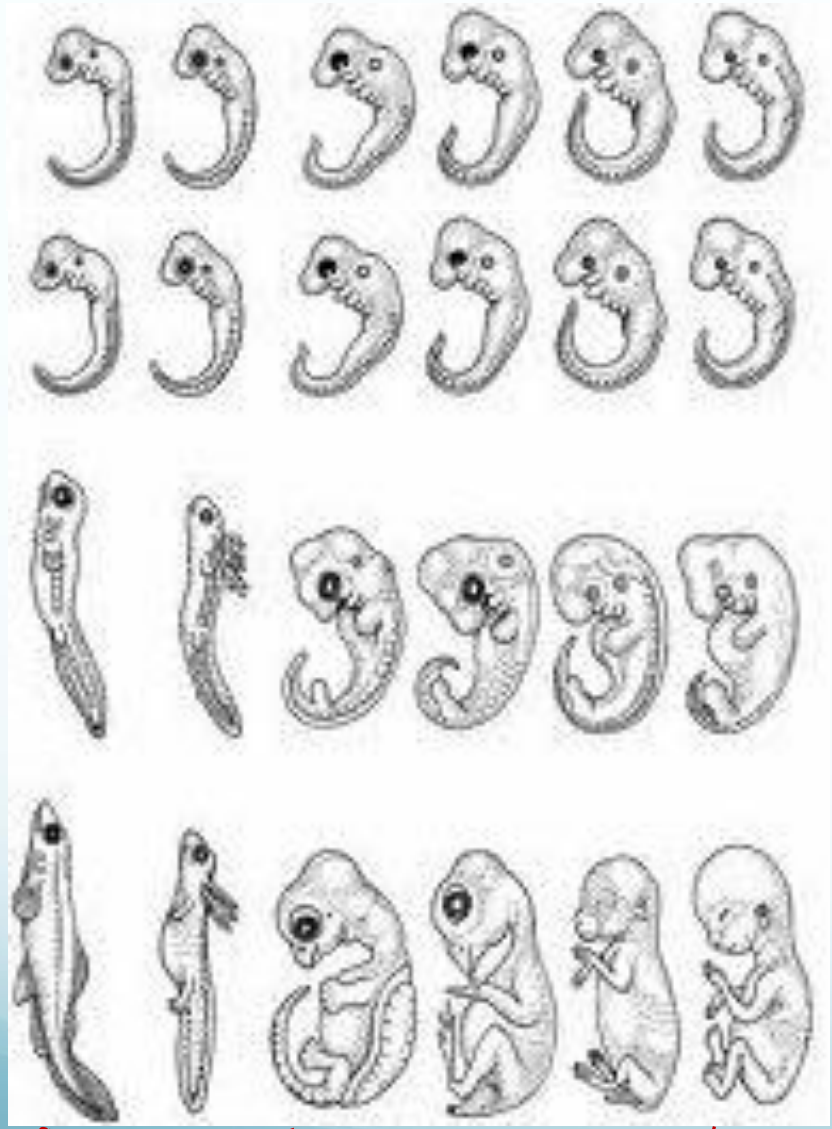

Two organisms that bear no resemblance to one another anatomically may still be related to one another.
Two different "looking" organisms may have similar genes in their DNA.

Do the two organisms being compared have the same __number__ of chromosomes? The same __type__ of chromosomes?

Example: Humans have a gene that is the code for building a protein called myosin. This protein is a primary component of our muscles. Yeasts (which have no muscles) have the same gene. The gene in yeasts produces the same myosin protein as it does in humans. In yeasts, this protein is used to materials around the inside of the cell.

This genetic similarity is an indication that yeasts and humans share __a common ancestry_____.

# Embryological Similarities



fish salamander turtle chicken rabbit human

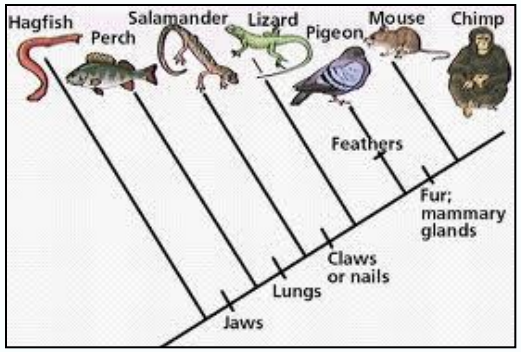
Similarities in
embryological development

__ provide evidence of phylogenetic relationships.

Some organisms show no similarities as adults, but are very, very similar as _embryos_.

