

Who are you?

Who am I?

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LSC #120

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# IS SCIENCE EVER WRONG?

(Don't be a chump!)

Our job is to question and think critically.

# INDUCTIVE

- People who use cell phones for 1 hour/day have more ipsilateral gliomas after 10 years

Cell phones cause brain cancer?

**NEEDS Deductive** – provable –  
general to specific

Test and question

Use scientific method

- 1. *Observation*
  - *question*  
WHY???
- 2. *Hypothesis*
  - prediction
    - IF....THEN (MUST be testable)
- 3. *Designing an Experiment*
  - test a hypothesis. Use right PREP!

\*\*\*\*\*All experiments have controls  
VARIABLES MUST BE 'CONTROLLED'
- 4. *Data Interpretation*
  - "What do these results mean?". figures help
- 5. *Conclusions* - inference
  - The data suggest.....

How to study:

1. Read before class
2. Ask yourself questions about the headings
3. Read first sentence of each paragraph
4. Preview figures
5. Now read – and take notes (do not read out loud)
6. Read again after 3-4 days
7. Know key terms
8. Use study aids
9. Use other books
  
10. Take breaks
  
11. SLEEP

# What is a theory IN SCIENCE ??

- A theory is:
  - a proposed explanation for a natural phenomenon.
  - the body of interconnected concepts, supported by scientific reasoning and experimental evidence.
- **solid ground of science**

# HYPOTHESIS IF...THEN

PREDICTION IF.....

EXPERIMENT AND I DO THIS .....

And that??? **(NEVER)**

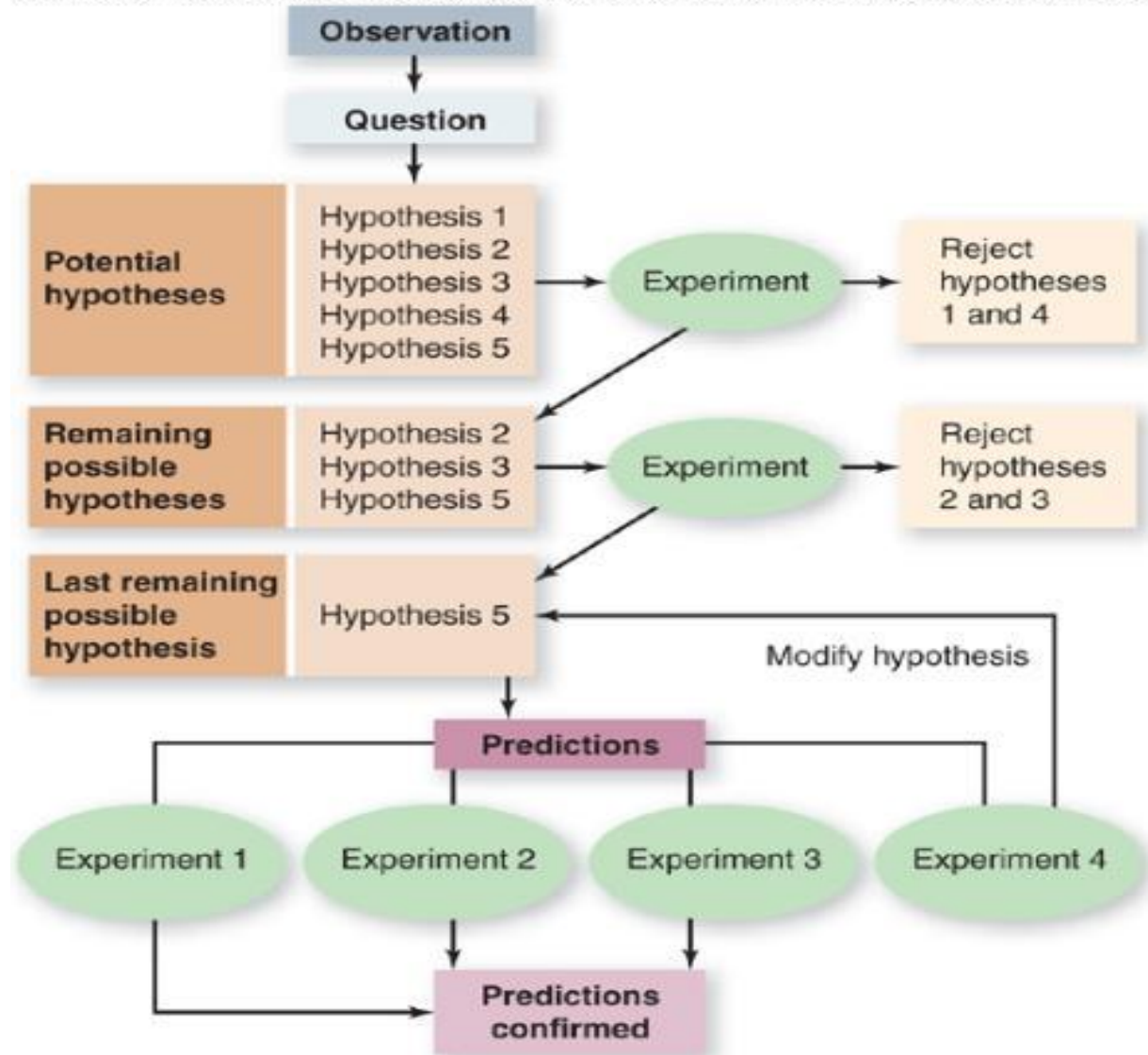
PREDICTED RESULT THEN.....

- Called “Deductive reasoning”

# IS INDUCTIVE ENOUGH?

## Scientific inquiry

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- scientific method

- HYPOTHESIS

# controls

- What is the purpose of a control group?

2 ways we use the word control in science

- What are variables? How many do we change at a time? (How do we “control” them?)
- When making a graph - what goes on x axis and what goes on y axis?

➤ **REPLICATION**

➤ **REPETITION**

**ARE THEY DIFFERENT?**

HYPOTHESIS IF...THEN

IN SCIENCE

MUST BE ABLE

TO TEST

GHOSTS?      LIFE AFTER DEATH?

ESP?

INTELLIGENT DESIGN?

EVOLUTION?

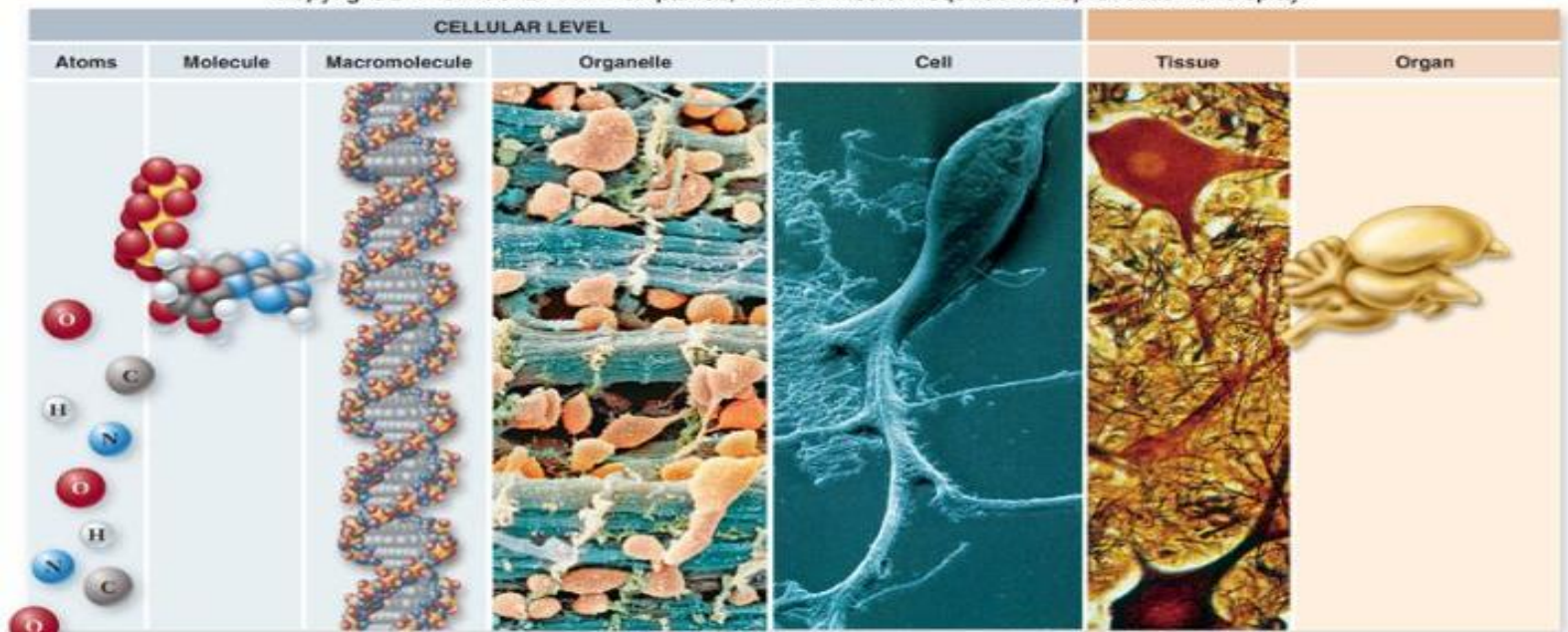
- How is a hypothesis different from a theory?
  - Theories -preponderance of evidence
    - Principles, laws
      - Gravity
      - Cell theory
      - Germ theory of disease
      - Plate tectonics
      - Evolution
  - Hypotheses are ideas - educated guesses

