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 2

1. Pioneers in the Theory of Evolution

a. Carolus Linnaeus (1730's)– father of taxonomy (classification).
Invented binomial nomenclature: *Genus species*

b. Jean-Baptiste Lamarck (Early 1800's) theory of "use and disuse" leading to "inheritance" of acquired characteristics

c. Thomas Robert Malthus (Early 1800) – Limited resources

d. Alfred Russel Wallace and Charles Darwin (1850-60)- Naturalists
Explored the world – articulated common ancestor (evolution)

2. Theory of Evolution

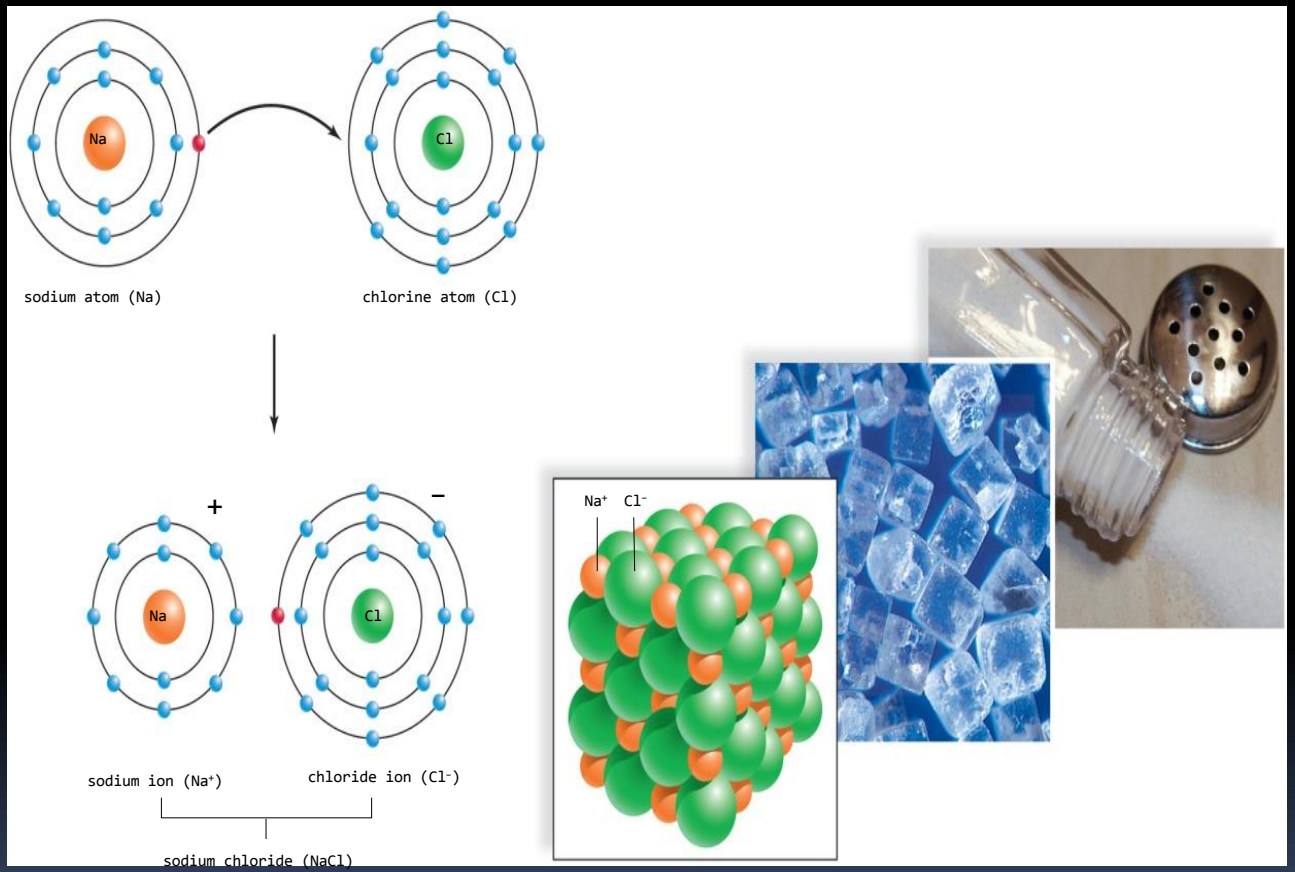
a. Organisms are related
b. Individuals have heritable variations
c. Limited resources
d. Natural Selection
Caused by Adaptation to a changing environment

3. Evidence for Evolution

a. Biogeographical, Anatomical Evidence, Biochemical

http://www.telegraph.co.uk/news/2017/02/18/newly-discovered-weird-life-forms-may-offer-clue-life-mars/

INORGANIC CHEMISTRY



Outline

- Matter, Elements, Compound & Molecules
  - Definitions
  - Formula
- Atoms
  - Subatomic particles
  - Atomic Mass and Atomic Number
  - Atomic symbols
- The Periodic Table
- Isotopes
  - Definition & examples
  - Medical use
  - Electrons and Energy
- Electrons
  - Orbitals and Shells
  - Bohr's model and the Octet Rule
  - Oxidation and Reduction
  - Energy
  - Activation Energy and Enzymes