# Cladistics

Cladistics is a relatively new method of:
classifying organisms.




Cladistics uses features called "shared derived characters" to establish evolutionary relationships.

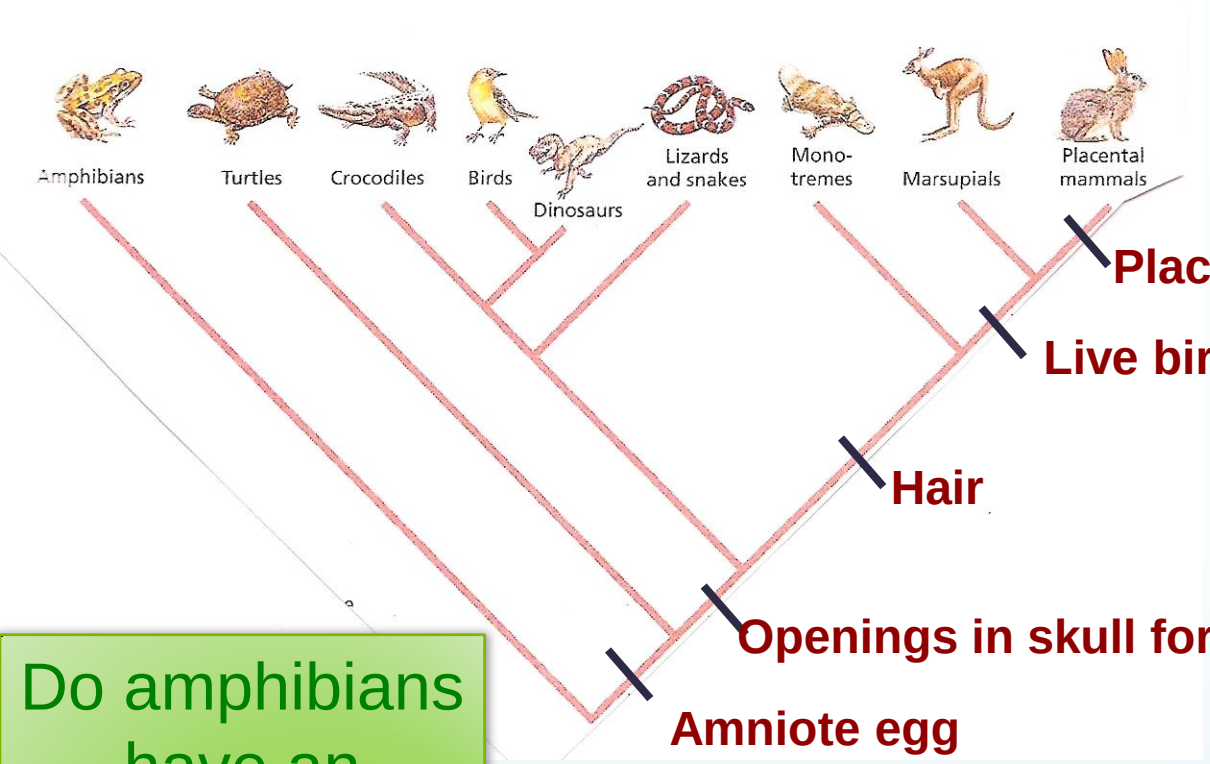
A "derived character" is a feature that:
evolved only within the group under consideration.

**An example might be the _feathers_ of birds. Birds are the only animals to have feathers. It is therefore assumed that feathers evolved within the bird group and were not _inherited_ from a distant ancestor.**

**Shared derived characters are strong evidence of _common ancestry_ between the organisms that share them.**

# Cladogram:

A diagram that shows the evolutionary relationships among a group of organisms.




What are the derived characters shown in this cladogram?

Do amphibians have an amniote egg?

**NO**

Do turtles have an amniote egg?

