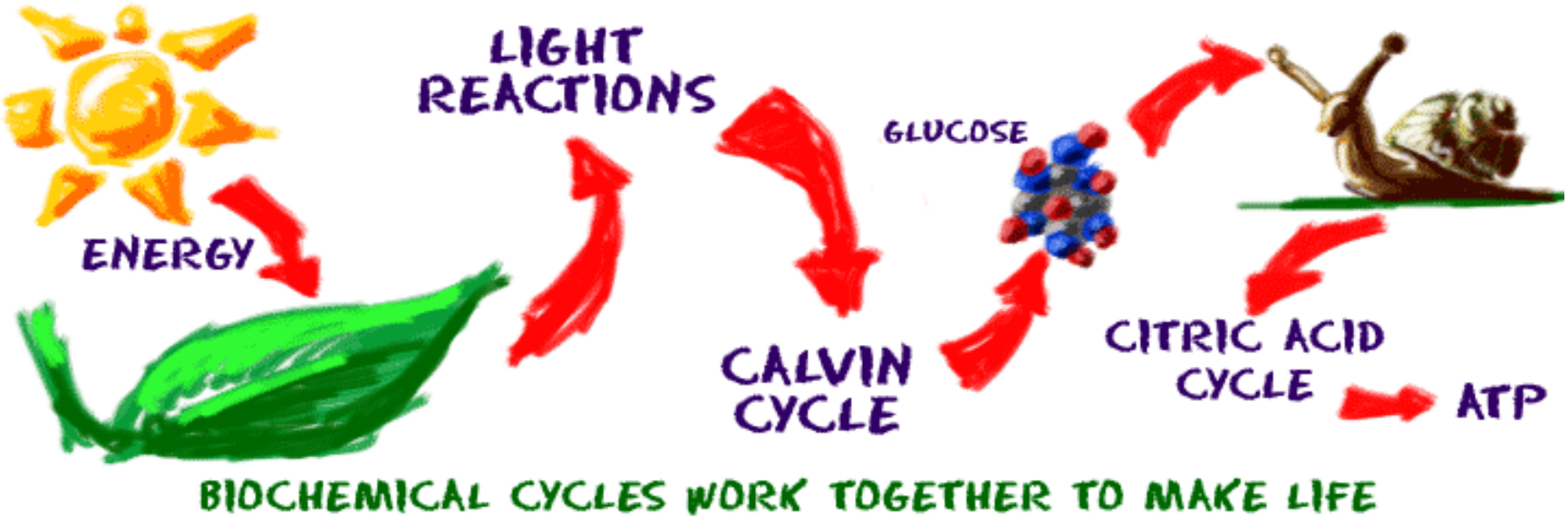
WELCOME to CHM 260
Fundamental Biochemistry



Glendale Community College, AZ

Mrs. Sandy Gruin

- BS in chemistry from Bowling Green State University
- MS in Biochemistry from Montana State University
- NIH research grant University of Pennsylvania Medical School
- Several technical and business management positions in Dupont Co.
- 12+ years teaching college chemistry