- The activity of the scientific method that sets science apart from many other human endeavors is \_\_\_\_\_ .

- A.** making careful observations and keeping careful records.
- B.** formulating theories that lead to natural laws.
- C.** forming hypotheses.
- D.** experimental testing of hypotheses.

# Biology unifies science

the science of life!

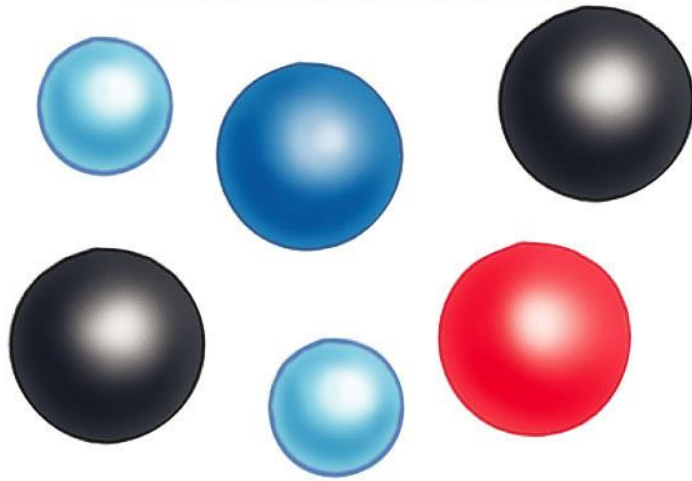


# Life is not simple

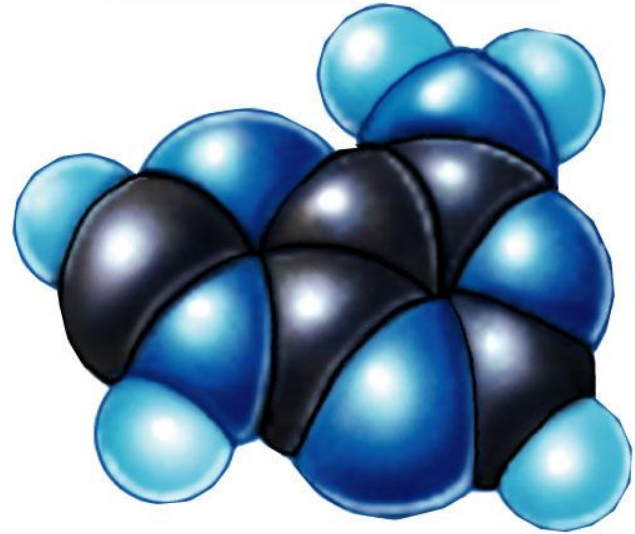


# Life depends on chemical and molecular reactions

we must understand atoms and molecules



**ATOMS**



**MOLECULES**

- CELLULAR ORGANIZATION

- ORDERED COMPLEXITY

# Properties of life

- SENSITIVITY -RESPONSE TO ENVIRONMENT

- GROWTH, DEVELOPMENT REPRODUCTION

- ENERGY UTILIZATION

- HOMEOSTASIS

- EVOLUTIONARY ADAPTATION (DNA INFORMATION BASE)



# Regulation

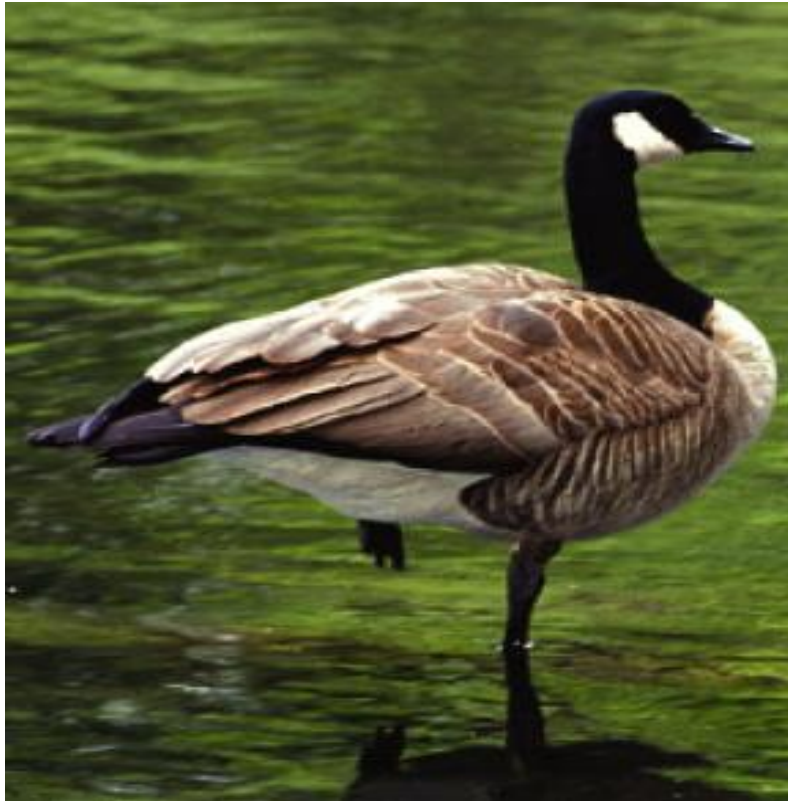
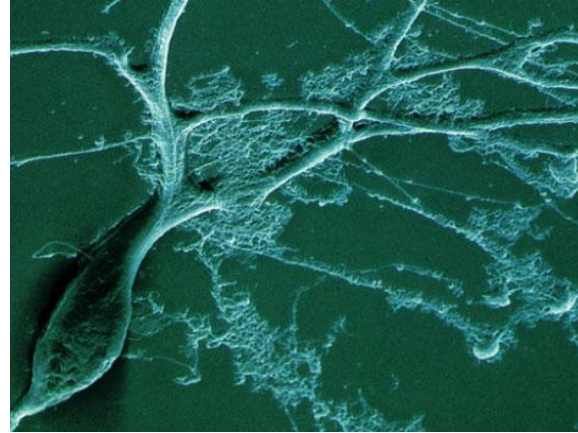
- Homeostasis
- Feedback
  - negative - temperature
  - positive – blood clots

