UNIT 1

What is Biology?

THEMES IN THE STUDY OF BIOLOGY
1.1 Life’s levels of organization define the scope of biology
   These levels represent a hierarchy
   Life’s Hierarchy of Organization
   The upper tier is a global perspective of life
   ___________________ : all the environments of Earth that support life
   ___________________ : All the living and nonliving components of a
   particular environment
   ___________________ : All the living organisms in an ecosystem
   ___________________ : an interacting group of individuals of one species
   ___________________ : An individual living entity
   The middle tier is characterized by the organism, which is composed of
   Organism → Organ systems → 
   Life emerges at the level of the cell, the lower tier, which is composed of
   → Organelles → 
   Emergent Property

   The combination of the parts that form a more complex organization is called a _____

1.2 Living Organisms Interact with their Environments
   Producers –

   Consumers

   To be successful, an ecosystem must accomplish two things
   Recycle chemicals necessary for life
   Move energy through the ecosystem

1.3 Cells are the structural and functional units of life
   Cells perform all functions necessary for life
   By studying a biological structure, you determine what it does and how it works
1.4 The unity of life: All forms of life have common features

__________ is the genetic (hereditary) material of all cells

A ___________ is a discrete unit of DNA

The chemical structure of DNA accounts for its function

The diversity of life results from differences in DNA structure from individual to individual

Other common properties of organisms:

1.5 The diversity of life can be arranged into three domains

Scientists have identified about 1.8 million species (particular types of organisms)

**Taxonomy**

Three domains are the most overarching groups:

- **Domain ______________________**, unicellular prokaryotes (cells that lack a nucleus)
- **Domain ______________________**, unicellular prokaryotes
- **Domain ______________________**, unicellular and multicellular eukaryotes (cells with a nucleus), including protists, plants, animals, and fungi

1.6 Evolution explains the unity and diversity of life

**Charles Darwin** proposed the theory of evolution by ______________________

Species evolved from ancestors through "______________________________"

The product of natural selection is ______________________

**THE PROCESS OF SCIENCE**

1.7 Scientists use two main approaches to learn about nature

**Discovery science**

**Hypothesis-based science**

**Hypothesis:**
1.8 With hypothesis-based science, we pose and test hypotheses. Hypothesis-based science applies the five steps of the scientific method:

1. ______________________________ from others or results of earlier tests
2. ______________________________ about unclear aspects of the observations:
   How? Why? When?
3. ______________________________ or tentative explanations of a phenomenon
   Must be ______________________
   Must be ______________________
4. Predictions developed by the use of _____________________ (if...then)
5. ________ of predictions to determine if the predictions are supported or falsified.

**A Case Study from Everyday Life**
Following the scientific method to discover why a flashlight doesn't work
Using deductive reasoning to test alternative hypotheses
If a hypothesis is correct, and we test it, then we can expect a particular outcome

**A Case Study of Hypothesis-Based Science**
Another hypothesis: Mimicry helps protect nonpoisonous king snakes from predators where poisonous coral snakes also live
The hypothesis predicts that predators learn to avoid the warning coloration of coral snakes
The experiment has a ______________________________ using brown artificial snakes for comparison
The ______________________________ is artificial snakes with the red, black, and yellow ring pattern of king snakes

**THE CHEMICAL BASIS OF LIFE**
**ELEMENTS, ATOMS, AND MOLECULES**
2.1 Living organisms are composed of about 25 chemical elements
   **Elements**

2.3 Elements can combine to form compounds
   **Compounds**

   Different arrangements of the atoms of elements determine the unique properties of each compound
   The smallest unit of an element is an ________________
2.4 Atoms consist of protons, neutrons, and electrons
Subatomic particles

___________ and _____________ occupy the central region (nucleus) of an atom
A proton has a

A neutron is

Electrons surround the nucleus
An electron has a

How do you calculate the amount of subatomic particles in the atom?

