Basic Food Chemistry: The Nature of Matter

The Periodic Table of Elements

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Objectives

- **Describe** the basic structure of atoms.
- **Identify** symbols on the periodic table commonly used in food science.
- **Explain** the difference between pure substances and mixtures.
- **Compare** physical and chemical reactions in laboratory experiments.

continued
The Basic Nature of Matter

• Chemistry is the study of the makeup, structure, and properties of substances and the changes that occur to them
  – It is the study of matter

• An atom is the smallest unit of any elemental substance that maintains the characteristics of that substance
The Basic Nature of Matter

- **Subatomic particles** make up an atom
  - the **nucleus**, or central core of an atom, contains positively charged **protons** and **neutrons**, which have no charge
  - negatively charged **electrons** spin around the nucleus in an **orbital**

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Chemical Changes

• Occurs whenever new substances with different chemical and physical properties are formed.

• Chemical changes result in:
  – Changes in color – enzymatic browning, carmelization of sugar
  – Changes in odor – cooked cabbage smell
  – Flavor changes – cooked onions, fermented foods.
  – Release of gas – mixing baking soda and vinegar, alcoholic beverages
The Basic Nature of Matter

- An **element** is a substance that contains only one kind of atom
  - The number of protons determines the element of an atom
  - Elements are organized by structure and chemical properties in the periodic table
  - A system of symbols is used to identify elements
The Periodic Table

• Chart showing how elements relate and react to one another
• Each cell gives the symbol of the chemical element and includes the
  – atomic number—number of protons in the nucleus in each atom of that element
  – atomic mass—sum of the masses of the protons and neutrons in an atom

continued
The mass of a proton or neutron is defined as equal to one **atomic mass unit (AMU)**
- The mass of an electron is so small it is insignificant
- Organization of the cells indicates how elements interact chemically

Elements are grouped as either metals (left side) or nonmetals (right side)
The Periodic Table

[Image of the Periodic Table]

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Compounds

- **Compounds** are substances in which 2 or more elements chemically combine
  - The basic unit of any compound is a molecule
  - Sodium (Na) combines with chloride (Cl) to form sodium chloride (NaCl) or table salt

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Chemical Formulas

• A chemical formula is a combination of symbols of elements making up a compound that
  – represents one molecule or unit of a compound
  – has the symbol and subscript numbers of atoms for each element in the compound

continued
Knowing how to read a chemical formula can help identify the elements in the substance
- \( \text{H}_2\text{O} \) is composed of 2 hydrogen atoms and one oxygen atom

Chemical formulas can indicate how atoms are arranged in a molecule
The force that holds 2 atoms together is a **chemical bond**

- Electrons form the bond
- Each orbital contains 2 electrons
- The space around the nucleus with one or more orbitals is called a **shell**
- Atoms have up to 7 shells
- The number of shells determines an element’s position (its row) on the periodic table
Chemical Bonding

- Atoms are most stable when the outer shell is full of electrons

- Atoms that are not stable will share or transfer electrons from another atom

- Each column, or group, in the periodic table has the same number of electrons in the outermost shell
A pure substance is matter in which all the basic units are the same
- grouped as elements or compounds

Compounds are categorized into organic compounds or inorganic compounds
- Organic compounds contain chains or rings of carbon
- Inorganic compounds contain no carbon or only single carbon atoms

continued
Mixtures are substances that are put together, but not chemically combined

- **homogeneous mixtures** have a uniform distribution of particles
- **heterogeneous mixtures** have a nonuniform distribution of particles
- Most homogenous mixtures are a **solution** in which a **solute** is dissolved by a **solvent**
Physical and Chemical Changes

- A **physical change** involves changing shape, size, temperature and/or the physical state

  – **Phase change** is a physical change in the visible structure without changing the molecular structure

continued
Physical and Chemical Changes

- **A chemical change** occurs whenever new substances with different chemical and physical properties are formed
  - This produces a change in color, odor, or flavor, or releases a gas

- Physical and chemical changes may or may not be reversible
Chemical Equations

- Chemical formulas are used to represent the compounds involved in a chemical change
  - Chemical formulas on the left side of the equation are called **reactants**
  - Chemical formulas on the right side of the equation are called **products**

\[ \text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \]
Chemical Equations

- The **law of conservation of matter** states that matter can be changed, but not created or destroyed
  - This is shown in chemical equations

- Equations must balance by having the same number of each type of atom on both sides of the equation

\[ \text{C}_{12}\text{H}_{22}\text{O}_{11} + 12\text{O}_2 \rightarrow 12\text{CO}_2 + 11\text{H}_2\text{O} \]
Recap

• Atoms are composed of
  – a nucleus containing protons and neutrons
  – electrons moving about outside the nucleus

• The periodic table is a chart that shows how elements relate and react to one another

continued
Recap

• Pure substances have the same basic units, whereas mixtures are substances put together, but not chemically combined

• Changes to food compounds can be described as both physical and chemical

• Chemical equations are used to describe chemical changes
Elemental Experience

Project Description & Rubric

Many of the elements found in the periodic table play a significant role in our body’s daily functioning and overall development.

Part I: Presentation
In pairs or individually, choose one element from Figure 4-3 on page 95 of the text or from the list above to research and create a media-based presentation that includes:

- Element Name/Symbol
- AMU
- Basic information regarding period/group
- Importance to food science or science as a whole
- Most common foods containing the element
- Function of the element for the body
- Recommended Daily Amount (RDA) recommended for the body
- Identify as a *macronutrient* (major) — requires 100 milligrams or more per day
  OR
- *micronutrient* (trace) — requires less than 100 milligrams per day
- Problems that can occur if too much and/or too little is consumed

Part II: 3D Representation
In addition to the media presentation, you must also create a 3D representation of the element that will serve as a visual of your element. The 3-D representation can be made of any product or materials you wish and you have access to anything found in our lab/kitchens/supplies as approved by your instructor.

Your project does not have to be an expensive one. There should be several building materials you can find for free around you house that can be repurposed for your project. You will be really surprised what you can find when you look through the various rooms in your house. *Edible projects are welcome as long as the food is non-perishable;* this is not a mold experiment! (marshmallows, gum drops, macaroni, etc.).

Maximum dimensions: 3 ft. x 3 ft

Part III: Bibliography
Use on-line resources, your textbook, and any other valuable, reliable resources to assist you in your research. Please cite any sources using an on-line bibliography tool such as [www.bibme.org](http://www.bibme.org).

Choose from any of the following:

ALUMINUM (Al)
CALCIUM (Ca)
CHLORINE/CHLORIDE (Cl)
MAGNESIUM (Mg)
PHOSPHORUS (P)
POTASSIUM (K)
SODIUM (Na)
SULFUR (S)
CHROME/CHROMIUM (Cr)

COPPER (Cu)
FLUORINE/FLUORIDE (F)
IODINE (I)
IRON (Fe)
MANGANESE (Mn)
MOLYBDENUM (Mo)
SELENIUM (Se)
ZINC (Zn)