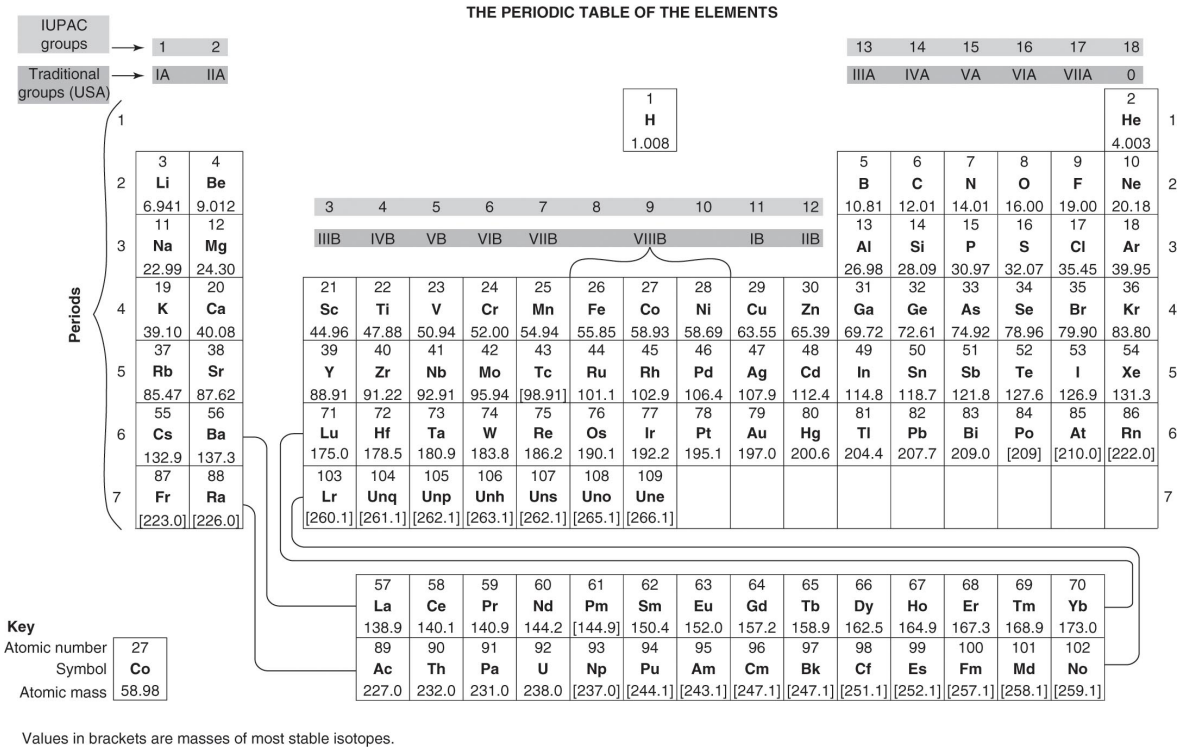
- Grew up in NW Ohio (farm country)
- Sax player in Jazz, Dance, Concert bands
- Pianist
- Always fascinated by chemistry & biology
- Accidental chemist
- Avid tennis player, hiker
  - also golf & pickle-ball
- Artist in Cross-stitch, stain glass, fused glass
- 3 daughters, 1 son, 4 grandsons, 2 granddaughters

Syllabus Review

- Web page: web.gccaz.edu/~san2159818
- Strongly Recommend text: Biochemistry the Molecular Basis of Life
- Attendance mandatory
  - Attendance taken daily
    - Dropped after 3 absences in succession
  - Excused absences
- Course Grading
  - Four exams (50%) – 100 points each
  - Cumulative Final(25%) – 200 points
  - 10 Quizzes (12%) – 10 points each
    - Cannot be made up
  - Study Guides
- Special Topic Presentation (13%) – 100 points
  - Group presentation (2 to 3)
  - Powerpoint presentation or other creative way of presenting

