General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

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Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER
Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:
Exams (4): 20% Each
Quizzes: 20% Average

Recap: Lecture 3

1. Matter

Mass and Space

2. Atoms

1) Protons, Neutrons, and Electrons
2) Elements/Isotopes
3) Valence Electrons (Octet) - Octogan

3. Periodic Table

4. Molecules

1) Two or more atoms combine H_2O, $C_6H_{12}O_6$, O_2
2) Redox – Reduction/Oxidation
   Gain of Electron is Reduction
   Gain of Hydrogen (**H^-**) is Reduction
   Gain of Oxygen is Oxidation

5. Reactions

1) Activation Energy
2) Catalyst/Enzyme

Outline

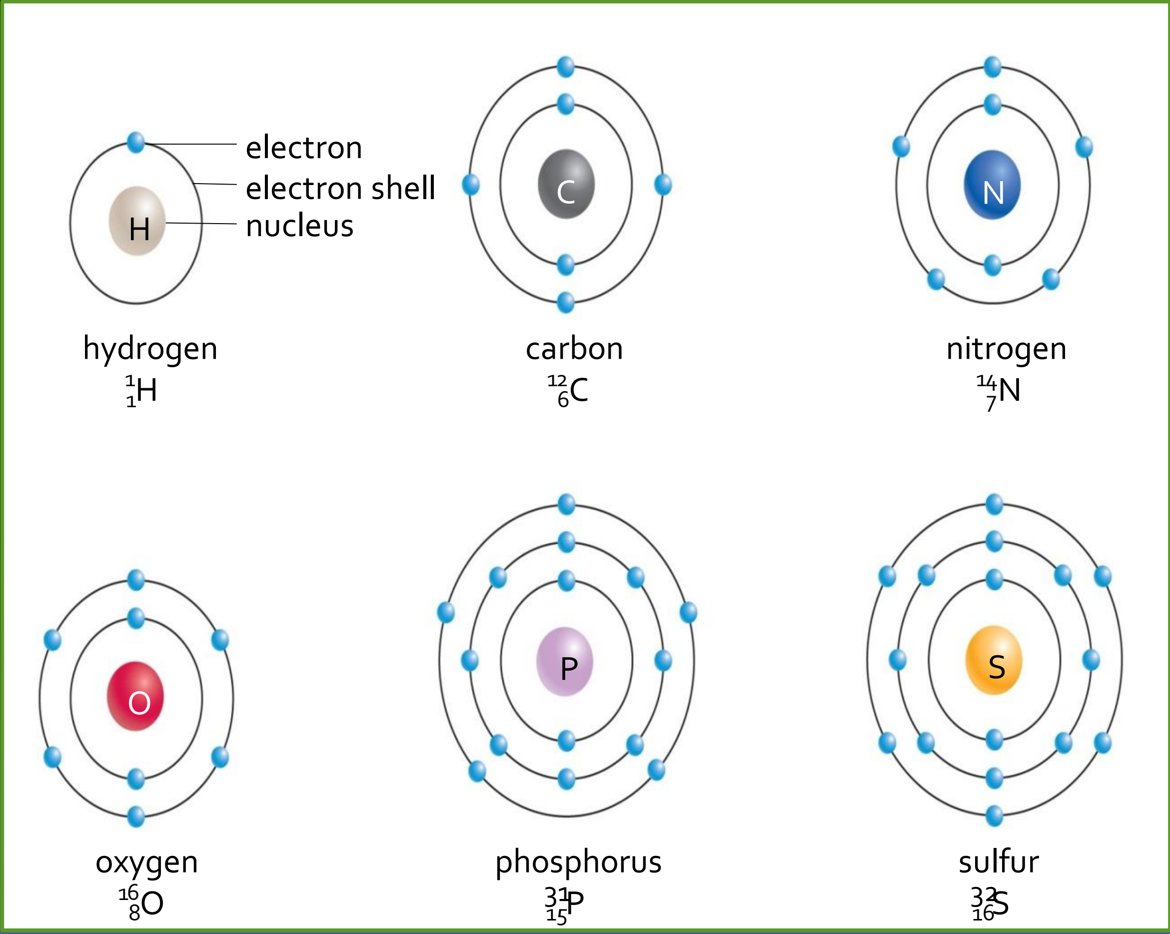
- Review:
  - Atomic symbol
  - Electron configuration

- Chemical Bonds
  - Covalent Bonding
    - Electronegativity
    - Polar and nonpolar covalent bonds
  - Ionic Bonding
  - Weak Bonds
    - Hydrogen Bonding
    - Van der Waals forces

The Octet Rule for -- Distribution of Electrons

Neils Bohr models (1910's) show electron shells as **concentric circles** around nucleus

- Each shell has two or more electron orbitals
  - Innermost shell has two orbitals
  - Outer most orbital (valence) should have 8 electrons (octet)



Dmitri Mendeleev's Table: 1869

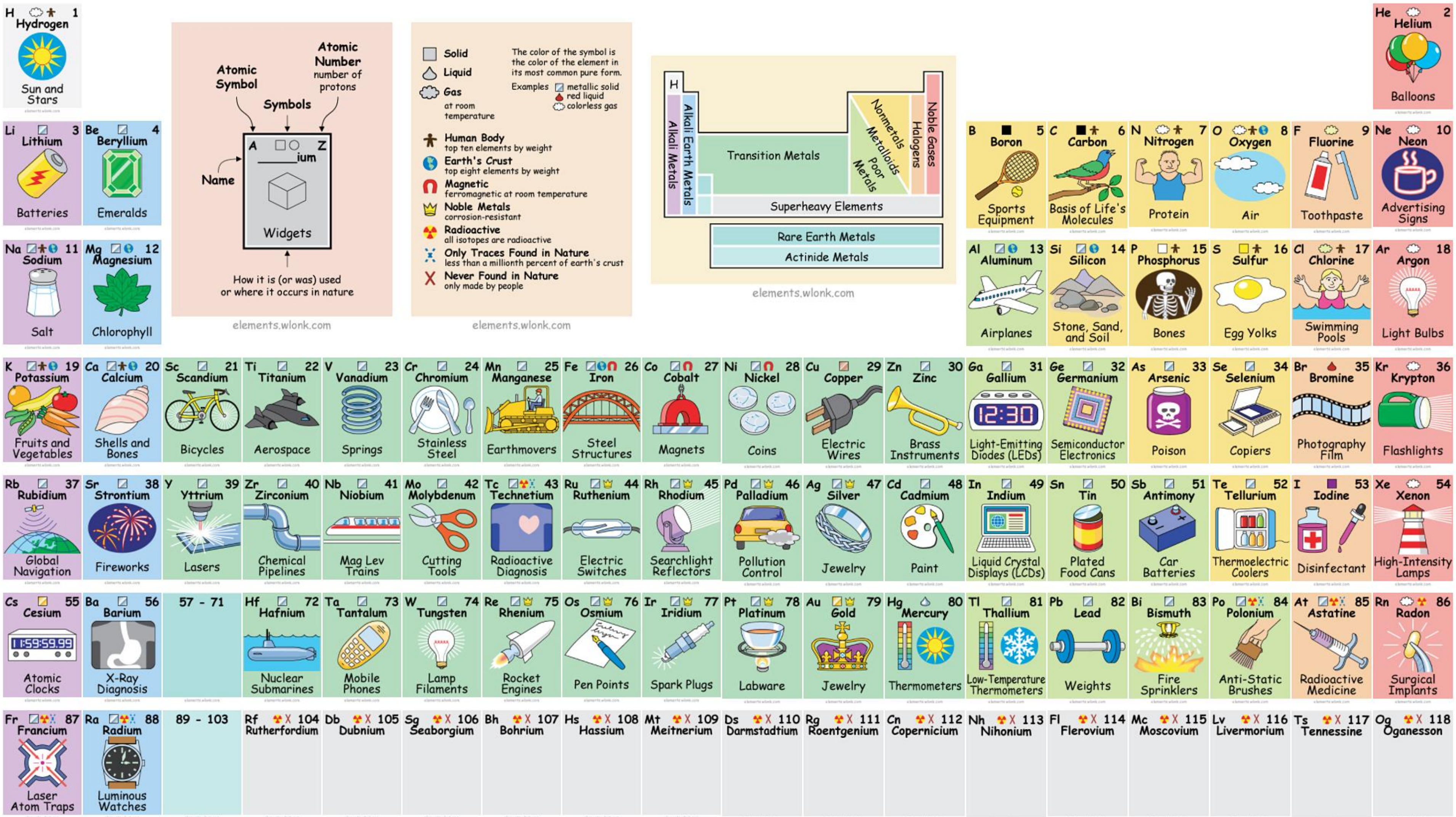
*Nickel has a lower mass than Cobalt

*Au is right next to Hg, huh????? – Who cares?