# levels

CELLULAR – BIO 1

ORGANISMAL – BIO 2

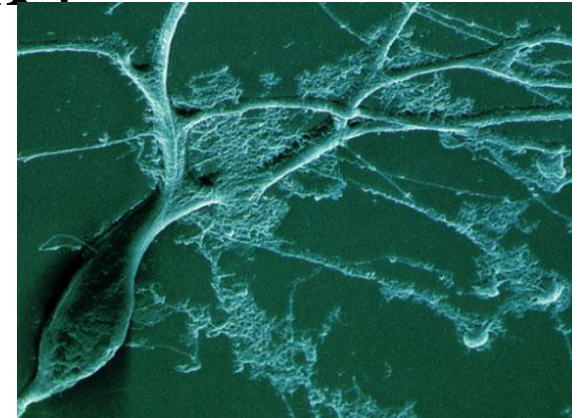
POPULATION – BIO 2 ++



# Hierarchy

Atoms  
Molecule  
Macromolecules  
Organelle  
Cell

CELLULAR

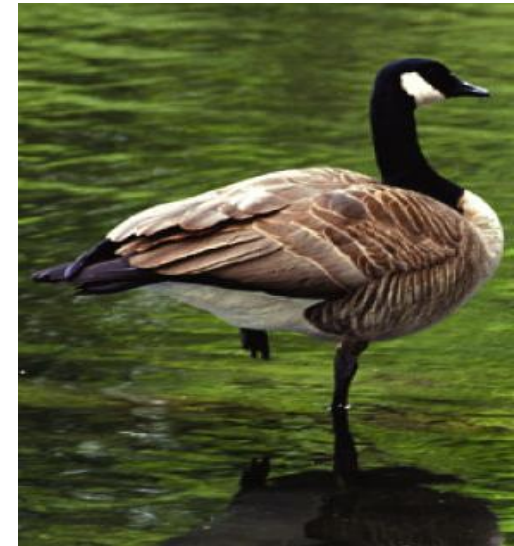


- tissue
- Organ
- Organ system
- organism

ORGANISMAL

Population  
Species  
Community  
Ecosystem  
biosphere

POPULATION



# Organisms are open systems that interact with the environment

- Ecosystems
  - cycling of nutrients
  - flow of energy
  - produce and consume

- GENES INTERACT WITH ENVIRONMENT

PKU

- Energy conversion

- plants solar energy to chemical energy



# Evolution is the core of biology

- Species descend with modification
- Natural selection

(Darwin published first)

## CHANGE OVER TIME

Natural selection

# Darwin used **INDUCTIVE** reasoning

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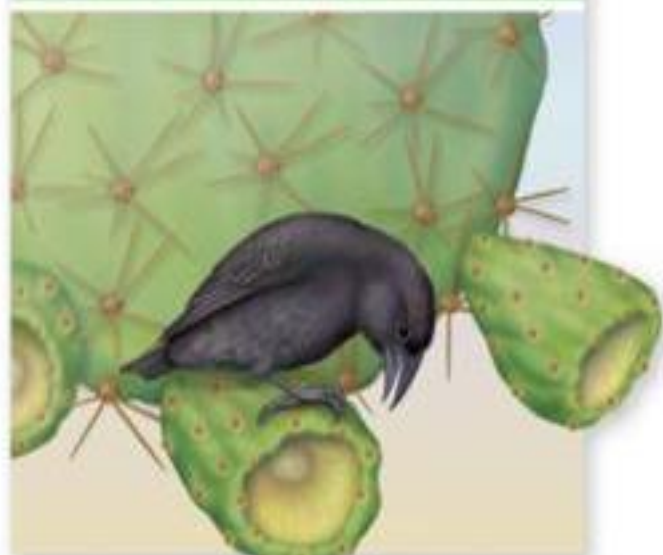
Woodpecker Finch (*Cactospiza pallida*)



Large Ground Finch (*Geospiza magnirostris*)



Cactus Finch (*Geospiza scandens*)



- does **NOT** mean we descended from apes!!!!

- does mean things change over time

life has been shaped by evolution



1	
2	
4	
8	
16	
32	100
64	
128	
256	
512	
1,024	100
2,048	
4,096	
8,192	
16,384	
32,768	100
65,536	
131,072	
262,144	
524,288	
1,048,576	100
2,097,152	
4,194,304	
8,388,608	
16,777,216	
33,554,432	100 33 million 500 years later
67,108,864	
134,217,728	
268,435,456	
536,870,912	
1,073,741,824	100
2,147,483,648	
4,294,967,296	
8,589,934,592	
17,179,869,184	
34,359,738,368	100
68,719,476,736	
137,438,953,472	
274,877,906,944	
549,755,813,888	
1,099,511,627,776	100
2,199,023,255,552	
4,398,046,511,104	
8,796,093,022,208	
17,592,186,044,416	
35,184,372,088,832	100
70,368,744,177,664	
140,737,488,355,328	
281,474,976,710,656	
562,949,953,421,312	
1,125,899,906,842,620	100 1000 years later

# DNA DIFFERENCES??



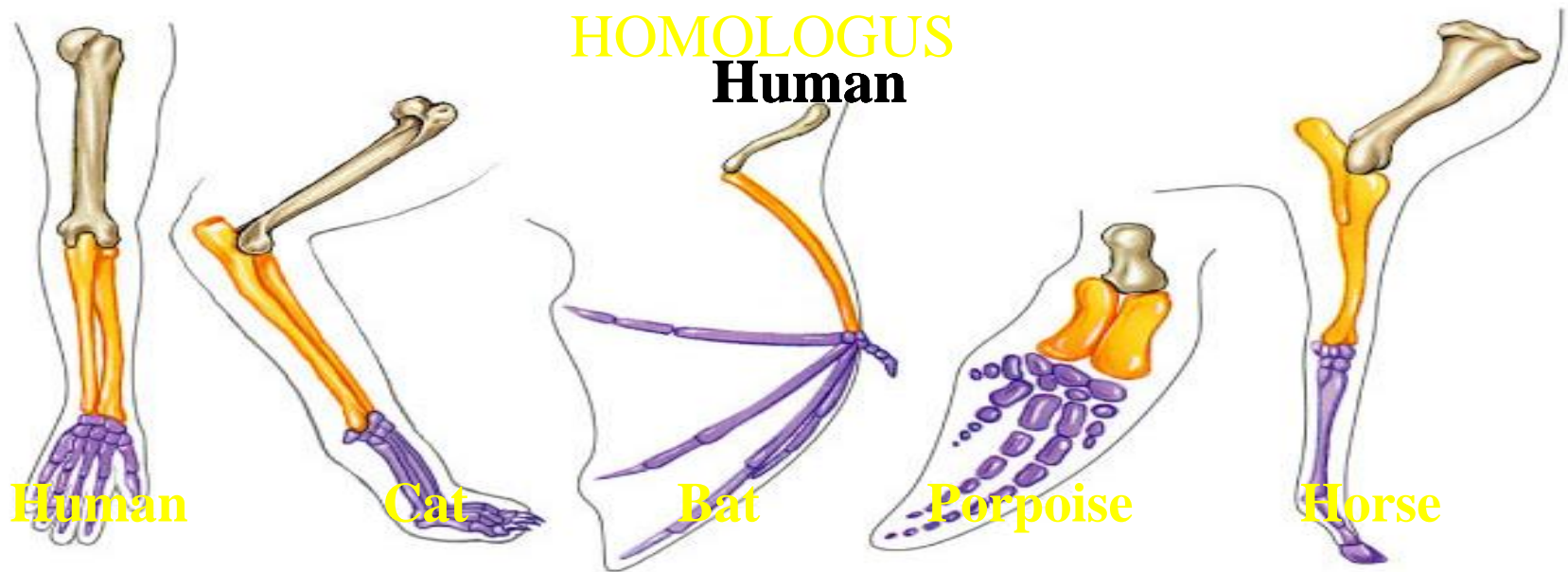
# Fossil Record

Age of the Earth (4.5 BYA)

Mechanism of Heredity

Comparative anatomy

Molecular evidence (genomes)