Atomic number

___ protons in nucleus of an atom (establishes identity of the atom)

Atomic mass

___ protons plus ___ neutrons in _________ of an atom

How can we determine the number of neutrons in an atom?

Do all carbon atoms have the same number of protons?
Do all carbon atoms have the same number of neutrons?

Isotopes

2.6 Electron arrangement determines the chemical properties of an atom
Electrons in an atom are arranged in electron shells, which may contain different numbers of electrons
Chemical bonds

Two major types of chemical bonds

2.7 Ionic bonds are attractions between ions of opposite charge

2.8 Covalent bonds join atoms into molecules through electron sharing
Covalently bonded atoms share one or more pairs of outer shell electrons, forming a
Covalent bonds can be represented in various ways
2.9 Unequal electron sharing creates polar molecules
A molecule whose covalently bonded atoms share electrons equally is _______________
A molecule whose covalently bonded atoms share electrons unequally is _______________
2.10 Hydrogen bonds are weak bonds important in the chemistry of life

Hydrogen bonding occurs in many biologically important compounds
Water, DNA, and Proteins

WATER'S LIFE-SUPPORTING PROPERTIES
2.11 Hydrogen bonds make liquid water cohesive
  **Cohesion** is

  **Surface tension**

  **Adhesion** is

2.12 Water's hydrogen bonds moderate temperature
  It takes a large amount of energy to change the temperature of water
  Water also moderates temperature by evaporative cooling
2.14 Water is the solvent of life

What is the difference between a solution, solvent, and solute?

2.15 The chemistry of life is sensitive to acidic and basic conditions
  What is an acid and a base?
  **Acid** is a compound that

  **Base** is a compound that

Therefore the **pH scale** measures the

THE MOLECULES OF CELLS
INTRODUCTION TO ORGANIC COMPOUNDS
3.1 Life's molecular diversity is based on the properties of carbon
  ____________________________________ contain at least one carbon atom
  ____________________________________ are composed of only hydrogen and carbon
3.2 Functional groups help determine the properties of organic compounds
  Functional groups are groups of atoms attached to the carbon skeleton of molecules
  Usually participate in chemical reactions
  Give organic molecules their particular properties
Six main functional groups are important in the chemistry of life:
3.3 Cells make a huge number of large molecules from a small set of small molecules
Four main classes of biological macromolecules

Cells make the most of their large molecules by joining smaller organic monomers into chains called ________________________________
____________________ are usually linked by ________________________________

Polymers are broken down to monomers by the reverse process, _____________________

Now let’s look at the four major organic molecules needed for life.
CARBOHYDRATES
3.4 Monosaccharides are the simplest carbohydrates
   Monosaccharides

3.5 Cells link two single sugars to form disaccharides
   Disaccharide

3.7 Polysaccharides are long chains of sugar units
   Polysaccharides

LIPIDS
3.8 Fats are lipids that are mostly energy-storage molecules
   Lipids are

   Linked by nonpolar covalent bonds
   ________________________________ (water-fearing)

3.9 Phospholipids and steroids are lipids with a variety of functions
   Phospholipids

   Are a major component of cell membranes
   Steroids
PROTEINS
3.11 Proteins are essential to the structures and activities of life
A protein is
The structure of the protein determines its function
The seven major classes of protein are
________________________: hair, cell cytoskeleton
________________________: producers of movement in muscle and other cells
________________________: sources of amino acids, such as egg white
________________________: antibodies, membrane proteins
________________________: carriers of molecules such as hemoglobin, membrane proteins
________________________: hormones, membrane proteins
________________________: regulators of the speed biochemical reactions
3.13 A protein's specific shape determines its function

3.14 A protein's shape depends on four levels of structure

NUCLEIC ACIDS
3.16 Nucleic acids are information-rich polymers of nucleotides
There are two types of nucleic acid-

Nucleic acids are

DNA vs RNA
 DNA is a
 DNA uses a
 DNA is composed of

Specific sequences of DNA make up genes that program the amino acid sequences of proteins
RNA is
RNA uses a
RNA is composed of
RNA copies the
A TOUR OF THE CELL
Why is it important to know about cells?