Hg named after the planet Mercury (the origin of the symbol Hg is the Latin word "**hydrargyrum**" meaning "liquid **silver**")

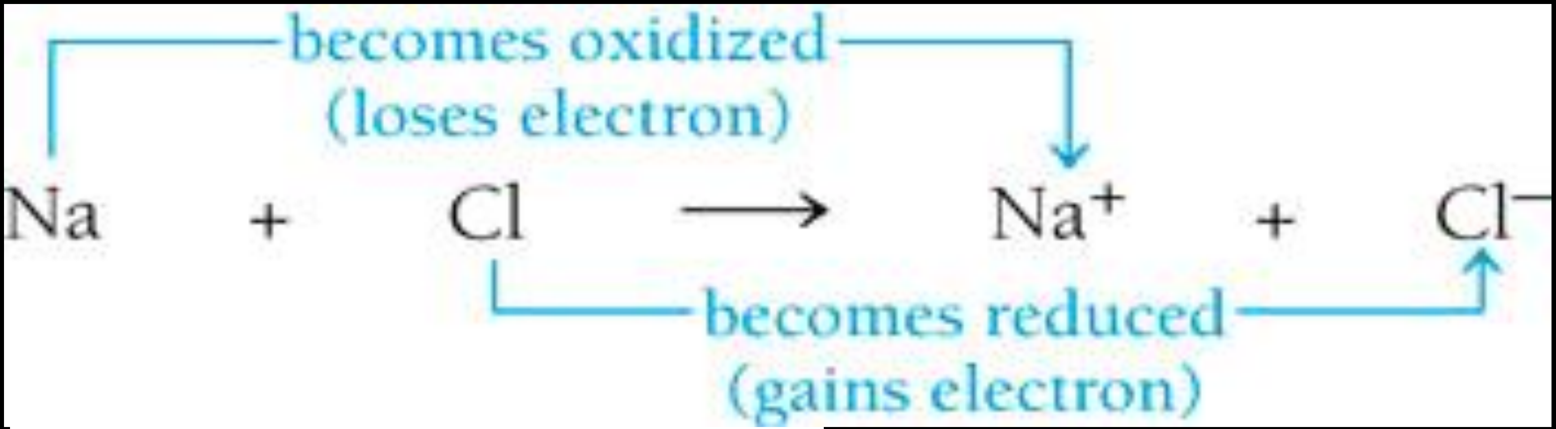
Reihen	Gruppe I. — R^2O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^3	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^1 RO^3	Gruppe VII. RH R^2O^7	Gruppe VII. — RO^4
1	H = 1							
2	Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 31	S = 32	Cl = 35.5	
4	K = 39	Ca = 40	– = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co* = 59, *Ni = 59, Cu = 63.
5	(Cu = 63)	Zn = 65	– = 68	– = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	– = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108.
7	(Ag = 108)	Cd = 112	In = 113	Sa = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	–	–	–	– – – –
9	(–)	–	–	–	–	–	–	
10	–	–	?Er = 178	?La = 180	Ta = 182	W = 184	–	Os = 195, Ir = 197, Pt = 198, Au = 199.
11	(Au* = 199)	Hg* = 200	Tl = 204	Pb = 207	Bi = 208	–	–	
12	–	–	–	Th = 231	–	U = 240	–	– – – –

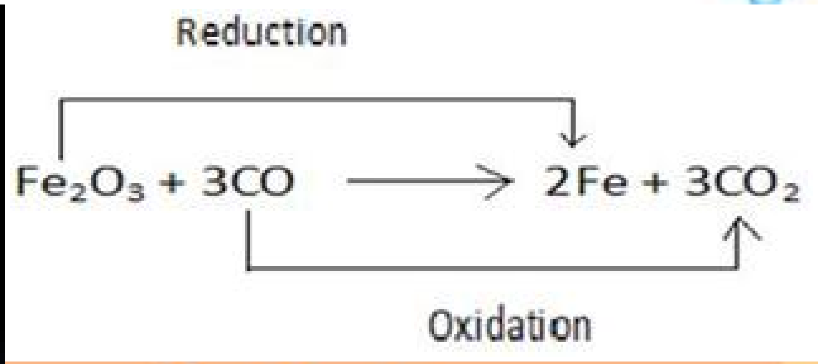
Periodic Table:

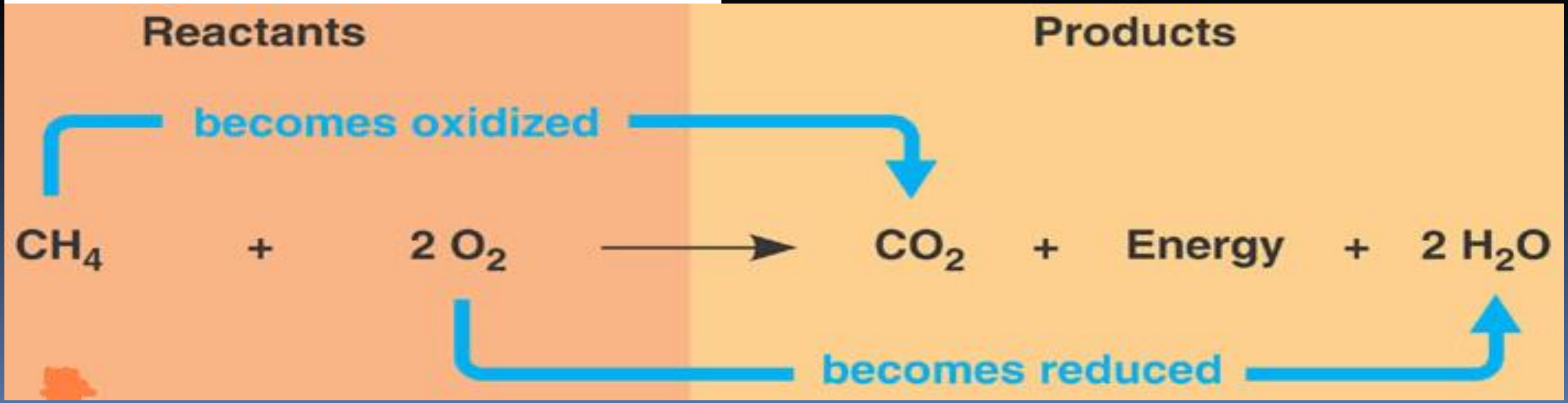


https://www.youtube.com/watch?v=YIlUXHZR3ZA

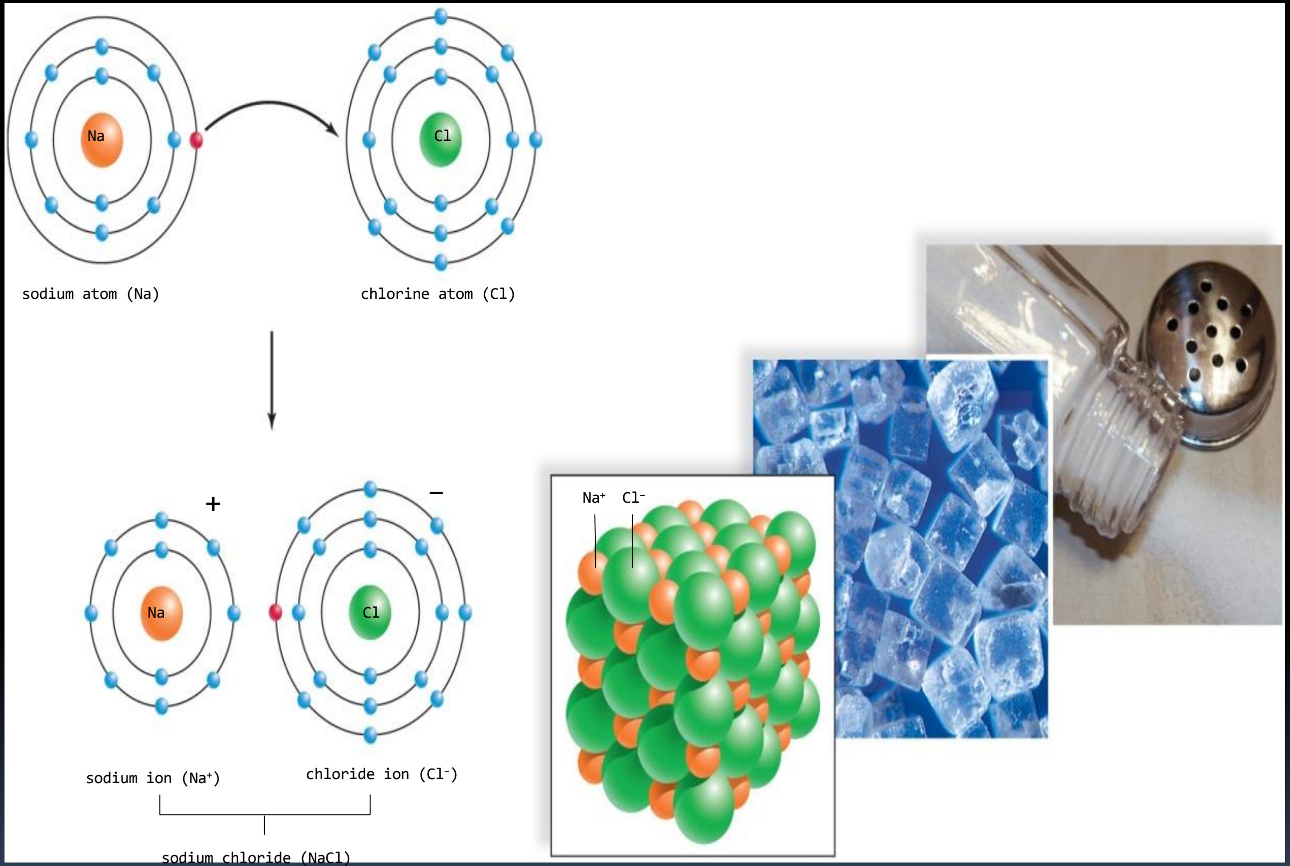
Redox Reactions







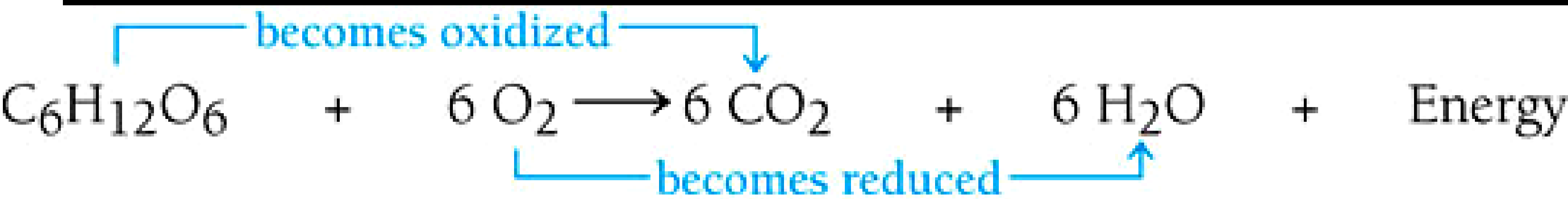
INORGANIC CHEMISTRY (CONT.)



