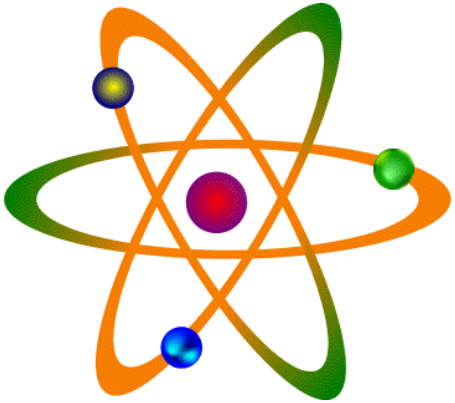
About Lecture

- Include notes from all sources
- Take legible and complete notes
- It's fine to paraphrase or abbreviate
- Take notes in a designated notebook
- Ask relevant and thoughtful questions
- If you miss lecture, get notes from a peer
- Include examples, diagrams and pictures
- Stay with the same pattern or outline as the lecture notes
- You are required to take proper notes in class, no exception
- Watch out for bold, underlined, colored, or emphasized terms
- If I go too fast or you need further explanations during lecture, let me know
- Place handouts/assignments/labs from lecture in the designated binder
- Notes are the primary source for homework, study guides, labs, activities, and exams

Introduction to Biology

Introduction to Biology

Hierarchy of Life

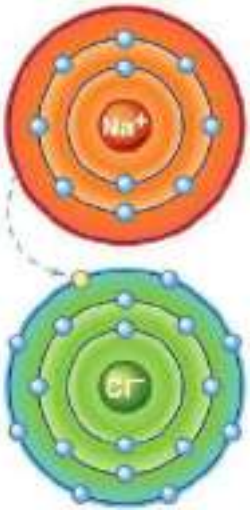


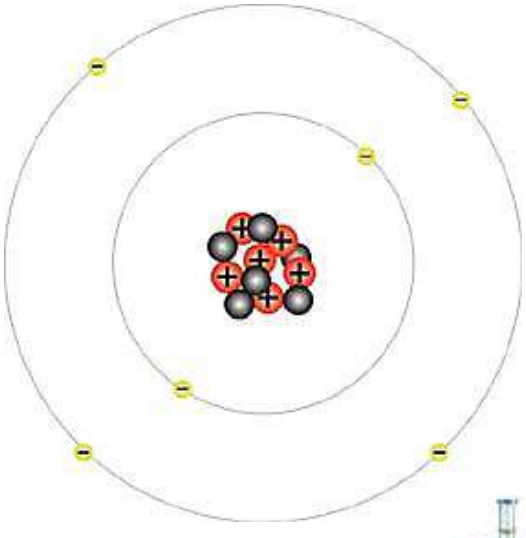
Atom = particle of living and non-living things

- **protons (p+), neutrons (n^0), electrons (e-)**
  - **p+'s and n^o's in center, "nucleus"**
  - **e-'s in levels: orbits/shells (ie max # per level: 2, 8, 18, 32 …)**
- **want levels filled (1st level 1st … etc) "and" be neutral**
- **typically: # of e-'s = # of p+'s**

Ion = charged atom (- or +)

- **atom losses e- = pos.; ie. Na+**
- **atom gains e- = neg.; ie Cl-**





H

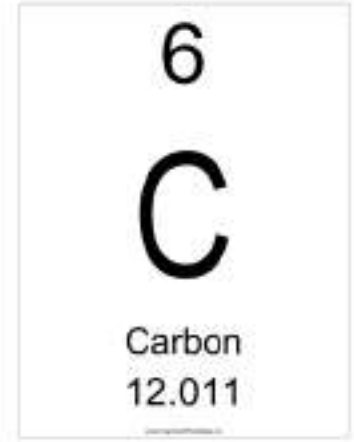
He

C

atomic number = # of p+'s

- <u>defines</u> atom

- ie. C = 6



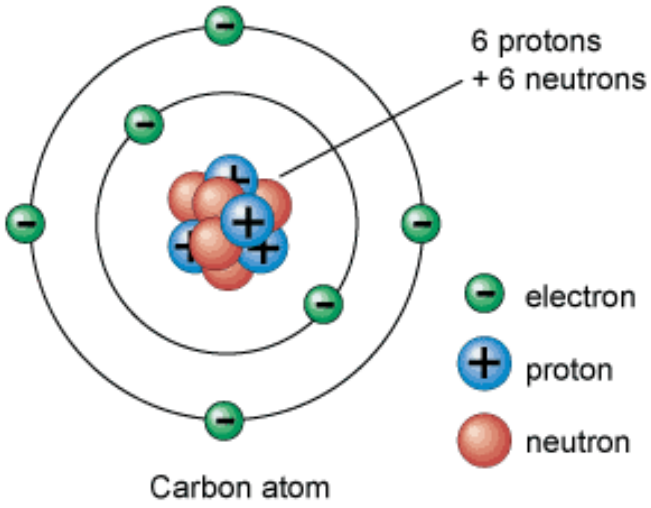
atomic mass unit (AMU) = # of p+'s "+" # of n^0's

- p+ = 1 AMU

- n^o = 1 AMU

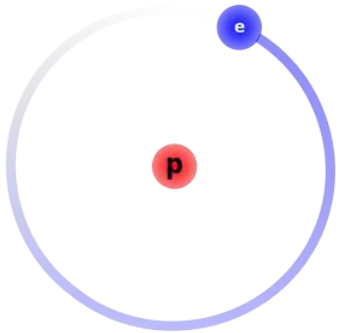
- e- = .00055 AMU ← but, not incl.

- ie. C = 12; not 12.<u>011</u> = wt. (*tbd*)



isotopes = atoms of the same type (# of p+'s); but, diff. AMU's (nº's)

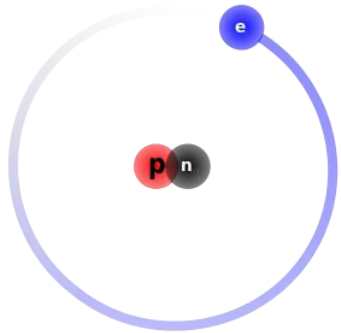
- **occur in diff. abundances (%); *tbd***
  - **ie: (3) H's = 1p0n (99.9 %), 1p1n (.0112 %), 1p2n (tiny%)**
- **help define wt**
  - **ie. H's wt = 1.0078**



$^{1}_{1}H$

protium

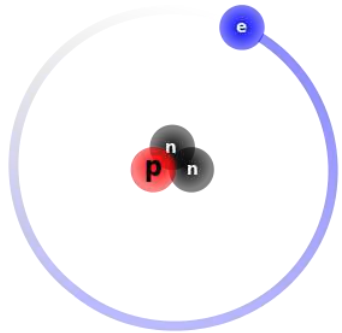
1 AMU
+
99.989 %



$^{2}_{1}H$

deuterium

2 AMUs
+
0.0115 %



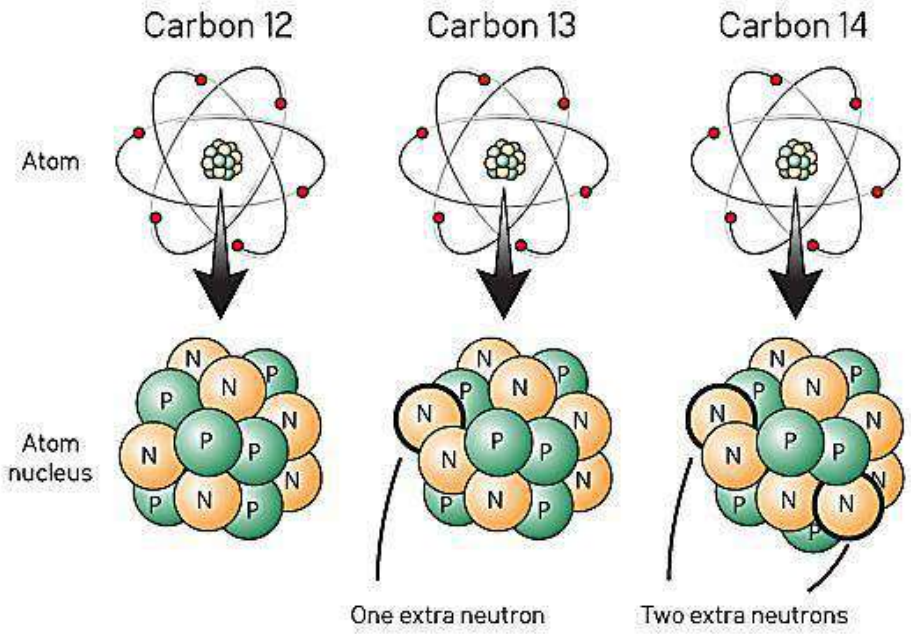
$^{3}_{1}H$

tritium

3 AMUs
+
"tiny" %

C = (3): 6p6n, 6p7n, 6p8n

C^{12} C^{13} C^{14}



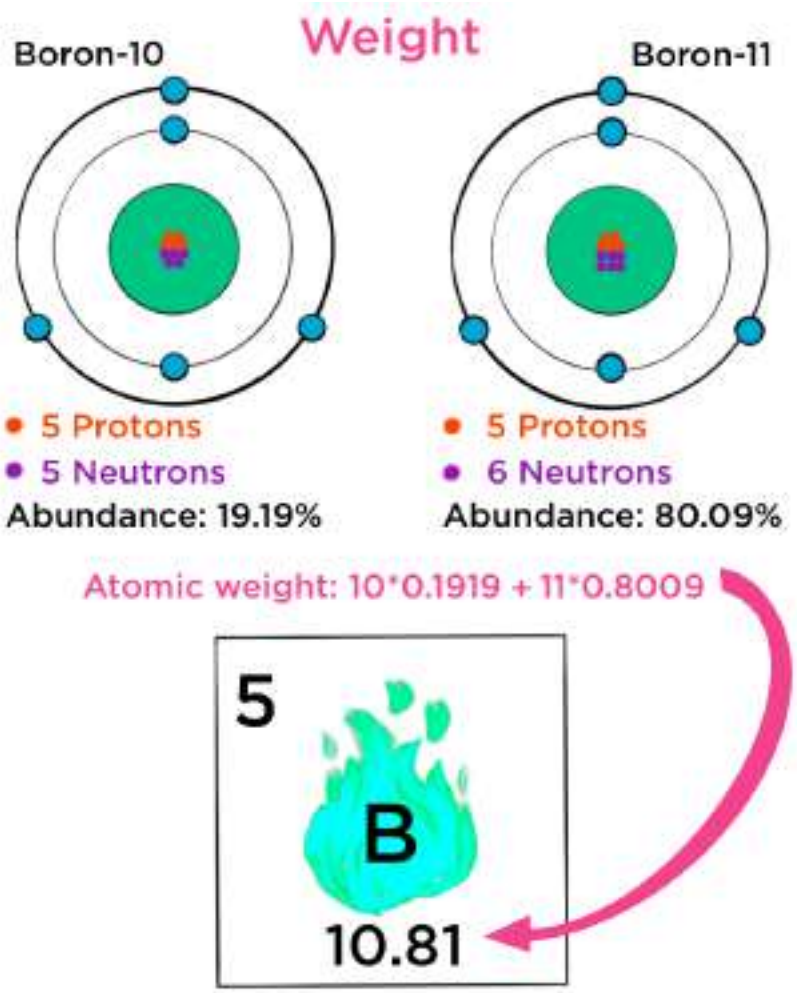
O = (3): 8p8n, 8p9n, 8p10n

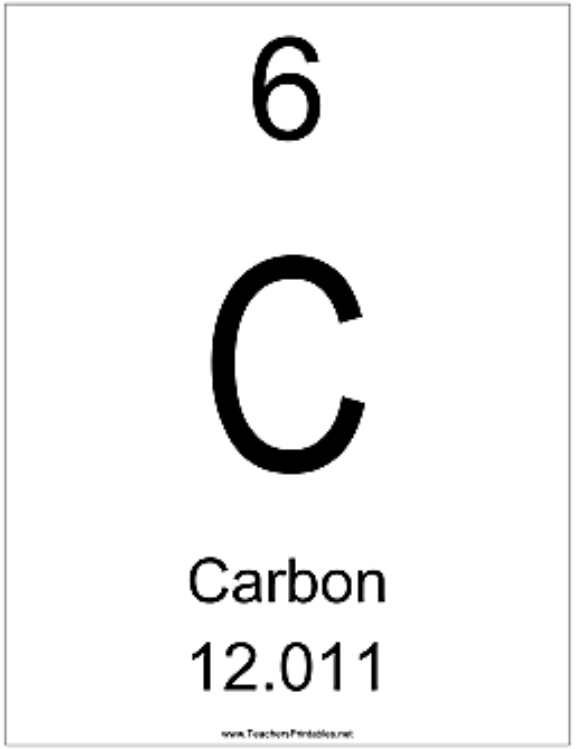
O^{16} O^{17} O^{18}

atomic weight = average AMU of all isotopes + their % of abundance

- ie. B = 10.81

- ie. C = 12.<u>011</u>

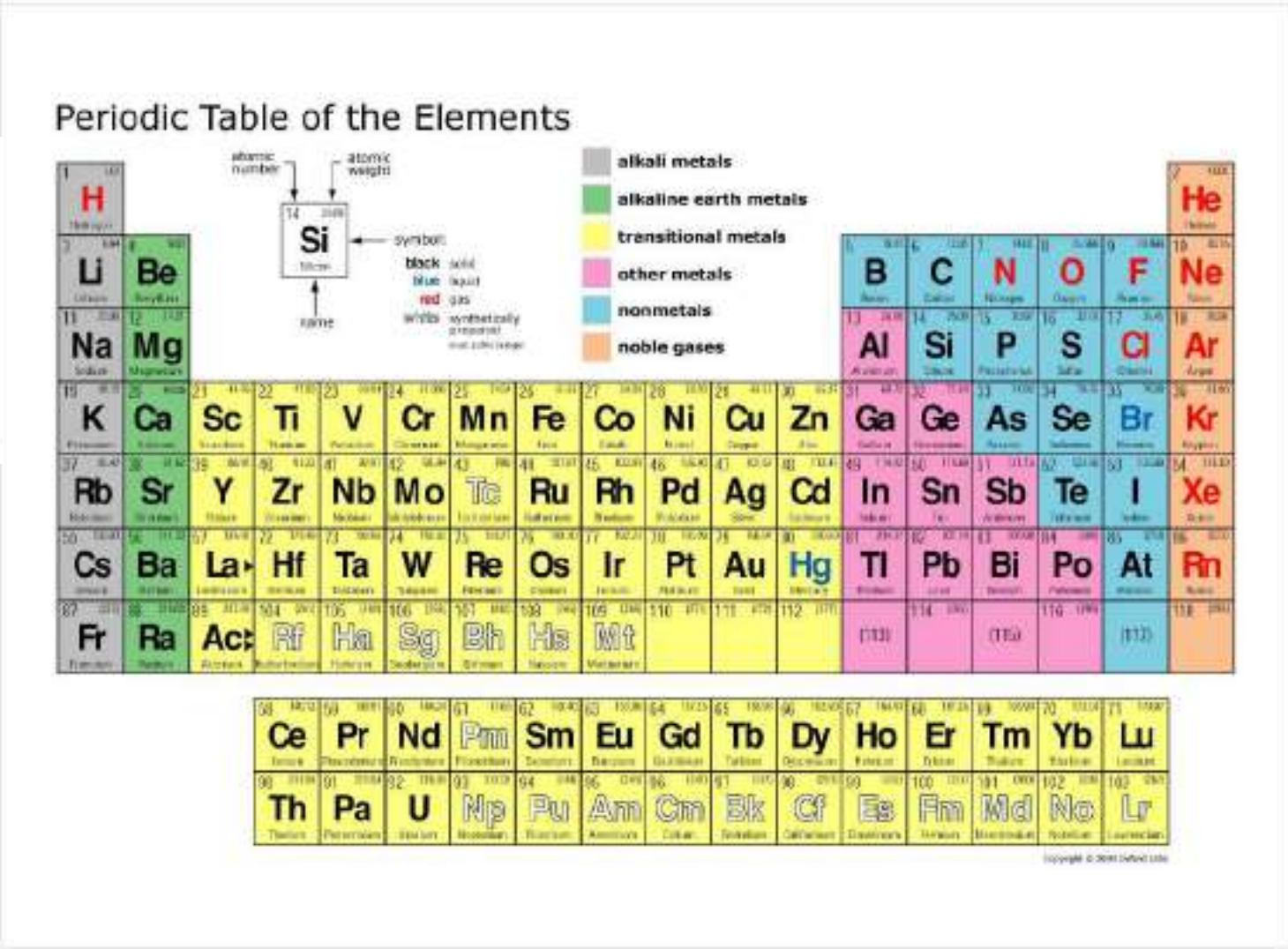




Element = <u>group</u> "club" of similar atoms

- ie H = 3 atoms make up the element "H"

- 92 naturally occurring



Elements Important to Life:

Carbon, Hydrogen, Oxygen, Phosphorus, Nitrogen, Sulfur, Calcium and Iron (Fe)

CHOPN'S CaFe

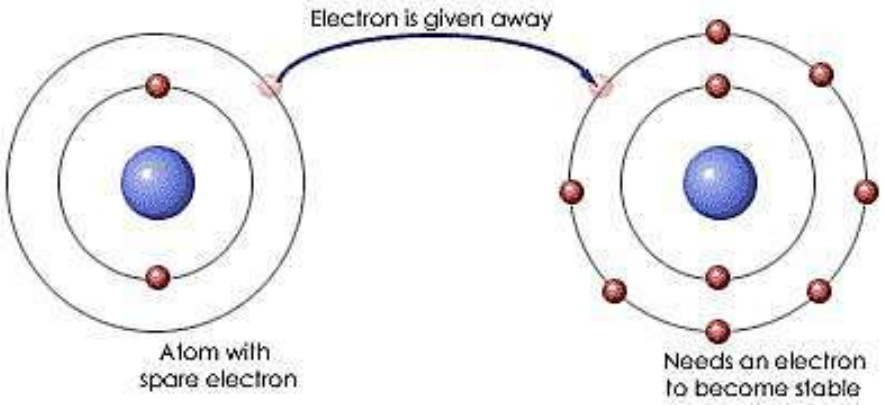
Translation:
"CHOPN'S" CaFe

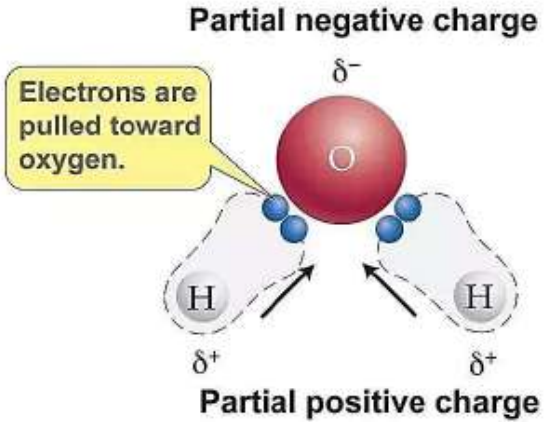
Bonds = creates/contains energy btwn atoms ; (3) types:

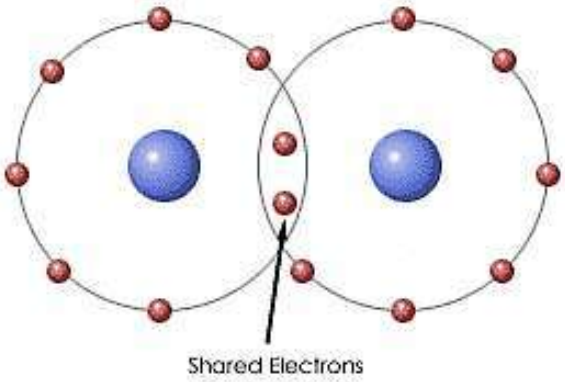
- Ionic = btwn ions via e- exchange; strong

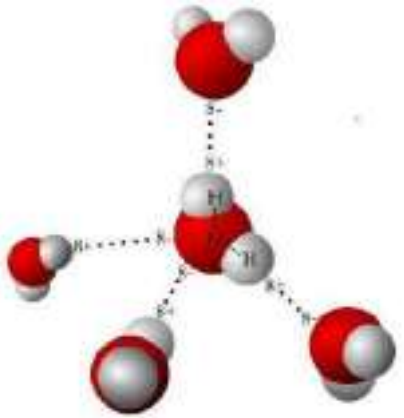
- Covalent = btwn atoms via e-'s sharing; very strong

- Hydrogen = btwn H "+ area" and O, N, F "- areas" due to unequal sharing of e-'s; not ionic; weak



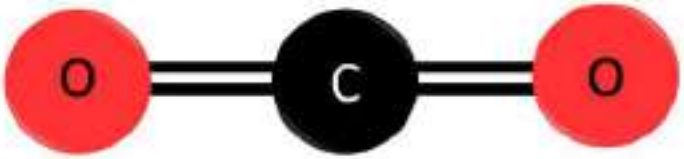


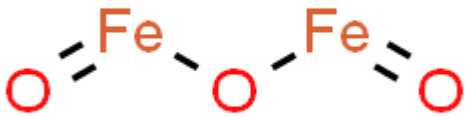


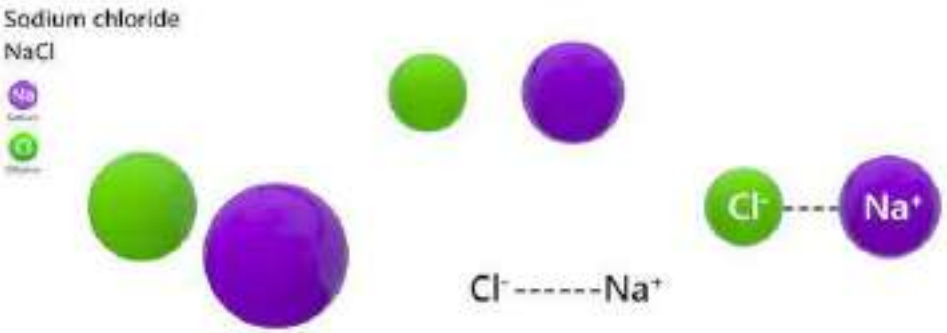


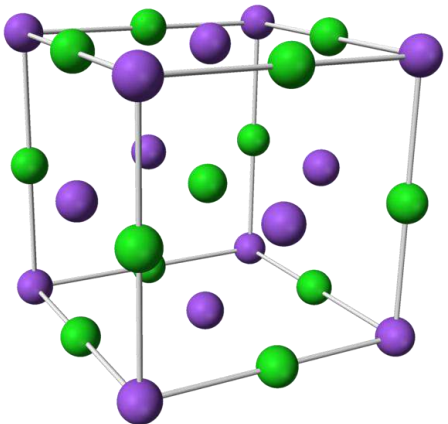
Compound = two "different" atoms; ionic or covalent; linear

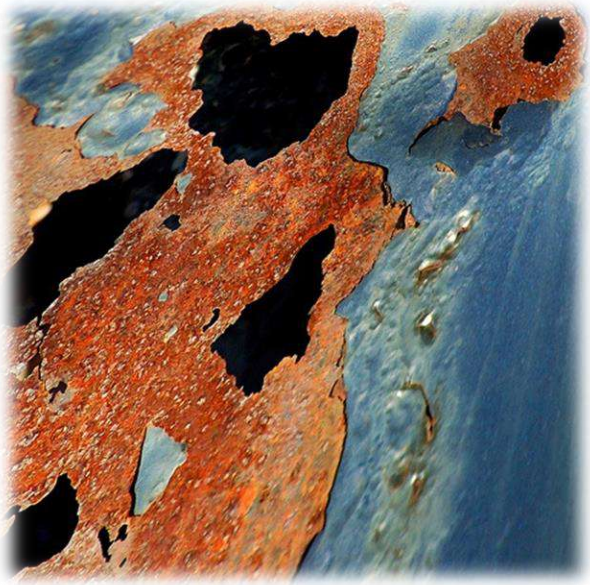
- ie. NaCl = sodium chloride
- ie. CO_2 = carbon dioxide
- ie. Fe_2O_3 = iron oxide











Molecule = two or more atoms; covalent; angular

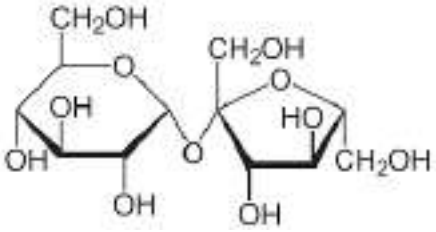
See Diagrams on GD or Text for this Chapter

- monomers = small molecules that make up larger ones

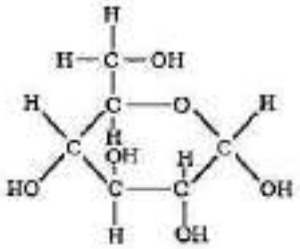
- polymers = large molecules made up of monomers

- ie H_2 ; (diatomic); also O_2 or N_2

- ie's: Sugars "carbs": C, H, O (ie. Glucose = $C_6H_{12}O_6$)

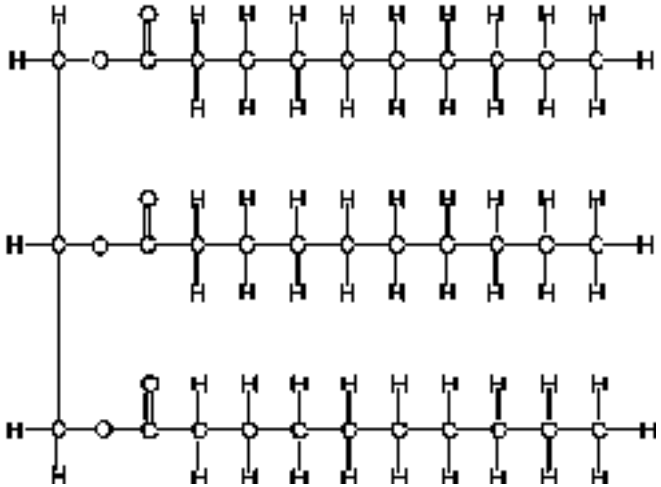


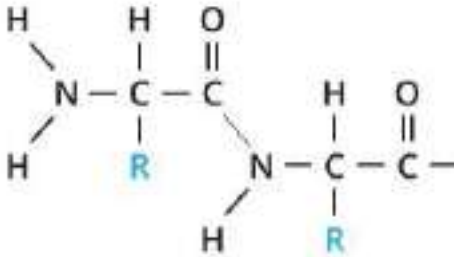
Lipids "fats": C, H, O

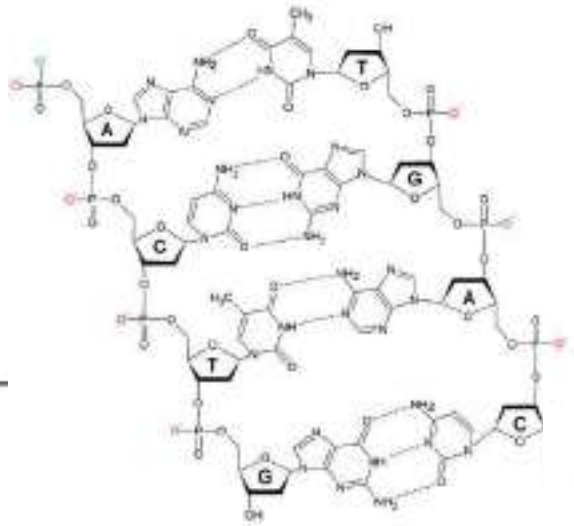


Proteins: C, H, O, N, S

Nucleic Acids: C, H, O, N, P

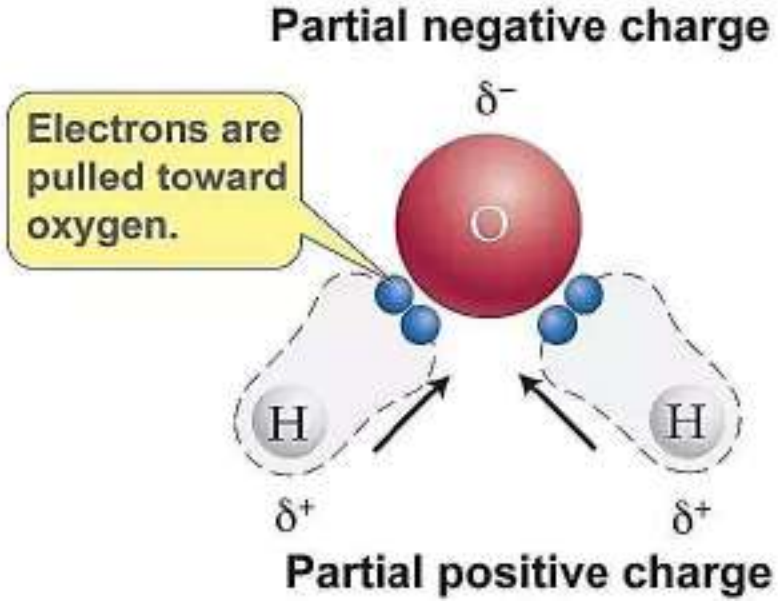


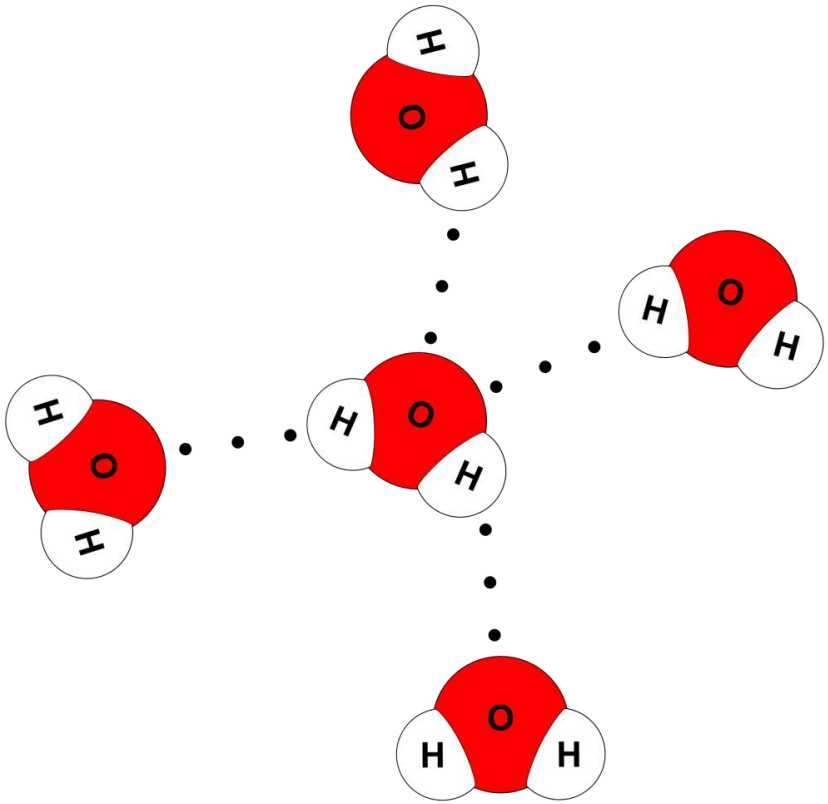




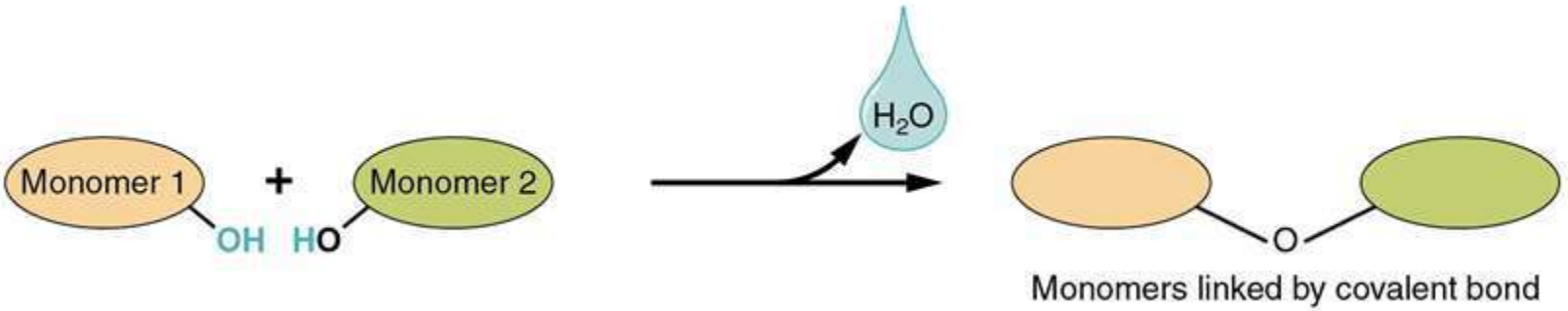
Water = H_2O; "compound-molecule":

- two diff. atoms = compound
- shares e-'s unequally / angular = molecule
  - thus, bipolar (- and + sides ; yet, neutral) → H-bonds

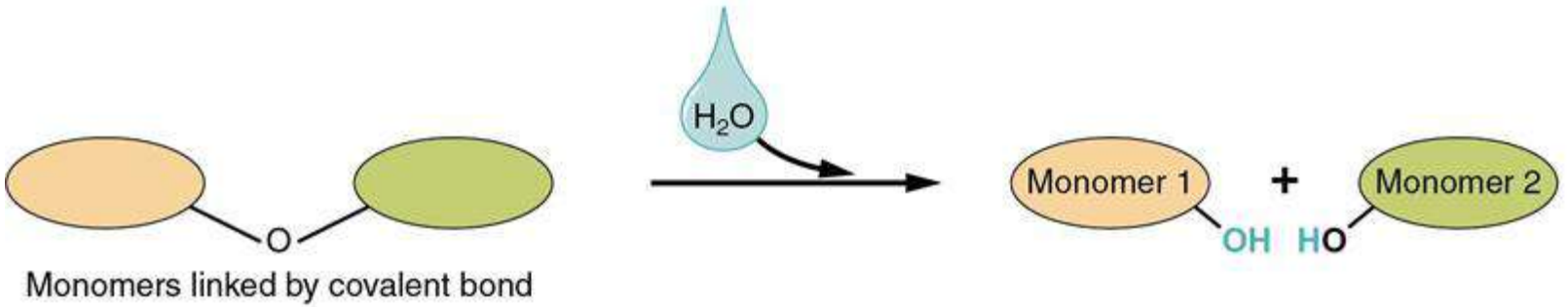




- if H_2O removed → molecules "made" = dehydration synthesis
  - "anabolism"



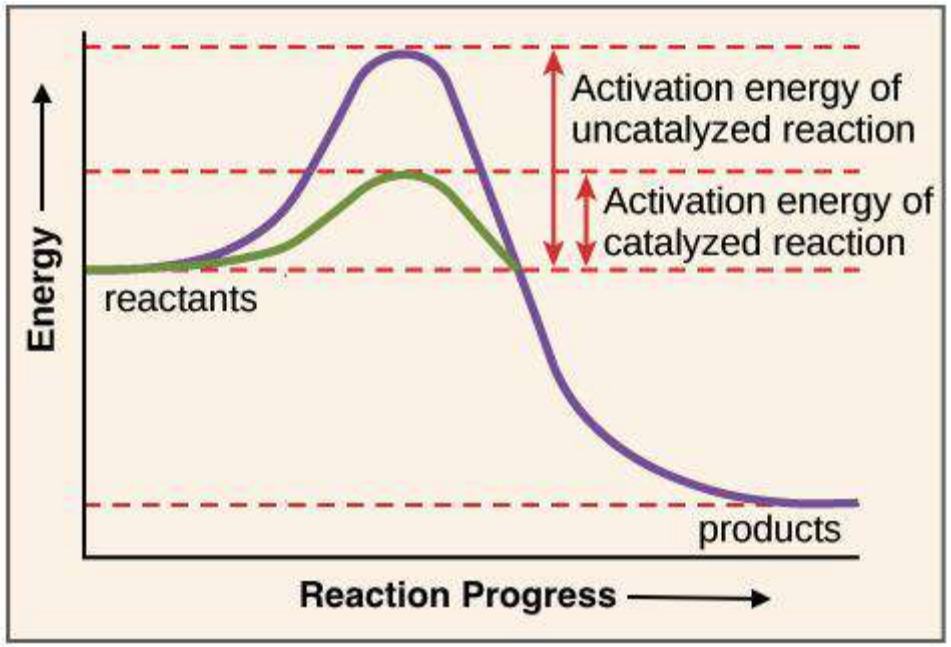
- if H_2O added → molecules "break" = hydrolysis
  - "catabolism"

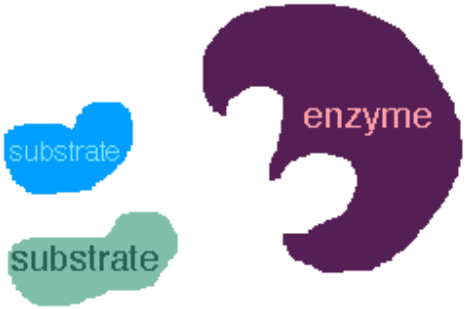


Enzyme = protein

- **reduces energy for chemical reactions**

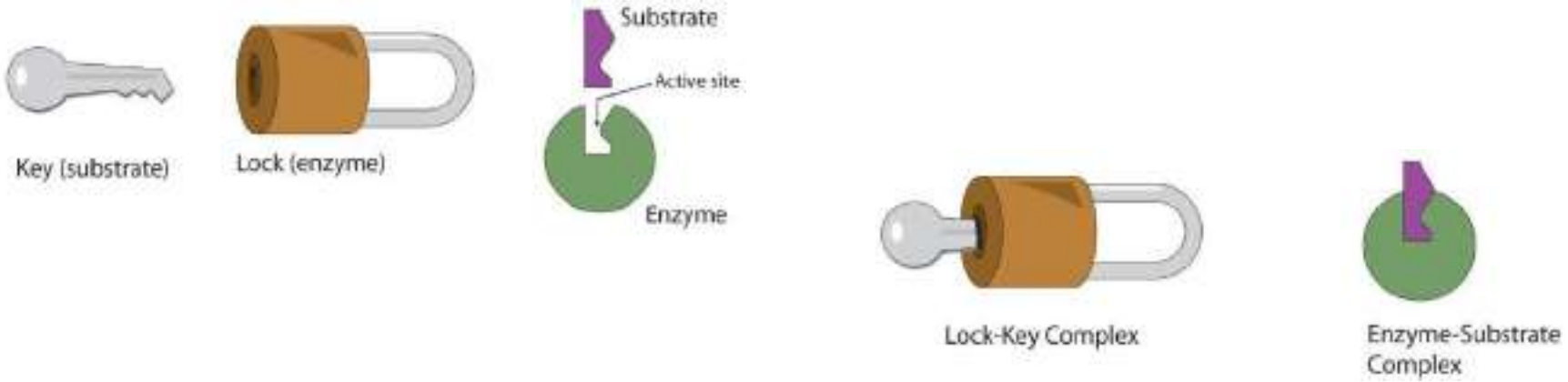
- **makes "or" breaks molecules in cells; H_2O helps**



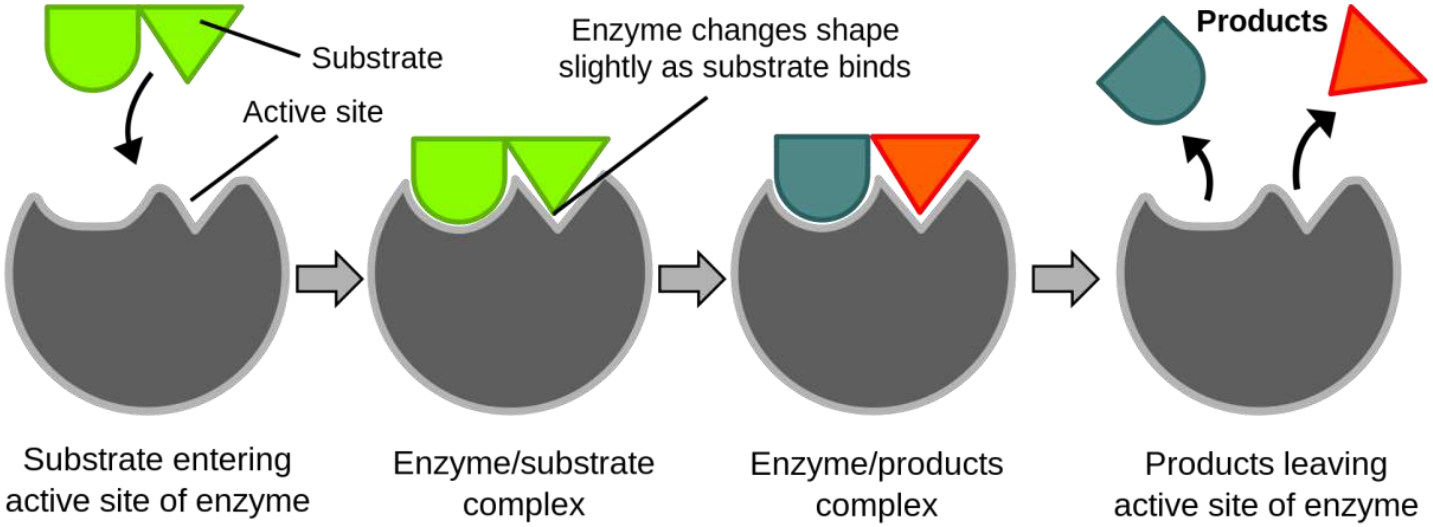


Substrate(s) = <u>specific</u> molecule(s) that bond to an enzyme

-ie key/lock



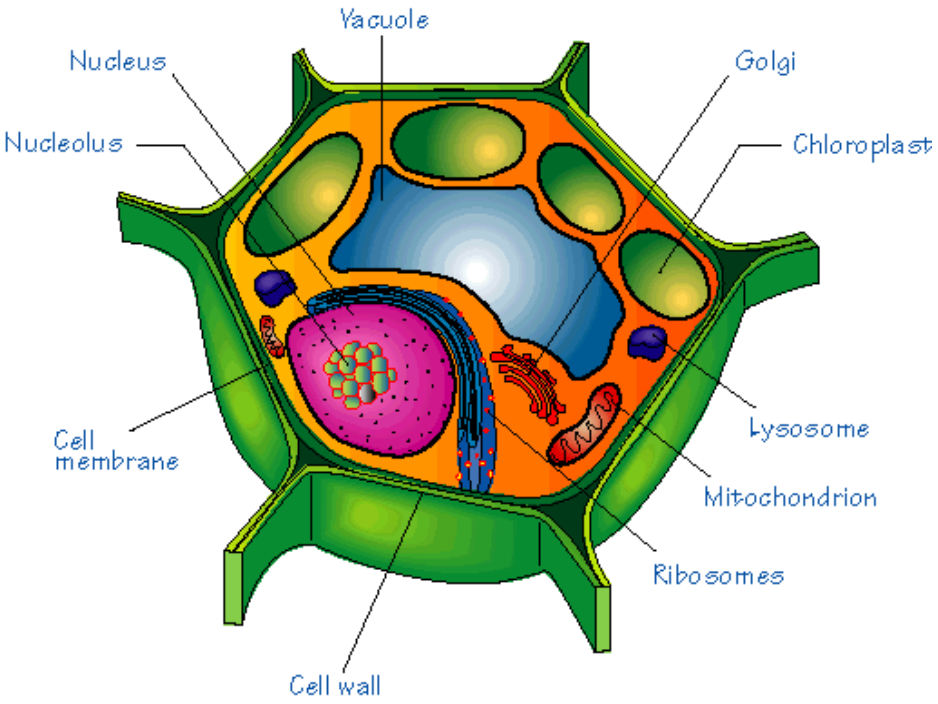
Active Site = bonding "area"

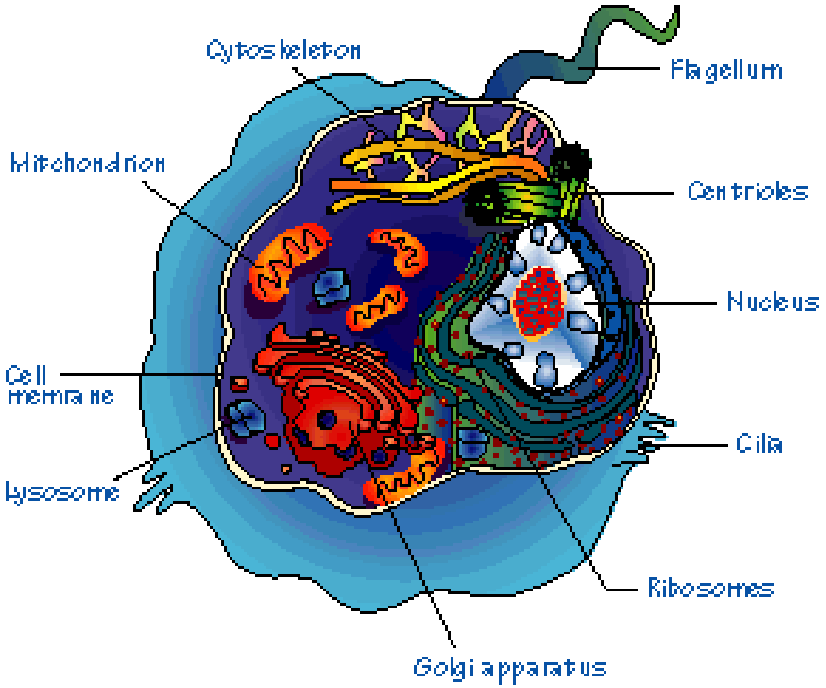


Organelles = molecules working together

- structures in cells w/ specific functions

- ie nucleus, ribosomes, mitochondrion, etc…



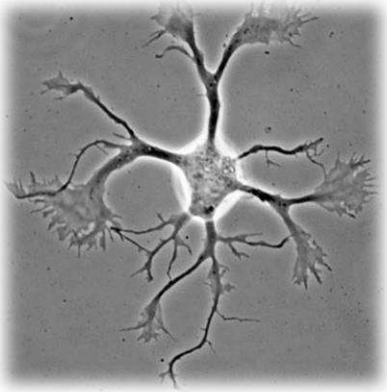


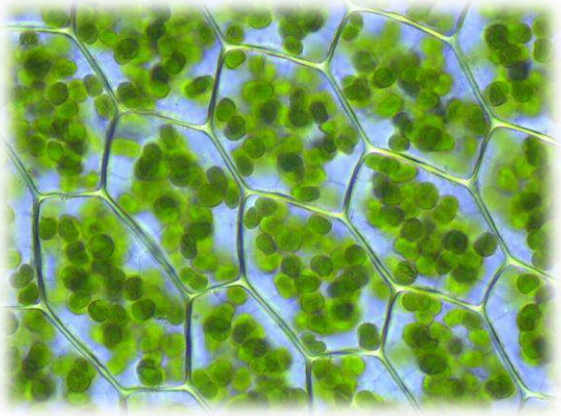
CELL = organelles working together

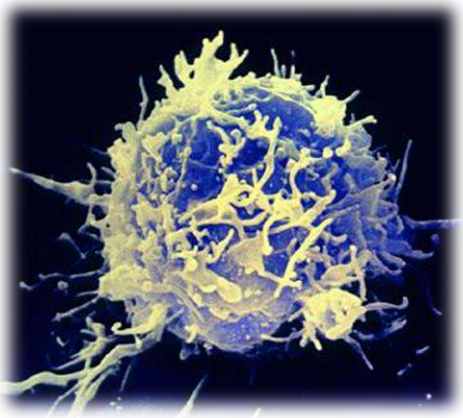
- defines LIFE *(tbd)*

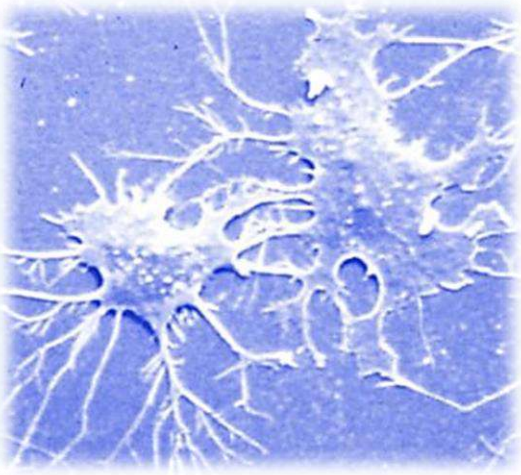
- ie's animal: neuron, epithelium, lymphocyte, osteocyte

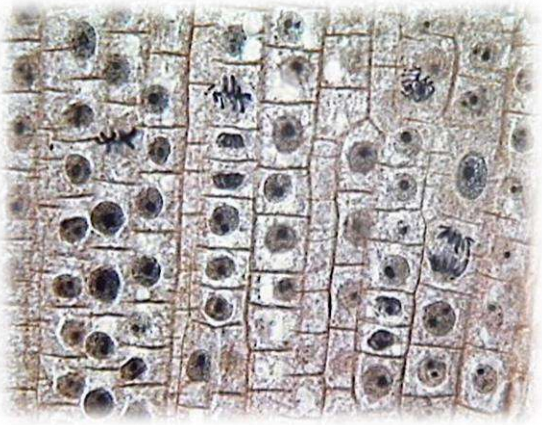
- ie's plant: epithelium and parenchyma



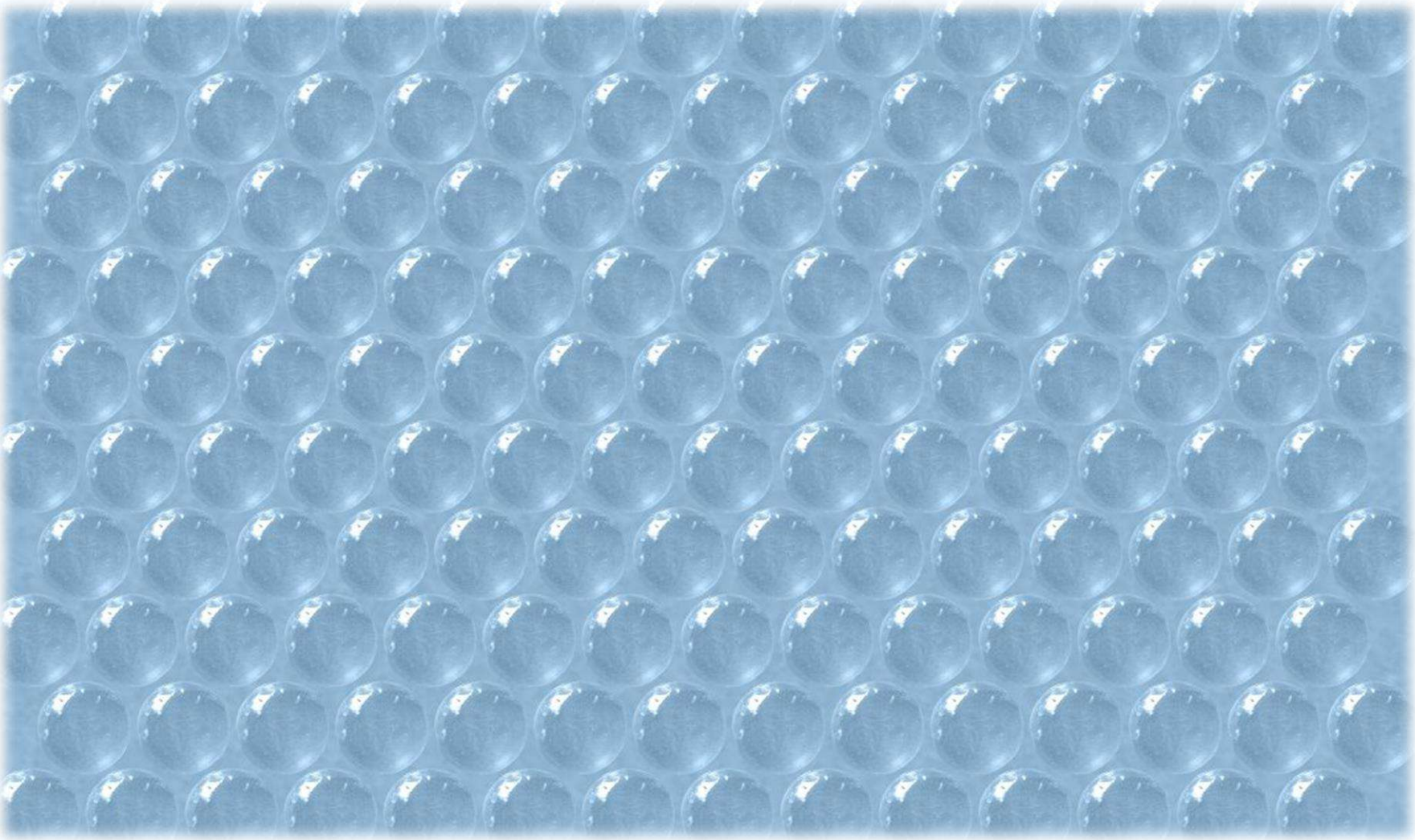






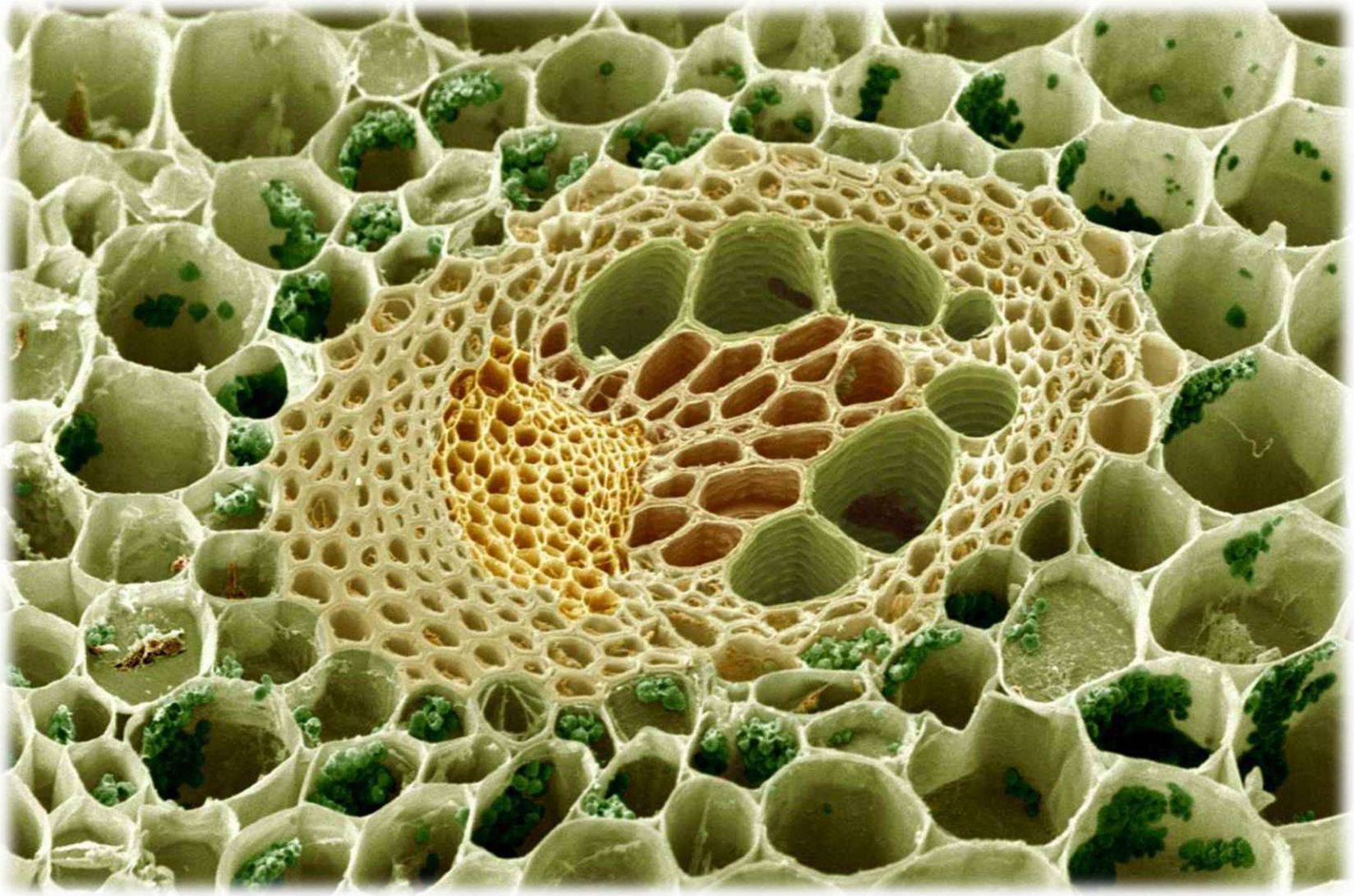


Tissue = cells working together

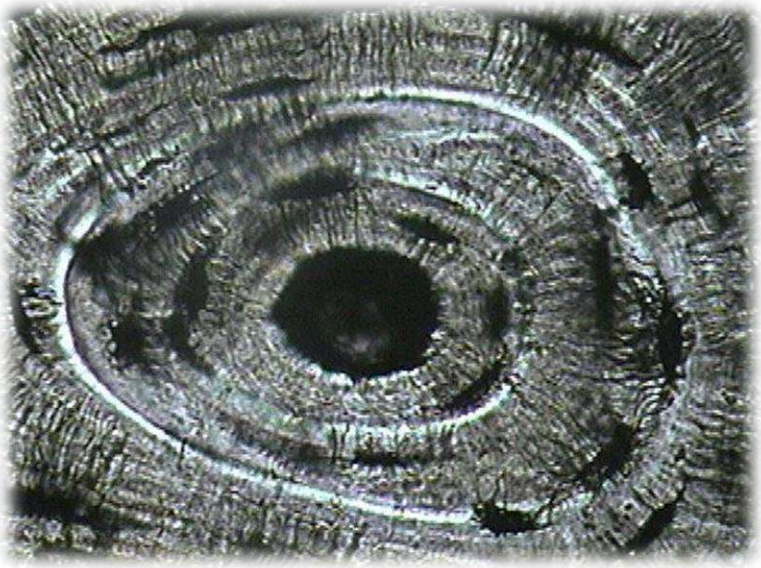


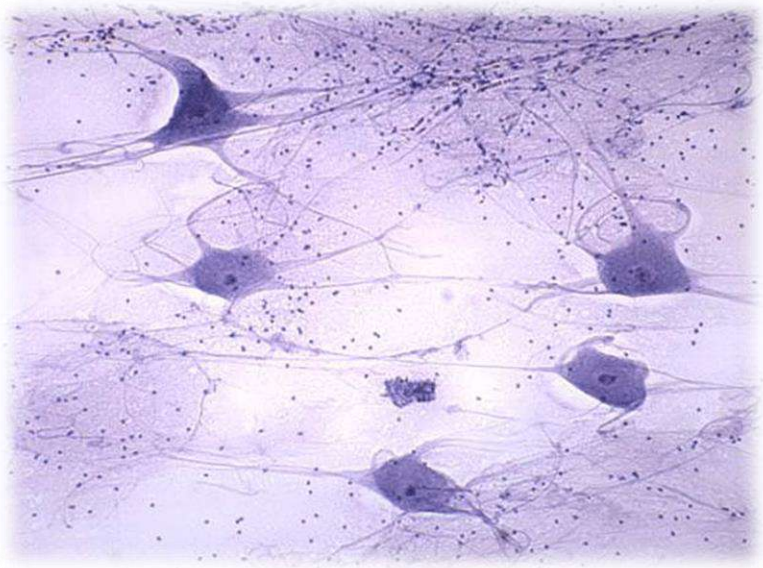
click picture or go to: http://www.primepuzzle.com/images/bubblewrap.swf *(don't let complete)*