Cell theory

1. [Schleiden & Schwann]
2. [Virchow]

INTRODUCTION TO THE CELL
4.2 Most cells are microscopic
4.3 Prokaryotic cells are structurally simpler than eukaryotic cells
   There are two kinds of cells

   All cells share some common features

Prokaryotic cells
Do not have a membrane-bound ______________________

DNA is coiled into a ______________________ region in the cytoplasm

_______________ includes ribosomes

________________________

Complex ______________________________

Capsule, __________, prokaryotic ______________________ in some forms

4.4 Eukaryotic cells are partitioned into functional compartments

   Distinguished by a true __________________________

   Contain both membranous and nonmembranous ______________________________

   So let’s look at an animal and plant cell

Animal cells

   Are bounded by the ________________________________ alone

   Lack a ________________________________

   Contain ___________________________ and ____________________________

   Often have __________________________

Plant cells

   Are bounded by both a plasma membrane and a rigid cellulose __________________
CELL STRUCTURES

4.6 The nucleus is the cell's genetic control center
   The nucleus contains the cell’s _______________
   Controls cellular activities by directing protein synthesis
   The nucleus is separated from the cytoplasm by the _______________________________
   _____________________________ in the envelope control flow of materials in and out
   Ribosomes are synthesized in the _______________________________

4.7 Ribosomes make proteins for use in the cell and export

4.8 Many cell organelles are connected through the endomembrane system
   The endomembrane system is a collection of _______________________________
   Work together in the synthesis, storage, and export of molecules

4.9 The endoplasmic reticulum
   Broken into two parts
   Smooth ER lacks attached _______________________________
   Rough ER is studded with _______________________________

4.10 The Golgi apparatus finishes, sorts, and ships cell products
   The Golgi apparatus consists of stacks of flattened membranous sacs

4.11 Lysosomes are digestive compartments within a cell
   Lysosomes are sacs of enzymes that form from the Golgi apparatus
4.14 Mitochondria harvest chemical energy from food
Mitochondria are found in nearly all eukaryotic cells

4.15 Chloroplasts convert solar energy to chemical energy
Chloroplasts are found in plants and some protists

4.16 Mitochondria and chloroplasts evolved by endosymbiosis

THE WORKING CELL
MEMBRANE STRUCTURE AND FUNCTION
5.1 Membranes are a fluid mosaic of phospholipids and proteins
Membranes are commonly described as a ________________
The proteins are actively floating about in a ________________
Phospholipids
Have a

Bilayer embedded with ______________________
Proteins
The proteins embedded within the bilayer have a variety of functions
Integrins, Enzymes, Receptors (signal transduction), and Transporter
Because membranes allow some substances

5.3 Passive transport is diffusion across a membrane with no energy investment
**Diffusion** is a process

Particles move from an area of more concentrated particles to an area where they are less concentrated
This means that particles diffuse down their __________________________

5.4 Osmosis is the diffusion of water across a membrane
5.5 Water balance between cells and their surroundings is crucial to organisms

**Tonicity** is a term

Tonicity

______________________ indicates that the concentration of a solute is the same on both sides

______________________ indicates that the concentration of solute is higher outside the cell

______________________ indicates a higher concentration of solute inside the cell

**Osmoregulation**

This process prevents excessive uptake or excessive loss of water

5.6 Transport proteins may facilitate diffusion across membranes

5.8 Cells expend energy in the active transport of a solute against its concentration gradient

It requires ________________

The mechanism alters the shape of the membrane protein through phosphorylation using ATP

5.9 Exocytosis and endocytosis transport large molecules across membranes

A cell uses two mechanisms for moving large molecules across membranes

**Exocytosis** is used to export

**Endocytosis** is used to import

In both cases, material to be transported is packaged within a vesicle that fuses with the membrane

5.9 Exocytosis and endocytosis transport large molecules across membranes