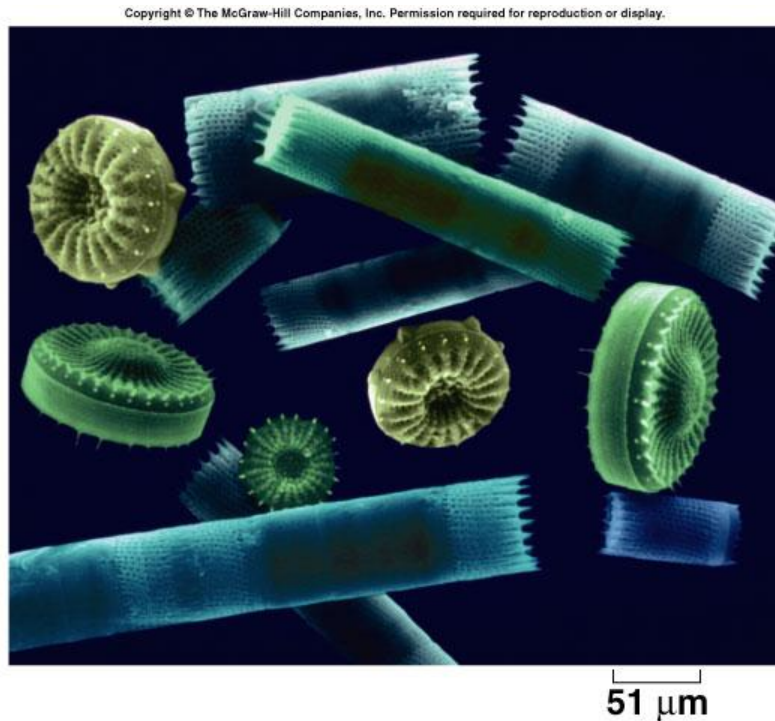
# UNIFYING THEMES

# CELL THEORY DESCRIBES THE ORGANIZATION OF LIVING SYSTEMS

- Cell theory 1839
  - living things are made of cells
  - cells come from other cells
    - all cells have membranes
    - all cells have DNA (at some stage)

# Two main cells types

1. prokaryotic – simple (bacteria, archaea)
2. eukaryotic – compartments, nucleus (protists, plants, animals, fungi)



Do they both have DNA?

How big is a micron?

Protist (single cell, but organized)

# MOLECULAR BASIS OF INHERITANCE EXPLAINS CONTINUITY OF LIFE based on

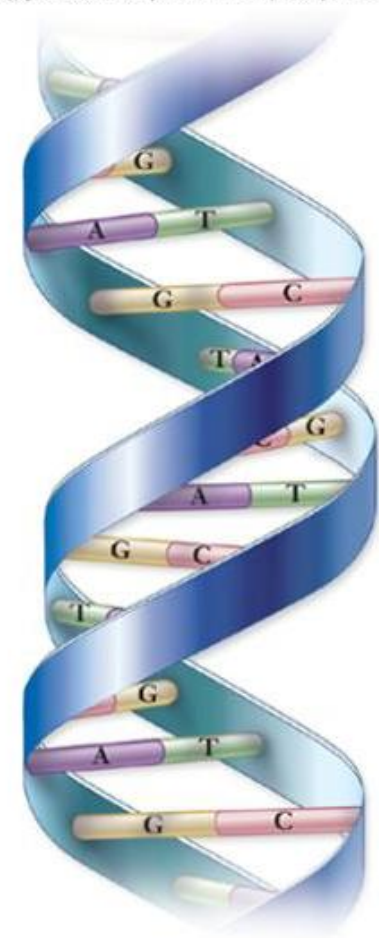
- Order requires **DNA**  
instruction

- four building blocks  
nucleotides make up genome  
(entire sequence) - same to all  
life

example: eyes

Huntington's disease (CAG  
repeats)

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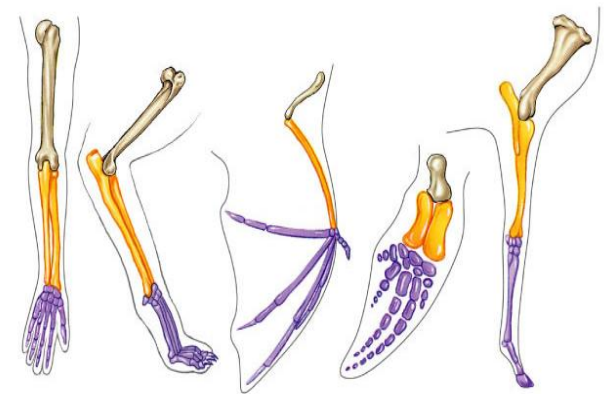
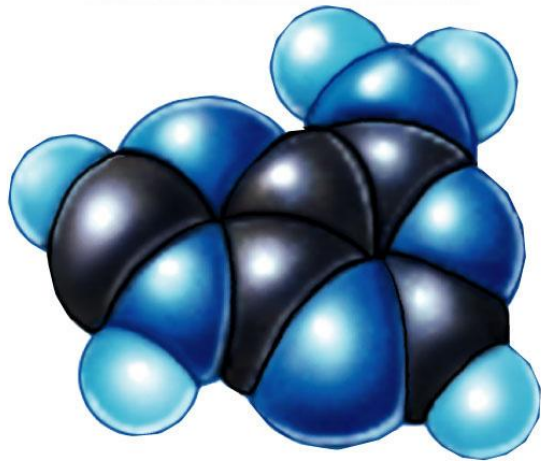


# Central Dogma of Molecular Biology

- DNA makes RNA
- RNA makes proteins

Dogma? No exceptions?

Structure is related to function  
Function is related to structure  
**UNDERLIES LIVING  
SYSTEMS**



which comes first?

# Diversity based on evolution (mutations = change)

- Estimates - 10 million - 200 million species!!!!
  - Currently 1.8 million species.
    - 280,000 plants
    - 50,000 vertebrates
    - 750,000 insects
  - Thousands more each year

3 DOMAINS  
based on similarities and differences

1) Bacteria (prokaryotic)  
(TB, syphilis, plague, skin)

2) Archaea (also prokaryotic)  
(hot springs, swamp gas, gut)

3) Eukarya (eukaryotic)



- Both Bacteria and Archaea are prokaryotes
- Archaea more closely related to eukaryotes than to bacteria?
- Eukarya includes four kingdoms:
- **Protista** (slime molds, protozoa)

**Plantae**

**Fungi** (mushrooms, molds)

**Animalia**

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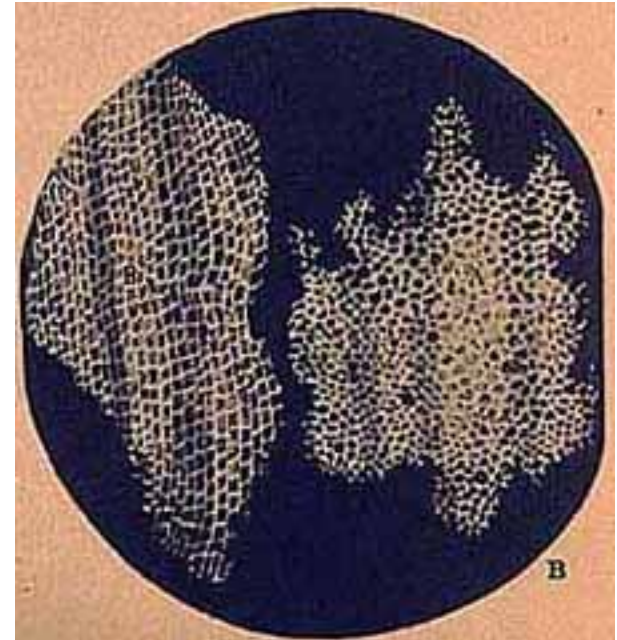
# Underlying DIVERSITY – UNITY – based on evolutionary conservation (DNA)

- 3 domains
  - Bacteria
  - Archaea
  - Eukarya
  
- Taxonomic scheme
  - species
  - genus
  - family
  - order
  - class
  - phylum
  - kingdom
  - domain

# Cells are information processing systems

- Hooke (1665) discovered cells
- Leeuwenhoek (1675)

