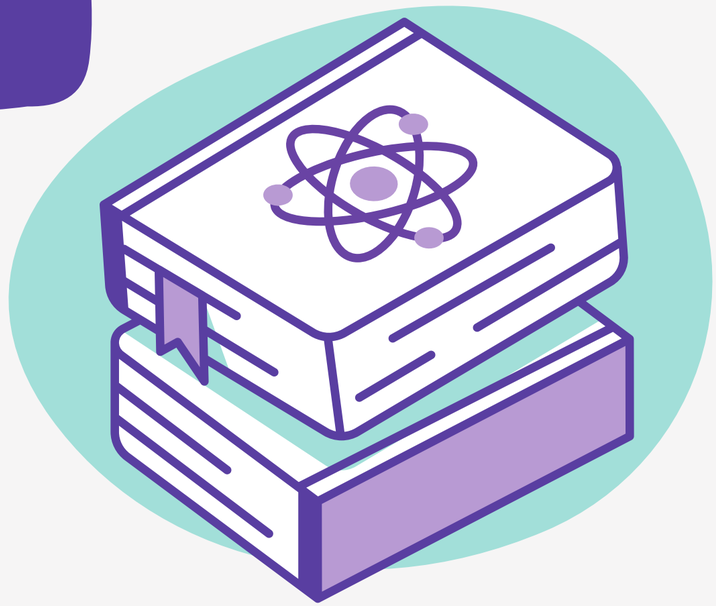
Unit 1

Scientific Method and Chemistry of Life



review vocab

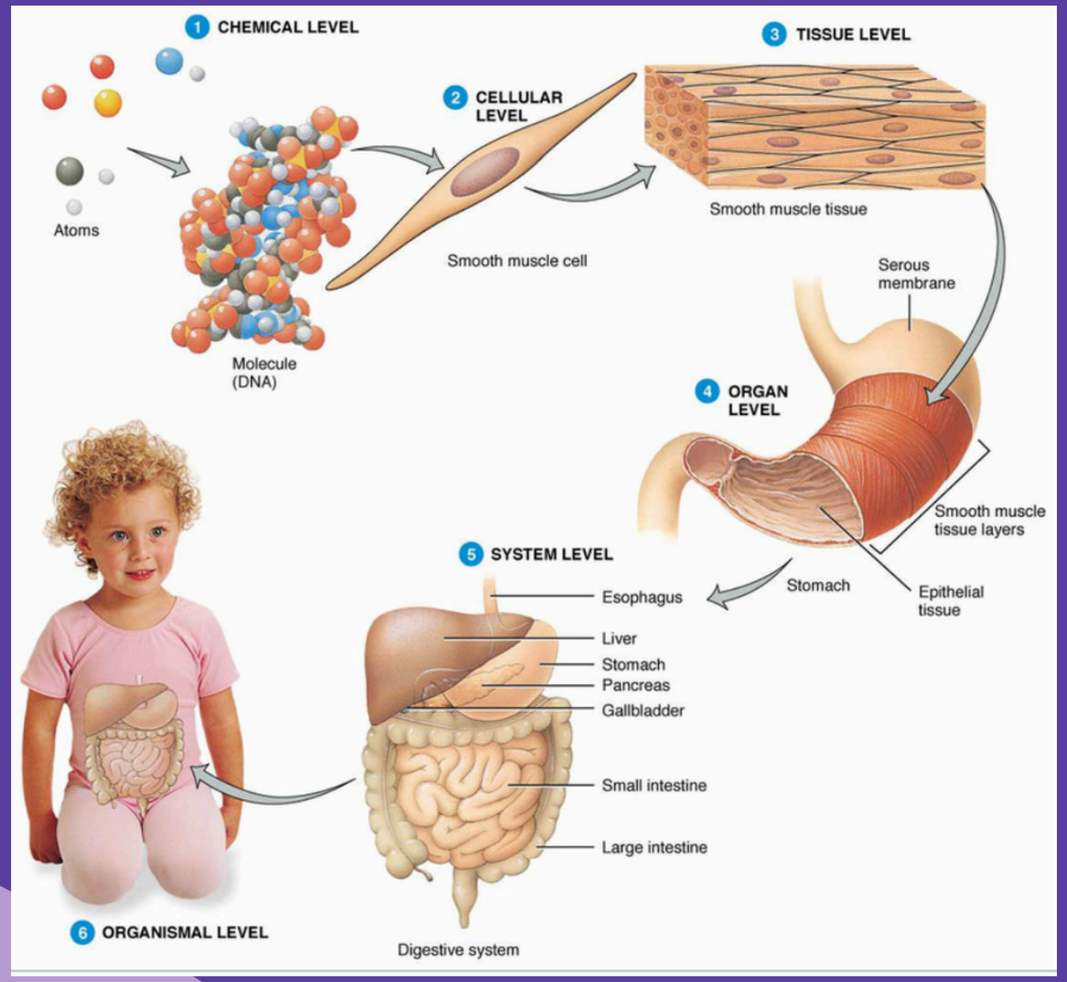
1. **Biology**: The study of living things and their interactions with their environments
2. **Cell**: The smallest unit of **LIFE** that can perform all processes of life.
3. **Organism**: Any individual living thing
4. **Species:** A group of organisms that are closely related and can produce fertile offspring

All living things have these 7 characteristics

1. All organisms are made of one or more cells.
2. All organisms need a source of energy to carry out life processes.
3. All organisms must be able to react to stimuli or changes within their environment.
4. All organisms must have the ability to reproduce.
5. All organisms have systems of related parts.
6. All organisms must maintain homeostasis.
7. All organisms evolve over generations.

#1

All organisms are made of one or more cells

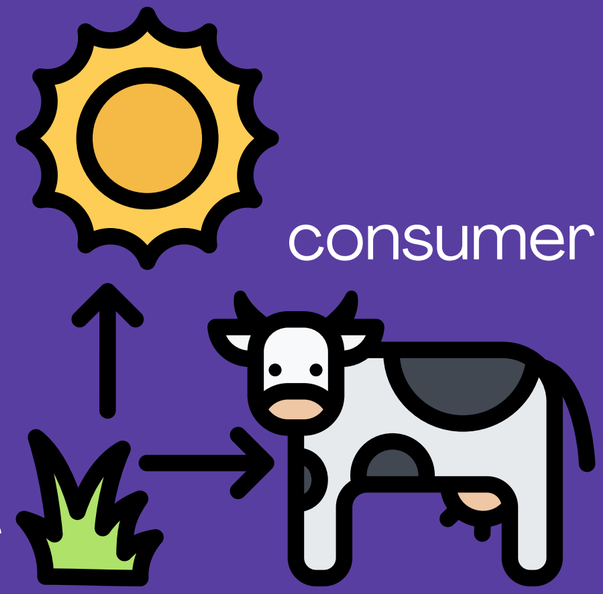


Organisms can be unicellular (bacteria) or multicellular (plants, animals)

#2

All organisms need a source of energy to carry out the processes of life

Metabolism is the sum of all chemcial processes that build or break down materials for energy



#3

All organisms must be able to react to stimuli or changes within their environment.

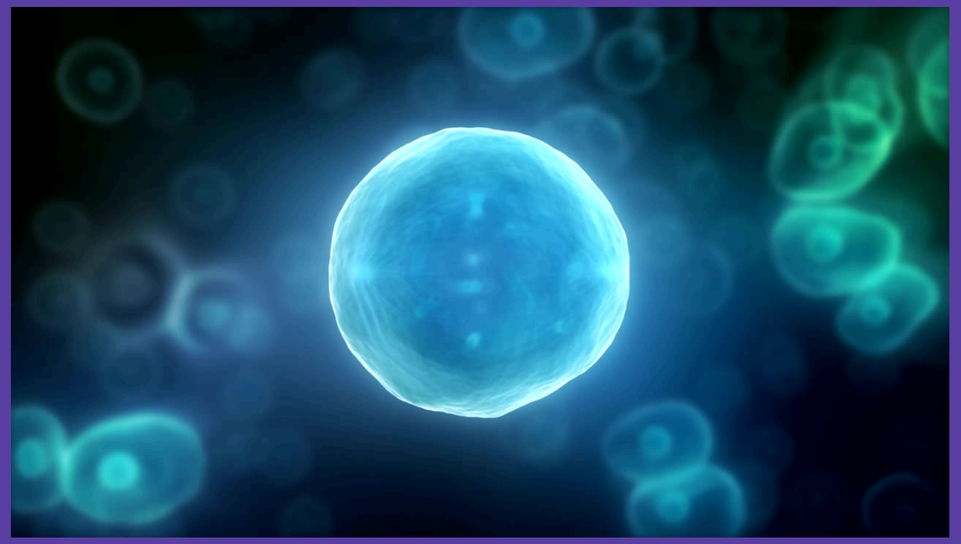
Response to a hot environemnt

Stimulus a thing or event that evokes a specific functional reaction in an organ or tissue.
Ex: light or touch

Response to light in the environment

#4

All organisms must have the ability to reproduce.



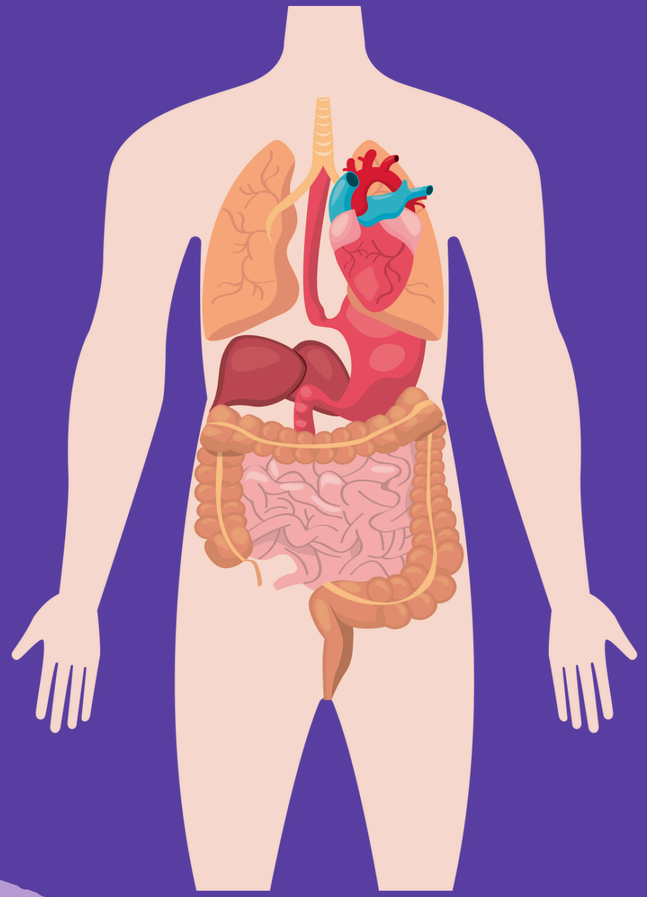
Asexual reproducton

Organisms can reproduce asexually or sexually.
In both cases, DNA gets passed to offspring.
Organisms grow and develop after reproduction

Sexual reproduction with a sperm and an egg cell

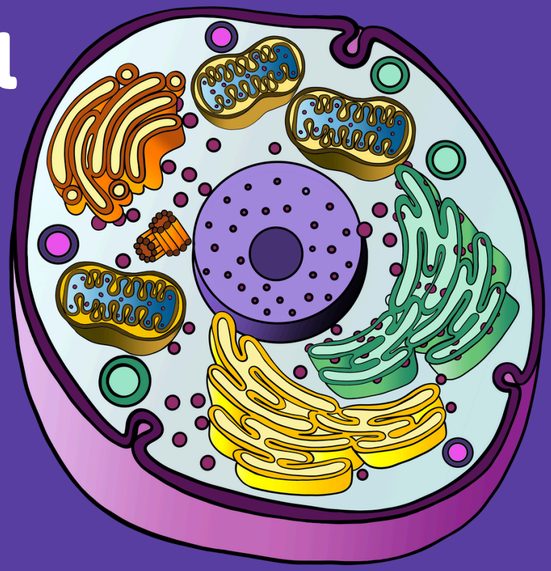
#5

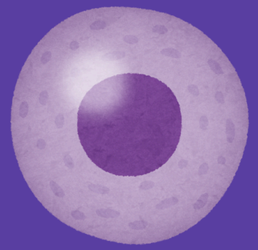
All organisms have a system of related parts



Bodies have body systems
(ex: circulatory system)
Cells have organelles (mini organs)

The cell



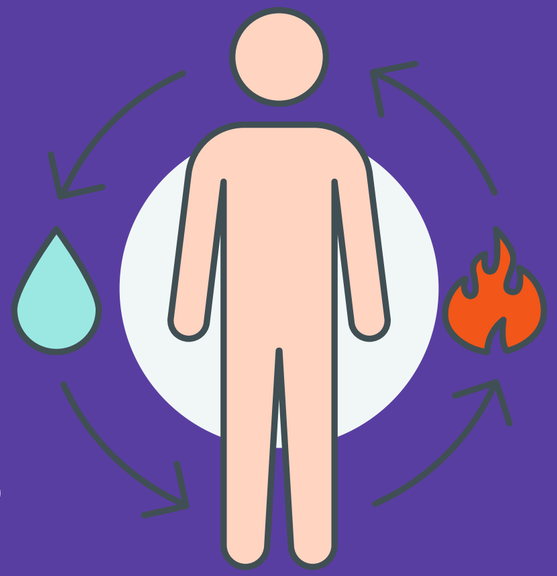


The organelles

#6

All organisms must maintain homeostasis.

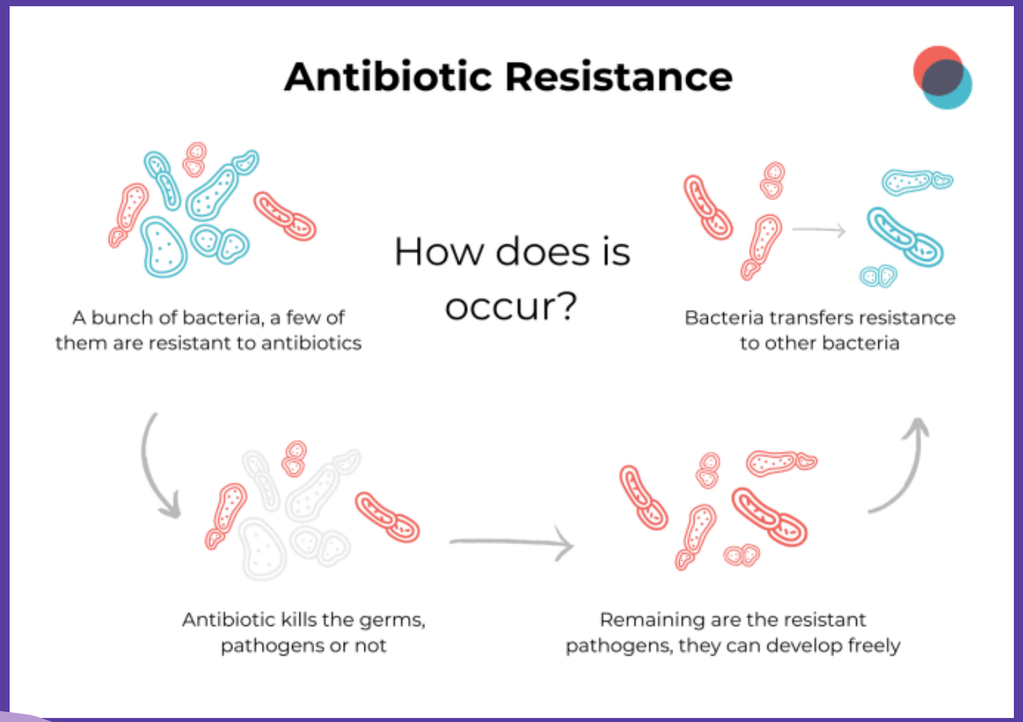
Regualting your body temperature



Homeostasis is the process of maintaining a stable balanced internal environment despite changes to the external environment.

#7

All organisms evolve using adaptations.