Energy

- **Energy** is the capacity to cause change ("ability to do work")
- Things tend to flow from high to low energy: High energy = unstable, low energy = stable
- Forms of Energy
  - **Kinetic**:
    - Energy of motion
    - Mechanical
  - **Potential**:
    - Stored energy
    - Chemical
- **Potential energy** is the energy that matter has because of its location or structure

Exergonic and Endergonic Reactions



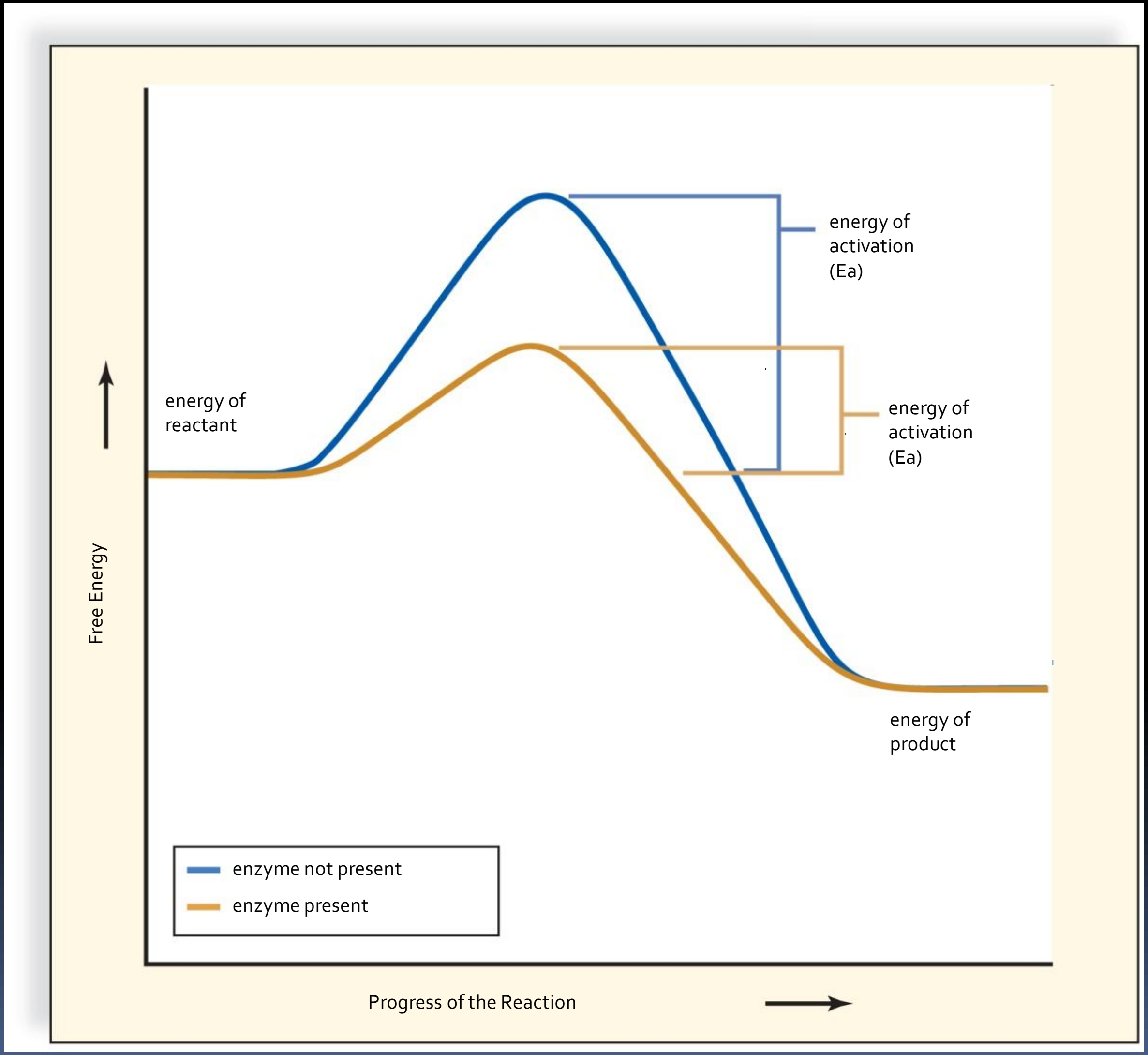
ΔG = -686 kcal/mol !!!!!!!!!

- **Exergonic** Reactions - Products have *less* free energy than reactants => energy is released reaction is **spontaneous**
  - **Exothermic – energy is released as heat**
- **Endergonic** Reactions - Products have *more* free energy than reactants => Energy is necessary
  - Endothermic – energy is absorbed as heat

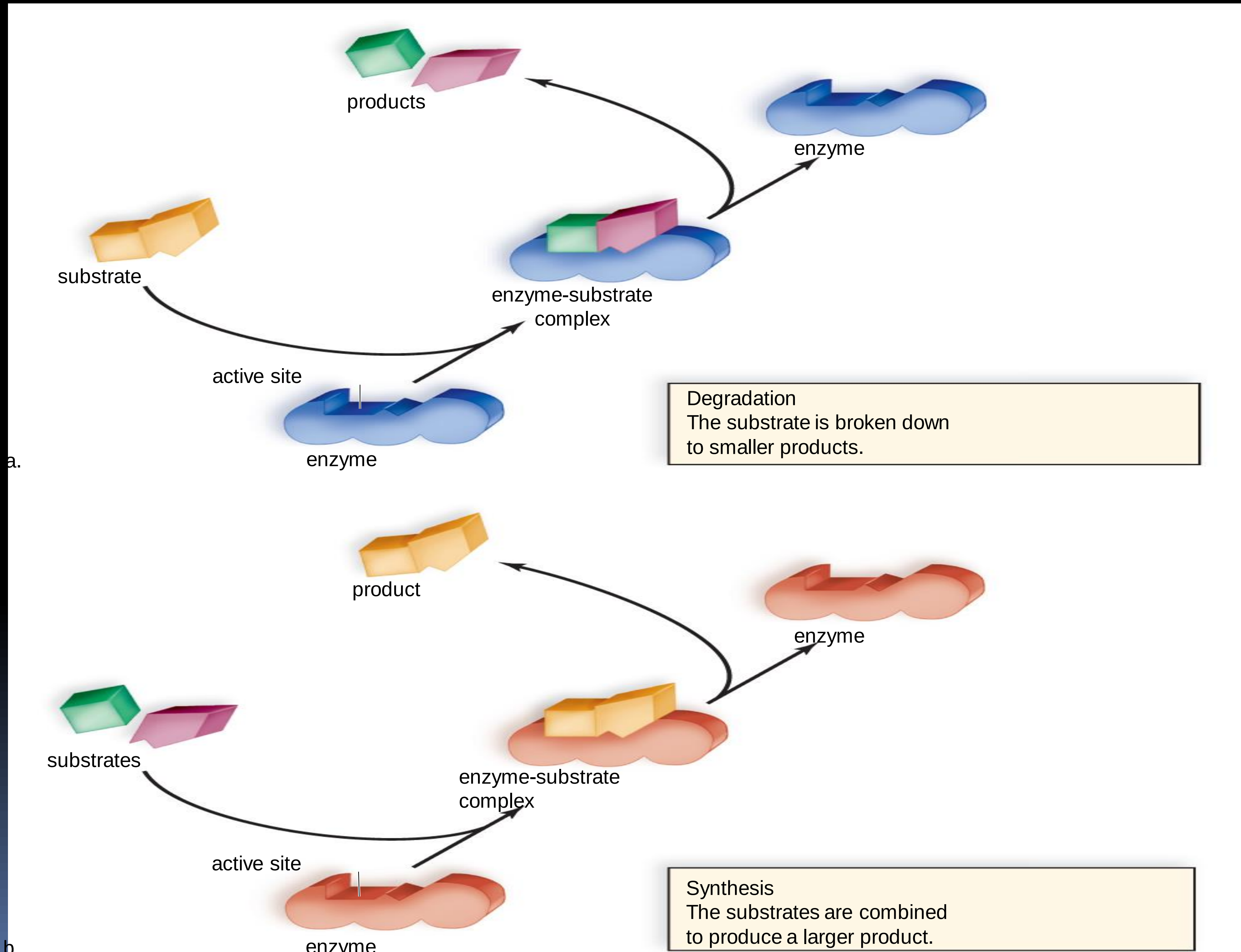
Energy of Activation and Enzymes

- Reactants often “reluctant” to participate in reaction
  - Energy must be added to at least one reactant to initiate the reaction
  - **Energy of activation (Ea)**
  - Catalysts operate by **lowering the energy of activation**
- **Enzymes:**
  - **are Organic Catalysts**
  - Enzyme Lower (Ea) by bringing the substrates into contact with one another