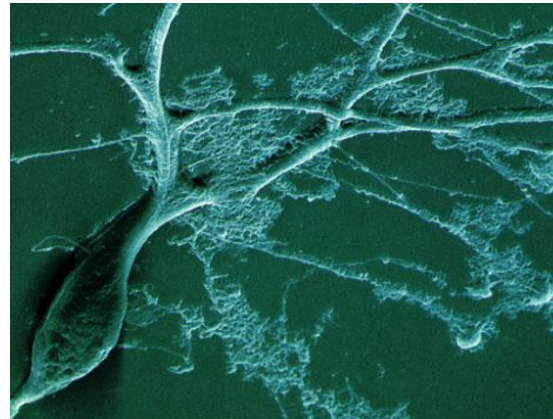
Cells maintain homeostasis



# Emergent properties

## •Hierarchy

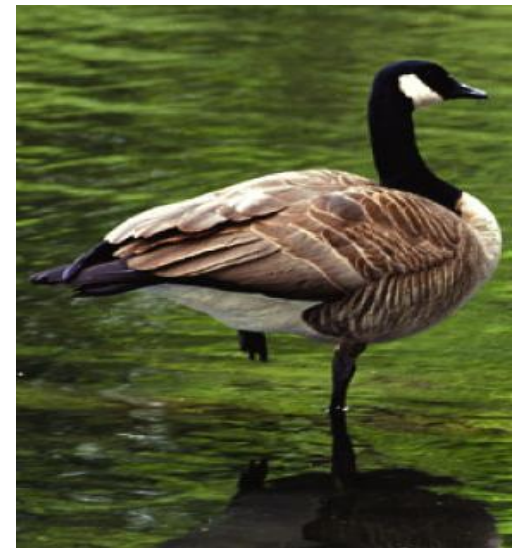
- molecule
  - organelle
  - cell
  - tissue
  - organ
  - organism



Is the whole greater than its parts?

Novel properties emerge

Problem ?Reductionism



# Science, technology and society are interdependent

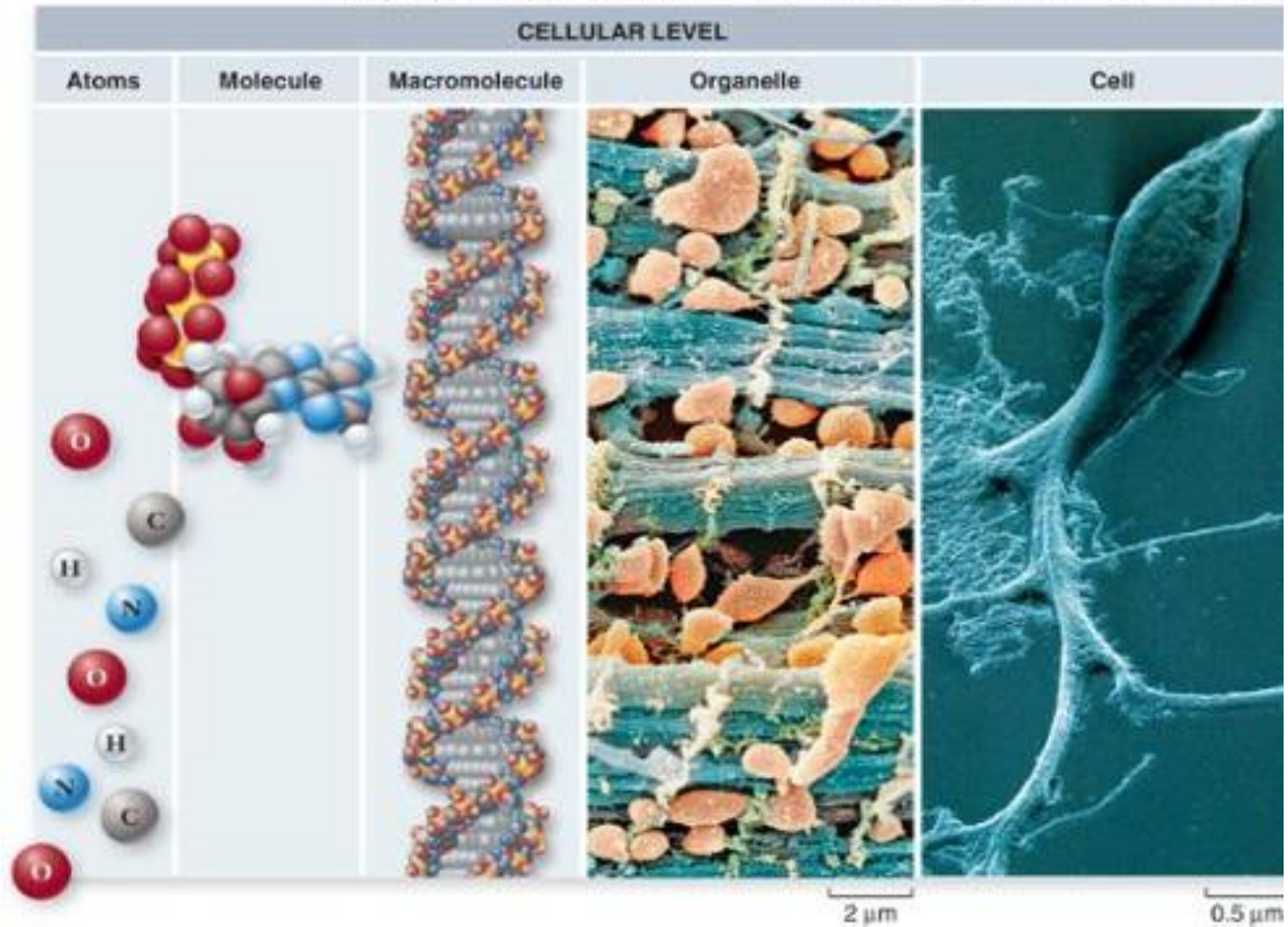
- Example – scientific discovery needs tax dollars  
educate
- politicians
- bureaucrats
- corporate leaders
- voters

Neuroscience in USA (Both Watson and Crick moved here)

# What is common to LIFE?

- cells

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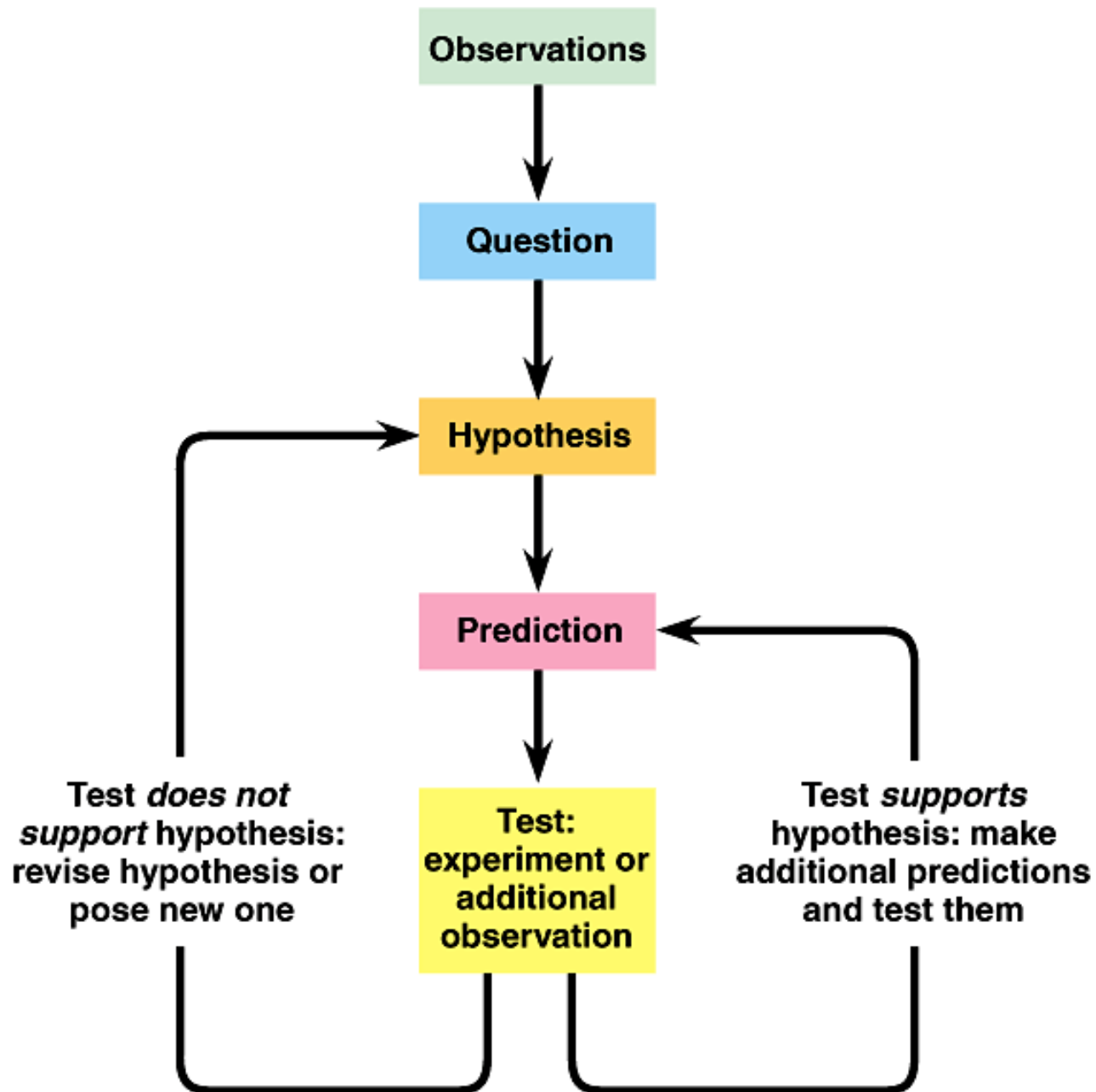