Overview

- **Section 1:** General Chemistry
- **Section 2:** Organic Chemistry

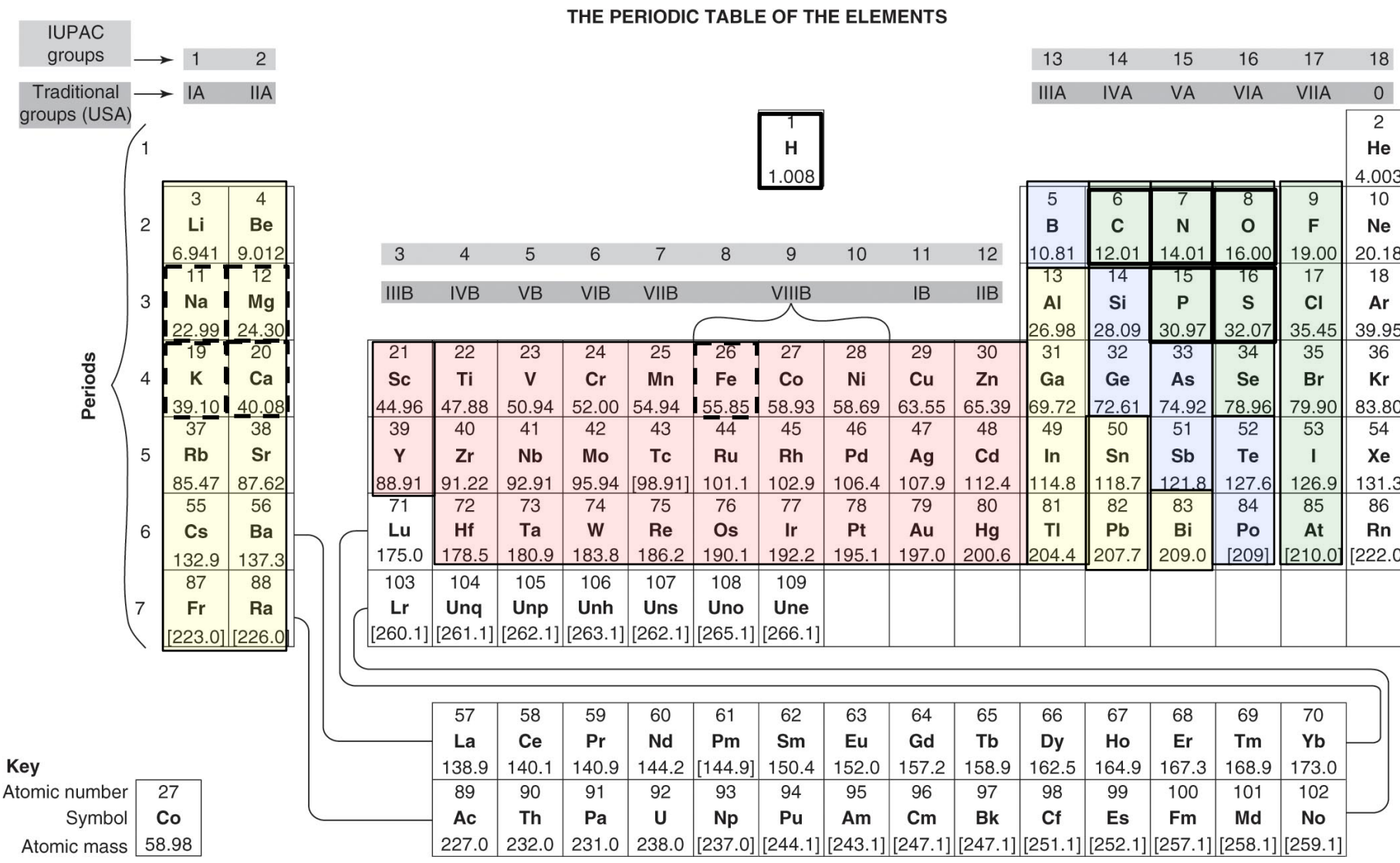


Life: It is a Mystery!

- **General Chemistry**
  - Chemistry is the investigation of matter and the changes it can undergo
  - Each chemical element is a pure substance composed of one type of atom
  - 118 known elements (4 have just been added)
  - Elements fall into three categories:
    - Metals (like sodium, gold, and iron)
    - Nonmetals (like oxygen and nitrogen)
    - Metalloids (like silicon and boron)
      - Metalloids include elements with properties intermediate between metals and nonmetals

- **Atomic Structure: The Basics**
  - Atoms are the smallest units of an element that retain the properties of that element
  - Atomic structure consists of positively charged central nucleus surrounded by one or more negatively charged electrons
    - Nucleus contains positively charged protons and neutrons - no charge
    - Exception: Hydrogen
  - Ions form when atoms lose electrons (cations) or gain an electron (anions)

- **Atomic Number and Mass Number**
  - Atomic number of an element is the number of protons in its nucleus
  - Atomic number uniquely identifies an element
  - Mass number of an element is equal to the number of protons and neutrons
    - Measured in atomic mass units
  - Isotopes are atoms of an element with different numbers of neutrons
    - Some isotopes are radioactive, meaning they undergo a spontaneous process in which an atomic nucleus undergoes a change accompanied by an energy emission



- **Chemical Bonding**
  - Chemical bond is a strong attractive force between atoms in a chemical compound
  - **Two major types**
    - Ionic bonds
      - Electrons are transferred from atoms with a tendency to release electrons to electronegative atoms that tend to gain electrons.
    - Covalent bonds
      - Electrons are shared between atoms with similar electronegativity values
        - Polar covalent bonds
        - Coordinate covalent bonds