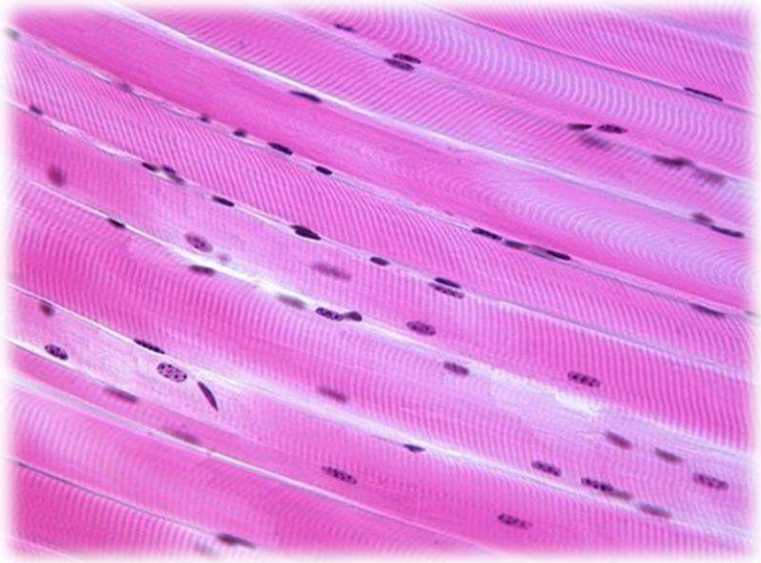
- ie’s plant: vascular and ground tissue



- ie’s animal: bone, muscle, nerve, and epithelial

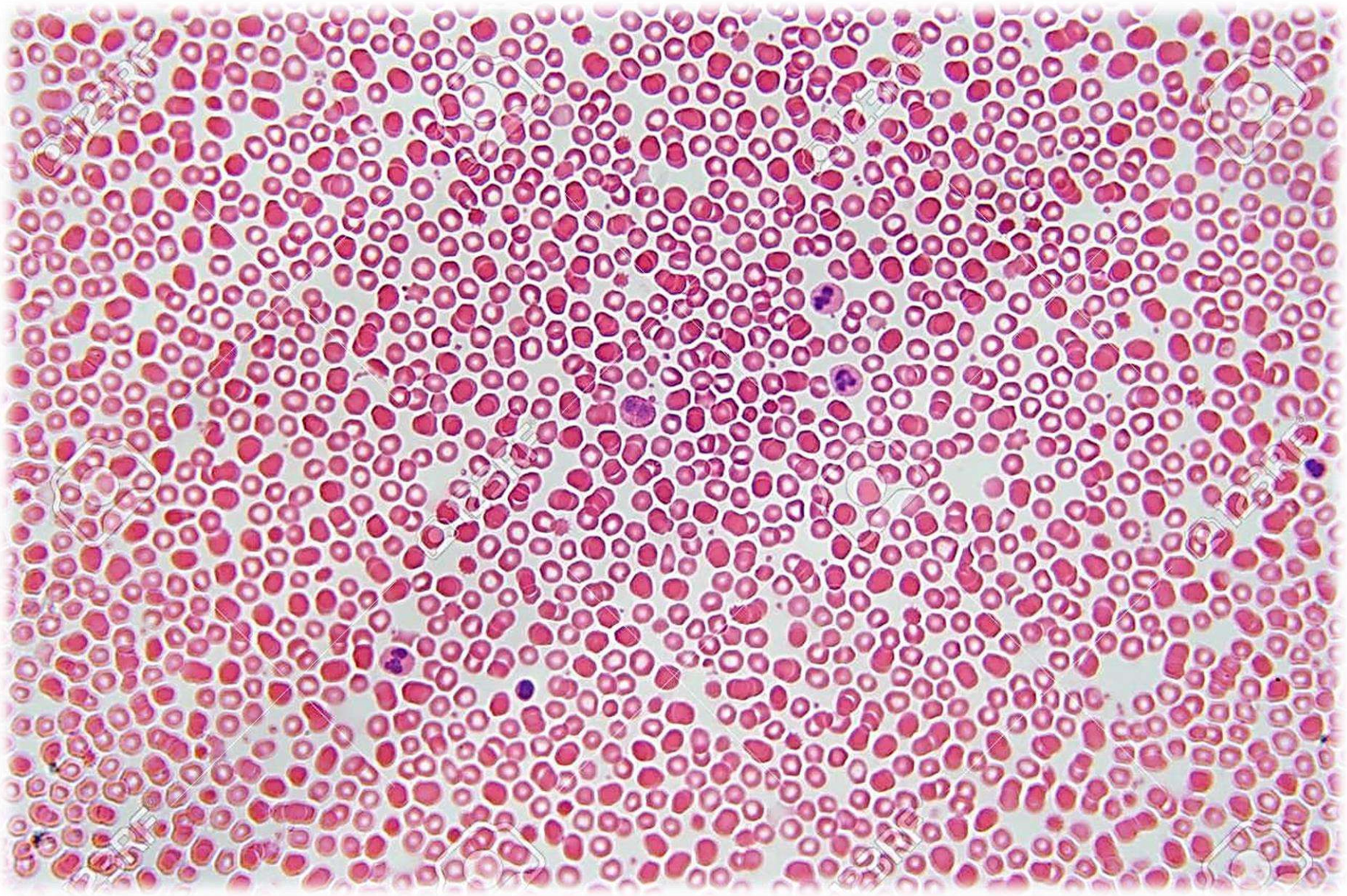






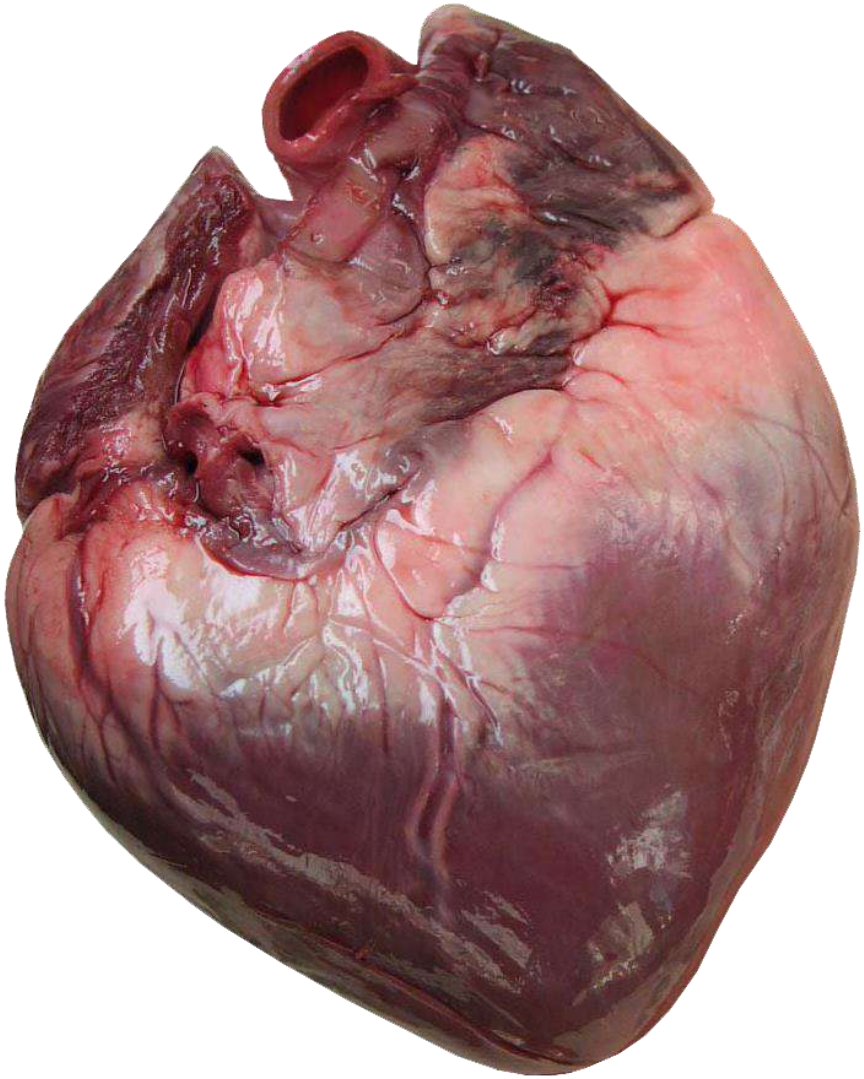
Blood a Tissue ?

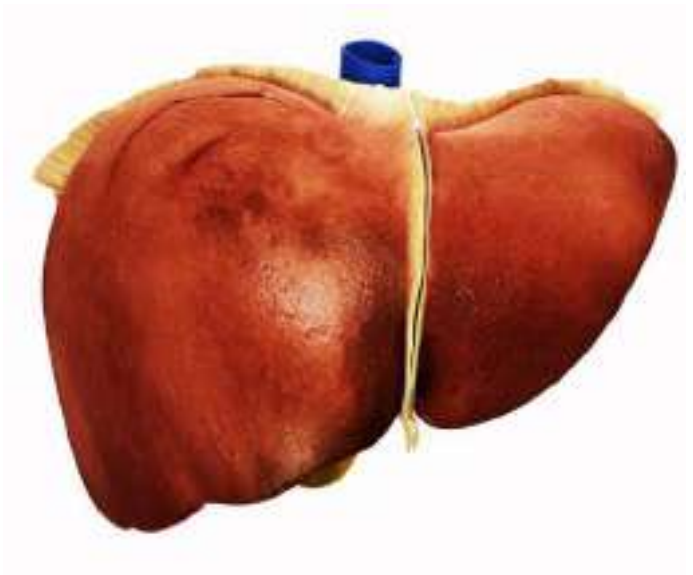
Yes

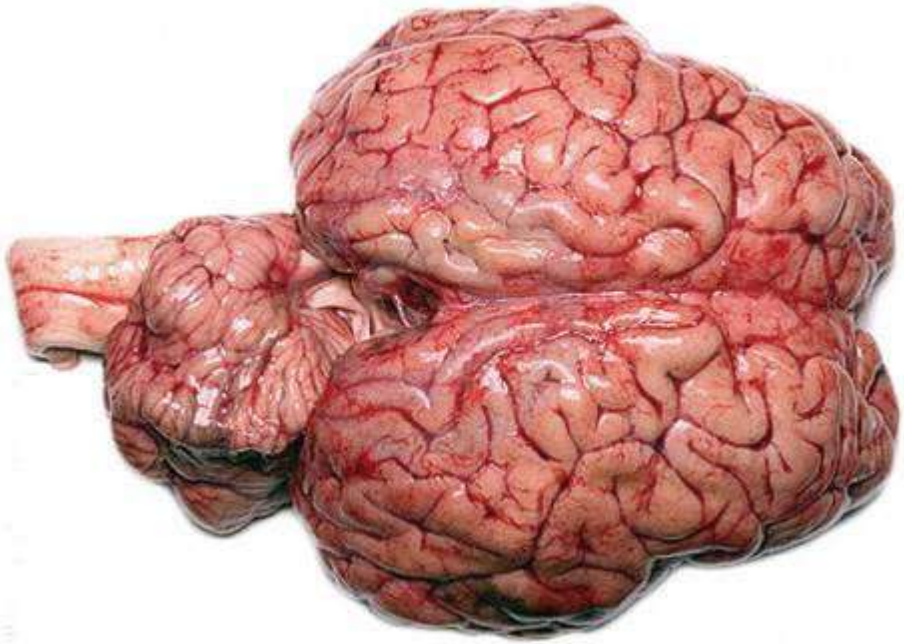


Organ = tissues working together

- ie's animal: heart, liver, brain

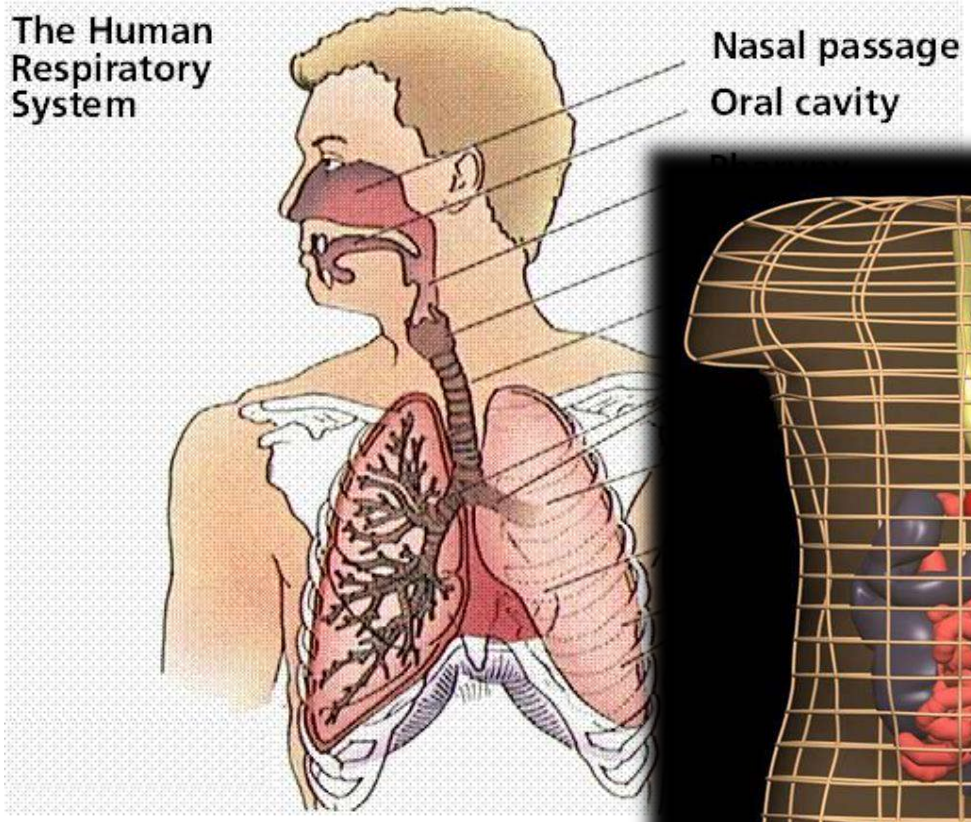


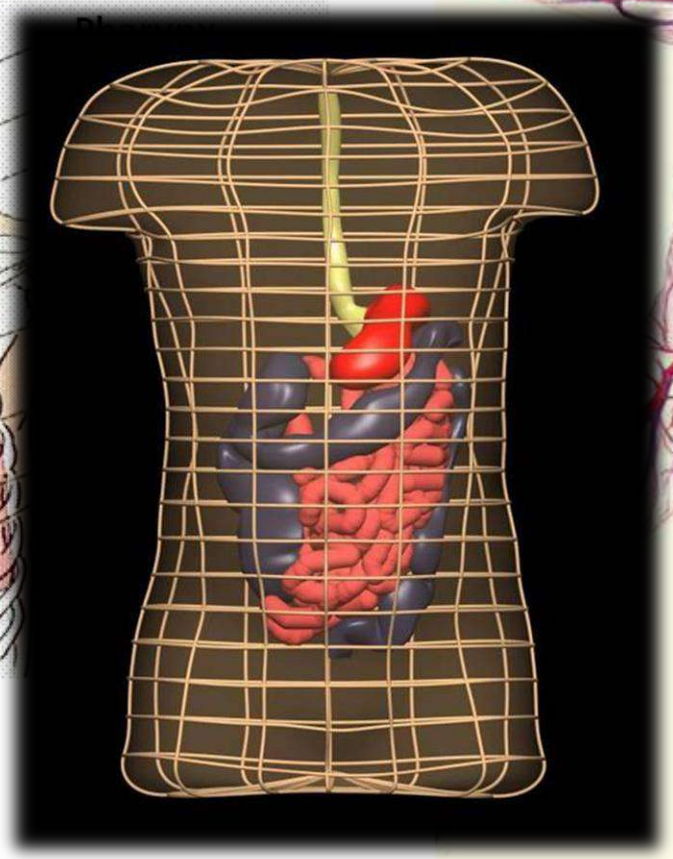


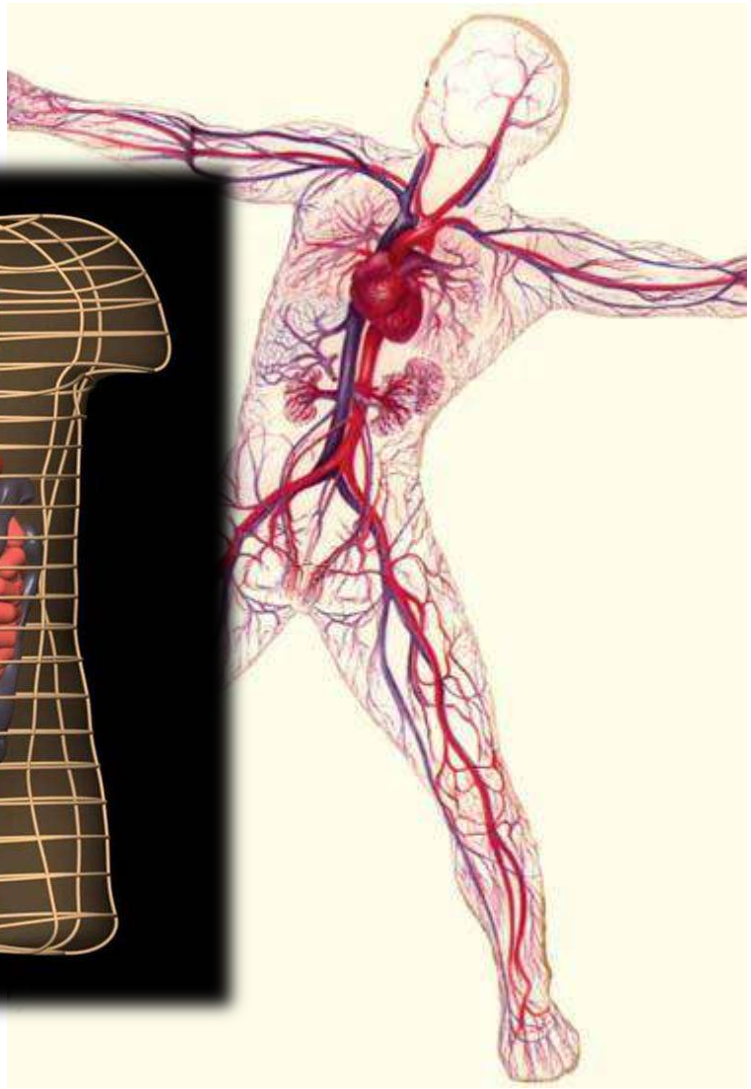


System = organs working together

- ie animal: circulatory, respiratory, digestive







Organism = systems working together

- <u>single</u>-celled, ie. protozoa: amoeba / paramecium

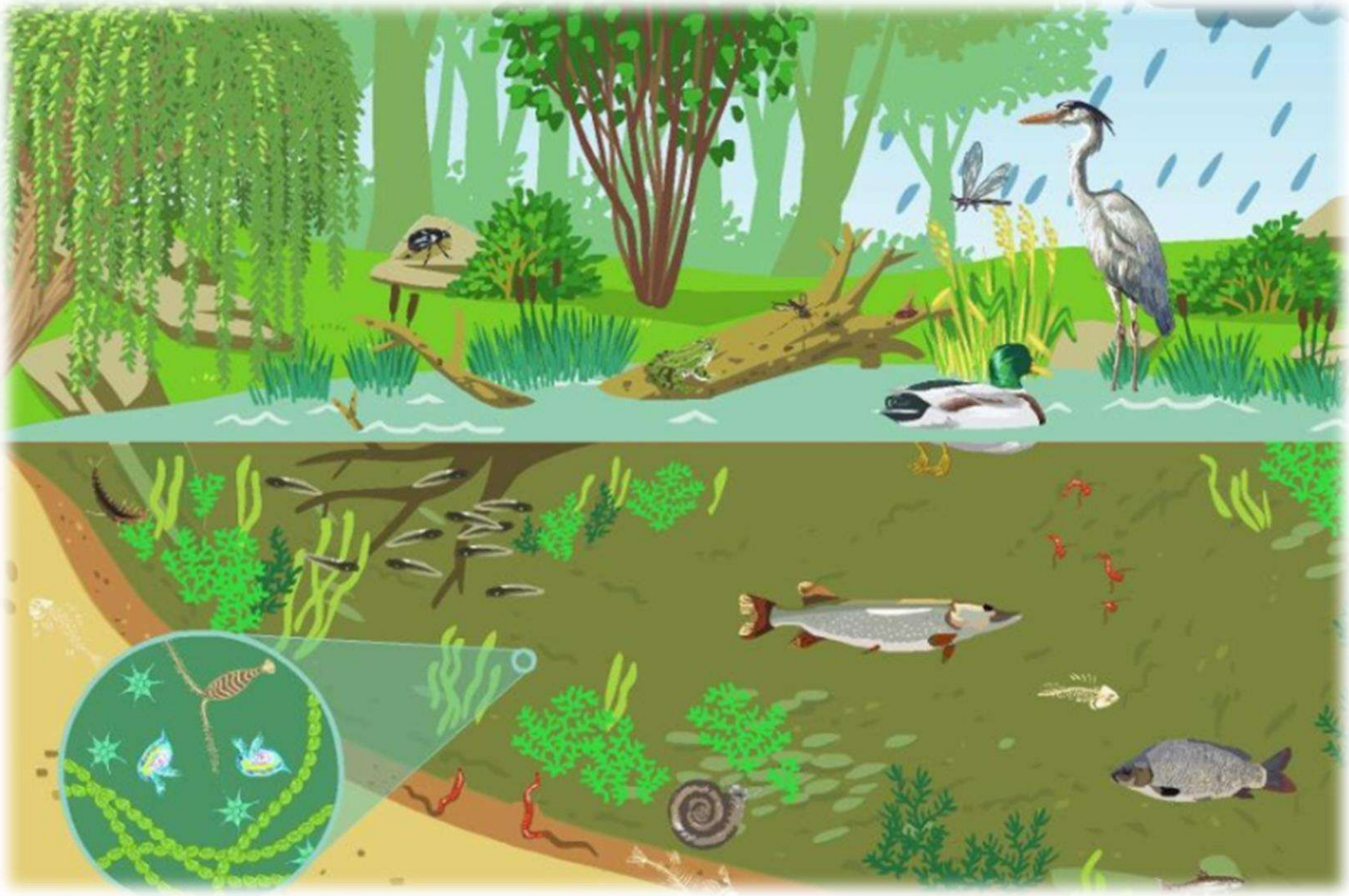
- <u>multi</u>-celled, ie. plant, fungi, animal ; dependent = good

Population = organisms of the <u>same</u> species

- ie rainbow trout

Community = <u>different</u> populations

- ie beaver, fish, birds, lily pads, cattails, microbes, etc…



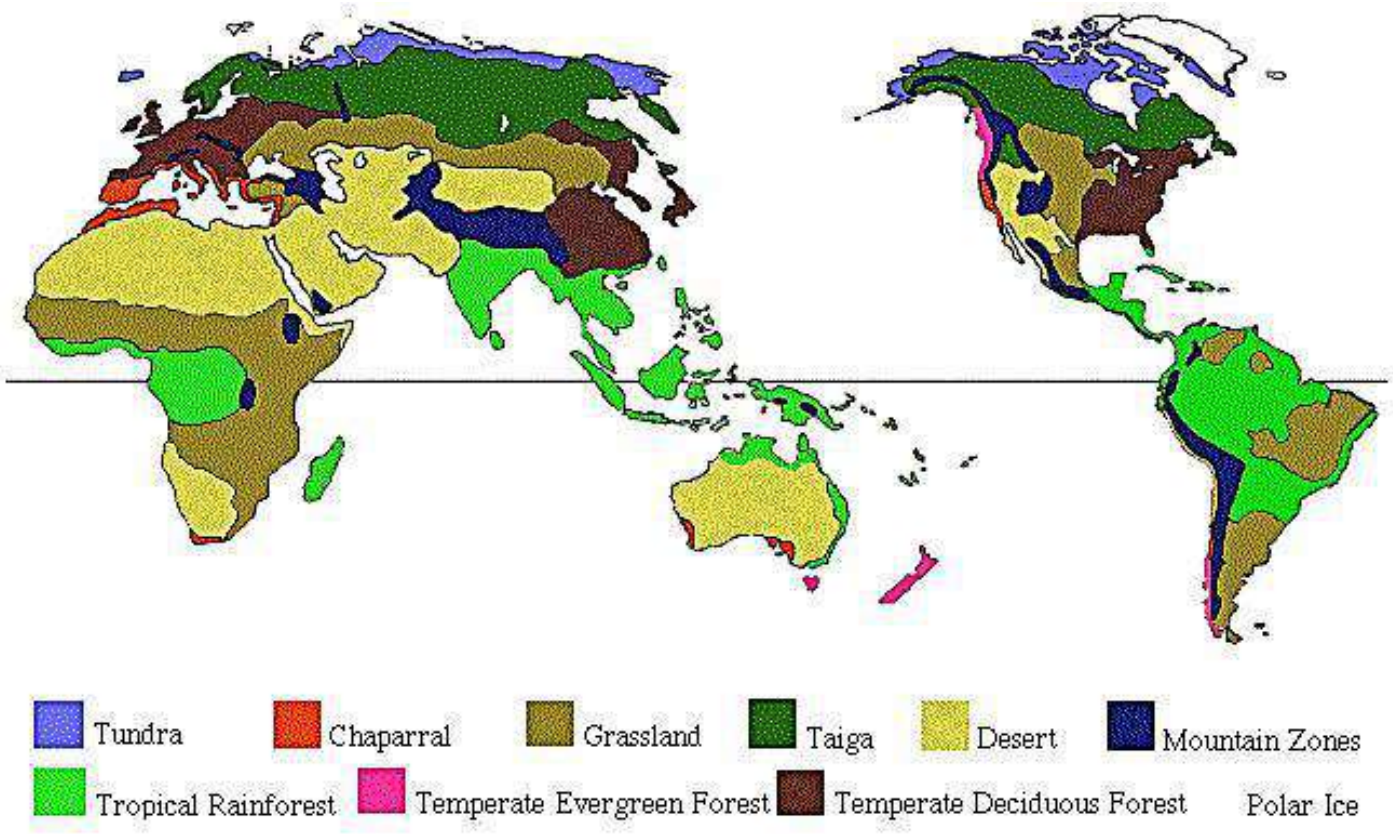
Ecosystem = community + "environment" ; living + non-living

- ie. fish, snails, cattails, ... <u>and</u> H_2O, gases, light, temp, ...

- ie. pond (or a playground, woods, mud puddle, etc…)

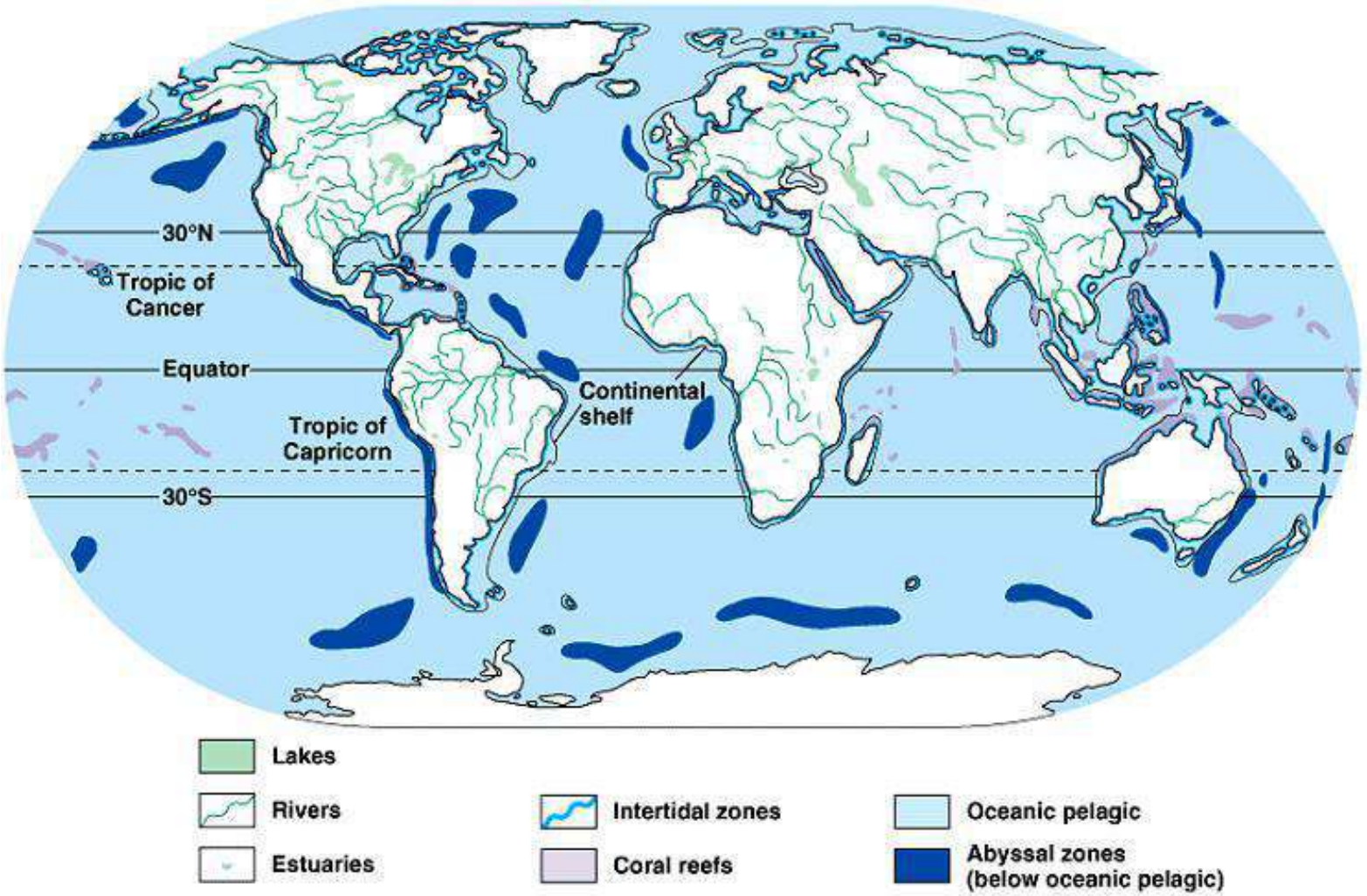
Biome = group of ecosystems

- land: ie. rain forest, desert, tundra, deciduous forest, coniferous forest, and grassland



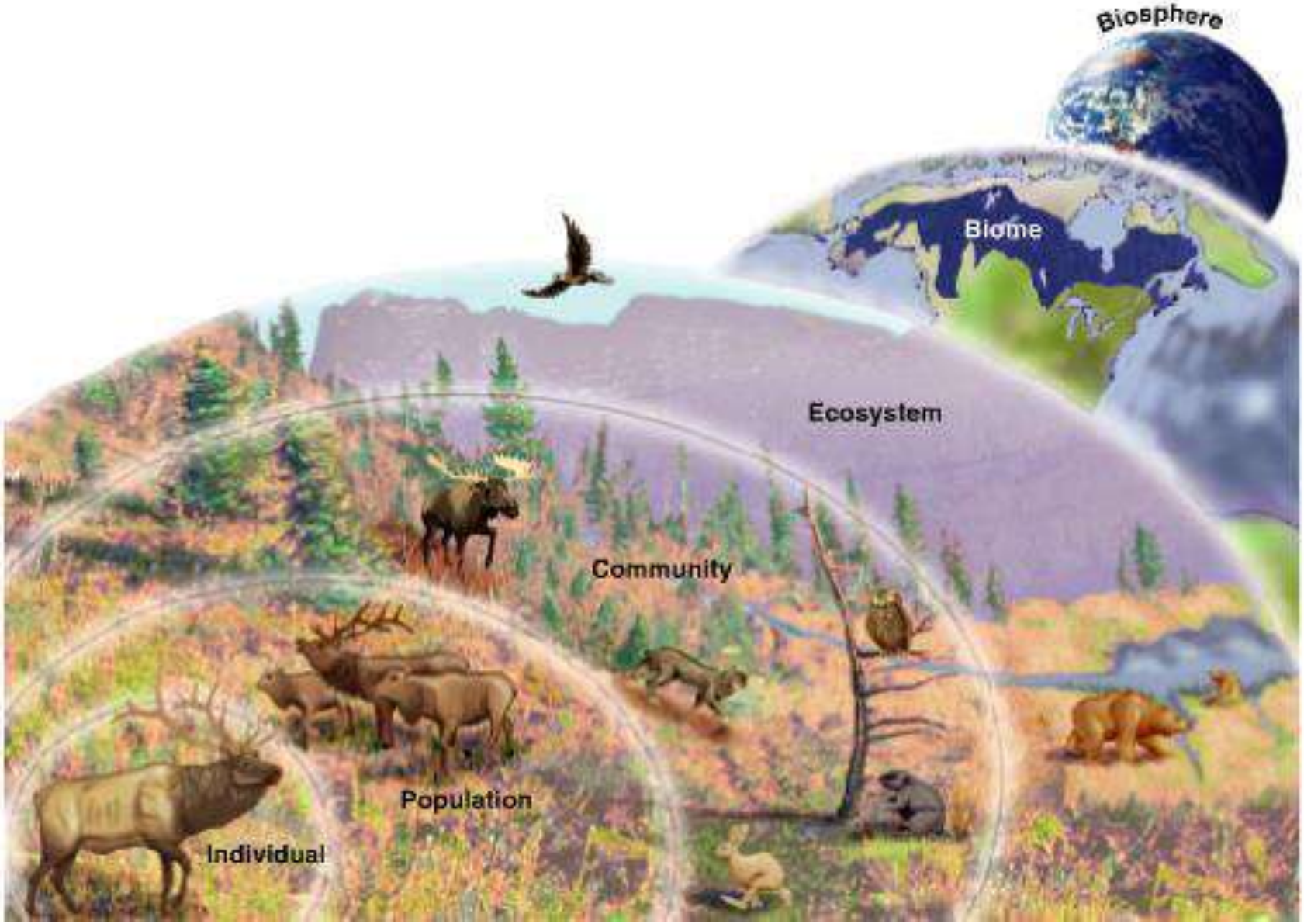
Note: "Chaparral" biomes contain mostly shrubs, dwarf trees, grasses not found in desert biomes ; "Taiga" would be your coniferous forest biomes

- aquatic: ie lakes, rivers, and reefs, etc…



Biosphere = group of biomes

- ie Earth



“Hierarchy of Life”

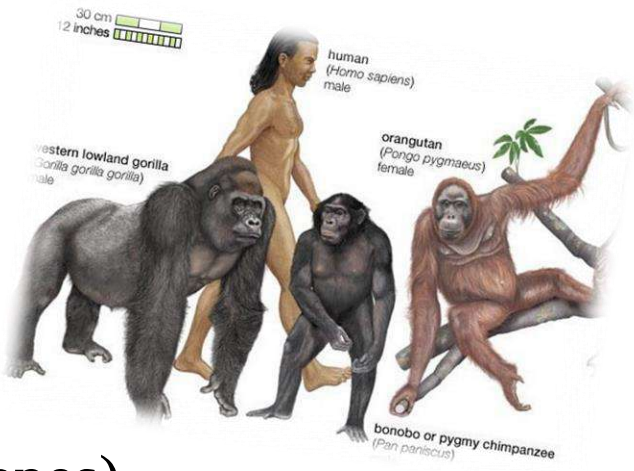
Biological Classification "Taxonomy"

ie. Humans

Kingdom = **Animalia** (1 of 5; vital breath)

Phylum = **Chordata** (vertebrate)

Class = **Mammalia** (hair, milk, warm)

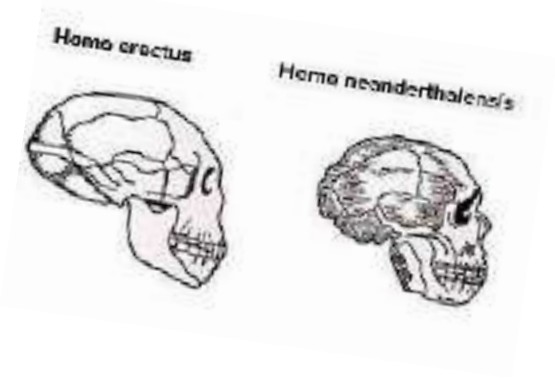


Order = **Primate** (ie's lemur, monkeys, apes)

Family = **Hominid** (ie's great apes (humans, chimps, gorillas))

Genus = **Homo** (human-like); *tbd*

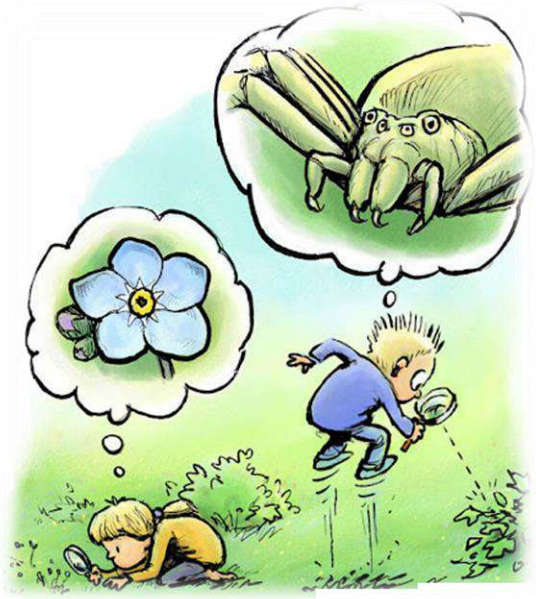
Species = **sapien** (wise)



"**K ing P hillip C alled O nly F or G ood S oup**"

Life

- **Spread out so nobody is w/in 10 feet of you; no talking**
- **Use eyes and ears to observe ; move around / look under things**
- **<u>Draw</u> 8+ examples of life in your notebook**
- **<u>Write</u> 1 word that describes why your example is alive next to your drawing**
- **Be prepared to share**

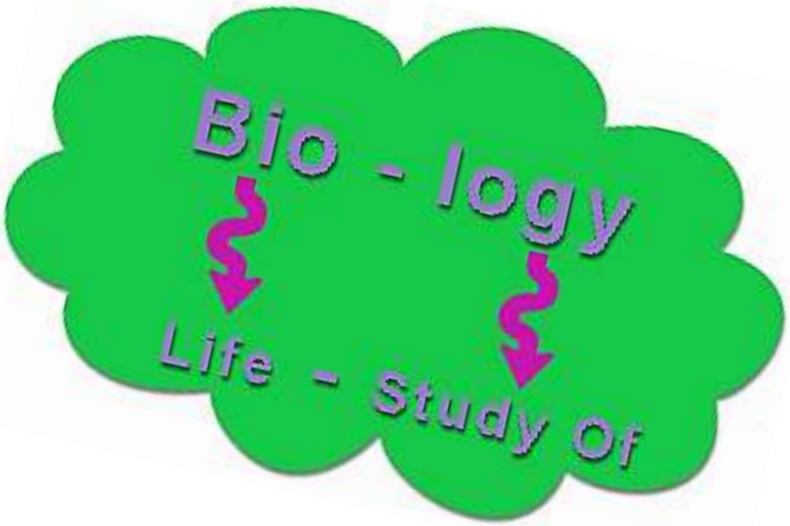


- Let’s say you’re an alien looking for life…

- Write 3-4 reasons why you would think the flame is a life-form…

- Why then….. *(tbd)*

Characteristics of Life



- **Moves**
- **Energy** (autotrophic or heterotrophic)
- **Adapts**
- **Grows**
- **Excretes** (heat, gases, water)
- **Response** (stimuli)
- **Water**
- **Organic** (carbon based)
- **Reproduces** (ability to)
- **Metabolism** (chemicals broken down for energy → heat waste)
- **CELLS** (is "a" and/or composed of) = **#1**

It's a ..... MEAGER WORM, "C" it?

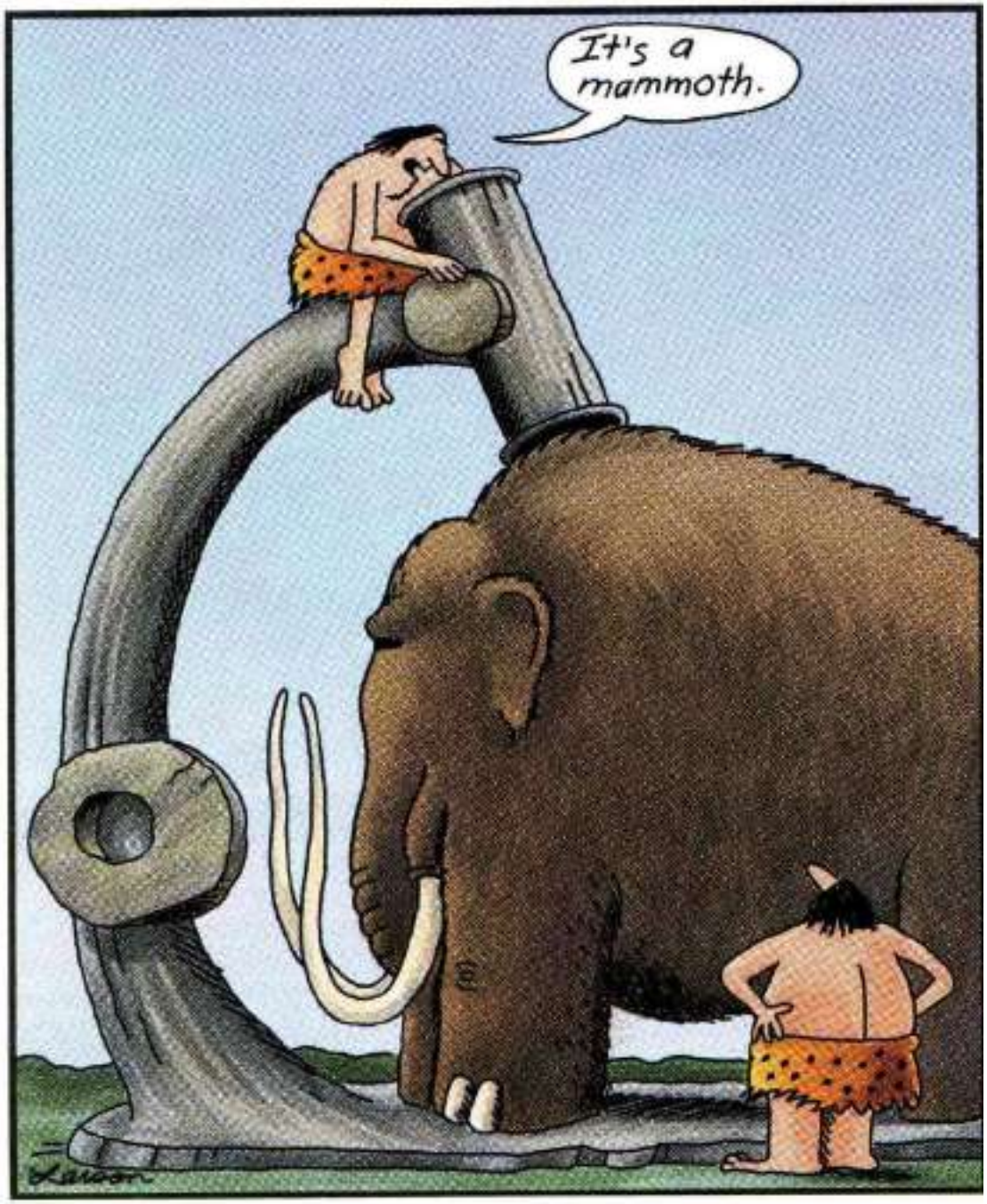
Thin/Lean

Biological Tools

Microscopes

Magnification = increase in size

Resolution = increase in detail ; focus



Early microscope

Types and History

Light Types

Simple Scope (uses one lens):

- ie magnifying glass

Anton van Leeuwenhoek (1632-1723), Dutch

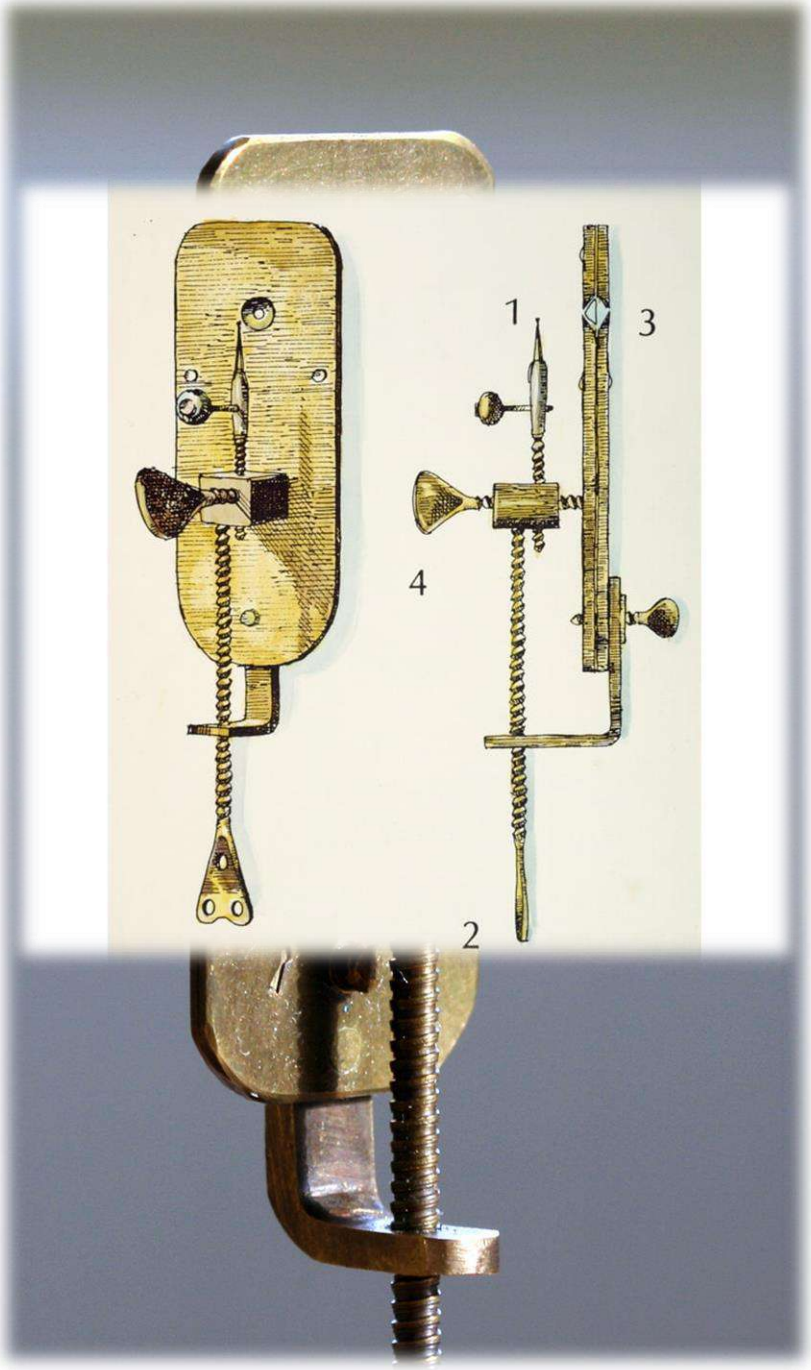
- cloth merchant / lens grinder

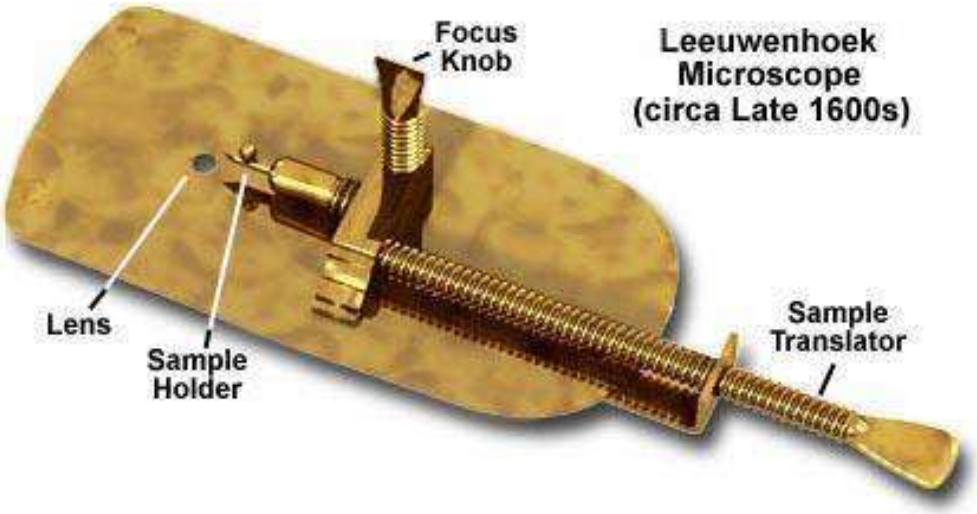
- <u>1668</u>, invented a “practical” simple scope

- ~270x

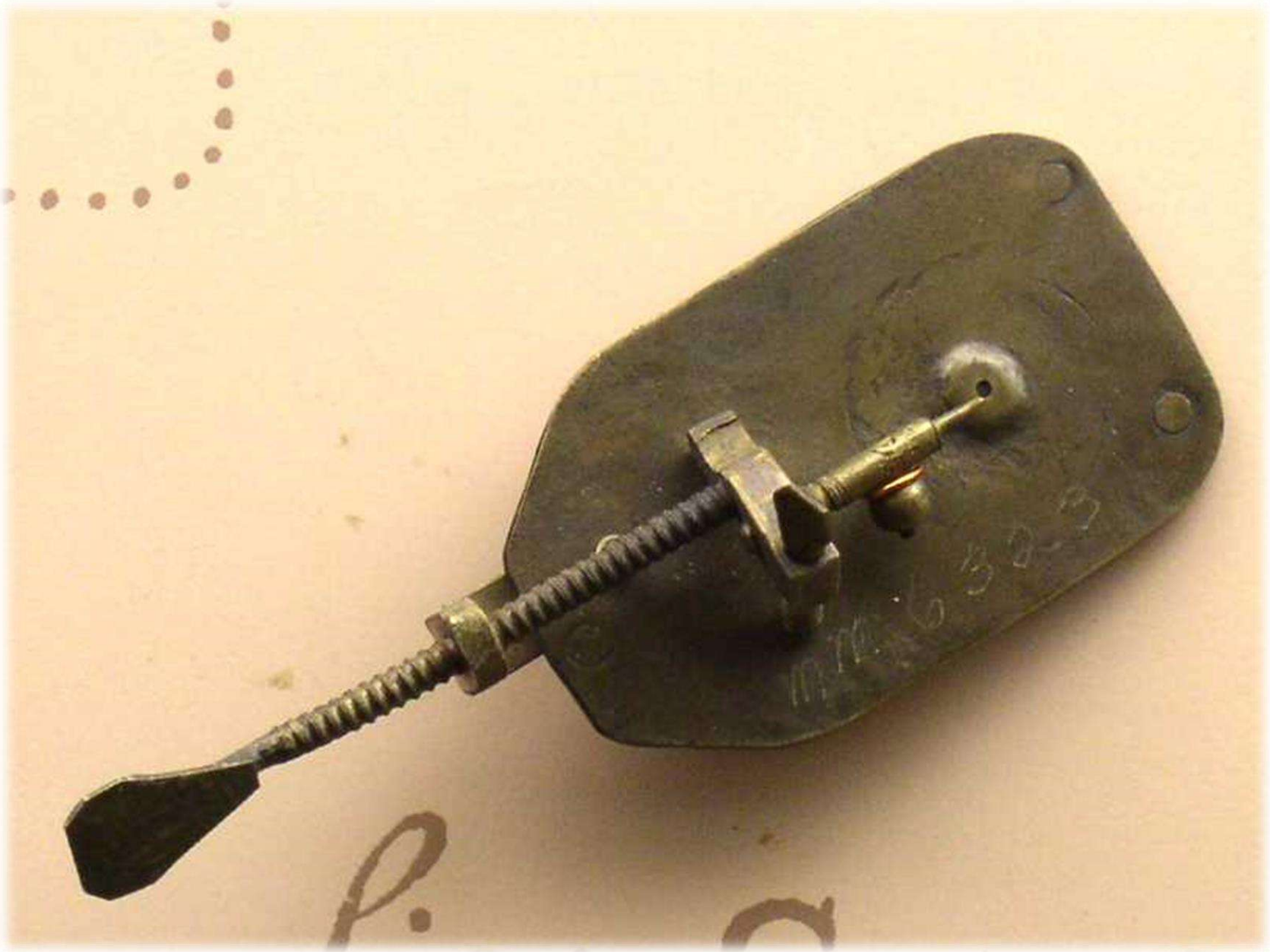
- algae, protozoa, blood, etc…

So… what did it look like?





