Introduction to Biology and Atomic Structure

Chapter 1
What is Biology?

- Famous Greek Philosopher, Aristotle, came up with an idea called Spontaneous Generation for explaining where living things come from.
- Some highlights include...
  - Mice came from grains stacked up in barns
  - Frogs came from mud
  - Worms came from horsehair
  - When leaves fall...
    - on the ground, they turn into birds
    - into water, they turn into fish
Characteristics of Living Things

• Biology is the study of life and everything that affects them, also known as the environment.
  ▫ Environment is all the conditions that influence an object, living or non-living.

• Biologists have developed a list of characteristics that are required for something to be considered “living.”

• Anything that possesses these characteristics is called an organism
Characteristics of Living Things

- #1: Living things have an orderly structure
  - Living things are made of between 1 and 10 trillion cells.
  - These cells must all work together without failure for the organism to remain alive.
  - For this to work, there must be organization and each cell must have a role or purpose.
Characteristics of Living Things

• #2: Living things reproduce
  ▫ Living things simply can’t live forever.
  ▫ Organisms may find ways to prolong life, but cannot avoid death.
  ▫ If a species is going to survive, they must reproduce offspring for the future.
  ▫ A specie is a group of organisms that can breed and produce fertile offspring
    • An eagle and a hawk are different species, but a St. Bernard and a Chihuahua are the same species
Characteristics of Living Things

#3: Living things grow and develop

- Growth is not merely stretching of material. Growth is adding cells to old material
  - Example: Muscle cells
- Growth occurs to aid in survival and to increase the number of functions and abilities an organism possesses.
  - I need to handle heat, cold, pain, education, stress in varying ways throughout life
  - I need to be stronger, faster, bigger—overall better than YOU.
- All of the changes an organism undergoes in a lifetime is called development.
Characteristics of Living Things

• **#4: Living things adjust to surroundings**
  - Throughout their lives, organisms will experience various stimuli from their environment. These stimuli cause organisms to respond in some way.
    - Tree’s have sensors that detect temperature and humidity levels to know when rain is coming. What’s their response?
  - Organisms need to adjust so that their bodies maintain homeostasis (the ability to maintain an internal environment despite changes in the external environment.)
    - Average temperature range in Clark County: 41-85 degrees
    - Average “normal” body temperature: 96.1-99.9 degrees
Characteristics of Living Things

• #5: Living things adapt and evolve
  ▫ An adaptation is any structure or behavior that enables an organism to respond to environmental factors that would otherwise cause harm.
  ▫ Adaptations begin as individual mutations in a single organism, giving them an advantage.
  ▫ Through reproduction, the adaptation eventually makes its way through the population.
  ▫ Name that Adaptation!
    ▪ Squirrels to the evergreen forest
    ▪ Orca whales to the Puget Sound
    ▪ Badgers to living underground.
Classification

- The National Science Foundation has identified over 2 million species of organisms currently living on earth, ranging from single cell bacteria to human beings
  - That’s “identified.” Estimates of how many actually exist right now go up to 100 million.
- This does not include the species that have gone extinct
- How do we keep track of them?
Taxonomy

- Taxonomy is the process of naming and grouping animals in a universally accepted manner
- We want to have a method for tracing the evolutionary history of animals
- We want to make sure everyone is using the same name and description
• What is this?
  ▫ Cascades: Cougar
  ▫ Northeast: Puma
  ▫ Rockies/Sierras: Mountain Lion
  ▫ Southeast: Panther

• Which is endangered?
  ▫ Only Florida Panthers
Domains

- Taxonomy and classification are human inventions. They change constantly.
- Very recently, a new category was added: Domains
- Now that humans know how to read DNA sequences, we’ve noticed three separate domain groups with overall similar DNA patterns
  - Prokaryotes: Single-celled, simplified organisms
    - (Domains: Archaea/Monera, Bacteria)
  - Eukaryotes: Mostly multi-celled, complex organisms
    - (Domains: Eukarya)
Archaea/Monera

- Archaea are single-celled organisms that live in extreme environments
  - Salty
  - Acidic
  - Temperature extremes
- Archaea are believed to be the oldest organisms on the planet
Bacteria

• Bacteria are single-celled organisms that are found everywhere Archaea are not.
  ▫ Typically, they are discovered on, inside, or surrounding other organisms
• Bacteria form both positive and negative roles with the organisms they live with
  ▫ Disease (salmonella, campylobacter)
  ▫ Waste Treatment
  ▫ Symbiotic aid (Streptococcus on teeth, E. coli in colon)
Eukarya

- Eukaryotes are the multi-cellular organisms and the more complex single-cellular organisms
  - Animals
  - Plants
  - Fungi
  - Protists (Algae, protozoans, etc)
    - Protists are single-celled organisms but live in colonies, creating a “multicellular” effect.
# Humans

<table>
<thead>
<tr>
<th><strong>Domain</strong></th>
<th><strong>Eukarya</strong></th>
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<tbody>
<tr>
<td>Kingdom</td>
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<td>Genus</td>
<td>Homo</td>
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<tr>
<td>Species</td>
<td>Sapiens</td>
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Chemistry of Biology

• It is impossible to understand biology to a great extent without chemistry.
  ▫ What are organisms made of?
  ▫ How do cells bond together?
  ▫ What is the effect of electricity, acids/bases, toxins on the human body?

• You need to understand
  ▫ Atoms, elements, molecules and compounds
  ▫ Bonding principles
  ▫ Structures of some elements
Elements

- An element is any substance that cannot be broken down any further and still remain the same.
- Elements take the form of atoms, which are tiny particles made up of different electrical charges.
- As of this year, we are at 114 different elements that exist (94 occur naturally, 20 built in labs)
  - Four elements (#113, 115, 117 and 118 may have been discovered; still waiting on confirmation)
- *All elements are atoms, but each atom is unique.*
Atomic Structure

• Each atom has three components

• Protons and Neutrons
  ▫ Protons have a positive charge, neutrons no charge
  ▫ The number of protons an atom has indicates which element it is
  ▫ Protons and neutrons are in the center of the cell, called the nucleus

• Electrons
  ▫ Electrons have a negative charge
  ▫ Electrons float in specific groups, or “shells” surrounding the nucleus
Atomic Structure

• The majority of the atom is empty space
  ▫ *If you put a quarter at the center of a football field, and called it the nucleus, the electrons would be outside of the stadium*

• If an atom is stable, the number of protons (+ charge) in the nucleus will equal the number of electrons (- charge)

• 99% of an atom’s weight is it’s protons and neutrons, or it’s nucleus
Atomic Structure

- Electrons, meanwhile, orbit the nucleus in specific shells.
- Each shell contains a specific number of electrons.
- Electrons cannot begin a new shell before filling the last shell.
  - The first shell only contains two electrons.
  - Every shell after this one, whether the second or sixth shell, contains up to eight electrons.
Atomic Structure

• An element is decided by the number of protons in it’s nucleus.
• The same element cannot have a different number of protons, but it can with neutrons
• When two atoms have the same number of protons but different numbers of neutrons, they are called isotopes
• Isotopes are highly unstable, and tend to lose the extra neutrons
• When these neutrons break, it causes radiation
Periodic Table of the Elements

- The periodic table can be confusing at first, but a few simple rules are all you need to understand it.
- Every grid represents one element:
  1) The symbol, which represents the element's name
     - “Al” is much easier to write than “aluminum”
  2) The atomic number, which is the number of protons the element has
  3) The atomic weight, or mass number
<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>% of the Human Body</th>
<th>Element</th>
<th>Symbol</th>
<th>% of the Human Body</th>
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