Unit 3 Exam Review

Most Important Ideas

- Structure gives rise to function. Be able to describe a few examples from this unit of this idea.
- All life can be traced back to a molecule doing something in or on a cell.
- Cells are the smallest unit that can be independently defined as living.
- Why cells need unique internal environments and how those environments are maintained.
- Where biological energy ultimately comes from, how it is turned into a form usable for life, and how life uses that energy.

Past Units

The following information learned in past units will be especially helpful to you in understanding this new material:

- What hydrogen bonding is and how polarity relates to hydrogen bonding.
- How to tell if a molecule is polar or nonpolar.
- The difference between osmosis and diffusion, and when each will occur across a semipermeable membrane
- How to predict which way molecules will go across a membrane that is permeable to that solute and that isn't (but is permeable to water).
- How a molecule's stability relates to how much energy it has.
- That molecules will react to make the overall products more stable.

Life

You should know how to:

- Classify something as living, non-living, or once-living based on these 7 criteria:
  - Made of cell(s)
  - Have different levels of organization
  - Use energy
  - Grow
  - Reproduce
  - Respond to the environment
  - Adapt or evolve

You should understand:

- That no classification scheme is perfect, including the one for living things, because the real world is more complicated than a simplified list of categories.
- The hierarchy of life, including the unique criteria that defines each level which units can be independently defined as living:
  - Molecules
  - Cells
  - Tissues
  - Organs
  - Organ systems
  - Organisms

- Populations
- Communities
- Ecosystems
- Biosphere

Biochemistry

You should know how to:

- Identify the following molecules based on their chemical structures:
    - **Glucose** (6-membered ring)
    - **Fructose** (5-membered ring)
    - **Disaccharides**
    - **Polysaccharides**
    - **Triglycerides**
    - **Phospholipids**
    - **Steroids/sterols**
    - **Amino acids**
    - **Nucleic acids**
    - **ATP**

You should understand:

- That water's unique structure allows it to hydrogen bond really well, which gives it unique properties that allow it to sustain life. These properties include:
    - It's a great **solvent** (dissolves stuff well).
    - It's has a high **specific heat** (is hard to heat up and cool down)
    - It has a high **buoyancy** (it is able to support a lot of weight and keep cells from collapsing)
- What it means for a molecule to be **organic**.
- The key functions of these small molecules:
    - **Oxygen**
    - **Carbon dioxide**
    - **Electrolytes**
    - **Vitamins**
    - **Monomers:**
        - **Monosaccharides**
        - **Fatty acids**
        - **Amino acids**
        - **Nucleic acids**
- The key functions of these macromolecules:
    - **Carbohydrates**:
        - **Monosaccharides** and **disaccharides**
        - **Starches**
        - **Glycans**
    - **Lipids**

        - **Triglycerides**
        - **Phospholipids**
        - **Cholesterol**
        - **Steroids**
    - **Proteins**
        - **Enzymes**
        - **Structural proteins**, such as **collagen**
        - **Carrier proteins**
        - **Signalling proteins**
    - **Nucleic acids**
        - **DNA**
        - **RNA**
        - **ATP**
- That cells need energy to power the chemical reactions of life, and which macromolecules provide that energy (short-term, “medium-term,” and long-term storage)
- That proteins do most of the jobs of a cell and are made using the genetic instructions from DNA.

Cells

You should know how to:

- Use a light microscope.

You should understand:

- That all living things are made of one or more cells.
- That cells (and the molecules they are made of) are the basic unit of function of living things.
- That all cells come from other cells.
- That an **objective** of a light microscope is where most of the magnification happens, and that most microscopes have multiple objectives to adjust magnification.
- That **prokaryotic cells** are small and simple, while **eukaryotic cells** are larger and more complex.
- That **plant cells** and **animal cells** have several structural differences that are related to their function:
    - Plant cells have a cell wall and animal cells don’t. This makes them sturdy, but at the cost of moving around. It also makes plant cells square-ish.
    - Plant cells have chloroplasts and animal cells don’t. These allow them to do photosynthesis.
    - Plant cells have a vacuole and animal cells don’t. Vacuoles allow for storage of, for example, starch (food for winter) and pigments. They also help plant cells maintain their shape by adjusting water pressure.