Energy of Activation



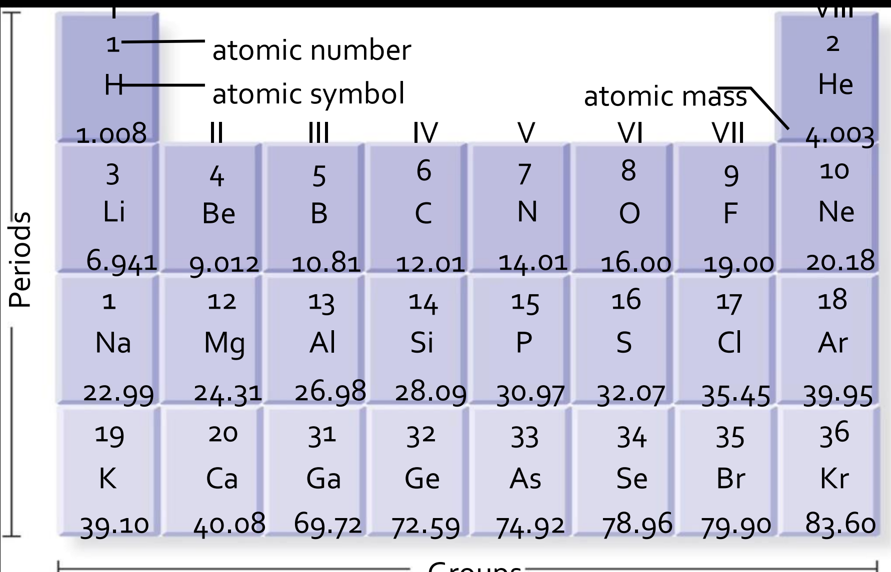
Enzymatic Actions

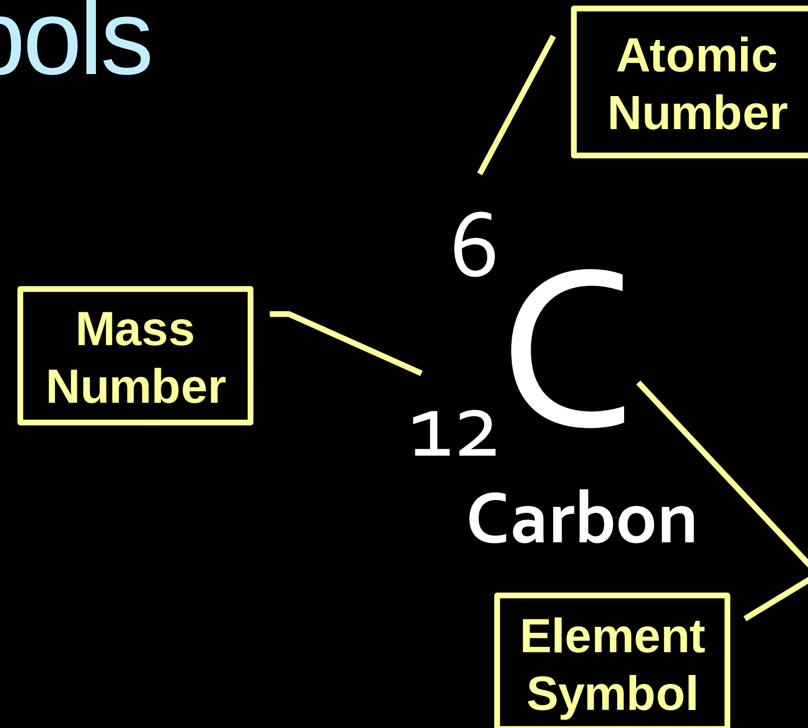


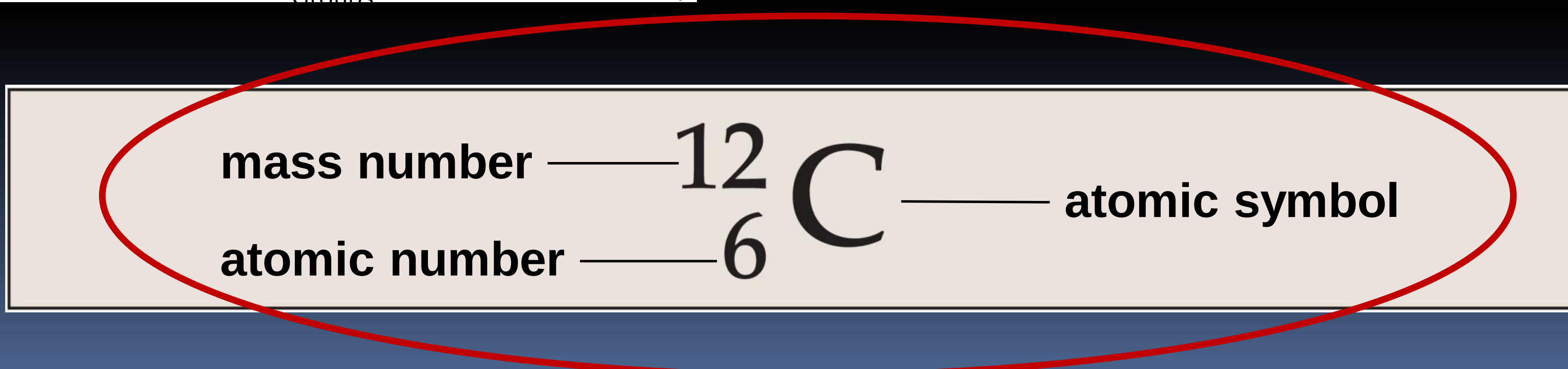
Atomic Symbols

Atomic number = number of protons ($_2$He)

Mass number = number of protons + neutrons (^{4}He)







Periodic Table (Revisited)

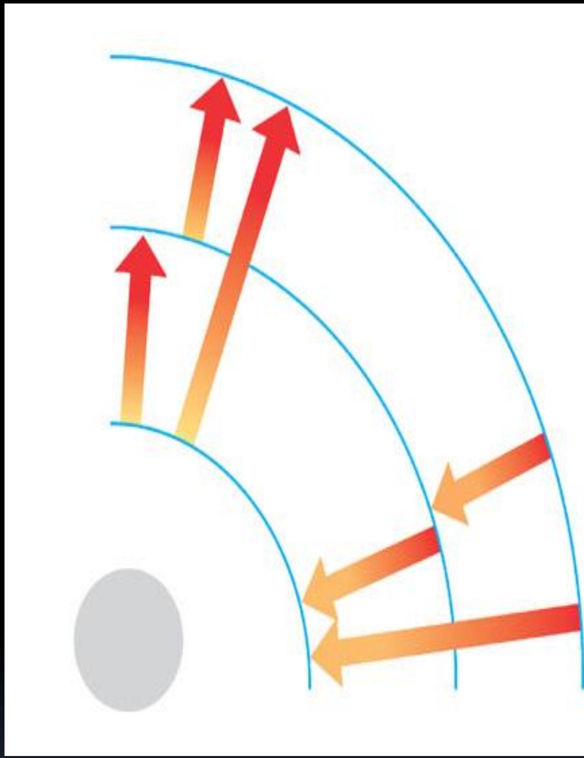
Vertical columns indicate number of electrons in outermost shell

Horizontal periods indicate total number of electron shells

Period	I	II	III	IV	V	VI	VII	VIII
1	1 H 1.008							2 He 4.003
2	3 Li 6.941	4 Be 9.012	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.60

Electrons Configuration

- 1^{st} electron shell = capacity of 2 e^-
- 2^{nd} electron shell = capacity of 8 e^-
- 3^{rd} electron shell = capacity of 18 e^- (but only fills to 8)



- **VALENCE shell** = outer shell (valence = properties)

  -valence electrons: electrons in the outermost shell

  -Atoms "like" to have their valence shell filled (2 or 8)

Question (Test like)

Look at Magnesium ($^{25}_{12}Mg$). How many electron shells does it have? How many valence electrons?