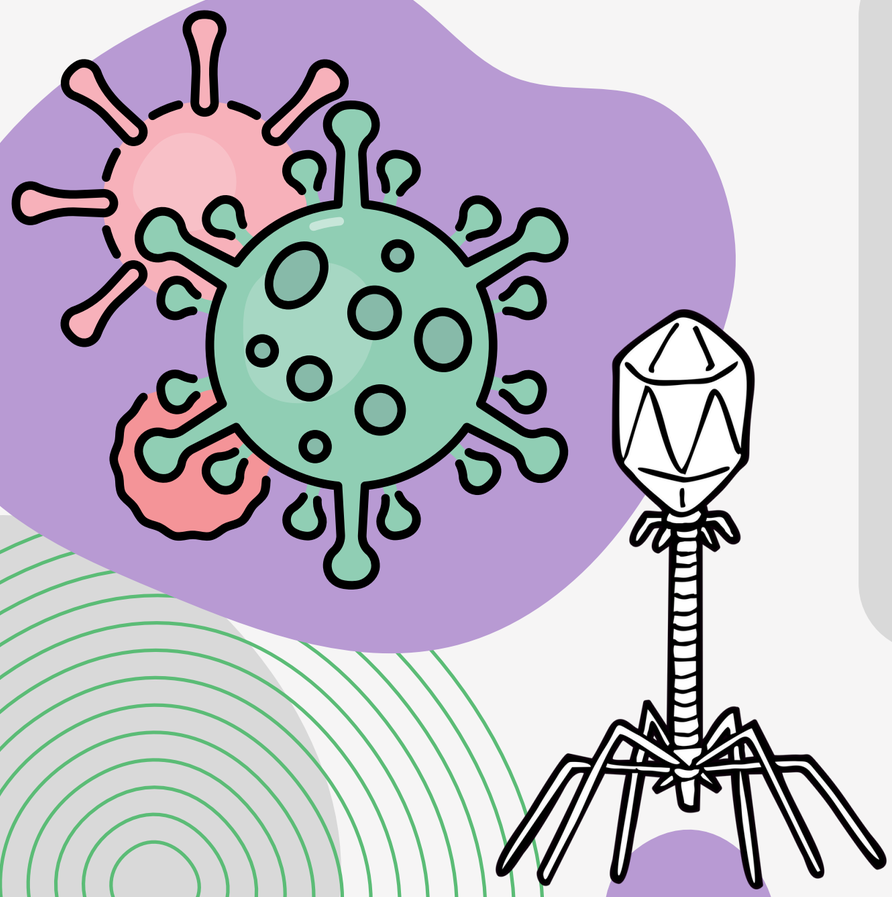
Evolution is the change in living things over time.

Adaptations are inherited traits that give an advantage to individual organisms and are passed onto future generations

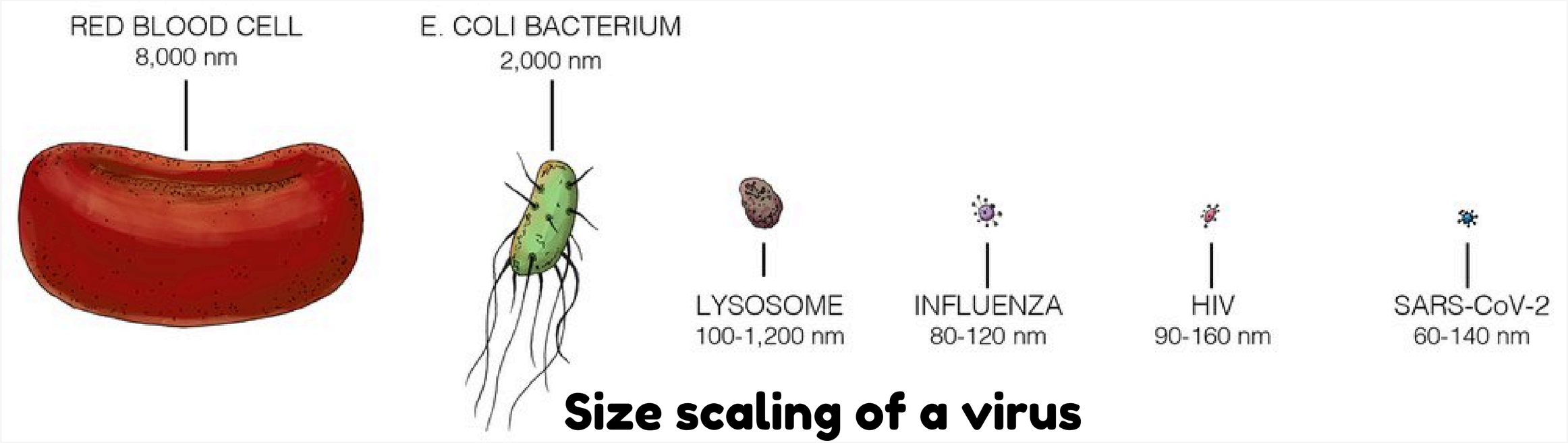
What do you think about viruses?

Are they living?

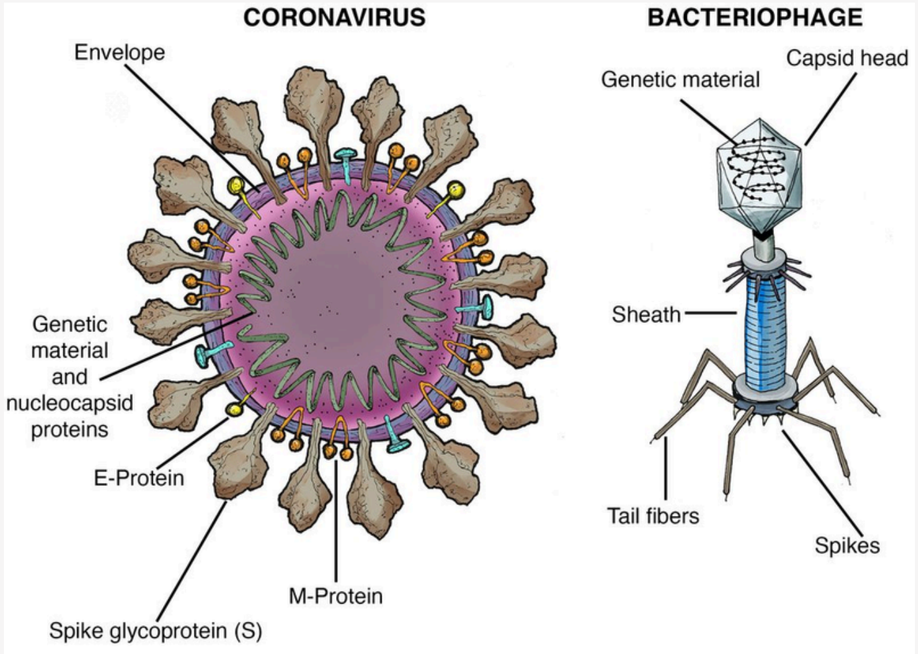
What is a Virus?



- composed of a core of **DNA or RNA** surrounded by a protein coat called a **capsid**
- reproduce only by infecting a living cell (**host cell**)
- all viruses enter living cells and, once inside, use the host's machinery to produce more viruses
- They differ in size and structure, depending on what they infect and the illness it causes.



Size scaling of a virus



Coronavirus infects humans, the bacteriophage infects bacteria cells

Characteristics	Virus	Cell
Structure	DNA or RNA, Surrounded by a cpasid	Cell Membrane and organelles
Reproduction	Only within a host cell	Independent (sexual and a sexual)
Genetic Code	DAN or RNA	DNA
Growth/Development	No	Yes
Uses energy	no	yes
Responds to Environment	no	yes
Evolves	yes	yes
Metabolism	no	yes
Maintains Homeostasis	no	yes

Experimental Design

What is it and how is it useful?

Scientific Thinking

Scientists make careful and sytematic **observations** and record observations as data

- form a hypothesis as a possible answer to a question
- test the hypothesis and analyze the data
- evaluate results and possibly begin the cycle again

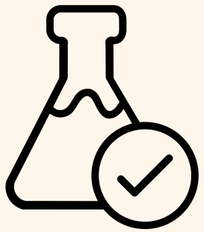
Hypothesis

a proposed answer for a scientific question

- must be specific and testable
- experiments test hypotheses

Question

Research



Testable

Variables

Scientific Theory

explains a wide range of observations and experimental results

- supported by a wide range of scientific evidence
- theories can change based on new evidence

Scientific Law

a statement of fact that defines relationships that are valid everywhere in the universe

- generally accepted to be true and universal
- examples: law of gravity, law of conservation of mass

Types of Investigations

Descriptive

describes or quantifies a natural system

- has a question, procedures and a conclusion
- used when little is known about the topic
- no hypothesis

Key Words: observe, describe, list, and identify

Example

observing cells under a microscope and diagramming what is seen

Types of Investigations

Comparative

collects data over different objects, organisms or conditions (ex: time of year

- has a question, hypothesis, procedures and a conclusion
- can have variables
- no control

Key Words: compare/contrast, similarity/difference, categorize

Example

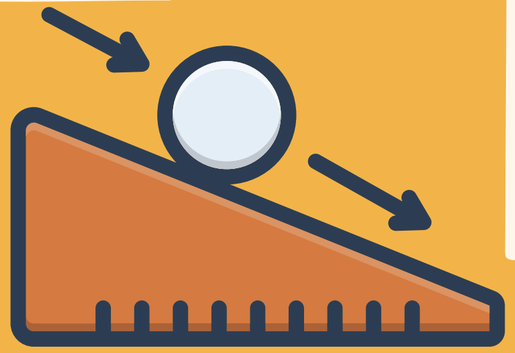
Comparing bear diets and eating frequencies during different seasons

Types of Investigations

Experimental

"fair test", variables are manipulated, controlled and measured to gather evidence to support/refute a relationship

- has a question, hypothesis, procedures, control and a conclusion
- variables identified
- all factors are held **constant** except the manipulated variable



Example

testing the height of a ramp to determine how far a marble will roll

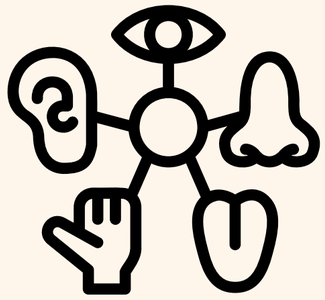
Two Types of Data

1

Qualitative

descriptions in words of what is being observed

Think of your 5 senses



2

Quanitative

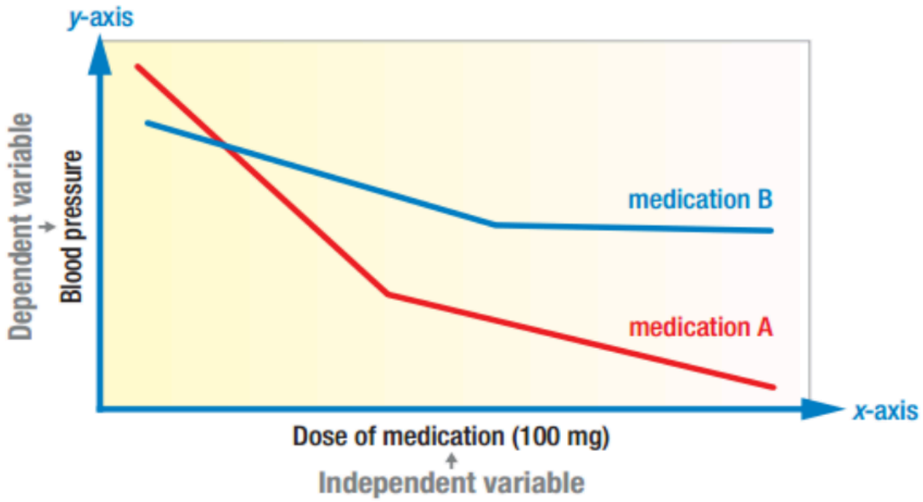
analyzes results using numerical values

Height, weight, age

Experimental Setup

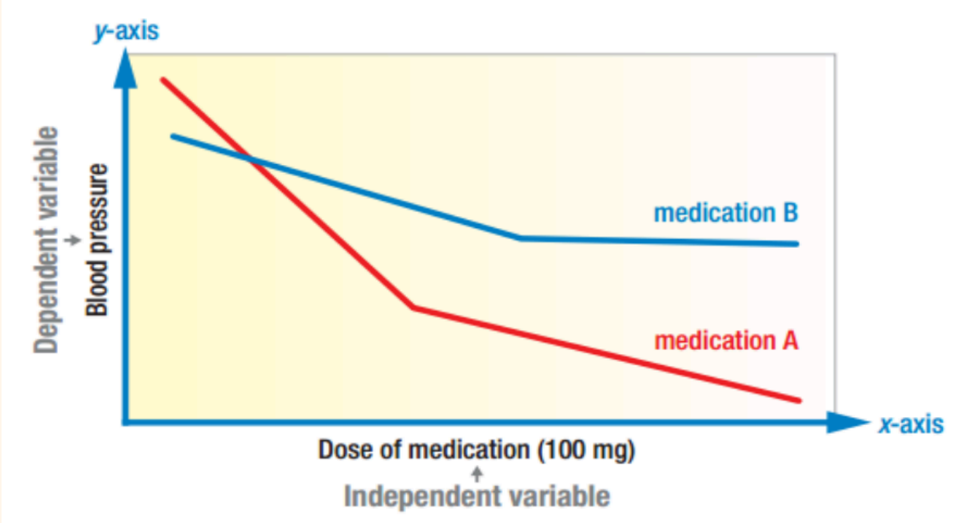
- **independent variables** are manipulated/changed (X-axis)
- **dependent variables** are observed and measured (Y-axis)
- **constants** are conditions that are kept the same
- the **control** is not changed but used for comparison

This graph compares the effects of the same dosage of two different medications on blood pressure. The independent variable (dosage) stayed the same for each type of medication tested.



Experimental Setup

- independent variable
- dependent variable
- constants
- control group



This graph compares the effects of the same dosage of two different medications on blood pressure. The independent variable (dosage) stayed the same for each type of medication tested.

Are student test scores impacted by the amount of noise in the room?

independent variable	noise
dependent variable	test scores
control	classroom with no noise
constant	same room, same test, same temp, same age
what type of data is collected?	quantitative

Will different solutions (penny, asprin, bleach) keep flowers in a vase alive longer?

independent variable	type of solution
dependent variable	days alive
control	plain water
constant	sunlight, temp, type of flower, water amount
what type of data is collected?	quantitative

Graphing Checklist

- **T** Title
- **A** Axis
- **L** Labels
- **K** Key
- **S** Scale/Spacing

Title

THE TITLE SHOULD TELL THE VIEWER WHAT THE GRAPH/DATA IS ACTUALLY SHOWING.

IT SHOULD **NOT** SAY LAB, GRAPH, OR EXPERIMENT

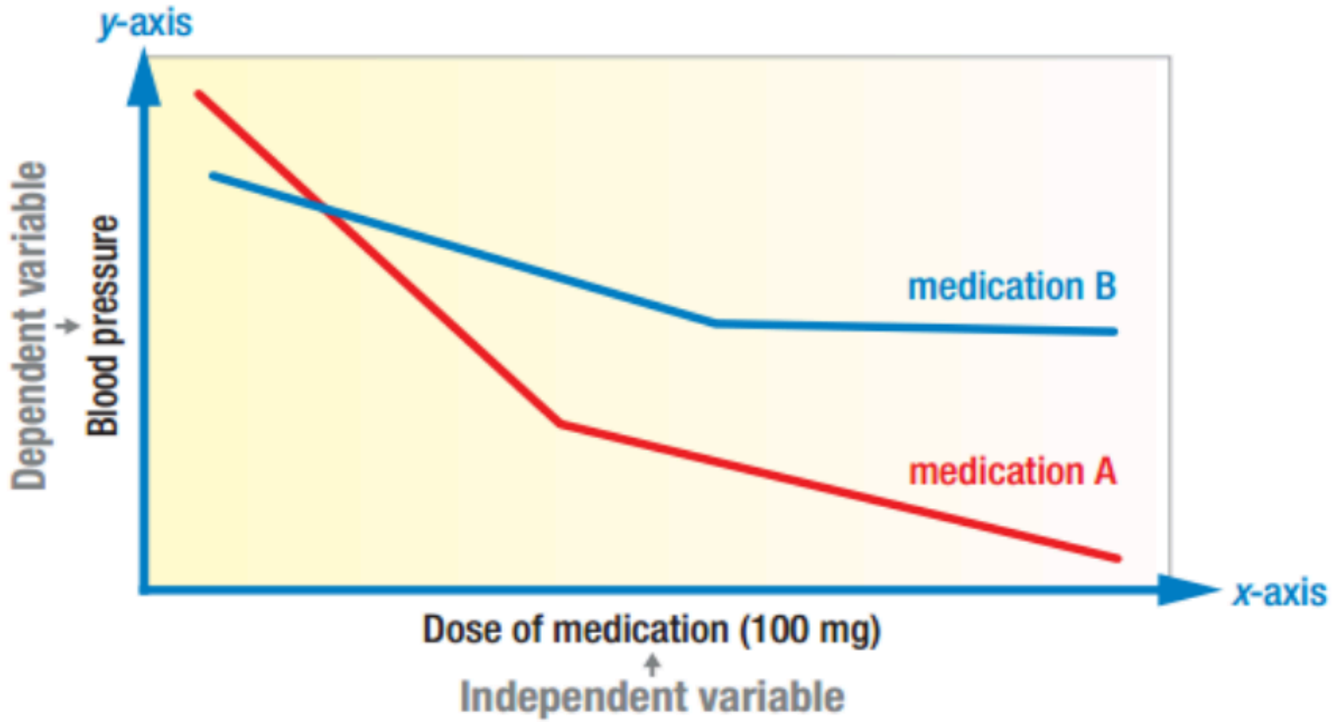
EX:

"THE EFFECT OF _____ ON _____"

"THE CHANGE IN _____ OVER TIME"

WHAT WOULD YOU CALL THIS GRAPH?