MATTER

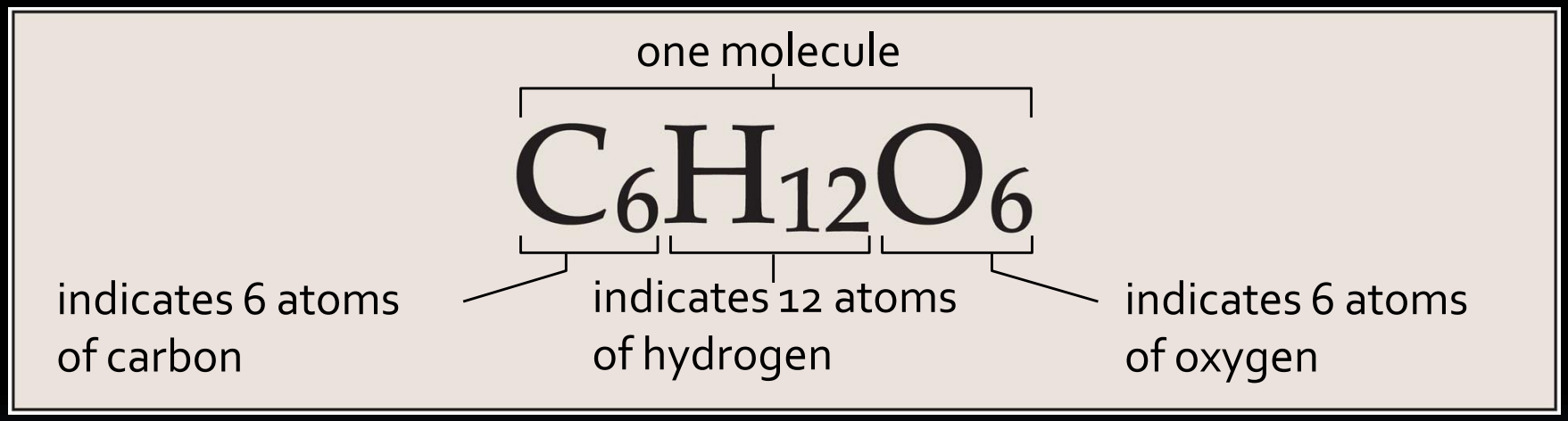
Organisms are made of **matter**

- Matter is defined as anything that has mass and occupies space
- Matter exists in three states: **solid, liquid, and gas**
- All matter (both living and non-living) is composed of 92 naturally-occurring **elements**
- 98% of body weight of organisms are primarily composed of six elements (carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur—acronym CHNOPS) make up 98% of the body weight of organisms.

Elements, Compounds and Molecules

- Matter is made up of elements
- **Element** – pure substance made of ONE type of **atom**. Cannot be broken down, even by chemical reaction.
  - 92 naturally occurring elements
  - 25 are essential to life
  - 96% of biomass is: O,C,H,N
  - CHNOPS make up 98% of the body weight of organisms.
- **Compound** – two or more different elements chemically combined, in a fixed ratio, into a new substance with new properties (emergent properties)
- **Molecule** and compound is used interchangeably
  - In Biology molecule is used e.g. molecule of water (H_2O) molecule of glucose ($C_6H_{12}O_6$)
- **Bonds** that exist between atoms in molecules contain **energy**

Compounds and Molecules: Formula



Glucose

ATOMS

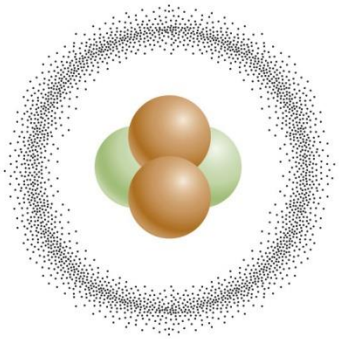
- Atom is the smallest unit of an element
- Atoms composed of subatomic particles:
- The subatomic particles are:
  - **Protons** - positive charge; weight of approximately 1 Dalton, found in the nucleus
  - **Neutrons** - no charge; weight similar to protons, found in the nucleus
  - **Electrons** - negative charge; weigh 1/1836th Dalton; found in electron shell
- Atoms contain specific numbers of **protons**, **neutrons**, and **electrons**.

http://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Anyone Recognize Him?

What's the symbol on his head? →

Subatomic Particles



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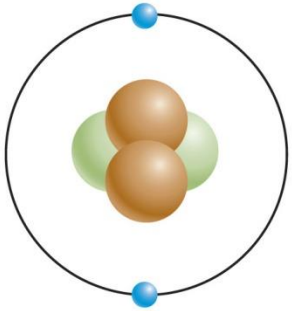

