

$\pi = 3,141592$



# Biology & Chemistry Fundamentals

Tree of Life Tutoring - Emily Rose



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## Modern cell theory

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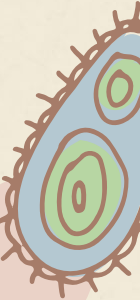
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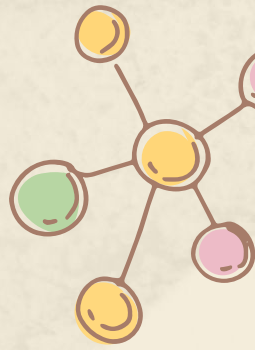
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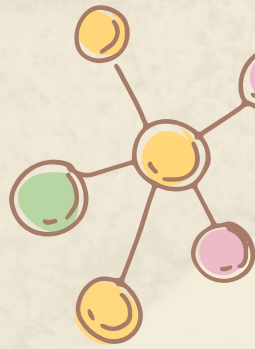
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Proteins, right down to the subunit level



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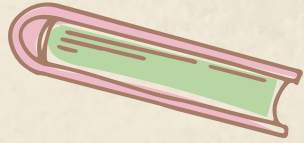
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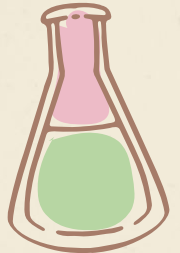
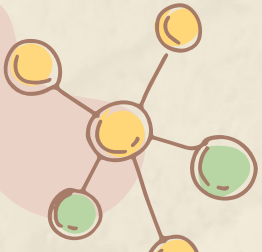
## Redox reactions

How they work & what is involved





# Intro to Biology



# Modern Cell Theory

01

All living things are composed of one or more cells

02

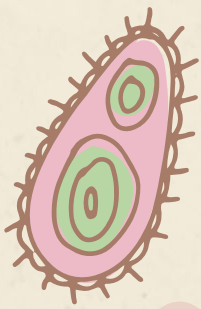
Cells contain hereditary information that is passed along from cell division

03

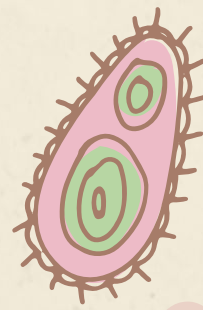
Biochemical reactions ensures that energy flow is maintained within cells

04

Cells depend on their intracellular components to carry out life functions



# Macromolecules



## Carbohydrates

- Composed of carbon, hydrogen & oxygen
- Monosaccharide, Disaccharide, Oligosaccharide, Polysaccharide

## Lipids

- Composed of hydrocarbon chains with a carboxyl group
- Saturated or unsaturated

## Proteins

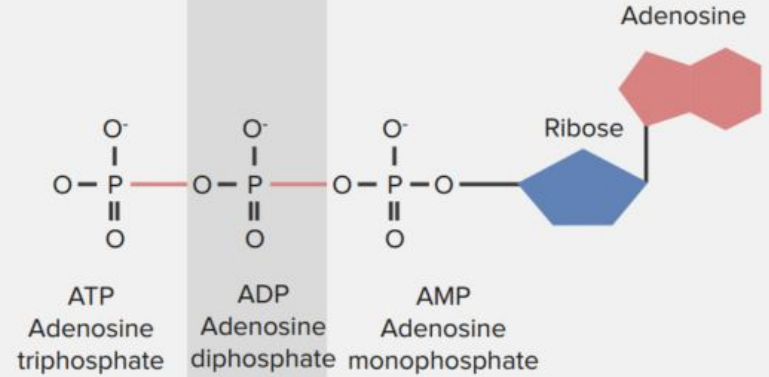
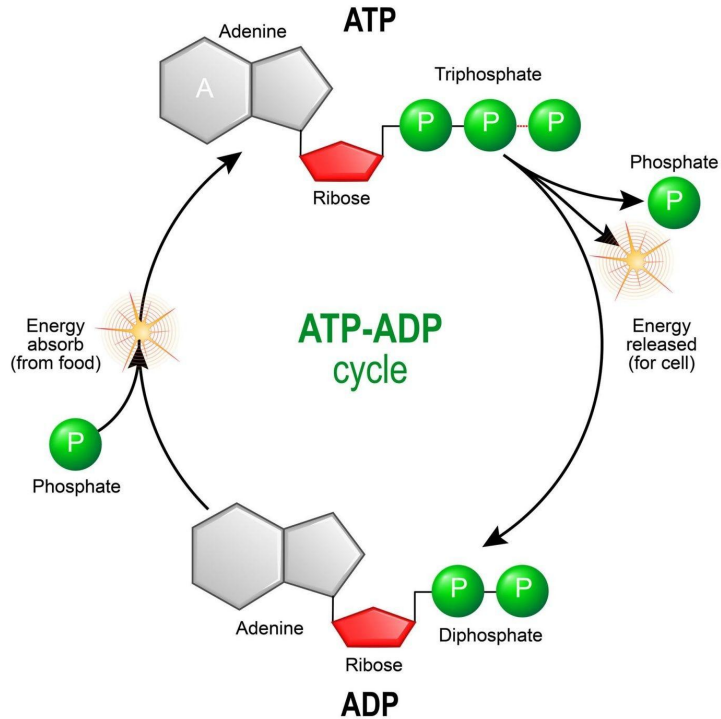
- Composed of amino acids
- Primary, secondary, tertiary, and quaternary structure

## Nucleic acids

- DNA & RNA
- Composed of Nitrogenous bases, ribose or deoxyribose sugar, and a phosphate group