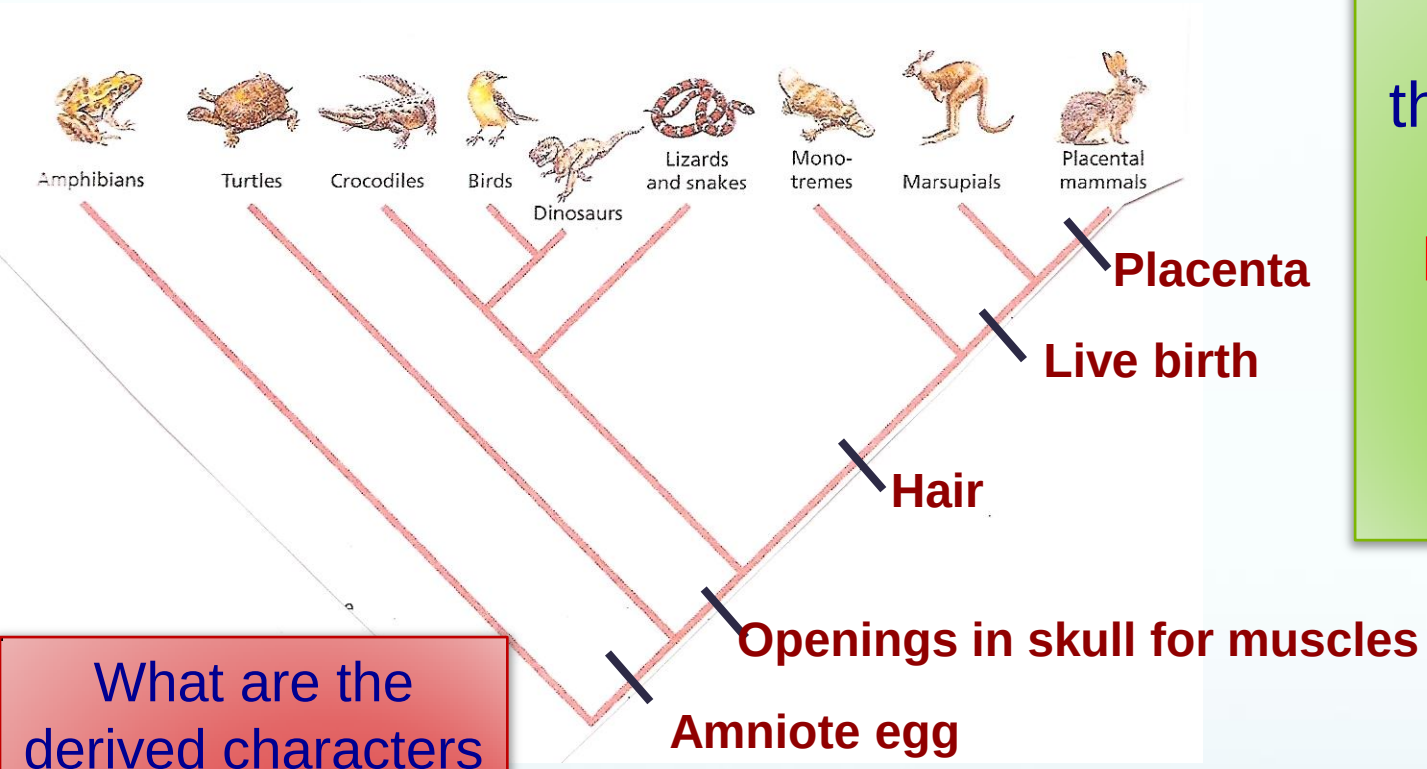
YES

Which group on the cladogram arose first?

Amphibians

Which two groups on the cladogram seem to be most closely related?
Birds and Dinosaurs

List the groups that have hair.
Monotremes, marsupials, and placental mammals.




List the groups that give live birth to their young.
Marsupials and placental mammals

What are the derived characters of the monotremes?
**Amniote egg, openings in skull, and hair.**

Which two groups have the most shared derived characters?
Marsupials and placental mammals

# Kingdoms and Domains

As new discoveries have been made, the systems of classification had to be changed. The first attempt at scientific classification was Linnaeus with his 2-kingdom system. Since the time of Linnaeus, many changes have been made in the ways that scientists classify organisms.

| A Brief History of Classification Kingdoms | | | | | | |
|---|---|---|---|---|---|---|
| First Introduced | Names of Kingdoms | | | | | |
| 1700's | Plantae | | | | | Animalia |
| Late 1800's | Protista | | | Plantae | | Animalia |
| 1950's | Monera | | Protista | Fungi | Plantae | Animalia |
| 1990's | Archae-bacteria | Eubacteria | Protista | Fungi | Plantae | Animalia |

A change to the 5 and 6-kingdom systems is the evidence that all living things seem to fall naturally into ___three broad groups___.
In recent years, this led to the establishment of a:
3-domain system.
Domains are essentially:
super kingdoms, a taxonomic level even higher than the kingdom level.