This graph compares the effects of the same dosage of two different medications on blood pressure. The independent variable (dosage) stayed the same for each type of medication tested.



A

Axis

THE **INDEPENDENT** VARIABLE GOES ON THE **X-AXIS**

THE **DEPENDENT** VARIABLE GOES ON THE **Y-AXIS**

D = dependent

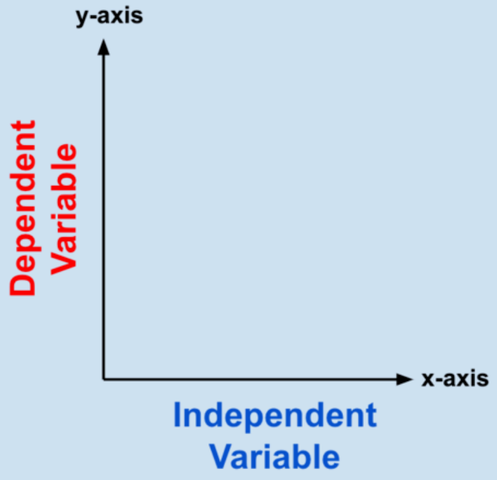
R = responding

Y = y-axis

M = manipulated

I = independent

X = x-axis



Labels

LABEL ALL AXES WITH THE VARIABLE THAT GOES WITH IT

INCLUDE UNITS!

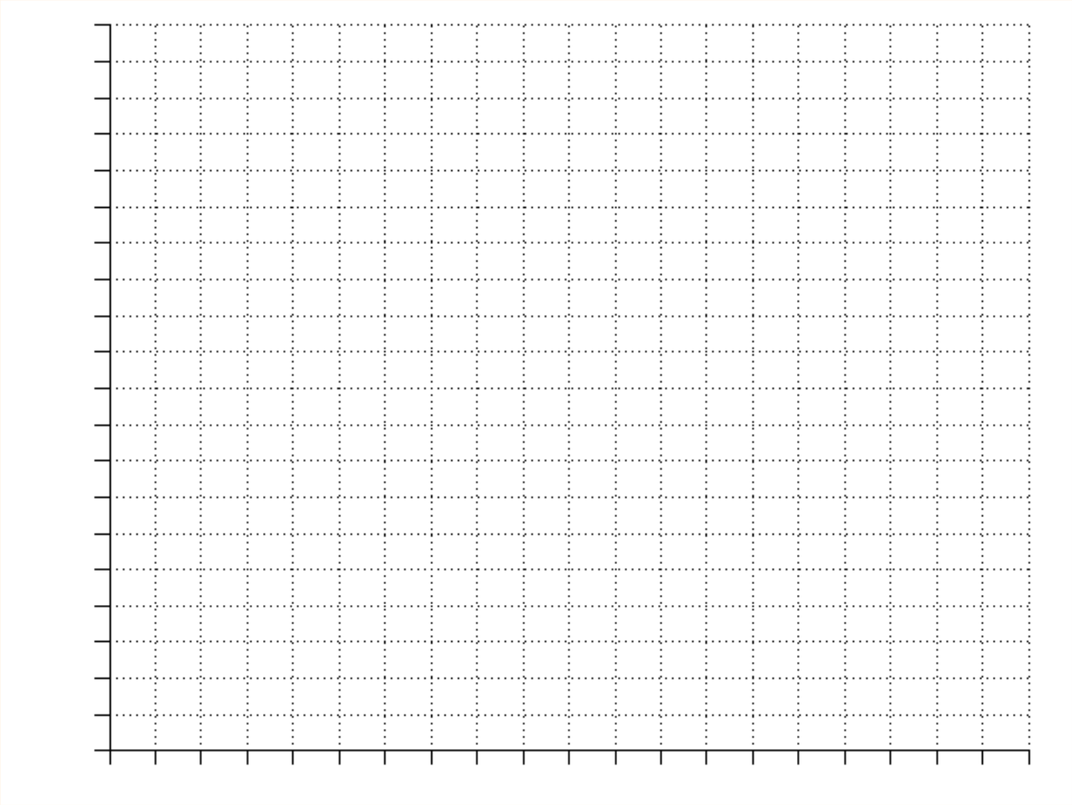
ALWAYS LABEL ZERO, EVEN IF YOU DON'T GRAPH ZERO

GROUP PRACTICE

WHAT IS ON THE X-AXIS AND Y-AXIS?

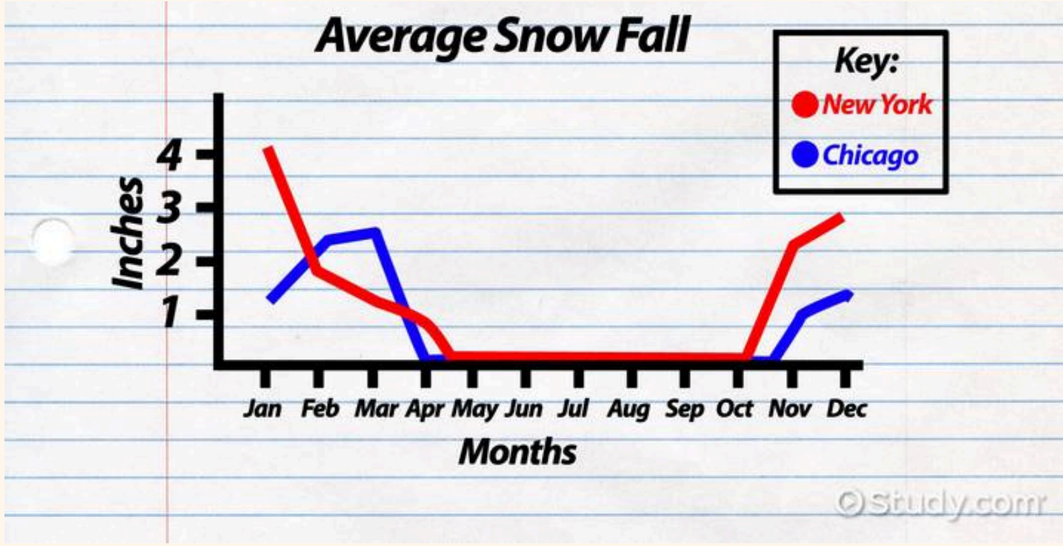
Experiment: What is the effect of different fertilizers on plant height?

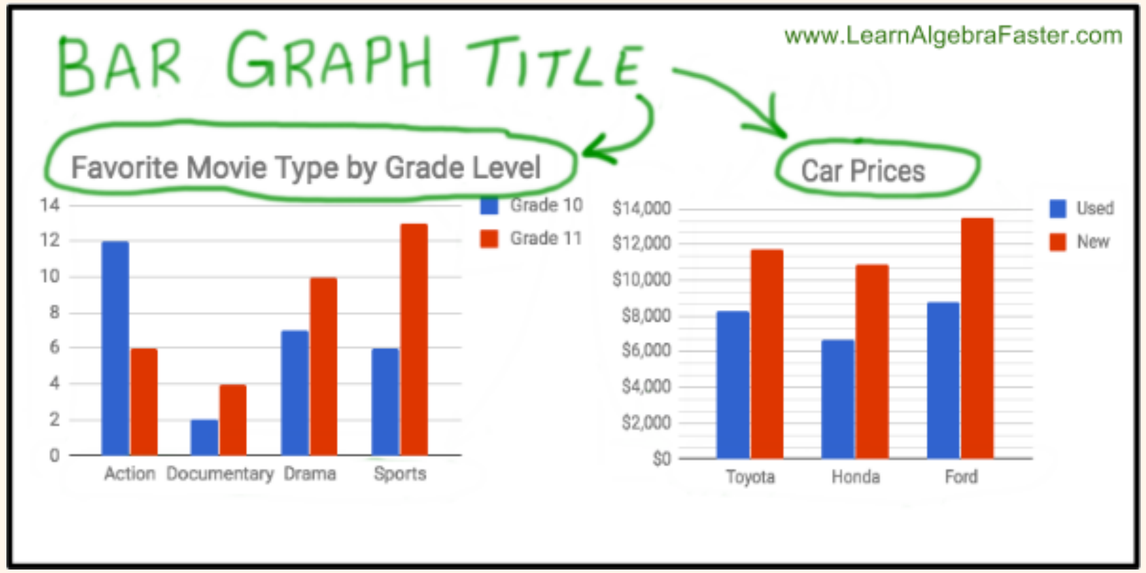
Fertilizer	Height after 3 weeks
Miracle Gro	17 cm
Germination Giant	9 cm
GroPro	13 cm
Feed Me, Seymour	4 cm



Key

FOR LINE GRAPHS WITH MULTIPLE LINES OR BAR GRAPHS

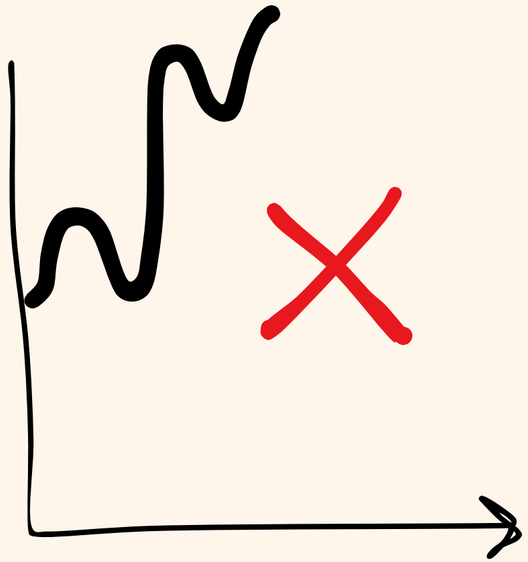


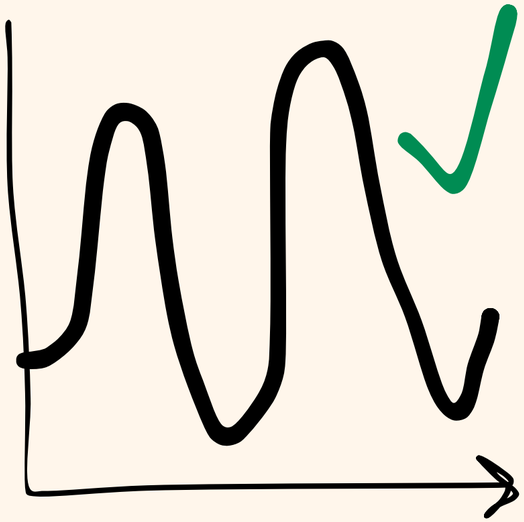


S Scale/Spacing

PLAN AHEAD!
THE GRAPH SHOULD TAKE UP AT LEAST 50% OF THE PROVIDED GRID.

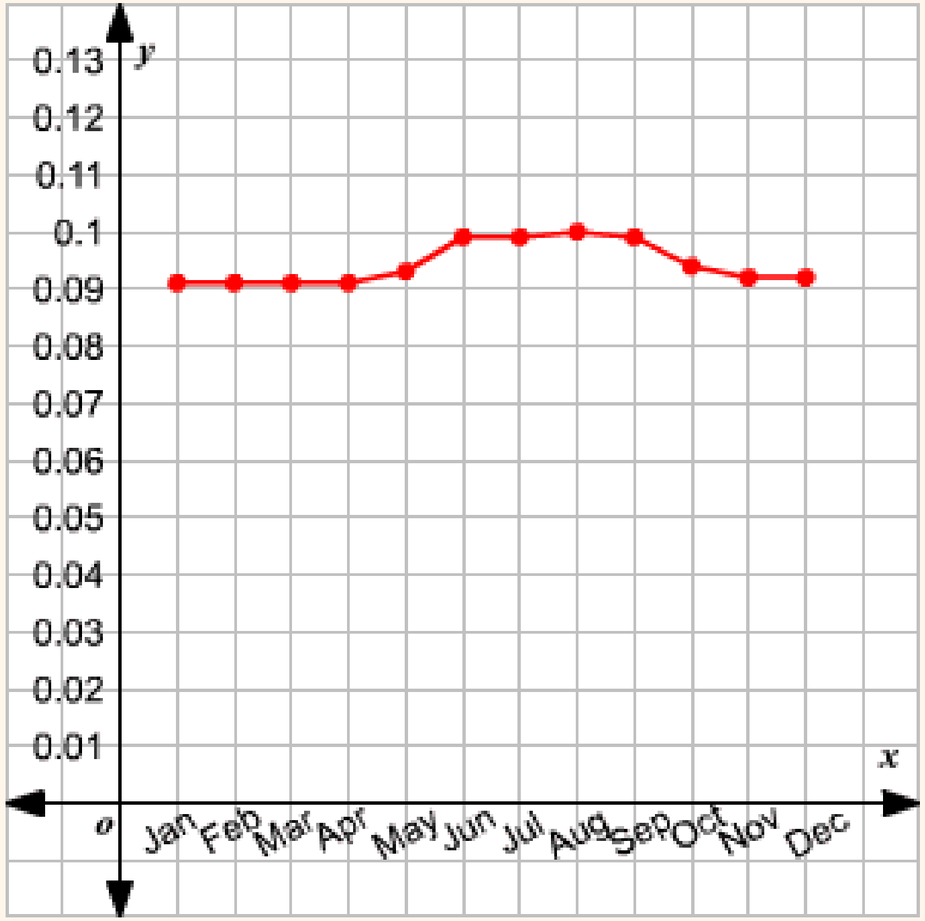
THE GRAPH SHOULD NOT GO OUTSIDE OF THE GRID SPACE.

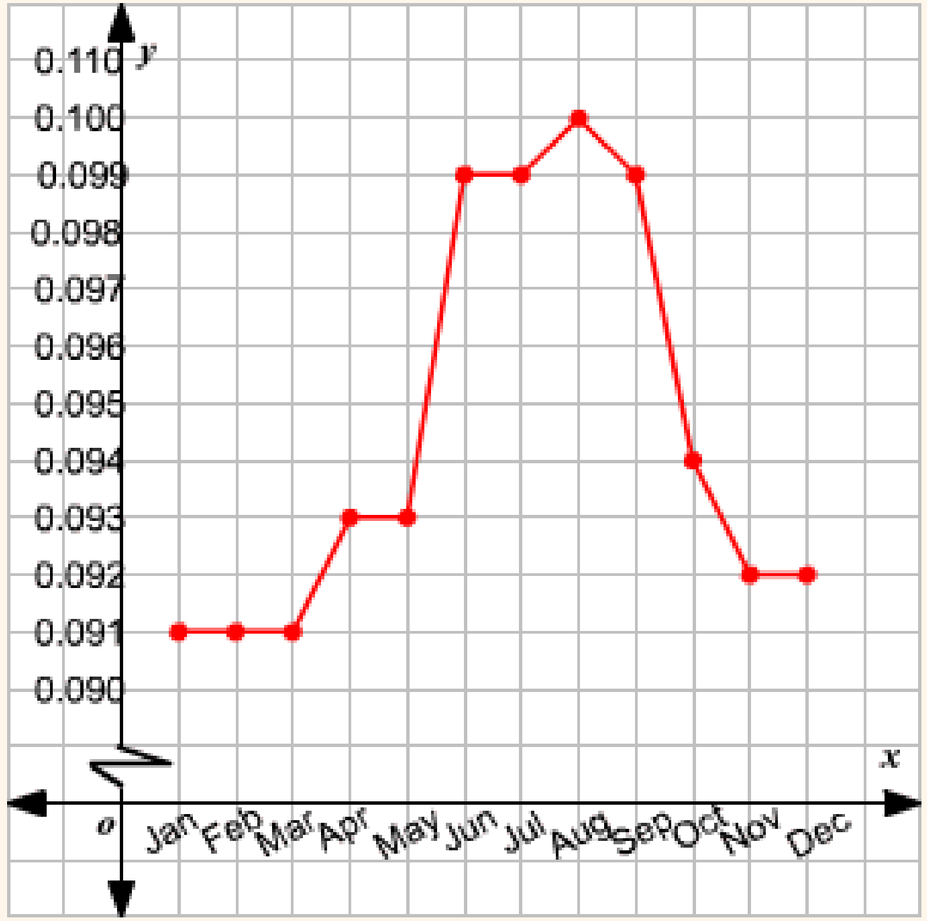




HINT: IF YOU NEED TO SKIP A LARGE SET OF NUMBERS, DRAW A ZIGZAG ABOVE ZERO ON THE AXIS TO SHOW YOU SKIPPED NUMBERS, THEN BEGIN YOUR SCALE.