# YOUR 1440 LABS

read the web site BEFORE CLASS!!!!

- DIRECTED INVESTIGATION
- OPEN ENDED INVESTIGATION

# Idealized version of the scientific method



# GRAPH

DEPENDENT  
VARIABLE

WHAT VARIES  
BASED ON  
WHAT YOU DID  
(DEPENDS)

INDEPENDENT VARIABLE

WHAT **YOU** VARY OR  
CHANGE IN EXPERIMENT

ARE  
BIOLOGICAL  
SYSTEMS  
PREDICTABLE?

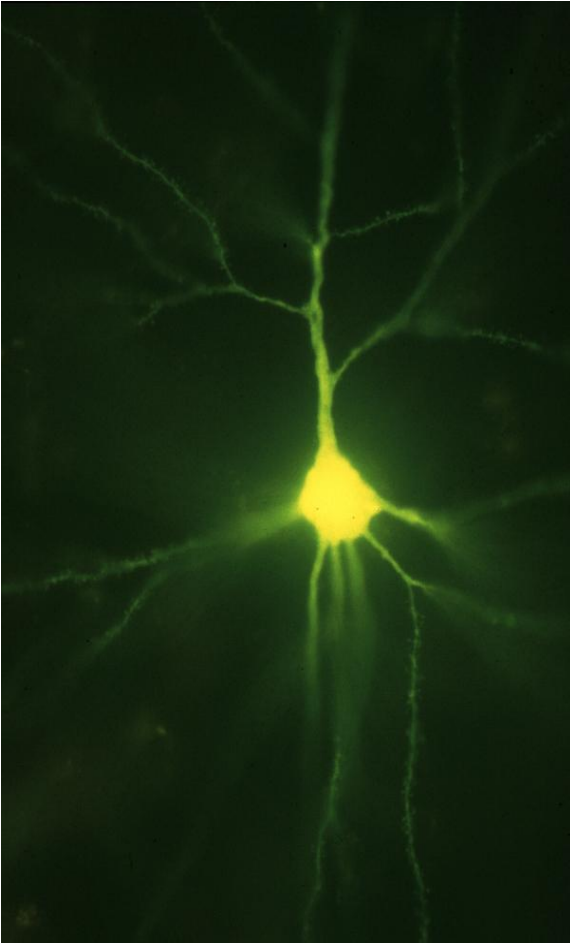


# What do cell membranes do?

LIPIDS

PROTEINS

Carbohydrates



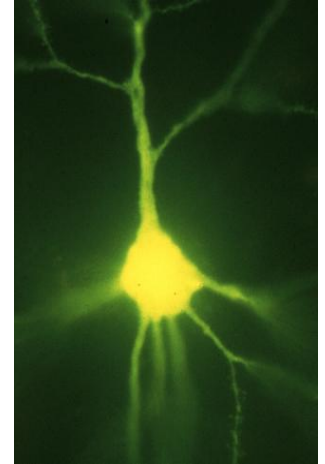
Selective permeability

## What are vacuoles?

membrane-bound sacs

prion (mad cow) disease

# HOW DO WE MEASURE COLOR?



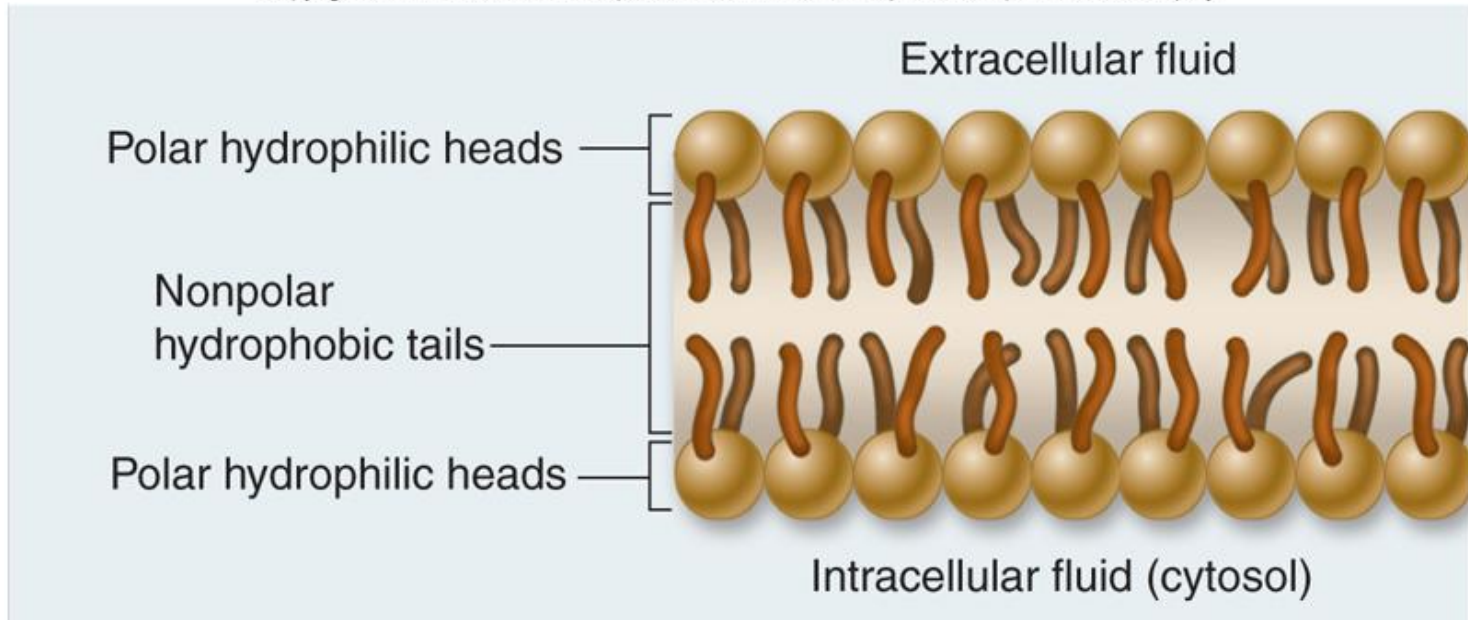
- Do you see what I see?
- Spectrophotometer - measures the intensity of a light beam after it is directed through and emerges from a solution.
- Absorb/transmit - we will record **absorbance**

# The Scientific Method

How Does Ethanol Affect Cell Membranes?