A. 1 shell; 2 valence e-

B. 12 shells; 3 valence e-

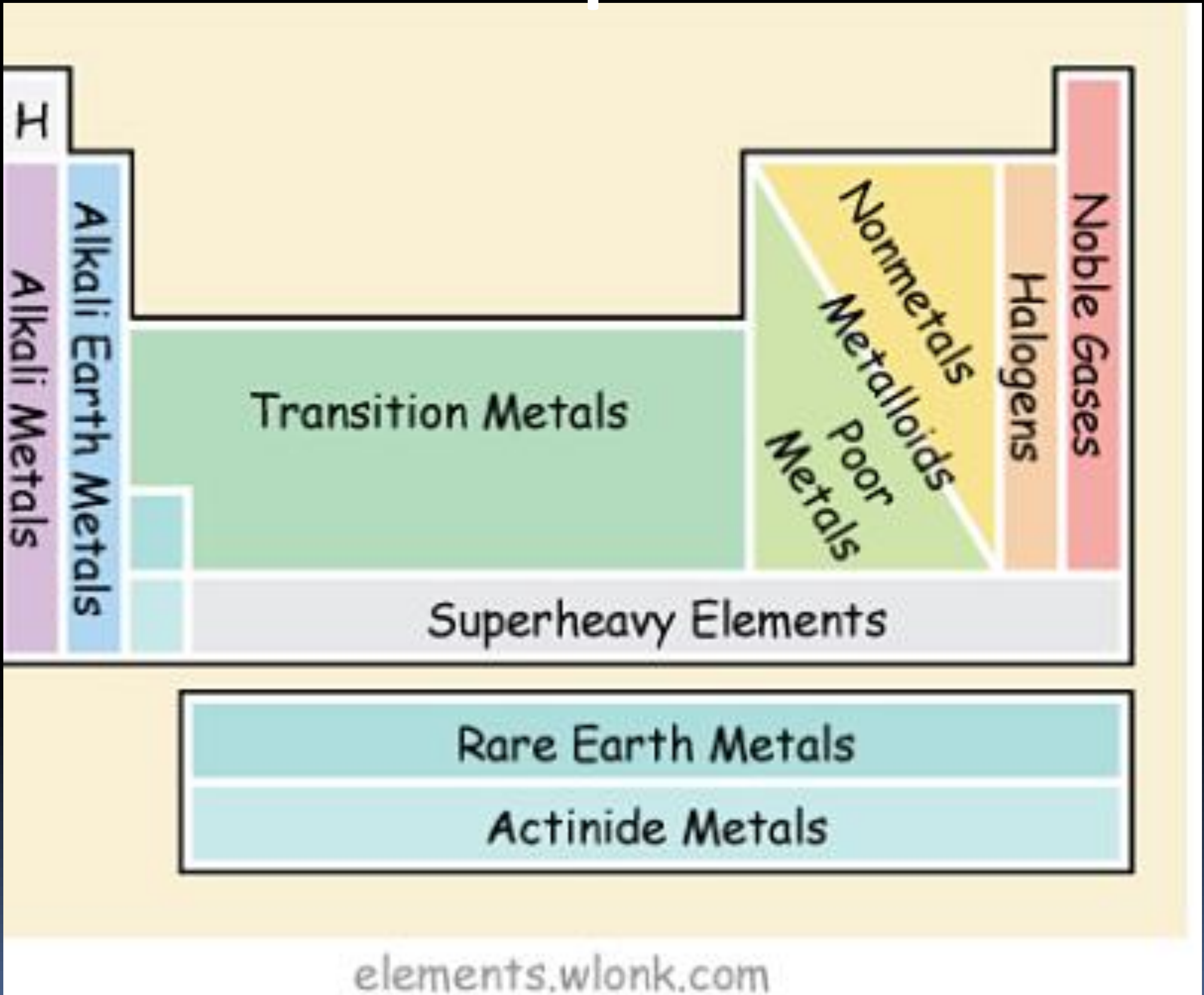
C. 3 shells; 12 valence e-

D. 3 shells; 2 valence e-

Electrons Configuration & Chemical Properties

- The periodic table of the elements shows the electron distribution of each element
- An atom’s chemical properties are due to the configuration of its electrons
- The chemical behavior of an atom is mostly determined by the valence electrons

Chemical Properties:



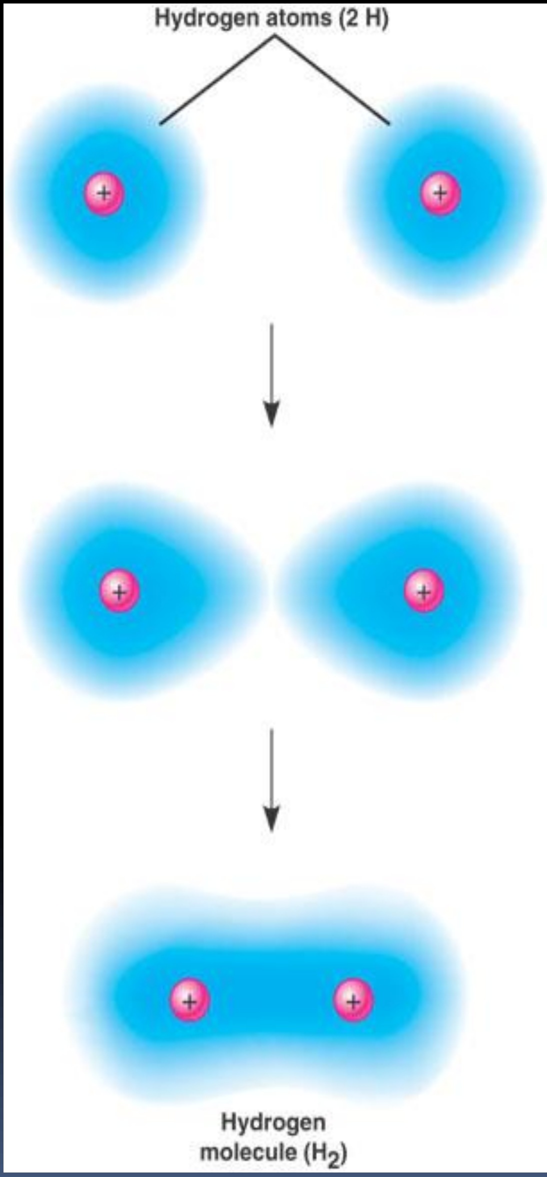
https://www.youtube.com/watch?v=LcUNYGdNKlo

Chemical Bonding

- Atoms are “bonded” together when their electrons interact in one of two ways…

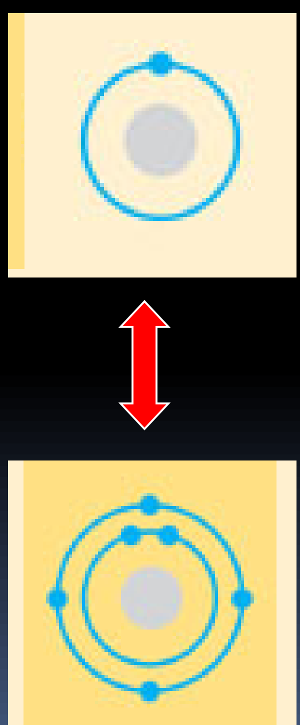
- **Covalent Bonding**
  - Sharing of valence electrons between 2 atoms
  - If the atoms are different, it is a “compound”
  - Electrons are shared in pairs! One pair = single bond, two pairs = double bond, etc.
  - This forms a “molecule” (hydrogen atom vs. molecule)

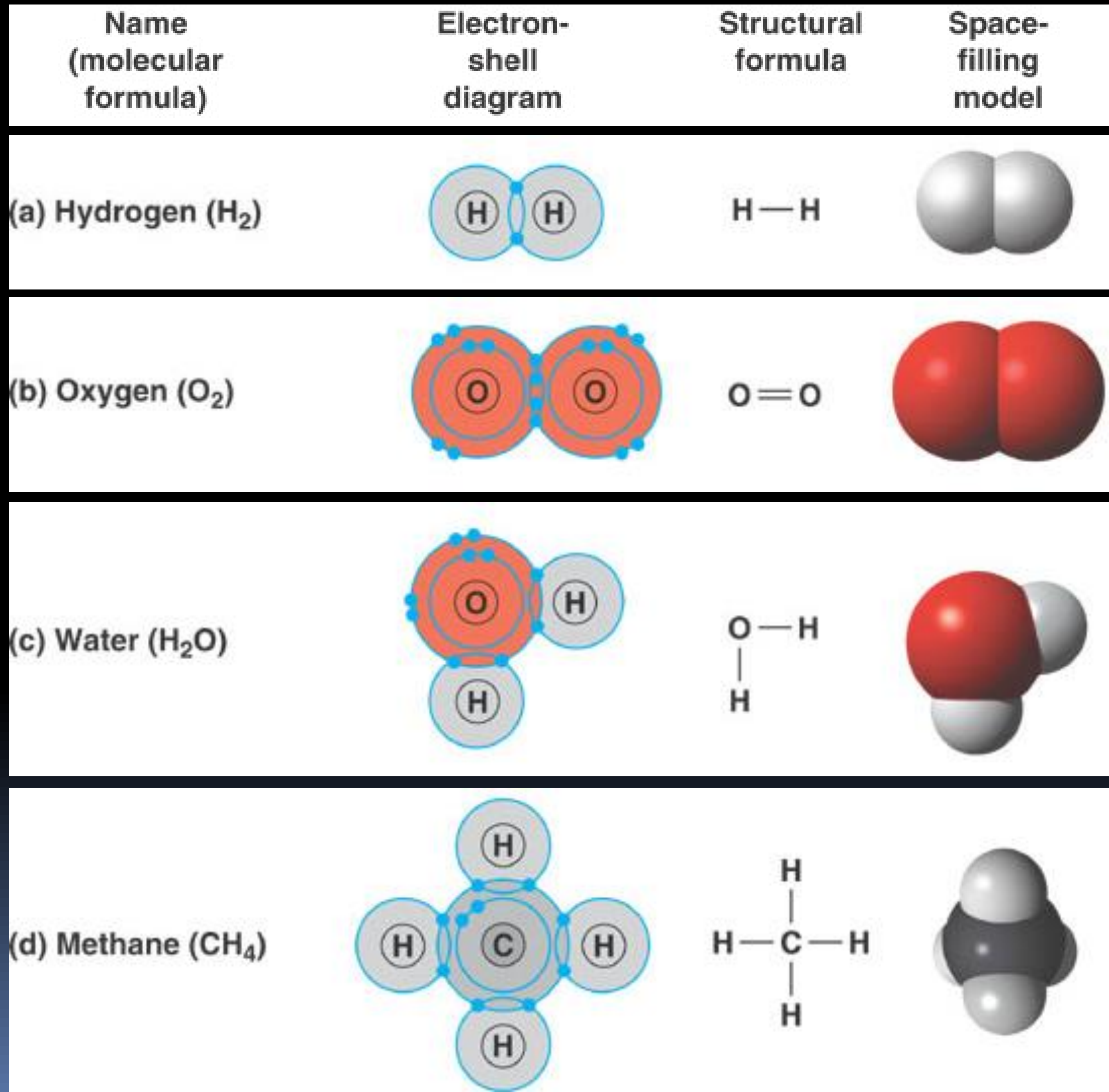
- **Ionic Bonding**
  - Strong electrostatic attraction between two atoms due to transfer of electron(s) from one atom to the other.
- Atoms “want” to bond together in a way that will fill their valence shells. (Valence number = e^- needed)