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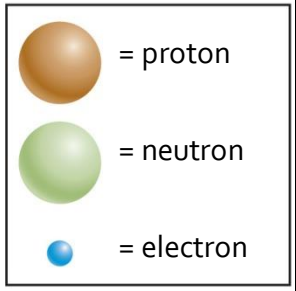
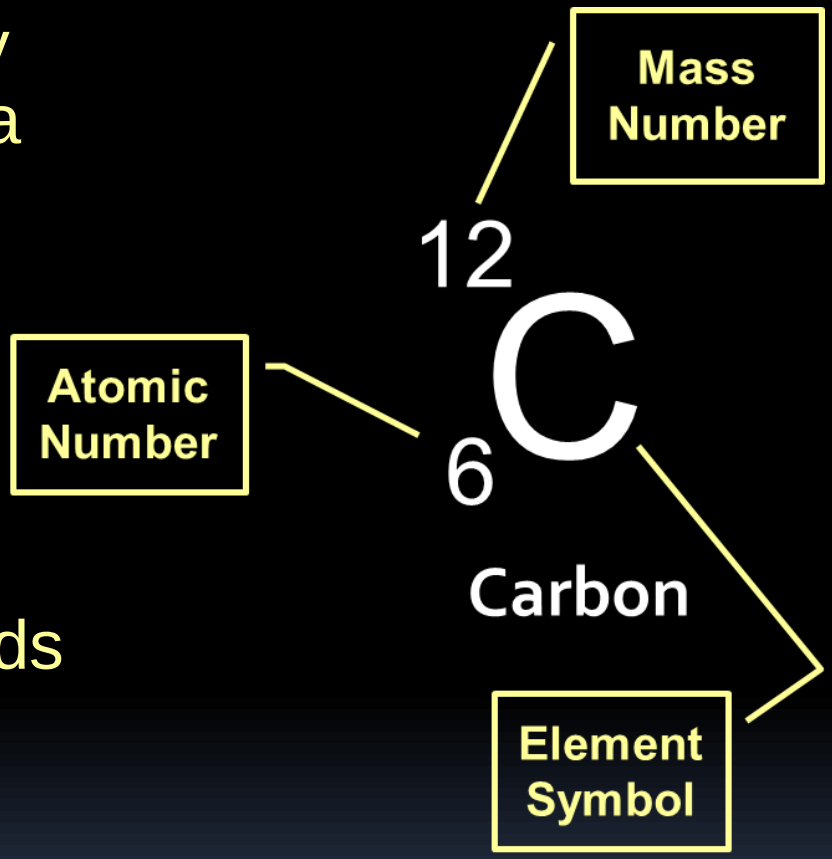


Subatomic Particles			
Particle	Electric Charge	Atomic Mass Unit (AMU)	Location
Proton	+1	1	Nucleus
Neutron	0	1	Nucleus
Electron	–1	0	Electron shell

c.

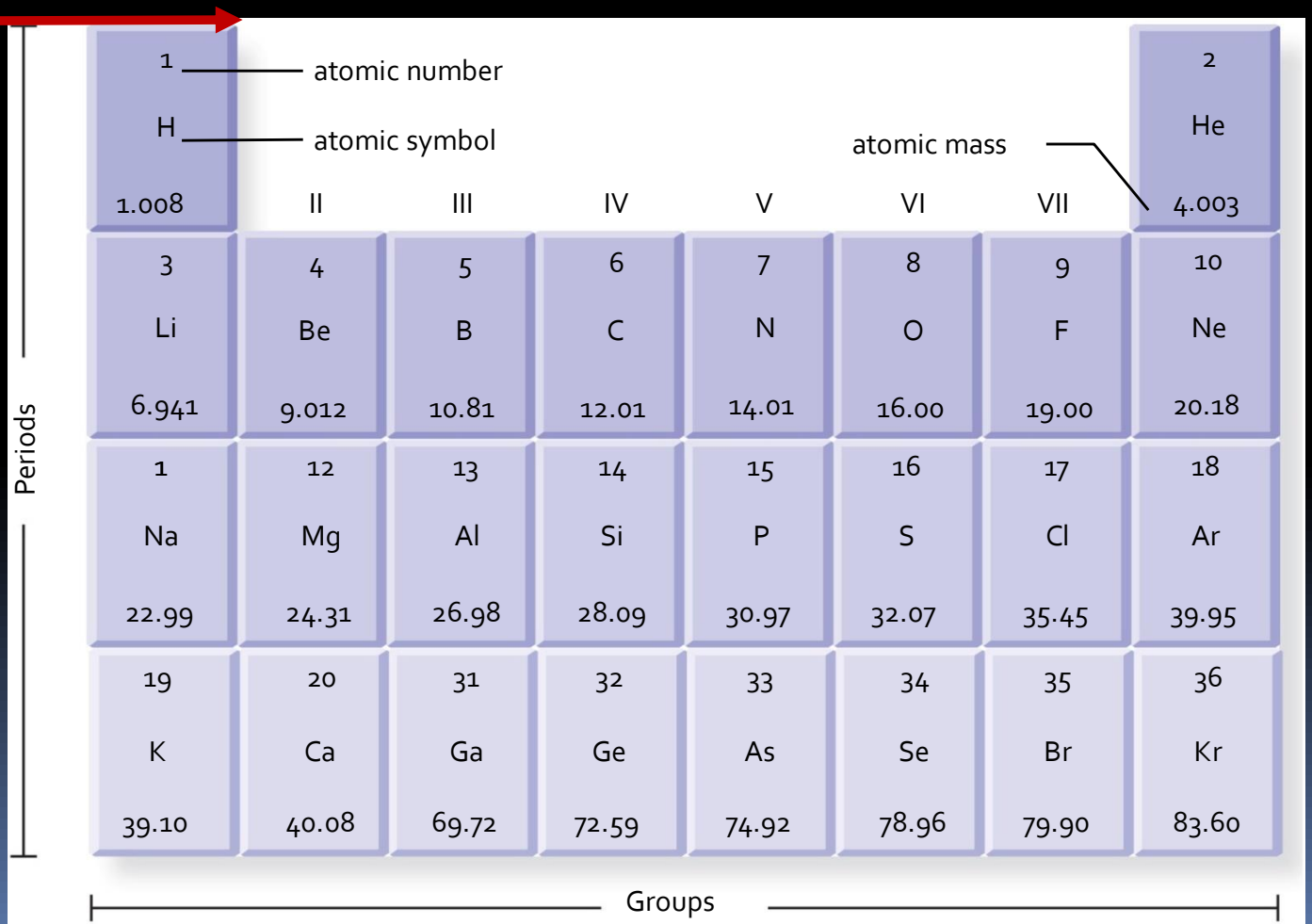
Atomic Symbols

- Each element is represented by one or two letters to give them a unique **atomic symbol**
  - H = Hydrogen, Na = Sodium, C = Carbon
- Each atom has its own specific mass (**atomic mass**)
- Atomic mass of an atom depends on the presence of subatomic particles
  - **Atomic number = proton number;**
  - **Atomic mass or mass number = protons and neutrons**



PERIODIC TABLE

- Elements grouped in periodic table based on characteristics
  - Vertical columns = groups; chemically similar
  - Horizontal rows = periods; larger and larger
- Atomic mass increases as you move down a group or across a period.