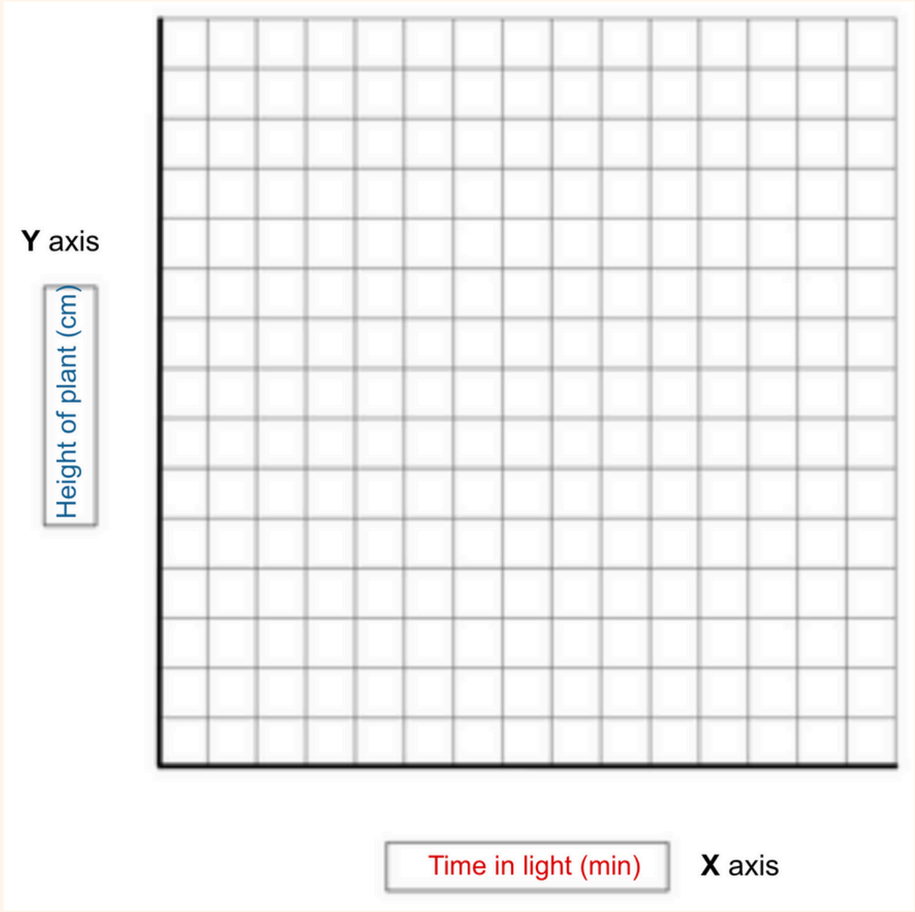
BEFORE





AFTER

Make a line graph

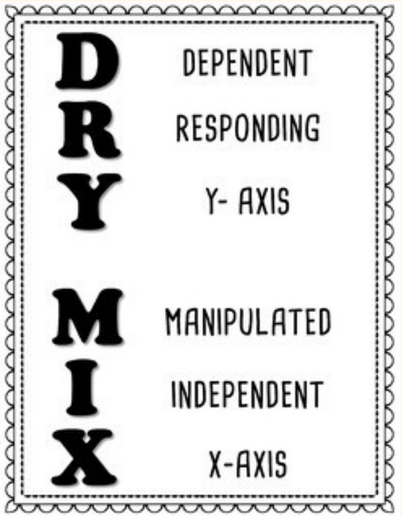


Time in Sunlight (min)	Height of the plant (cm)
5	2
10	4
15	7
20	8
25	10
30	12
35	15

Should you graph (0,0)?

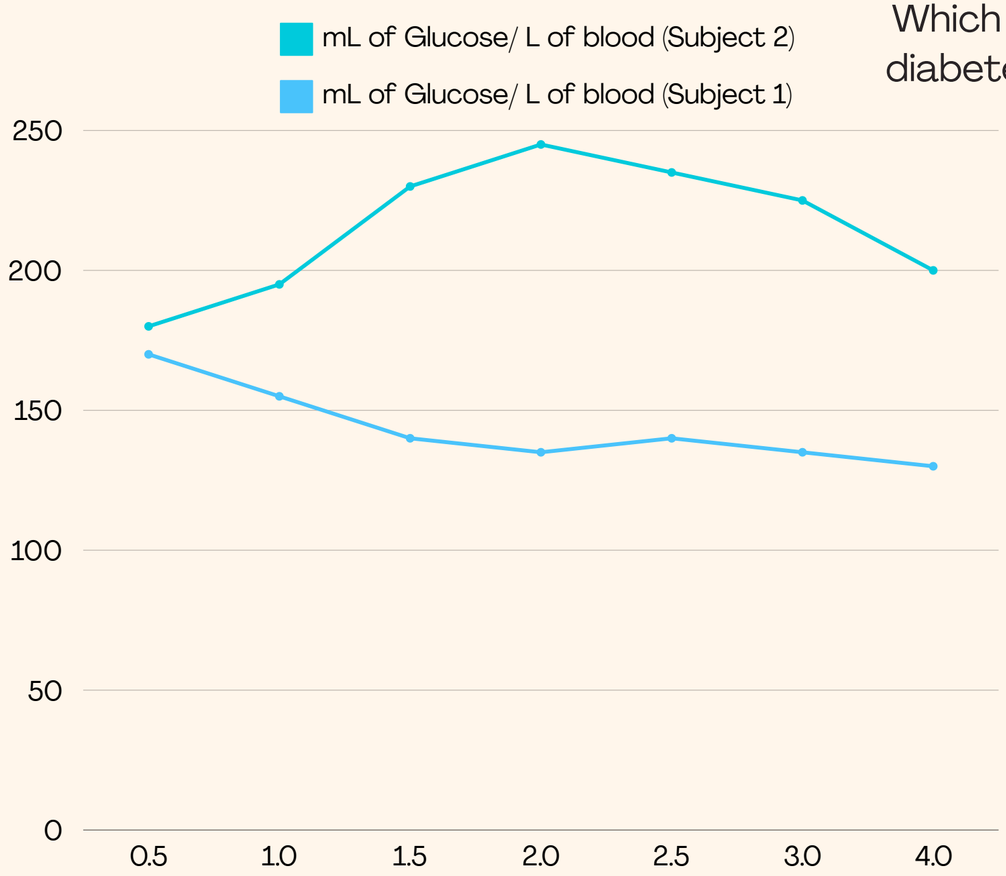
Try it on your own!

Diabetes is a disease affecting the insulin producing glands of the pancreas. If there is not enough insulin being produced by these cells, the amount of glucose in the blood will remain high. A blood glucose level above 140 for an extended period of time is not considered normal. This disease, if not brought under control, can lead to severe complications.



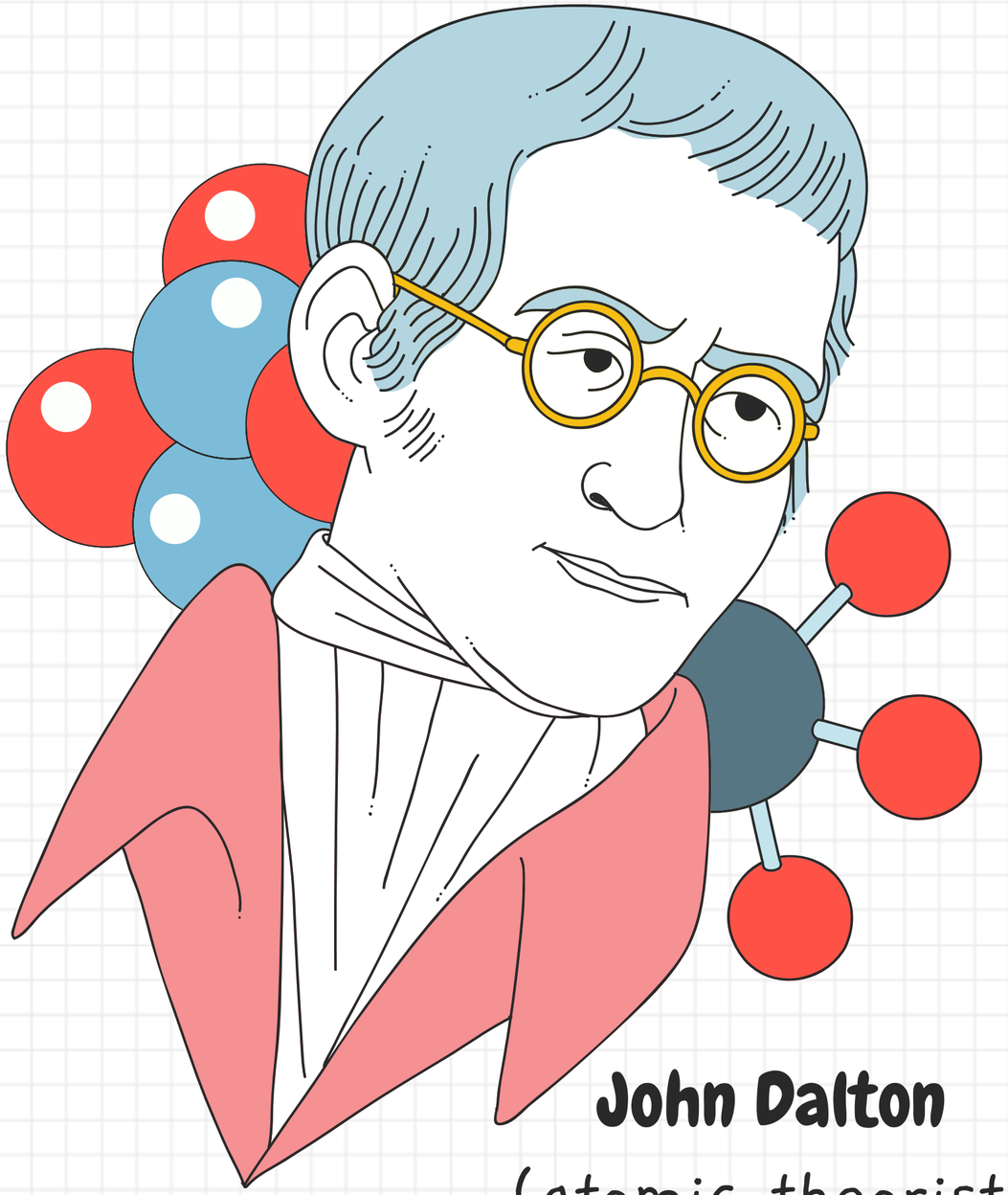
Time after eating (Hrs)	mL of Glucose / L of blood Subject A	mL of Glucose / L of blood Subject B
0.5	170	180
1	155	195
1.5	140	230
2.0	135	245
2.5	140	235
3	135	225
4	130	200

Make a line graph



What should the title of the graph be?
Independent Variables?
Dependent Variables?
Which subject has diabetes and why?

Time after eating (**Hrs**)	**mL of Glucose** / **L of blood Subject A**	**mL of Glucose** / **L of blood Subject B**
0.5	170	180
1	155	195
1.5	140	230
2.0	135	245
2.5	140	235
3	135	225
4	130	200

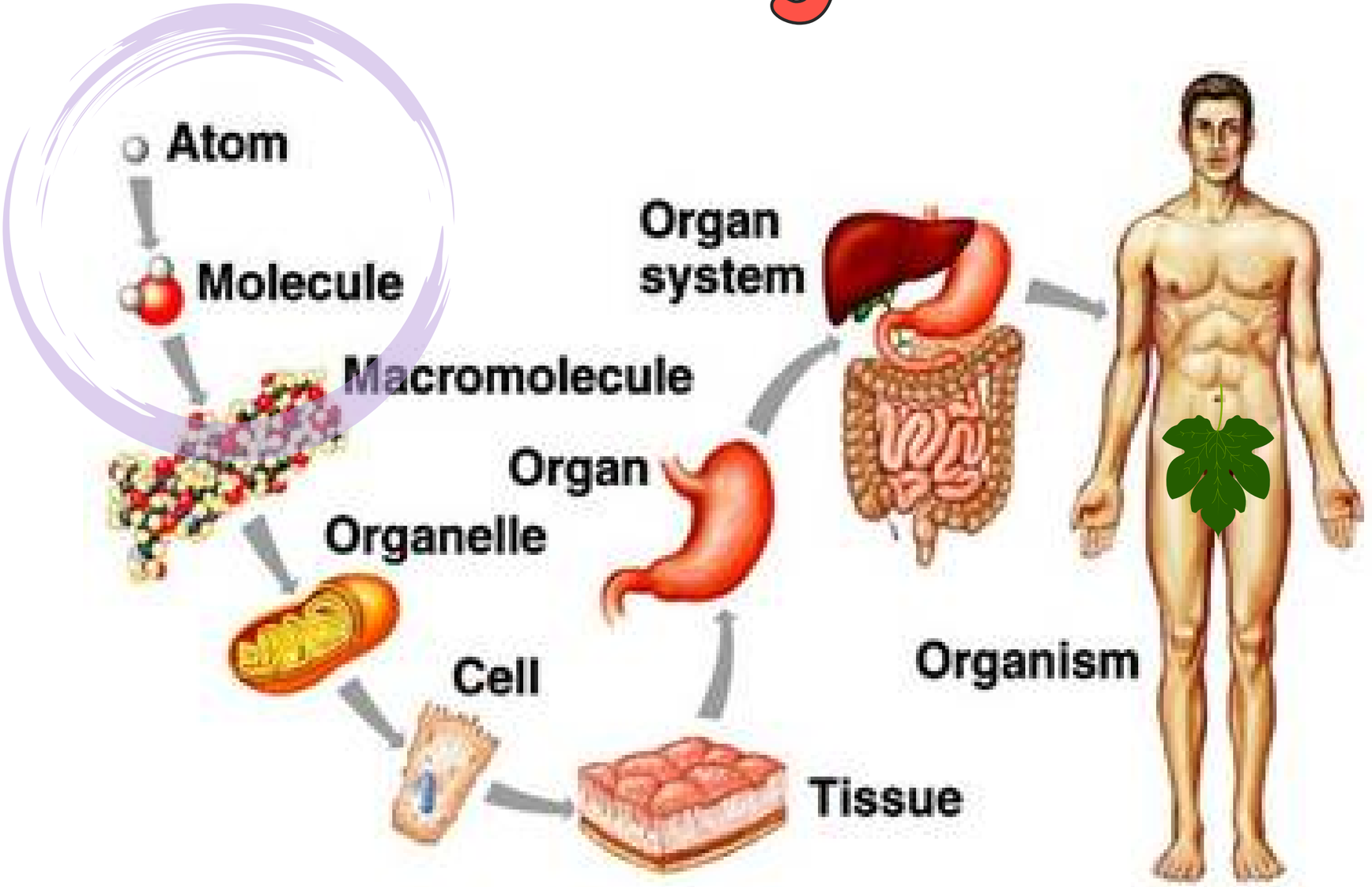


John Dalton

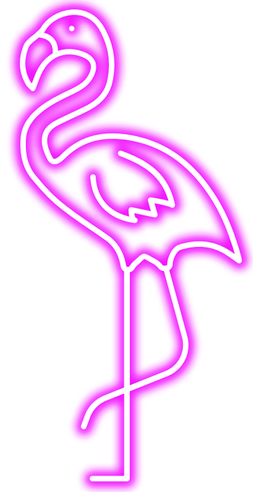
(atomic theorist)