# ATP, the universal energy source

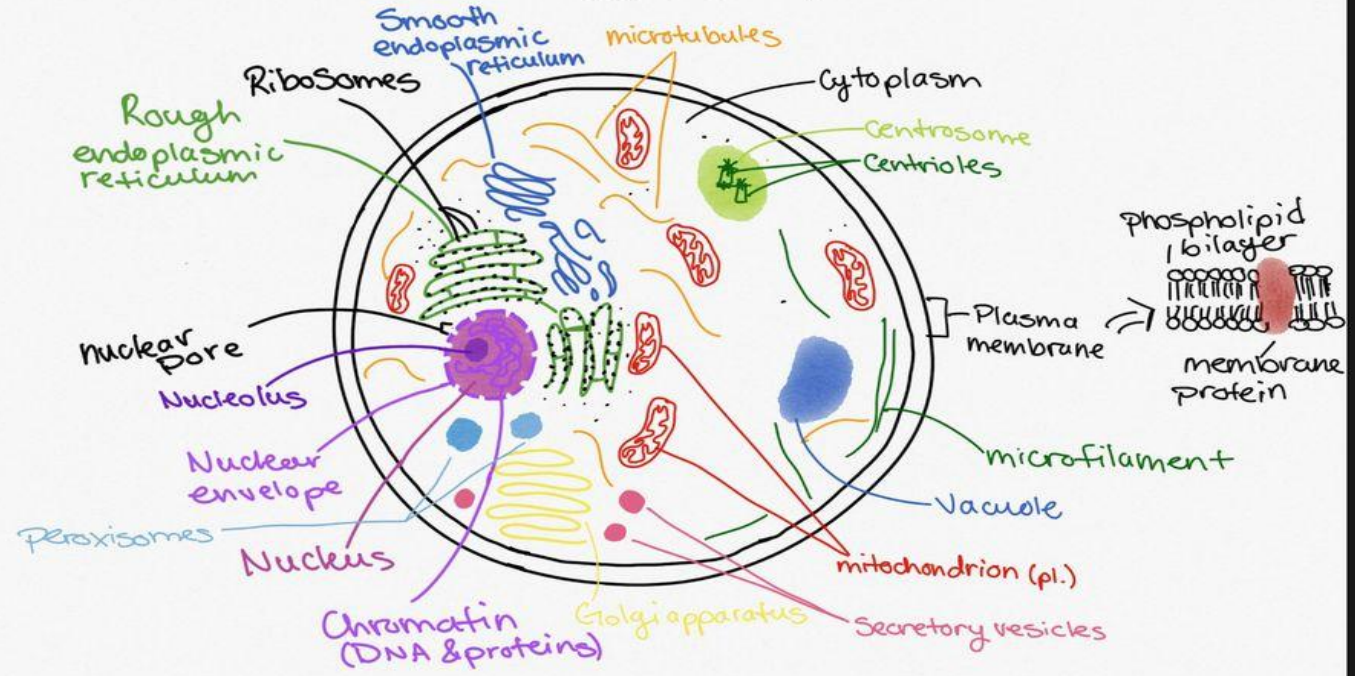


<https://www.lecturio.com/magazine/adenosine-triphosphate-atp/>

<https://www.biologyonline.com/tutorials/biological-energy-adp-atp/>



# Basic eukaryotic-animal cell (2-D)






# Functions of the Cell Components

## Cell Structure


## Function (Job)




<b>Nucleus</b>	Houses the cell's genetic material
<b>Cytoplasm</b>	Aqueous medium in which organelles and cellular material exists
<b>Cell Surface membrane</b>	Composed of a lipid bilayer
<b>Mitochondria</b>	Main site of cellular respiration

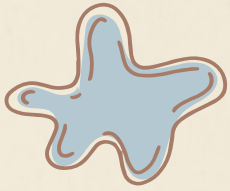
## Cell Structure

## Function (Job)

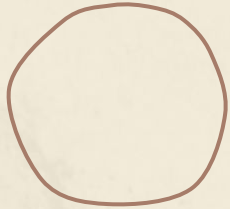
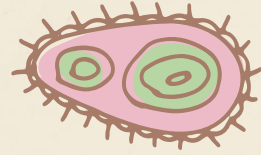


<b>Vesicles</b>	Important for endocytosis and exocytosis
<b>Endoplasmic Reticulum</b>	Protein synthesis and sorting
<b>Golgi body</b>	Protein sorting and packaging into vesicles





# Organelles Found in the Cytoplasm

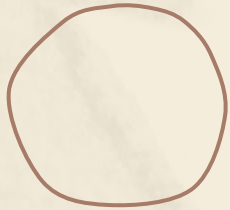
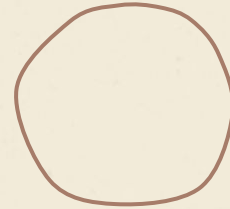


## Ribosomes

Site of translation

## Lysosomes

Important for degradation



## Vacuoles

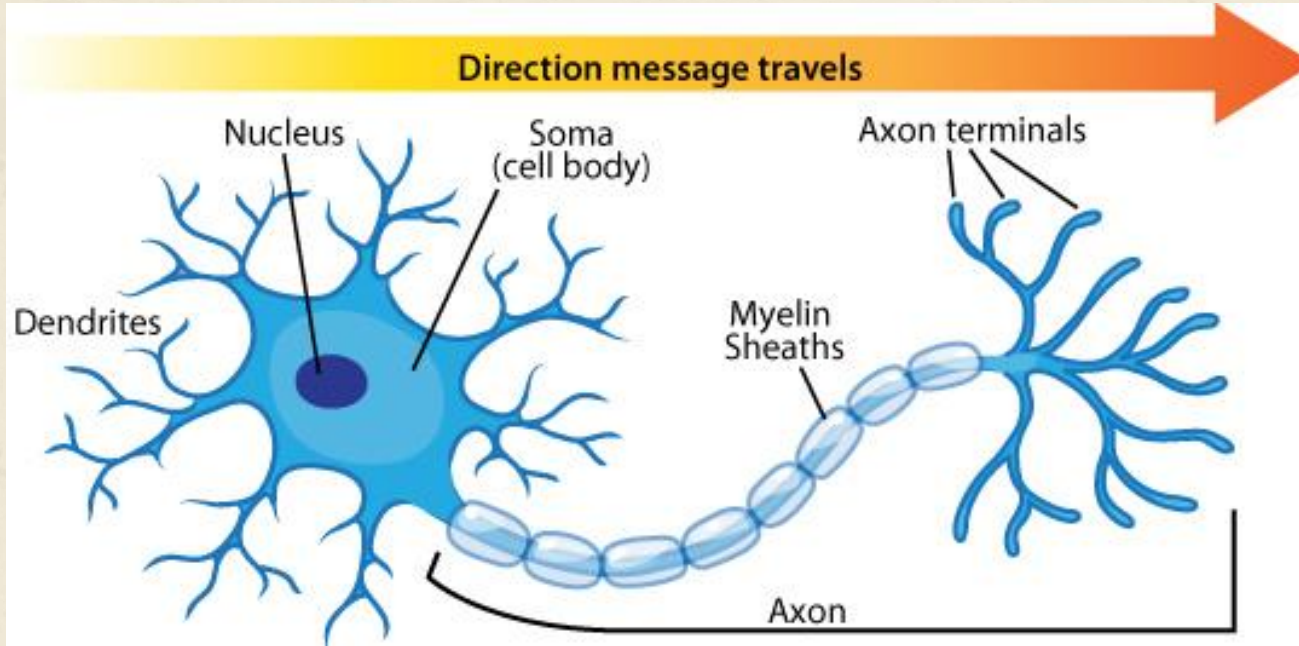
Important for maintaining solute concentrations