So, how big was it?



Thought to have made ~500 scopes ; ~9 exist today

Compound Scope (uses 2 lenses):

Hans and Zach Janssen (son-father); spectacle makers

- <u>1590</u>, invented a somewhat "impractical" compound scope

- ~3-9x

Note: Galileo re-positioned lens → telescope

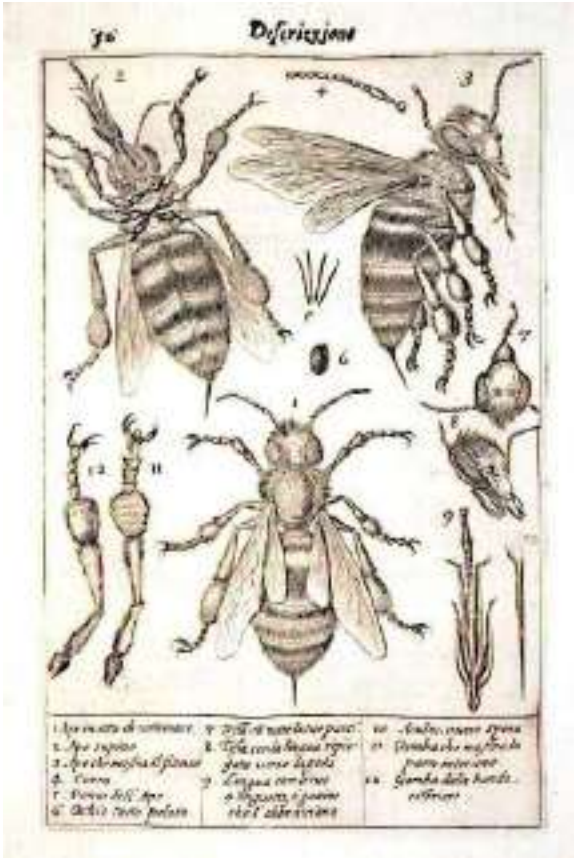
Francesco Stelluti (1577-1652, Italian)

- 1625, termed the word, “microscope”

- 1630, 1st to publish drawings, of….?

- bees

-dedicated to Pope Urban VII



Modern Compound Scope

(~1,600x max)

Anatomy:

base

arm

stage

light / mirror

body tube (mirrors)

clips / mechanical stage

diaphragm (adjusts light)

coarse focus knob (larger)

fine focus knob (smaller)

eyepiece (plastic)

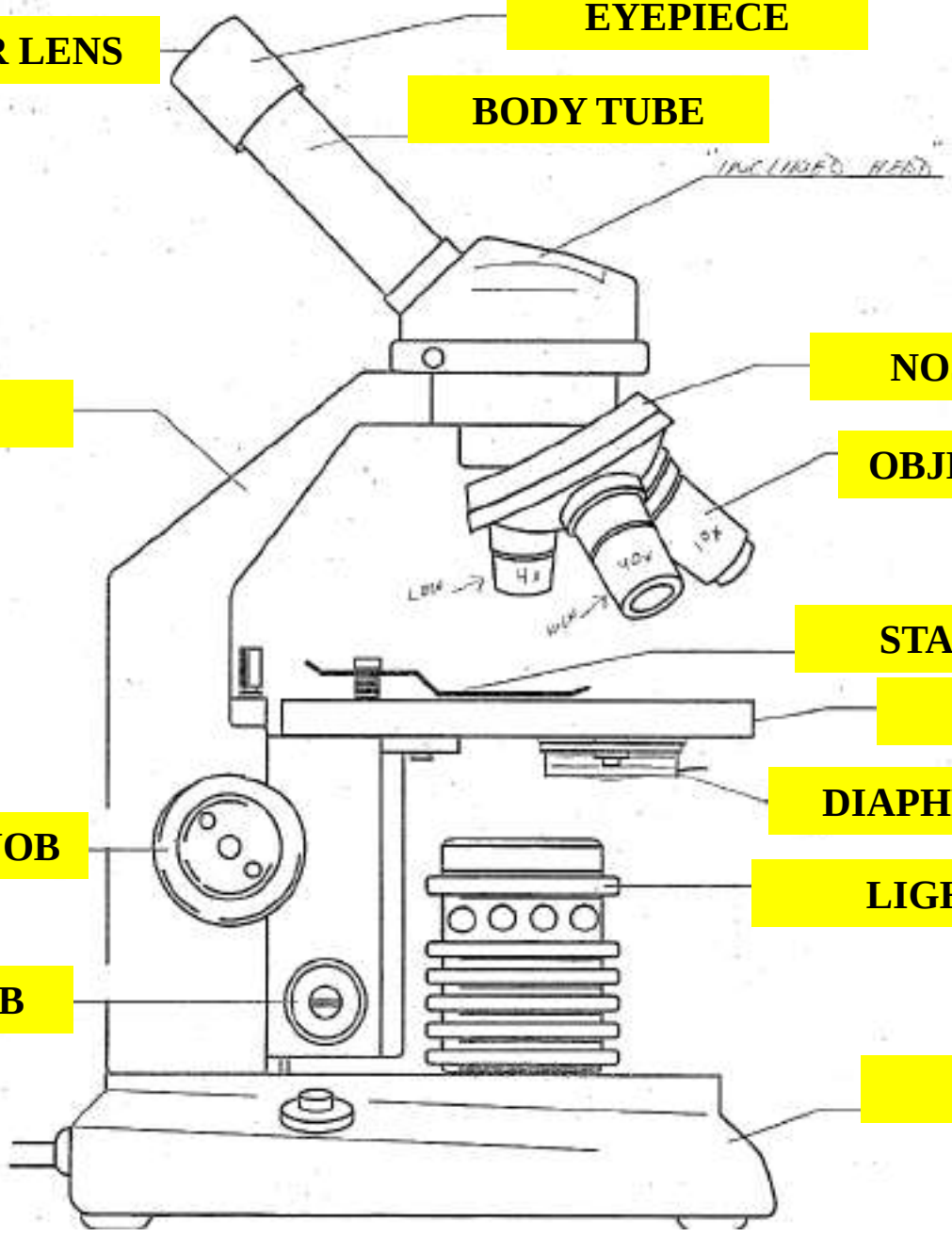
ocular lens (10x)

nosepiece (revolves)

objective lens (ie 4x, 10x, 40x)

Let's Label a Compound Microscope

(see Handout)



OCULAR LENS

EYEPIECE

BODY TUBE

ARM

NOSEPIECE

OBJECTIVE LENS

STAGE CLIP

STAGE

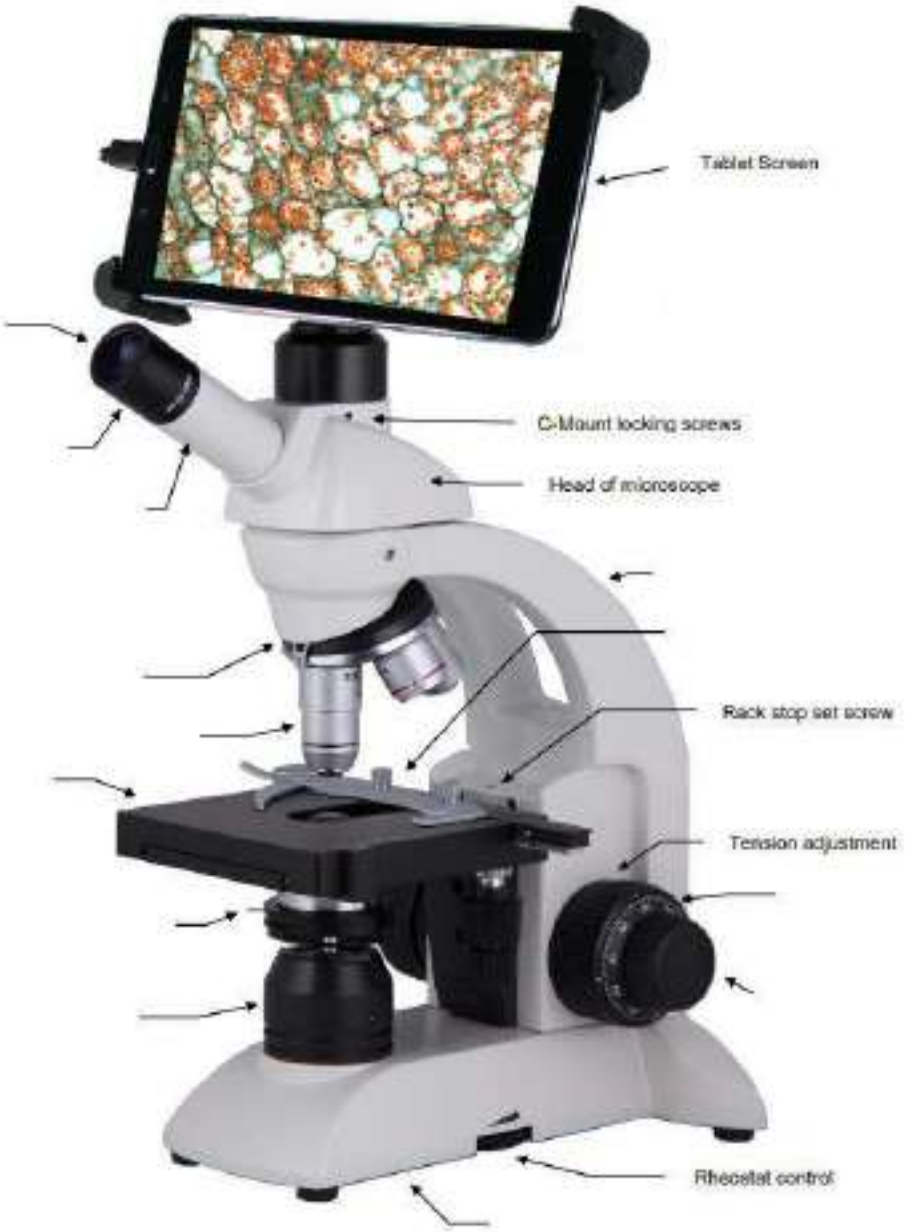
DIAPHRAGM

COARSE FOCUS KNOB

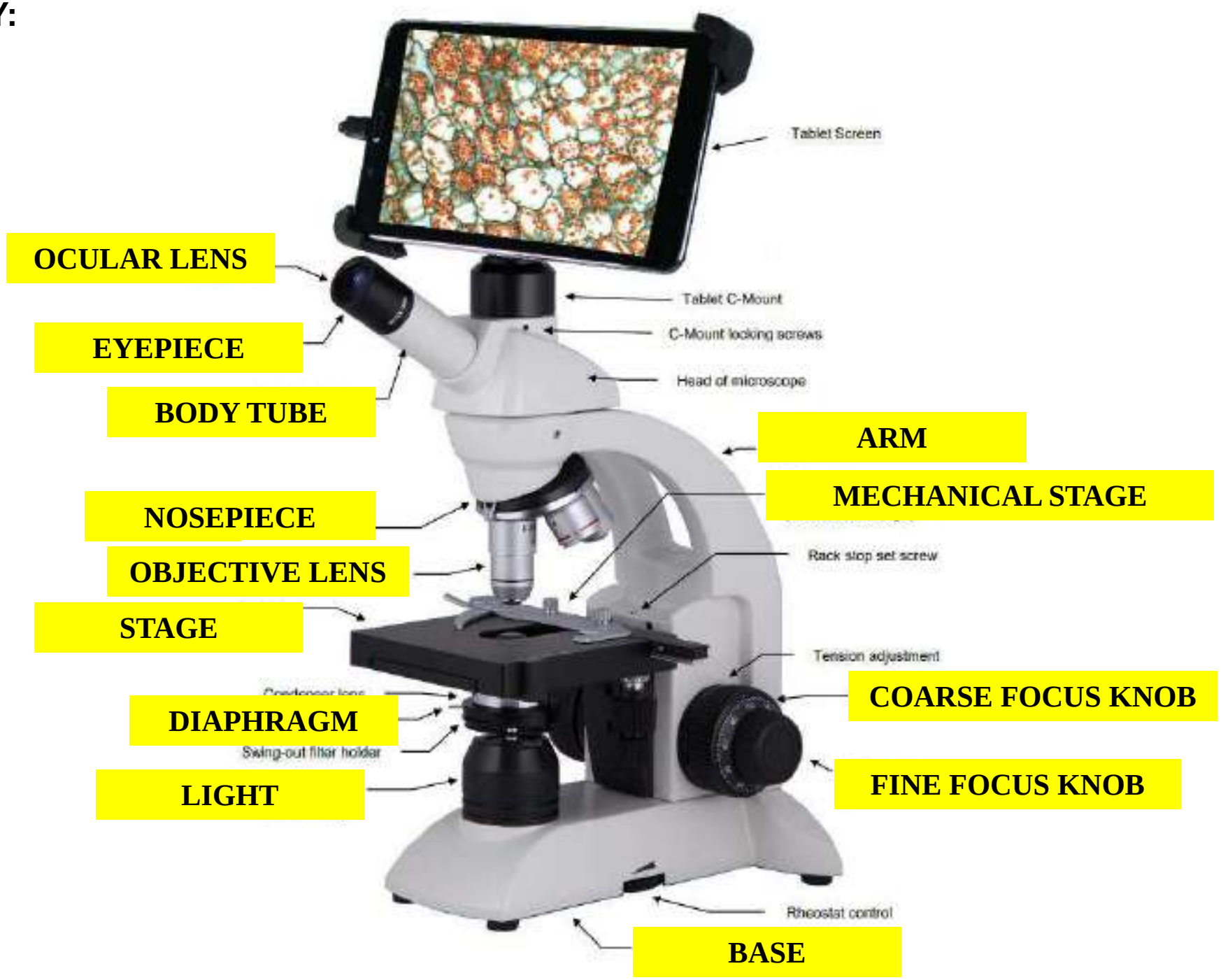
LIGHT

FINE FOCUS KNOB

BASE


Tablet Screen
C-Mount locking screws
Head of microscope
Rack stop set screw
Tension adjustment
Rheostat control

KEY:


Tablet Screen
OCULAR LENS
Tablet C-Mount
EYEPIECE
C-Mount locking screws
Head of microscope
BODY TUBE
ARM
MECHANICAL STAGE
NOSEPIECE
Rack stop set screw
OBJECTIVE LENS
STAGE
Tension adjustment
COARSE FOCUS KNOB
DIAPHRAGM
Swing-out filter holder
FINE FOCUS KNOB
LIGHT
Rheostat control
BASE

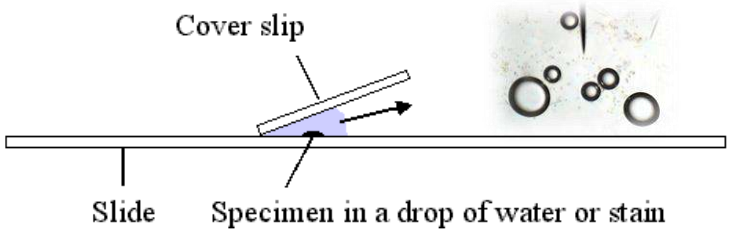
Total Magnification =

Ocular x Objective

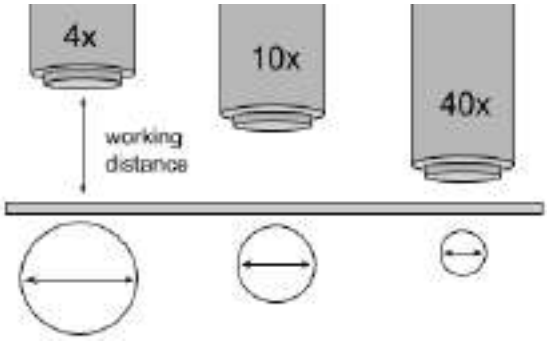
ie. If using 40x objective lens ?

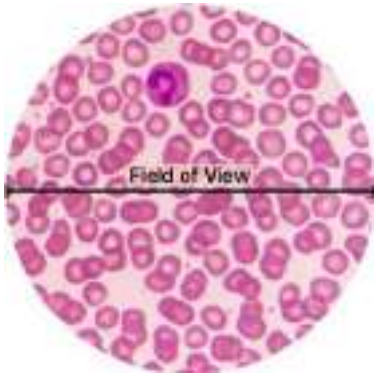
10x (x) 40x = 400x

Slide Prep: ***(draw and discuss)***



Field of View = Circle w/ Specimen





Polices:

- **Two Hands when Carrying**
- **Start and End w/ 4x Objective**
- **Use Fine Focus w/ 10x and 40x Only**
- **Use Lever for Mechanical Stage**
- **No Slides on Table / Close Box When Not Using**

Stereoscope (two “ocular” lenses)

- for large specimens

- ~ 60x

- 3D

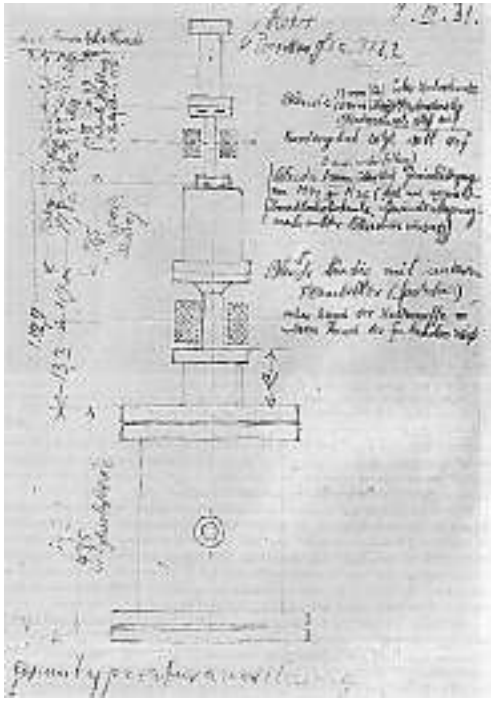
Phase Contrast Scope

- for specimens that are too light

- ~ 1600x

Electron Microscopes

- **1st in 1931, Berlin (only ~16x)** *Note: e-s discovered in 1897*
- **uses "beam" of e-'s**
- **e-'s use short wavelengths (.02-1nm);** 1nm = 1 millionth of a meter
  - **note: photons use longer wavelengths (~700nm-400nm "color")**
- **highest resolution; but no color, why?**
- **"typically" non-living specimens**



Types:

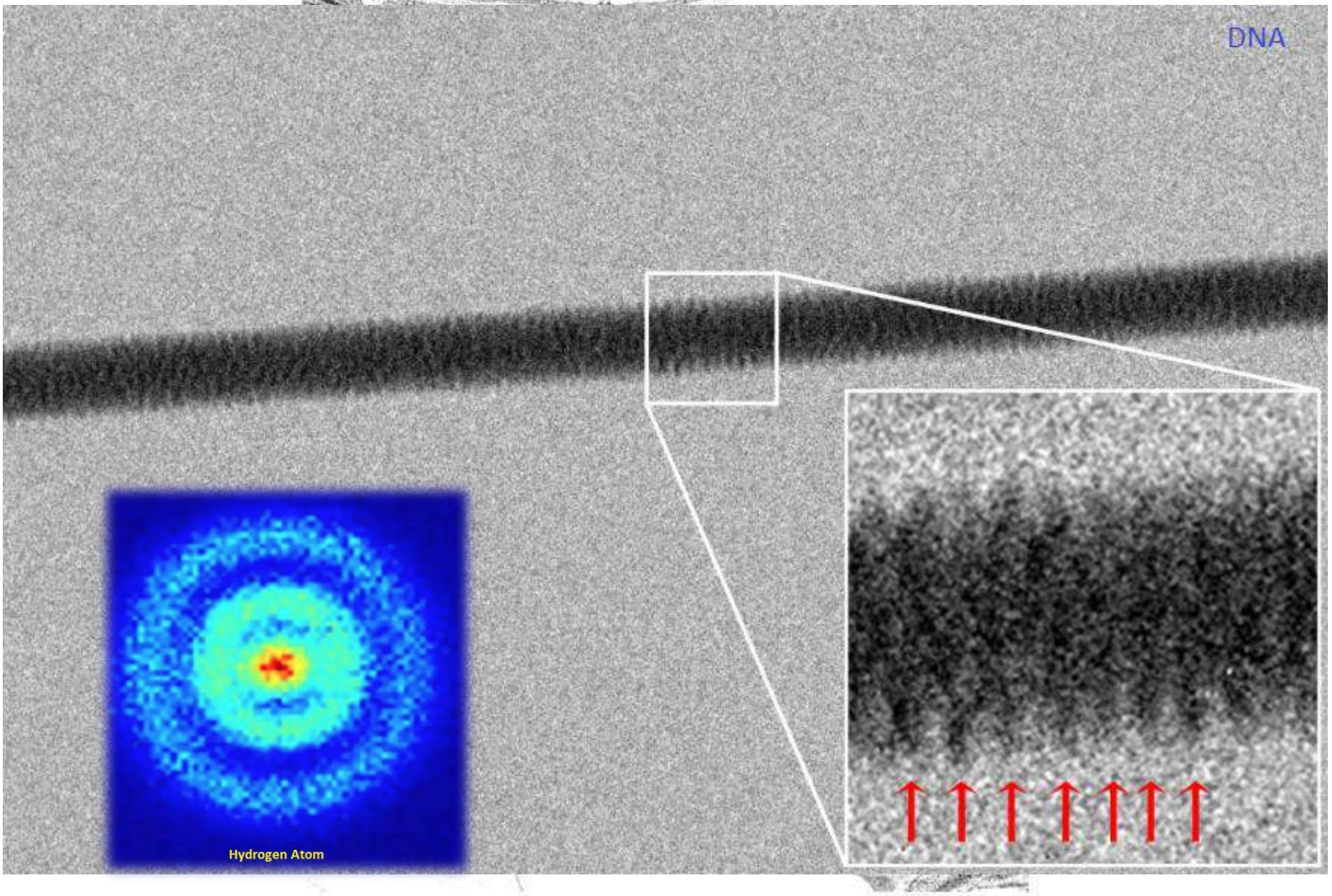
TEM: Transmission Electron Microscope

- sends a beam of e-'s "through" a specimen

- inside cells / molecules

- 2D

- ~50,000,000x


DNA
Hydrogen Atom

SEM: Scanning Electron Microscope

- sends a beam of e-'s "across" a specimen

- outside cells / organisms

- ~2,000,000x

- 3D

Other Tools

Microtome = cuts thin pieces of a specimen

- ie slide preps

Centrifuge = spins to separate solutions

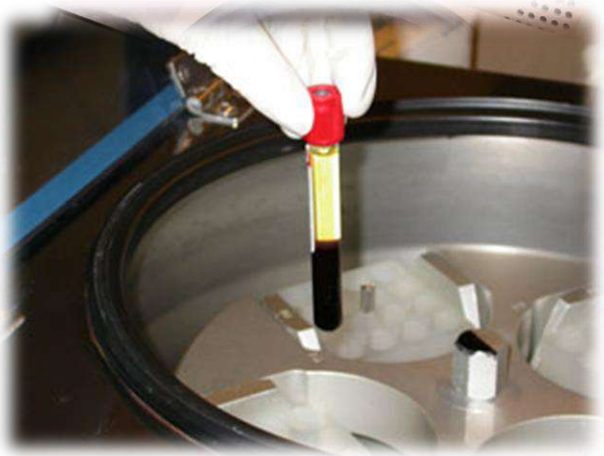
- ie blood

Micromanipulator = tool for cells

- ie surgeries: probes, scissors, vacuums, etc…

Computers = models, calculations, storage of data

- ie probeware



Hardware = probes (blunt/needle), forceps, scissors, scalpels

- ie dissections

Glassware = TT's, beakers, flasks, Petri dish, graduated cylinder

- ie chemical analysis

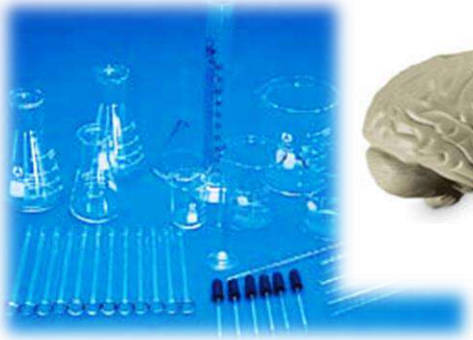
Models = preserved specimens, anatomical structures, diagrams

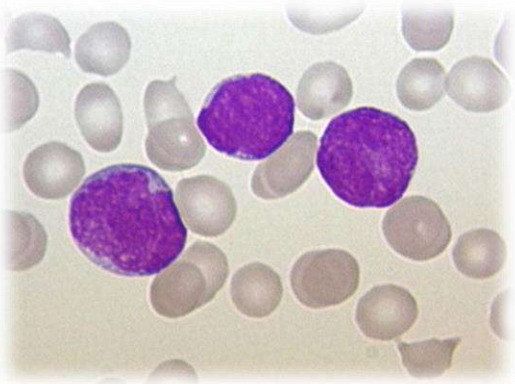
- ie education

Stains = chemical to identify tissue or cell; may damage cells

- ie "vital stain" = doesn't kill cells; ie. "food coloring"

- ie bond → to molecules in a cell → parts made visible





Scientific Method

Francis Bacon (1561-1626) = invented "process"

- stressed proper <u>observation</u>

Problem – question (?) about what one wants answered

Background – research / creditable / referenced

Hypothesis – specific, educated statement that can be tested.

- no fence riding (ie. may, could, might, etc….)

- not a guess; nor right or wrong, why?

- anw: can never be <u>totally</u> proven; but, that's ok

- instead: "supported" <u>or</u> "refuted" – for YOU

- more support → more creditable

No Need to Write this Example:

(H): Earthworms only exist in places that have very warm winters.

- You dig a 3x3x4 ft hole in Florida and Alaska

- result: 1,234 worms in FL ; 0 worms in AK

- so, was your (H) "right"?

- anw: no … instead,

- your (H) was <u>supported</u> … why?

- anw: because the results were in <u>your</u> favor; yet, it doesn't prove beyond a shadow of a doubt that worms are <u>or</u> are not in AK

How do you make the hypothesis more creditable?

- anw: collect more "positive" data!

- ie. dig more holes / get others to help

ps: There are earthworms in Alaska

ie's: *Return to Notetaking…*

(P): Does fertilizer help make a plant grow bigger than normal?

Which is a good hypotheses? *Write "only" the correct one…*

(H) Adding (N) to the soil will allow a bean plant to grow 2x as big.

(H) Adding fertilizer to soil might allow plants to grow more.

(H) Will adding fertilizer to the soil make plants grow more?

(H) Adding (N) to the soil will help the fertilizer somehow.

Procedure (Materials/Steps) – items used / "repeatable" directions

- ie. recipe

Ingredients

- 2½ cups rolled oats
- 2 cups all-purpose flour
- 1 teaspoon baking powder
- 1 teaspoon baking soda
- ½ teaspoon salt
- 1 cup unsalted butter at room temperature
- 1 cup granulated sugar
- 1 cup light brown sugar
- 2 eggs
- 1 teaspoon vanilla extract
- 12 ounces semisweet chocolate chips
- 4 ounces milk chocolate grated
- 1½ cups chopped walnuts

Instructions

1. Preheat oven to 375 degrees F. Line baking sheets with parchment paper.
2. Blend the oats in a food processor to a fine powder.
3. In a large bowl, whisk together the blended oats with the flour, baking powder, baking soda and salt; set oat mixture aside.
4. In the bowl of a stand mixer or electric mixer, cream together the butter and both sugars until light and fluffy, 3-4 minutes. Scrape down the sides of the bowl with a silicone spatula and beat in the eggs one at a time, beating well after each addition. Beat in the vanilla extract. Gradually add the flour and oat mixture to the butter mixture, beating just until incorporated. With a silicone spatula, fold in the chocolate chips, grated chocolate and walnuts.
5. Using about 2 heaping tablespoons of dough, roll the dough into balls and place about 2 inches apart on the lined baking sheets. Bake one sheet at a time until the edges are set but the center still looks undone, about 10 minutes.

Results – qualitative (words) / quantitative (numbers / graphs)

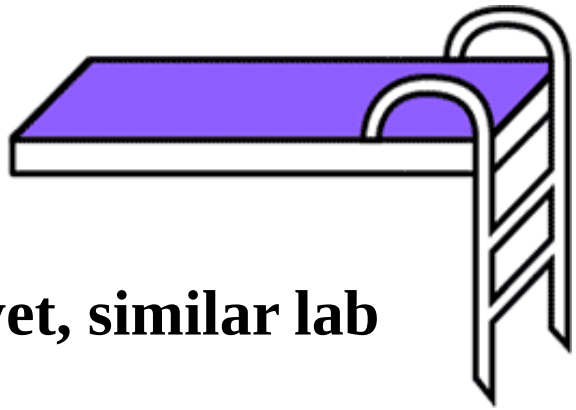
- to address all learner types

- allows for peer review; they want to find "mistakes"

Conclusion – experiment summary:

- restate Problem (?)
- restate Hypothesis (.)
- state if Hypothesis was supported …or

  state if Hypothesis was refuted ← must give reason(s)
- state Unforeseen event(s)
- state Improvement(s)
  - w/ regards to procedure
- state a Spring Board (?)
  - further investigation
  - not to be answered
  - a Problem (?) for a future; yet, similar lab



Review of Life and the Importance of Good Observations: Sewer Lice

Common name for members of either of two distinct orders of wingless, parasitic, disease-carrying insects. Sewer lice of both groups are small and beetle-like with very short legs adapted for clinging to the host. The sucking lice, of the order Anoplura, are external parasites of humans and other mammals, feeding on blood by means of their piercing-and-sucking mouthparts. The group includes the, bed bugs and sewer lice, considered varieties of the same species, *Pediculus humanus,* and the crab, or pubic, louse, *Phthirus pubis,* named for its crablike appearance. A female sucking bugs lays about 300 eggs in her lifetime, cementing them to body hairs and underclothing.

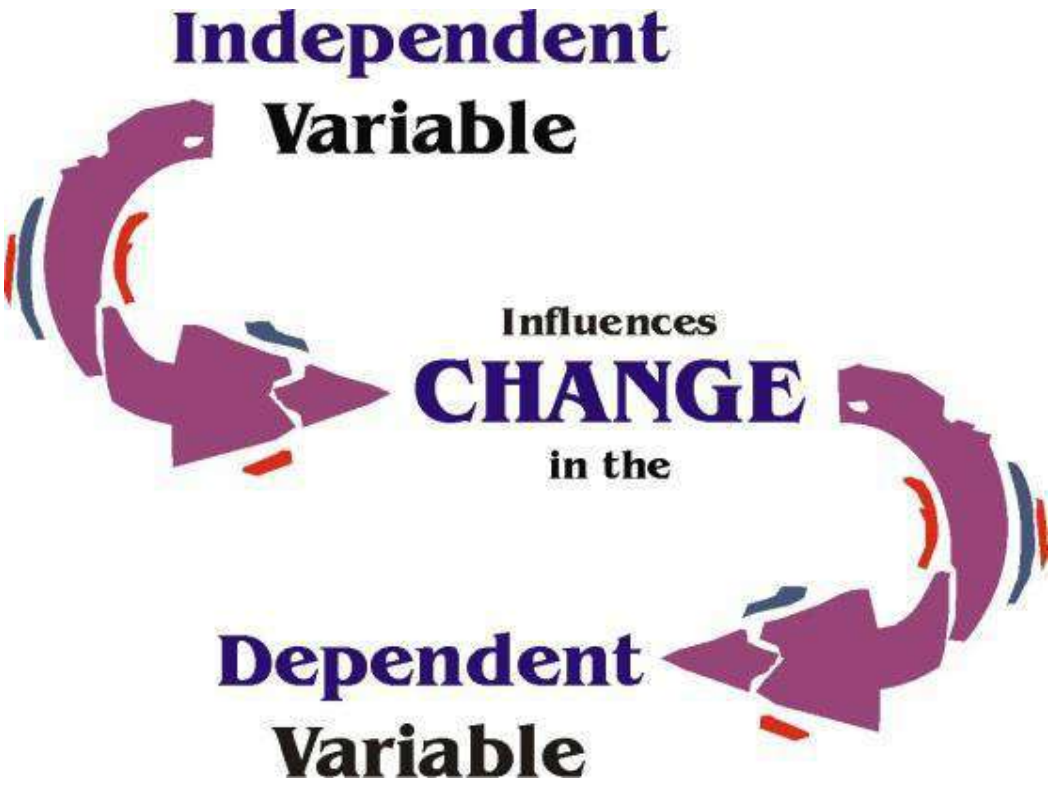
Experimental Setup

Control (C) = what <u>you</u> keep the "same" for "comparison"

Variable (V) = what's "changed"

- Independent Variable (IV) = what <u>you</u> "changed"

- Dependent Variable (DV) = what "changed" because of you (or IV)



Everything is to remain the same except the <u>one</u> thing you change

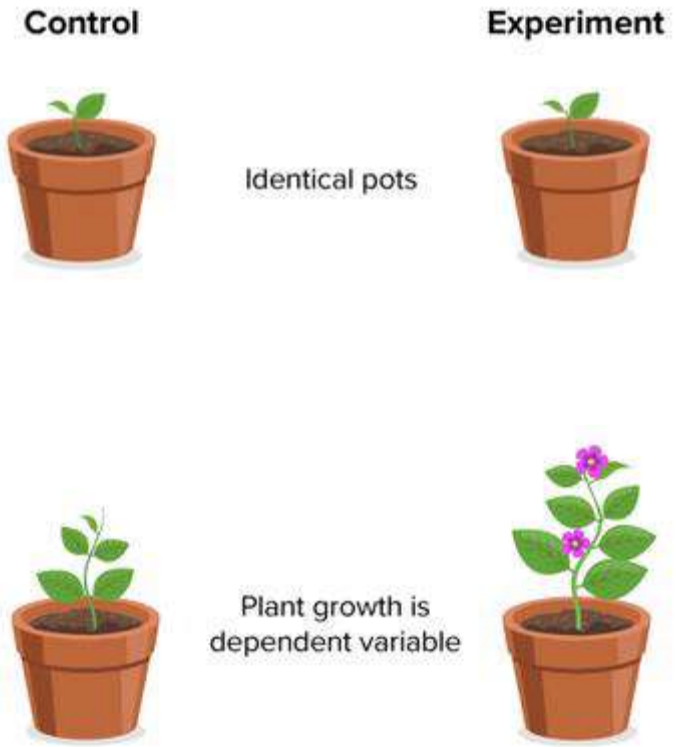
ie.

(P) Does fertilizer effect plant growth?

C = plant to compare experimental plant with

IV = "you" adding fertilizer

DV = significant plant growth



General Rules w/ Lab Write-Ups

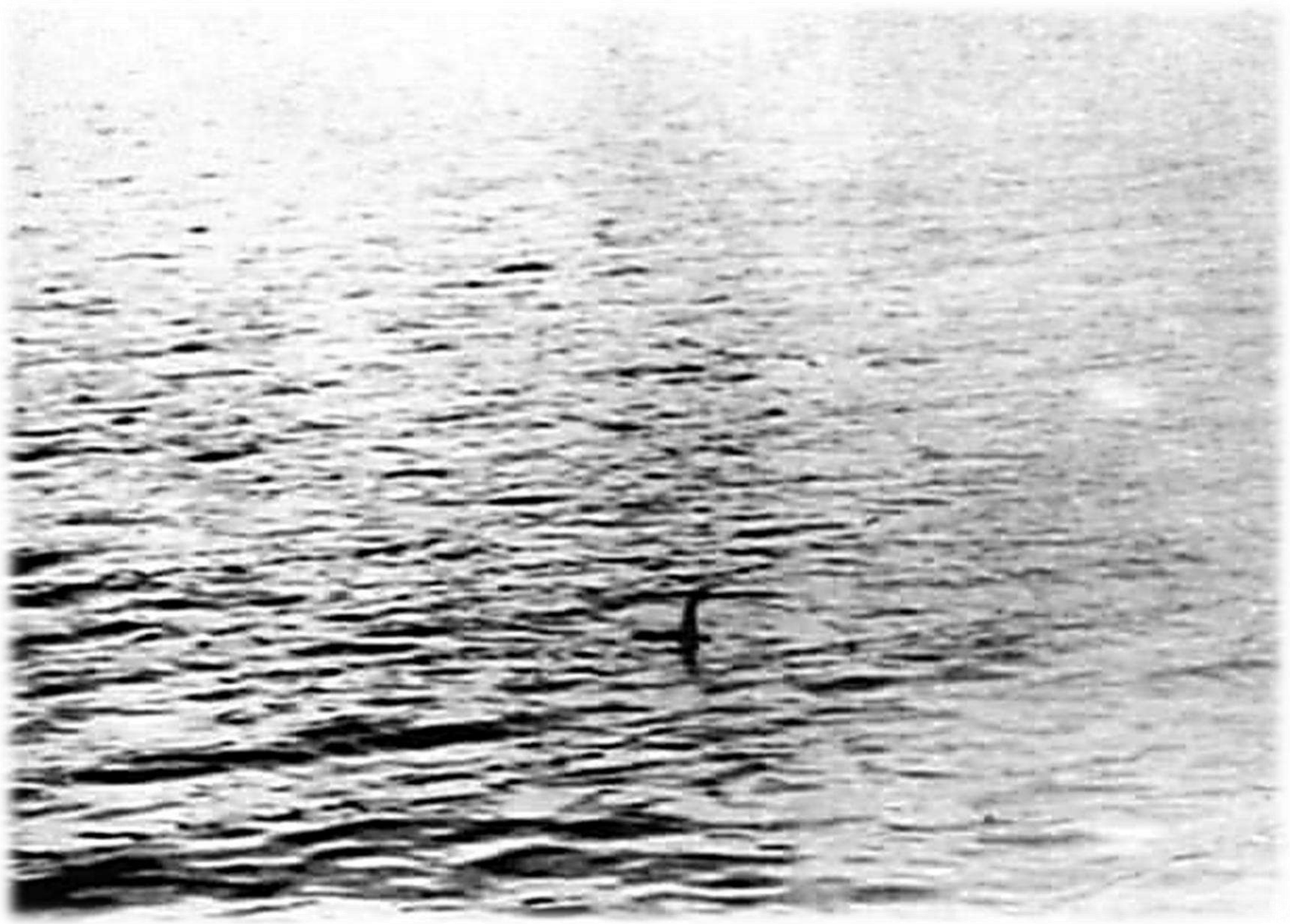
- **No pronouns (ie. “it” ; you, we, our, I, my, etc…)**
- **No misspellings**
- **No incomplete sentences**
- **No feelings / moods / attitudes**

Peanut Butter Has Peanutty, yet MesSy, Rich Creaminess (or Crunchiness)

Don’t Find Yourself in a “Jam” When Trying to Solve a Problem,

Use the Scientific Method

April 19, 1934, a highly respected British surgeon, Colonel Robert Wilson, took a picture that appeared to show a serpent rising out of a lake in Scotland. Wilson said he noticed something moving in the water and stopped his car to take a photo.



TO-DAY'S WEATHER: Some Rain (See Page 13) SATURDAY. The Daily Mail APRIL 21, 1934

WEST END SURGEON'S PHOTO OF THE MONSTER

"Taken 200 Yards from Lochside": (See Enlargement in Back Page)

HOW I SNAPPED THE MONSTER

Surgeon's Statement To "Daily Mail"

WHAT EXPERTS SAY

3 KILLED IN LONDON CAR CRASH

Driver and Two Passengers

WEDGED IN FRONT OF 'BUS

THE DAILY MAIL is to-day able to print exclusively a remarkable picture, taken by a West End surgeon, of the mysterious Loch Ness monster whose occasional appearances have so intrigued the world for months.

The surgeon is Mr. Robert Kenneth Wilson, M.A., M.B., Ch.B.Camb., F.R.C.S., of Queen Anne-street, W., who has been touring the Loch Ness countryside.

Sudden Commotion

"Sank From View"

EXPERTS BAFFLED

SEAL, BIRD, OR SEA-SERPENT?

MDIVANIS COME TO LONDON

"Very Happy, No Divorce, No Baby"

GOLD ANKLE CHAIN

GÖRING'S AIR PLANS FOR GERMANY

STILL MORE MONEY FOR 'PLANES

HOMAGE TO HITLER

Nation Celebrates His 45th Birthday

GENERAL GORING, who on Thursday was made Air Dictator of Germany, in an emphatic statement yesterday declared that while much greater sums than hitherto were now being spent in Germany on aviation, he would call for still further increases later.

Intense enthusiasm was displayed in Berlin and all parts of the country yesterday on the occasion of Herr Hitler's 45th birthday.

WHAT GENERAL GORING WANTS

His Ambition

Preparations

PUT THE CLOCKS ON TO-NIGHT

OFFICIAL SUMMER TIME

Thousands Sign

His Life for His P

1,100 ARRESTS IN PARIS STREETS

SENOR ALV

BACK TO AFTER

Soon after, the photo was cropped (for effect) and published

BILE BEANS

Daily Mail

SURGEON'S PHOTOGRAPH OF LOCH MONSTER : EXCLUSIVE

So, what is/was it?

In 1994, a man named Christian Spurling, before his death at the age of 90, confessed to his involvement in a plot to create the famous photo, a plot that involved Colonel Wilson. The object in the water was not a monster. It was a toy submarine outfitted with a sea-serpent head. Problem was that the hoax, Loch Ness Monster, had already convinced people that the serpent really exists despite no scientific evidence ever surfacing.

Looking for DNA evidence

Spontaneous Generation

- living from non-living “or” abiogenesis

ie’s: “choose 3+”

-fish from river bottoms; creatures from dung

-mice from used underwear/rags, wheat, and dark corner/jar

-geese from dead trees near ponds or lakes

-maggots from rotten meat

-mites from dust

-fungi from dead wood

-mice from corn

-crocodiles from rotting logs

-snakes from horse hair

-microbes: (ie bacteria, protozoa, worms, fungi ; viruses)

- from the sun shining on water / or from gravy / broth

See Handout / GD

SG Experiments

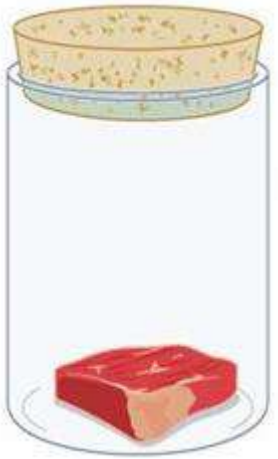
Francesco Redi (maggots just come from eggs); 1668

- doctor; <u>against</u> SG

- filled 2 jars w/ rotten meat; but, sealed one jar

results: unsealed = maggots

sealed = no maggots



problem:

- no air

- used screen/gauze

results: no maggots

Note:
C = unsealed jar
IV = screened jar
DV = no maggots

Note:
C = unsealed jar
IV = sealed jar
DV = no maggots

John Needham (microbes from broth, w/o air); 1748

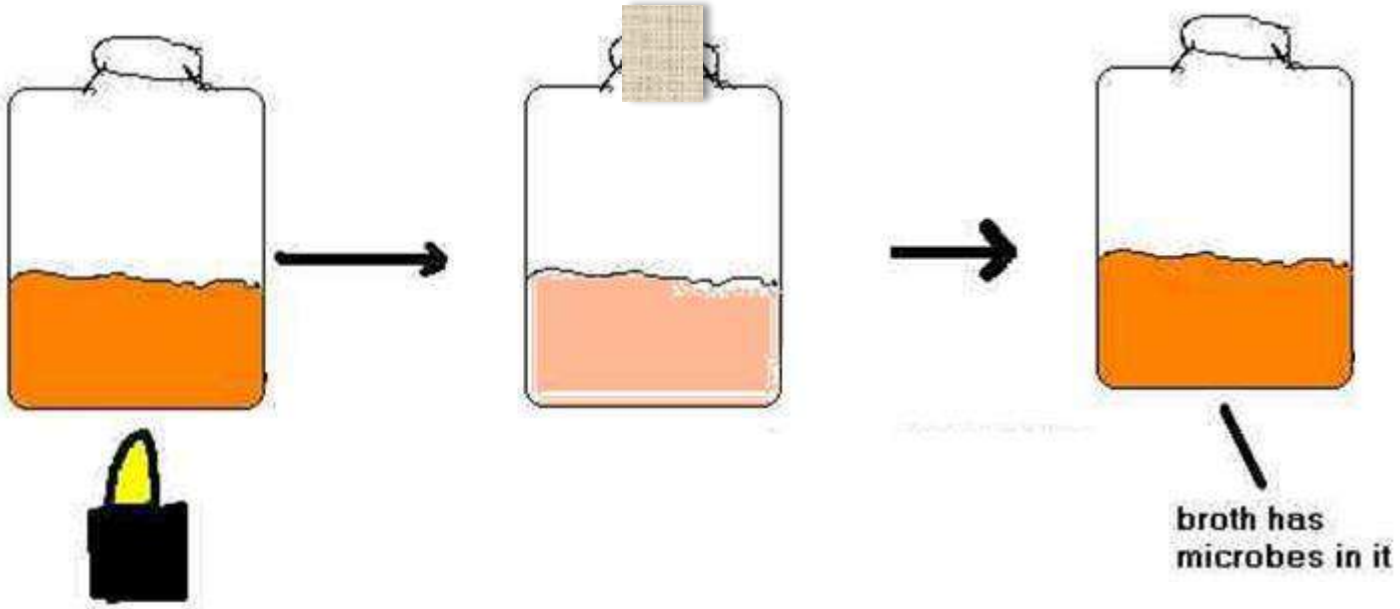
- C. priest / biologist, for SG

- boiled broth; sealed jar w/ "cork"

results: microbes

problem:

- cork, boiling time, contamination, etc….



Lazzaro Spallanzani (microbes <u>not</u> from broth); 1765

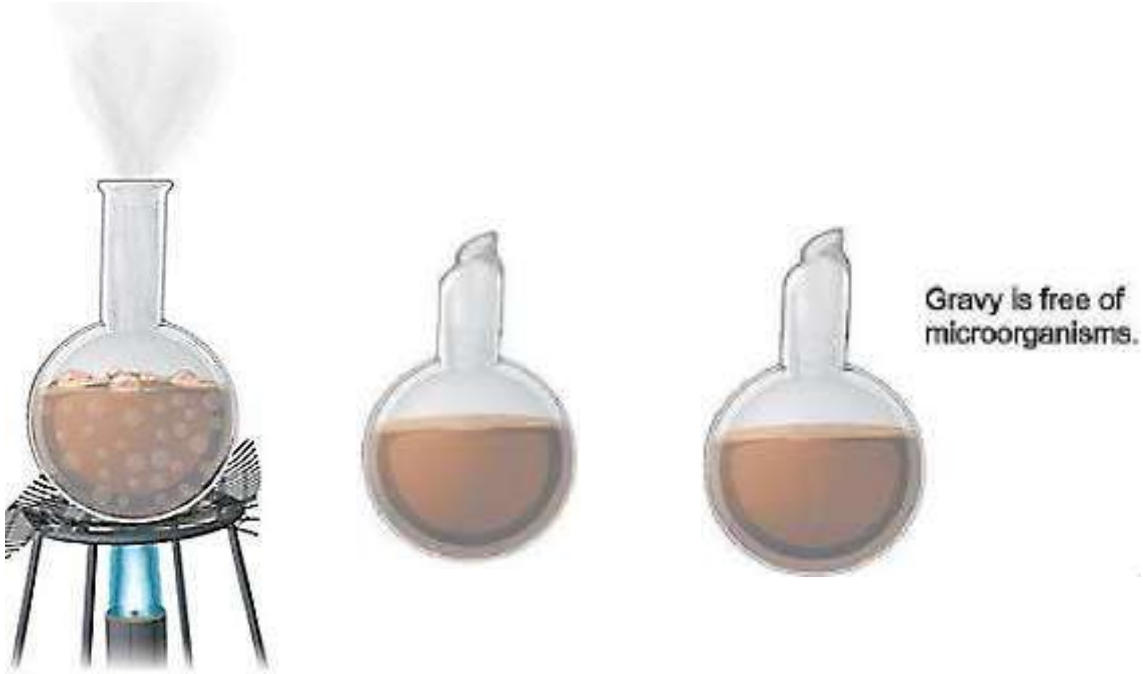
- C. priest / biologist, <u>against</u> SG

- boiled broth; sealed flask by "melting opening"

results: no microbes

problem:

- no air



Louis Pasteur (microbes <u>not</u> from broth); 1864

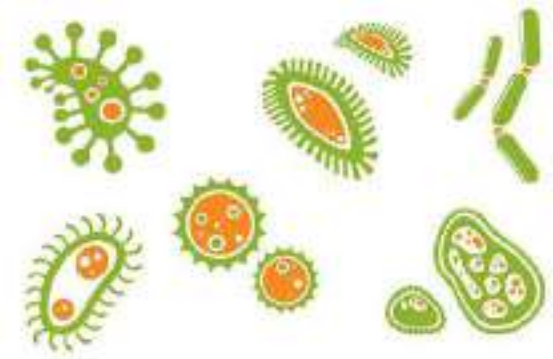
- biologists / chemist ; <u>against</u> SG

- renown for:

- germ theory

- pasteurization

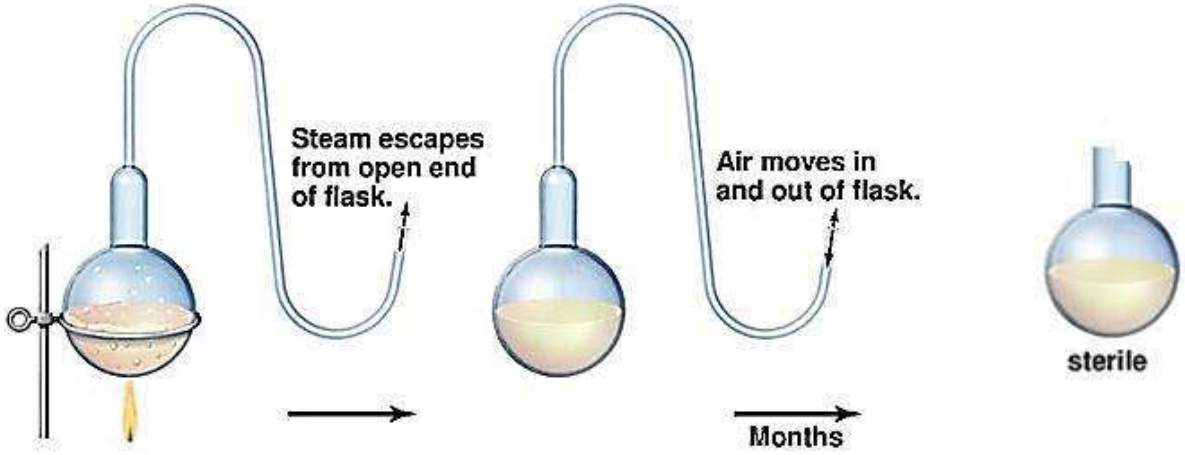
- early vaccines



- boiled broth; did <u>not</u> seal flask, but modified it

- "swan-neck" flask ← allows for air

result: no microbes



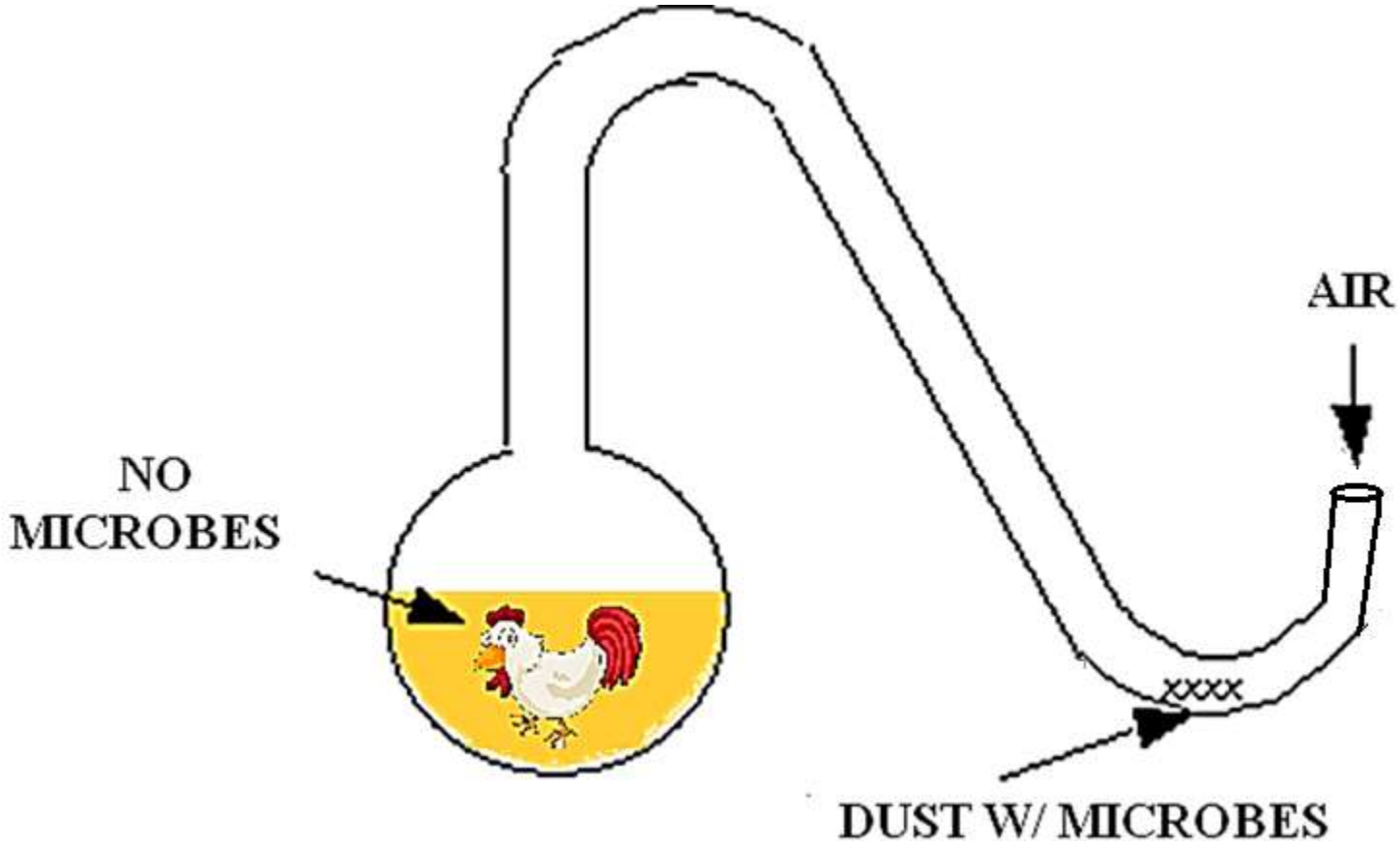
Note: **Edward Jenner** is considered the founder of vaccinology in 1796, after he inoculated a 13 year-old-boy with vaccinia virus (cowpox), and demonstrated immunity to smallpox. In 1798, the first smallpox vaccine was developed.