Atoms & Molecules

Levels of Organization



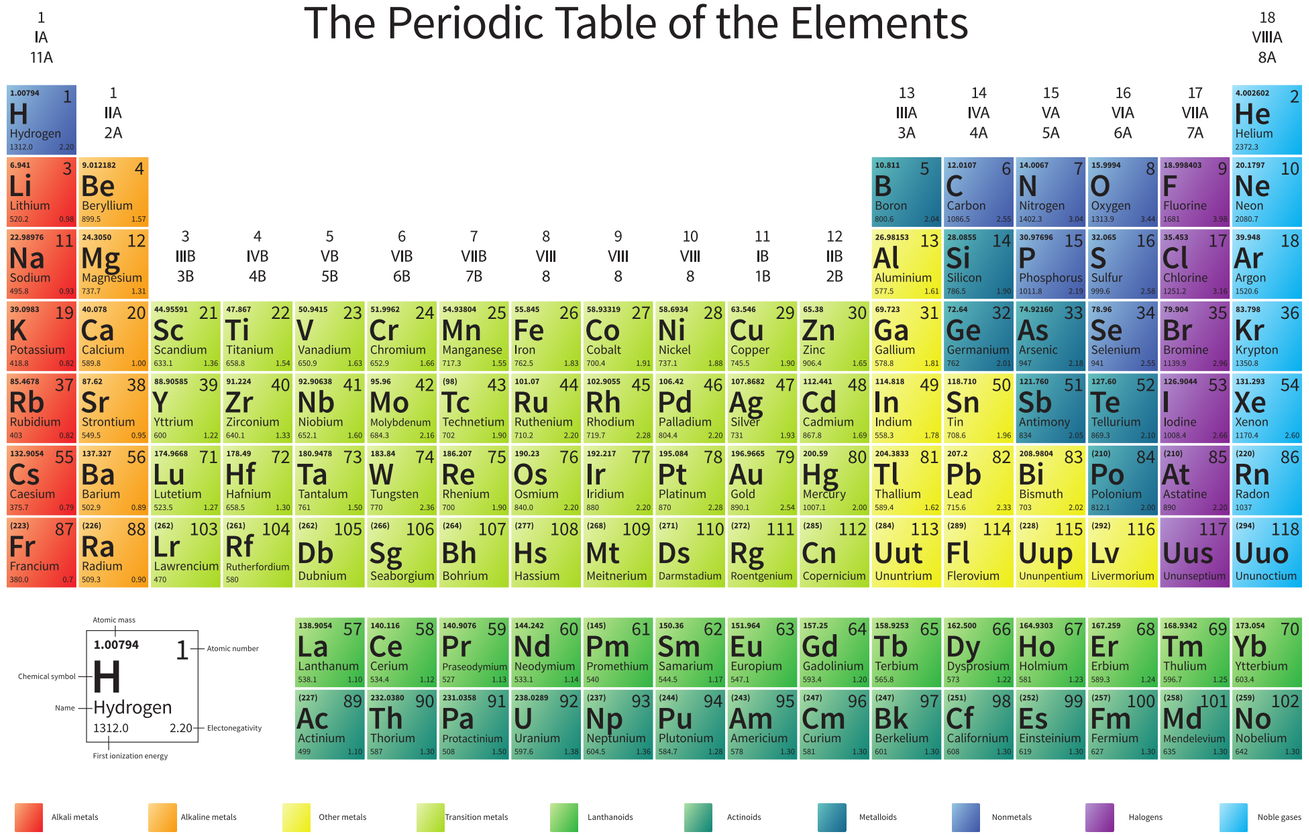
Do you know these Elements?



What are Elements?

An element is a pure substance that cannot be broken down into simpler chemical substances

The Periodic Table of the Elements



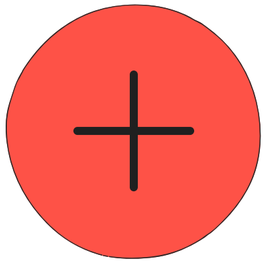
Major elements in the Human Body

Element	symbol	% of human body
oxygen	O	65%
carbon	C	18.5%
hydrogen	H	9.5%
nitrogen	N	3.2%

Atom and its Structure

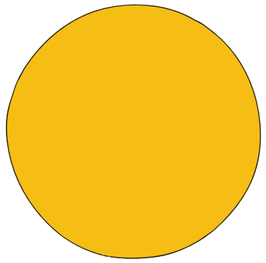
An atom is the basic unit of matter and the smallest particle of an element that retains its properties. Atoms are made up of three types of subatomic particles: protons, neutrons, and electrons.

Proton



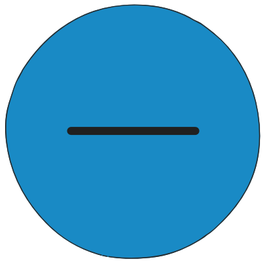
Protons are positively charged particles located in the nucleus (center) of the atom

Neutron



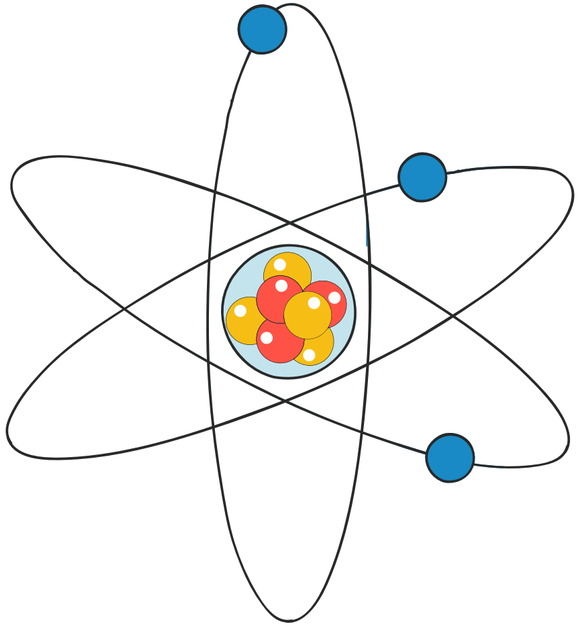
Neutrons are neutrally charged particles also located in the nucleus.

Electron

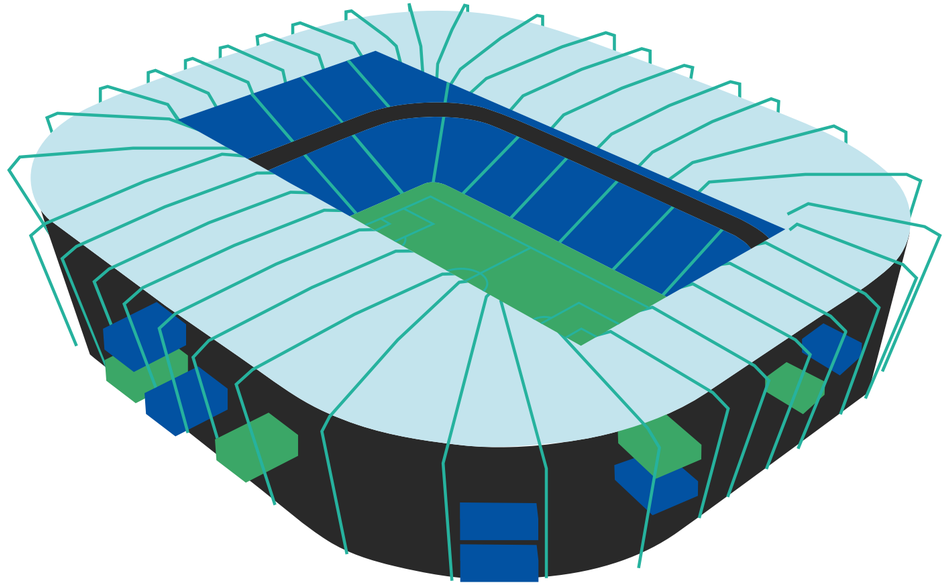


Electrons are negatively charged particles that orbit around the nucleus in energy levels.

Atom facts

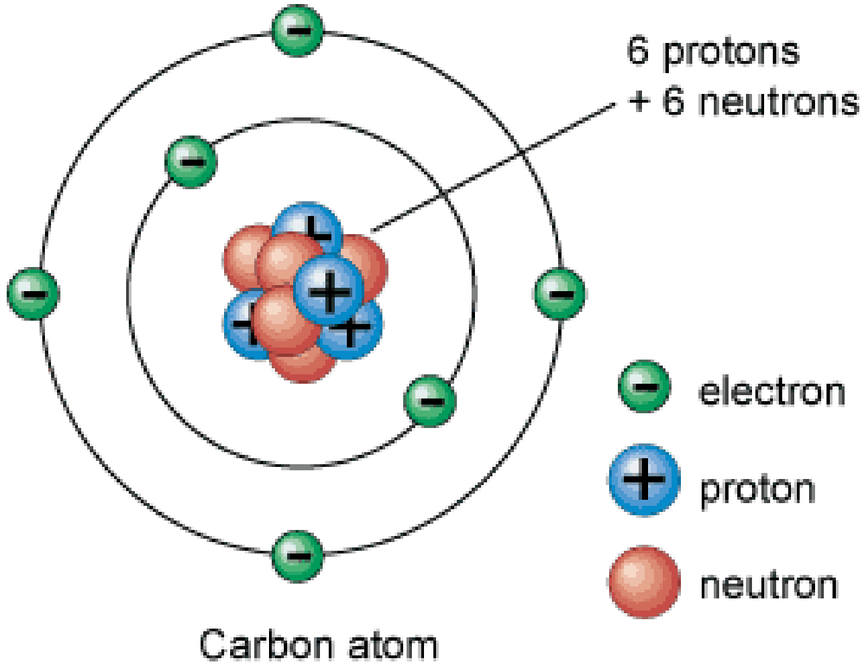


The nucleus of an atom is actually about 100,000 times smaller than the overall size of the atom.



In perspective, if we imagine an atom were the size of a stadium, the nucleus would be smaller than a grain of sand.

What is the overall charge of this atom?



How many protons? 6

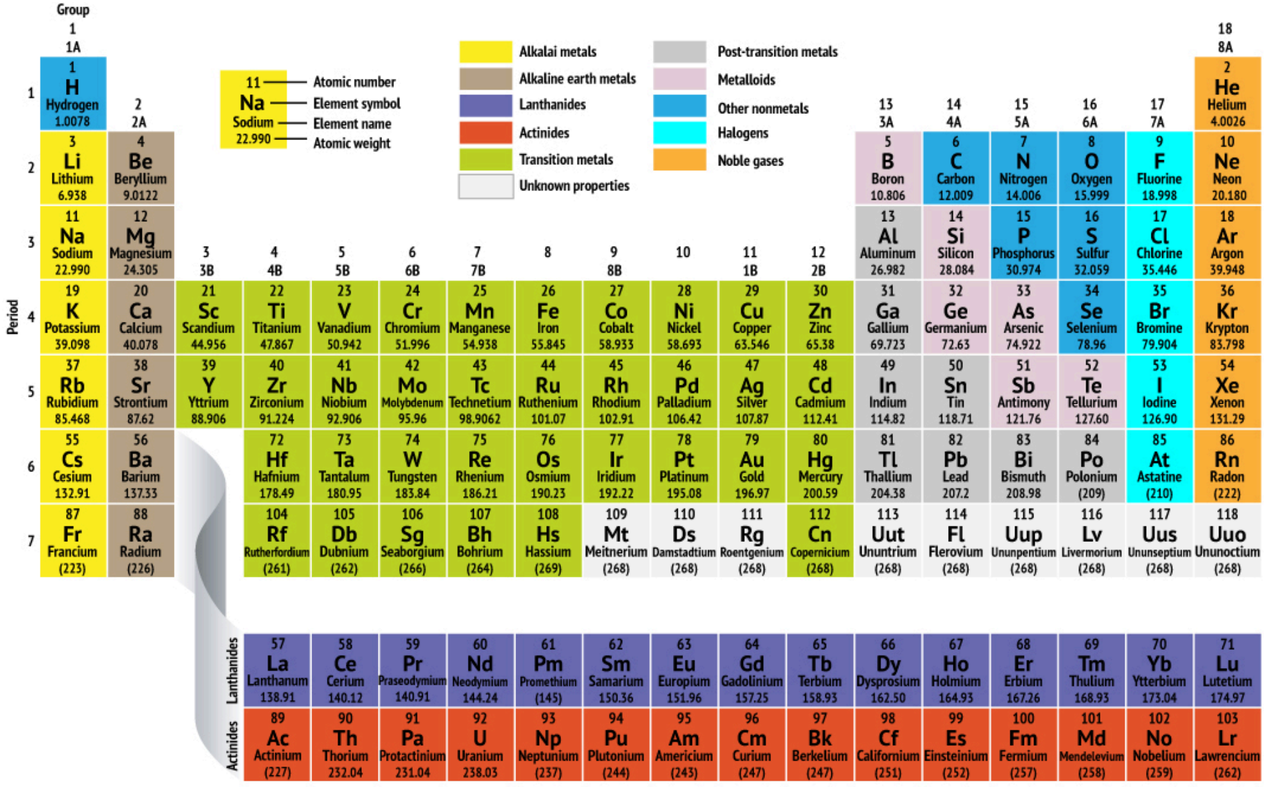
How many neutrons? 6

How many electrons? 6

Zero! (+6) + (−6) = 0

Reading the periodic table of elements

Periodic Table of the Elements



SOURCES: National Institute of Standards and Technology, International Union of Pure and Applied Chemistry

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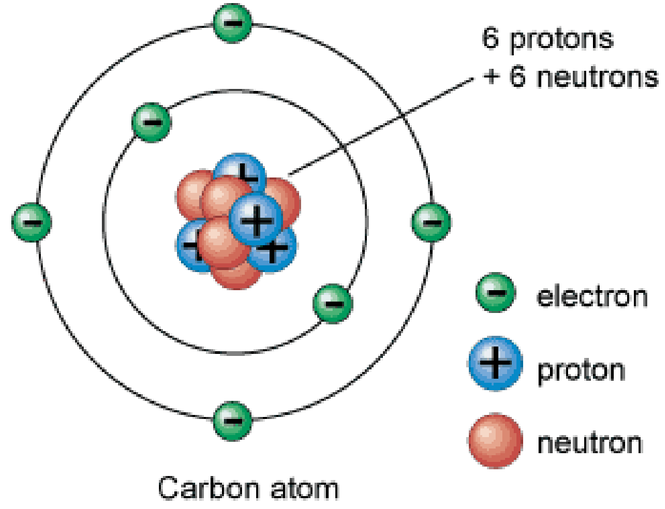
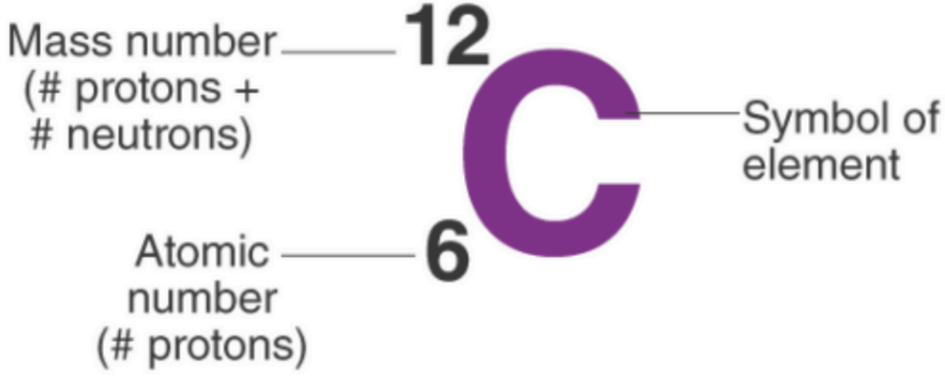
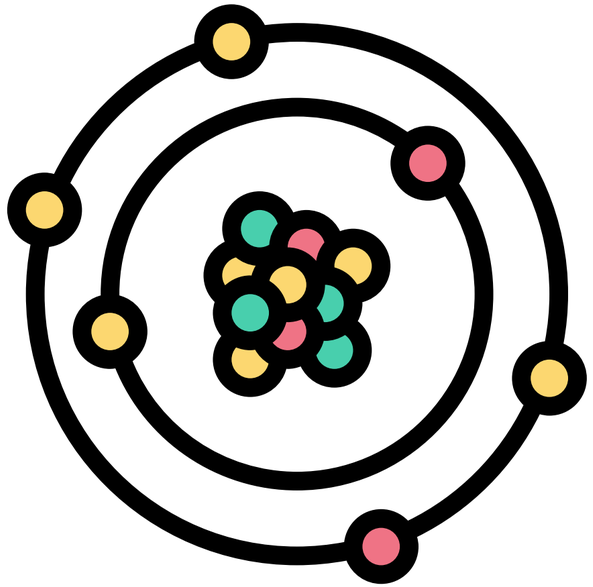


Carbon atom



What are valence electrons?