- **Chemical Reactions**
  - Atoms in chemical substances are rearranged to form new substances
  - Reaction rate in bimolecular reactions depends on the frequency of successful collisions between the chemical species
  - Successful collision occurs when there is sufficient *activation energy*
  - Reactants appear on the left, products appear on the right

$$A + B \rightarrow C + D$$

- **Reaction Kinetics**
  - Reaction rate is the change in the concentration of reactant or product per unit time

$$aA + bB \rightarrow cC + dD$$

  - Chemical equations tell us nothing about:
    - How fast the reaction occurs
    - Ratio of final product to reactant molecules
    - Whether the reaction requires or releases energy
  - Factors influencing reaction rate:
    - Reactant structure
    - Reactant concentration
    - Physical state
    - Temperature
    - Catalysts

- **Chemical Reactions and Equilibrium Constants**
  - Many reactions are reversible; will reach equilibruim

$$aA + bB \leftrightarrow cC + dD$$

    - K_{eq} - ratio of the molar concentrations of product to reactant, each of which is raised to the power of its coefficient

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

  - Le Chatelier's Principle
    - For a chemical reaction at equilibrium a change in the conditions of the reaction triggers a shift in the equilibrium to counteract the change

- **Acid-Base Equilibria and pH**
  - When acids and bases dissolve in water, they dissociate, forming ions
  - Weak acids and weak bases - dissociate only to a limited extent and establish a dynamic equilibrium with their ions
  - Behavior of weak acids and bases is especially important in biochemistry because many biomolecules possess carboxylate, amino, and other functional groups that can accept or donate hydrogen ions
    - Water also has a slight capacity to dissociate into ions

- **Reaction Types**
  - Synthetic reactions involve two or more substances combining to form a single new substance
  - Decomposition reactions involve a compound breaking down into simpler products
  - Displacement or substitution reactions involve a more reactive element replacing a less active element
  - Double displacement reactions involve two compounds exchanging ions to form two new compounds
  - Redox reactions involve the exchange of electrons between chemical species

Organic Chemistry

- Organic chemistry is the investigation of carbon-containing compounds
  - Carbon can form stable covalent bonds with other carbon atoms to form long chains, branch chains, and rings
  - Carbon also forms stable covalent bonds with a number of other elements
  - Carbon can form carbon-carbon double and triple bonds
  - Two major classes of organic molecules
    - Hydrocarbons
    - Substituted hydrocarbons

- **Hydrocarbons**
  - Hydrocarbons are nonpolar and hydrophobic; C and H
  - Four groups:
    - Saturated hydrocarbons (molecules containing only single bonds)
    - Unsaturated hydrocarbons (molecules with one or more carbon-carbon double or triple bonds)
    - Cyclic hydrocarbons (molecules containing one or more carbon rings)
    - Aromatic hydrocarbons (molecules that contain one or more aromatic rings, which can be described as cyclic molecules with alternating double and single bonds)

- **Substituted Hydrocarbons**
  - Replacing one or more hydrogens on hydrocarbon molecules with functional groups
  - Functional group is a specific group of atoms within a molecule that is responsible for the molecule's chemical reactivity
  - Functional groups also separate the substituted hydrocarbons into families
  - Three general classes of functional groups are important to biomolecules: oxygen-containing, nitrogen-containing, and sulfur-containing

Organic Chemistry

- **Functional groups of organic molecules**
  - Alcohols – hydroxyl group, R-OH
  - Aldehydes – carbonyl group, R-CHO
  - Amines – amino group, R-NH_2
  - Ketones - carbonyl group and two R groups, R-CO-R
  - Carboxylic acids - carboxyl group, R-COOH
  - Esters – ester group, R-COOR
  - Ethers – ether group, ROR
  - Thiols – sulfhydryl group, RSH

- **Organic molecules with nitrogen-containing functional groups**
  - Amines
    - Organic molecules considered derivatives of ammonia
    - Enormous number of biological molecules contain amine nitrogens (amino acids, alkaloids, etc.)
  - Amides
    - Amine derivatives of carboxylic acids
    - Neutral molecules

- **Organic Reactions**
  - Large number of organic reaction types
  - Beyond the reactions already described, there are two additional reaction classes in organic chemistry:
    - **Aliphatic substitution reactions**
    - **Aliphatic elimination reactions**