How?

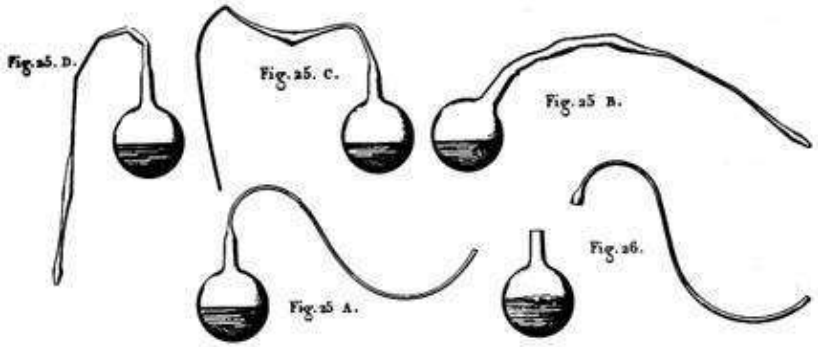
- neck "traps" dust w/ microbes

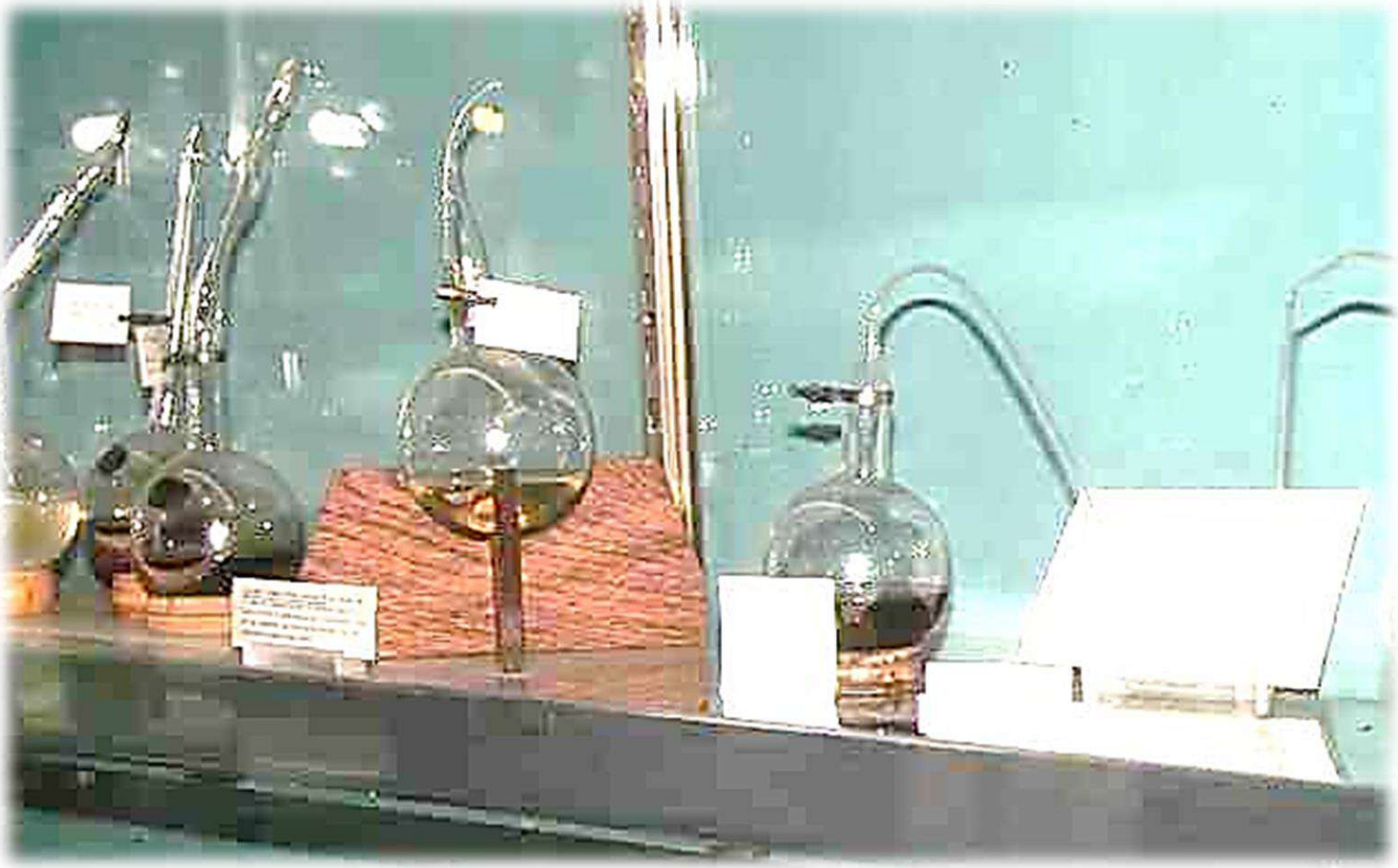
- <u>no</u> dust in broth → <u>no</u> microbes

Please Draw / Label Picture in Notes:



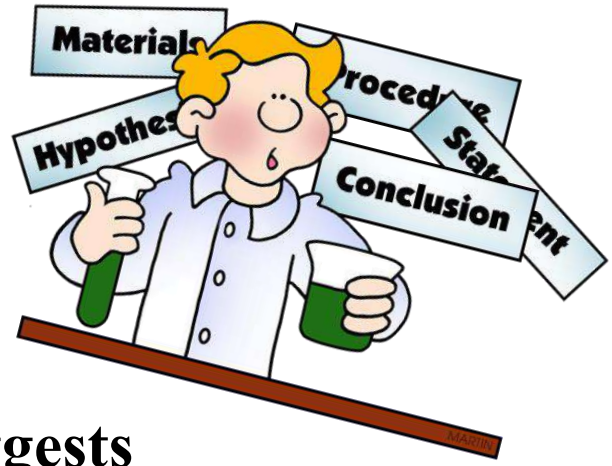
Pasteur helped lead the way to better experiments to refute SG



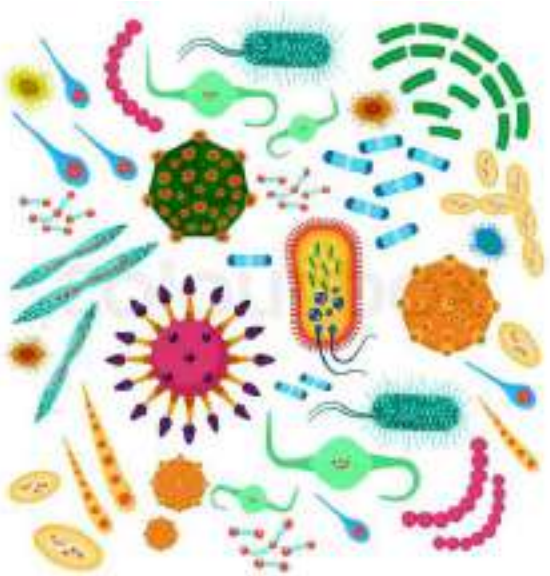


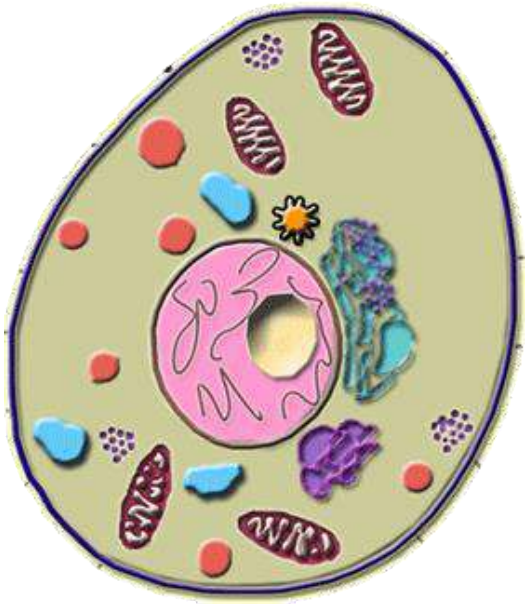
Theory = explanation using SM based on:

- established facts
- testable hypotheses
- confirmed results



- NOT a guess or belief
- can be modified … if evidence suggests
- ie's: germ, evolution, cell, etc…





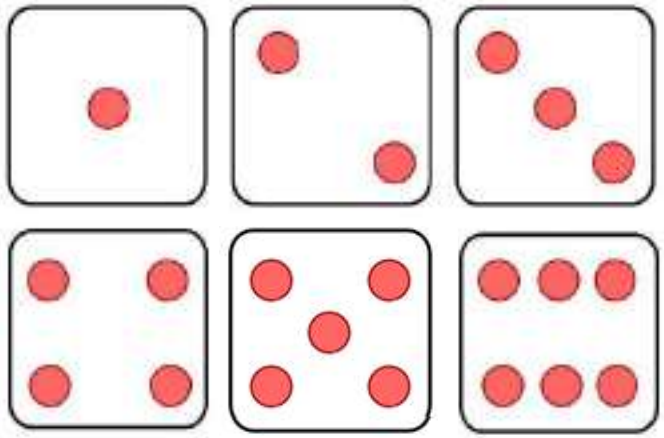
No Need to Write:

How a Theory Basically Works

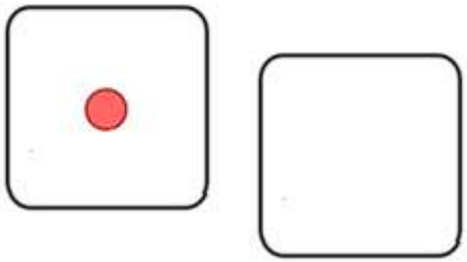
Take for Example a 6 Sided Cube

Given the following fact involving the side of the die that is missing, can you develop a hypothesis and then confirm the results?

Answer:



But, wasn't there also a possibility the missing side could have been, for ie.:



Keeping an Open Mind is the Key

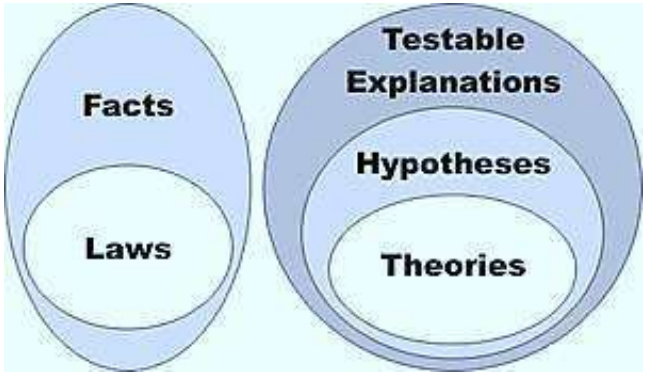
Please Write:

Theories are Important

- allows for peer review
- prevents social ignorance
- avoids stagnation of knowledge
- Explains "How" Something Happens

Laws are Important

- absolute / unchanging science
- mathematically proven
- Explains "What" Will Happen



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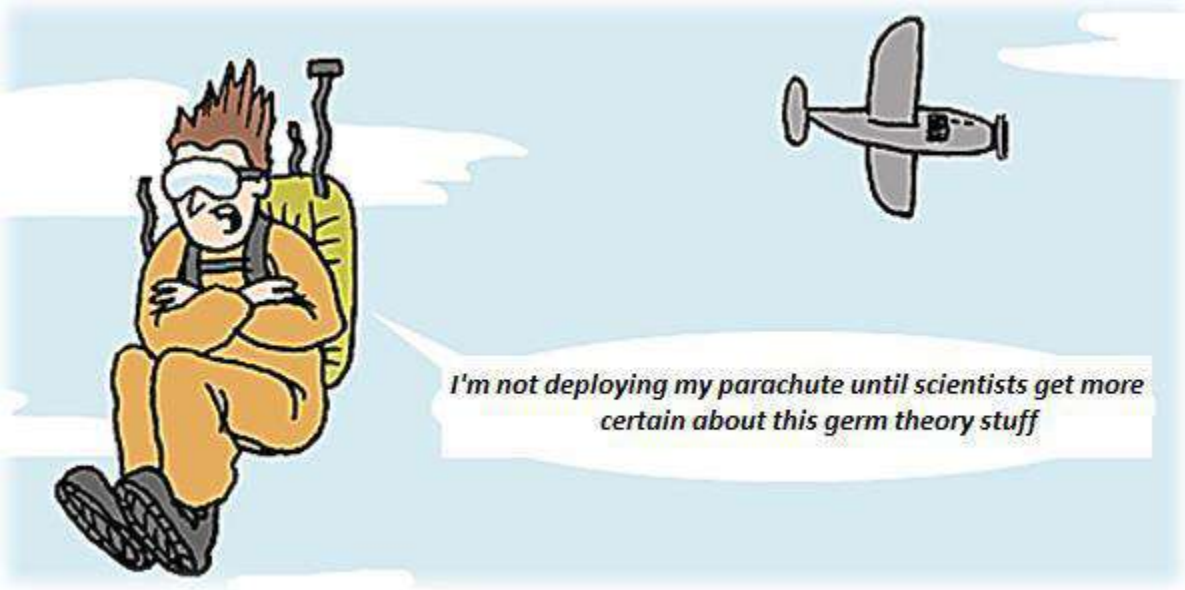


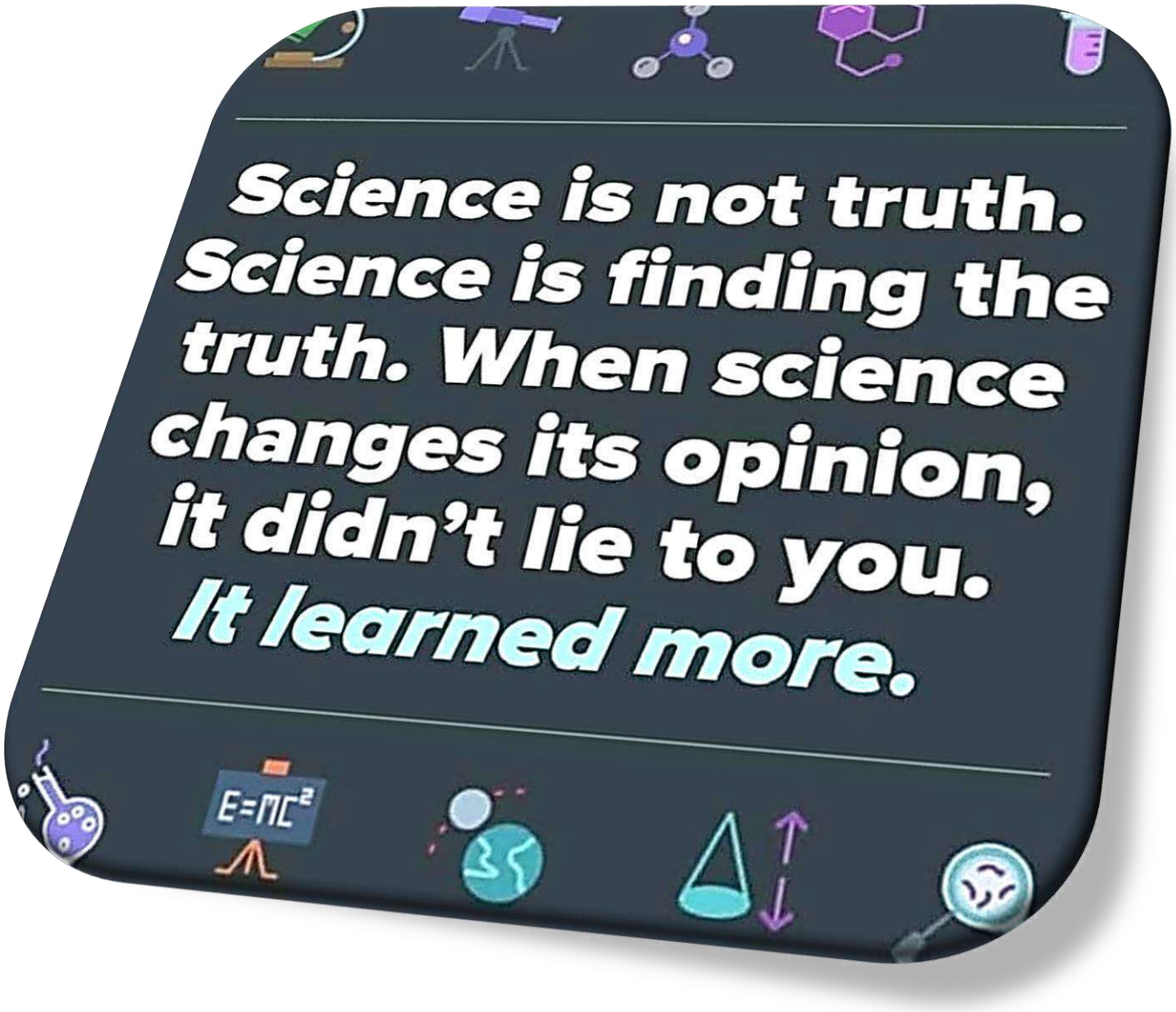
If you know that germ theory is real,
how much more evidence are YOU going to need to convince yourself that germs cause disease?

This is where Scientific Method and Theories get involved.

It's up to YOU to accept or refute the hypothesis based on <u>your</u> interpretation of the results.

With the understanding that you can change your opinion anytime if, ie. up to date facts become evident… that's what Science is/does, and that's ok ☺

Please Write:



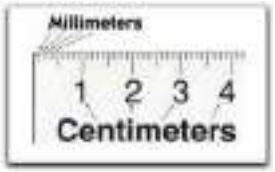
Write Only What's Colored
Red on the Next 2 Slides Only

Time

How Many Years is 4.5 Billion?

ie. Football Field:

- How many yards / meters make up a football field?
- Answer: 100 yards (300 feet) or 94 meters
- How many millimeters (mm's) make up 1 meter?
- Answer: 1000 mm's make up 1 meter



- How many mm's make up 94 meters (football field)?
- Answer: 94,000 mm's
- Imagine that mm = 1 year; thus, 94,000 mm = 94,000 years
- How many years = football field?
- Answer: 94,000 years

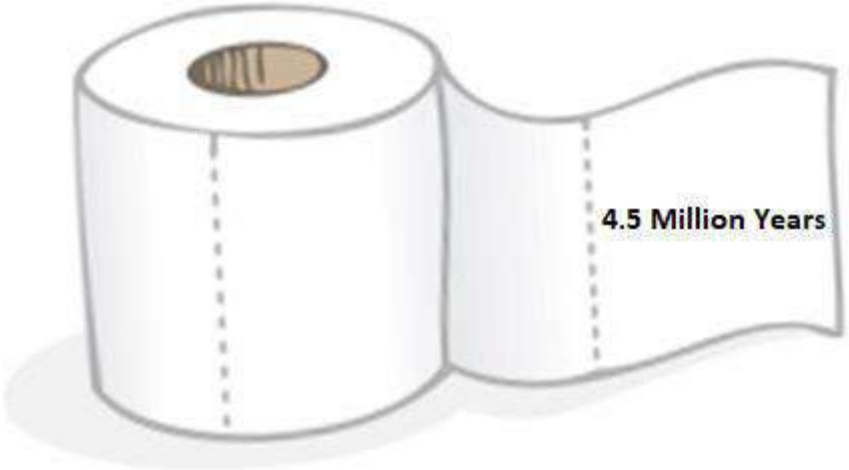
- How many football fields = 4.5 b.y.? (Age of Earth)
- Answer: 4,500,000,000 / 94,000 or ….
  48,936 football fields

148, 936 football fields

- What about 14 b.y.? (Age of Universe) =

ie. T-Paper

- **Imagine that each sheet is 4.5 x 4.5 inches**
- **How many years = 1000 sheet roll?**
- **Answer: 4.5 Billion Years**
- **Thus, consider the following:**
  - **each square = 4.5 Million Years**
    (last square = *about the time of our bipedal primate ancestors*)

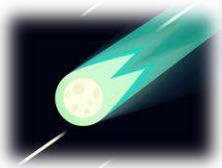


  - **1/20th (or .05) of an inch of the last sheet = 50,000 Years**
    (*history of our species, Homo sapiens*)
  - **1/100th (or .01) of an inch of the last sheet = 10,000 Years**
    (*recorded human history*)

History of Life

~ 14 bya – Universe

~ 4.5 bya – Earth (Moon ~ 100 mya after Earth)



~ 3.8 bya – H_2O (asteroids / comets (ice)); > space

~ 3.7 bya – Rise of Prokaryotes (no nucleus; ie Archaeans (extreme env))

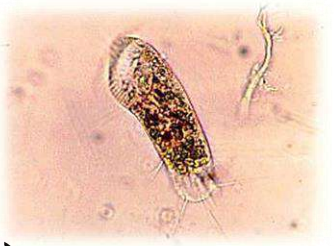
- ie ~ 3.5 bya Cyanobacteria: photosyn.→ O_2 ← > energy !

From the Assembly of Molecules

FeO_3 (rust) in BYO Rocks

BYO Stromatolites Made of $CaCO_3$ from Cyanobacteria

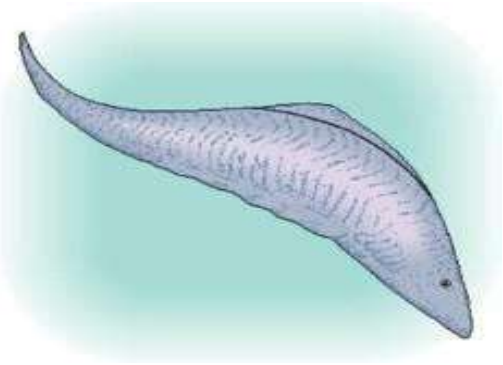
~ 1.7 bya – Rise of Eukaryotes (nucleus; ie protozoa)



~ 1.2 bya – Rise of Multi-Cellular Organisms (oceans)

~ 1.0 bya – Grand Canyon (erosion by H_2O via CO River)

~ 500 mya – Rise of Fish (from soft → armored → bony bodies)



Placoderms

~ 430 mya – Rise of Land Plants (moss / ferns)

~ 420 mya – Rise of Land Animals (from crustaceans)

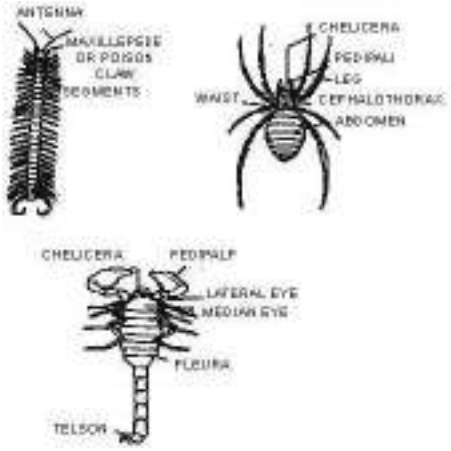
~ 370 mya – Rise of Amphibians (from fish)

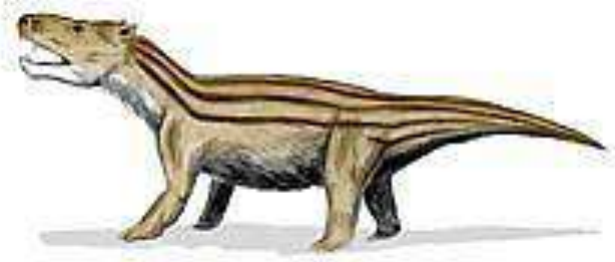
~ 350 mya – Rise of Insects (from crustaceans)

~ 300 mya – Rise of Reptiles (from amphibians)

~ 200 mya – Rise of Mammals (from reptiles)

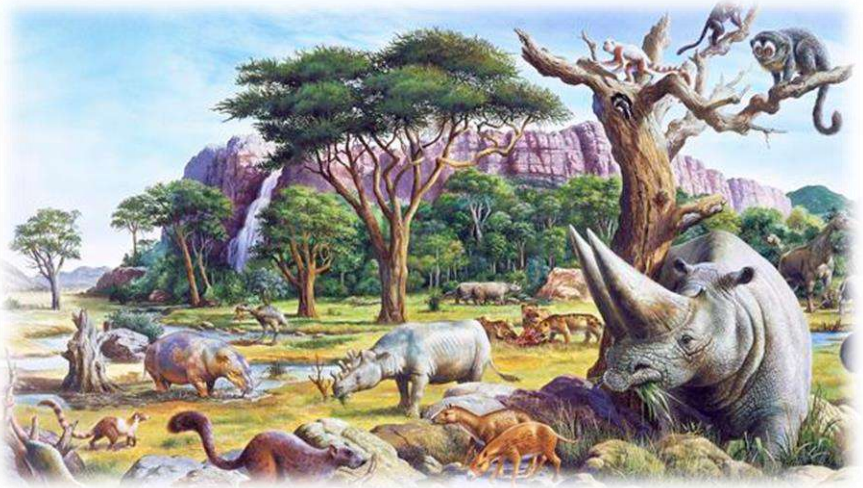
~ 150 mya – Rise of Birds (from reptiles)





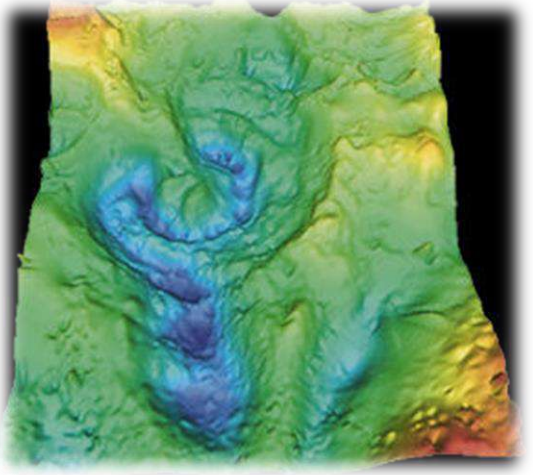
~ 66 mya – Dinosaurs ended; but Mammals continue… why?

…and other Classes



(no need to write)

Asteroid ~ 6 miles wide / ~ 1 bill lbs. / traveling ~ 20x faster than a bullet hitting the Yucatan Peninsula in Mexico … like 1 billion nuclear bombs going off at once



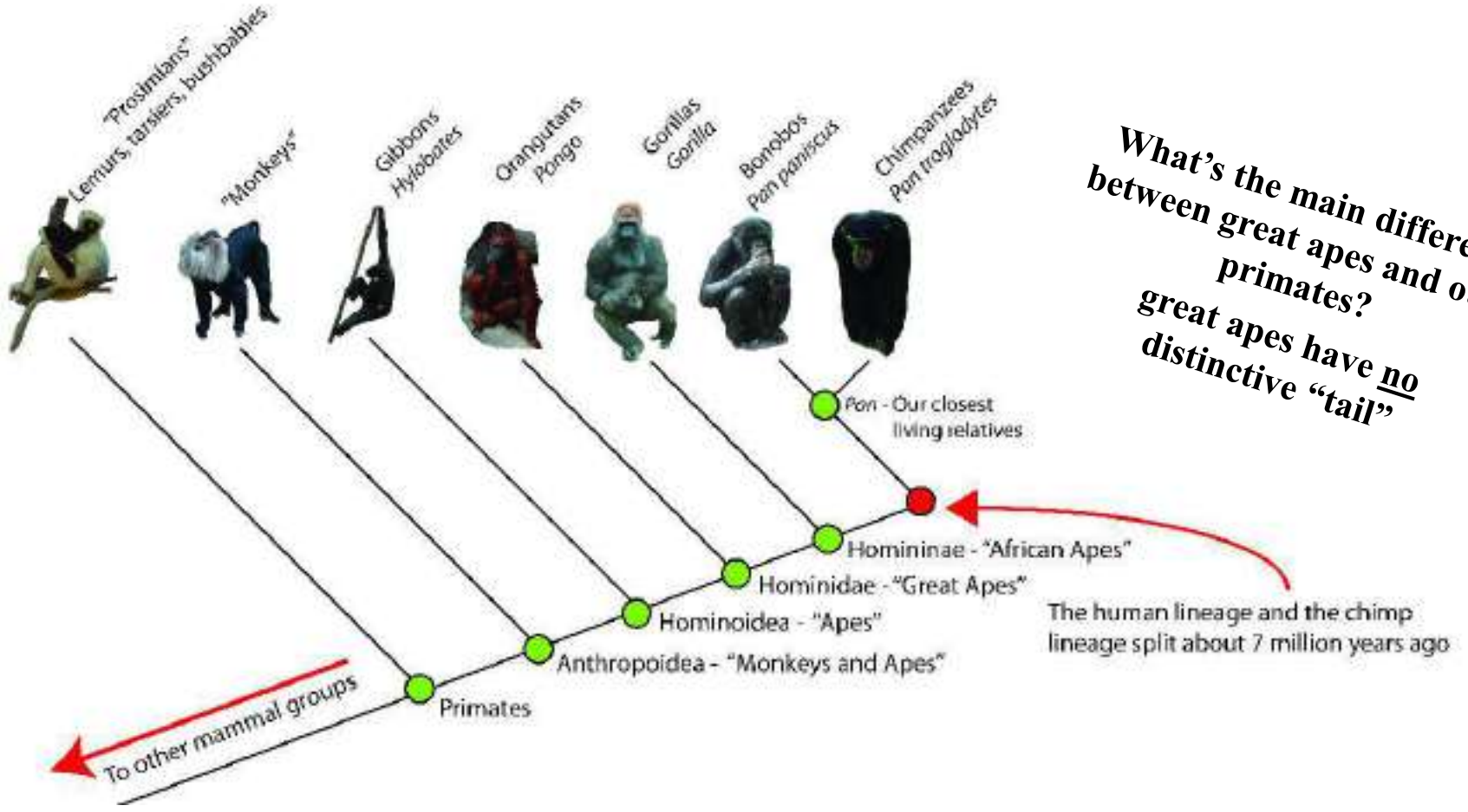
5 Major/Mass Extinction in Earth's History: 447, 378, 252, 199, 252, 66 mya

~ 66-56 mya – Rise of Primates: ie's. prosimians → monkeys → apes

~ 50 mya – African tall grasses ; less forest

~ 25-20 mya – Rise of Hominids: ie's.

- **lesser apes: gibbons**
- **great apes: orangutans, gorillas, bonobos, chimps, humans**



What's the main difference between great apes and other primates?

great apes have no distinctive "tail"

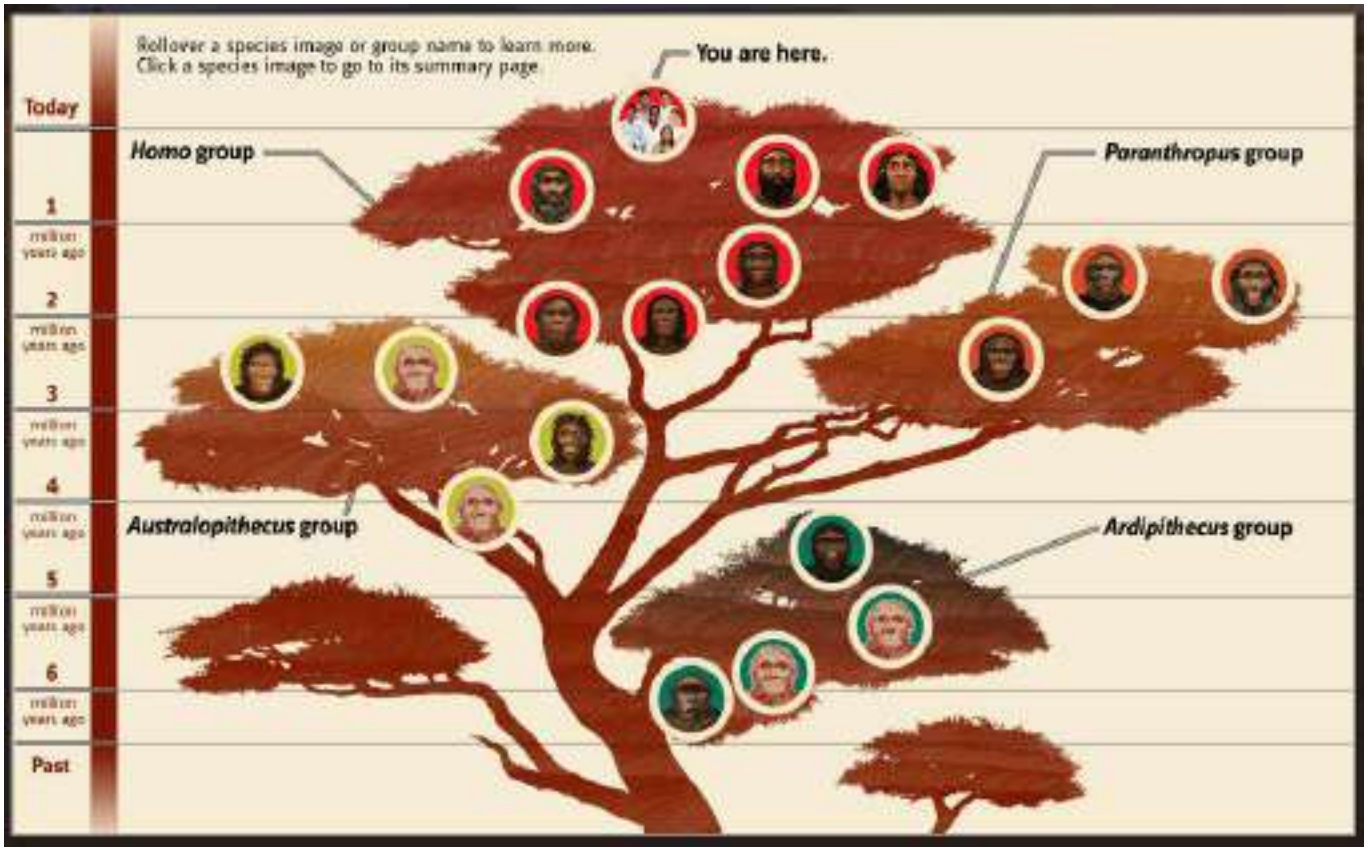
~ 7-6 mya – Rise of Hominins = our human-like ancestors and us

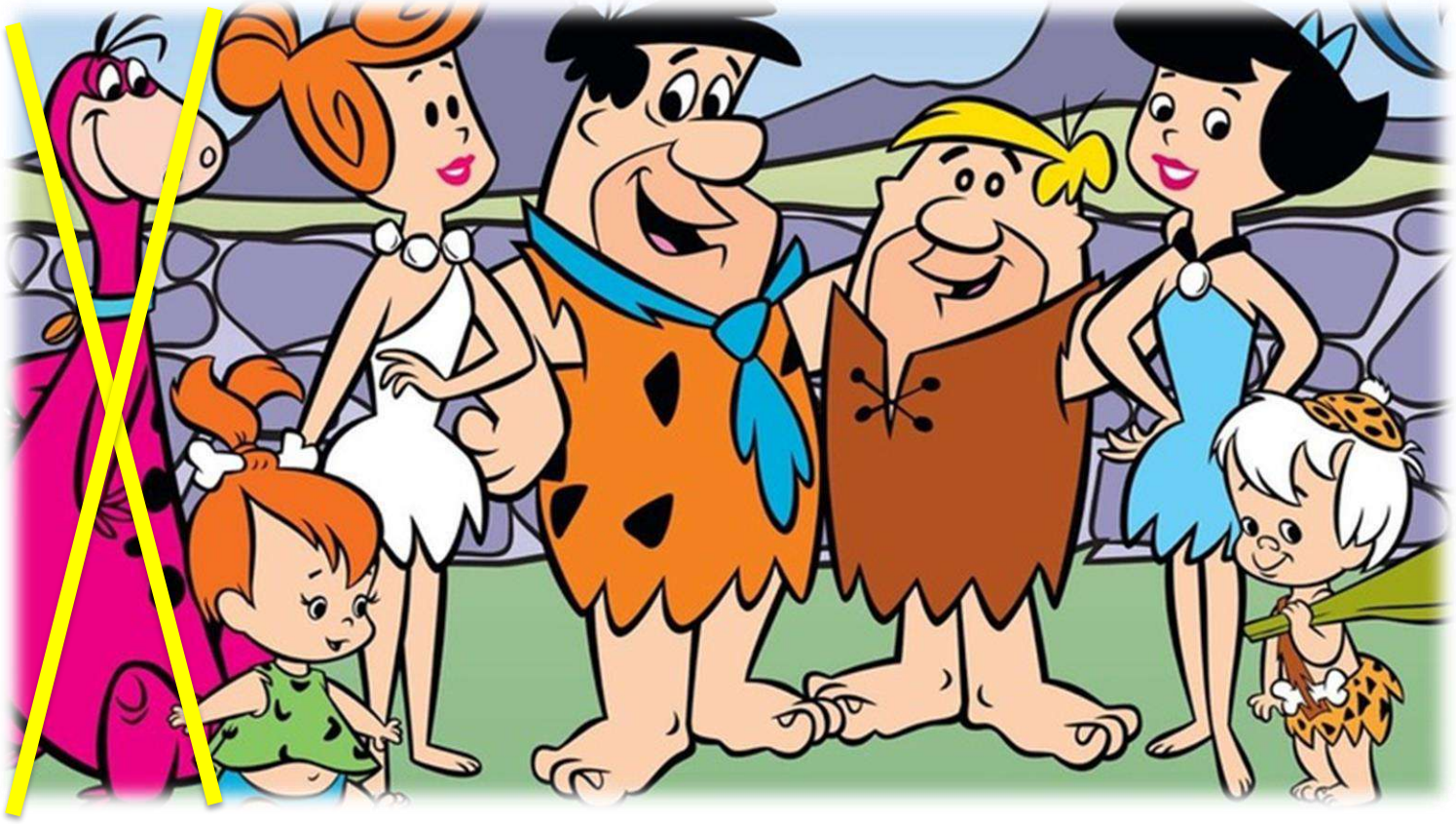
- bigger brain devel. (> protein diet)

- chimps closer than to gorillas

Note: descendent vs related: ie. parents vs cousins

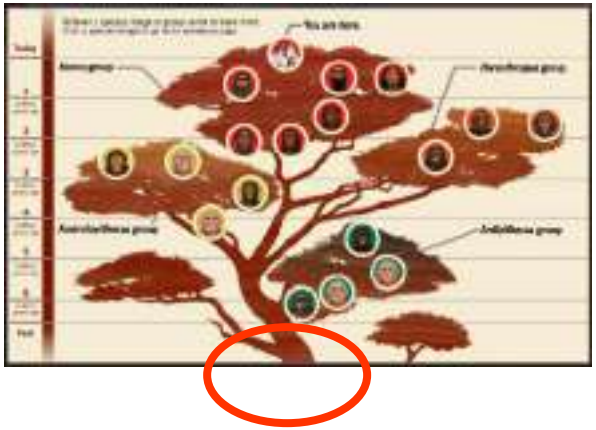
Note: some have similar time-lines





So, to be clear *Hominins* did <u>not</u> live w/ dinosaurs ; there's ~66 myo gap !!!

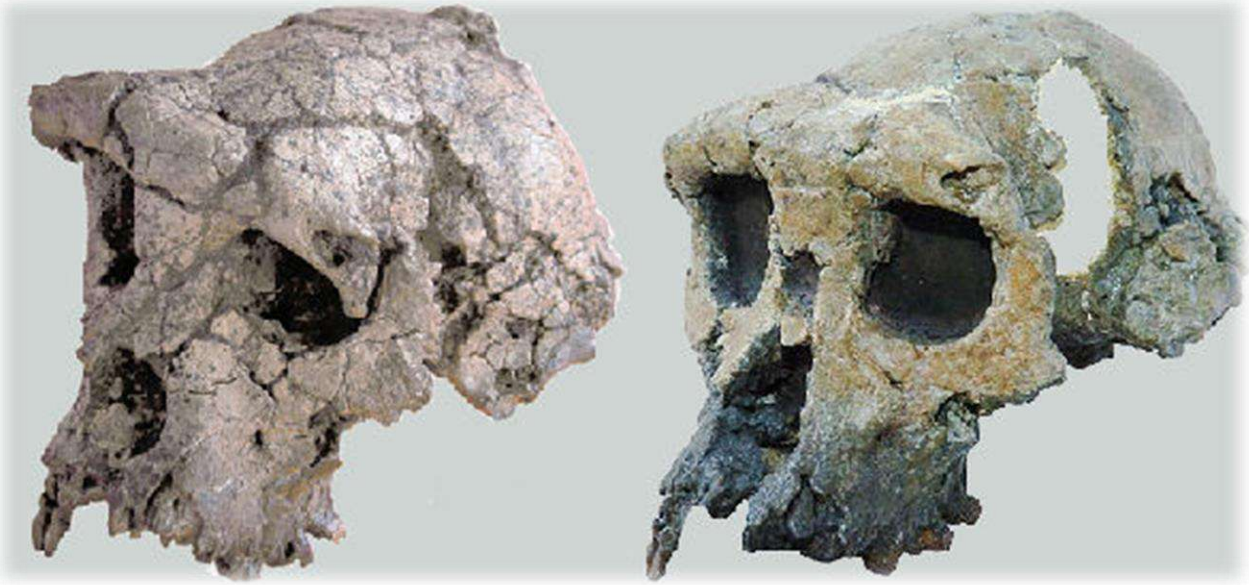
Hominin Examples: 6,000+ fossils; 27+ types; most in Africa



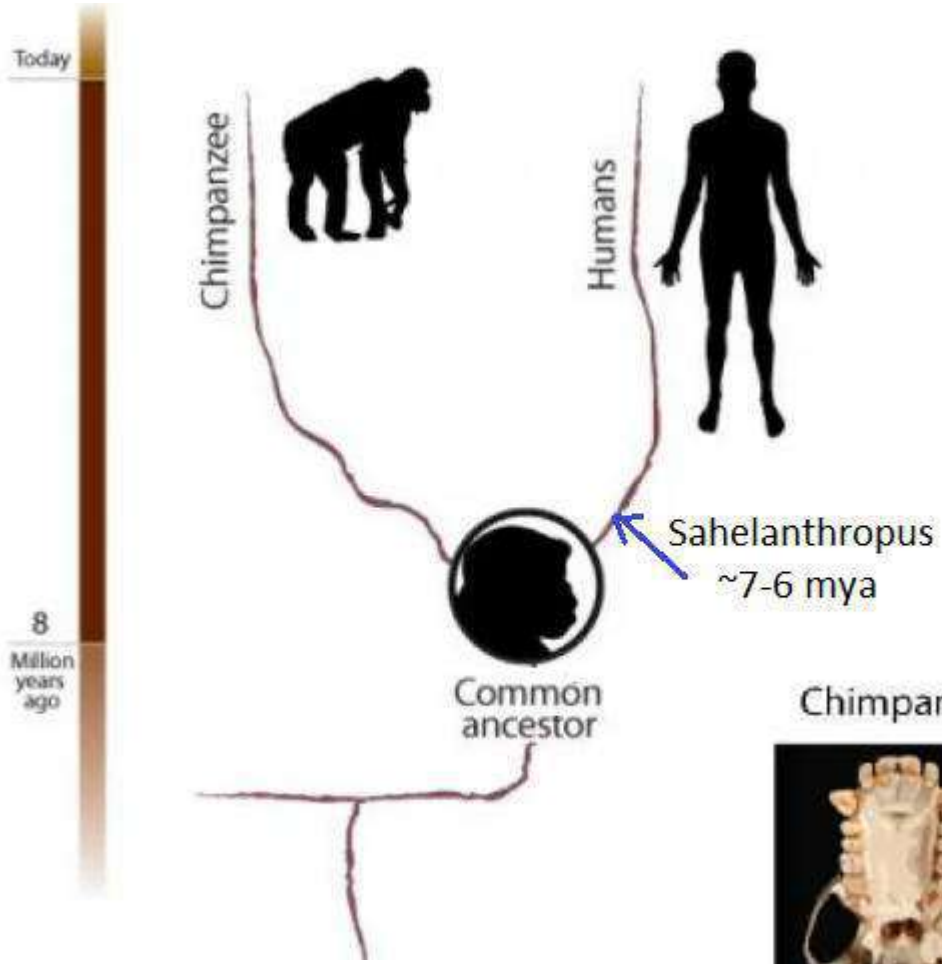
*Sahelanthropus**

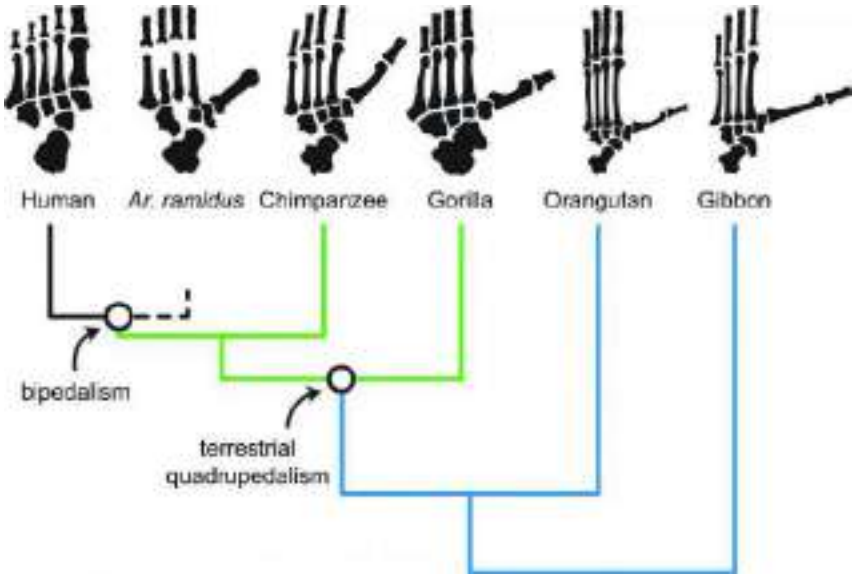
- ~ 7 - 6 mya

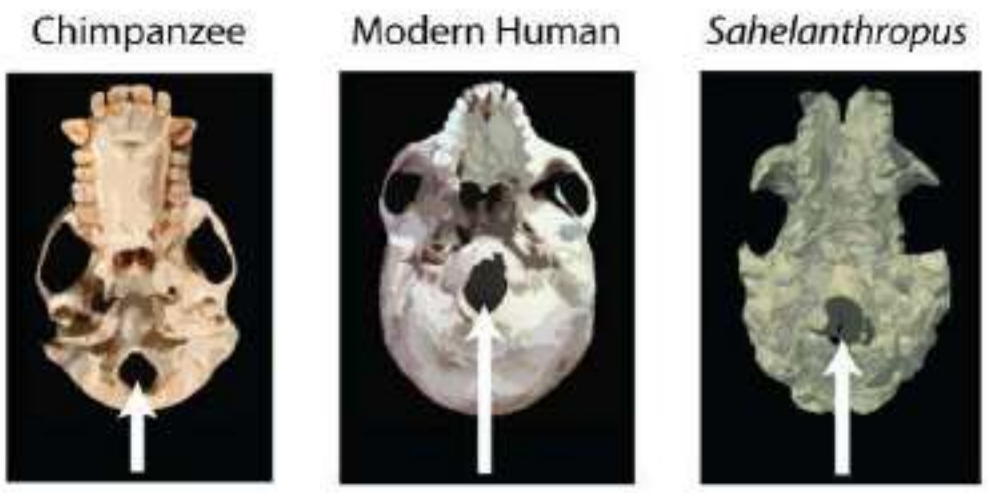
- 1st bipedal ; advantages?