## Peroxisomes

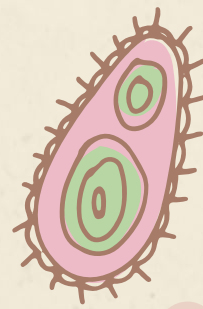
Important for cell metabolism



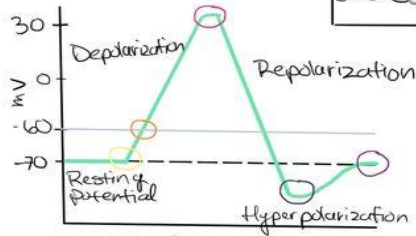
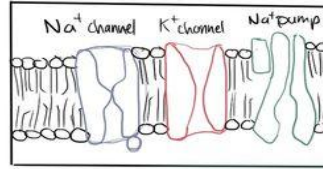
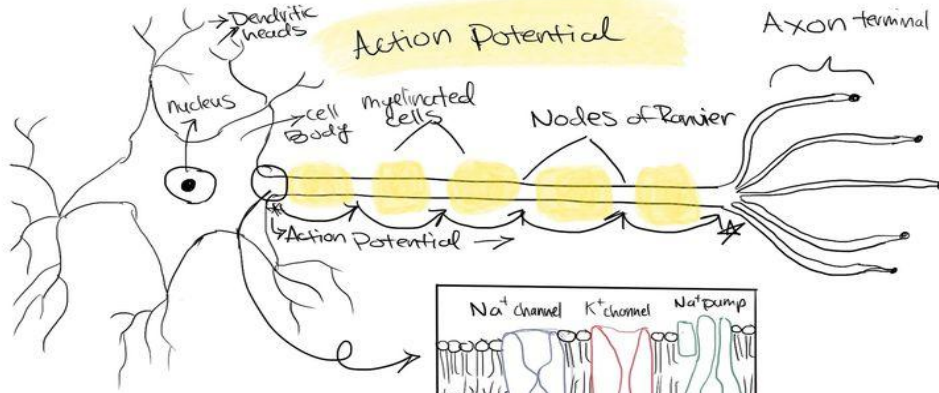
# Structure of a multipolar neuron



<https://askabiologist.asu.edu/neuron-anatomy>



# What is an action potential?



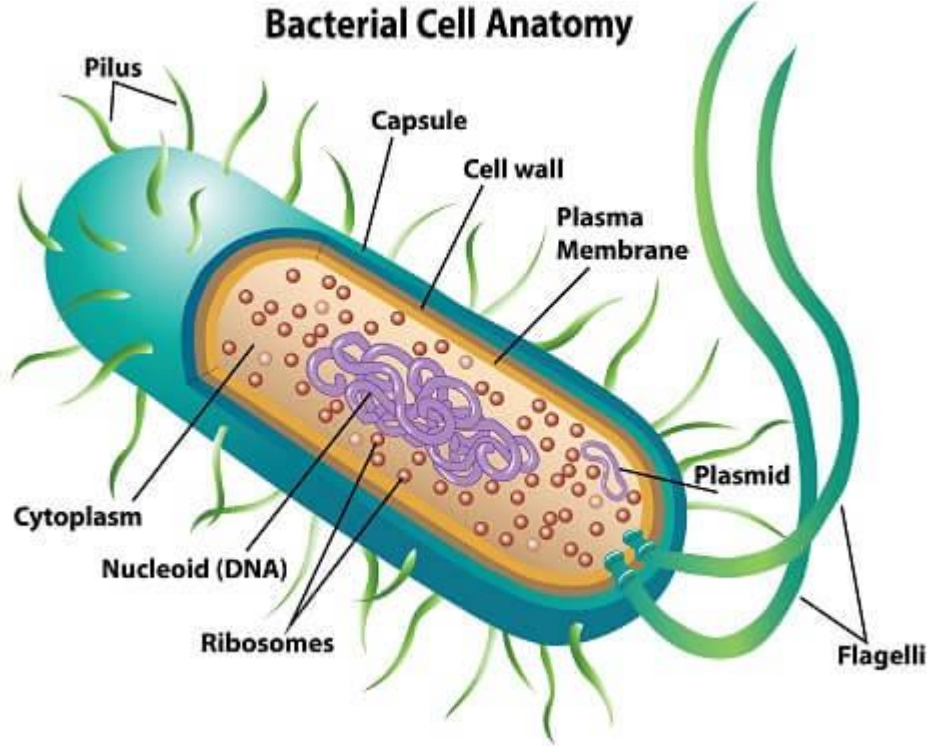
- → Stimulus excites membrane
- → Excitation threshold is reached
- → Peak action potential
- → Period of membrane hyperpolarization
- → Return to resting potential

\*Note: Action potentials are "all-or-nothing".