Substitution Reactions

Figure 12

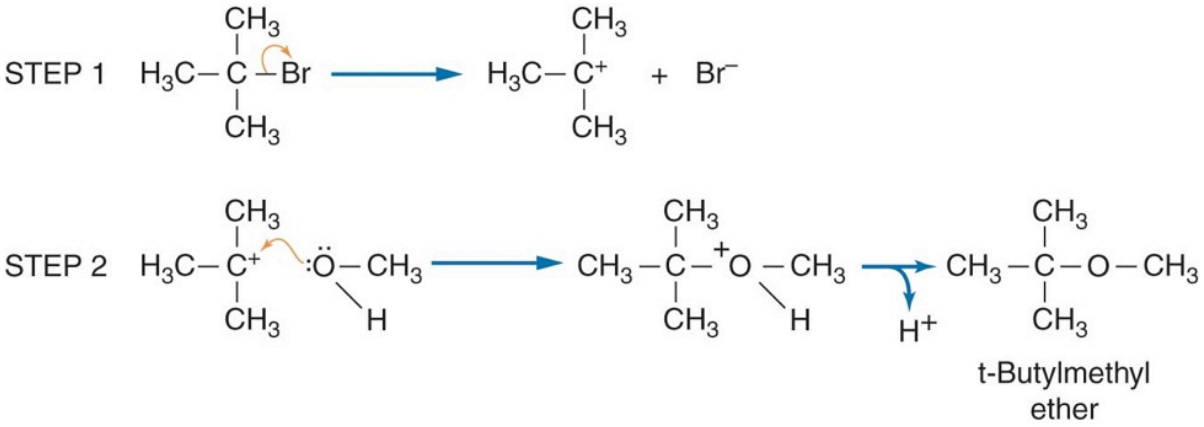
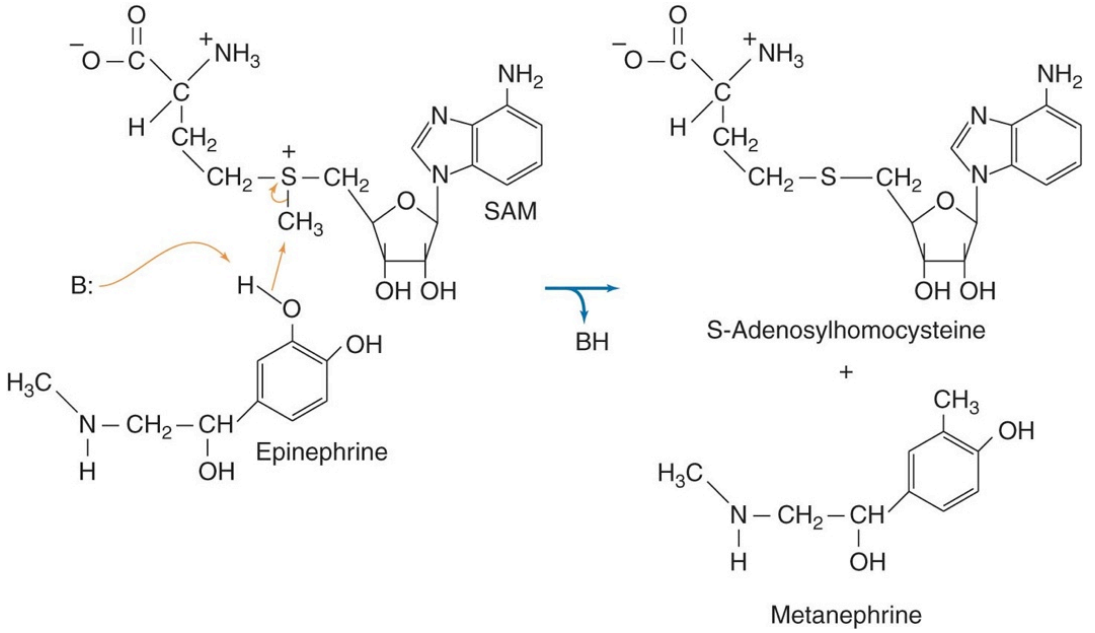


Figure 13



- **Elimination Reactions**
  - Elimination reactions involve the loss of two atoms or groups from a molecule
  - Three types of elimination reactions
    - E_1 (elimination unimolecular reactions)
    - E_2 (elimination bimolecular reactions)
    - E_{1cb} (Elimination unimolecular conjugate base reactions)