- oldest specimen closes to separating from chimp lineage about same time

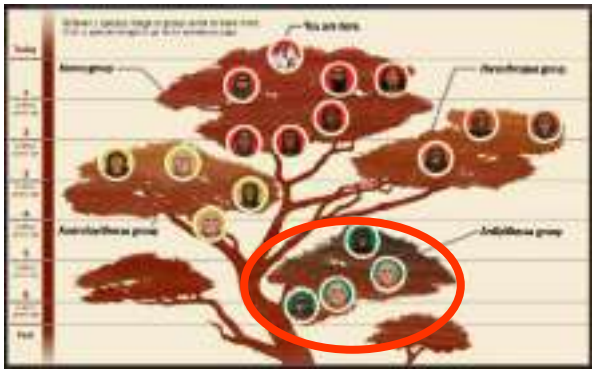






Ardipithecus ramidus , Arti

- ~ 4.4 mya
- female / ~ 4 ft
- skull more human-like

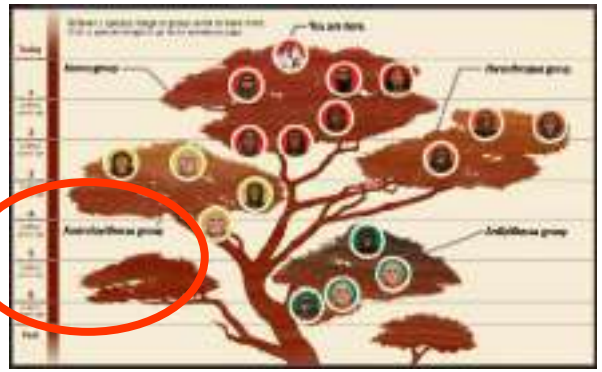


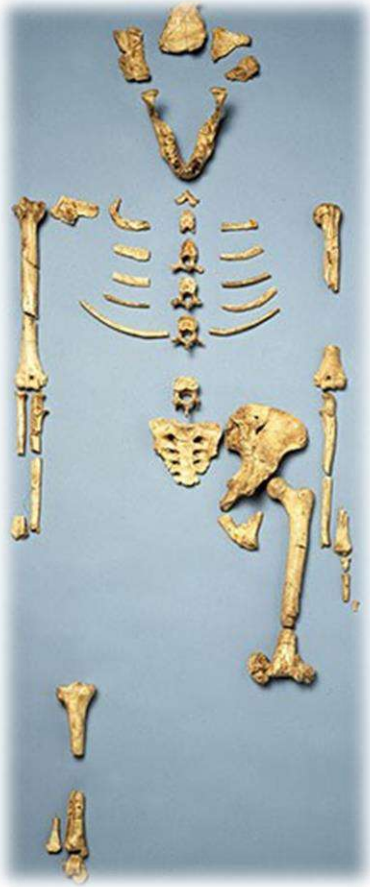
Australopithecus afarensis , Lucy*

- ~ 3.9 - 3.0 mya

- female / ~ 3-4 ft

- ground and tree dwellers



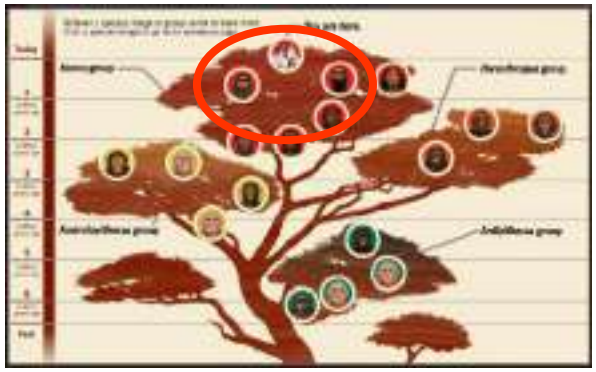


Homo Habilis , Handy Man*

- ~2.3 - 1.4 mya

- ~3-4 ft

- 1st fossil found w/ tools

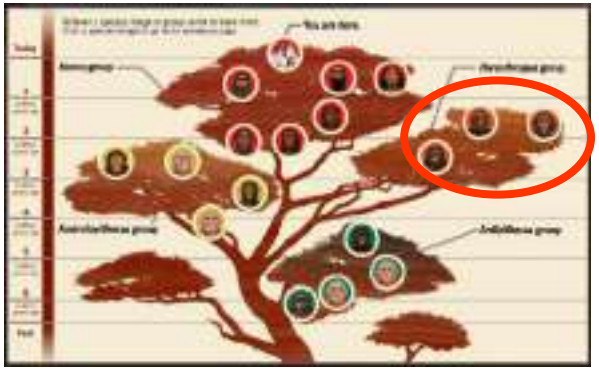


Paranthropus boisei

- ~2.3 - 1.2 mya

- ~ 4-5 ft

- large teeth / jaw



- ~ 2 mya - 10 tya **"Ice Age"** ***(Note: 1 of 4 major ones (~60 total))***

- **many Hominins might have disappeared, why?**

  - **anw: did not adapt (ie. diet / social skills), except one group:**

  - ***Homo sapiens*** ☺ **,** ***tbd***

Homo erectus ; Upright Man

- ~ 1.8 mya - 300 tya
- ~ 5-6 ft
- human-like proportions

*Homo heidelbergensis**

- ~ 600 tya - 250 tya
- ~ 5 ft
- “descendent” of next Hominins

*Homo Neanderthals**

- ~ 250 tya - 40 tya
- ~ 5 ft
- elongated skull ; large brain
- not our descendent

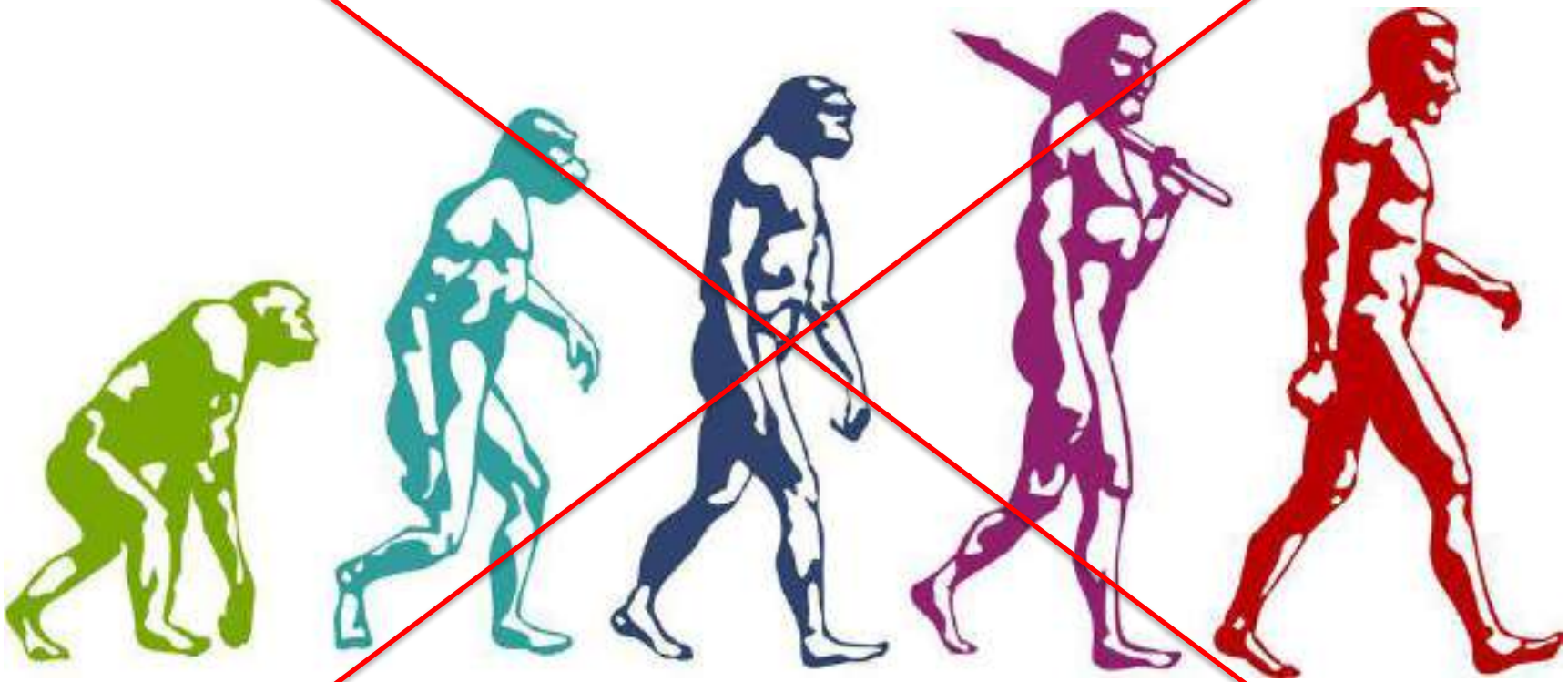
*Homo sapiens**

- ~ 315 tya - present
- better diet → brain / social skills
- we “teach” offspring → learn faster
- ~ 2% of our DNA is *Neanderthal*

No Need to Write

A Misconception of Hominin History

"linear"



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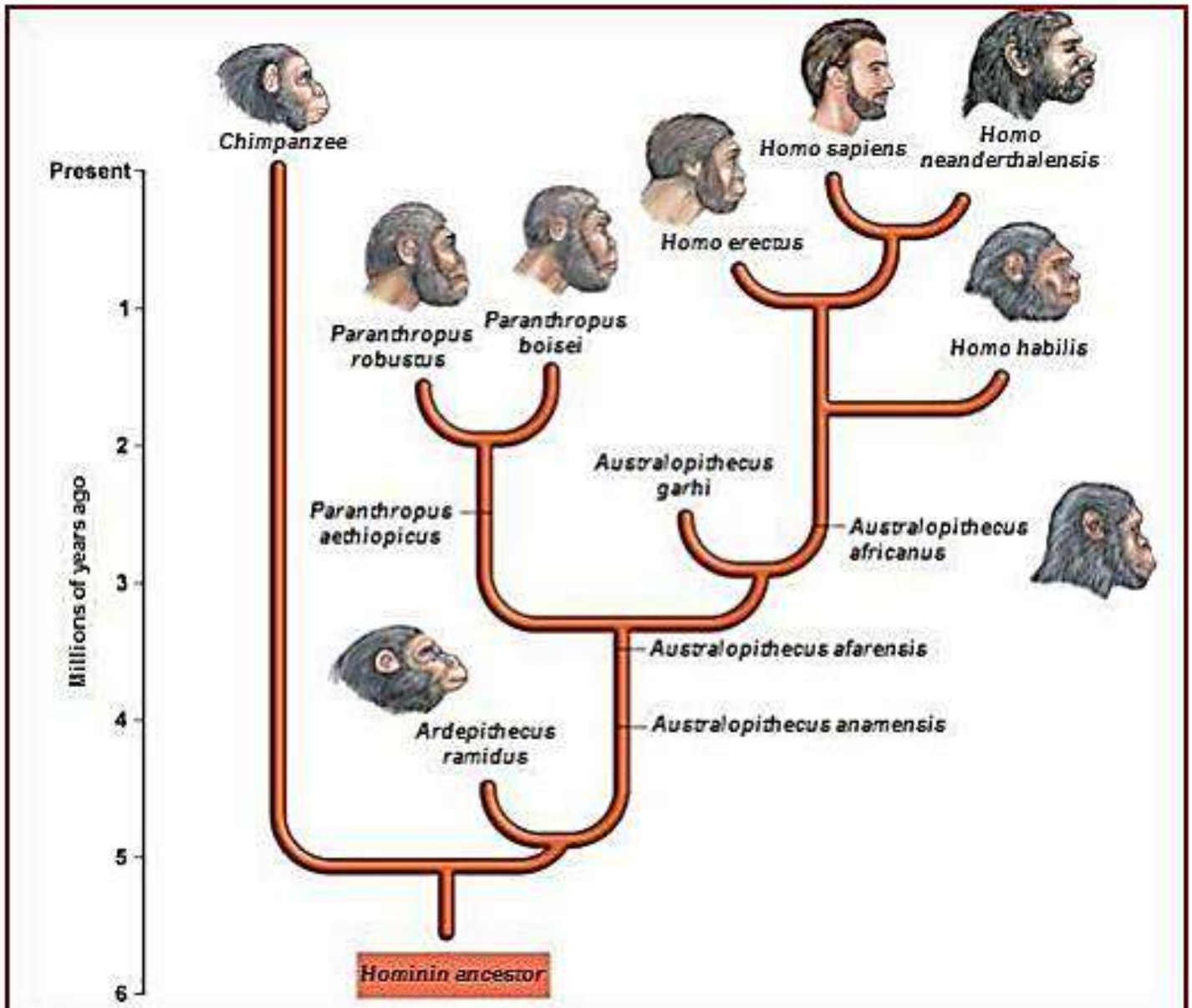
Better Conception of Primate History

"branchy/bushy"

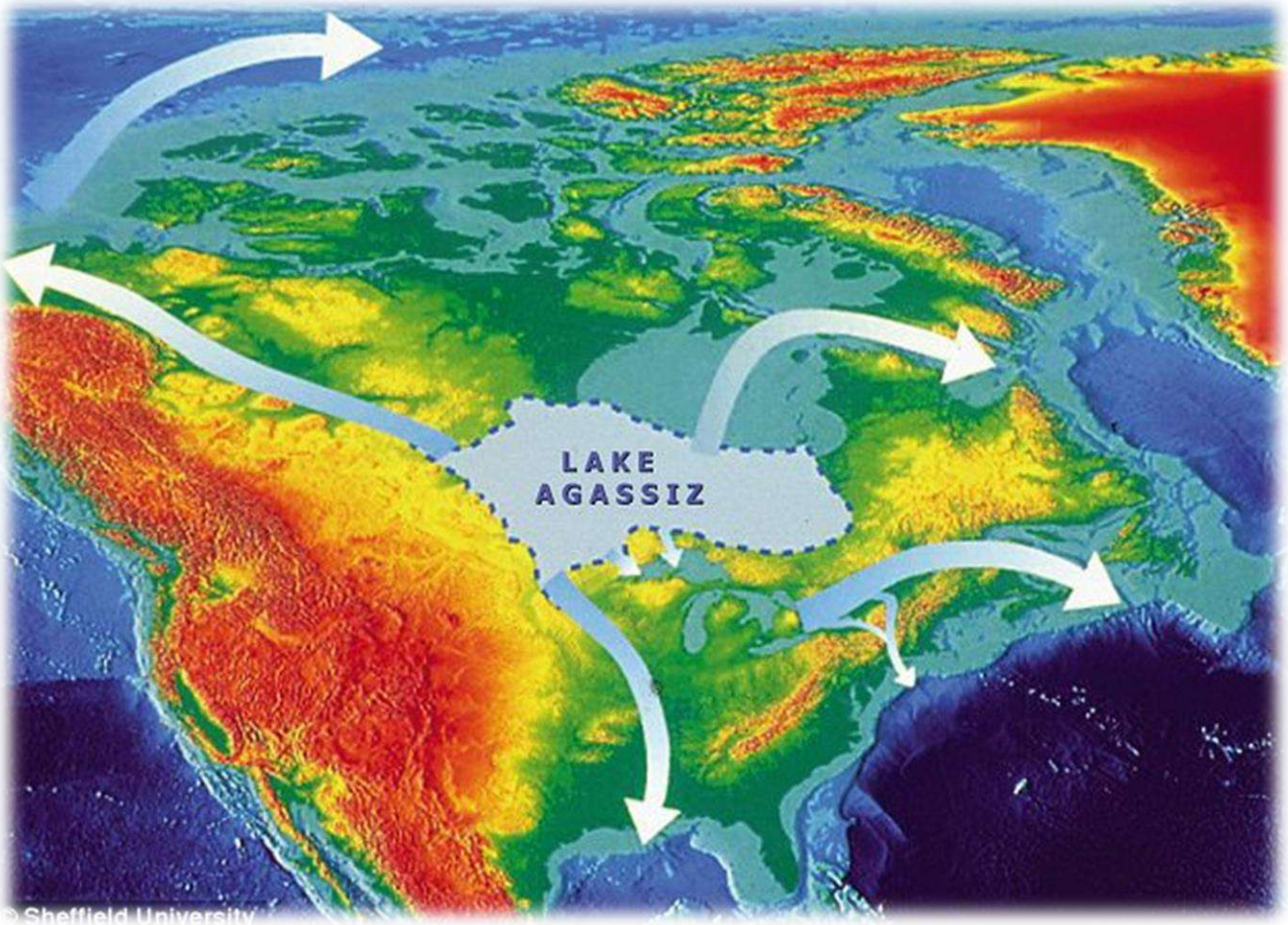


~ 8.1- 8.5 tya "Flood Event"

- ice dam in N. America broke

- releasing ~7x's the amt. of H_2O in today's Great Lakes

- est. that sea levels > ~ 5ft ; surely noticed throughout the world !

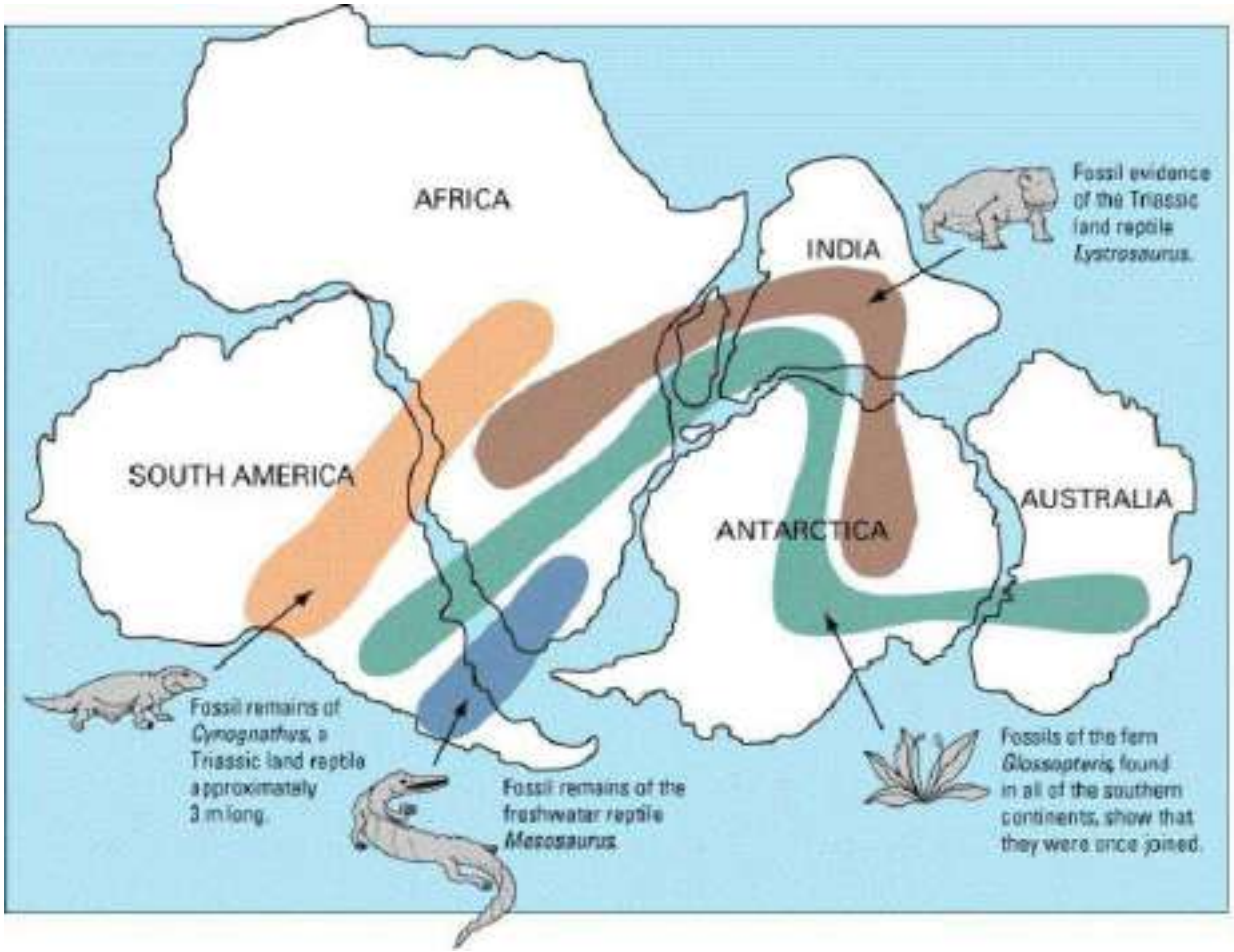


- ~ 250 mya "Pangaea" → Present Day

- plate tectonics and continental drift <u>effects</u> life

- biogeography = geographical distribution of plants/animals

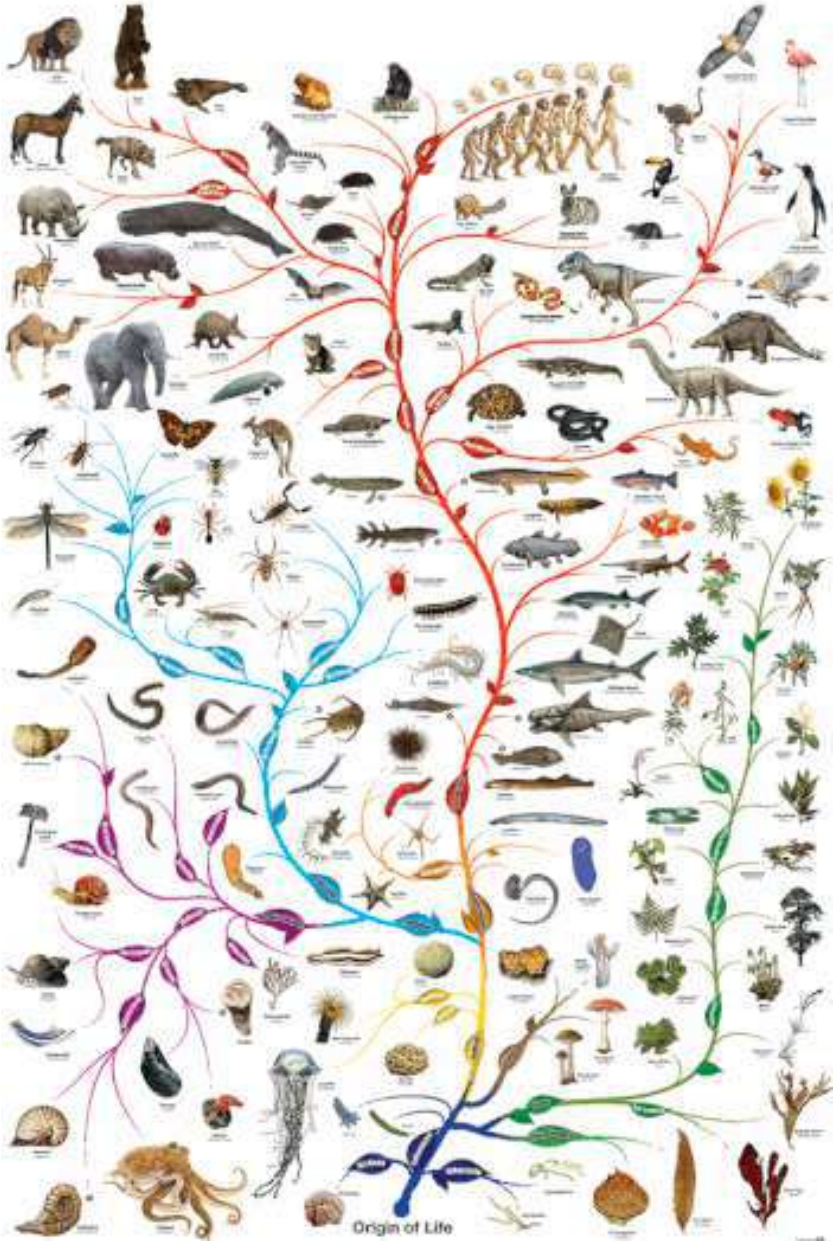
  - ie. reason for similar fossils in diff. places on Earth



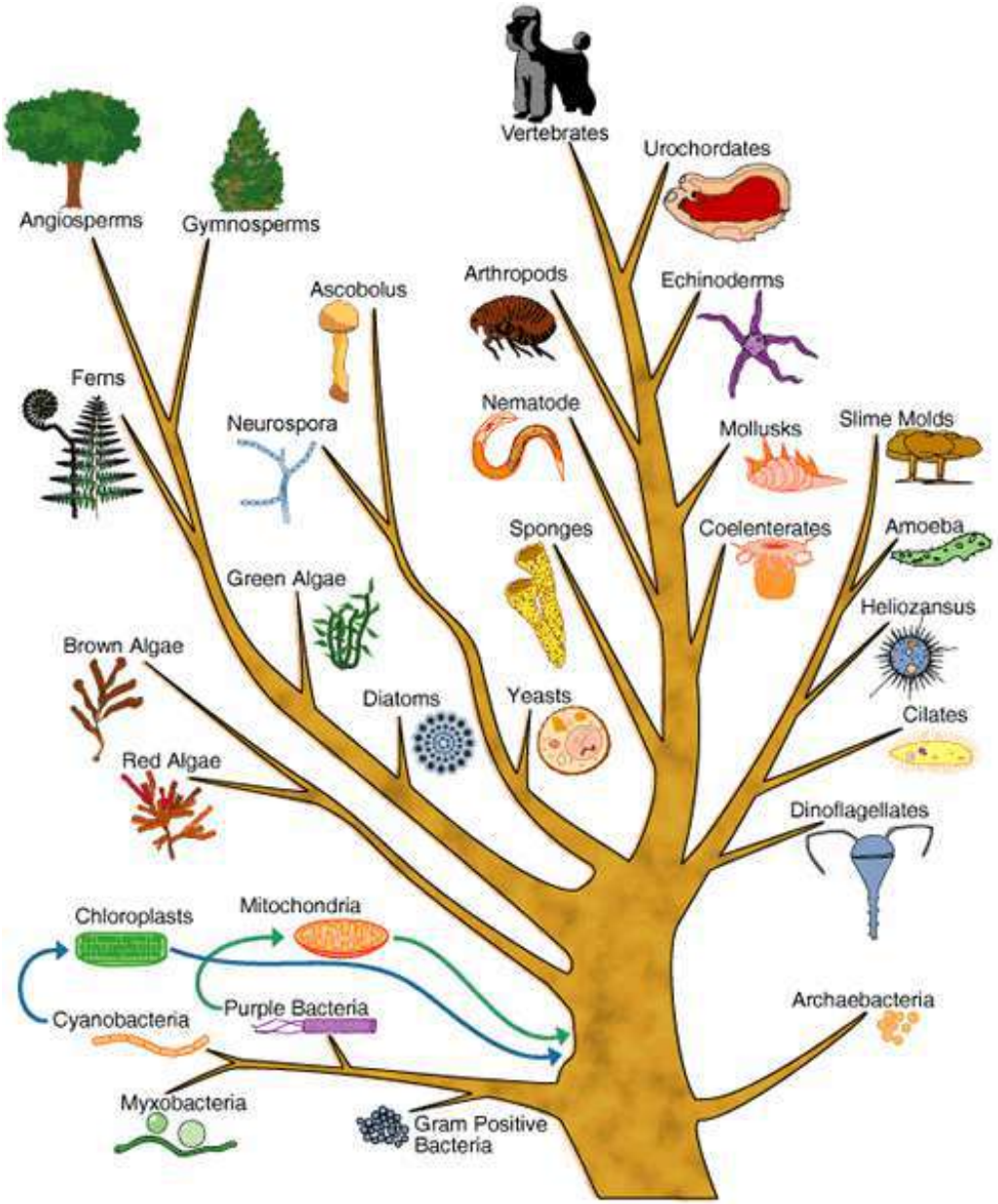
No Need to Write:

Better Conception Overall

"branchy/bushy"



Evolution

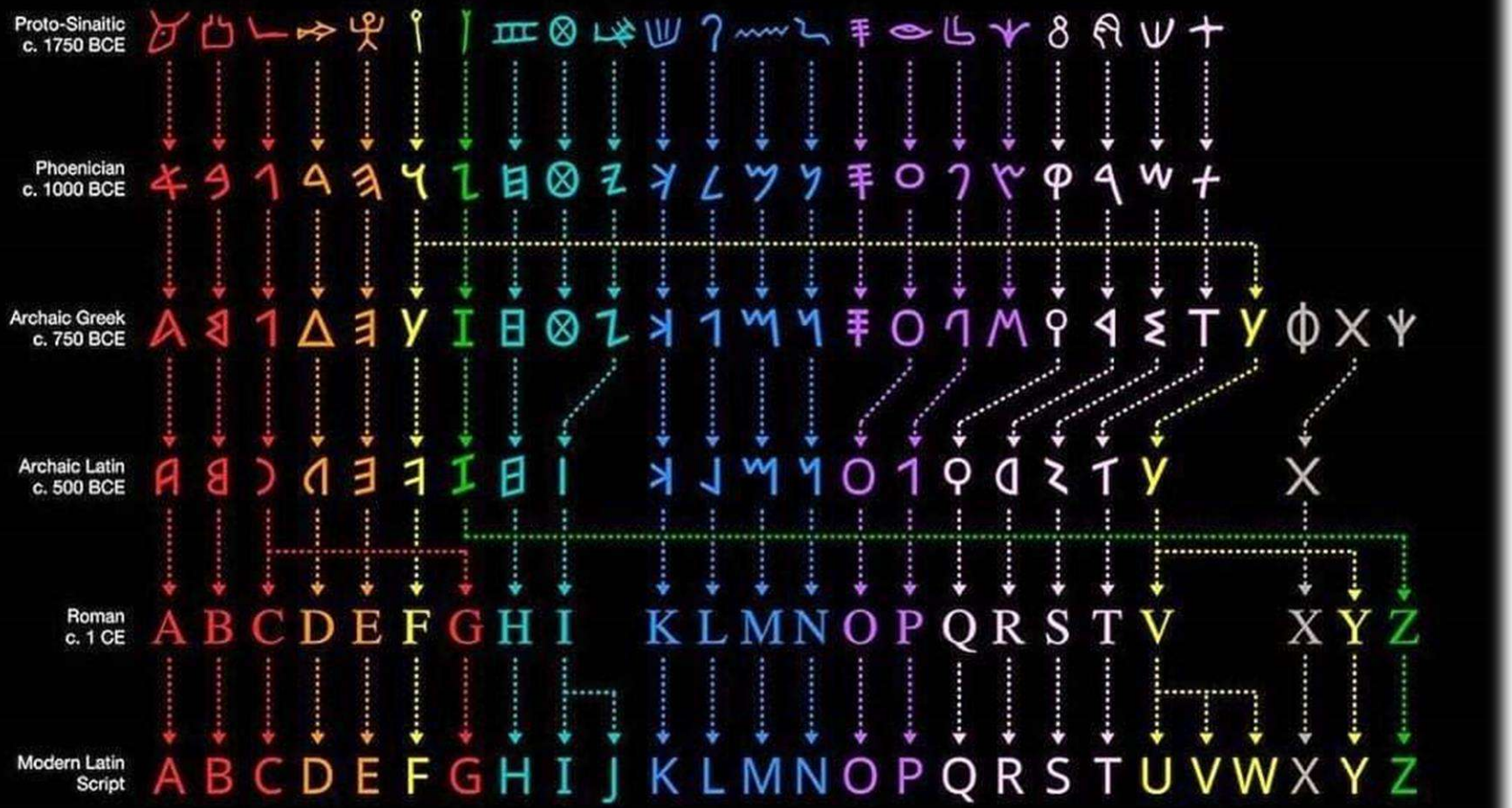

Vertebrates
Urochordates
Angiosperms
Gymnosperms
Ascobolus
Arthropods
Echinoderms
Ferns
Nematode
Neurospora
Mollusks
Slime Molds
Sponges
Coelenterates
Amoeba
Green Algae
Heliozansus
Brown Algae
Diatoms
Yeasts
Ciliates
Red Algae
Dinoflagellates
Chloroplasts
Mitochondria
Cyanobacteria
Purple Bacteria
Archaebacteria
Myxobacteria
Gram Positive Bacteria

No Need to Write:

What Non-Living Things Have Evolved?

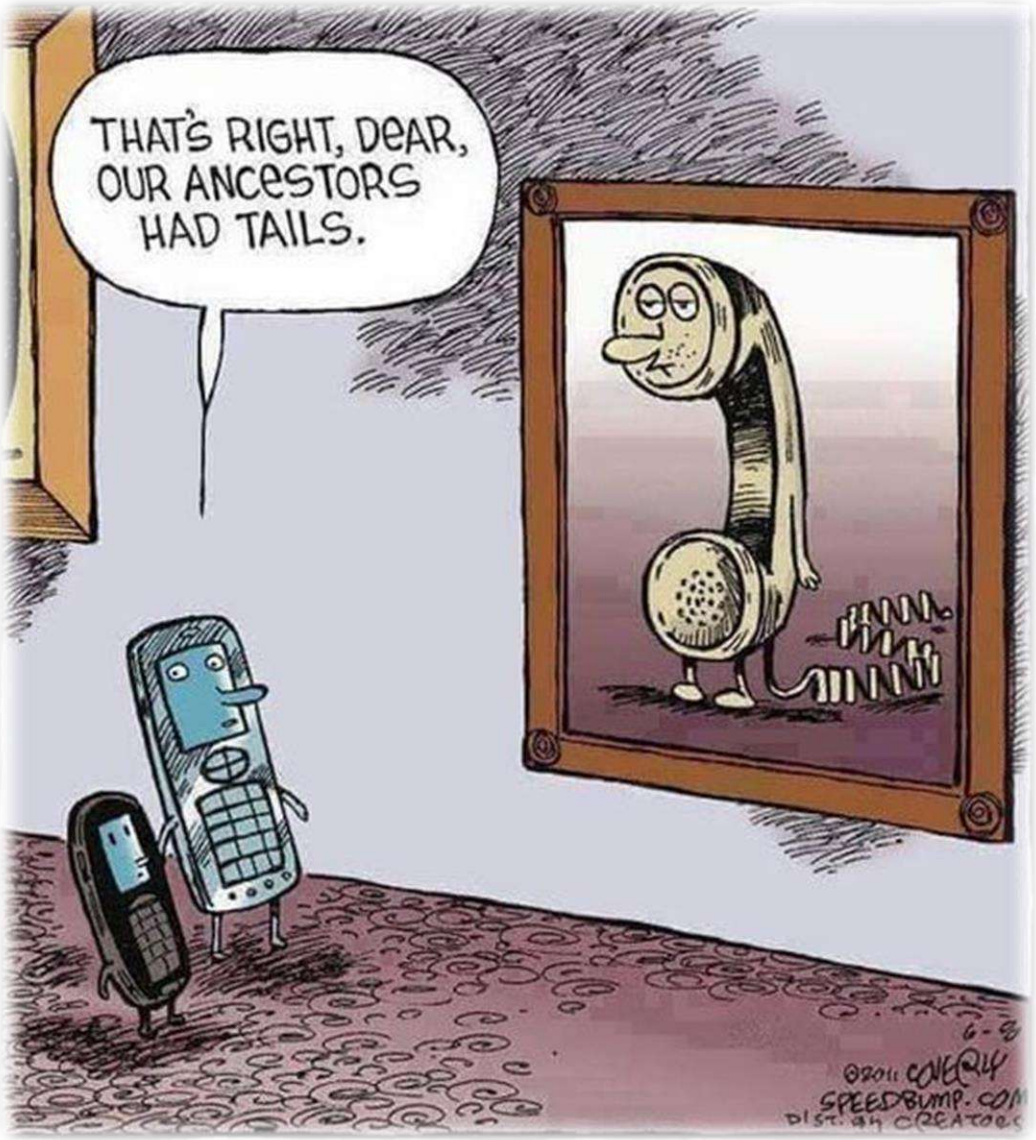
(and continue to evolve)

Evolution of the Alphabet



By Matt Baker | UsefulCharts.com

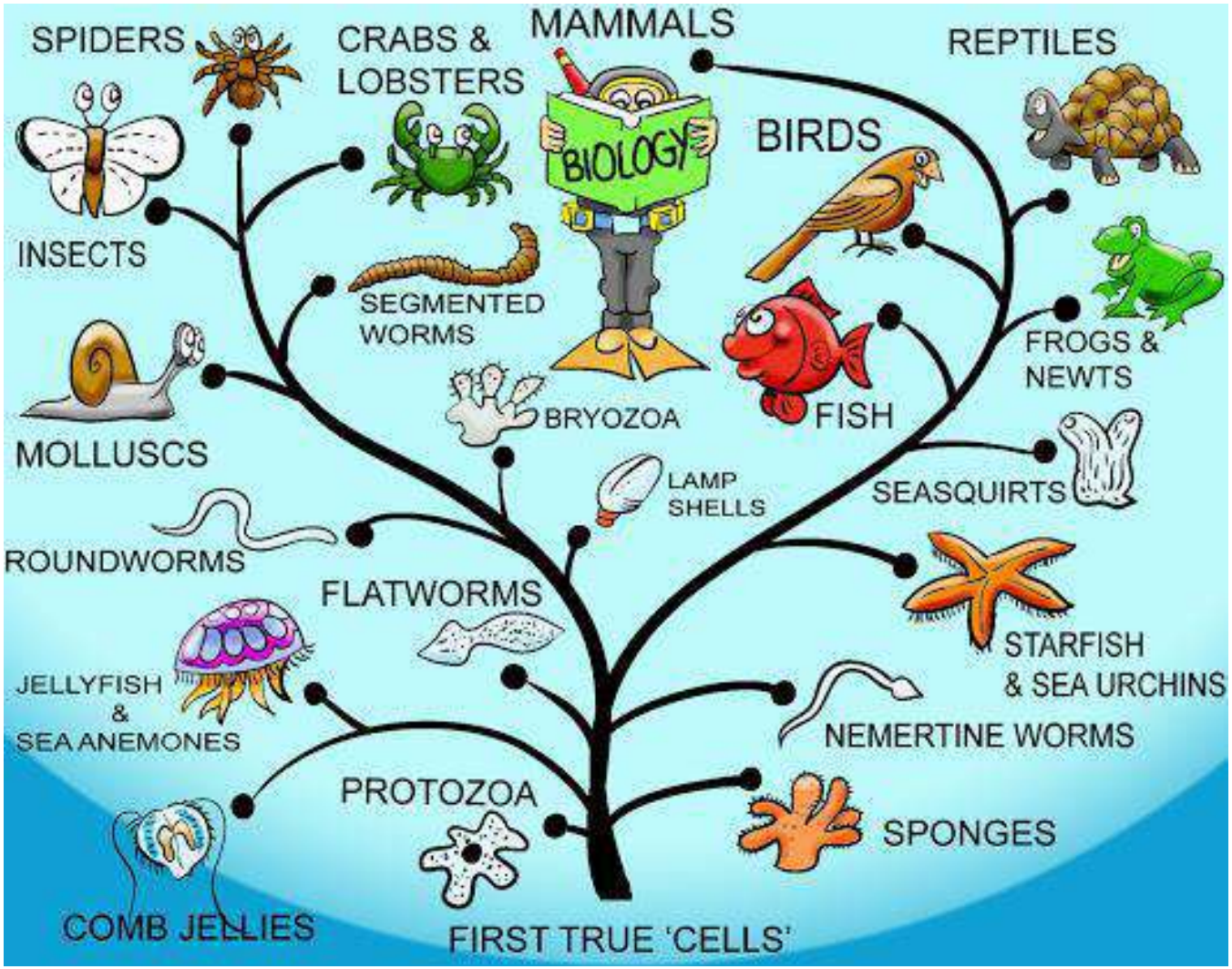
Alphabetum font by Juan José Marcos used for Ancient Greek/Latin


THAT'S RIGHT, DEAR, OUR ANCESTORS HAD TAILS.
©2011 COVERT SPEEDBUMP.COM

Evolution = event w/ heritable variations over time; living only

- descent w/ modification

- “change”



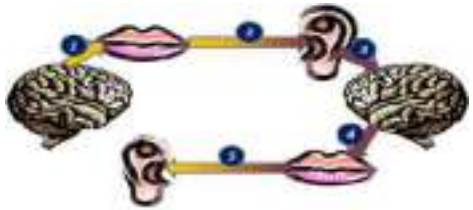
No Need to Write:

"Chinese Whispering Game"

What Evolution is Kinda Like

- **Need pencil/pen and notebook**
- **A "phrase" or "word" will be given to a single person**
- **After hearing the phrase/word, <u>tell</u> it to 2-3 different people behind you only <u>once</u>**
- **Then <u>write</u> down the phrase/word and <u>close</u> your notebook**

Discussion:



- Each "student" = population (ie. organisms)

- Each "telling" = passing of traits w/ <u>possible</u> mutations (ie. genetics)

- Each "notebook" = evidence (ie. fossil)

Requirements

Beneficial Mutation ← DNA

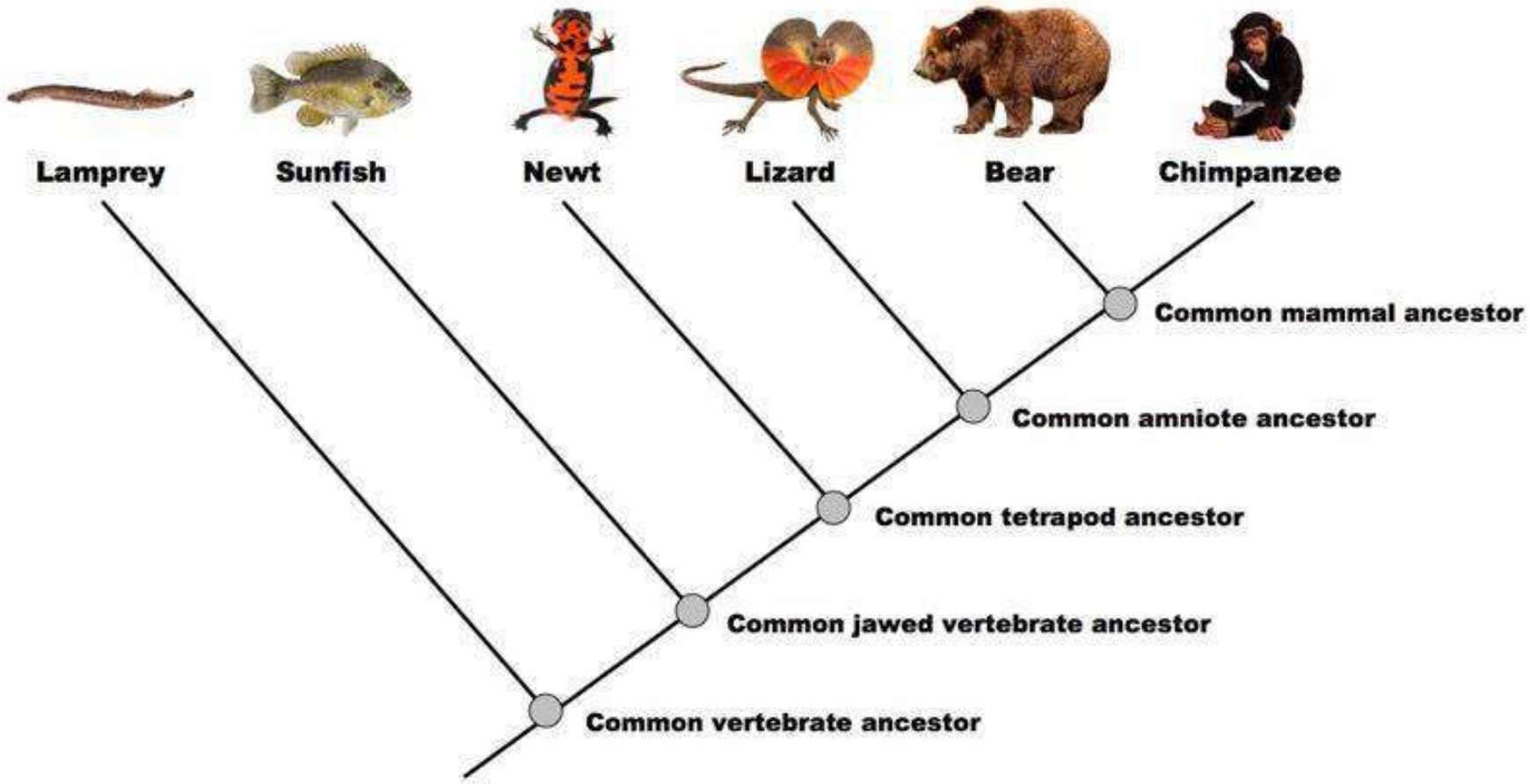
Natural Selection ← survival

Heredity ← generations

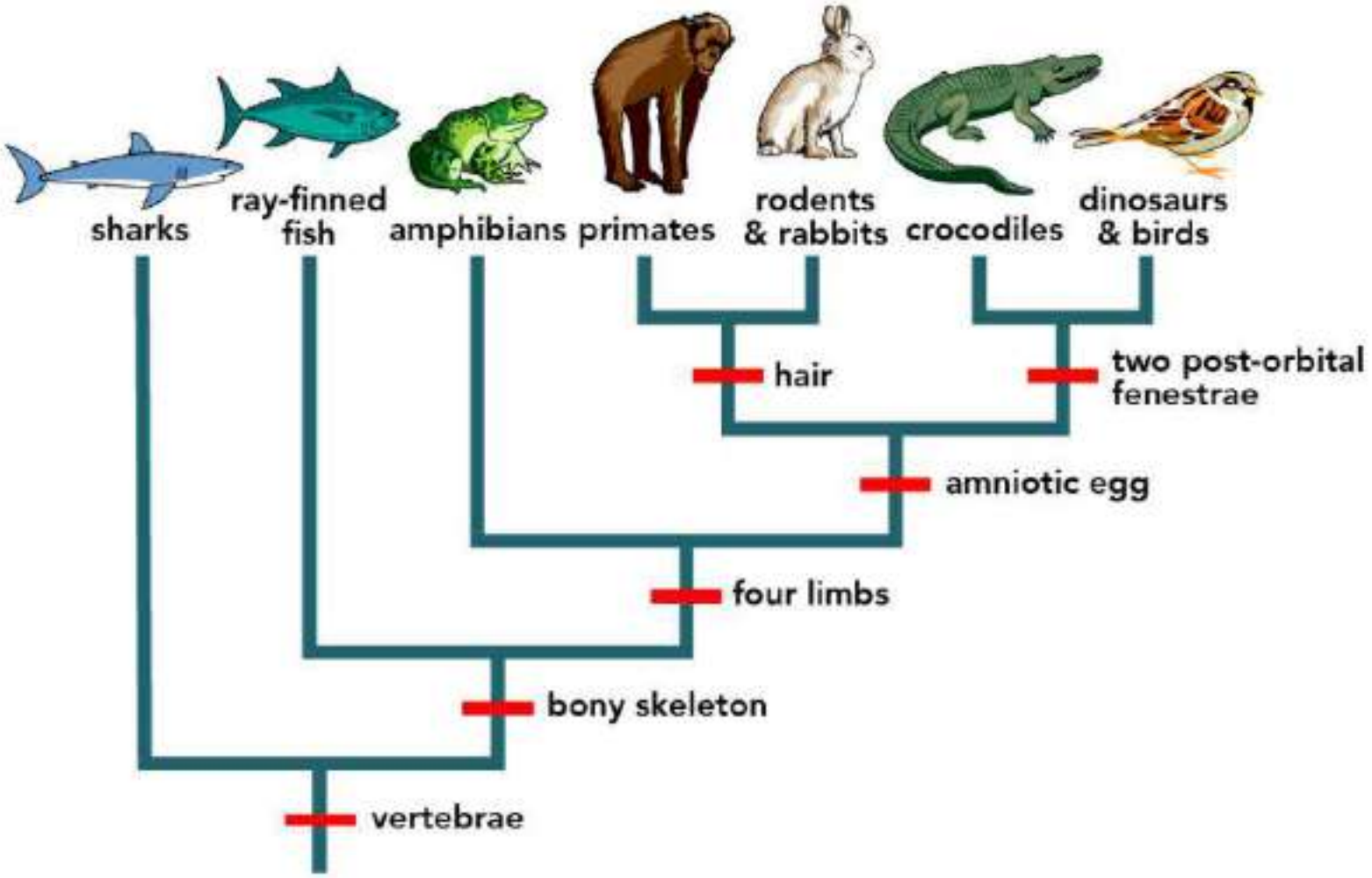
Depictions

Phylogenetics = shows evolutionary time and relationships; 2 types:

- cladogram = mainly shows <u>common ancestry</u>



- tree = mainly shows <u>common traits</u> – ie's backbone, skeleton, hair, limbs, etc…



History Behind Evolution

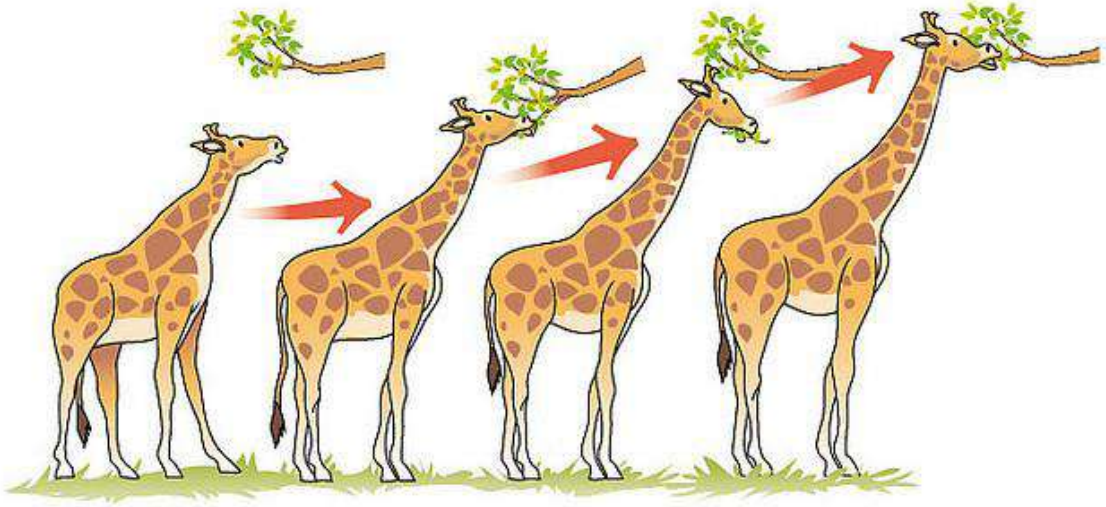
Jean-Baptiste Lamarck (French, 1744-1829); naturalist

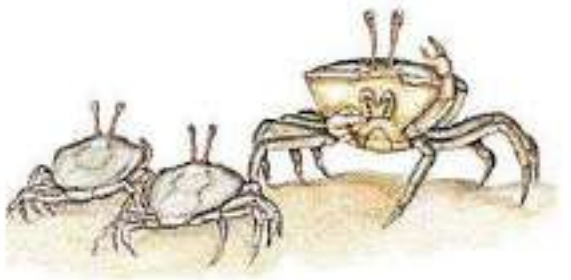
- 1809

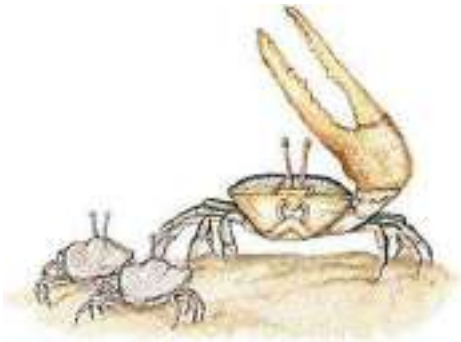
- use of a structure → caused change → got passed on

- ie's giraffe or fiddler crab ← *know the stories*

- didn't get it "quite" right







Charles Darwin (British, 1809-1882)

- 1825, (at 16) studied medicine; disliked human dissections; quit

- 1828, degree in theology instead; but never a clergyman

- loved studying nature and traveling

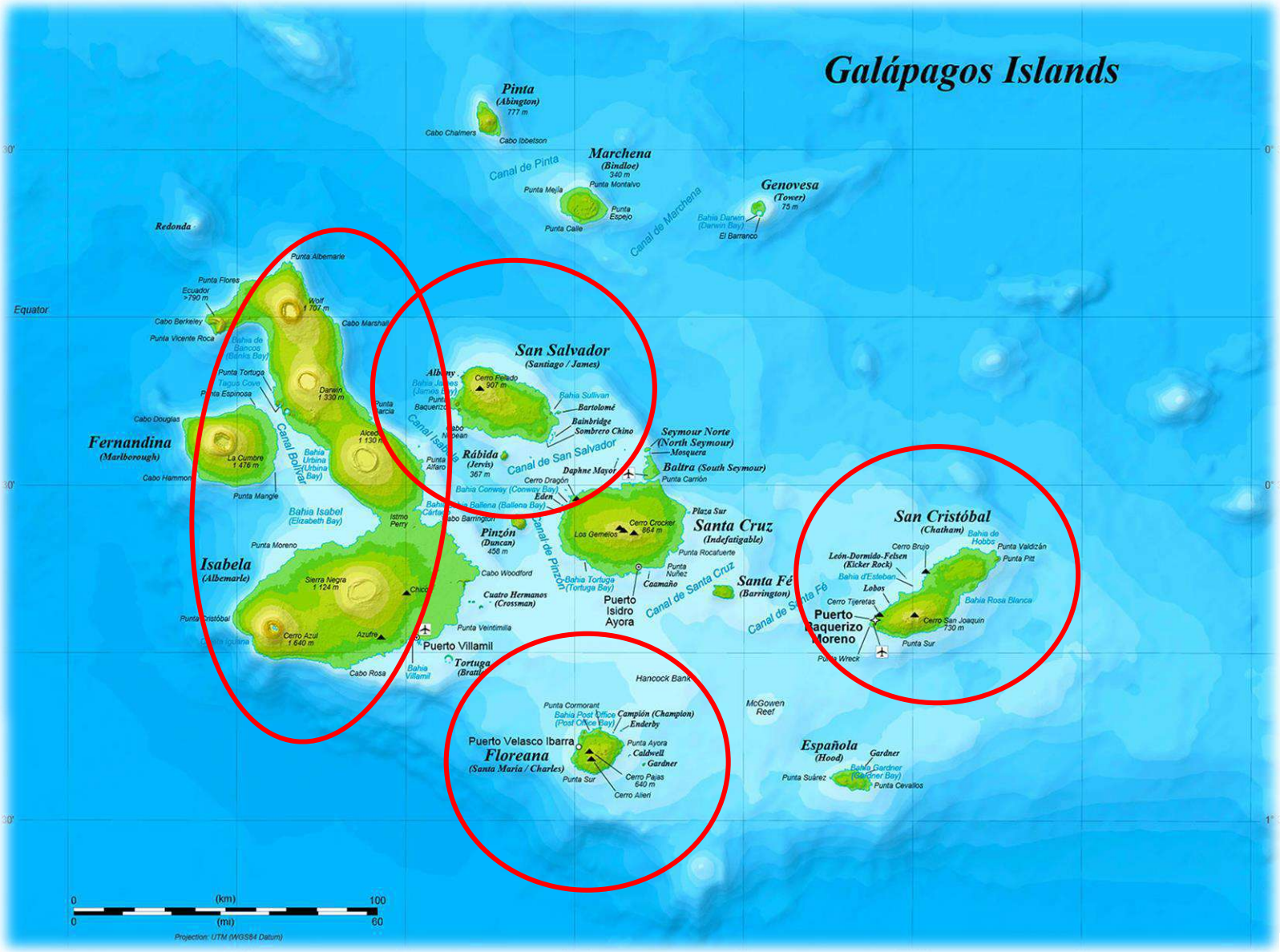
- 1831, (at 22) guest on H.M.S. Beagle ~ 5 yrs; got sea-sick a lot !

  - studied and collected everything; *tbd*

- 1859, published a famous book; *tbd*

H.M.S. *Beagle* in Straits of Magellan. Mt. Sarmiento in the distance.

- 1835 (9/15 -10/17) visited 4 (of 21) Islands of the Galapagos



Note: Galapagos is ~850 mls from Ecuador, S.A.

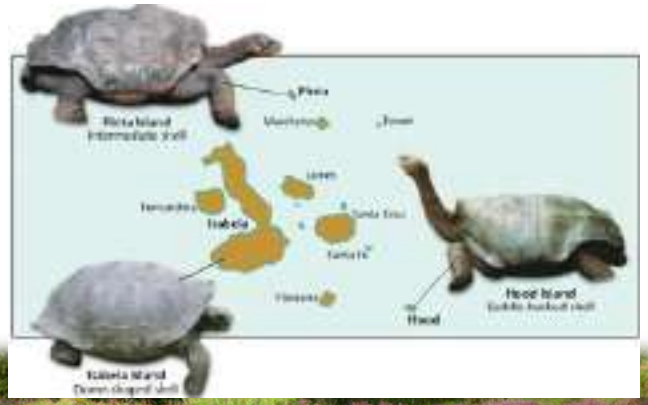
Organisms and Features Found on the Galapagos

Giant Tortoises: **However…Few Mammals, Why?**

ie. shell type:

domed shell = survived on islands w/ mostly low vegetation

notched (saddleback) = survived on islands w/ mostly high vegetation



Giant Prickly Pear Cactus: *(adult)*

ie. trunks = tall to escape most predators; looses spines on trunk

Flightless Cormorant:

ie. wings = small and unable to fly; but great for stirring under water

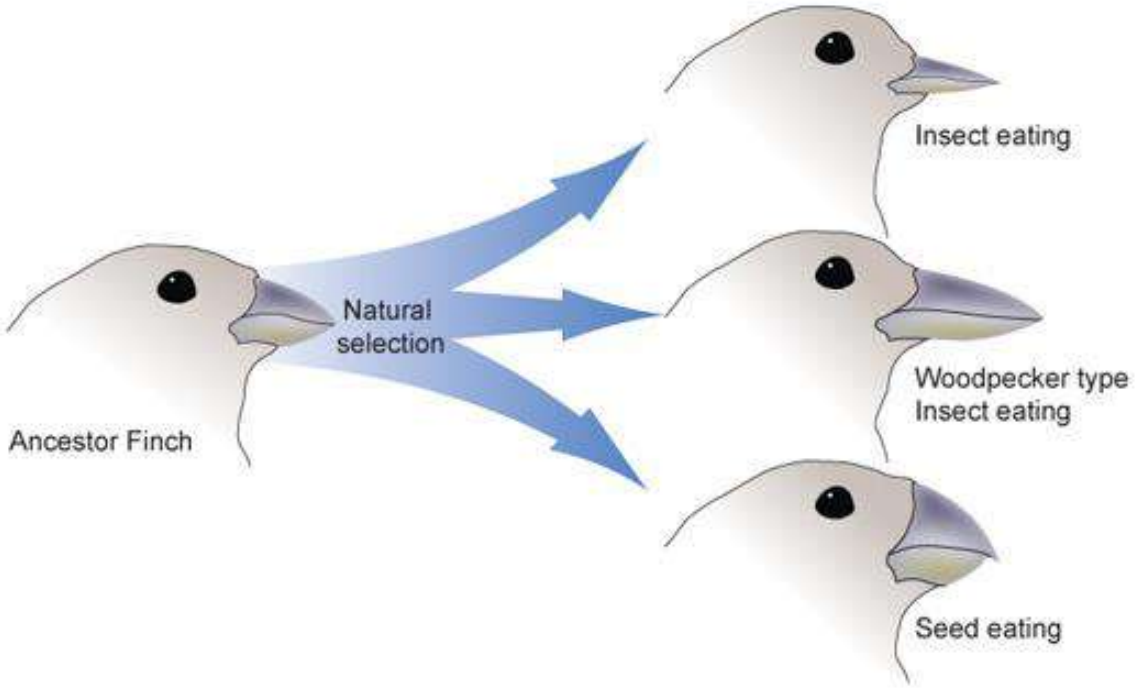
Marine Iguanas:

ie. face = allowed to scrape off aquatic plants under water

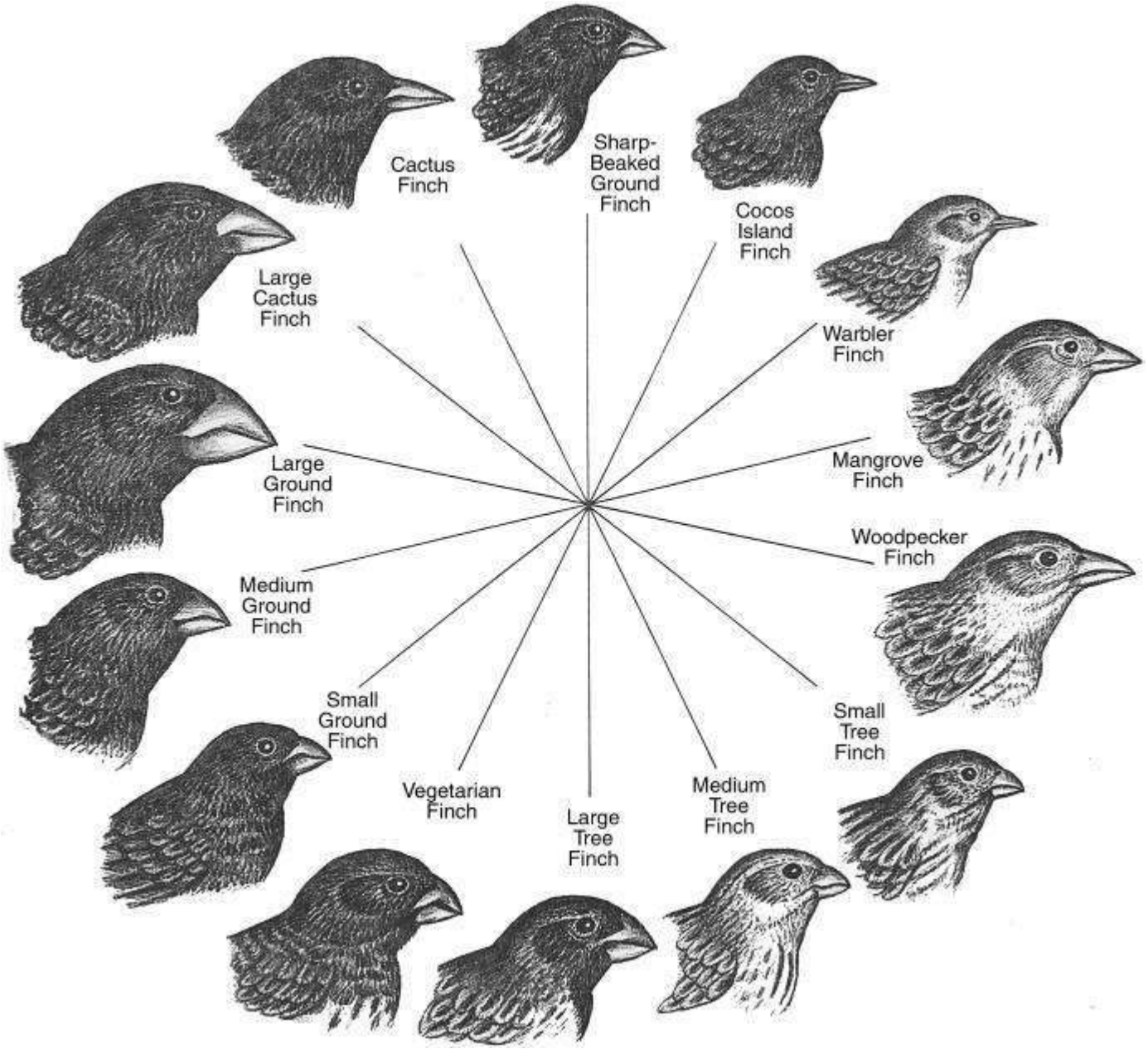
Note: Land Versions

Finches:

ie. beaks = eating certain foods (seeds or insects) on certain islands



~ 14 species:


Cactus Finch
Sharp-Beaked Ground Finch
Cocos Island Finch
Large Cactus Finch
Warbler Finch
Large Ground Finch
Mangrove Finch
Woodpecker Finch
Medium Ground Finch
Small Ground Finch
Small Tree Finch
Vegetarian Finch
Medium Tree Finch
Large Tree Finch

Darwin's Summation

Organisms:

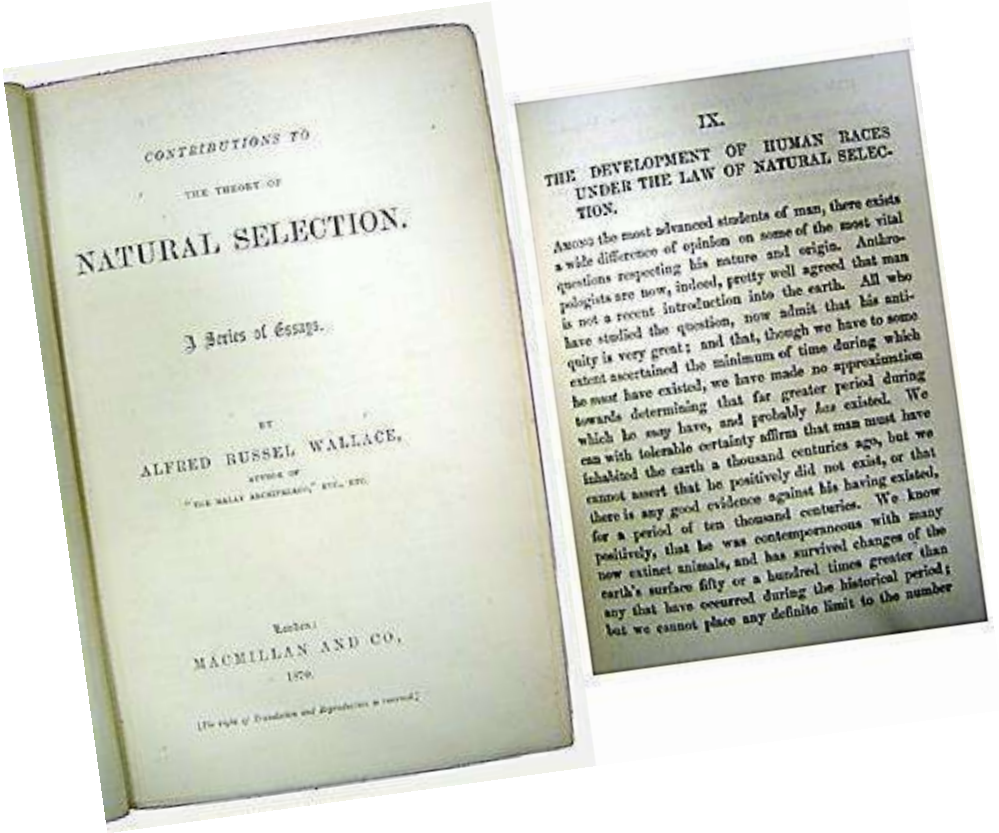
- developed beneficial changes
- adapted to their environment
- able to pass on their traits

Alfred Wallace (British, 1823-1913); naturalist

- 1858, came up w/ same theory; *tbd*, as Darwin ← sent him a letter

- forced Darwin to publicize his idea(s), *tbd*

Natural Selection = species whose characteristics are suited to their environment will survive and pass on their traits



CONTRIBUTIONS TO

THE THEORY OF

NATURAL SELECTION.