## \*Steps of an action potential

- ① Graded membrane potential excites the membrane out of resting potential, Na<sup>+</sup> leak channels allow for depolarization to begin.
- ② Depolarization excites the membrane & allows it to reach the threshold of -60mV. once crossed, voltage-gated Na<sup>+</sup> pumps open, causing an influx of Na<sup>+</sup>.
- ③ Membrane depolarizes to +30mV & reaches peak action potential → This triggers Na<sup>+</sup> channels to close & voltage-gated K<sup>+</sup> channels open. There is an efflux of K<sup>+</sup> out of the cell, beginning membrane repolarization.
- ④ Repolarization brings the membrane back down to the -60mV; voltage-gated K<sup>+</sup> channels begin to close, voltage-gated Na<sup>+</sup> channels are re-activated.
- ⑤ There is a slight delay in K<sup>+</sup> channel closure, resulting in membrane hyperpolarization, before membrane returns to resting potential.

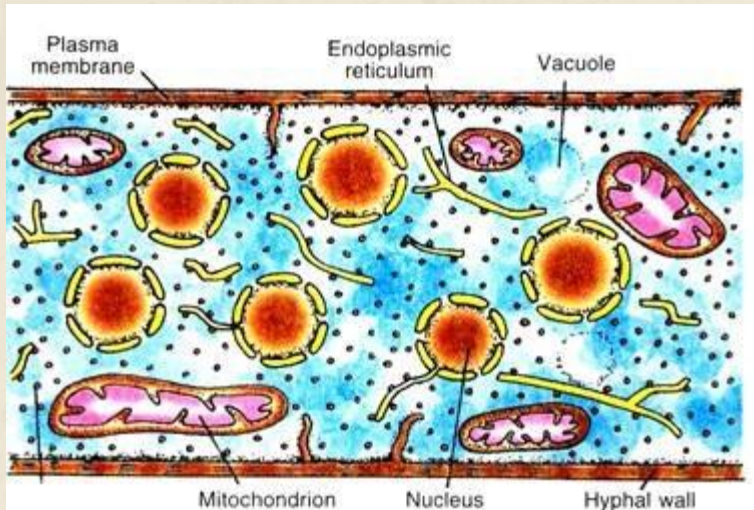
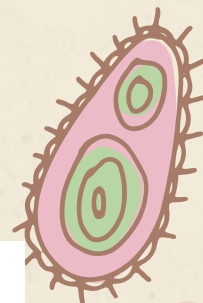
# Bacteria



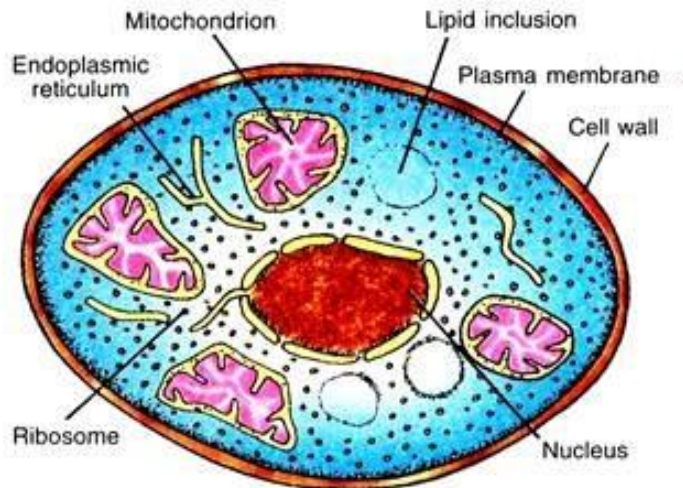
- ★ Prokaryotic
- ★ Single-celled
- ★ Smaller than eukaryotic cells
- ★ Classified based on physical characteristics (shape, grouping, etc)
  - Ex: *Staphylococcus aureus*
  - Cocci = round & Staphylococci = grouped & round



# Fungi



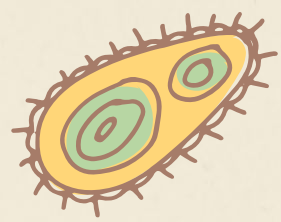
**Fig. 1.9.** *Fungi*. Fine structure of a hypha near the growing tip of *Mucor* based on an electron micrograph.



**Fig. 1.8.** *Fungi*. Fine structure of *Torula* Yeast cell based on an electron micrograph.

<https://www.biologydiscussion.com/fungi/structure-of-fungal-cell-with-diagram-fungi/63013>





# Differences between:

## Eukaryotic cells

- Contain membrane-bound organelles
- Genetic material found in nucleus
- Endomembrane system
- Replicates by cell division (mitosis or meiosis)

## Prokaryotic cells

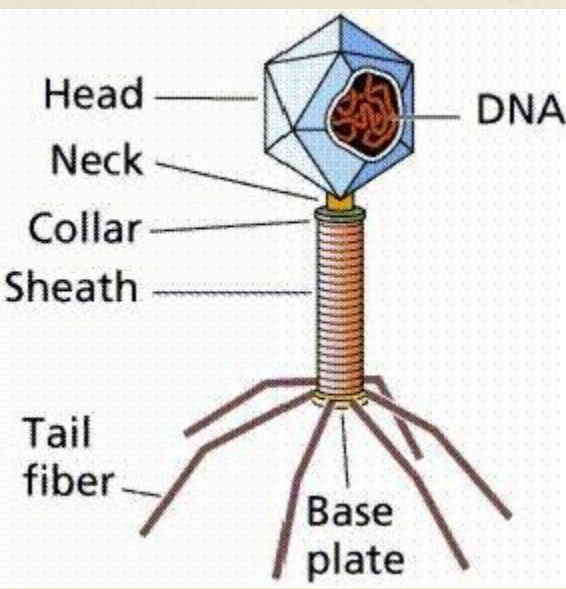
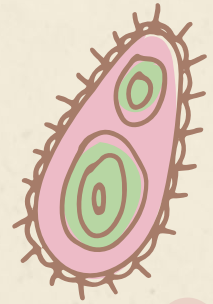
- No inner membranes (e.g., nuclear envelope)
- Biochemical reactions take place within the cytoplasm of the cell
- Replicates by binary fission