The Cell Membrane

- The big picture of why the cell membrane is important to life: Keeps good stuff in, keeps bad stuff out, and even forces some good stuff in against its concentration gradient.
- That the internal cell environment is necessarily different from the external cell environment, and that this is essential for life. The molecules of biochemistry wouldn't get in or stay in their biological "test tube" if not for the cell membrane.
- That the cell membrane is **semipermeable**.
- The cell membrane is composed of phospholipids, whose unique structure (they are amphipathic) allows them to act as a fence to keep out everything but small, nonpolar molecules.
- The cell membrane has many integral proteins, which let specific molecules that we want into the cell. This lets larger or more polar molecules, like glucose and water, get in.
- The cell membrane has many other proteins and carbohydrates that play important roles, especially in cell signalling, cell adhesions (which help with cell and tissue structure), and cell recognition.
- These details about **simple diffusion**, **facilitated diffusion**, and **active transport.**
    - Whether molecules go up or down their concentration gradient
    - Whether or not it requires proteins
    - Whether or not it requires energy
    - Whether or not it can be controlled
    - Some examples of which type of molecules can cross in that way

Energy and Cell Respiration

- That all living things convert chemical potential energy in the form of glucose into chemical potential energy in the form of ATP.
- That reactions that form complex, high-energy molecules require a significant input of energy and are unlikely to happen on their own, at normal temperatures. This includes many of the reactions of life.
- That ATP is an extremely high-energy molecule that will react with almost anything, making all kinds of unlikely chemical reactions in the cell possible. It is the most immediately useful form of stored energy in the cell. It releases a lot of energy when it's broken, making otherwise unlikely (uphill) reactions happen very readily.
- That **enzymes** make life possible by lowering the **activation energy** of a reaction, meaning that they bring molecules together in a way that makes them easier to react.
- That **cell respiration** is the process of gradually breaking down glucose and collecting usable energy from it.
- That **glycolysis** is the first step of **aerobic respiration** and is the *only* energy-producing step in **anaerobic respiration**. It *partially* breaks down glucose and releases a small amount of energy from it.
- That **aerobic respiration** is the preferred way of making energy, when it is possible, because glucose is *fully* broken down, releasing a large amount of energy from it.
- That NAD^+ must be recycled in anaerobic respiration, which happens through either **alcoholic fermentation** or **lactic acid fermentation**.
- These details about **glycolysis,** the **intermediate step**, the **Krebs cycle**, and the **electron transport chain**.
    - The starting and ending products of each step (you don't need to know the exact numbers for this class)
    - Where each step occurs

  - What type of energy we get out. It’s also helpful to have a rough idea of how much energy comes out (i.e., a little energy from glycolysis, a little from the Krebs cycle, and a lot from the electron transport chain).
- The steps of aerobic respiration that by far produce the most energy happen in the **mitochondria**, which is an **organelle** that **localizes** the important molecules involved in aerobic respiration into one spot, to make it more efficient. The unique structure of the mitochondria—especially its folded inner membrane—is what gives it its unique function.

Photosynthesis

- That the Earth’s energy ultimately comes from the sun.
- That plants convert solar energy into chemical potential energy in the form of glucose.
- That plants do both photosynthesis and cell respiration.
- That plants still need to take in nutrients.
- The overall equation for photosynthesis: plants form glucose from carbon dioxide, using energy from the sun.
- That photosynthesis happens inside of **chloroplasts**, which are a specialized organelle with a distinct structure to help with its distinct function.
  - The **thylakoid** is the site of the light-dependent reaction
- The main purpose of the **light-dependent reaction** and the **light-independent reaction**.
- The similarities and differences between photosynthesis and cell respiration.
- That plants are responsible for producing oxygen and biochemical energy that are essential for human life.
- That plants are responsible for absorbing carbon dioxide and protecting against climate change in many other ways.
- That humans are destroying plants and ecosystems in many ways, which worsens many of the other human-caused environmental problems. This can be prevented and reversed through political change as well as some changes in our habits.