A Series of Essays.

BY

ALFRED RUSSEL WALLACE,

AUTHOR OF

"THE MALAY ARCHIPELAGO," ETC., ETC.

London:

MACMILLAN AND CO.

1870.

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IX.

THE DEVELOPMENT OF HUMAN RACES UNDER THE LAW OF NATURAL SELECTION.

Among the most advanced students of man, there exists a wide difference of opinion on some of the most vital questions respecting his nature and origin. Anthropologists are now, indeed, pretty well agreed that man is not a recent introduction into the earth. All who have studied the question, now admit that his antiquity is very great; and that, though we have to some extent ascertained the minimum of time during which he must have existed, we have made no approximation towards determining that far greater period during which he may have, and probably has existed. We can with tolerable certainty affirm that man must have inhabited the earth a thousand centuries ago, but we cannot assert that he positively did not exist, or that there is any good evidence against his having existed, for a period of ten thousand centuries. We know positively, that he was contemporaneous with many now extinct animals, and has survived changes of the earth's surface fifty or a hundred times greater than any that have occurred during the historical period; but we cannot place any definite limit to the number

- ie White and Black Peppered Moths (~200 yr study)
  - England's industrial revolution (1760-1850) → pollution
    - ie. soot on birches: < # of white and > # of black
      - later → visa versa

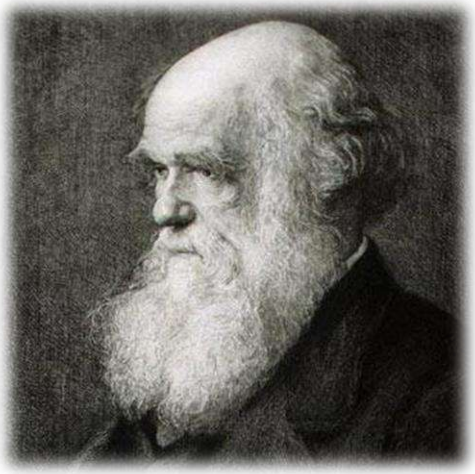
see: rm118.com

"Origin of Species" ; 1859-1872 by Darwin (~20 years after voyage)

Summary of Text: *(note: acknowledged Wallace)*

Species evolve based on:

- *** Beneficial Characteristics**
- *** Natural Selection**
- *** Common Descent**

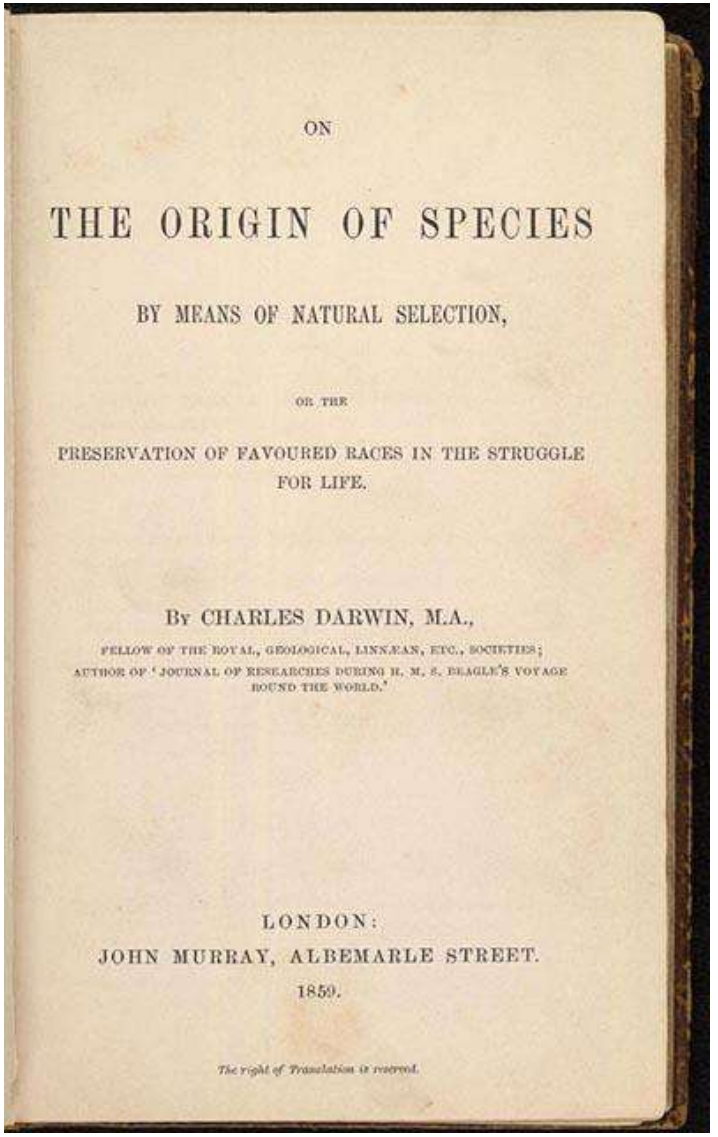


Also:

- Organisms did "not" just spontaneously appear on Earth

- Earth was "not" just 1000's of years old

- Humans are "not" any different when it comes to evolving



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

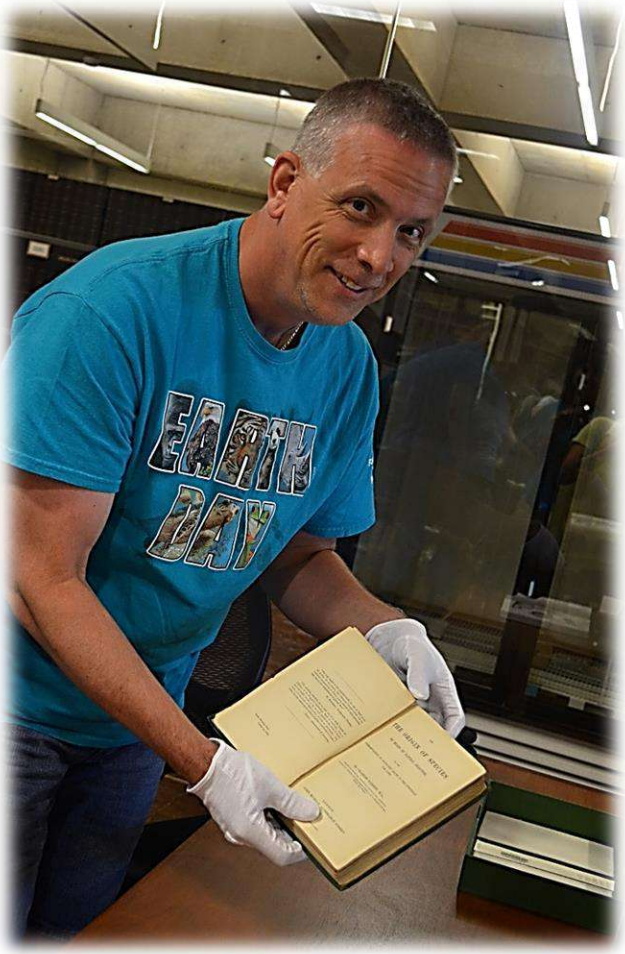
By CHARLES DARWIN, M.A.,

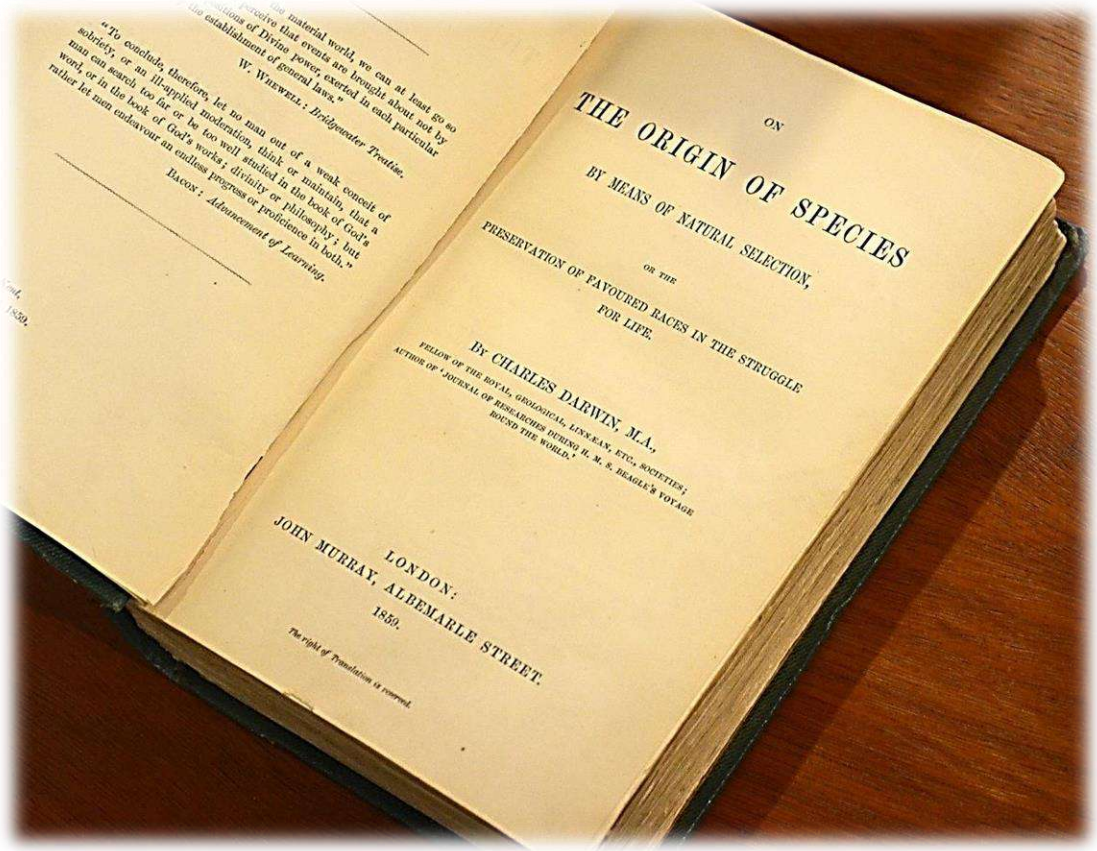
FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

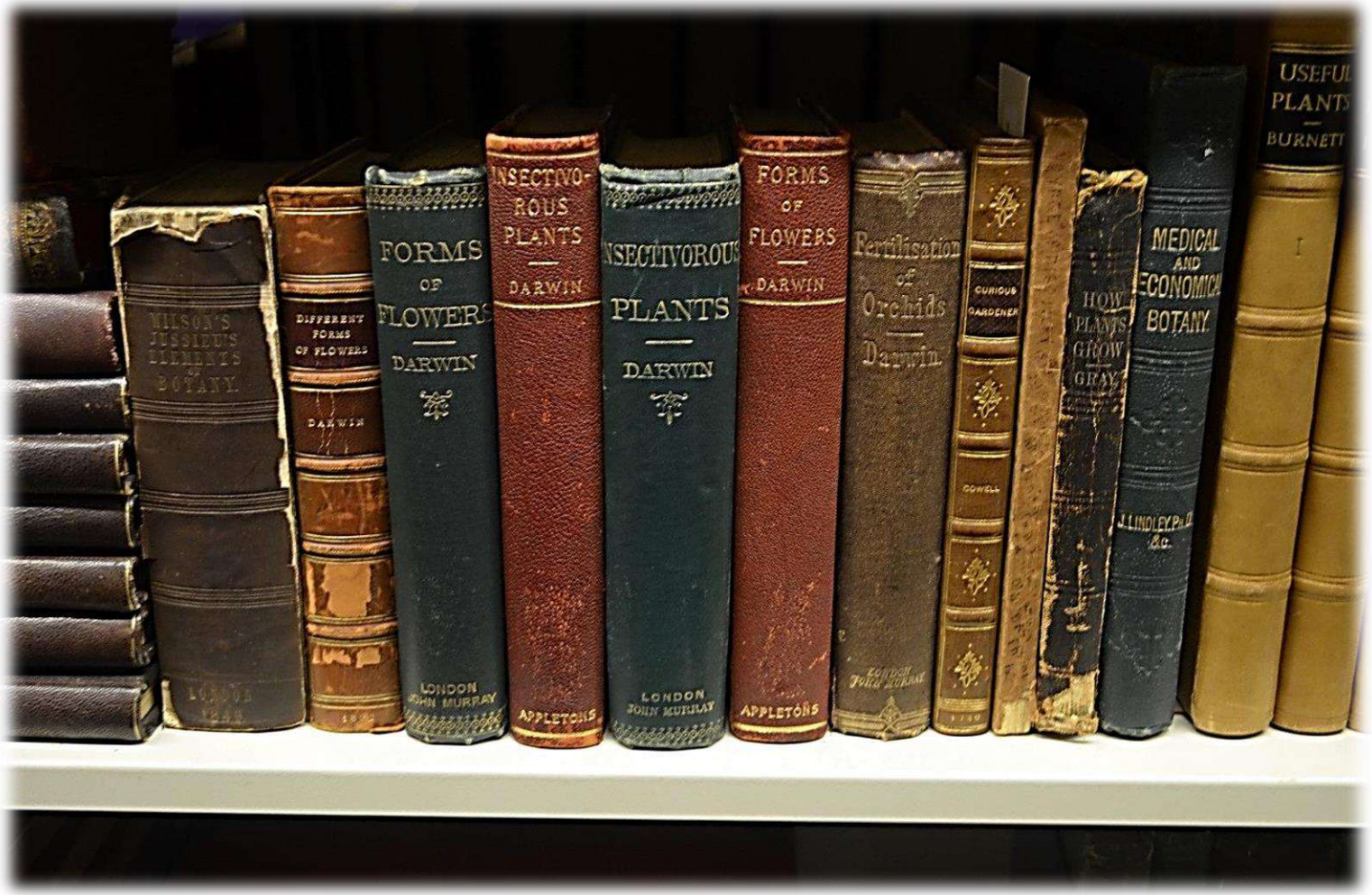
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

The right of Translation is reserved.

Had the Opportunity to Hold and Page Through an Original Copy of the "Origin of Species" from London England, 1859 at the National Tropical Botanical Garden in Kauai, Hawaii During a 2 Week Workshop, 2015



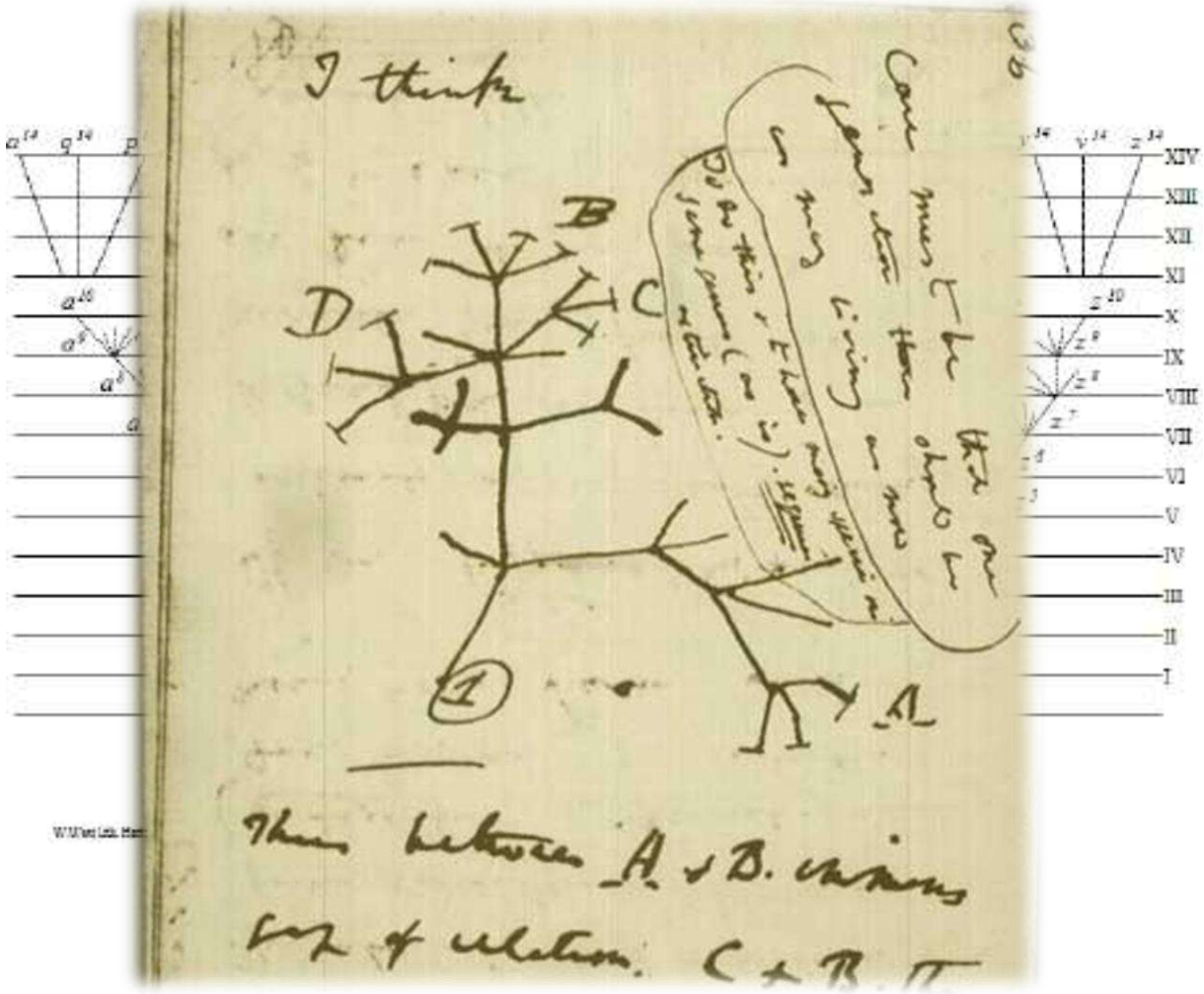




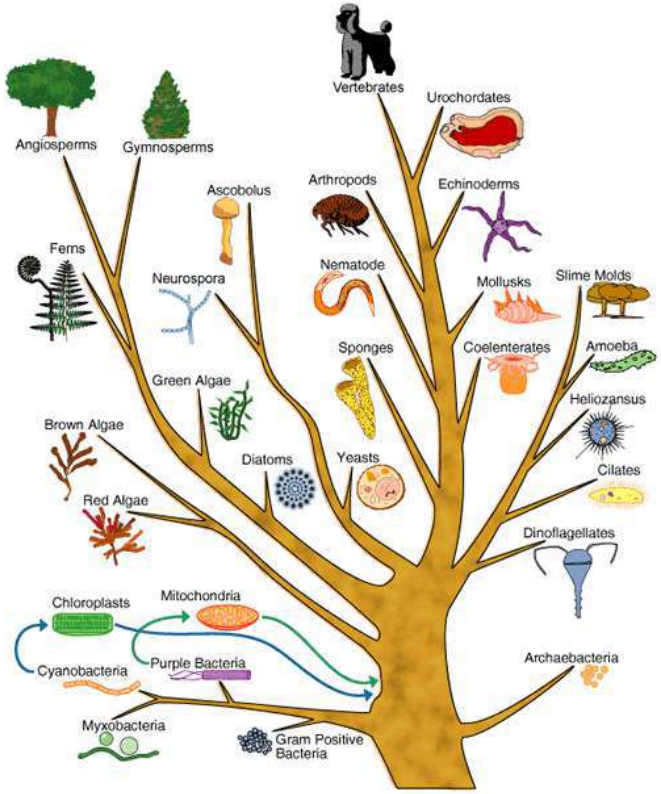
Charles Darwin wrote 19 different books during his lifetime. Some of them have been published in more than one edition. Some of his most famous works include On the Origin of Species, The Descent of Man, The Expression of the Emotions in Man and Animals, and several books the described the HMS Beagle travels.

The Only Sketch in the "Origin of Species", 1837

Illust. by William West (not C. Darwn)



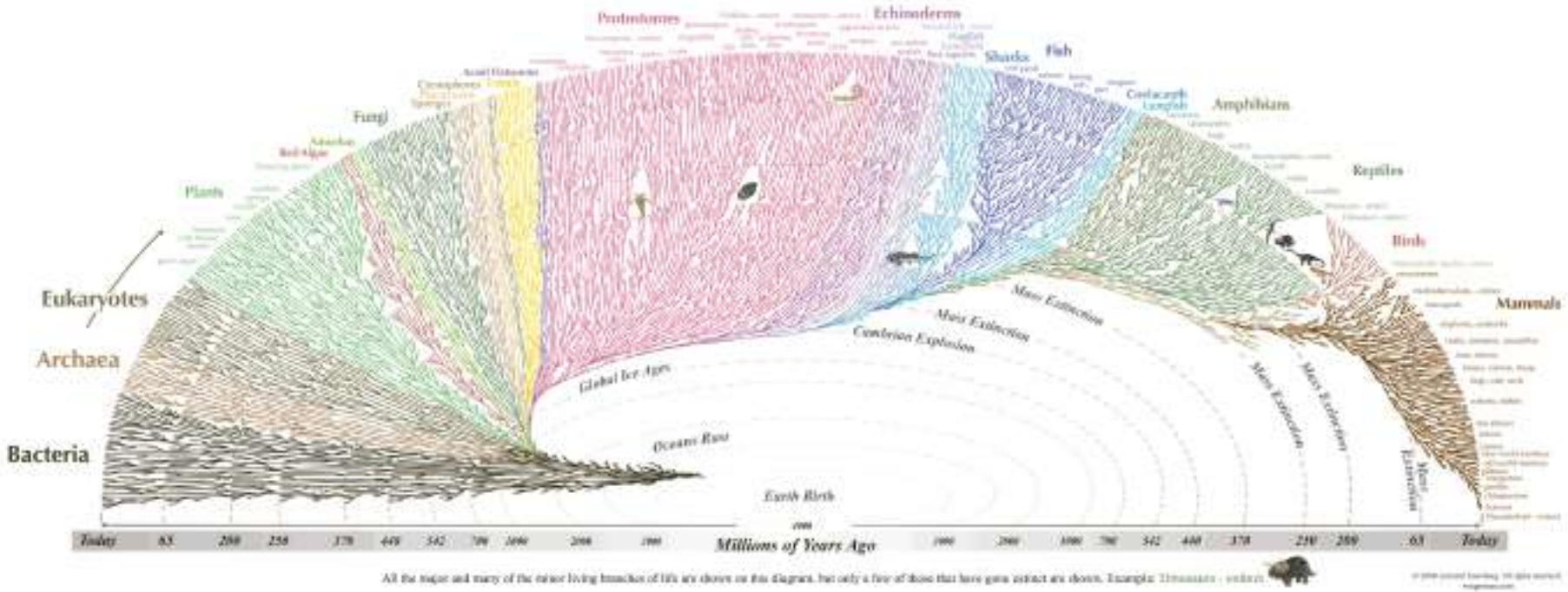
Tree of Life Sketch, *Illust. by C. Darwin*
in One of His Notebooks



Mr B's Galapagos Blog Assignment

Teacher Traveler to the Galapagos

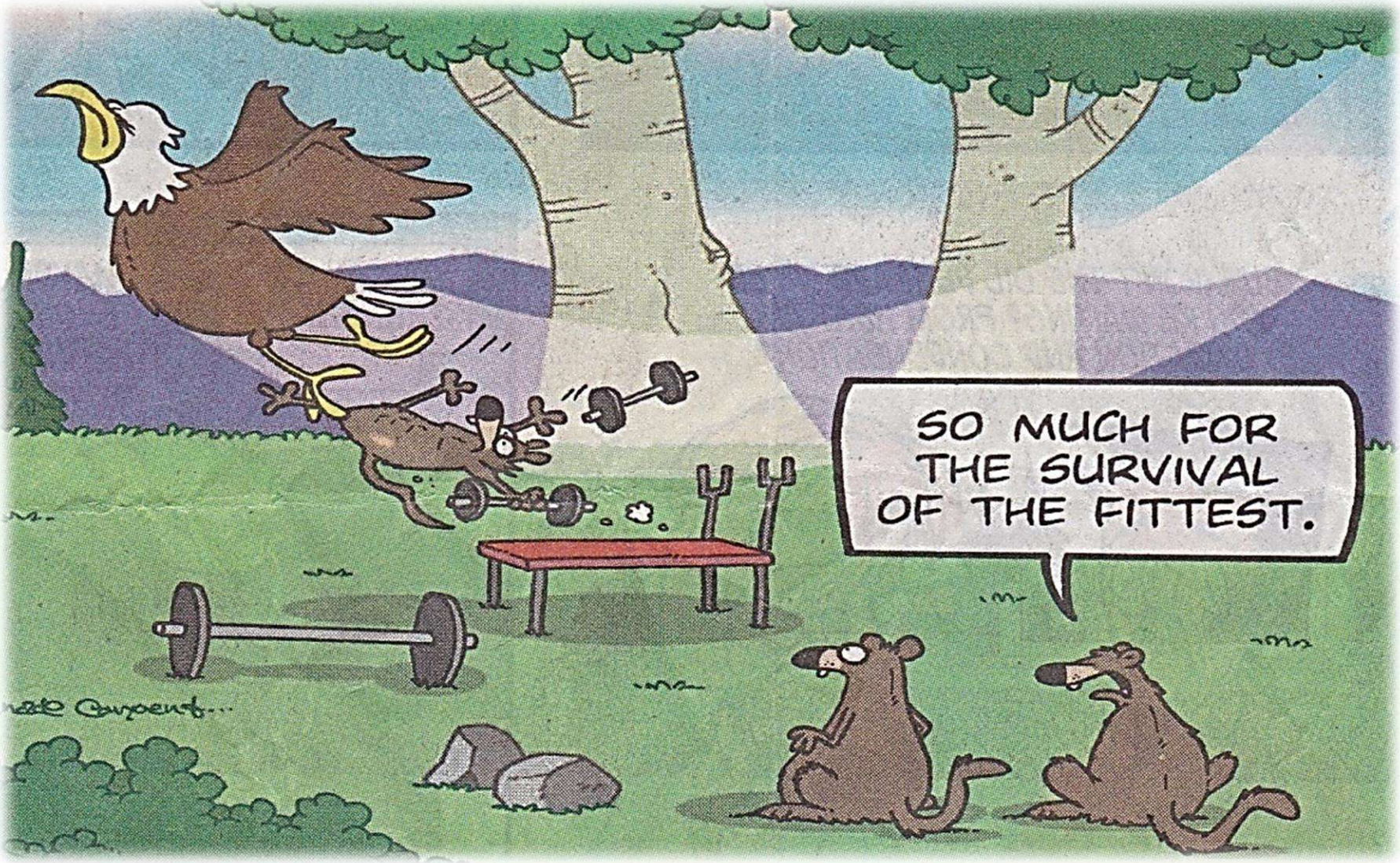
tbd


Echinoderms
Fish
Sharks
Amphibians
Reptiles
Birds
Mammals
Fungi
Plants
Eukaryotes
Archaea
Bacteria
Cambrian Explosion
Mass Extinction
Mass Extinction
Mass Extinction
Mass Extinction
Mass Extinction
Global Ice Ages
Oceans Rise
Earth Birth
Millions of Years Ago
Today
Today

Herbert Spencer (British; philosopher)

- described NS as the "Survival of the Fittest“

SURVIVAL THROUGH EVOLUTION



see: rm118.com

Gregory Mendel (Austrian, 1822-1884)

- helped to developed current understanding of genetics ; peas

No Need to Write

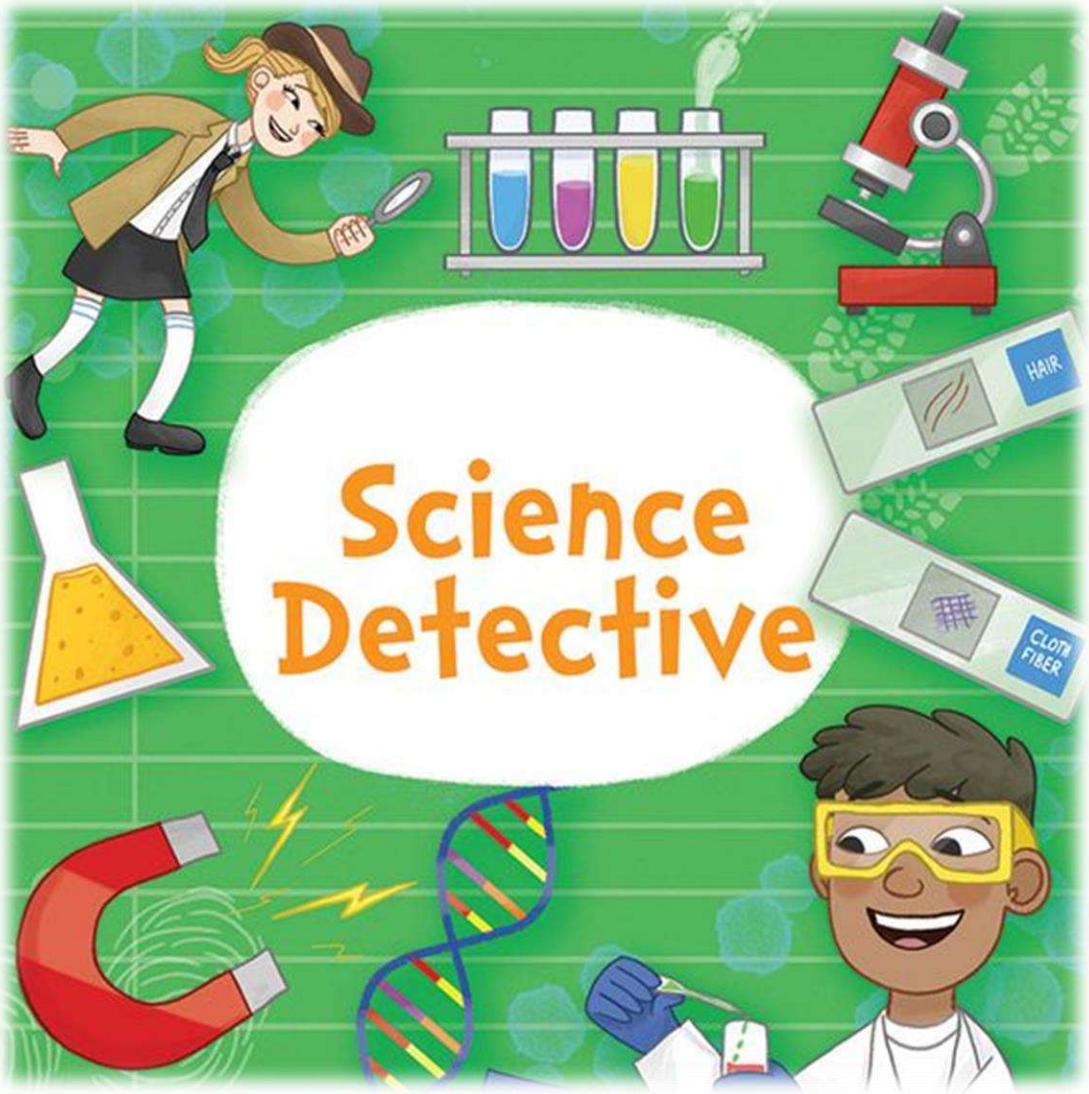
*** Darwin (~745 mls away) was unaware of Mendel's work on genetics despite Mendel having read Darwin's book and Mendel sending Darwin his research. – too bad ☹**

*** Connection btwn Evolution and Genetics not until the early 1900's**

Evidence for Evolution

No Need to Write

Like "ALL" Areas of Science, It's Similar to Being a Detective to Solve "How" Evolution Happened and Continues to Do So

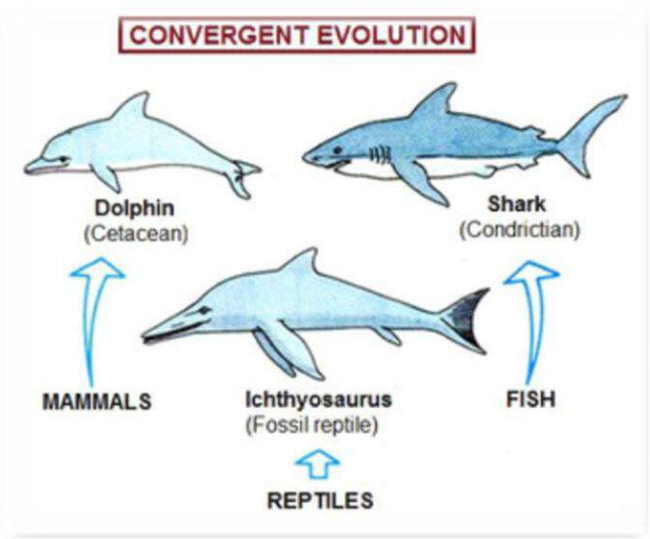


Kinship Similarities: (6)

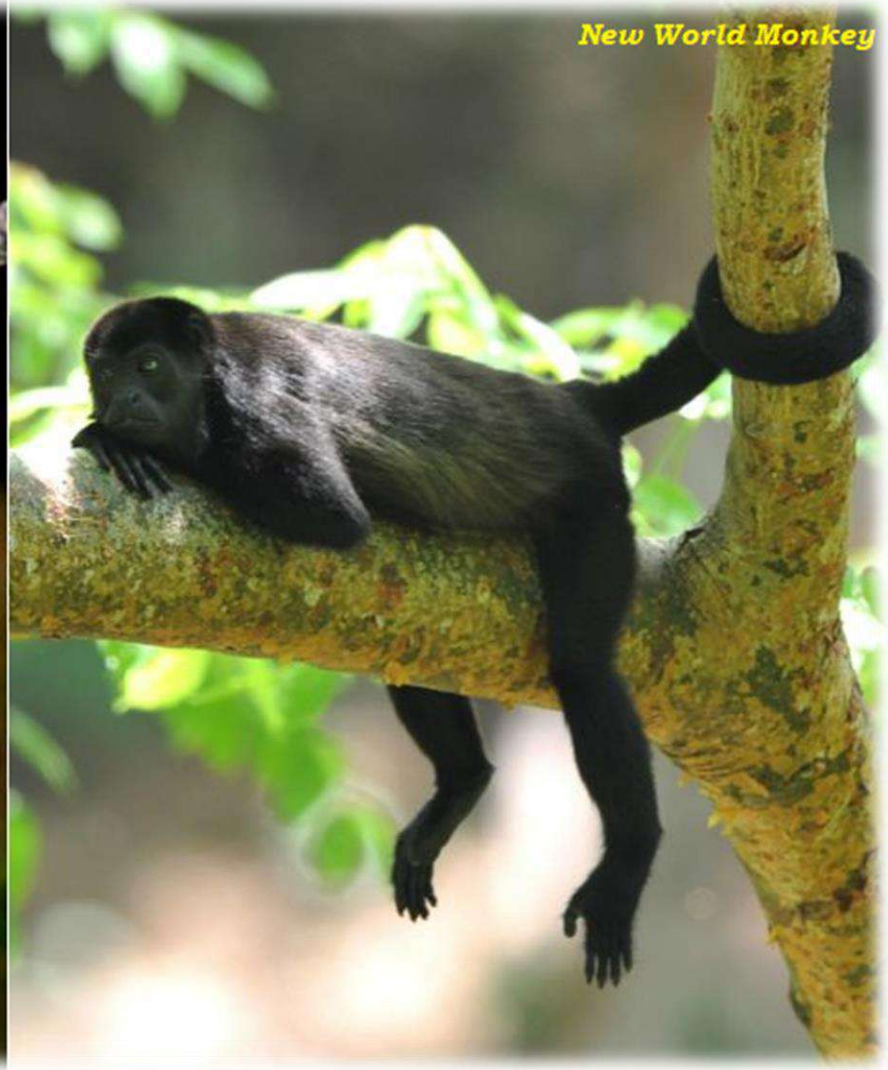
1. Convergence = evolving independently but ending w/ similar traits

- demonstrates “common ancestry”

ie. Dolphins vs Sharks – body

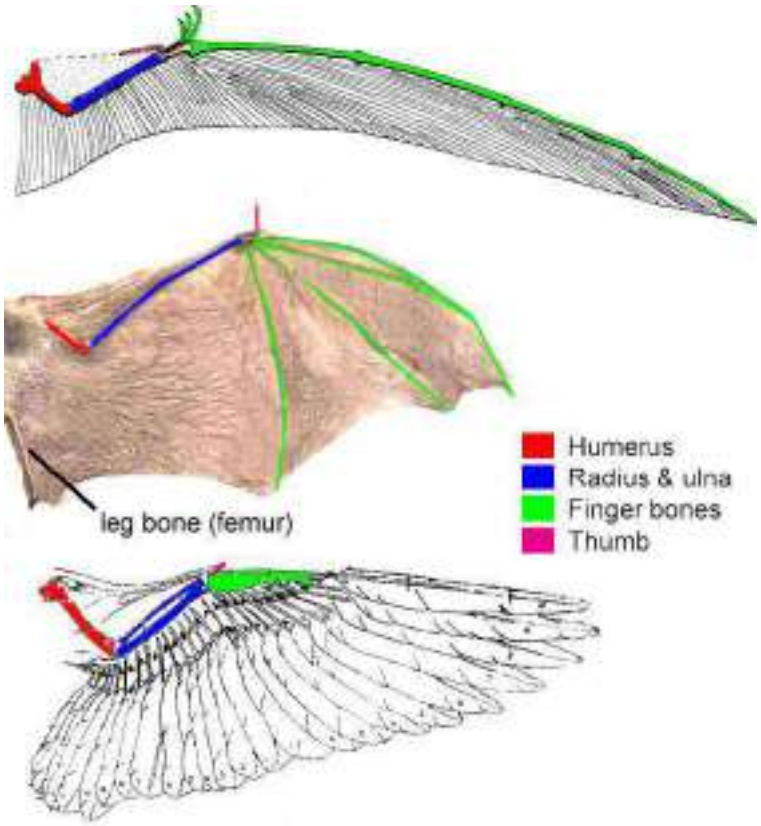


ie. Opossums vs New World Monkeys – tail; “prehensile”



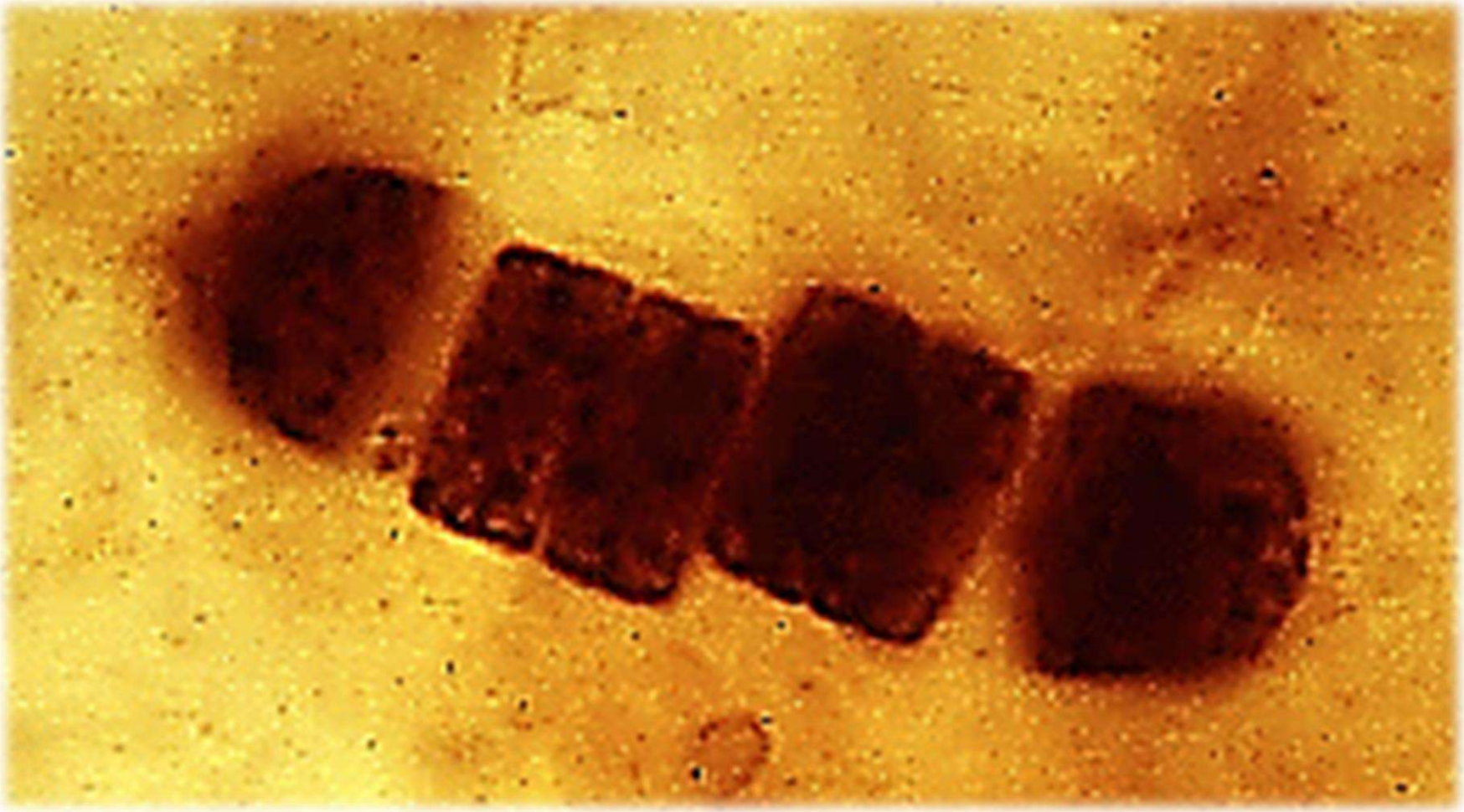
ie. Echidna vs Hedgehog – spines

ie. Bats vs Birds – wings; “ie. arm/bone anatomy”



2. Fossils

ie. Cyanobacteria ; (1^{st} to make O_2) ~ 3.5 byo



850 myo Cyanobacteria

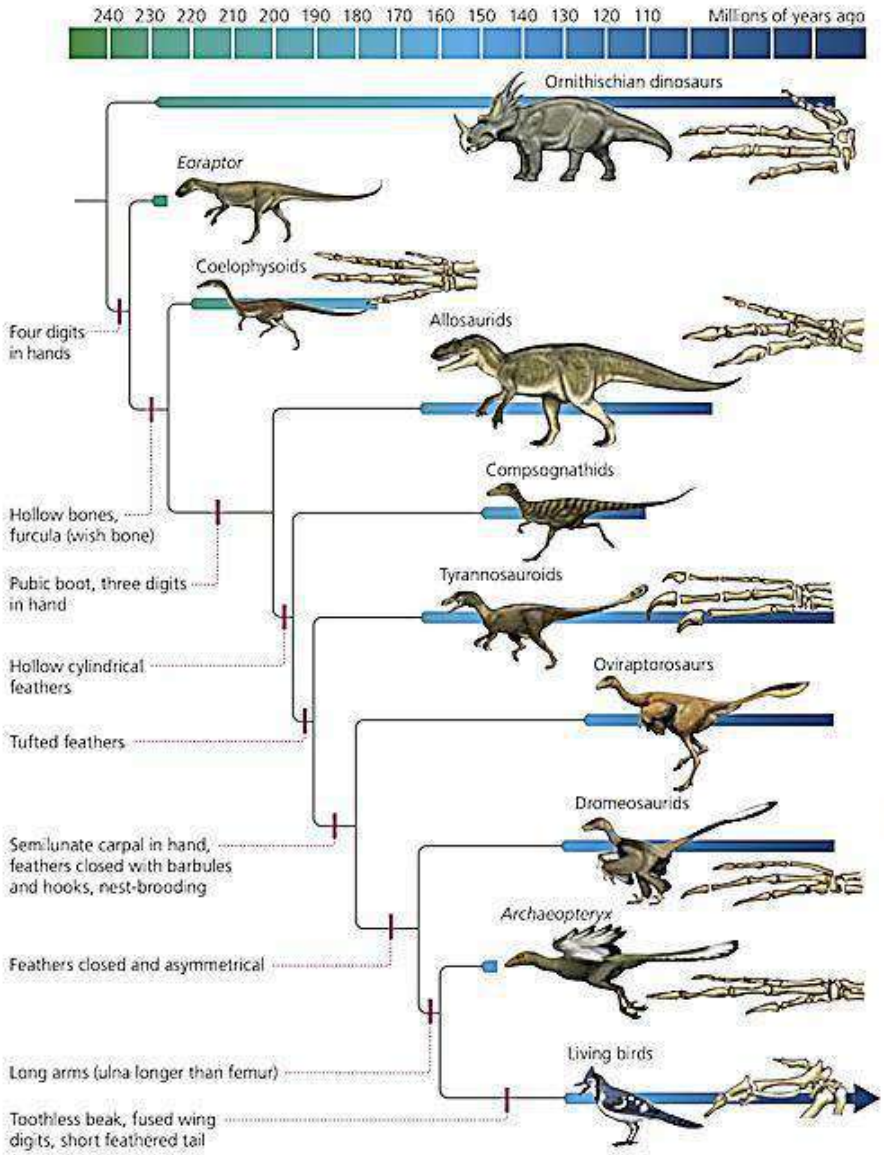
ie. Single → Multicellular ; ~ 1 byo

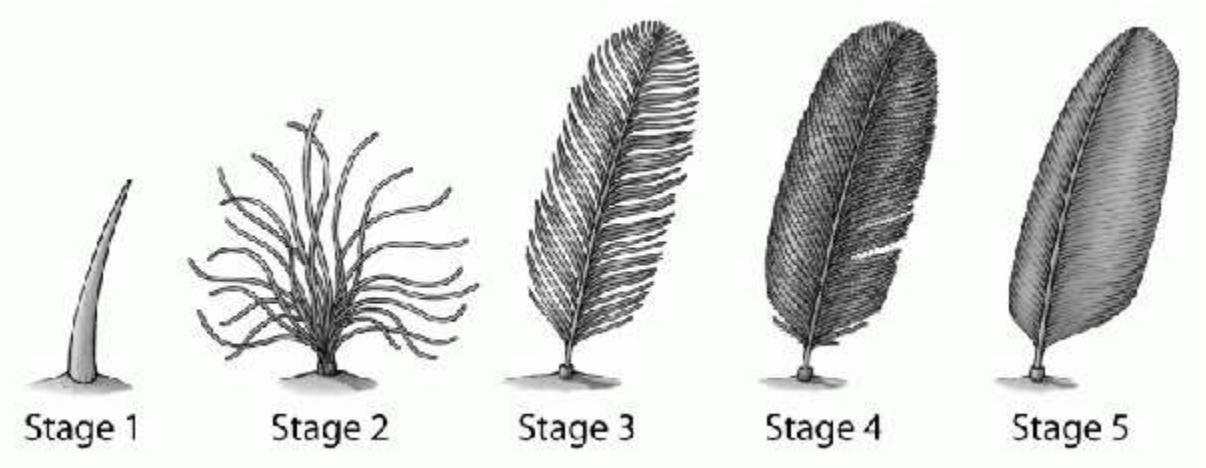
The spherical fossil contains two different types of cells: round, tightly-packed cells with very thin cell walls at the center of the ball, and a surrounding outer layer of sausage-shaped cells with thicker walls. This could be the oldest known fossil of a multicellular organism

ie. Haikouichthys ; (oldest Cordate) ~ 530 myo; thumb size

(hi-coo-ich-thes)

ie. Birds ; ~150 myo (ie. scales → feathers)





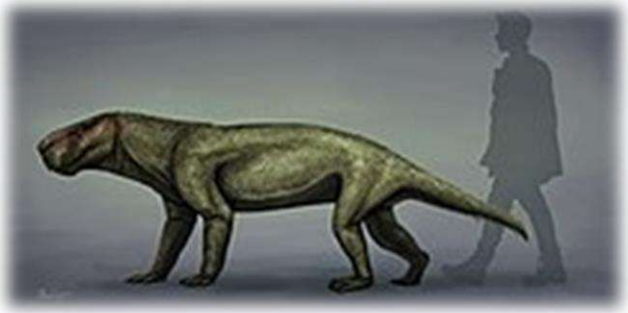
The yellow arrows point to feathers on the head and neck (right) and tail (above)

Chickens have scales on feet / legs

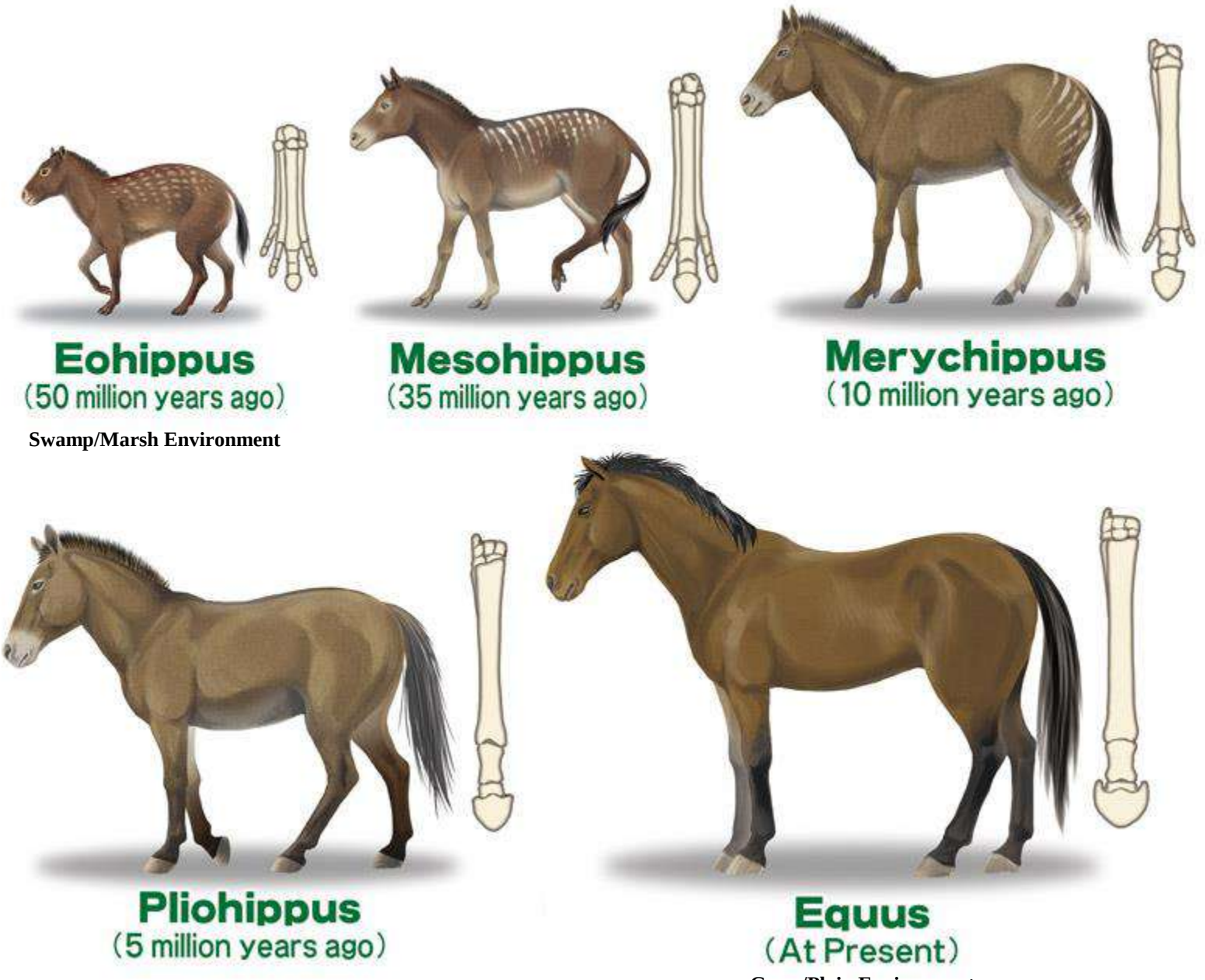
Side Note:
Pangolins – only mammal w/ scales