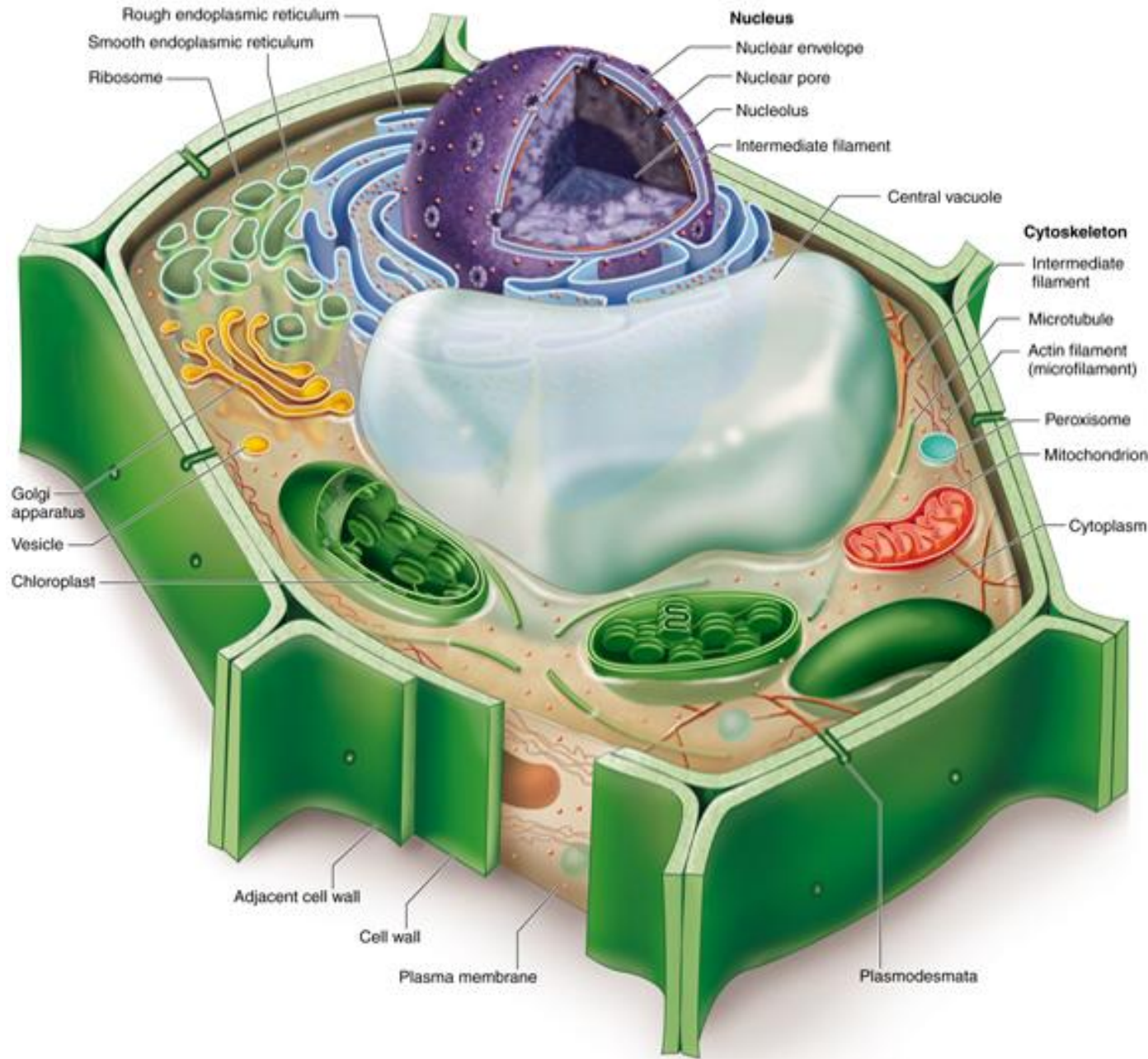
# Cell Membranes – lipid bilayer

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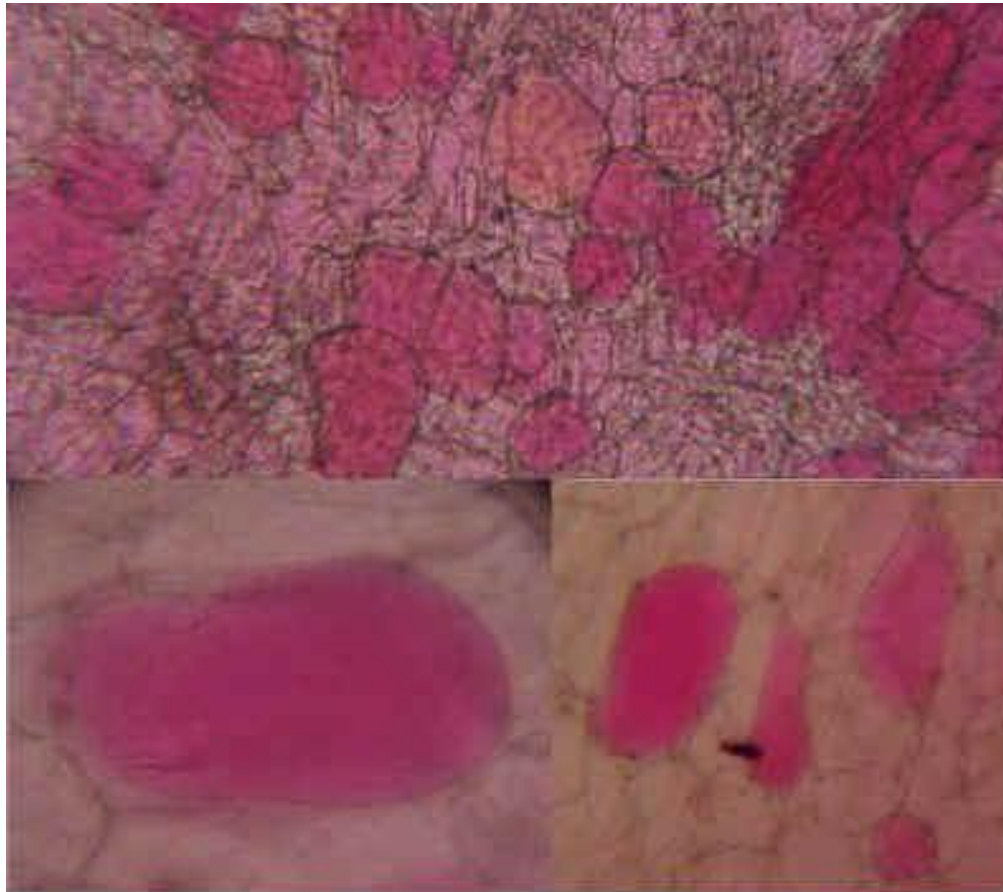