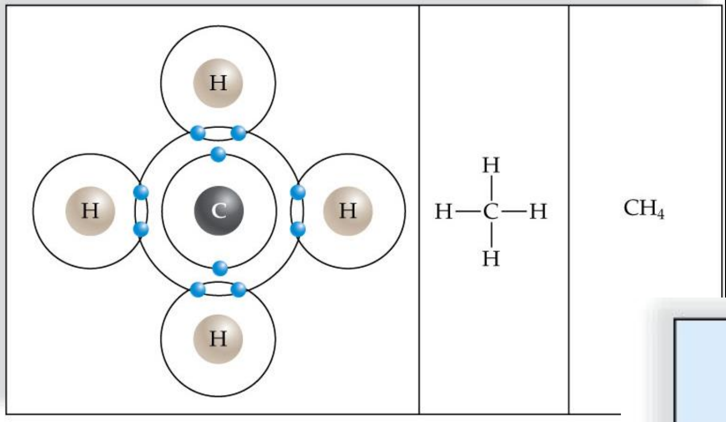
Covalent Bonding

Oxygen

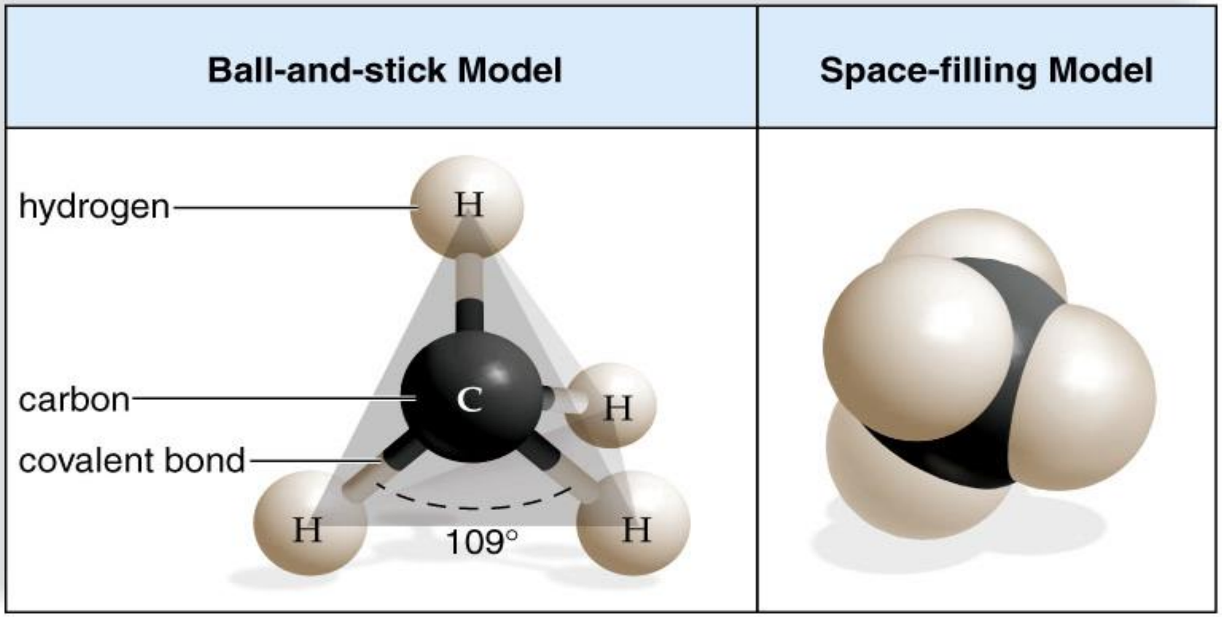




Molecules are in three dimensions!



c. Methane



d. Methane–continued

When an electron pair is shared, the shape of the orbital changes. No longer a "dumbell" around the nucleus, but in a cloud between the two bonded atoms

Electronegativity

- Electronegativity is an atom's attraction for the electrons in a covalent bond
- The more electronegative an atom, the more strongly it pulls shared electrons toward itself
- Remember, atoms to the RIGHT of the periodic table are more **<u>electronegative</u>** than atoms on the left.
- This means, when two atoms are bonded together in a covalent bond, the more electronegative atom will "pull" electrons more toward it and thus… it will have a partial negative charge

Electronegativity

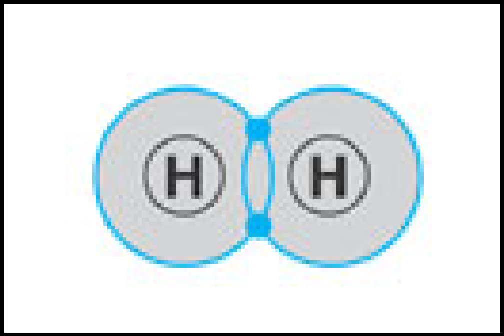
Pauling Electronegativity Values

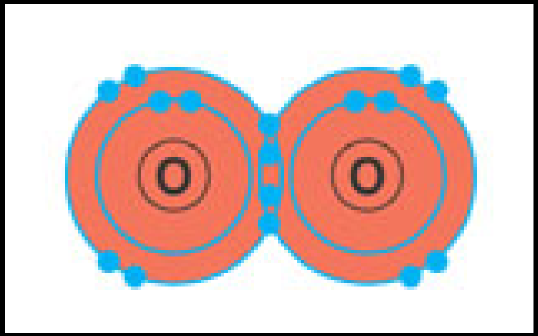
1 **H** 2.20																
3 **Li** 0.98	4 **Be** 1.57											5 **B** 2.04	6 **C** 2.55	7 **N** 3.04	8 **O** 3.44	9 **F** 3.98
11 **Na** 0.93	12 **Mg** 1.31											13 **Al** 1.61	14 **Si** 1.90	15 **P** 2.19	16 **S** 2.58	17 **Cl** 3.16
19 **K** 0.82	20 **Ca** 1.00	21 **Sc** 1.36	22 **Ti** 1.54	23 **V** 1.63	24 **Cr** 1.66	25 **Mn** 1.55	26 **Fe** 1.83	27 **Co** 1.88	28 **Ni** 1.91	29 **Cu** 1.90	30 **Zn** 1.65	31 **Ga** 1.81	32 **Ge** 2.01	33 **As** 2.18	34 **Se** 2.55	35 **Br** 2.96
37 **Rb** 0.82	38 **Sr** 0.95	39 **Y** 1.22	40 **Zr** 1.33	41 **Nb** 1.6	42 **Mo** 2.16	43 **Tc** 1.9	44 **Ru** 2.2	45 **Rh** 2.28	46 **Pd** 2.20	47 **Ag** 1.93	48 **Cd** 1.69	49 **In** 1.78	50 **Sn** 1.96	51 **Sb** 2.05	52 **Te** 2.1	53 **I** 2.66
55 **Cs** 0.79	56 **Ba** 0.89	57 **La** 1.1	72 **Hf** 1.3	73 **Ta** 1.5	74 **W** 2.36	75 **Re** 1.9	76 **Os** 2.2	77 **Ir** 2.20	78 **Pt** 2.28	79 **Au** 2.54	80 **Hg** 2.00	81 **Ti** 1.62	82 **Pb** 2.33	83 **Bi** 2.02	84 **Po** 2.0	85 **At** 2.2
87 **Fr** 0.7	88 **Ra** 0.9															