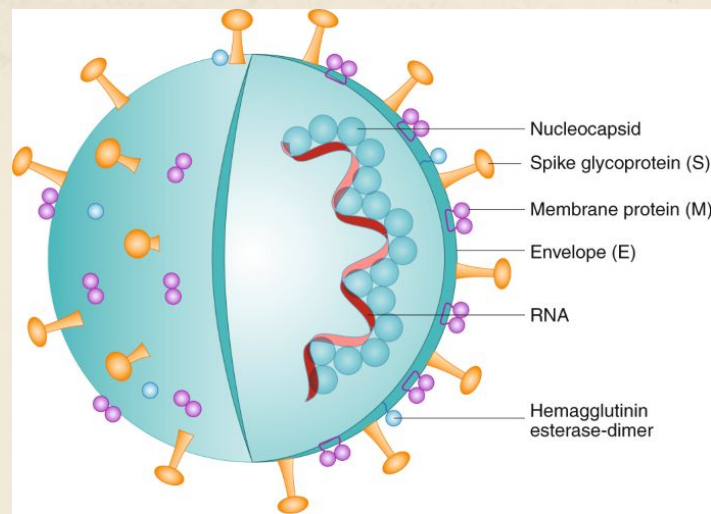


# Viruses



- Non-living → need a host to replicate genetic material
- Not composed of cells → Not eukaryotic or prokaryotic
- Highly adaptable to their environment

<https://www.nature.com/articles/s41565-020-0732-3>

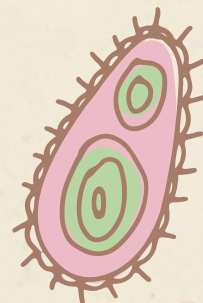


[https://www.researchgate.net/figure/Structure-of-a-Virus\\_fig1\\_260683286](https://www.researchgate.net/figure/Structure-of-a-Virus_fig1_260683286)

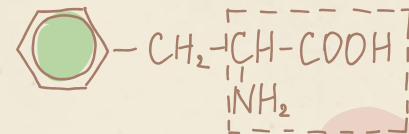




# What is a protein?

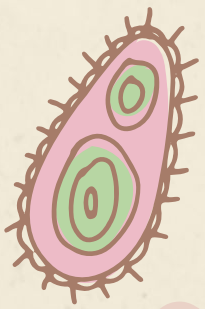


- The major structural component of cells
- Macromolecules composed of chains of amino acids
- There are 2 classes of amino acids: essential and non essential
  - Essential = cannot be made by the body
  - Non essential = can be made by the body

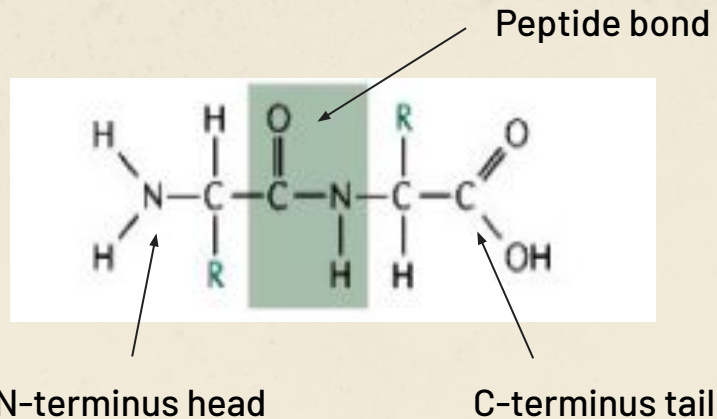




# Amino Acids



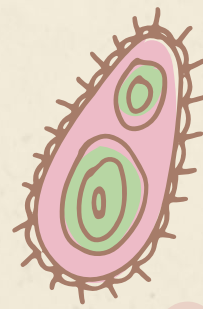
- 20 amino acids are found in humans → differentiated by their **side chain (R)**
- Composed of an N-terminus head and a C-terminus tail
- Joined together by a **peptide bond** to form proteins