ISOTOPES

- **<u>Isotopes</u>** – atoms of an element that have **different numbers of neutrons**
  - Protons are always the same (atomic number)
  - Mass will be different
  - Physical and Chemical properties are the same
  - However… as isotopes get heavy, they become radioactive

$^{12}_{6}C$	$^{13}_{6}C$	$^{14}_{6}C$
Carbon 12	Carbon 13	Carbon 14

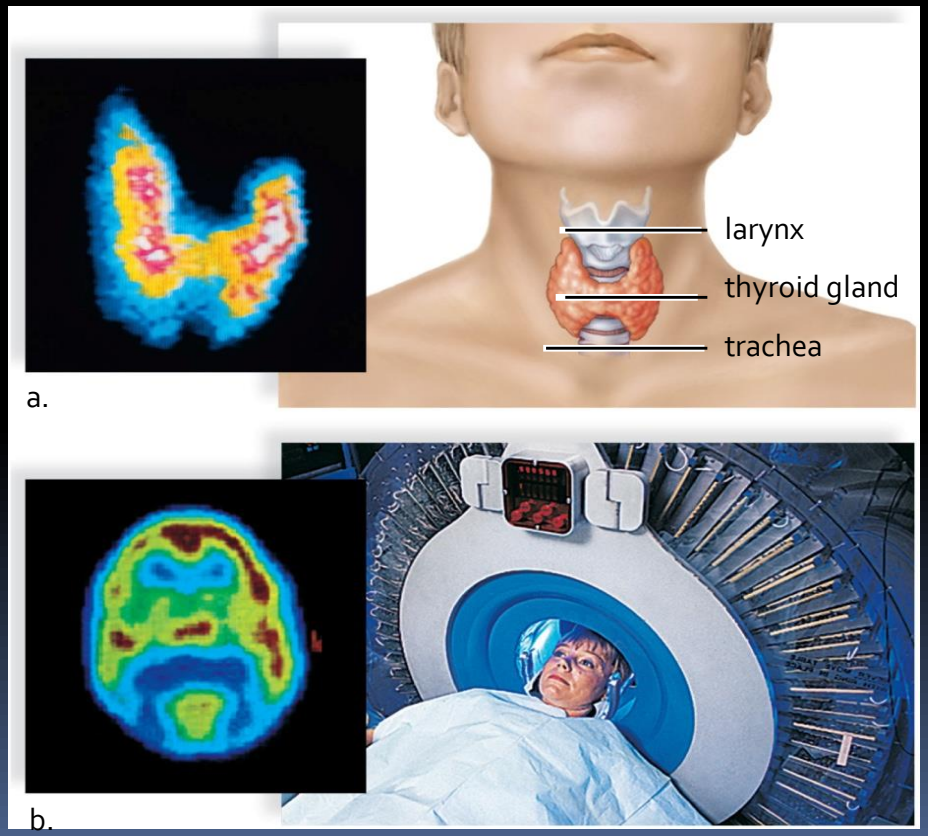
Some isotopes spontaneously decay
- Radioactive
- Give off energy in the form of rays and subatomic particles
- Can be used as tracers
- Mutagenic – Can cause cancer

- Examples
  - Hydrogen: ^{1}H = hydrogen, ^{2}H = deuterium, ^{3}H = tritium
    - "heavy water" = H_2O (with ^{2}H, instead of ^{1}H)
  - Carbon: ^{12}C (~99%), ^{13}C (~1%), ^{14}C
  - Radioactive Isotopes sometimes get an "*" e.g., $^{3}H^*$ or $^{32}P^*$

Some Medical Uses for ISOTOPES

- Low Level Radiation:

MRI, CT, Nuclear Medicine



- High Level Radiation

-Radiation can kill cancer cell

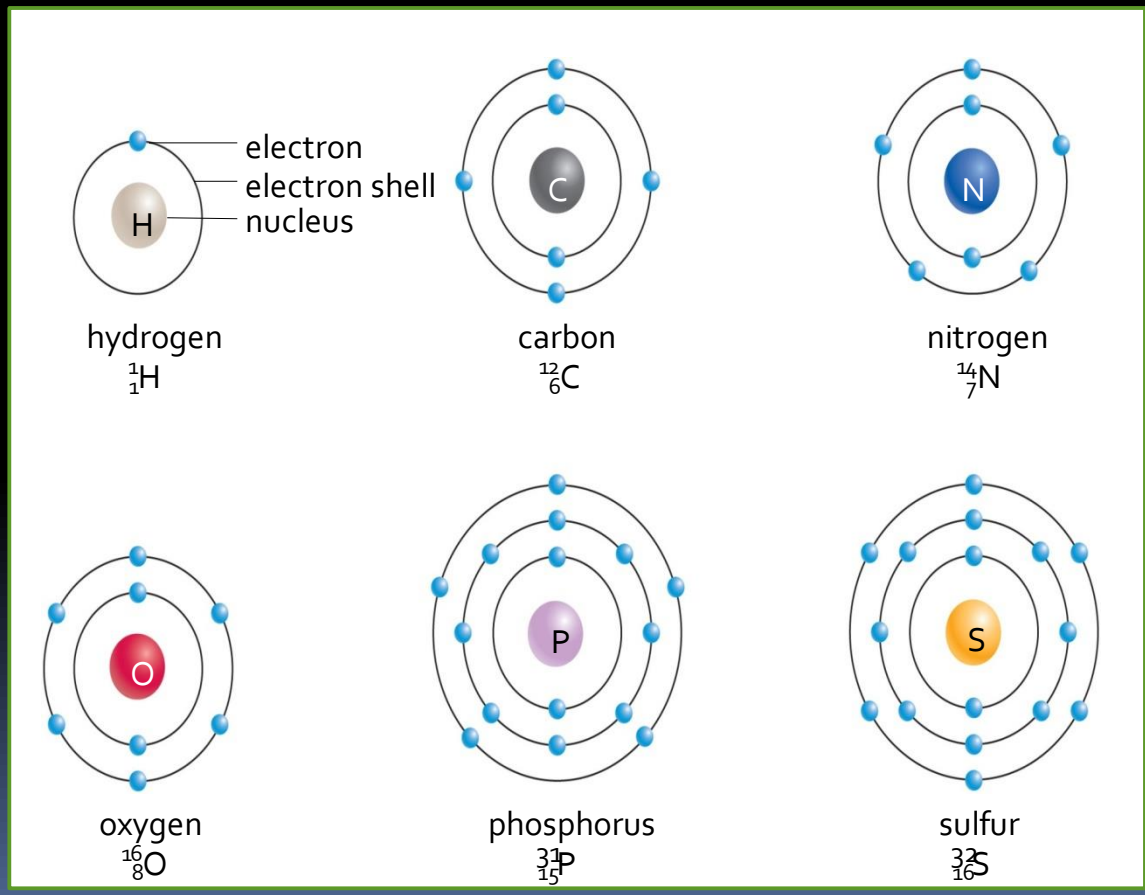
-Radiation can preserve food longer

ELECTRONS

- Atoms ALWAYS have as many electrons as protons
- Opposite charges balance leaving atom neutral
- Electrons are attracted to the positive nucleus
  - Revolve around nucleus in **orbitals**
  - Can be pushed into higher orbitals with energy
  - Release that energy when they fall back to lower orbital
  - **Different energy levels referred to as electron shells**
- **Bonds** between atoms are caused by electrons in outermost shells (called **valence shells**)

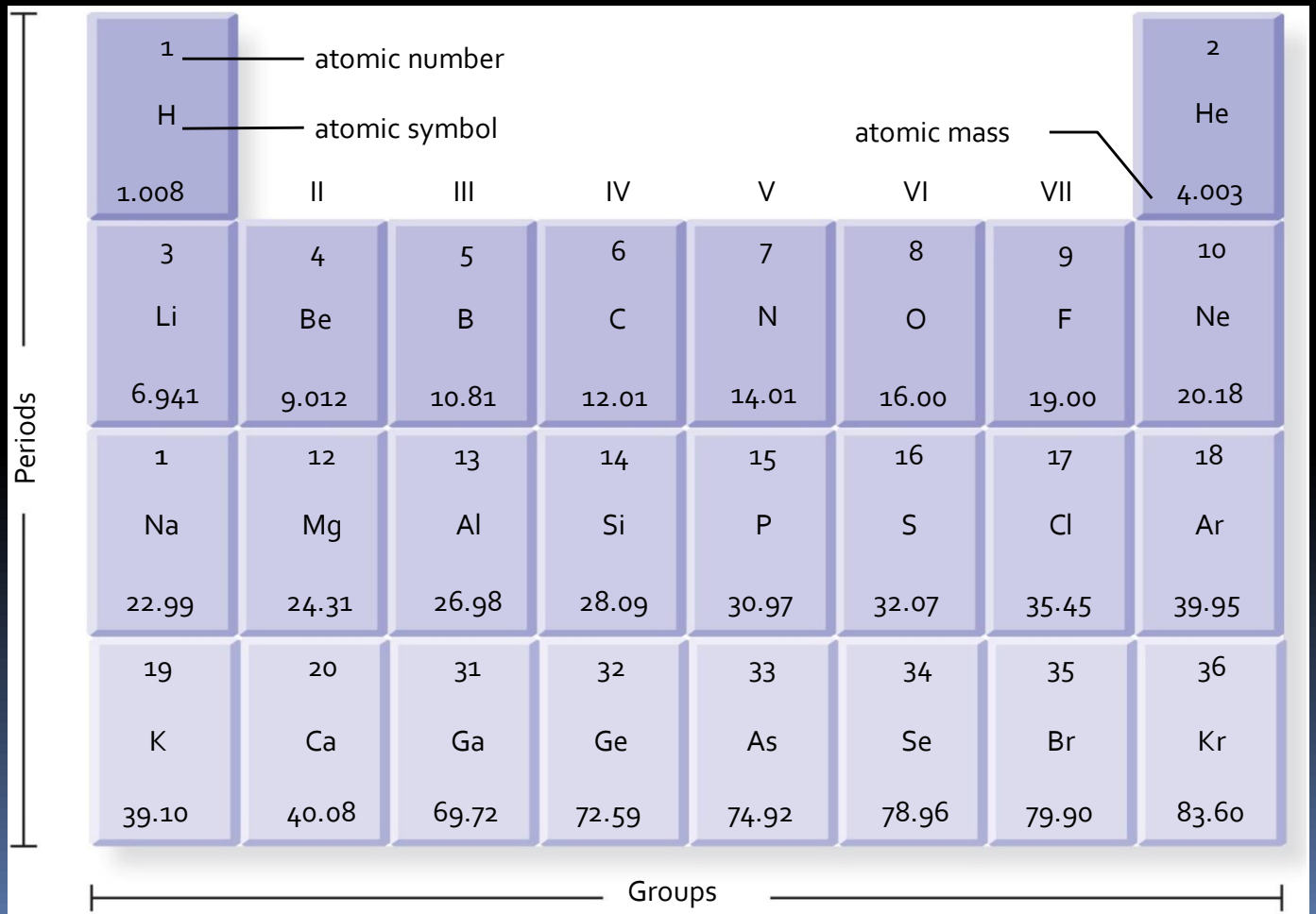
The Octet Rule for Distribution of Electrons