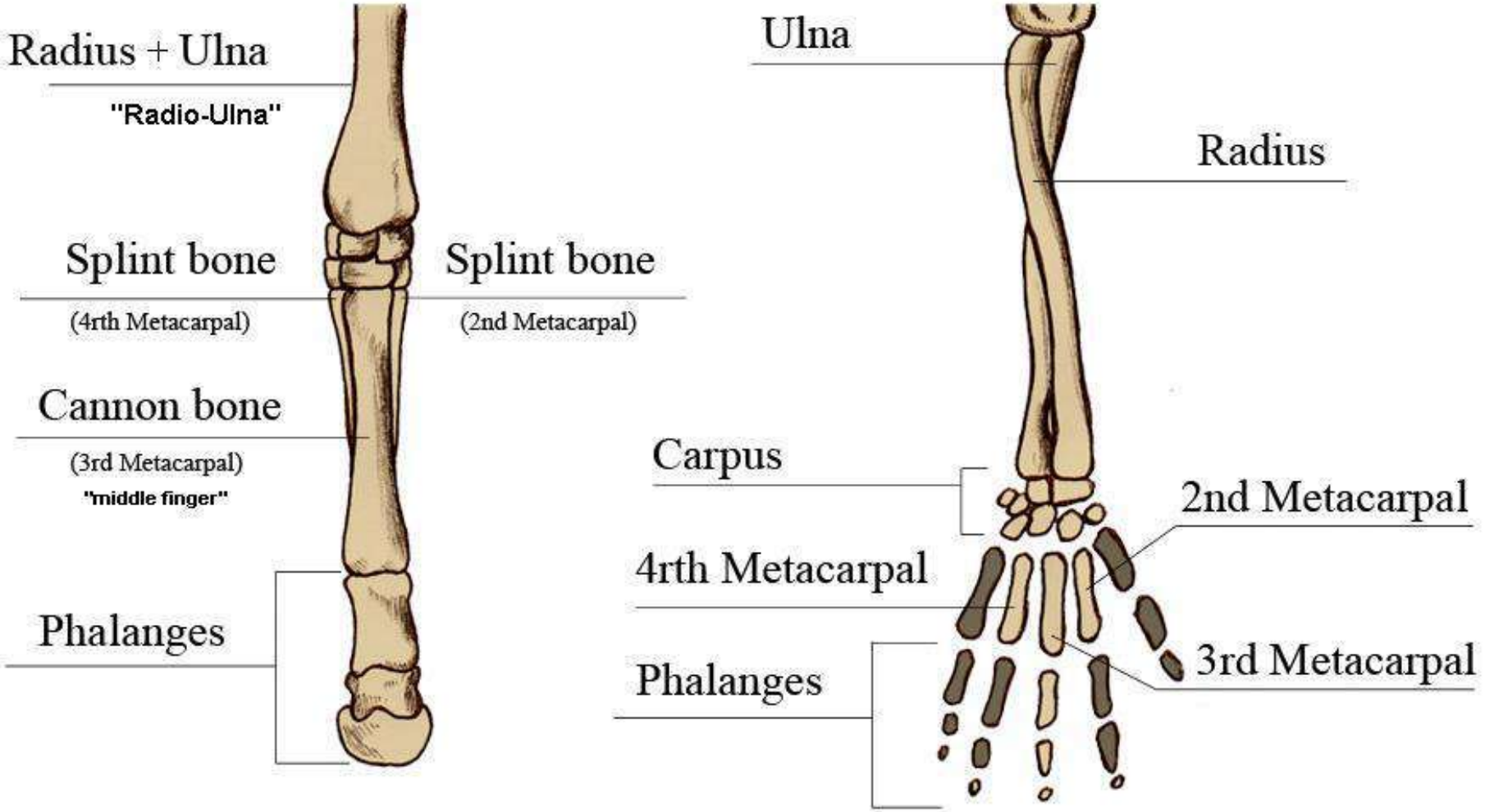
ie. Gorgons ; ~265-252 myo (ie. reptile → mammals)

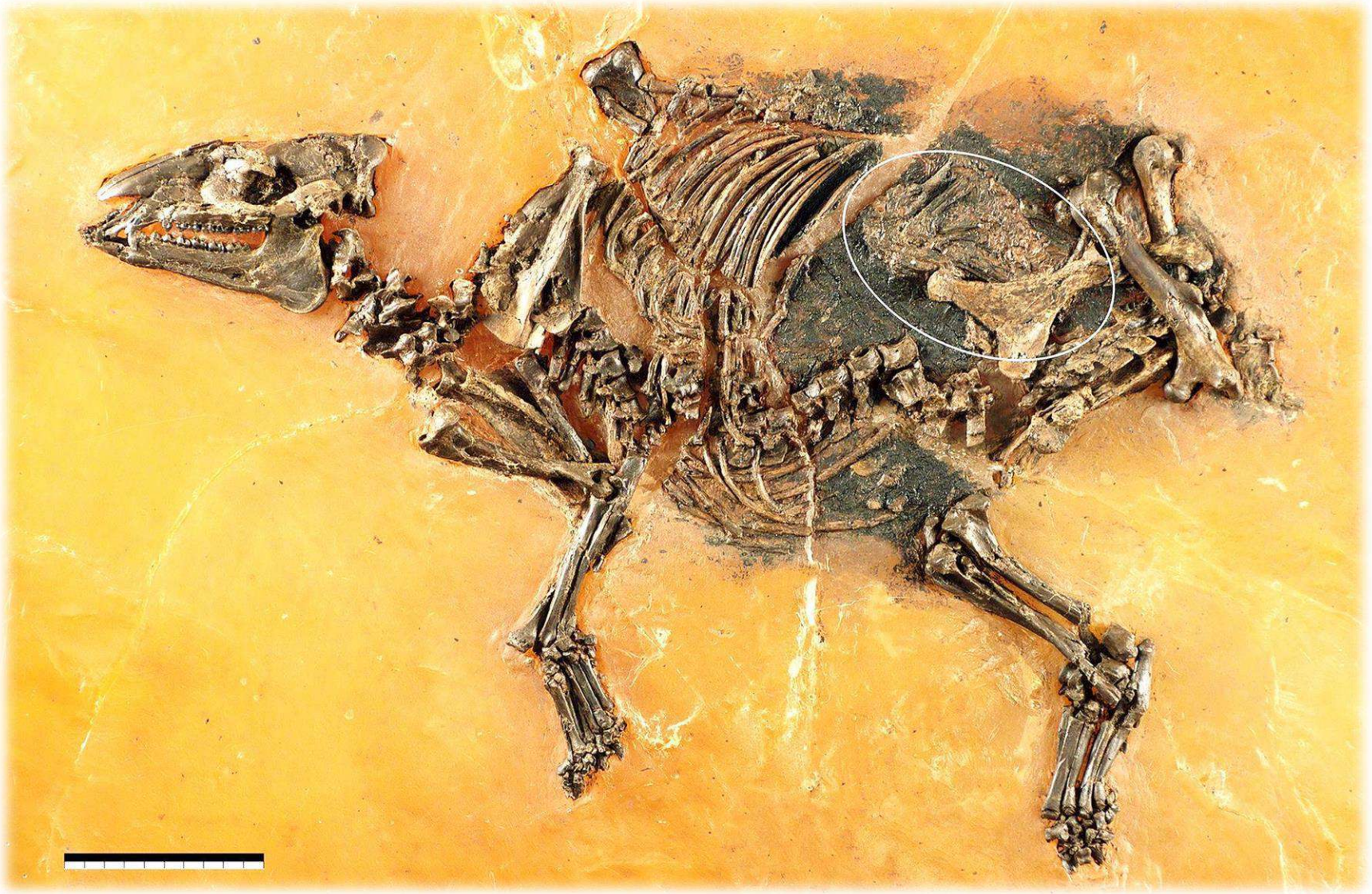
Note: other branch of reptiles → dinosaurs



ie. Horses ; ~ 50 mya (ie. 5 toed → 3 toed → 1 toed; longer legs)

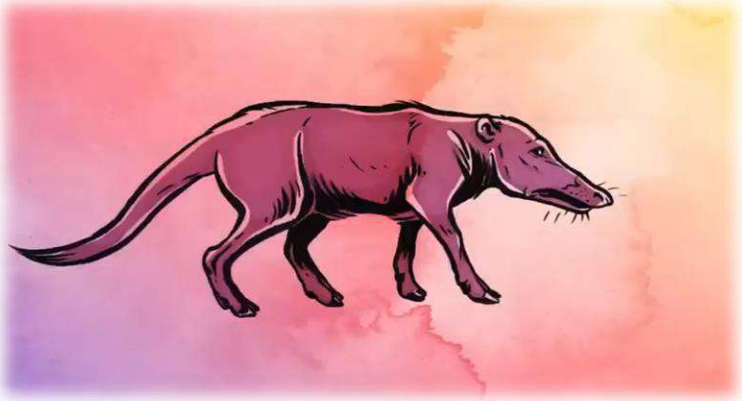



Radius + Ulna
"Radio-Ulna"
Splint bone
(4rth Metacarpal)
Splint bone
(2nd Metacarpal)
Cannon bone
(3rd Metacarpal)
"middle finger"
Phalanges
Ulna
Radius
Carpus
2nd Metacarpal
4rth Metacarpal
3rd Metacarpal
Phalanges



~ 50 myo horse-like skeleton w/ fetus; found in Germany

ie. Whales ; ~ 50 myo (ie. terrestrial → aquatic)

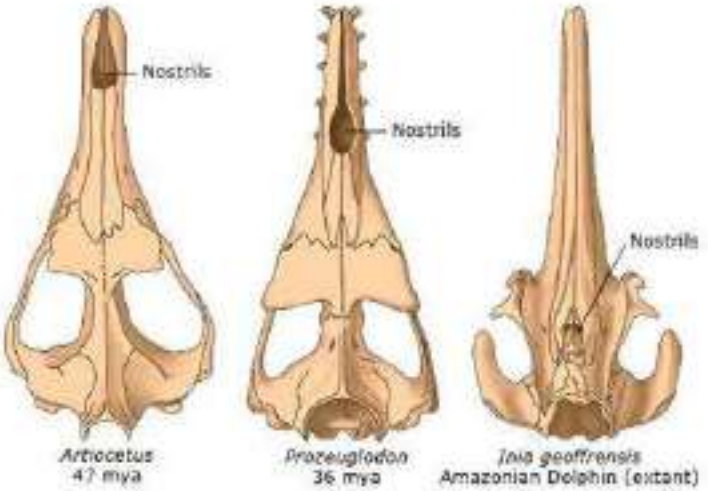


Pakicetus (terrestrial)

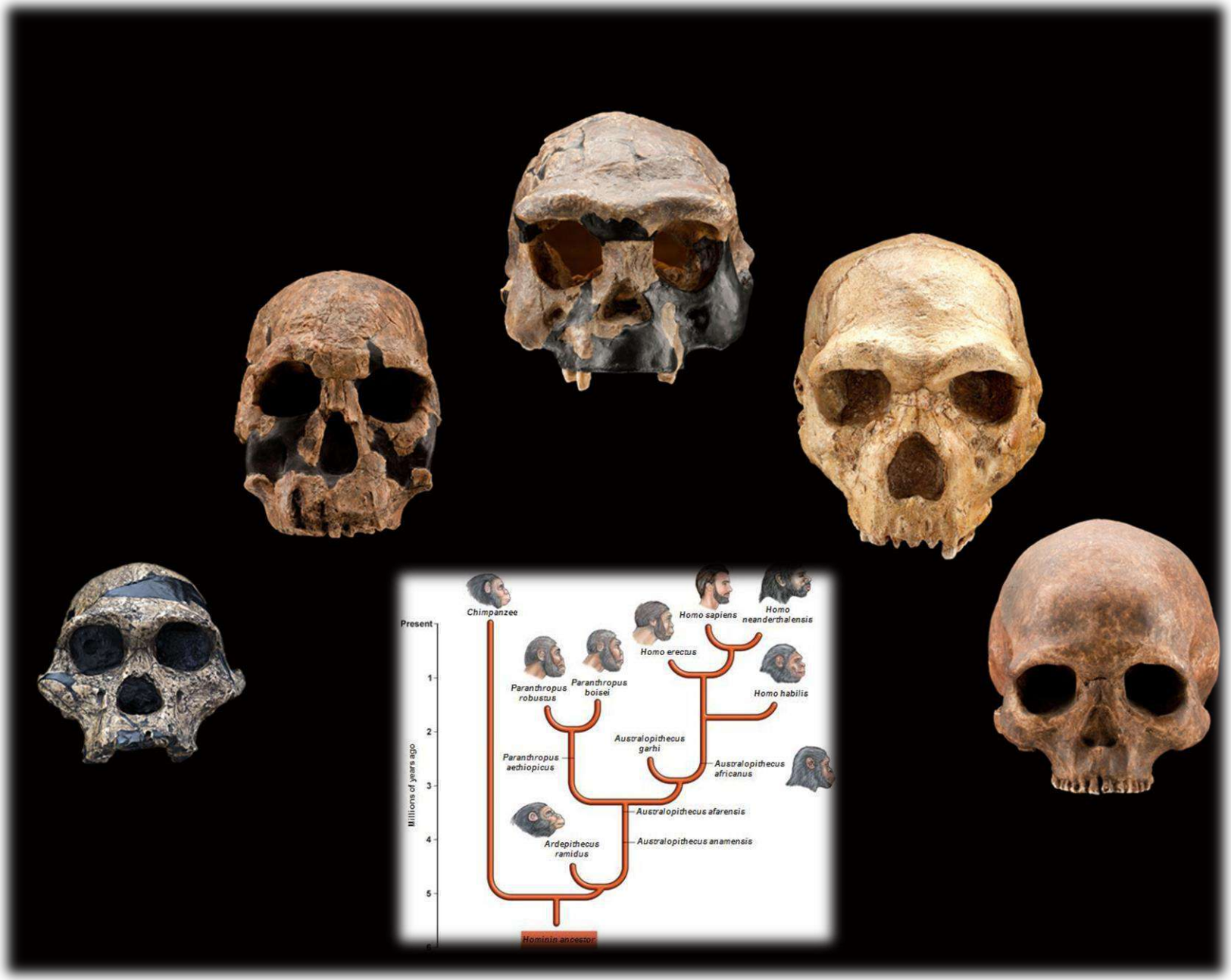
Rhodocetus (predominantly aquatic)

Dorudon (fully aquatic)

Balaena (recent whale ancestor)



ie. Hominins ; ~6-7 myo to present *(previously discussed)*



Telling the Age of Fossils

Radioactive Dating = using isotopes that <u>change</u>

ie. half-life = time for 1/2 (n^o's) to change to (p^+'s); thus, new isotope

ie's: ***Choose the 1st 2 Only***

4.5 b.y. for 1/2 of Uranium 238 → Lead 206

713 m.y. for 1/2 of Uranium 235 → Lead 207

13.9 b.y. for 1/2 of Thorium 232

→ Lead 209

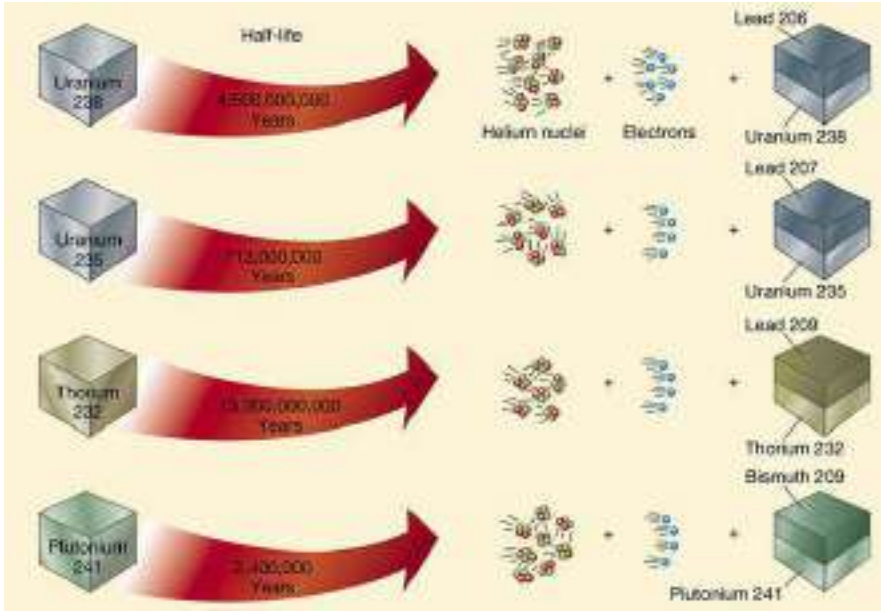
2.4 m.y. for 1/2 of Plutonium 241

→ Bismuth 209

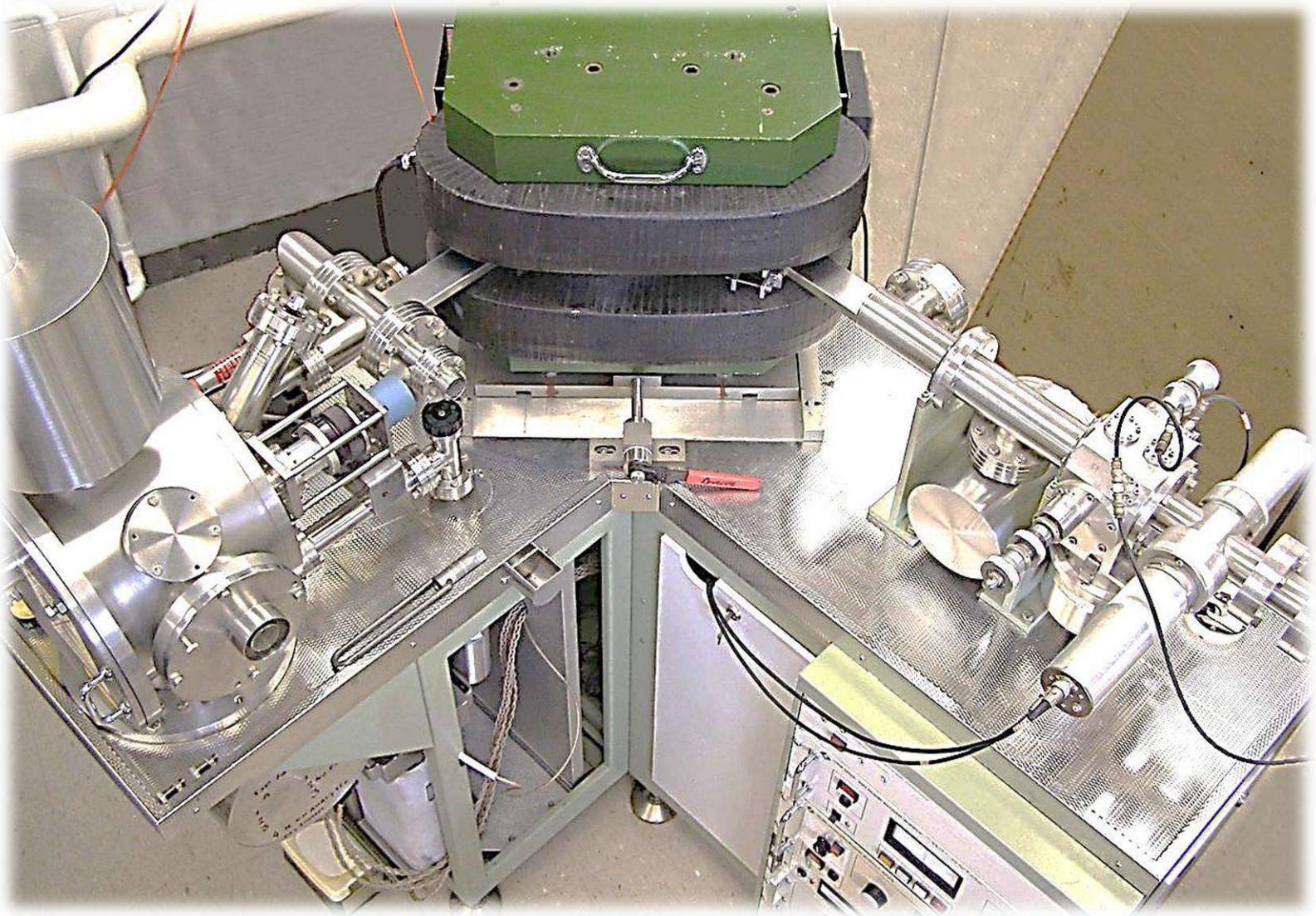
14.3 days for 1/2 of Phosphorous-32

→ Sulfur-32

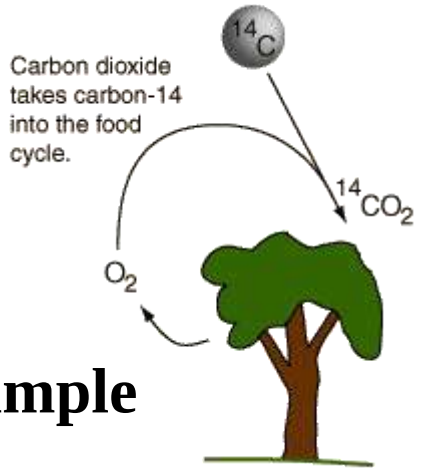
etc…..



Mass Spectrometer = used in determinating half-life

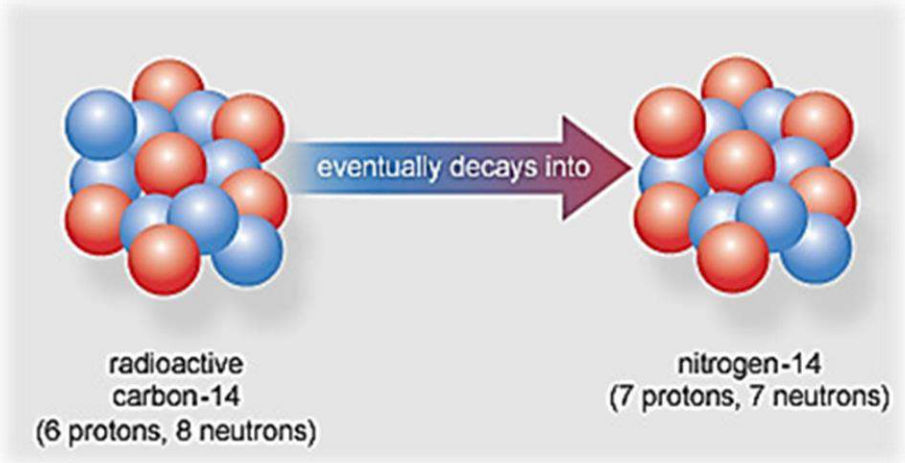


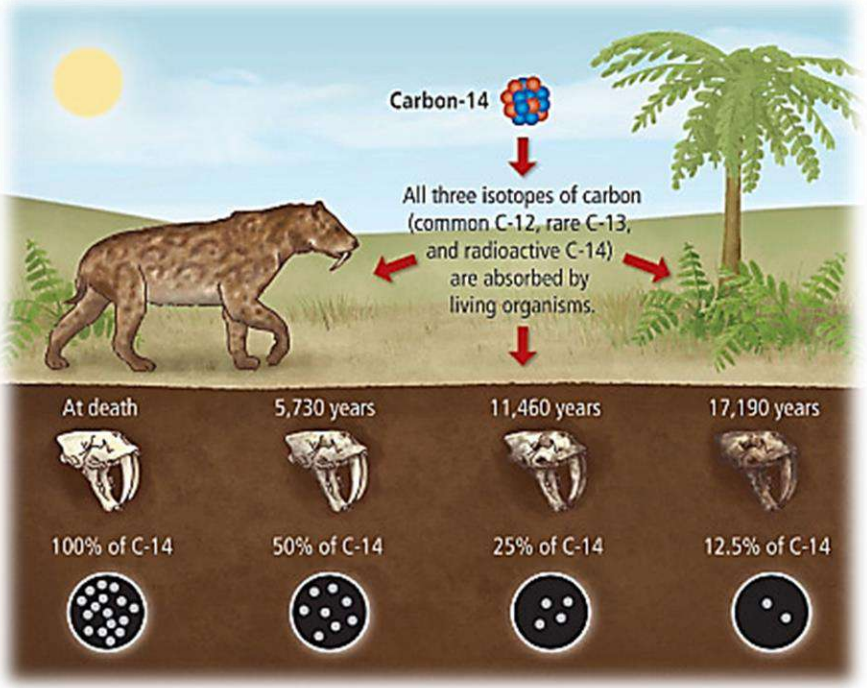
ie. Carbon 14



- C_{14} (6p 8n) + O_2 → $^{14}CO_2$ → plant → food cycle
- 5,730 yrs for 1/2 of C_{14} → N_{14} (7p 7n)
  - so, if 1/2 of C_{14} is left (½ → N_{14}) = 5,730 yrs old sample
    - if 1/4 (½ of a ½) of C_{14} is left (another ½ → N_{14}) = 11,460 yrs
      - if 1/8 (½ of a ¼) of C_{14} is left (another ½ → N_{14}) = 17,190 yrs

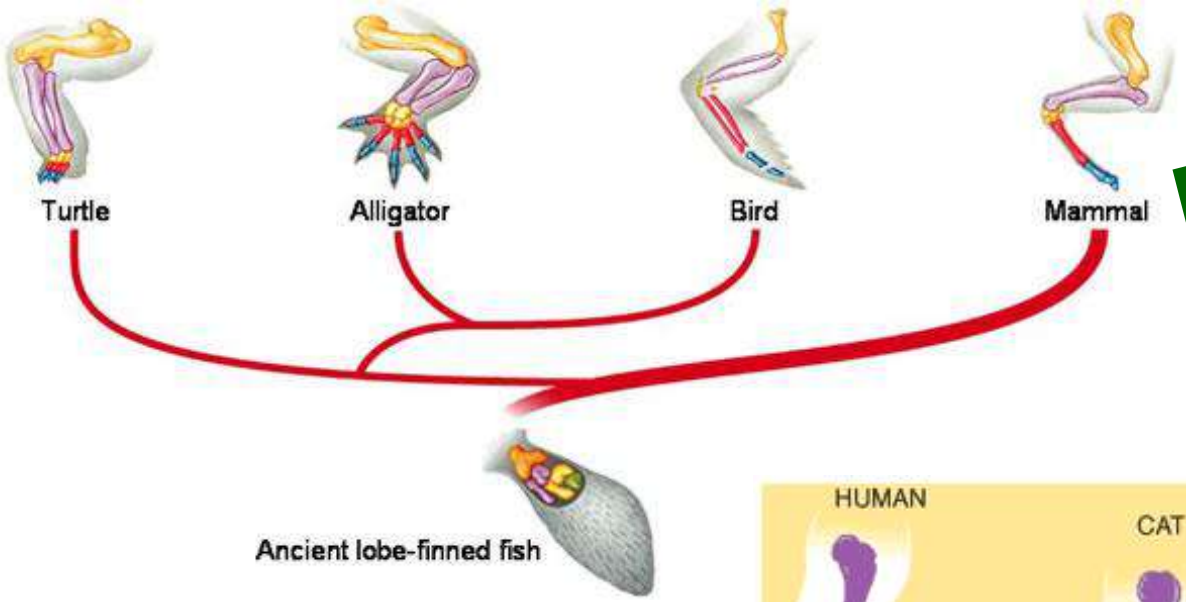
… etc

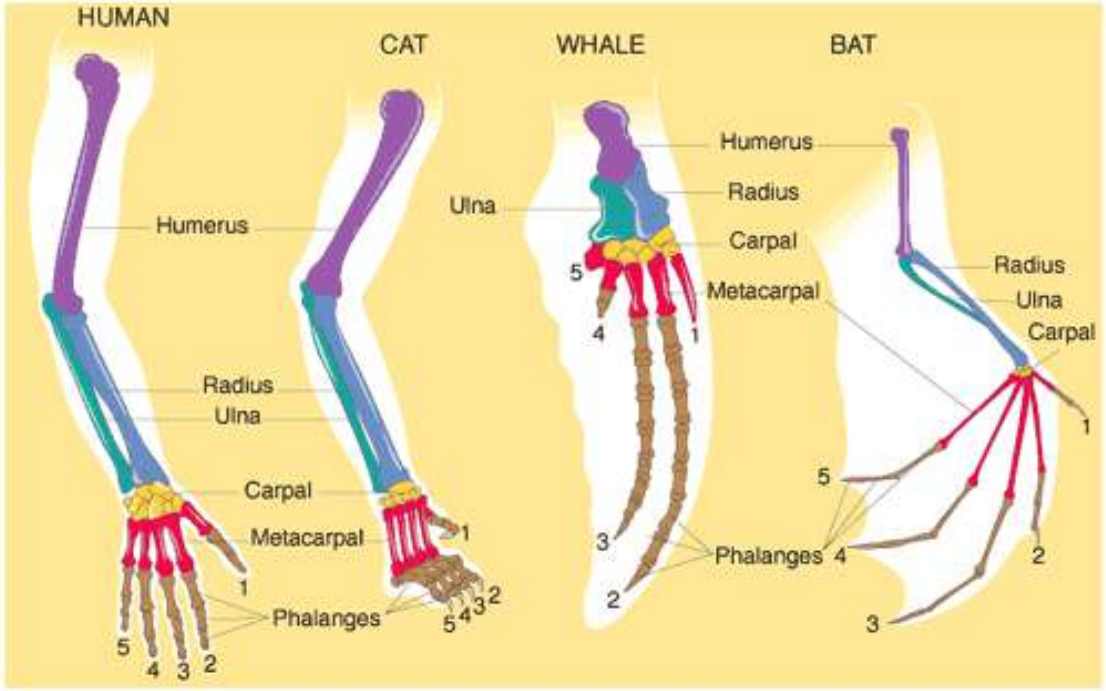




3. Anatomy

ie. Bones: Similarities

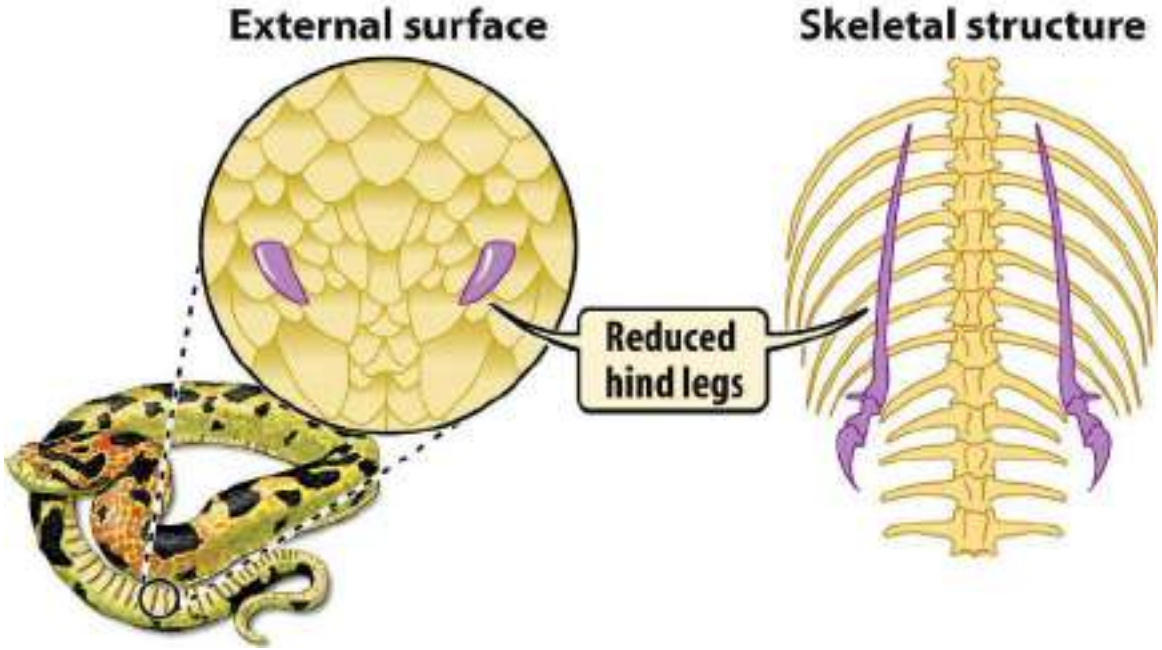


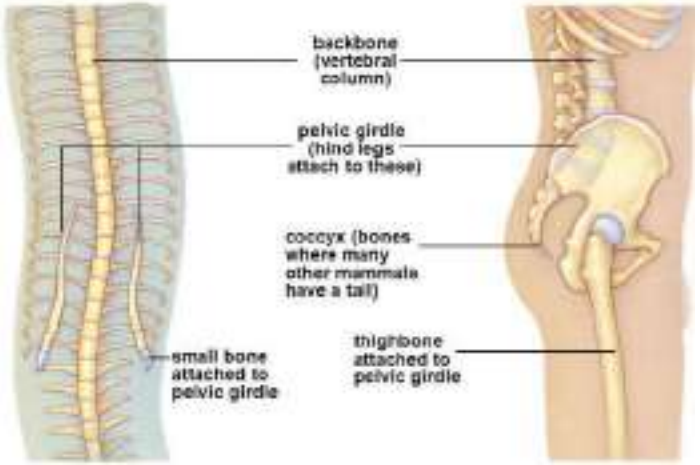


ie. Vestigial Structures = features that may have had a function:

pythons: spurs

Evolutionary Throwbacks

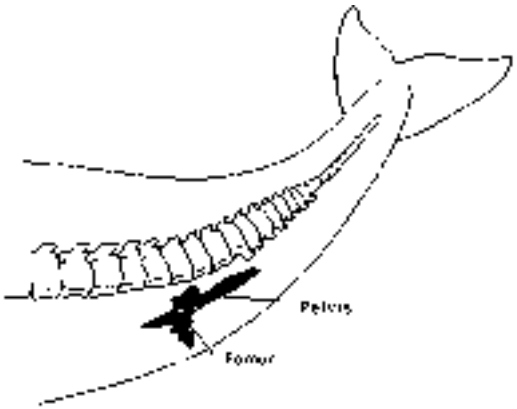


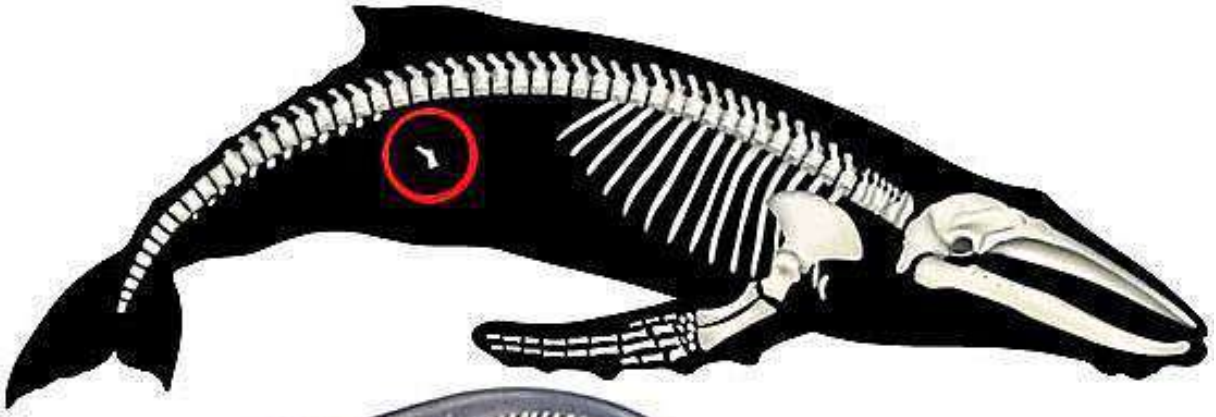


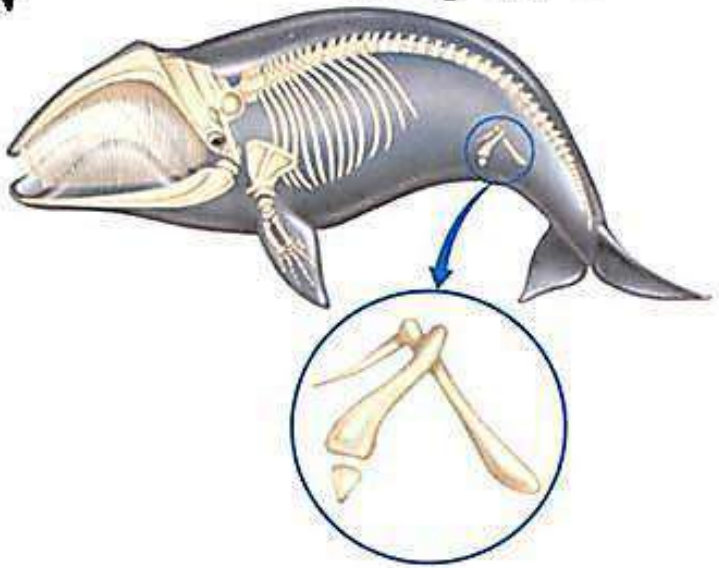
Albino Burmese Python

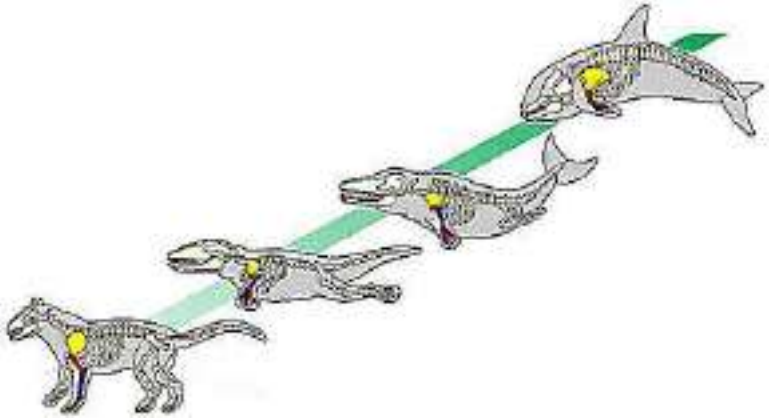
Rock Python

whales: pelvis/femur





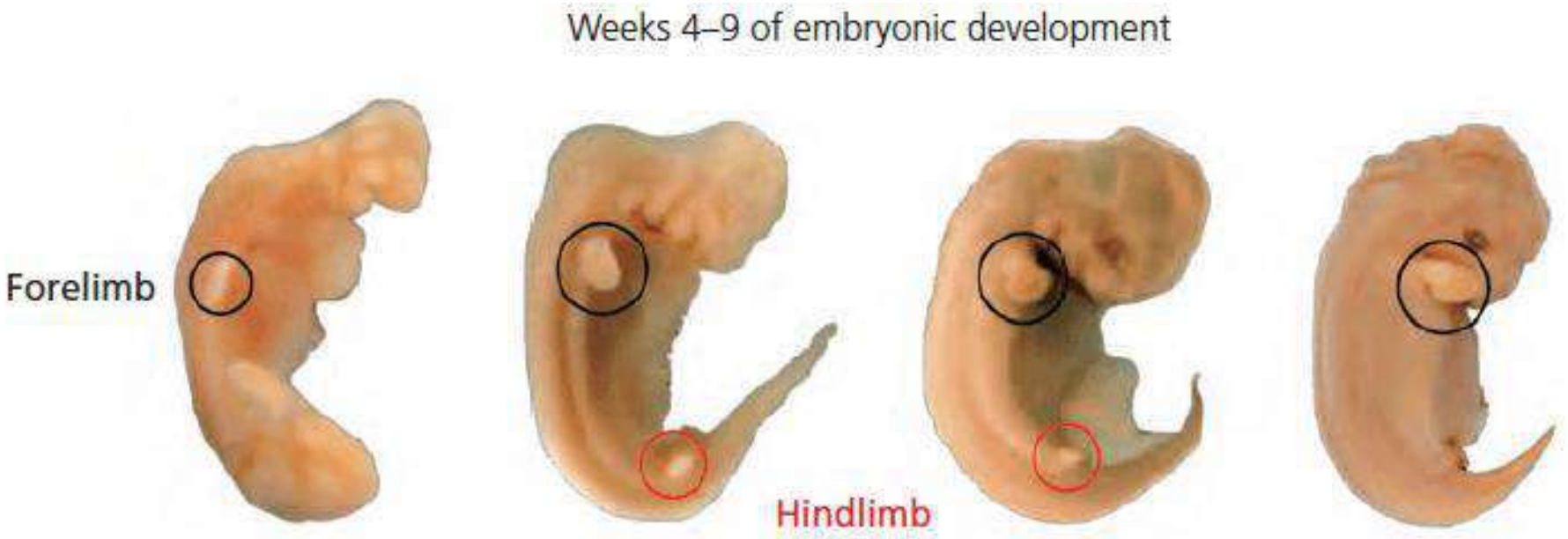




birds: tooth sockets (no teeth) in a beak

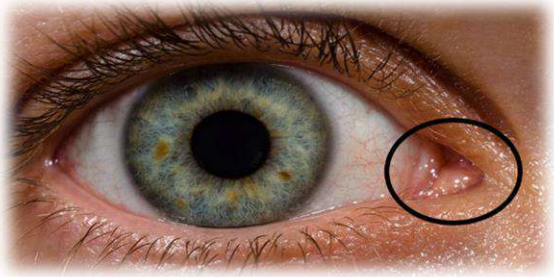
Sapeornis (ancient bird) **125-120 myo**

dolphins: early limbs



humans: ie's

nictitating membranes (eye)

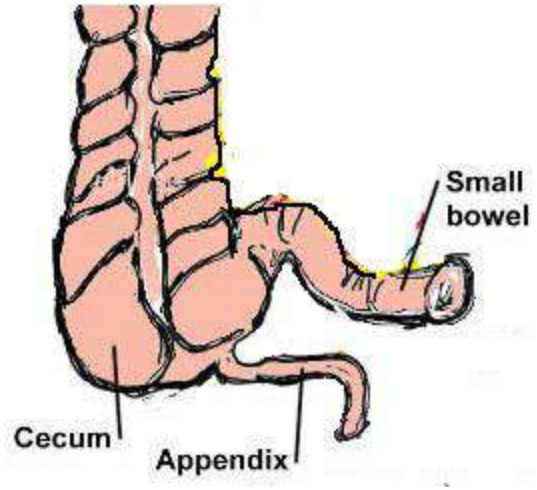


hair / nipples on males (chest)

wisdom / canines (teeth)

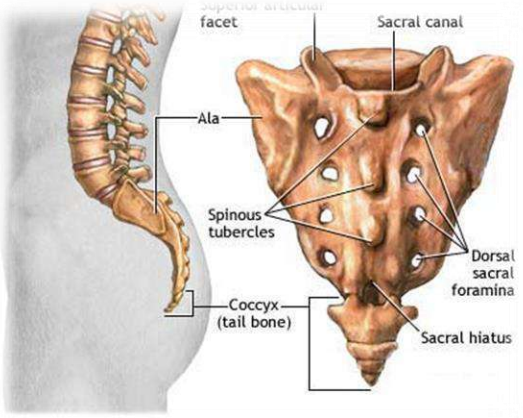
auricle muscles (ear)

appendix (cecum); *kinda*



erector pili (goose-bumps / skin)

coccyx (tail bone)

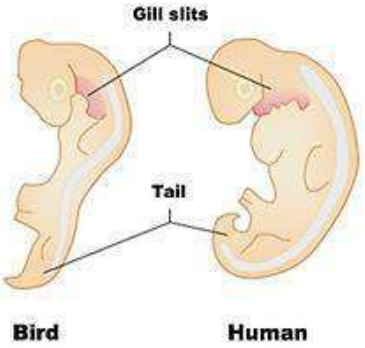


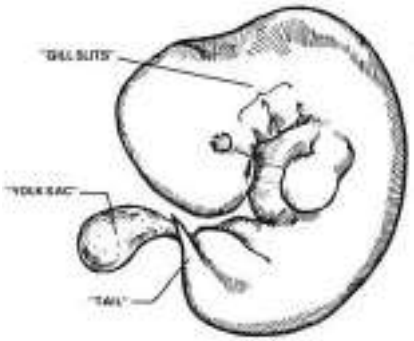
4. Embryology

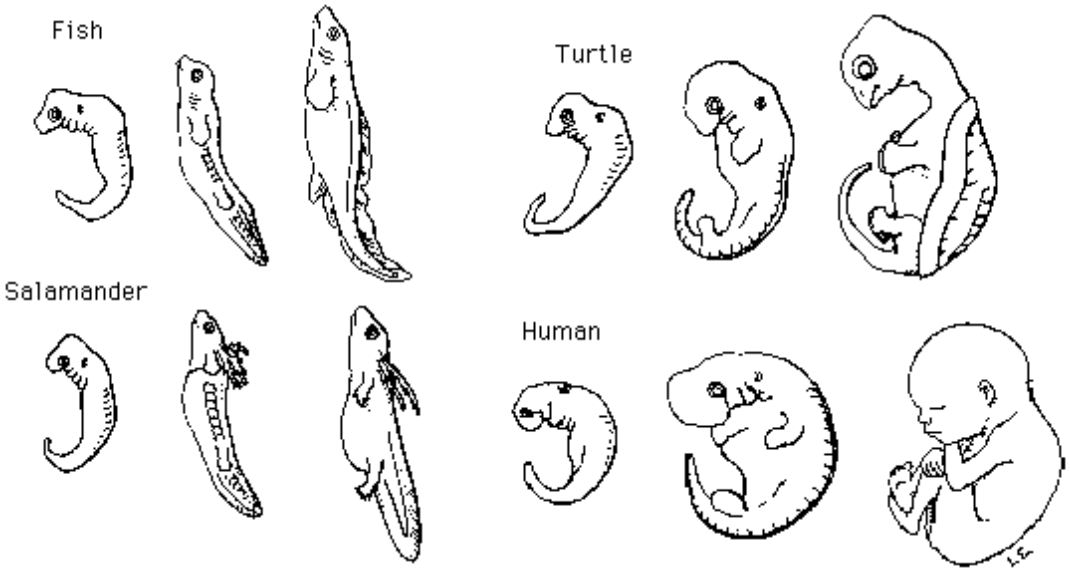
ie's:

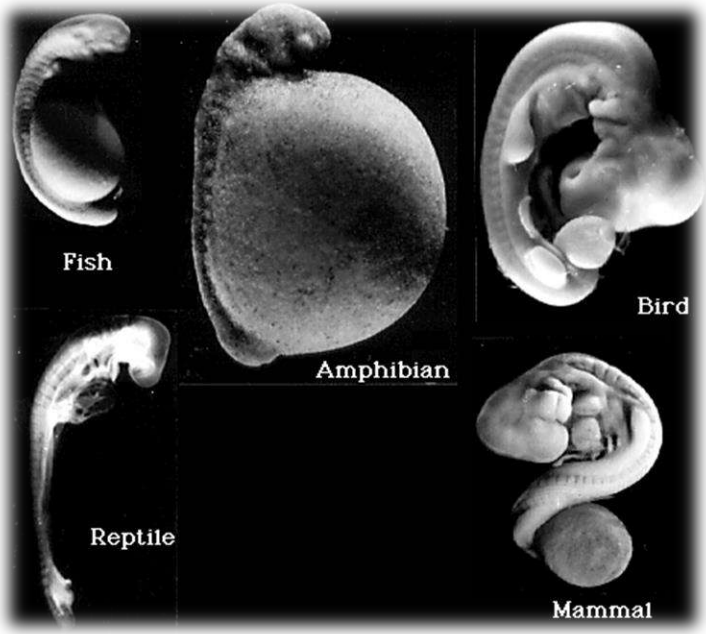
- **tails → coccyx**
- **gill slits → trachea/jaw/ears**
- **arching → spine**
- **limbs → legs/arms**
- **symmetry**
- **yoke sac**

Rare holes near the ears are remnant of gill slits

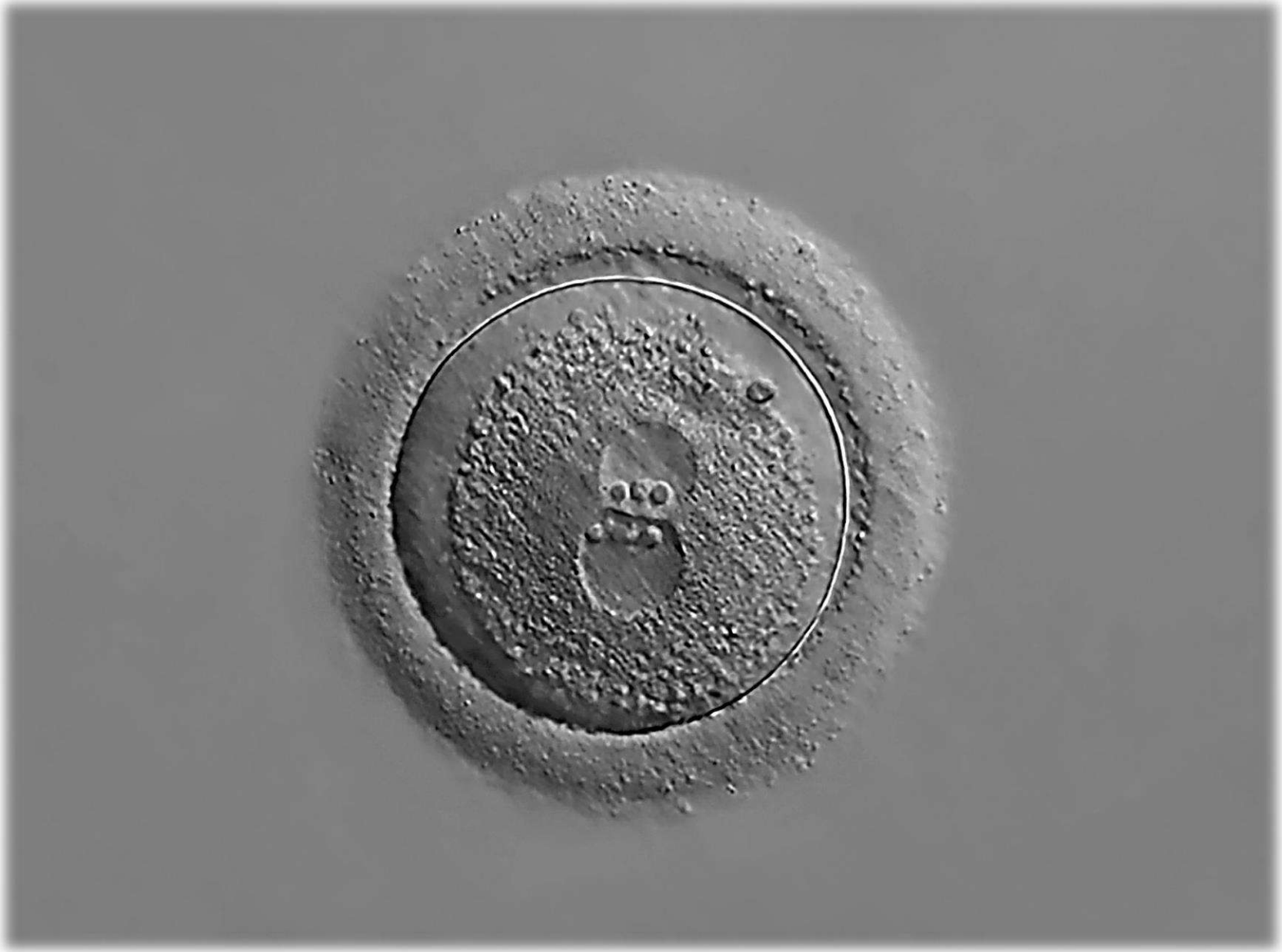






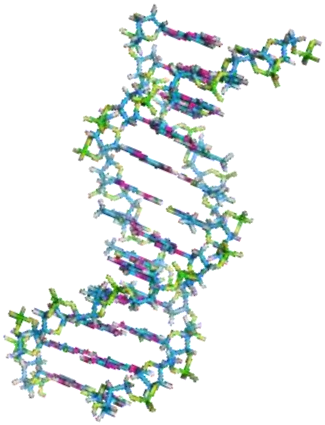


- zygote = fertilized cell



5. Genetics

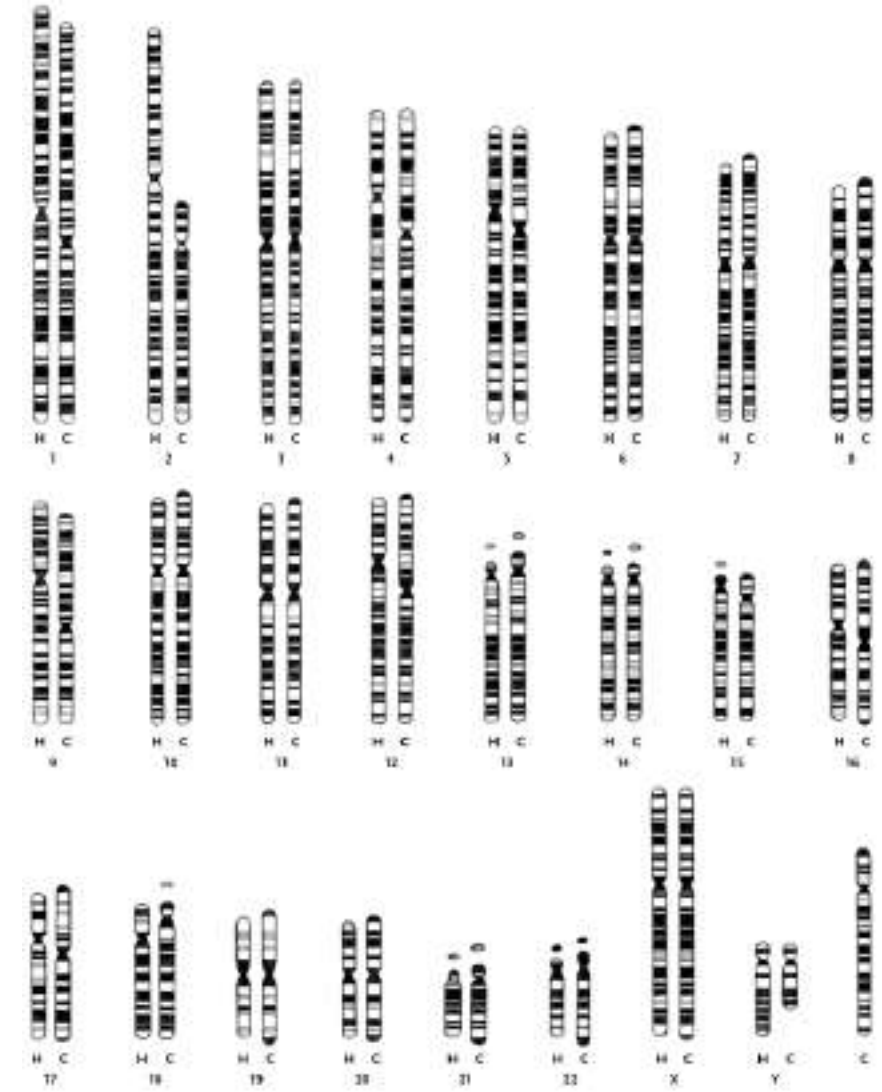
- <u>every</u> organism has DNA; mutations/change + time → diversity !