The number of electrons in the outermost energy level/orbital

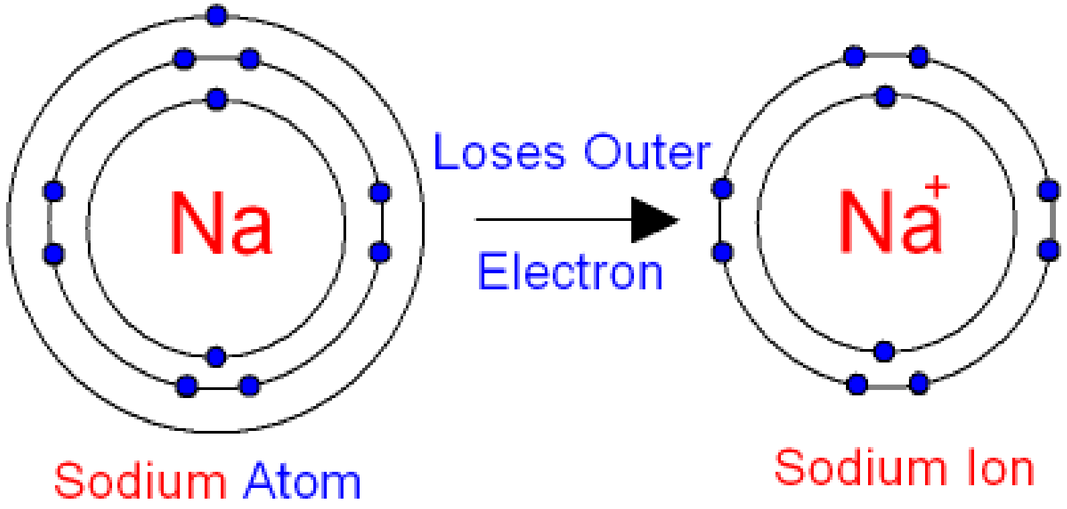
These electrons form bonds with other atoms to form molecules

How many valence electrons are in this atom?

4

8 electrons in the outer orbital is the happy, balanced number

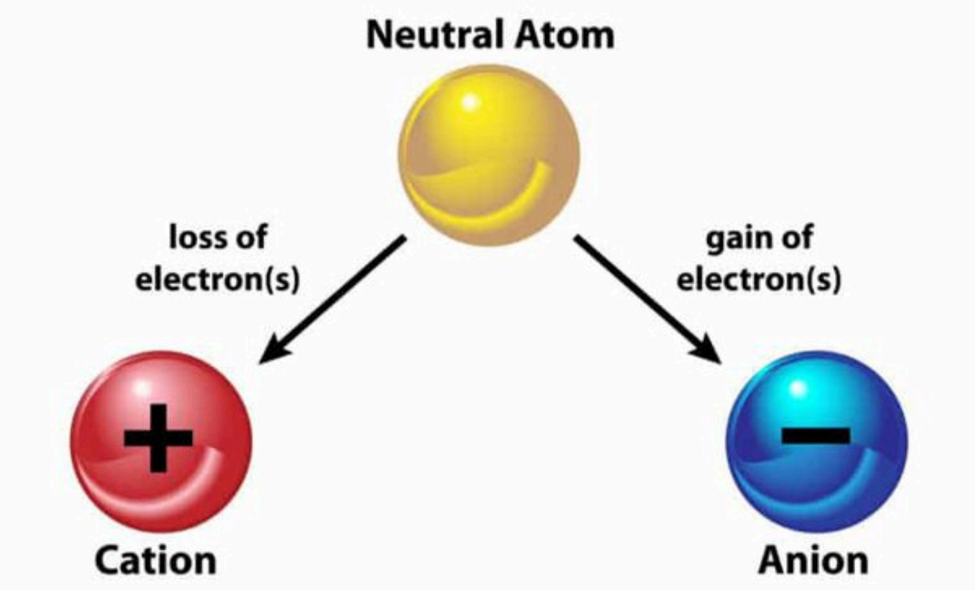
ions



an atom that has gained or lost one or more valence electrons and now carries a "charge"

positive ion lost electron

negative ion gained electron



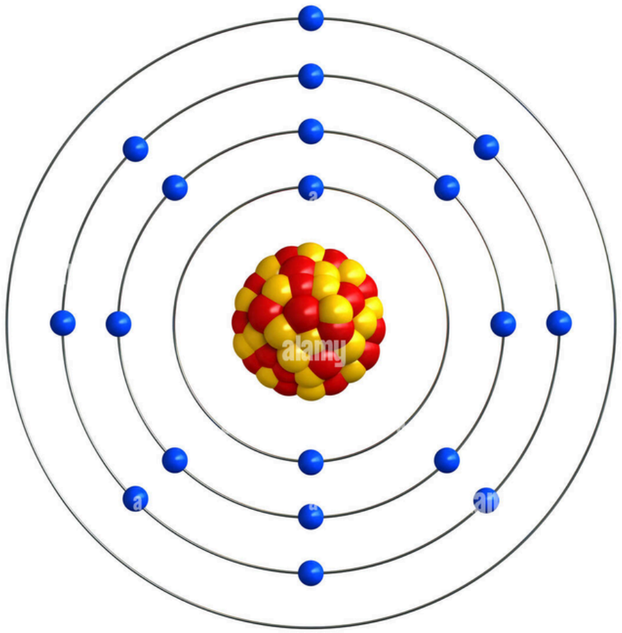
try it

Q: Potassium (K) is element 19 on the periodic table. When K forms an ion, it becomes K+1. How is K+1 different from K?

A: K carries no charge and is neutral (equal protons+ and electrons-)

K+1 carries a charge of +1 meaning that it lost one electron.

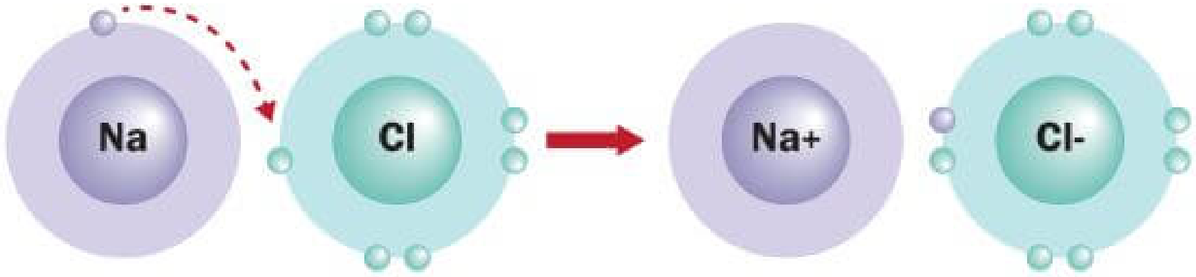
(+19 + -18 = +1)



Ionic Bonds

form when one atom TAKES an electron away from another atom

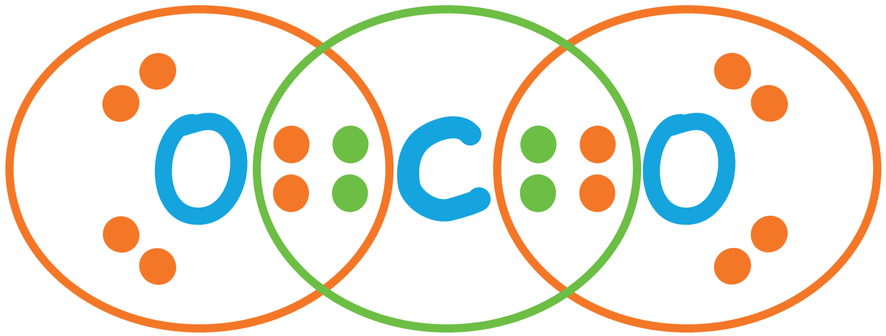
- created by oppositely charged ions
- easily broken apart by water
- ex: table salt (NaCl)

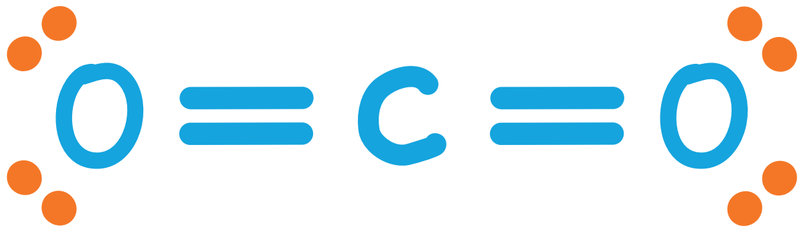


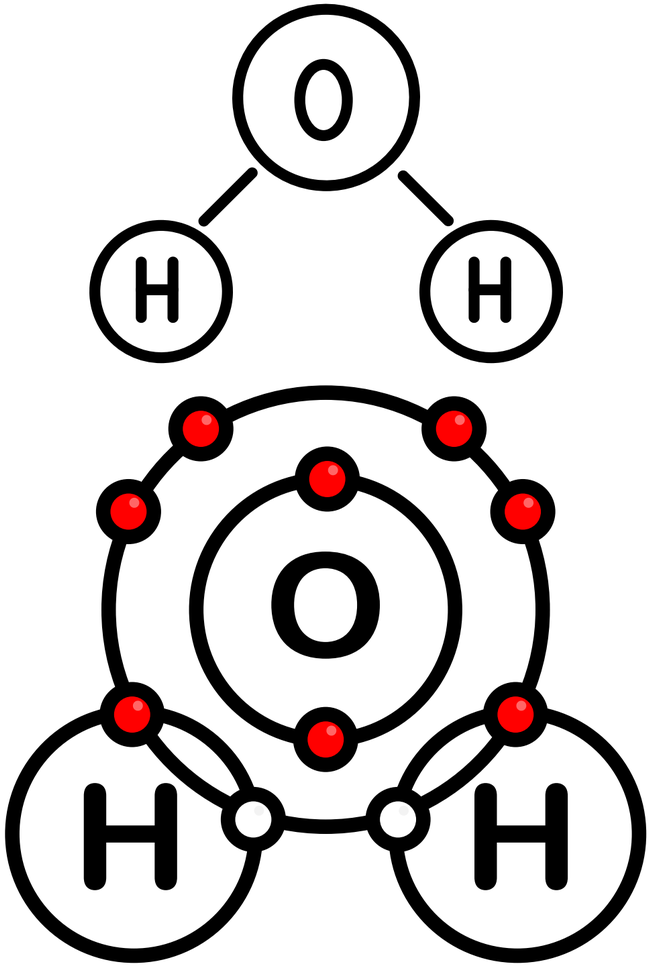
Covalent Bonds

form when atoms SHARE a pair of electrons

- strong 💪
- NOT easily broken apart by water
- ex: water (H_2O) carbon dioxide (CO_2)



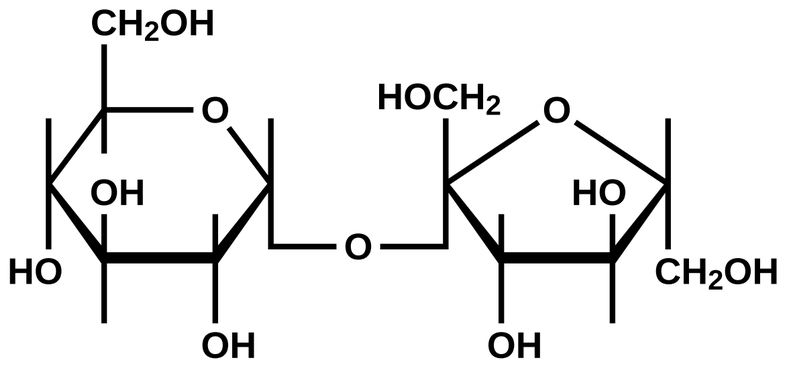




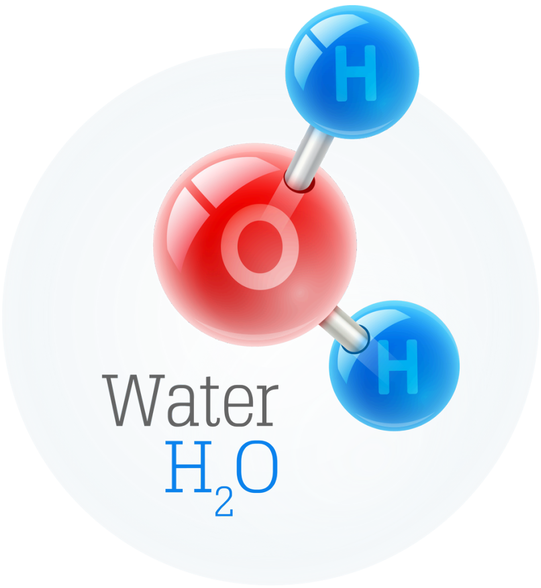
Molecule (molecular compound)

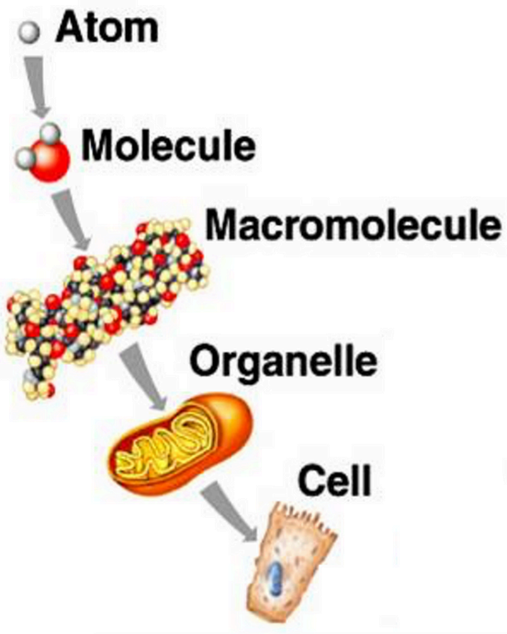
two or more atoms held together by covalent bonds

- stable
- does not **dissociate** (break apart) in water
- ex: CO2, H2O, **DNA, proteins, lipids (biomolecuels)**



sucrose (table sugar)





molecules

share electrons

held together with covalent bonds

strong bond

do not dissociate in water

ionic compounds

do not share electrons

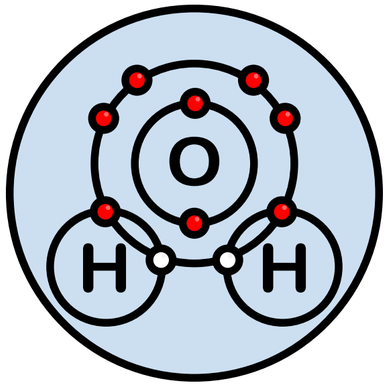
held together with ionic bonds

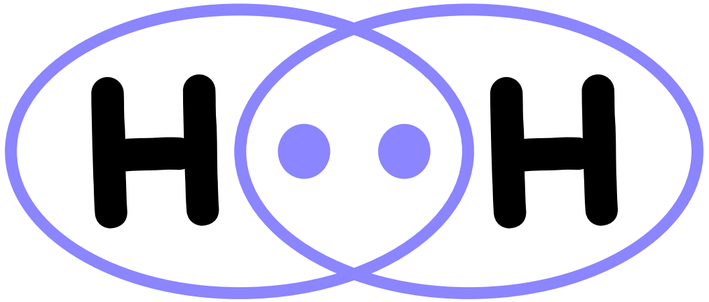
strong bond

dissociate in water

Biological significance of

Covalent Bonds





nearly all substance that make up living things use covalent bonds, because they do NOT break apart in water