- **Bohr models** show electron shells as **concentric circles** around nucleus
  - Each shell has two or more electron orbitals
    - Innermost shell has two orbitals
    - Others have 8 or multiples thereof
- The outermost electron shell determines the reactivity of the element
  - If 3 or less – Tendency to donate electrons
  - If 5 or more – Tendency to receive electrons



PERIODIC TABLE – Octet Rule

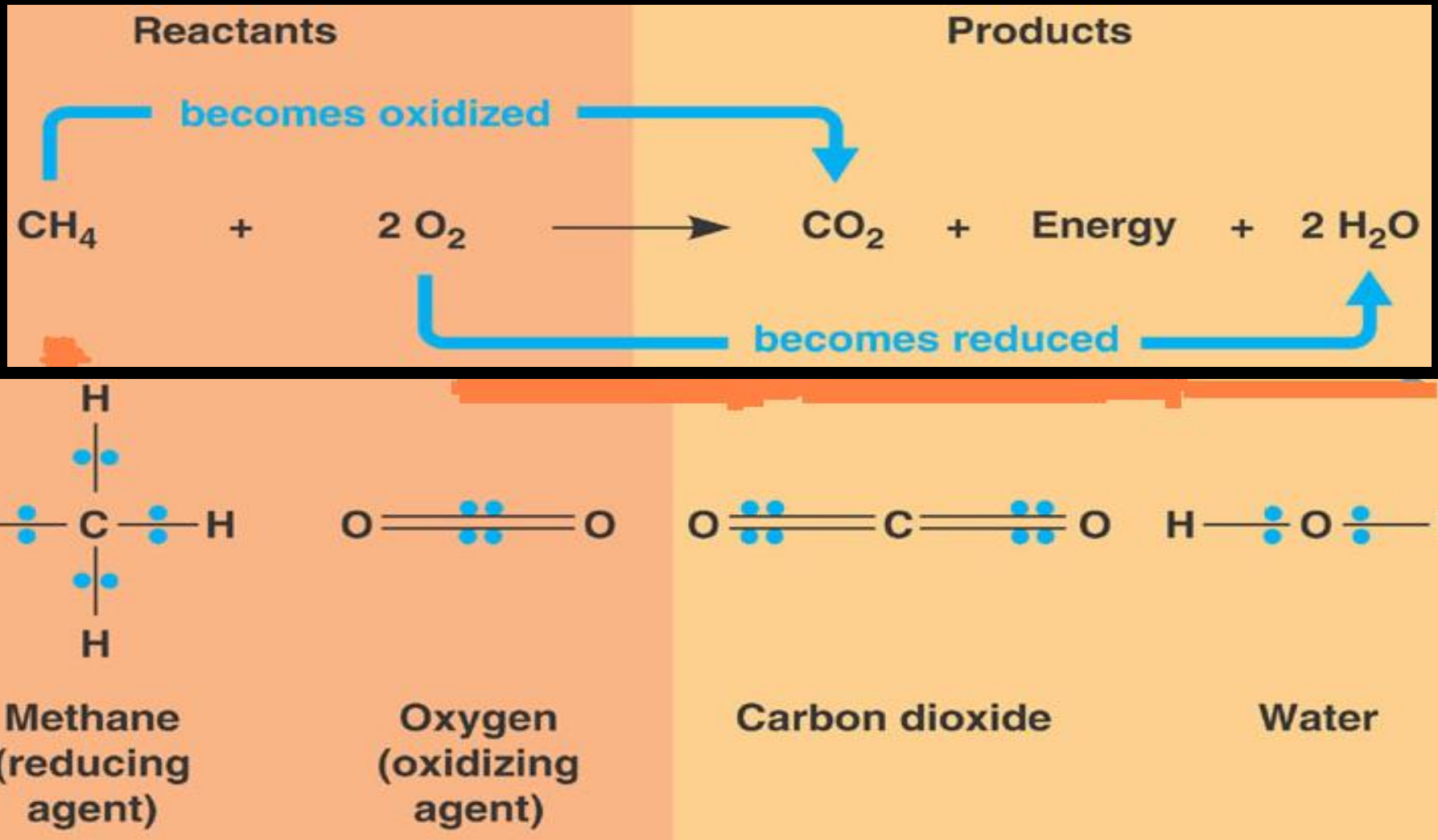
- Elements grouped in periodic table based on characteristics
  - Vertical columns = groups; chemically similar (same number of valence electrons)
  - Horizontal rows = periods; larger and larger (more and more elctrons)
- Atomic mass increases as you move down a group or across a period.