The 6-kingdom system

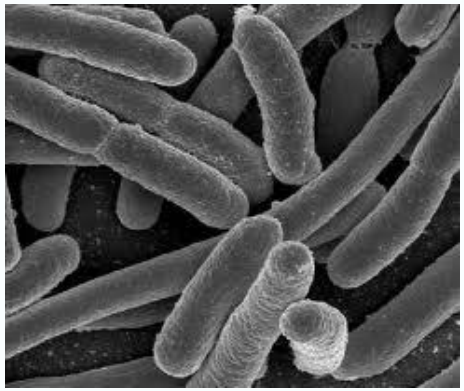
| Kingdom Eubacteria | Kingdom Archae-bacteria | Kingdom Protista | Kingdom Plantae | Kingdom Fungi | Kingdom Animalia |
|---|---|---|---|---|---|
| Domain Bacteria | Domain Archaea | Domain Eukarya (all eukaryotes) | | | |

The 3-domain system

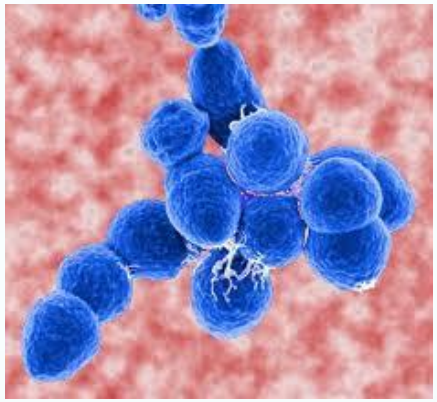
The domain Bacteria contains the Kingdom Eubacteria.
The domain Archaea contains the Kingdom Archaebacteria.
The domain Eukarya contains the Kingdoms Protista, Plantae, Fungi, and Animalia.

# Kingdom Comparison

| | |
|---|---|
| **Domain** | **Bacteria** |
| **Kingdom** | **Eubacteria** |
| **Cell Type** | **prokaryotic** |
| **Cell Structures** | **Cell walls composed of peptidoglycans** |
| **Cell Organization** | **Unicellular** |
| **Food Getting?** | **Autotrophs or heterotrophs** |
| **Examples:** | **Strep, staph, E. coli** |

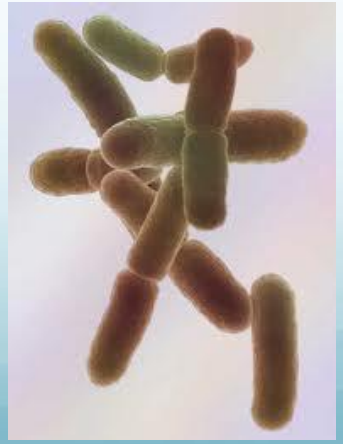


cyanobacteria



strep


staph



E. coli

# Kingdom Comparison

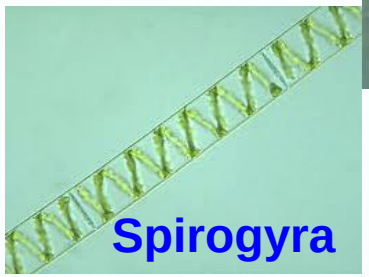
| | |
|---|---|
| **Domain** | **Archaea** |
| **Kingdom** | **Archaebacteria** |
| **Cell Type** | **prokaryotic** |
| **Cell Structures** | **Cell walls do not contain peptidoglycans.**<br><br>**These are very "ancient" organisms. Very primitive.** |
| **Cell Organization** | **Unicellular** |
| **Food Getting?** | **Autotroph or heterotrophs** |
| **Examples:** | **Methanogens**<br>**Halophiles**<br>**Thermophiles** |

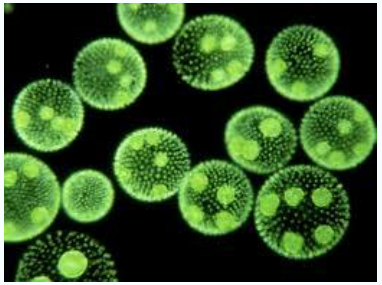
Halophiles:
(salt loving)

Thermophiles:
(heat loving)

| | |
|---|---|
| **Domain** | Eukarya |
| **Kingdom** | Protista |
| **Cell Type** | eukaryotic |
| **Cell Structures** | Cell walls composed of cellulose in some.<br><br>Some have chloroplasts. |
| **Cell Organization** | Most are unicellular.<br>Some are colonial.<br>Some multicellular. |
| **Food Getting?** | Autotrophs or heterotrophs |
| **Examples:** | Ameba, Paramecium, Algae, Slime molds, giant kelp. |