# Types of Amino Acids

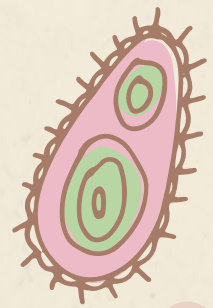
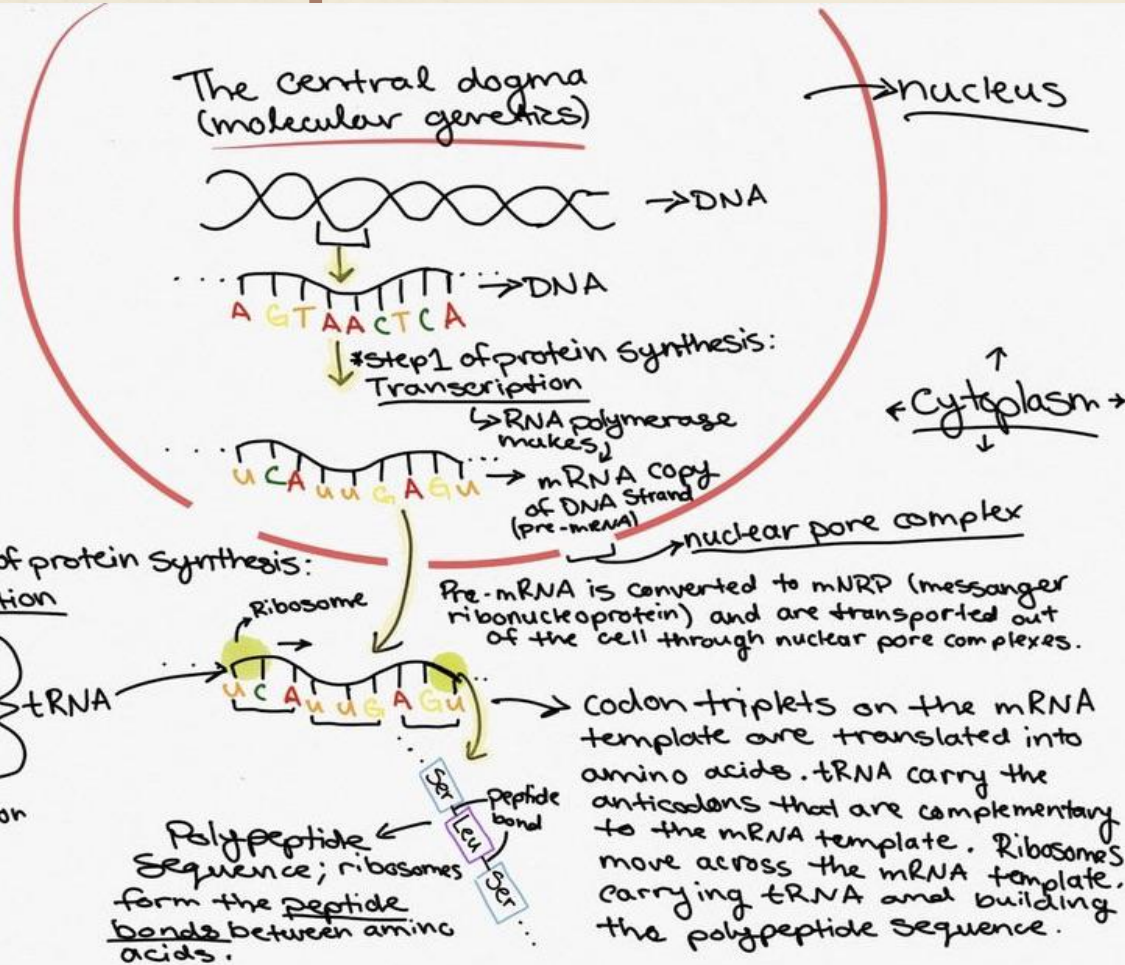
POLAR AMINO ACIDS				NONPOLAR AMINO ACIDS			
AMINO ACID			SIDE CHAIN	AMINO ACID			SIDE CHAIN
Aspartic acid	Asp	D	negatively charged	Alanine	Ala	A	nonpolar
Glutamic acid	Glu	E	negatively charged	Glycine	Gly	G	nonpolar
Arginine	Arg	R	positively charged	Valine	Val	V	nonpolar
Lysine	Lys	K	positively charged	Leucine	Leu	L	nonpolar
Histidine	His	H	positively charged	Isoleucine	Ile	I	nonpolar
Asparagine	Asn	N	uncharged polar	Proline	Pro	P	nonpolar
Glutamine	Gln	Q	uncharged polar	Phenylalanine	Phe	F	nonpolar
Serine	Ser	S	uncharged polar	Methionine	Met	M	nonpolar
Threonine	Thr	T	uncharged polar	Tryptophan	Trp	W	nonpolar
Tyrosine	Tyr	Y	uncharged polar	Cysteine	Cys	C	nonpolar

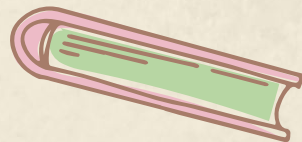
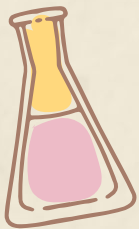
Figure 4-3 Essential Cell Biology, 4th ed. (© Garland Science 2014)



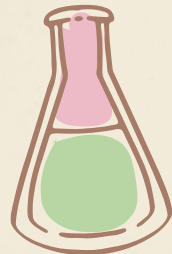
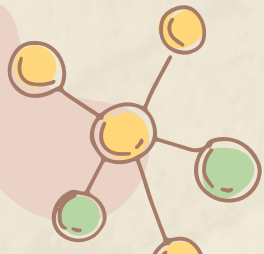
# How are proteins made?

e.rose/20

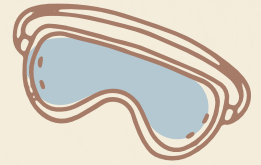




# Intro to Chemistry



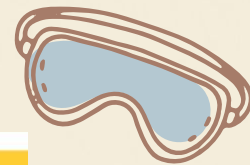
# Basic Terminology



- **Atom** = fundamental unit of a chemical substance
- Atoms combine to form **molecules**
- An **element** is a pure substance composed of only **one atom**
- A **compound** is composed of two or more elements
- An **electron** = a subatomic particle with a negative charge
  - Found in orbitals surrounding an atom's nucleus
  - **Valence electrons** are those found in the outermost orbital
- A **proton** = a subatomic particle with a positive charge
  - Found in the atom's nucleus



# The Periodic Table of Elements



**ACS**  
Chemistry for Life<sup>®</sup>

## PERIODIC TABLE OF ELEMENTS

**GROUP 1**

**PERIOD**

**Legend:**

- Alkali Metals (Yellow)
- Alkaline Earth Metals (Orange)
- Transition Metals (Blue)
- Other Metals (Dark Blue)
- Metalloids (Grey)
- Non-metals (Red)
- Halogens (Light Blue)
- Noble Gases (Purple)
- Lanthanides (Red)
- Actinides (Green)