Oxidation-Reduction

- Oxidation-reduction (redox) reactions:
  - Electrons pass from one molecule to another
    - The molecule that loses an electron is ***oxidized***
    - The molecule that gains an electron is ***reduced***
  - Both take place at same time: One molecule accepts the electron given up by the other
- **Oxidation** = loss of electrons
- **Reduction** = gain of electrons
  - *Tip – think "reduction" of charge number*
- Other rules of Redox
  - Gain of O = oxidation, loss of O = reduction
  - Gain of H = reduction, loss of H = oxidation
    - *Tip – the "H" always goes with the e^-'s*
    - *This is because, in redox, the e^-'s are passed as a hydride ion (H^-)*

Examples



- Chemical reactions lead to new arrangements of atoms
- The starting molecules of a chemical reaction are called **reactants**
- The final molecules of a chemical reaction are called **products**

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

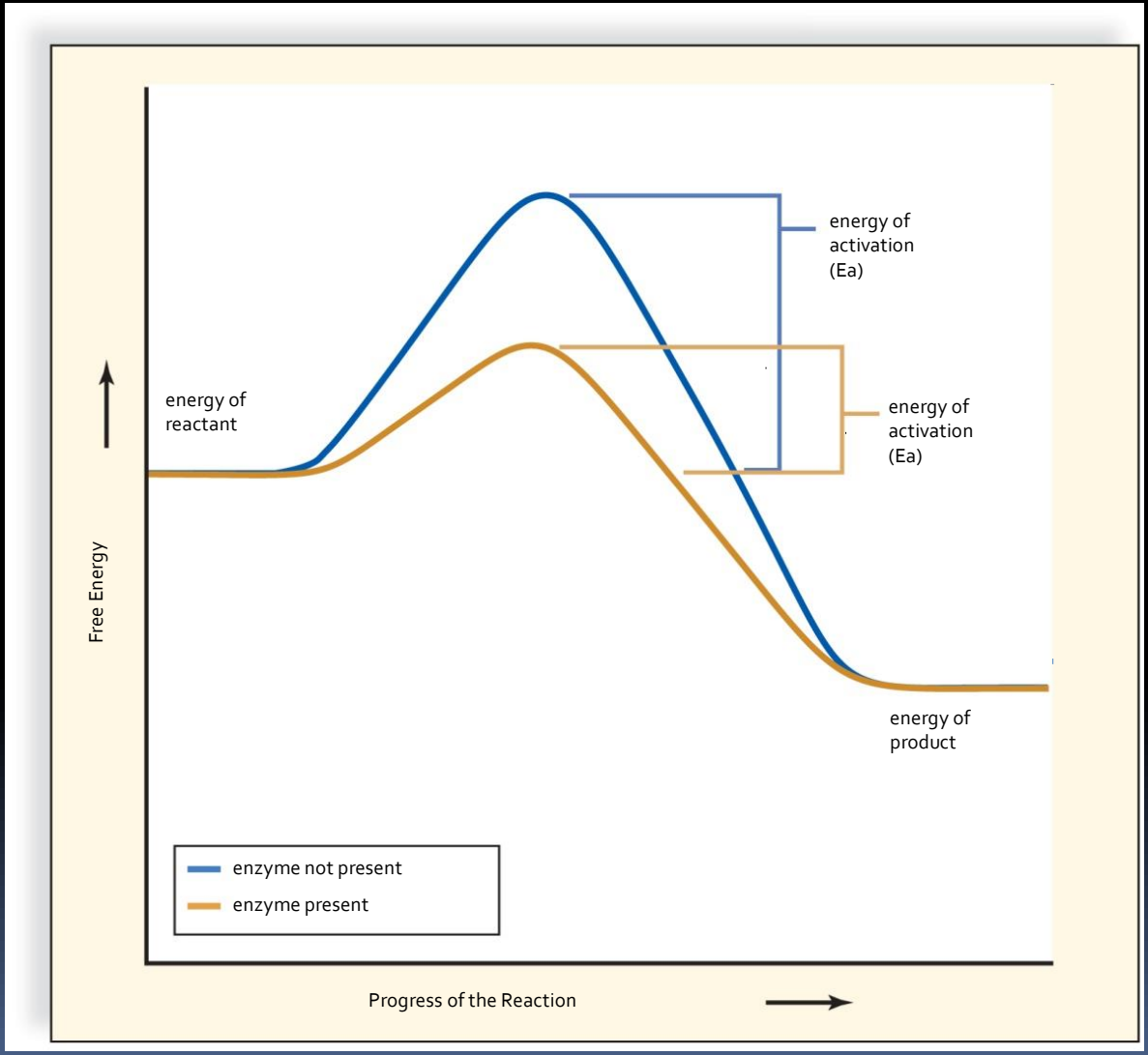
ΔG = -686 kcal/mol !!!!!!!!!