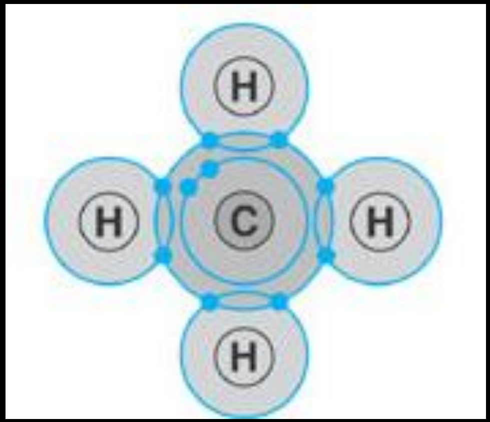
Non-polar vs. polar covalent bonds

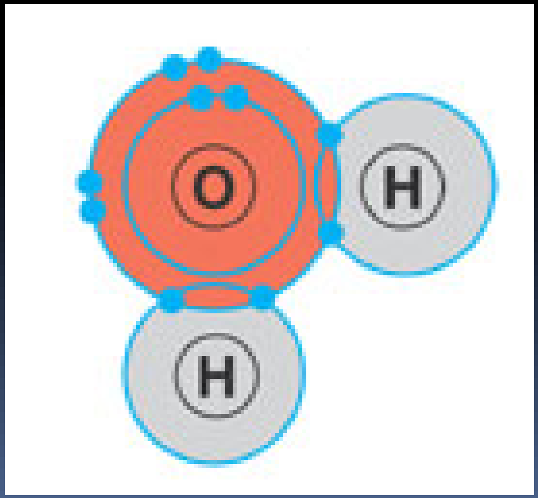
- **Non-polar covalent bonds**
  - Electrons are shared equally between atoms
- **Polar covalent bonds**
  - Electrons are NOT shared equally
  - This is because some atoms have higher “electronegativity”
    - This means they have a stronger attraction for electrons
    - INCREASES toward the RIGHT on the periodic table
  - If the there are differences in electronegativity that are not symmetrical, the molecule will be polar.
  - The shape of the molecule determines where the partial poles will be.

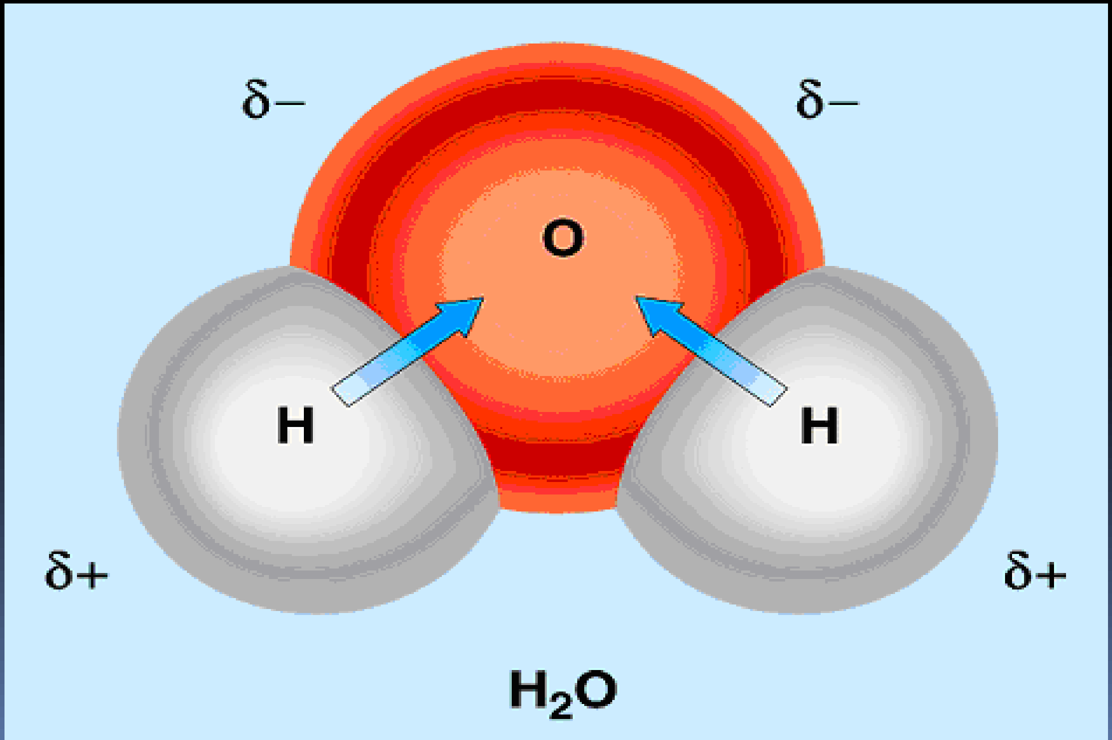
Examples of polar and non-polar





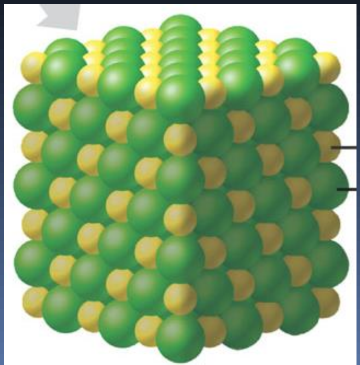


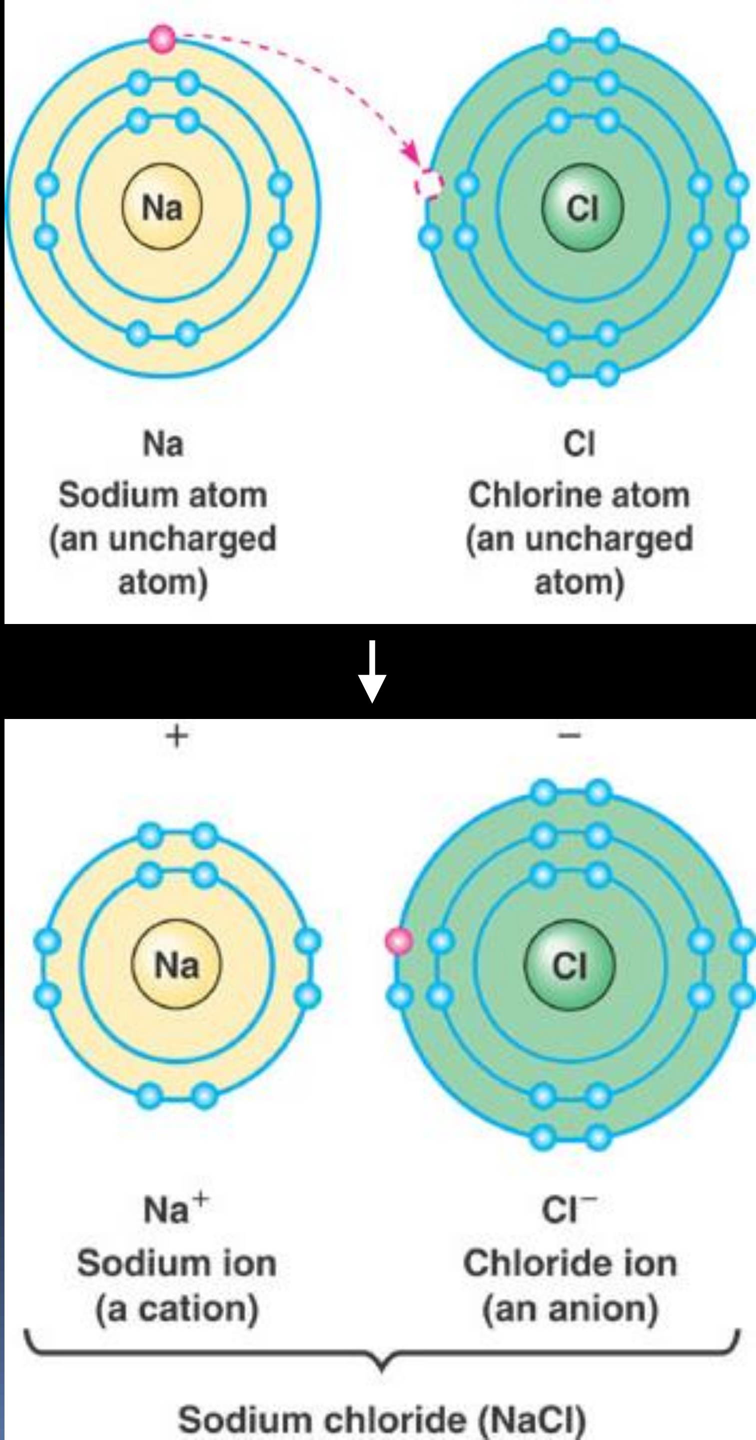




Ionic bonds

- This occurs when one atom actually TAKES an electron(s) from another
- (Just like with covalent bonds…) the goal is to end up with a FULL valence
- Both the DONOR and the Receiver will have full valences!
- Atoms that have an extra or missing electron are charged, called IONS. (+ = cation, - = anion)
- Two complimentary ions come together to form a SALT