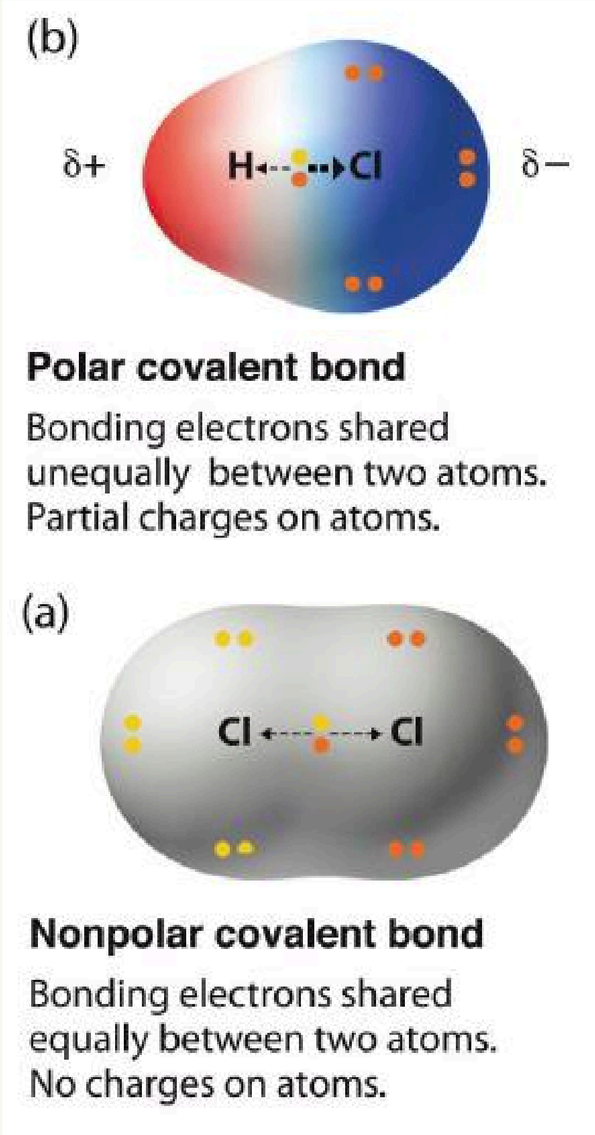
- carbohydrates (sugars)
- lipids (fats)
- proteins
- nucleic acids (DNA)

PROPERTIES OF WATER

Polar vs. Nonpolar Molecules

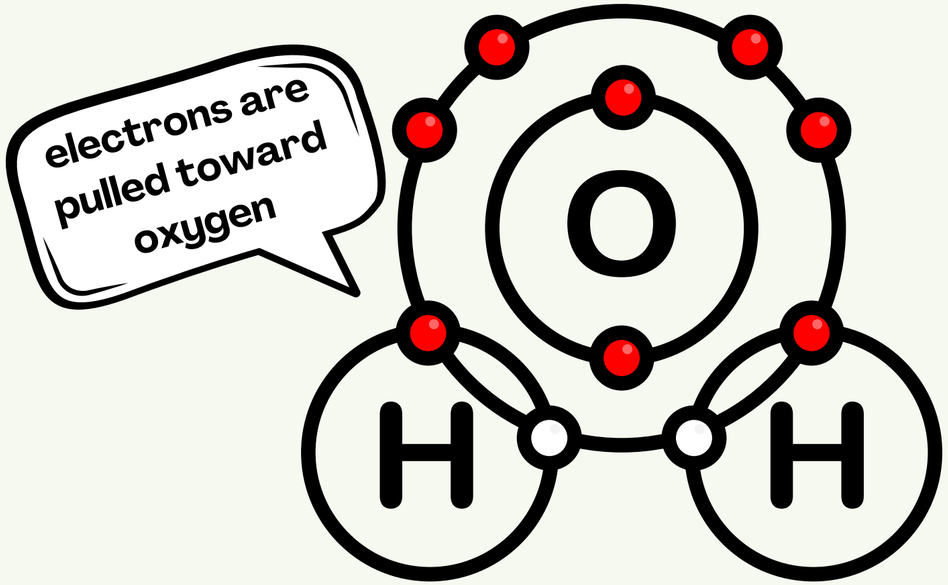
Polar:
has a positive and a negative end, like a magnet

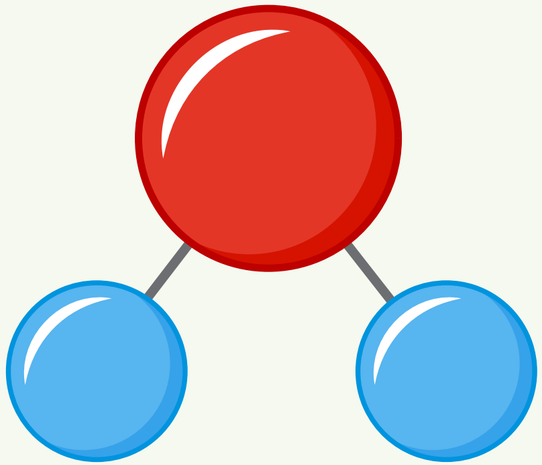
Nonpolar:
a molecule that is electrically neutral (not positively or negatively cahrged)



Water is a POLAR MOLECULE

the oxygen atom exerts a greater pull on the electrons, making oxygen slightly negative and the hydrogen atoms slightly positive

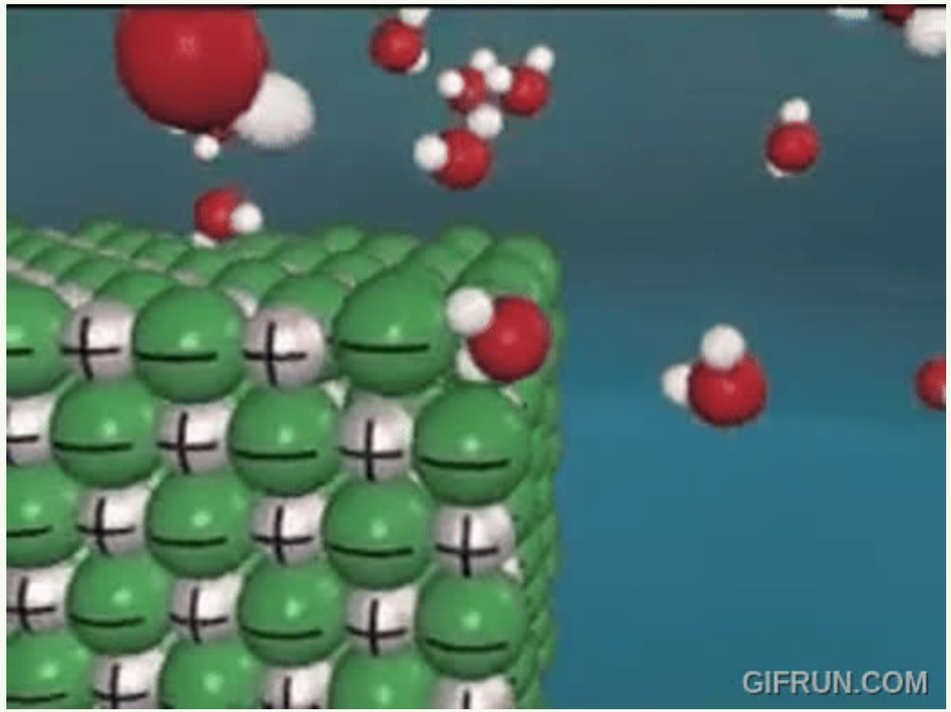


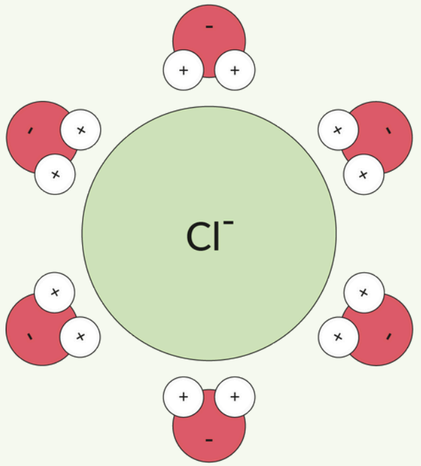


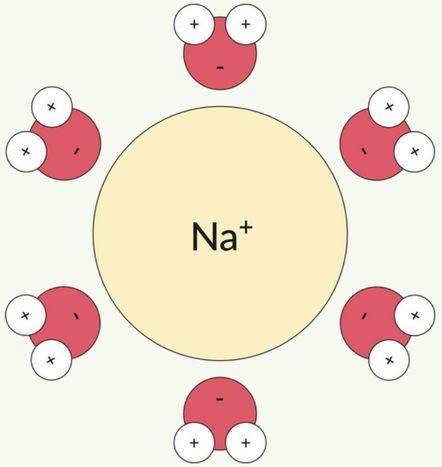
Water as a solvent

water causes ionic compounds to dissociate, or break apart

- the negative oygen atoms are attracted to the Na+
- the positive hydrogen atoms are attracted to the Cl-



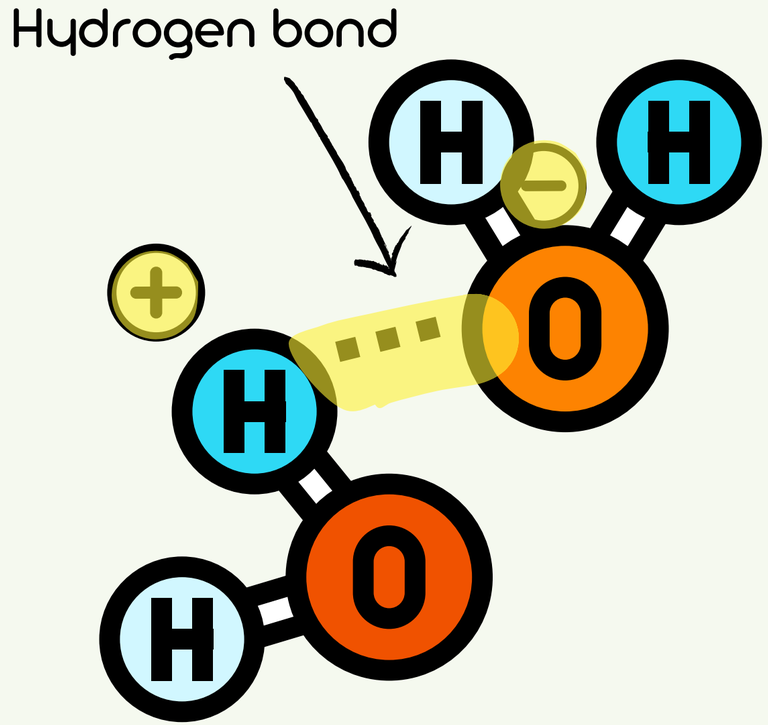




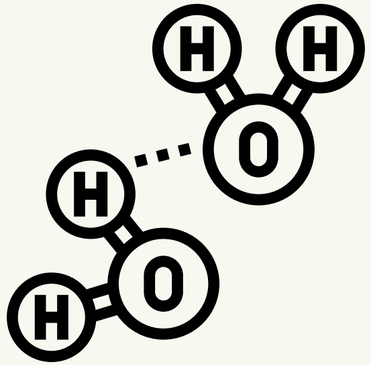
What is Hydrogen bonding?

an attraction between a slightly positive hydrogen atom and a slightly negative atom

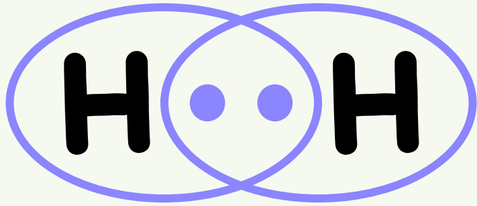
- hydrogen bonds are NOT true bonds
- there is no taking or sharing of electrons (not forming something new)
- like two magnets attracted to each other
- are weak and easily broken



Hydrogen vs Covalent Bonds

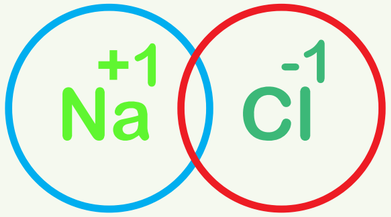


Hydrogen	Covalent
not real bonds	real bonds
attraction between charged molecules	atoms **share** electrons
easily broken	strong



Type of Bonds

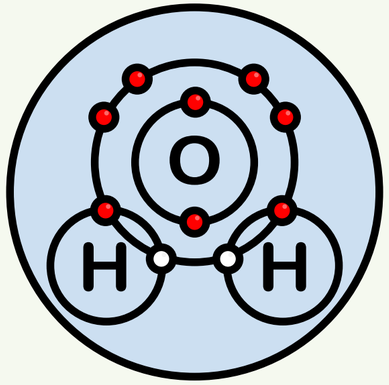
Ionic



*An ion is an atom that has gained or lost one or more electrons. It is now charged

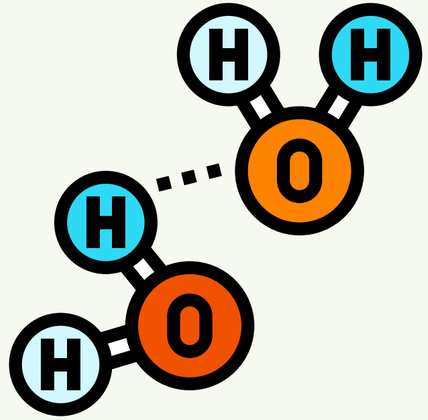
Forms when one atom TAKES an electron away from another

Covalent



forms when atoms SHARE electrons

Hydrogen



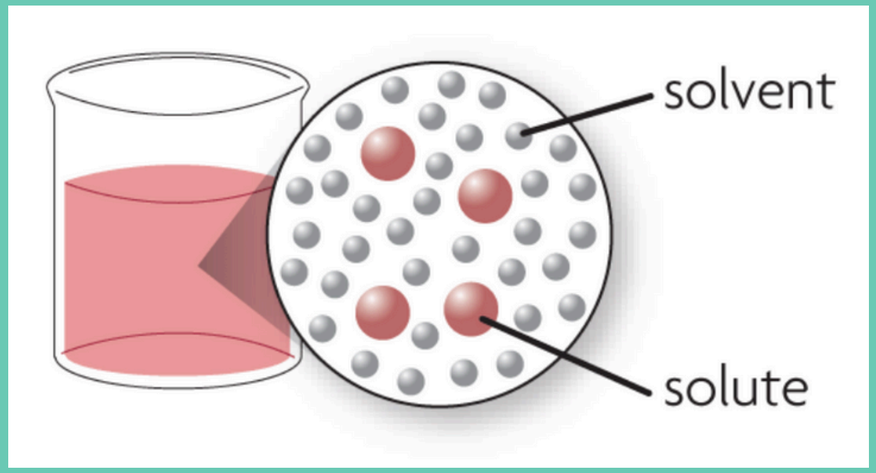
ATTRACTION between molecules; not a real bond

Solution

formed when one substance dissolves in another

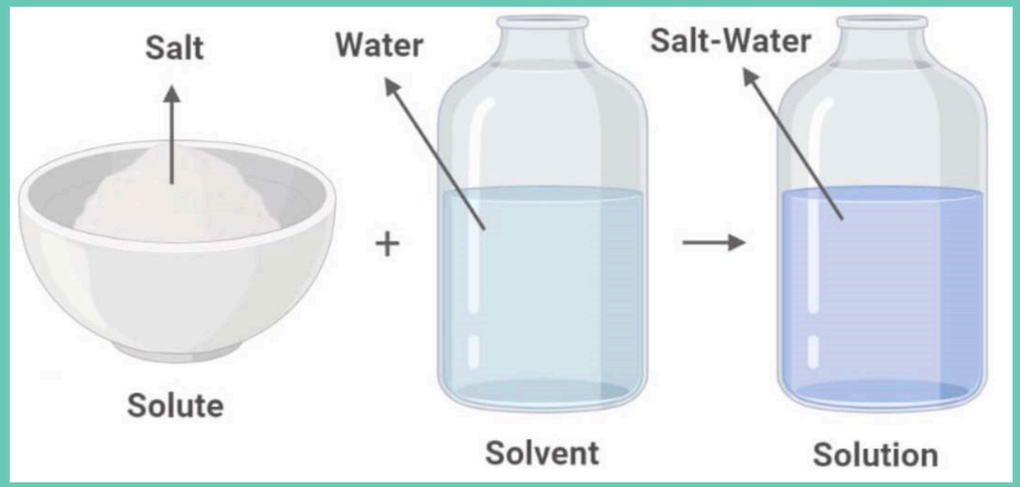
Solvent

dissolves other substances present in greater amounts (ex: water)



Solute

dissolves in a solvent present in smaller amounts (ex: kool-aid)



Like Dissolves Like

POLAR SOLVENTS
DISSOLVE POLAR SOLUTES

NONPOLAR SOLVENTS
DISSOLVE NONPOLAR SOLUTES

do water and oil mix?