# Plant cells

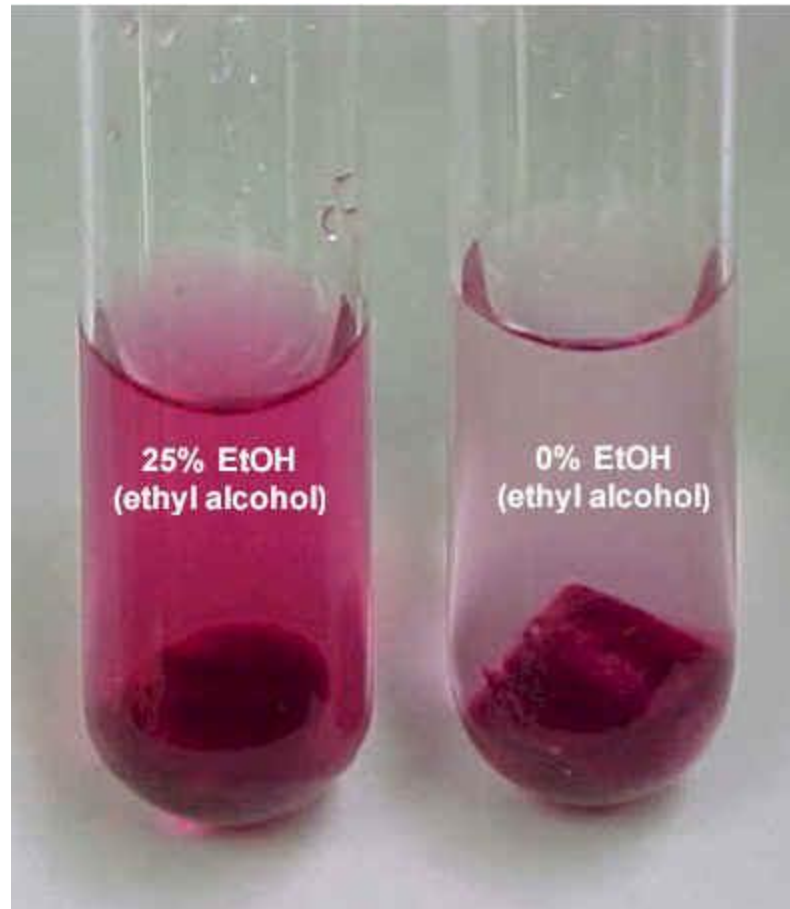
(central vacuole membrane = tonoplast)



# Beet cells - betacyanin



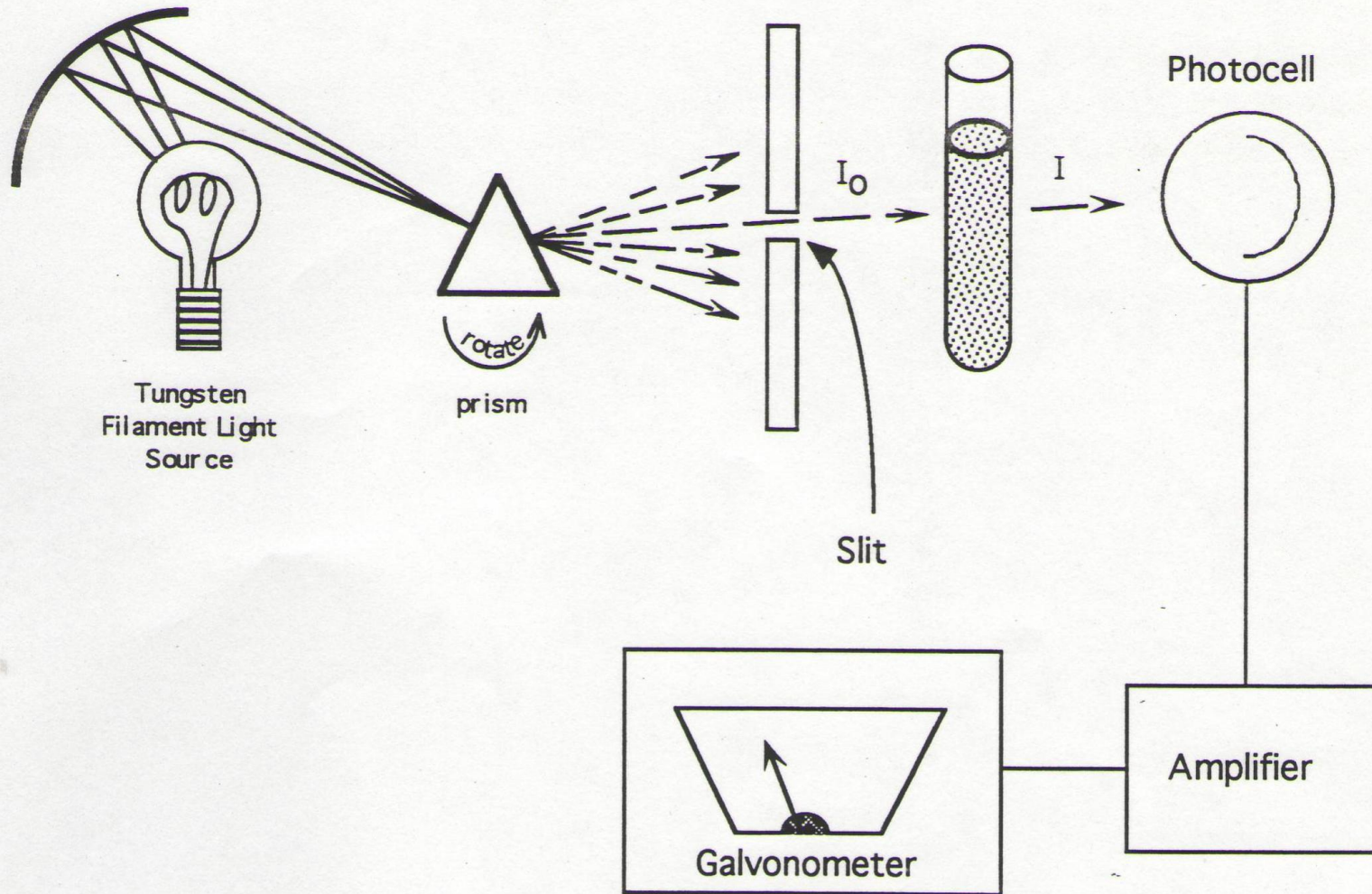
# How can membrane damage be measured?



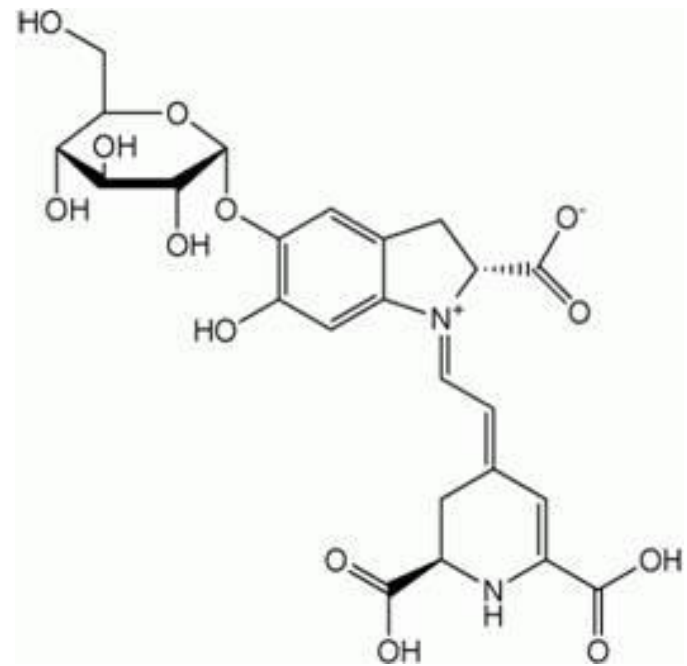
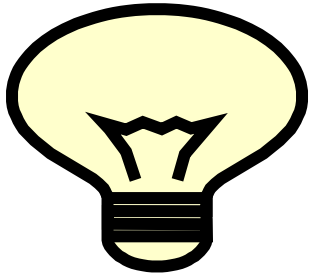
# Spectrophotometer



# Spectrophotometer



# Betacyanin



# Absorbance measured in AUs

- MUST be converted to concentration
- LAMBERT/BEER equation /Law

$$A = \epsilon lc$$

- $\epsilon$  = epsilon = molar coefficient (standardizes to 1cm/1M)
- $l$  = length (how far light travels)
- $c$  = concentration

# LAMBERT BEER (OR BEER LAMBERT)

- **Concentration and absorbance are related**

(intuitive)

In lab find absorbance (A), but we want to know (and graph) concentration (C)

$$A = ecl$$

$$c = A/el$$

e=molar coefficient (for betacyanin 38,000 L/mole-cm)

l = length of light path (for ours, 1.2 cm)

$$c = \frac{A}{0.0456 \text{ uM}}$$