**Example Element: Pt (Platinum)**

- Atomic Number: 78
- Symbol: Pt
- Name: Platinum
- Average Atomic Mass: 195.1

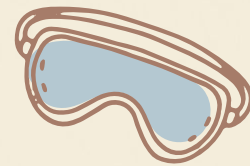
PERIOD	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16	GROUP 17	GROUP 18
1	H Hydrogen 1.008																	He Helium 4.003
2	Li Lithium 6.941	Be Beryllium 9.012											B Boron 10.81	C Carbon 12.01	N Nitrogen 14.01	O Oxygen 15.99	F Fluorine 18.99	Ne Neon 20.18
3	Na Sodium 22.99	Mg Magnesium 24.31											Al Aluminum 26.98	Si Silicon 28.09	P Phosphorus 30.97	S Sulfur 32.06	Cl Chlorine 35.45	Ar Argon 39.95
4	K Potassium 39.10	Ca Calcium 40.08	Sc Scandium 44.96	Ti Titanium 47.88	V Vanadium 50.94	Cr Chromium 52.00	Mn Manganese 54.94	Fe Iron 55.85	Co Cobalt 58.93	Ni Nickel 58.69	Cu Copper 63.55	Zn Zinc 65.39	Ga Gallium 69.72	Ge Germanium 72.64	As Arsenic 74.92	Se Selenium 78.96	Br Bromine 79.90	Kr Krypton 83.79
5	Rb Rubidium 85.47	Sr Strontium 87.62	Y Yttrium 88.91	Zr Zirconium 91.22	Nb Niobium 92.91	Mo Molybdenum 95.94	Tc Technetium (98)	Ru Ruthenium 101.1	Rh Rhodium 101.07	Pd Palladium 106.4	Ag Silver 107.87	Cd Cadmium 112.41	In Indium 114.82	Sn Tin 118.71	Sb Antimony 121.76	Te Tellurium 127.6	I Iodine 126.91	Xe Xenon 131.3
6	Cs Cesium 132.91	Ba Barium 137.33	57-71 Lanthanides	Hf Hafnium 178.5	Ta Tantalum 180.9	W Tungsten 183.85	Re Rhenium 186.21	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.08	Au Gold 196.97	Hg Mercury 200.59	Tl Thallium 204.38	Pb Lead 207.2	Bi Bismuth 208.98	Po Polonium (209)	At Astatine (210)	Rn Radon (222)
7	Fr Francium (223)	Ra Radium (226)	89-103 Actinides	Rf Rutherfordium (261)	Db Dubnium (262)	Sg Seaborgium (263)	Bh Bohrium (264)	Hs Hassium (265)	Mt Meitnerium (266)	Ds Darmstadtium (268)	Rg Roentgenium (269)	Cn Copernicium (284)	Nh Nihonium (286)	Fl Flerovium (288)	Mc Moscovium (289)	Lv Livermorium (293)	Ts Tennessine (294)	Og Oganesson (294)

57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.5	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.967
Ac Actinium (227)	Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (260)





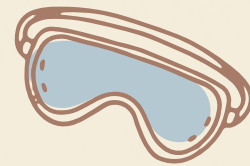
# How do I navigate the periodic table?



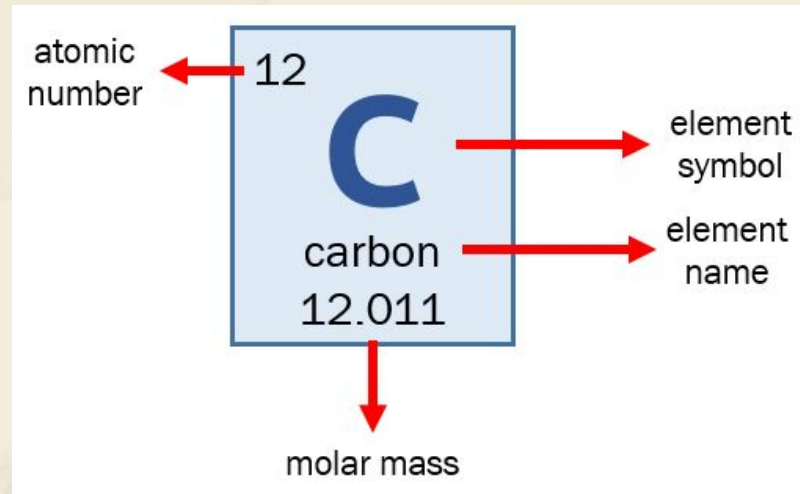
- The periodic table is composed of **elements**
  - elements are arranged based on their shared properties (physical or chemical)
- Rows = **periods**
- Columns = **groups**
  - Elements within a **group** tend to have similar properties
- Some groups have specific names
  - Group 1 = Alkali Metals
  - Group 2 = Alkaline Earth Metals
  - Group 7 = Halogens
  - Group 8 = Noble Gases
- Group number corresponds to the number of valence electrons an atom has



# How do I navigate the periodic table?



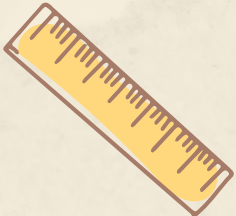
- Each element has a(n):
  - Atomic number
  - Symbol
  - Name
  - Average Atomic Mass (Molar Mass)
- The atomic number indicates how many **protons** the element has



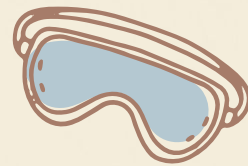
# Charges



- A **neutral** element will have an **equal** number of protons and electrons
- A **charged** element will have an **unequal** number of protons and electrons
  - A charged element is also known as an **ion**
- Elements become charged by either gaining or losing **electrons**
  - Positive charge = more protons than electrons = one or more electron(s) were **lost**
  - Negative charge = more electrons than protons = one or more electron(s) were **gained**



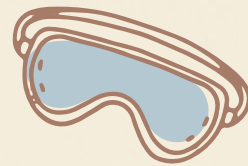
# Chemical Bonds



- **chemical bond** = an attractive force between 2 atoms
- The **octet rule** states that elements tend to bond in a way such that each element has 8 electrons in its outermost shell (valence shell)
  - Exceptions are Hydrogen and Helium, which can both only accommodate 2 valence electrons



# Types of Chemical Bonds



- There are 2 types of chemical bonds
- **Ionic**
  - Occurs between a metal and a nonmetal
  - Involves the transfer of electrons from the metal to the nonmetal so that each element has 8 valence electrons (making the bond stable)
- **Covalent**
  - Occurs between two nonmetals
  - Involves the sharing of atoms between two elements (both atoms end up having a stable octet meaning 8 valence electrons)