THE SIX PROPERTIES OF WATER

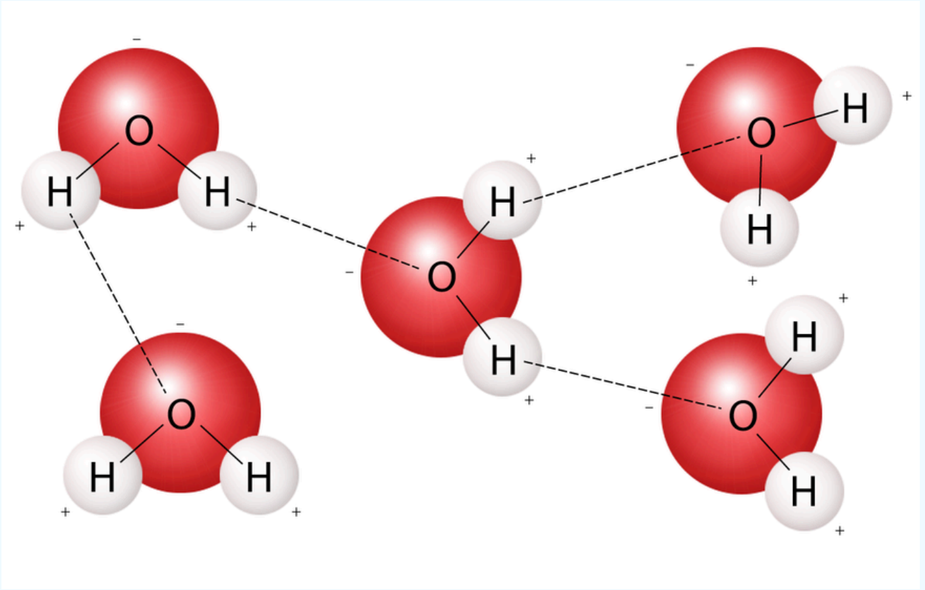
1. HIGH SPECIFIC HEAT

- it takes a lot of energy (heat) to increase temp.
- water resists changes in temp.

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

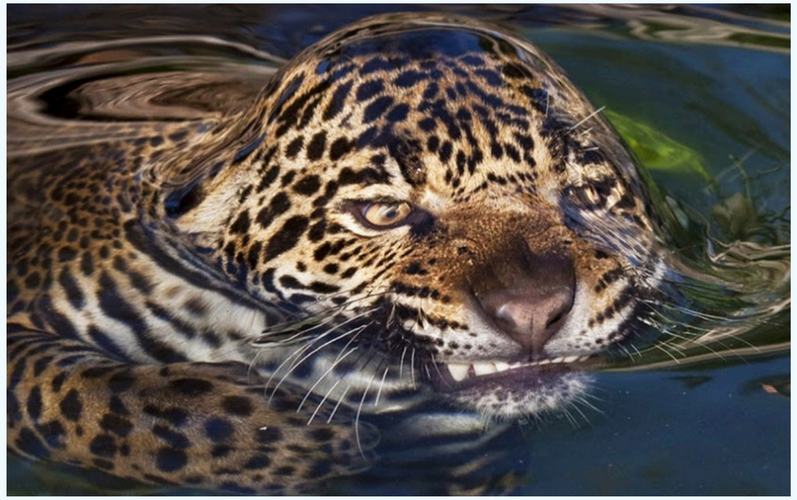
2. COHESION

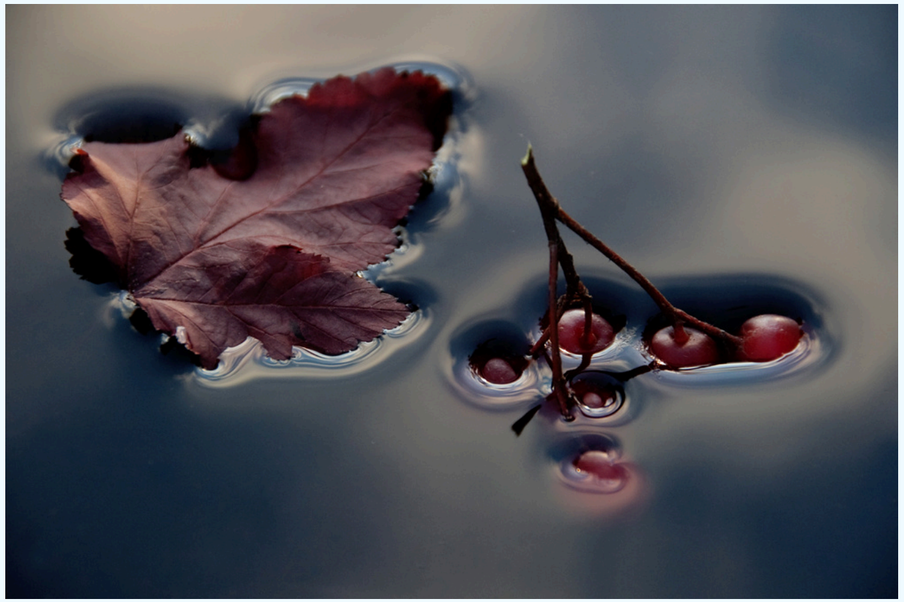
- water is attracted to water
- forms droplets

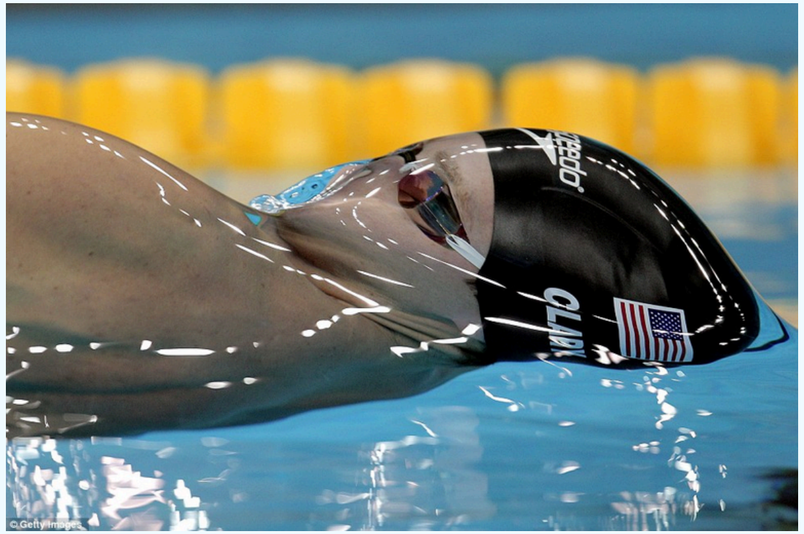


3. SURFACE TENSION

- water sticks to itself (cohesion) and will bend before breaking





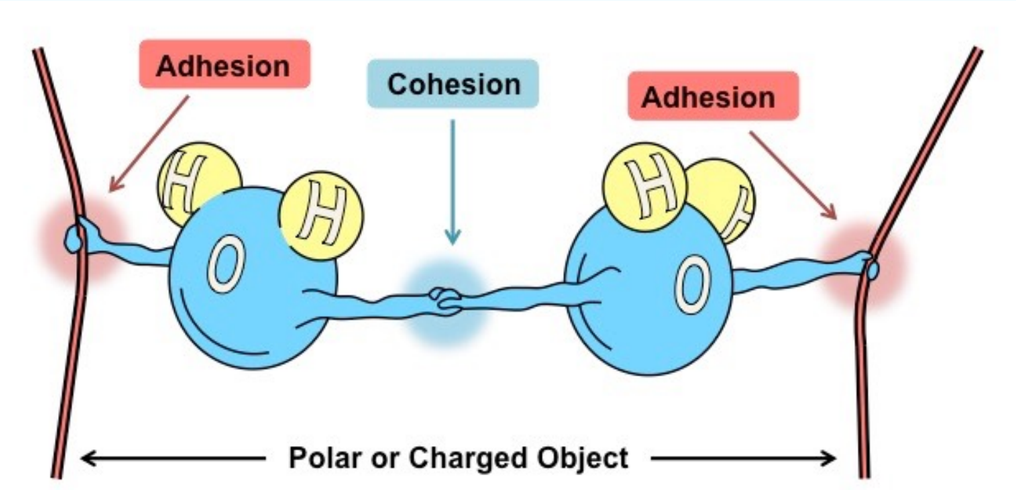


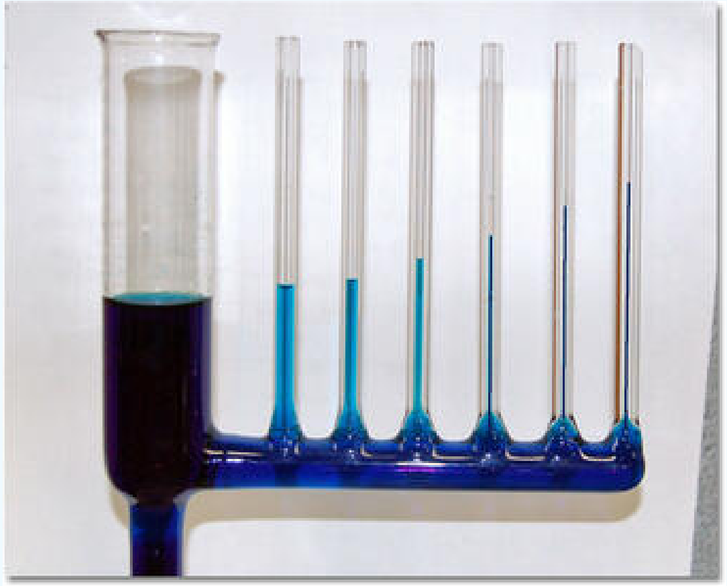
4. ADHESION

- water sticks to other objects

5. CAPILLARY ACTION

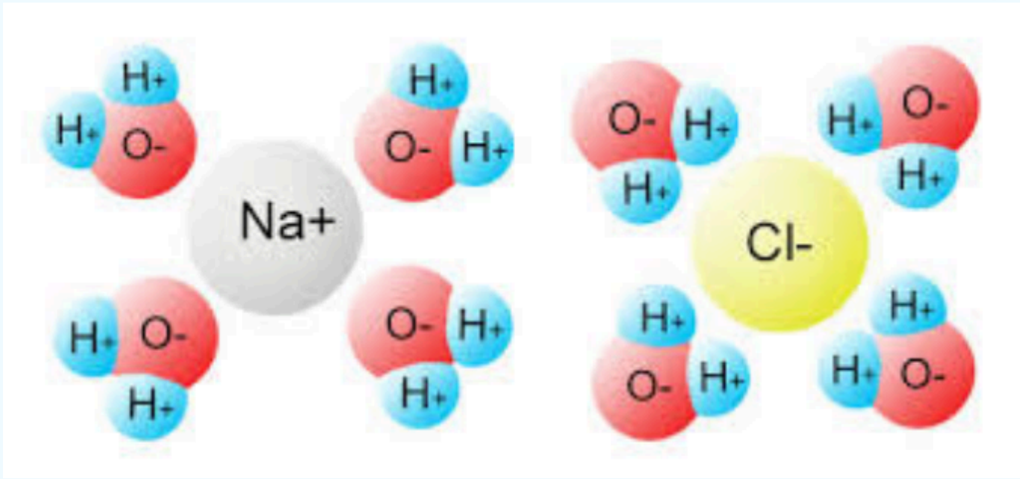
- tendency for water to climb up a thin tube
- thinner tube, higher water rises
- caused by cohesion and adhesion





6. UNIVERSAL SOLVENT

- water dissolves more substances than any other liquid
- many chemical reactions take place in the watery environment in our cells

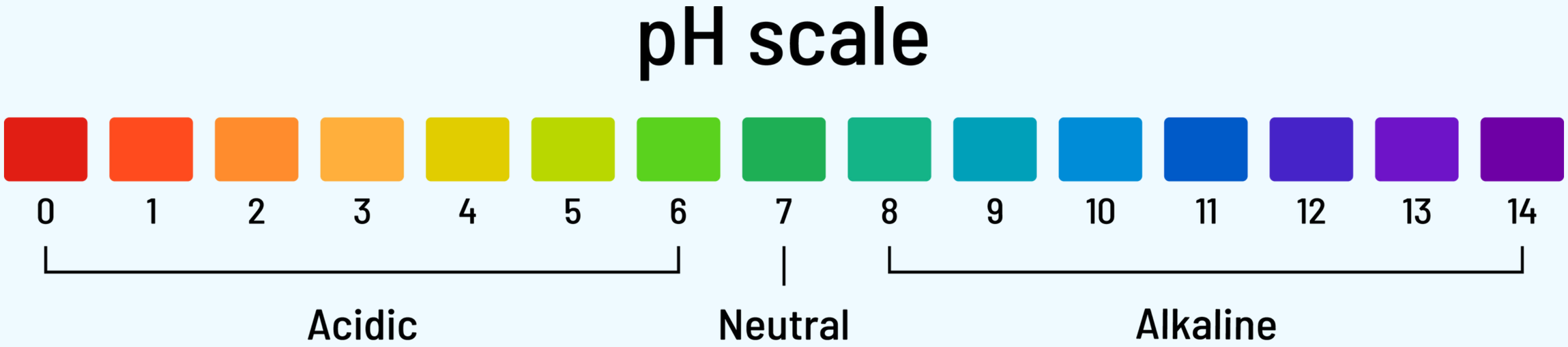


remember: water causes ionic compounds to dissociate, or break apart

THE pH SCALE

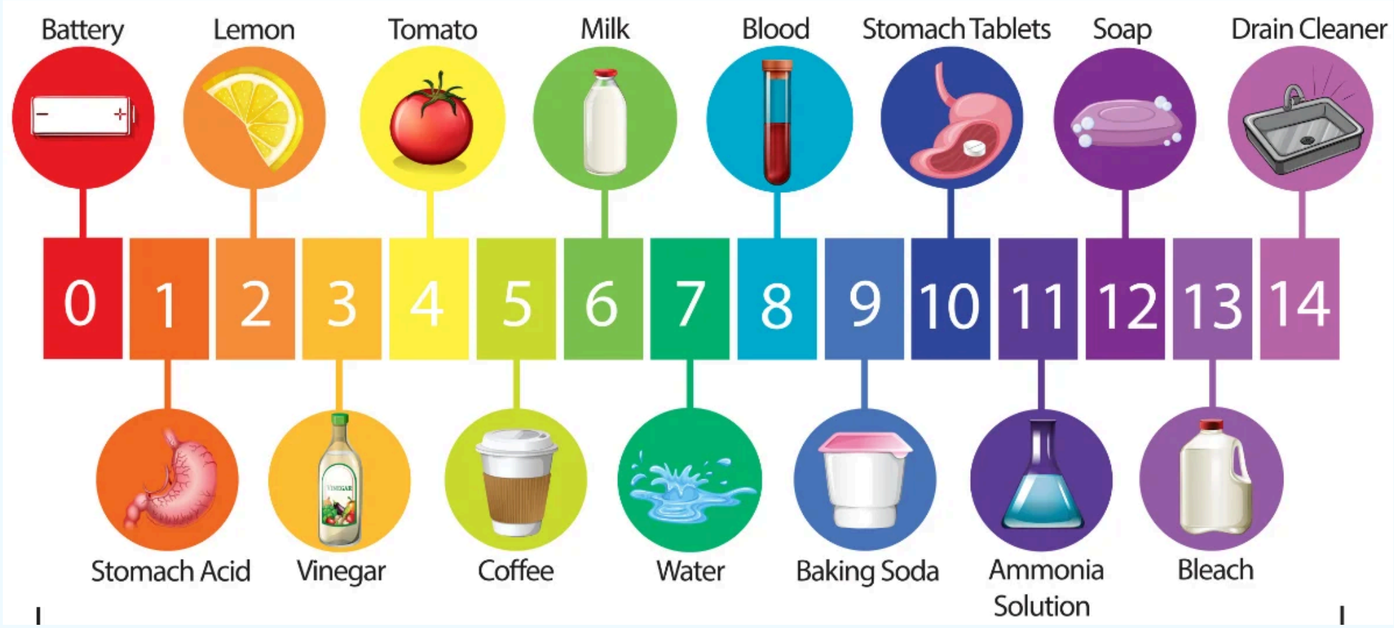
a measure of how acidic/basic a solution is

(actually a measure of the concentration of hydrogen ions (H+) in the solution)



THE pH SCALE

acidic	neutral	basic
pH < 7	pH = 7	pH > 7



the father away from neutral, the more extremely acidic/basic a solution is