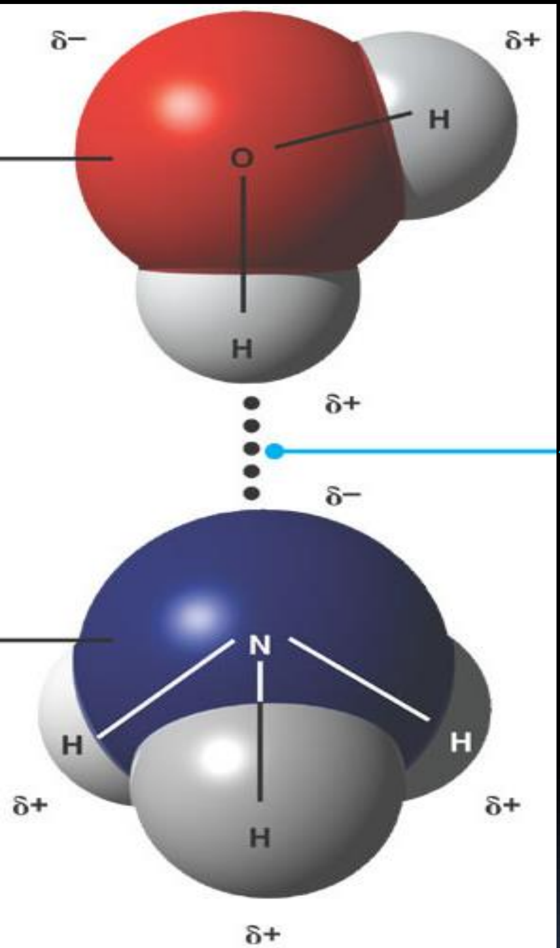




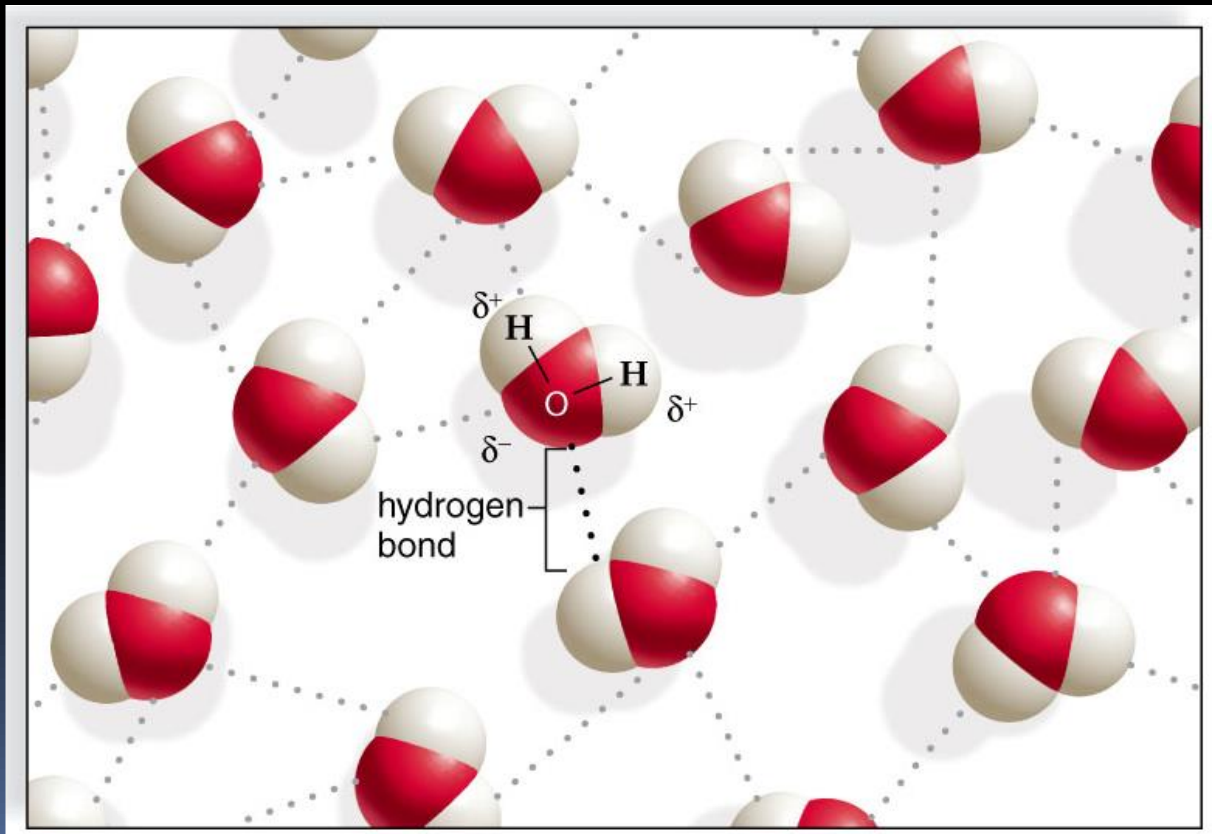
Weak Chemical Bonding

- Attraction between two molecules that is weak and transient (temporary), not a true “bond” because it can be easily broken without changing the chemical nature
- **Hydrogen bonding**
  - Hydrogen atoms are often bound to more electronegative atoms, and are thus slightly positively charged.
  - This slightly positive pole can then attract a negatively charged pole of another molecule.

Hydrogen Bonding



Hydrogen bond



b. Hydrogen bonding between water molecules

Weak Chemical Bonding

- **van der Waals Forces**
  - Because electrons are in constant motion, a molecule can have short-lived “hot spots” of positive and/or negative charge.
  - When molecules are VERY close together, this slight charges can result in attractive or repulsive forces
  - Collectively, such interactions can be strong, as between molecules of a gecko’s toe hairs and a wall surface

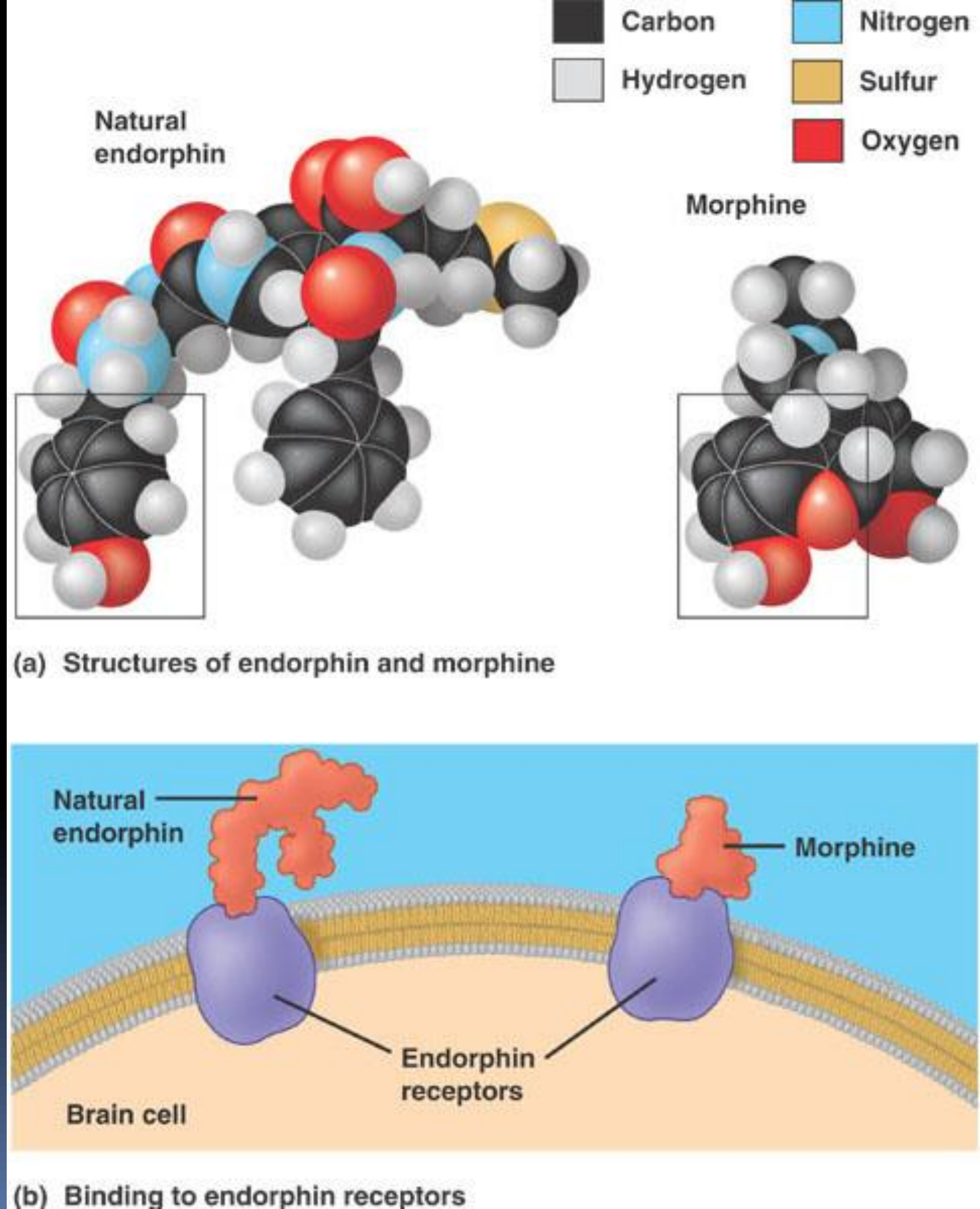
https://www.youtube.com/watch?v=45yabrnryXk
https://www.youtube.com/watch?v=wJ__rbsytjI

Molecular shape and function

- Most of the strongest bonds in organisms are covalent bonds that form a cell's molecules
- Weak chemical bonds, such as ionic bonds and hydrogen bonds, are also important:

  these bonds reinforce shapes of large molecules and help molecules adhere to each other

Shape = Function!



(a) Structures of endorphin and morphine

(b) Binding to endorphin receptors