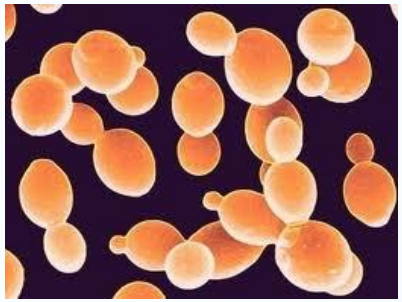



Diatoms

Coral fungus

| | |
|---|---|
| Domain | Eukarya |
| Kingdom | Fungi |
| Cell Type | Eukaryotic |
| Cell Structures | Cell walls are composed of chitin.<br>No chloroplasts |
| Cell Organization | Most are multicellular. Some are unicellular. |
| Food Getting? | Heterotrophs |
| Examples: | Mushrooms, yeasts, puffballs, molds, mildews, smuts, and rusts. |

Bracket fungus



Yeasts

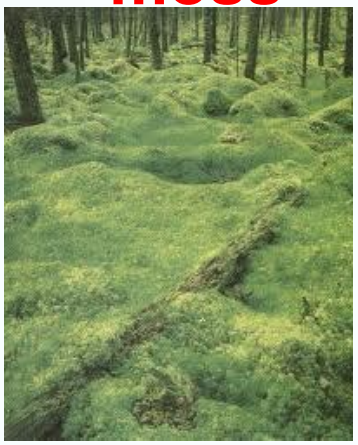
mold

Corn smut

rusts

Morels

moss



| | |
|---|---|
| Domain | Eukarya |
| Kingdom | Plantae |
| Cell Type | Eukaryotic |

liverworts

gingko

| | |
|---|---|
| Cell Structures | Cells walls are composed of cellulose.<br><br>Chloroplasts are present. |

ferns

| | |
|---|---|
| Cell Organization | Multicellular |
| Food Getting? | Autotrophs |
| Examples: | Mosses, ferns, liverworts, cone-bearing plants, flowering plants |

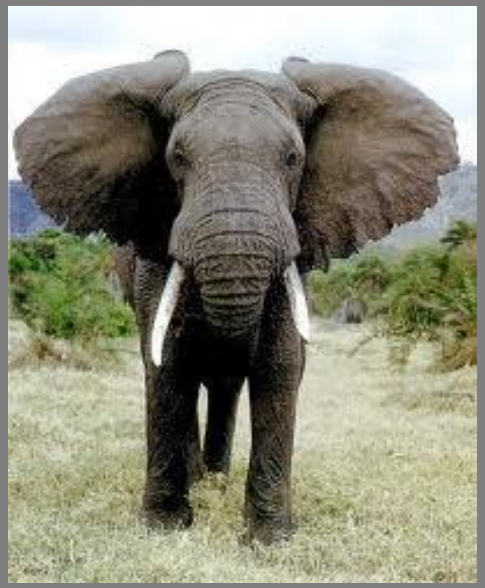
| | |
|---|---|
| **Domain** | **Eukarya** |
| **Kingdom** | **Animalia** |
| **Cell Type** | **Eukaryotic** |
| **Cell Structures** | **No cell walls.**<br>**No chloroplasts** |
| **Cell Organization** | **Multicellular** |
| **Food Getting?** | **Heterotrophs** |
| **Examples:** | **Sponges, worms, mollusks, arthropods, fis amphibians, birds, reptile mammals.** |

# Barriers between the species: What factors keep the species apart?

## Physical Characteristics

Mating is impossible under natural conditions for many organisms.

Can this mate with this???



# Mating occurs, but the offspring do not survive.

Bullfrog eggs may be fertilized by the sperm of the leopard frog. The eggs develop to a point, but do not survive. There is too much difference in the chromosomes.

# The offspring may survive but they are not fertile.

Example:  horse + donkey = mule

The mule is sterile and will not be able to reproduce.

# Geographical Barriers

Many organisms simply do not come into contact with one another.

No contact!

# Behavioral Barriers

Many organisms, especially in the animal kingdom, will not mate unless certain behaviors are exhibited.

# Classifying Organisms Using a Dichotomous Key

Here are the leaves from seven trees. Use the dichotomous key to classify each leaf.

1

Magnolia

2

Buckeye

3

Redbud

4

Pecan

5

Birch

6

Locust

7

Sweet Gum


Created by Amy Brown – Science Stuff