# Chemical Forces



- **Intramolecular Forces**

- Include ionic and covalent bonds
- Attractive forces between atoms and ions within a molecule

- **Intermolecular Forces**

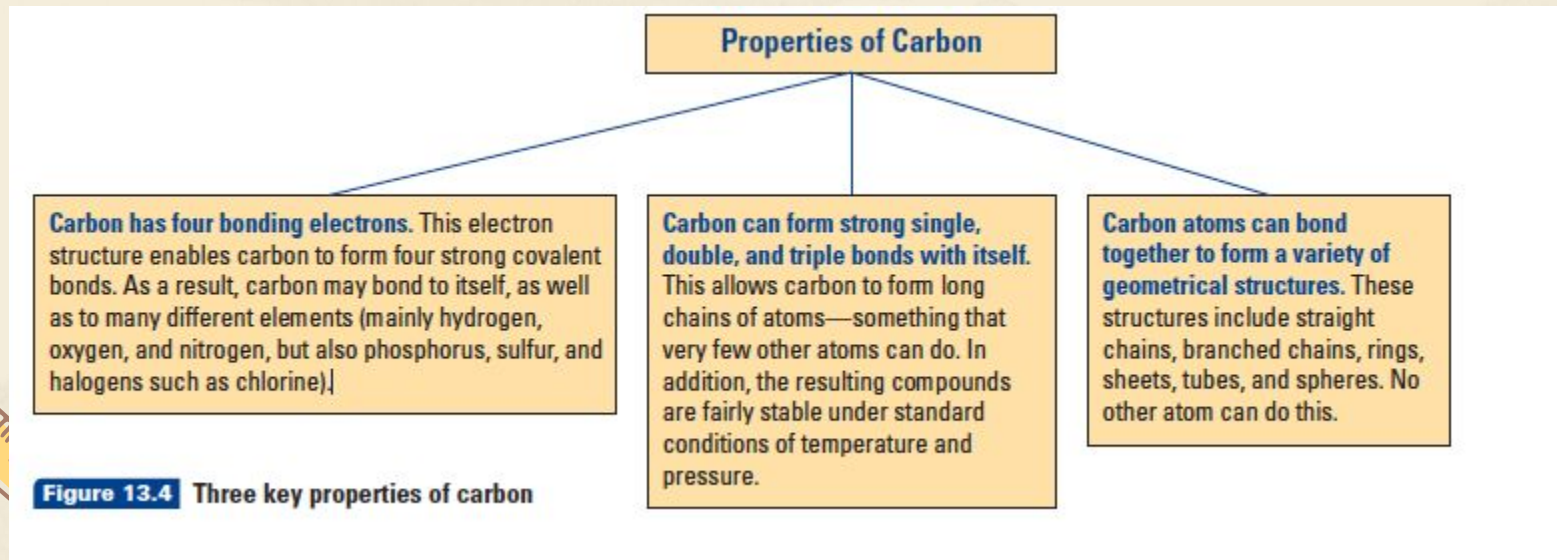
- Attractive forces between molecules
- Includes London Dispersion Forces, Dipole-Dipole, and Hydrogen bonding



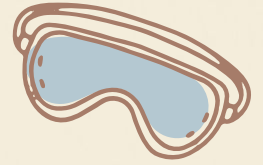
# Intro to Organic Chemistry



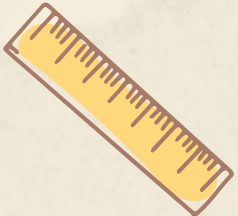
- The most important elements are carbon and hydrogen!
- Carbon based compound = organic



# Chemical Reactions



- A process in which chemical bonds are broken or formed in order to convert one set of chemical substances into another
- Reactant = substance that undergoes a chemical reaction
- Product = substance that is created as a result of the chemical reaction





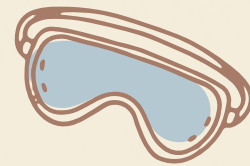
# Redox Reactions



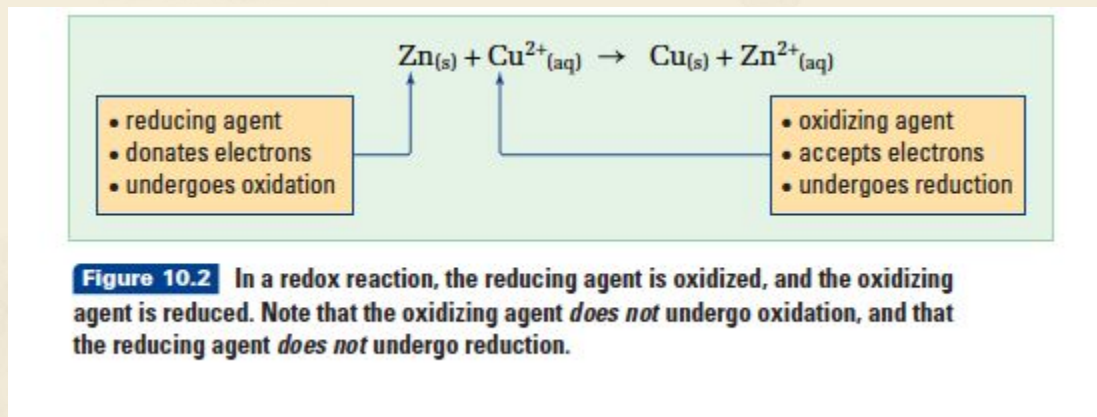
- Short form for an **oxidation-reduction reaction**
- Oxidation = **loss** of electrons
- Reduction = **gain** of election
- Acronym to remember: OIL RIG (oxidation is loss of electron, reduction is gain of electrons) OR LEO the lion says GER (lose electrons oxidize, gain electrons reduce)



# Redox Reactions



- **Reducing agent** = donates electrons
- **Oxidizing agent** = accepts electrons from the reducing agent



# Thanks!

Please feel free to email me if you  
have any questions!



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