- **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

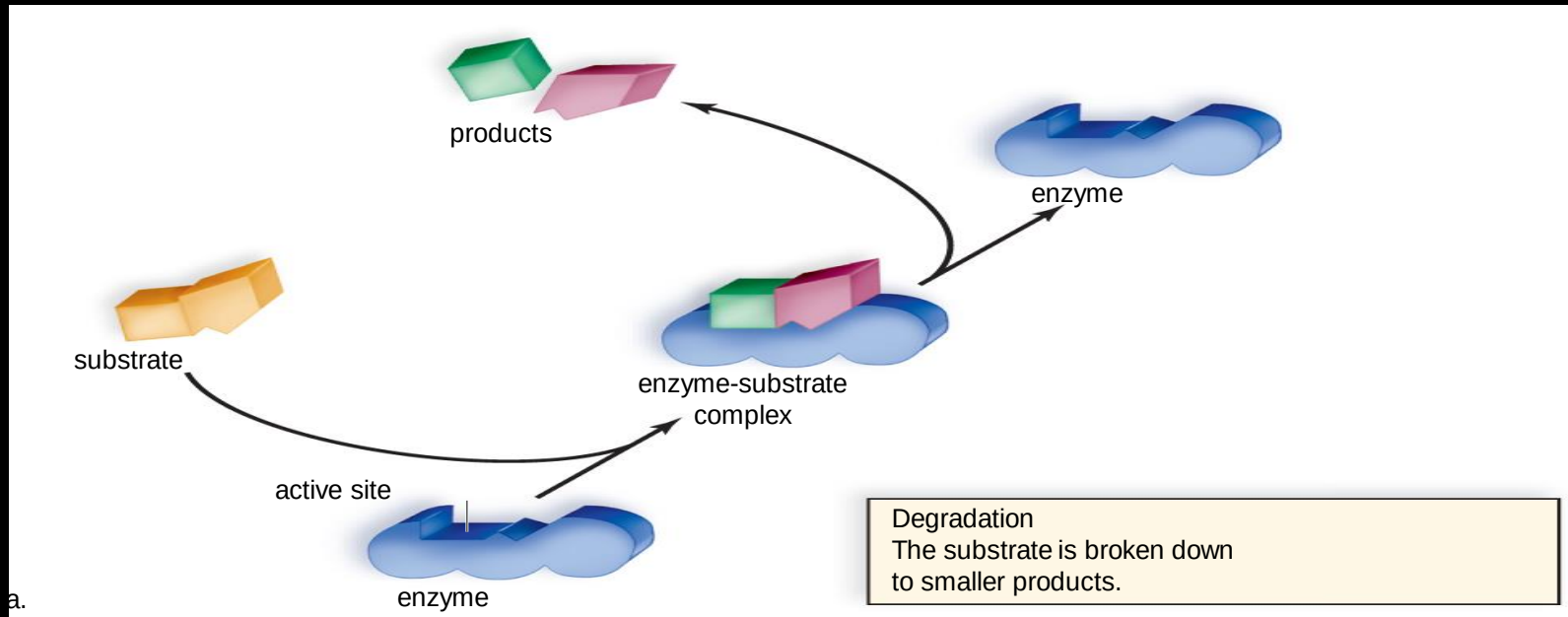
Energy of Activation and Enzymes

- 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



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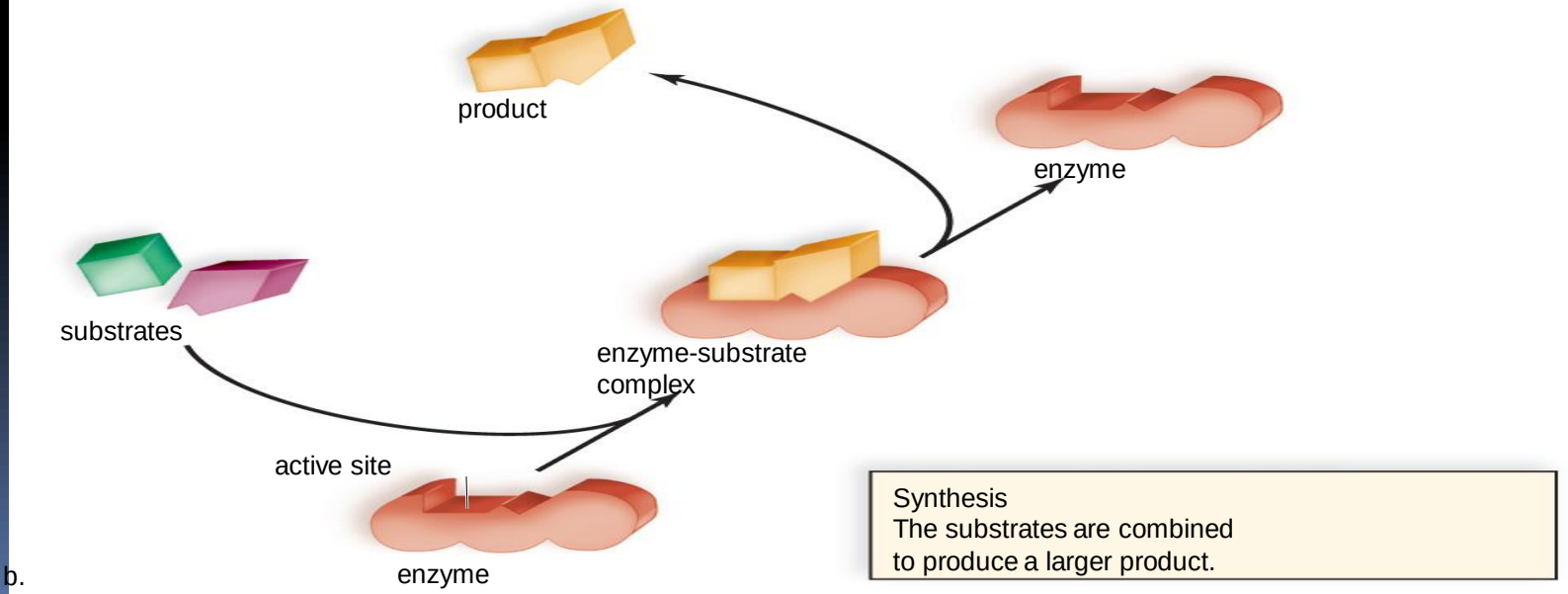

b.