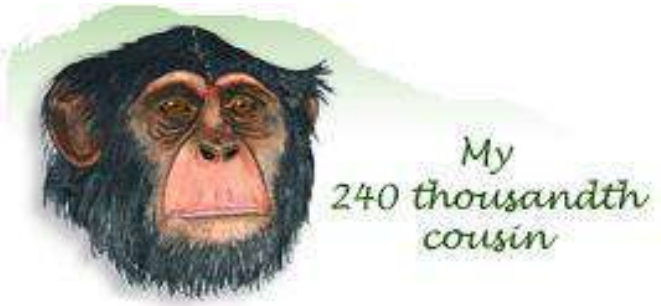


< DNA change > similarities:

ie. humans vs chimps = ~ 1.2% diff. ; thus, ~98.8% similar

ie. humans = ~ .1% diff.

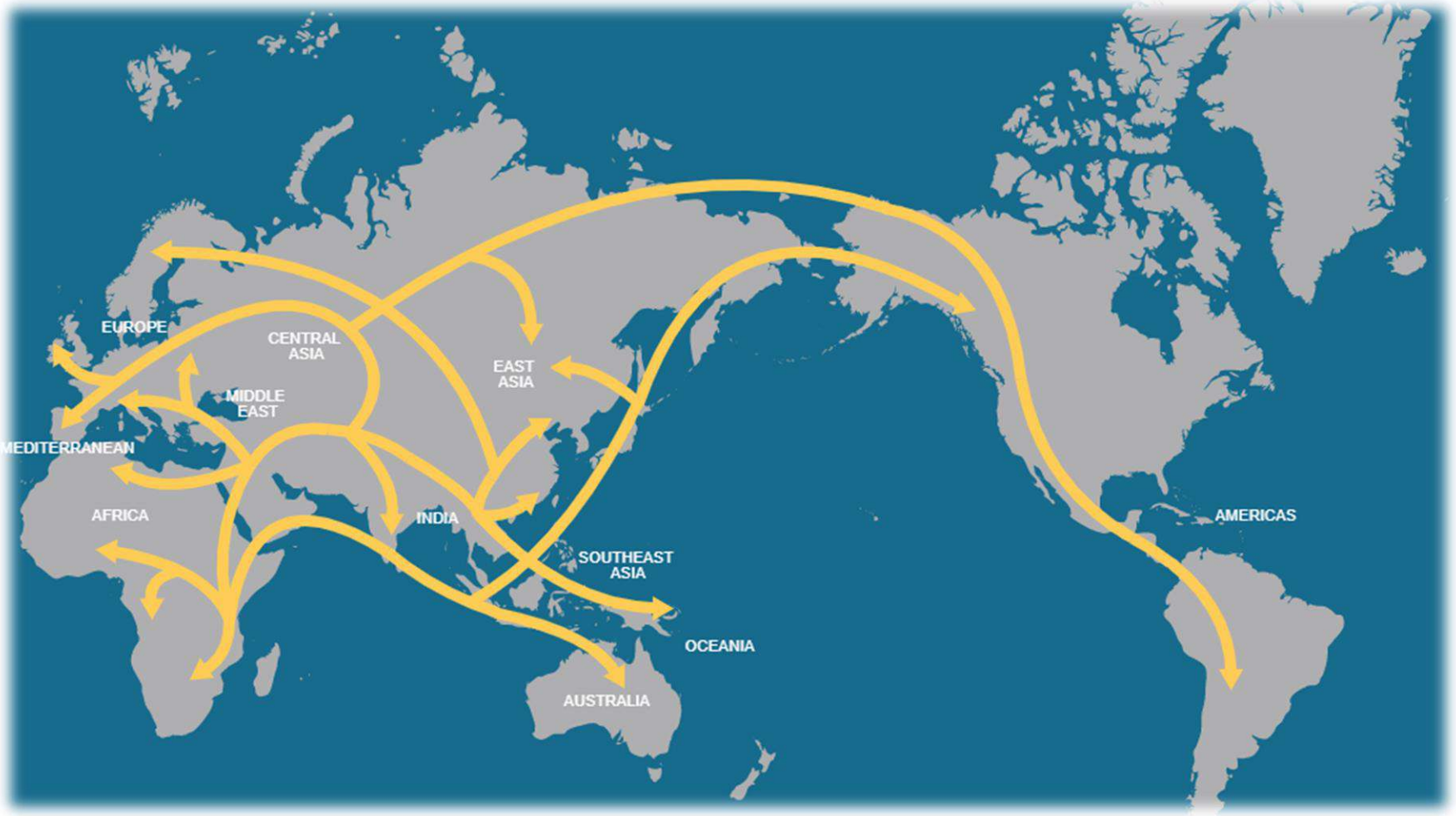




> DNA change < similarities: (choose 2+)

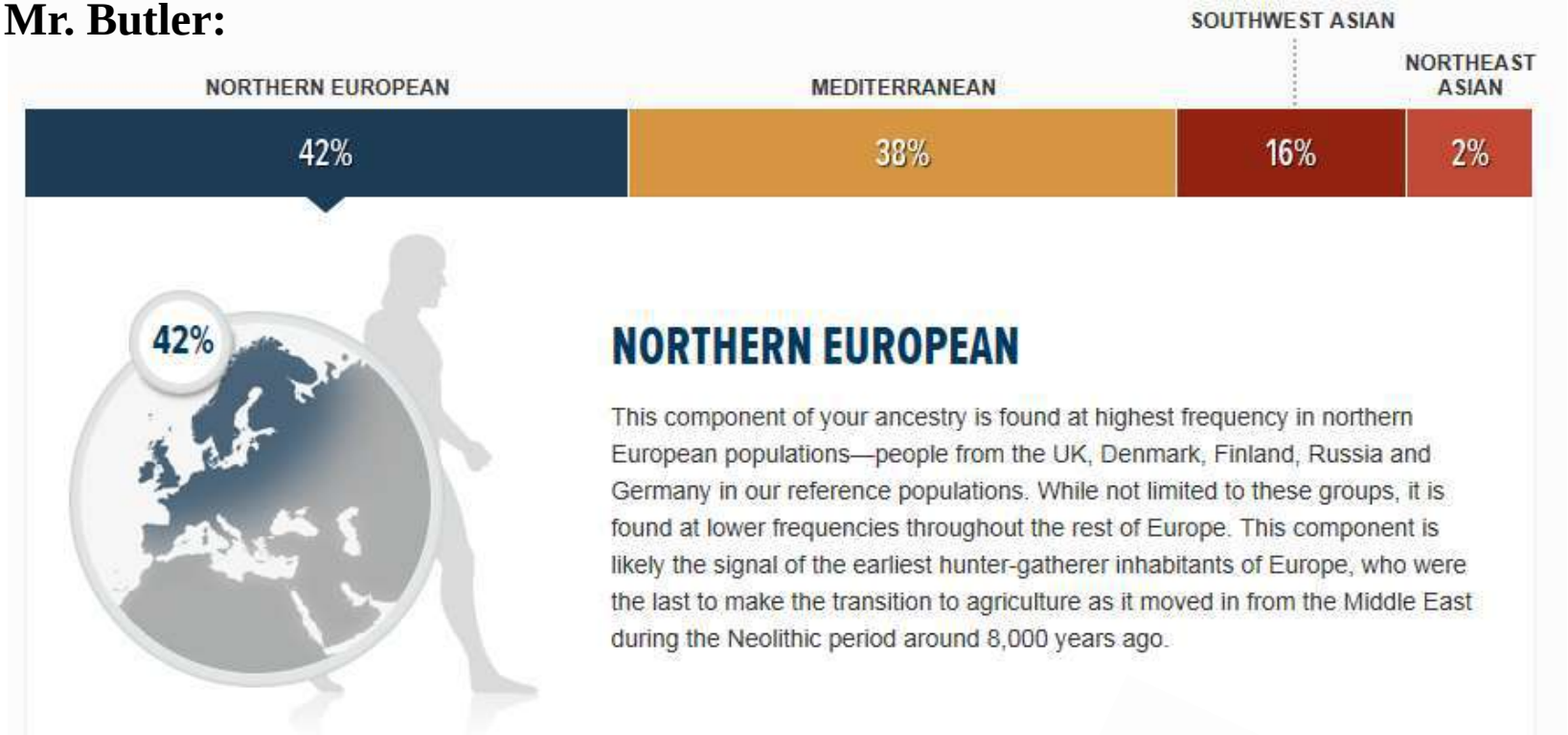
94% w/ Dogs

- used to trace ancestral Hominids from Africa ~100,000 - 60,000 ya



No Need to Write

- ie. Mr. Butler:



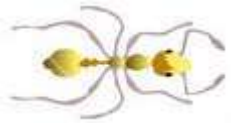
1st reference population: German

2nd reference population: Greek

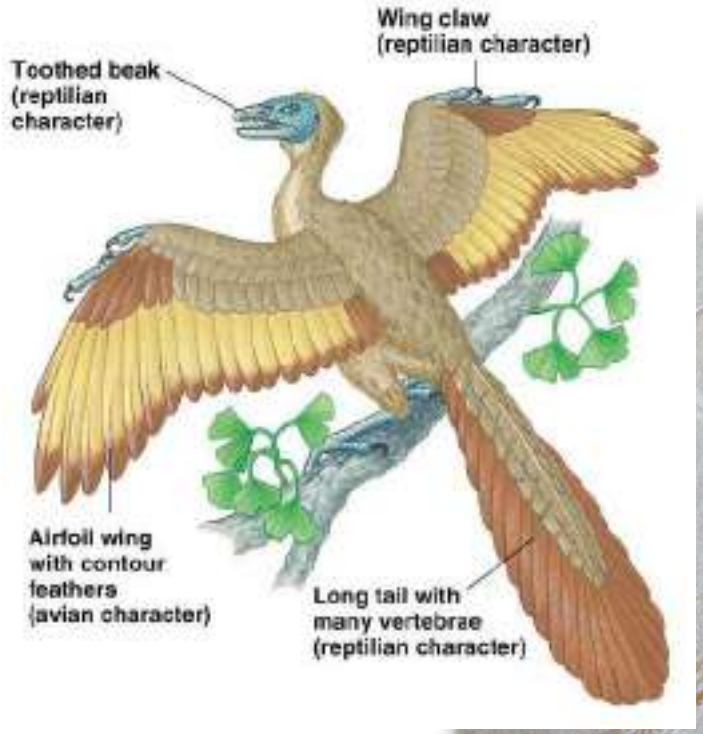
6. Transitional Life Forms

Wingless → Winged Insects

ie. ant-wasp ~92 myo



Reptiles → Birds ; ie. Archaeopteryx, ~ 150 myo ; ~12 found



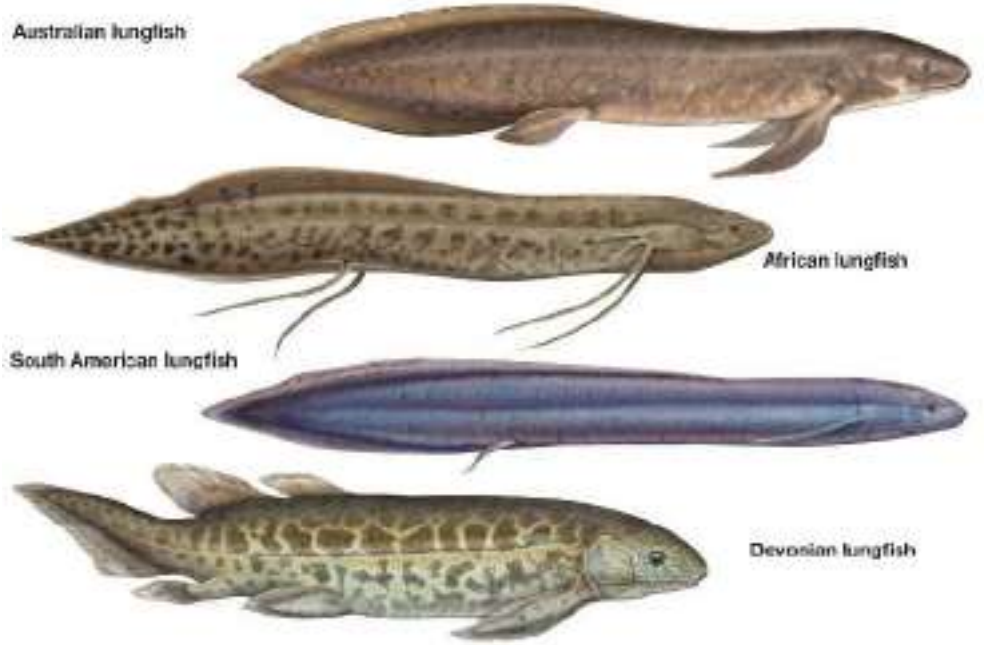
Side Note:

Hoatzin = when a chick, claws on wings (not as an adult)

Fish → Amphibians (lobe-finned (fins w/ bones) “and/or” lungs)

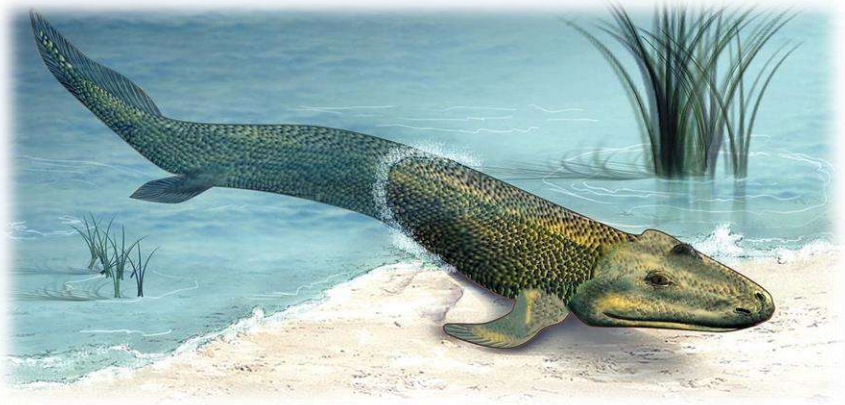
ie. **Coelacanth**
- lobe-finned

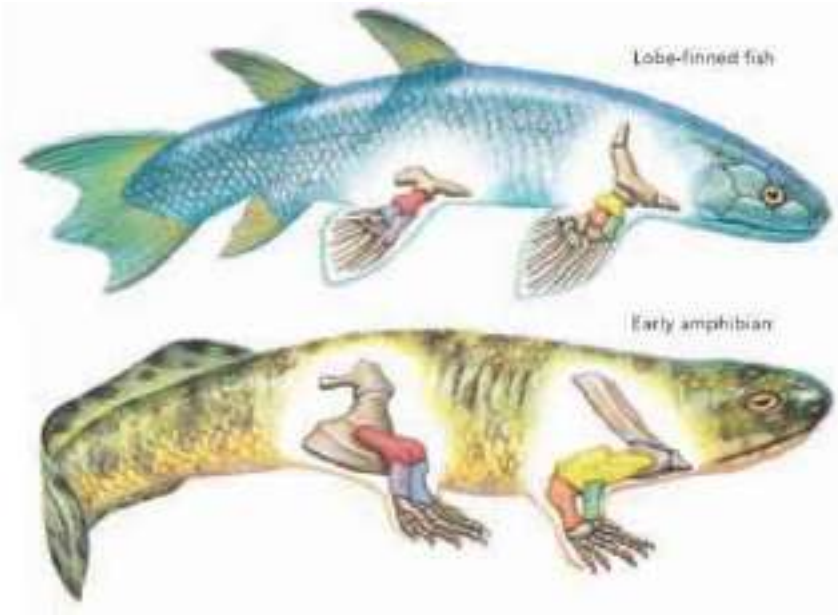
ie. **lungfish**
- lobe-finned
- 1-2 lungs (w/ gills)

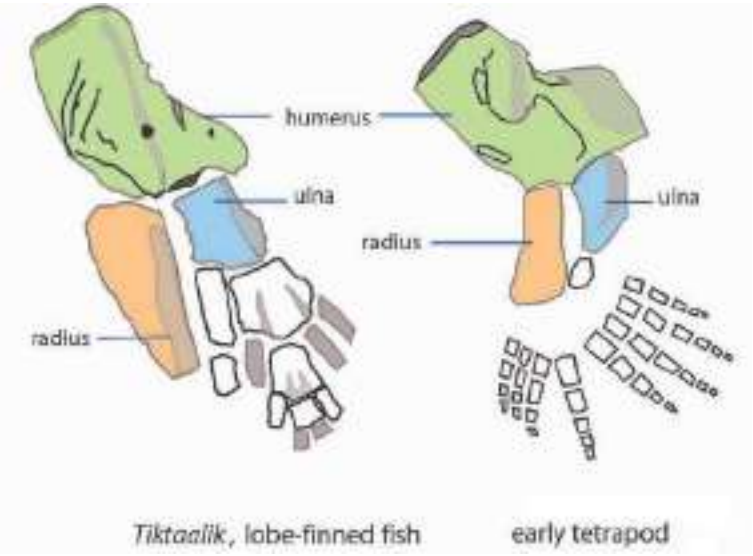


- ie Tiktaalik, ~ 370 myo ; 9 ft long

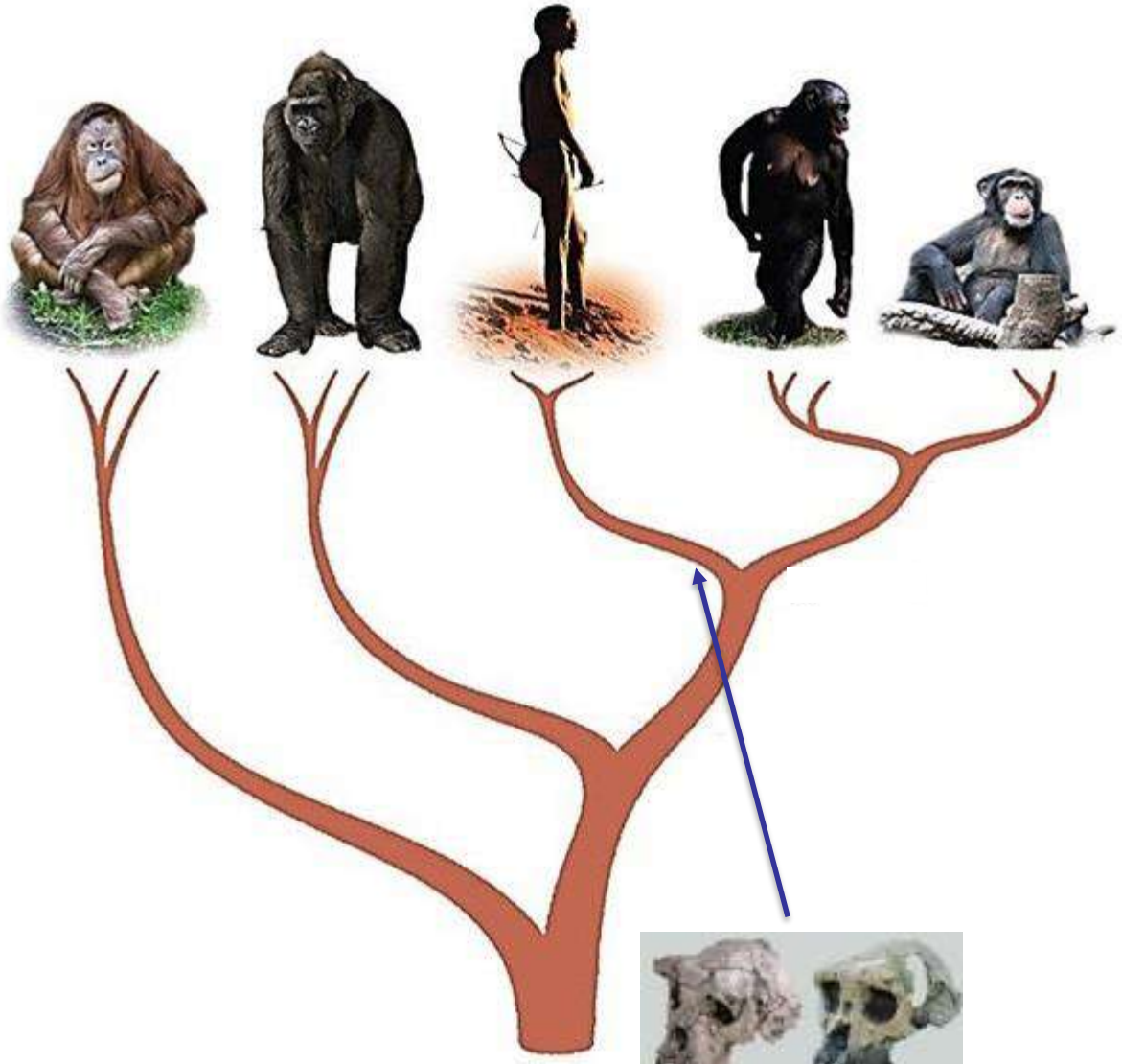
Ti-tall-lic



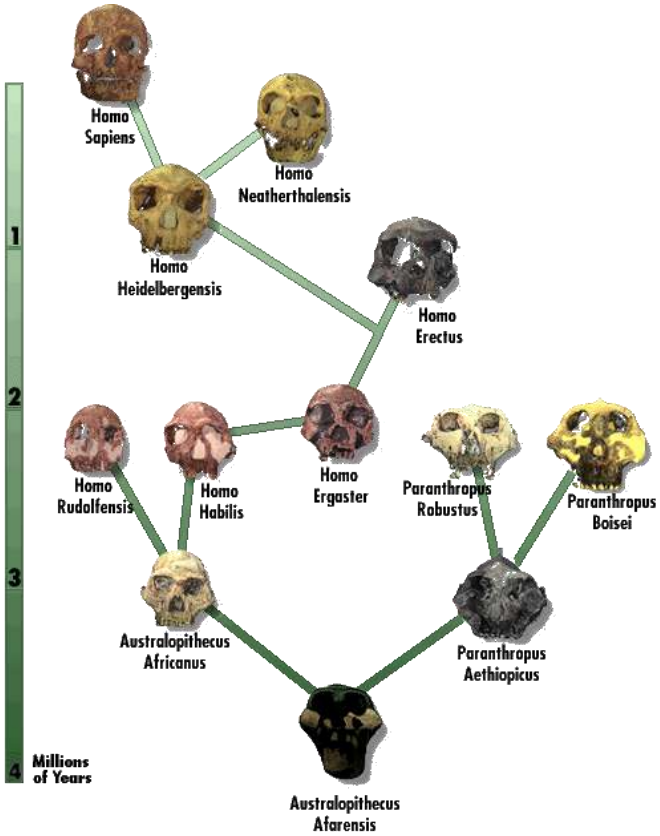




Primates → Hominids → ie. Hominins, ~6-7 mya (*previously discussed)*



Sahelanthropus
~6-7mya



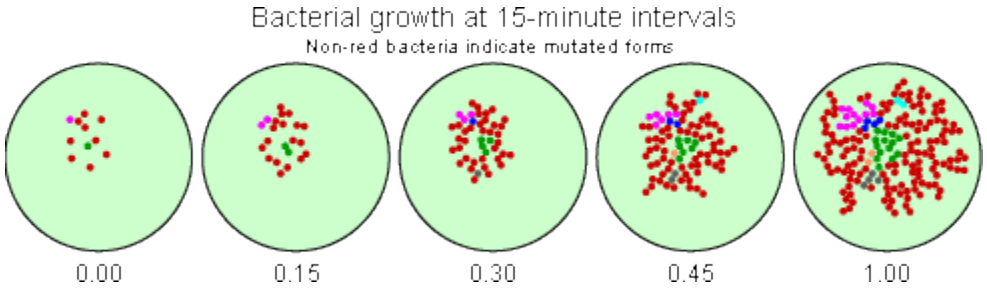
Others ?

Other Related Topics

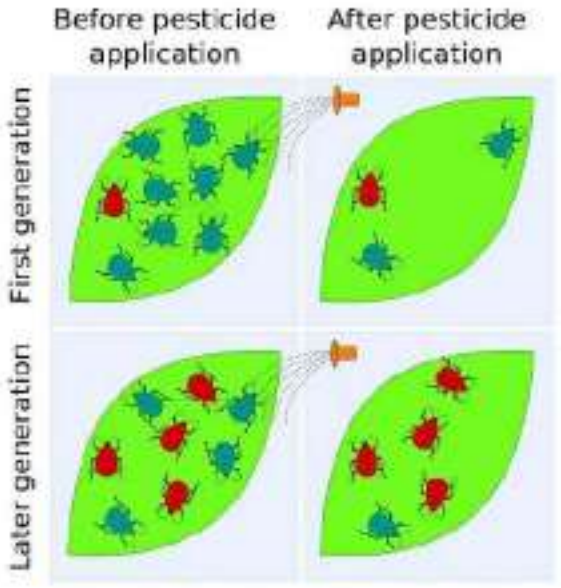
Macroevolution = change w/in species over a long time; ***previously discussed***

Microevolution = “” “” “” “” short time

ie. microbes: bacteria / viruses



ie. insects: pesticides

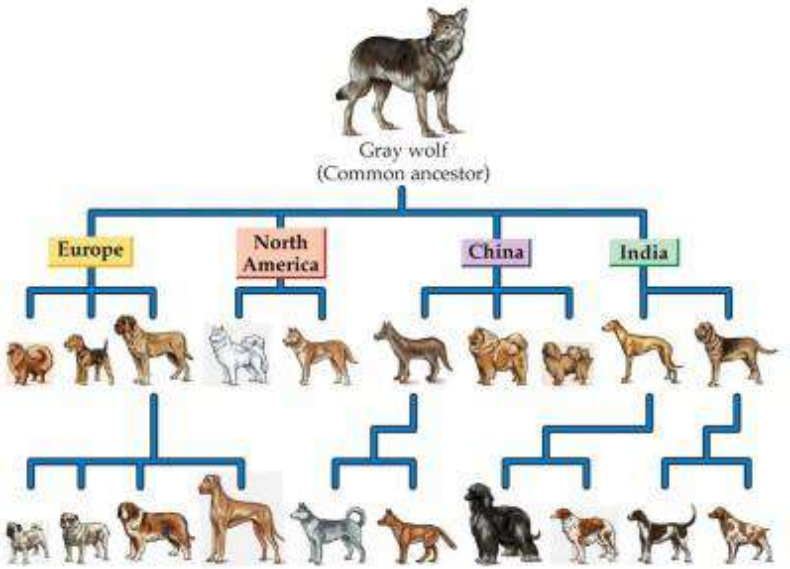


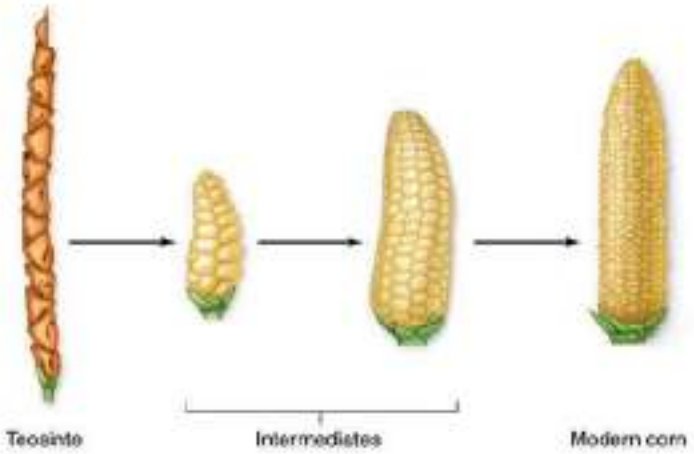
Coevolution = 2+ species affect each other's evolution

ie. pollinators and their flowers

Artificial Selection = change caused by humans for "our" benefit

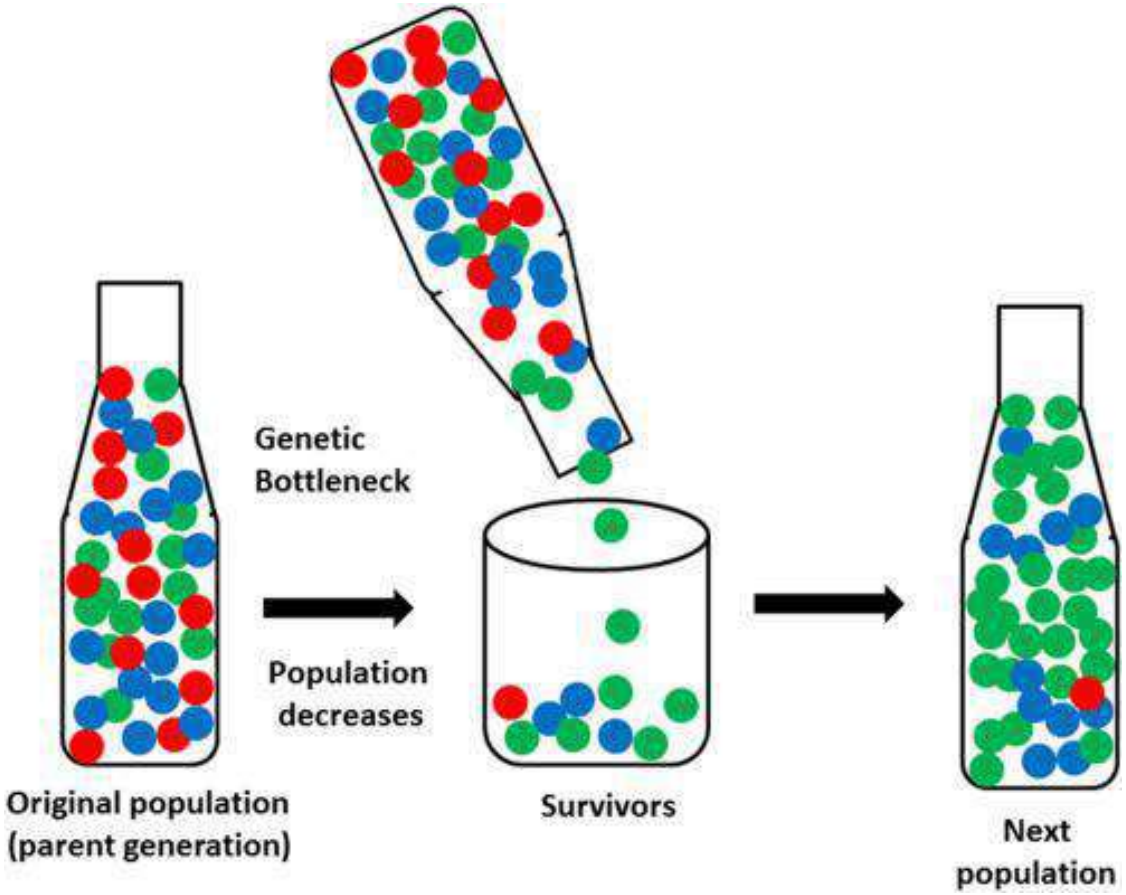
- ie's breeding (animal/plants) ; GMO's



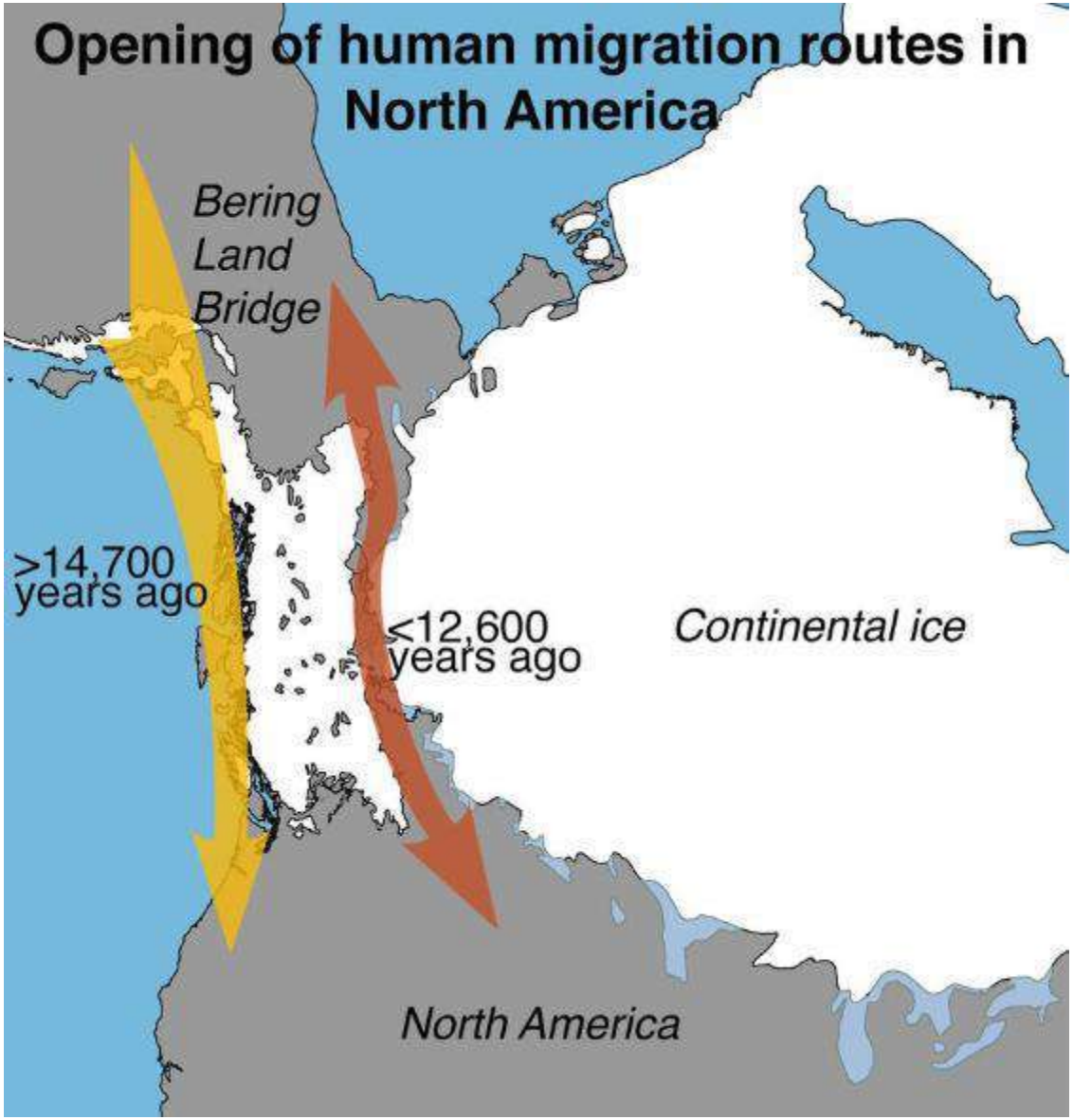


Genetic Drift = small pop. is <u>randomly</u> selected from a larger one

- ie. most American Indians have type "O" blood, why?



anw: grps w/ random types, mostly “O”, crossed from Siberia

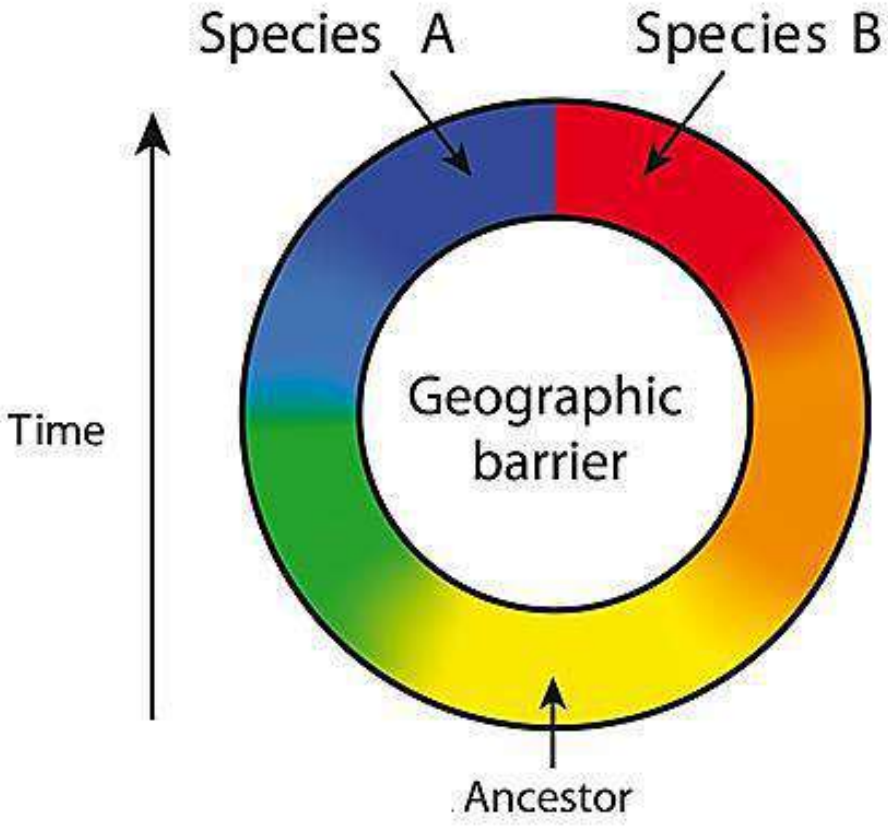


Speciation = forming new species ← only reproduces w/ own kind

ie. **Ring Species** = barrier (ie. geo.) separates a pop. <u>randomly</u>

- divided pop. adapts to new envir.

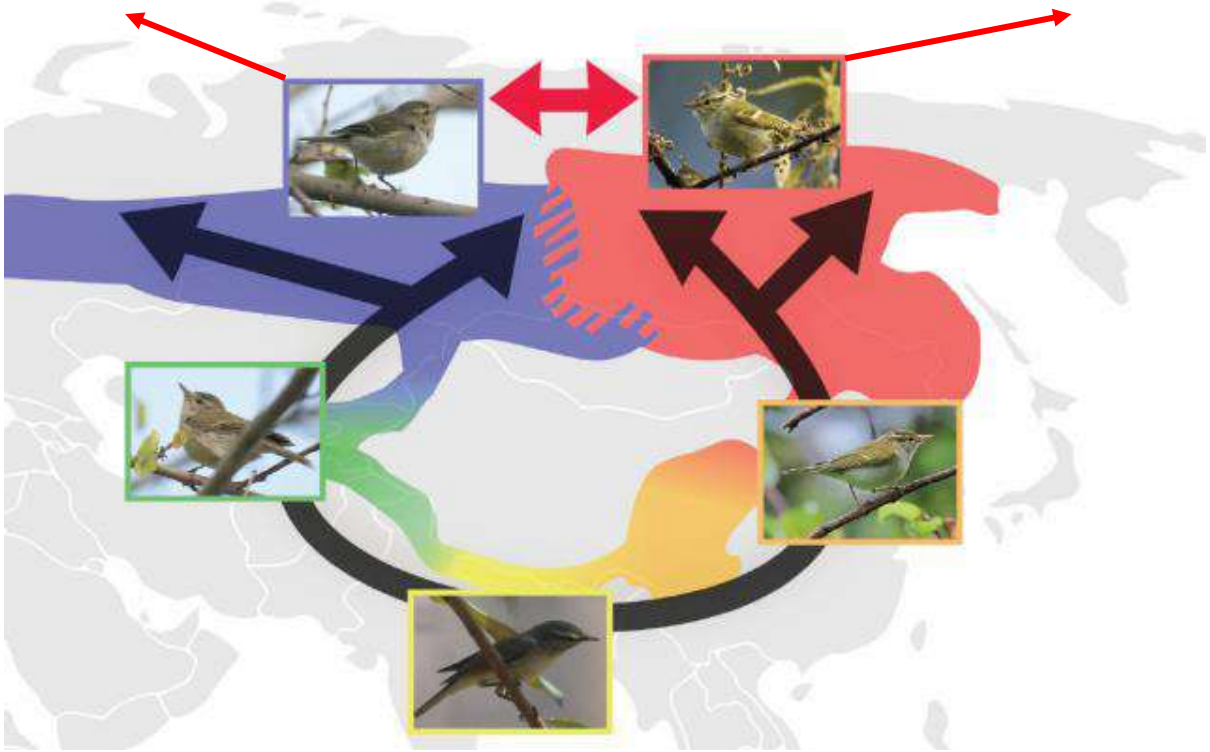
- causes incompatibility



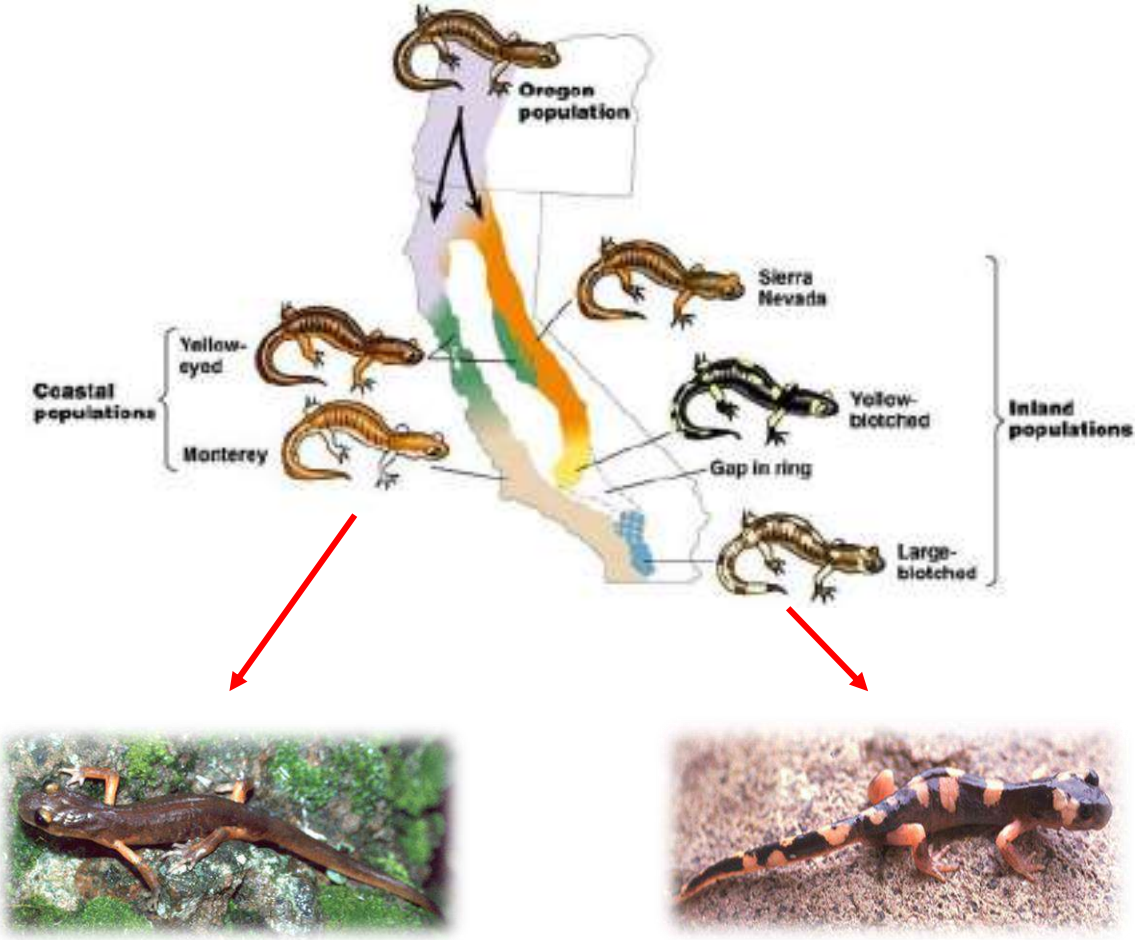
ie. Himalayan Greenish Warblers

Now different species of Warblers (Western and Eastern)

Differ subtly in their plumage patterns, most notably in their wing bars, which are used in communication



ie. California Salamanders



Now different species of California Salamanders

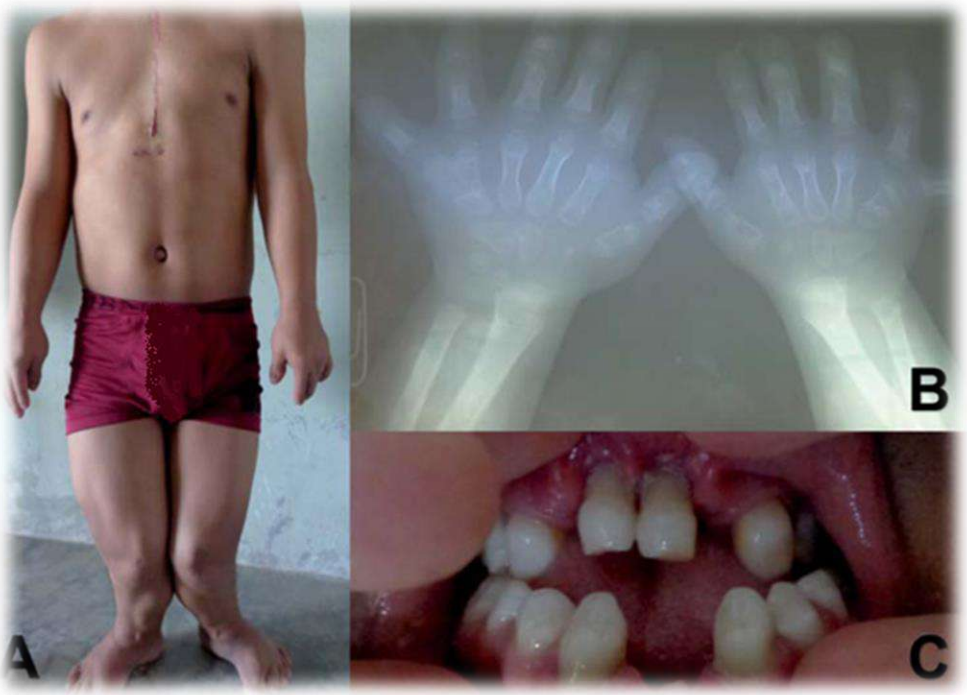
Subpopulation Isolation = small pop. separates from a larger one

- < pop. can lead to inbreeding → disease

ie. Founder Effect = humans isolating themselves

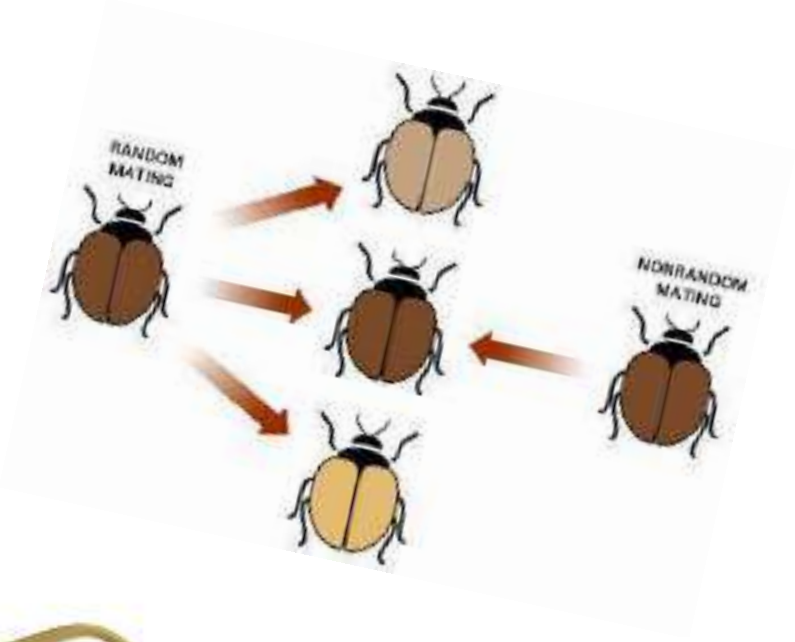
- ie. Amish: Ellis-van Creveld Syndrome

- dwarfism, polydactyl, abnormal nails, poor teeth devl. and heart defects



Genetic Equilibrium = pop. does <u>not</u> change because of:

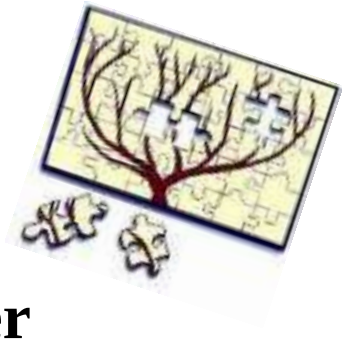
- no random mating
- no mutations
- no migrations
- no natural selection …and/or
- no small populations



Very, Very Difficult in Nature

Thus, Evolution Happens

Evolution is Like a Puzzle



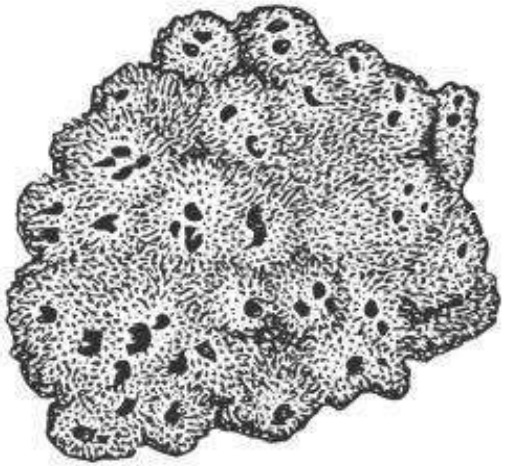
- picture = an evolving species

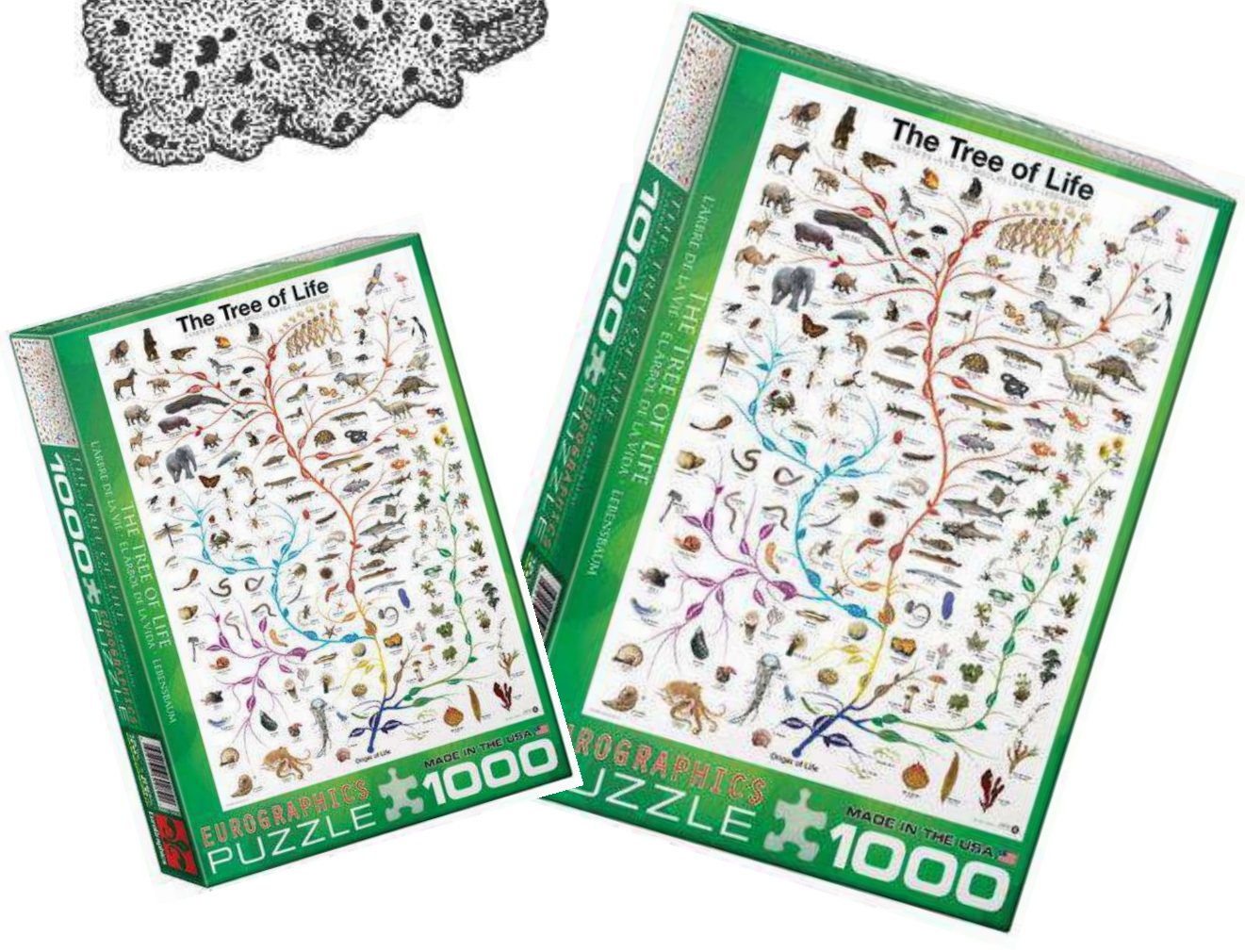
- pieces = (6) kinship similarities

- missing pieces = evidence yet to be found or lost forever

What Will Help Finish this Puzzle?

- Time
- Data
- Tools
- Knowledge
- Questioning
- Evidence
- Investigating
- Experimenting
- Open Mindedness





What are Some Common Misconceptions about Evolution?

No Need to Write / See GD and/or Handout

Evolution Does Not Explain Biology [No, Evolution Helps to Understanding / Study Life]

One "Believes" Evolution [No, Better to Say "Accepts/Refutes"; it's Not Theological]

Process of Evolution Focuses on Non-Living [No, Living]

Human Evolution is Depicted as a "Pipeline" [No, Phylogenetics]

Evolution is Always Slow [No, ie Microevolution (Microbes/Insects)]

Humans Came from Monkeys/Apes [No, Common Ancestor ~6-7 mya]

Theory is Just an Idea [No, Based on Facts, Testable Hypotheses and Confirmed Results]

Most Biologist Do Not Accept Evolution [No, Little Controversy Among Biologist; Unified]

Complex Systems Will Never be Explained [No, Tools / Research Have and Will Get Better]

Individual Life Forms Evolve During a Single Lifespan [No, It Takes Generations to Evolve]

Evolution Began Only a Few 100 or 1000s of Years Ago [No, ~ 3.7 bya]

Humans are an Exception to Evolution [No, Animalia Just Like Other Such Organisms]

There is No Evidence of or Support for Evolution [No, ie 1000's of Kinship Similarities]

Life Forms Spontaneously Generated then Evolved [No, S.G. was Refuted Years Ago]

Gaps in the Fossil Record Disprove Evolution [No, Expected to Happen "Naturally"]

Evolution is Not a Process [No, Evolution Does Happen; How it Happens Makes it a Theory]

Past Cannot be Tested [No, Existing Evidence Helps Tell What Happened; ie a Crime Scene]
"aka Historical Science"

Further Examples / Explanations: evolution.berkeley.edu

No Need to Write

Last sentence in the 1st Ed. of "Origin of the Species", 1859; p490

"There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

Never Stop Learning and Wanting to Know

Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.

Winston Churchill