Introduction

What is anatomy?
Anatomy is the structure

What is physiology?
Physiology is the function

What are the levels of organization?

- **Chemical**
- **Cellular**
- **Tissue**
- **Organ**
- **Organ System**
- **Organismal**

What are the necessary life functions?

- **Maintaining boundaries**
- **Movement**
- **Responsiveness**
- **Digestion**
- **Metabolism**
- **Excretion**
- **Reproduction**
- **Growth**

What is the function of the Integumentary System?

Forms external body covering, and protects deeper tissue from injury, also responsible for sweat, oil, and sense of pain and pressure.

What is the function of the Skeletal System?

Protects and supports body organs, and provides a framework the muscles can use for movement, Blood cells form in bones (hematopoiesis) & Bones store minerals

What is the function of the Muscular System?

Allows manipulation of the environment, locomotion and facial expression. Maintain posture and produces heat.

What is the function of the Nervous System ?

As the fast-acting control system of the body, it responds to internal and external changes by activating appropriate muscles and glands

What is the function of the Endocrine System?

Glands secrete hormones that regulate processes such as growth and reproduction

What is the function of the Cardiovascular System?

Blood vessels transport blood which carries oxygen to cells and disposes carbon dioxide

What is the function of the Lymphatic System?

Responsible for immune response

What is the function of the Respiratory System?

Keeps blood constantly supplied with oxygen

What is the function of the Digestive System?

Breaks down food into absorbable units. Also eliminates waste

What is the function of the Urinary System?

Eliminates urea and is responsible for water, electrolyte, and acid base balance of blood

What is the function of the Reproductive System?

For the reproduction of offspring

What are the five necessary needs for survival?

- **Nutrients**
- **Oxygen**
- **Water**
- **Normal body temp**
- **Appropriate atmospheric pressure**

What is homeostasis?

The condition of maintaining the body's internal environment in a relative constant state (steady temp, blood pressure, glucose levels, etc….), within limits.

What does homeostatic imbalance mean?

Anything that disturbs or alters the balance of the internal environment

What is a negative feedback loop?

- **The output shuts off the original effect of the stimulus or reduces it's intensity.**
- **A change in one direction results in a feedback that causes a change or adjustment in the opposite direction.**
- Example? **Body Temperature and Glucose Level**

What is a positive feedback loop?

- **The result or response enhances the original stimulus so that the response is accelerated.**
- **A change in one direction accelerates more change in the same direction.**
- Example? **Childbirth and Blood Clotting**

Basic Chemistry

What is matter? What are the three types?

Anything that has mass and takes up space

- **Solid: definite shape and volume**
- **Liquid: changeable shape and definite volume**
- **Gas: changeable shape and volume**

What is energy? And its four forms?

- **Energy is the capacity to do work or put matter into motion**
- **Chemical Energy**
- **Electrical Energy**
- **Mechanical Energy**
- **Electromagnetic Energy**

Element - **substances that cannot be broken down into simpler substances**
Atom - **smallest particles of an element with the properties of that element**
Proton - **carry a positive charge and weigh 1 amu**
Neutron - **have no electrical charge and weigh 1 amu**
Electron - **carry a negative charge and have no weight**
***incharge of bonding**
Ion - **a element that carries a positive or negative charge**
Isotope - **structural variation of an element, same number of protons different number of neutrons**
Atomic Number - **number of protons in nucleus**
Atomic Mass - **total number of protons and neutrons in nucleus**

What are the three different types of mixtures and their properties?

1. **Solutions: Are *homogeneous* mixtures, meaning particles are evenly distributed throughout**
   solvent- substance present in greatest amount
   solute- substances dissolved in solvent
2. **Colloids: Also known as *emulsions*; are heterogeneous mixtures, meaning that particles are not evenly distributed throughout mixture**
3. **Suspension: Heterogeneous mixtures that contain large, visible solutes that <u>do</u> settle out **blood is a suspension**

What are ionic bonds?
Gain or lose electrons, known as transfer of electrons
What are covalent bonds?
Covalent bonds are formed by sharing of two of more valence shell electrons between two atoms

- Nonpolar- **equal sharing of eletrons**
- Polar- **unequal sharing of electrons**

Describe a synthesis chemical reaction?
Synthesis (combination) reactions involve atoms or molecules combining to form larger, more complex molecule

- **Used in anabolic (building) processes A + B ® AB**

Describe a decomposition chemical reaction?
Decomposition reactions involve breakdown of a molecule into smaller molecules or its constituent atoms (reverse of synthesis reactions)

- **Involve catabolic (bond-breaking) reactions AB ® A + B**

Describe an exchange chemical reaction?
Exchange reactions, also called *displacement* reactions, involve both synthesis and decomp

- **Bonds are both made and broken**
  - **AB + C ® AC + B and AB + CD ® AD + CB**

What is an endergonic reaction?
Reactions result in a net absorption of energy (use up energy)

What is an exergonic reaction?
Reactions result in a net release of energy (give off energy)

What are the four ways to increase the speed of chemical reactions?
Temperature →Increase in temperature the higher the rate of reaction
Concentration of reactants/Pressure →Increased concentration/ pressure increase rate
Particle size →Smaller particles usually increase rate
Catalysts →*Increase rate without becoming a part of the reaction but speed up the rate*
**Enzymes* are biological catalysts

Inorganic Chemistry

What are the properties of water?

- **High heat capacity**
- **High heat of vaporization**
- **Polar solvent properties**
- **Reactivty**
- **Cushioning**

Acids
Are protons doners: the release hydrogen ions (H^+), bare protons (have no electrons) in solution

- **Example: HCl → H^+ + Cl^-**

Bases
Are proton acceptors : they pick up H^+ ions in a solution

- **Example: NaOH → Na^+ + OH^-**

When a base dissolves in solution, it releases a hydroxyl ion (OH^-)

Salts

Salts are ionic compounds that dissociate and separate ions in water

- **Separate into cations (positively charged molecules) and anions (negatively charged)**

What does pH mean? **pH scale** is measurement of concentration of hydrogen ions [H^+] in a solution

- **The more hydrogen ions the more acidic a solution is**
- **Acidic solutions have high [H^+] but low pH**
    - **Acidic pH range is 0–6.99**
- **Neutral solutions have equal numbers of H^+ and OH^- ions**
    - **All neutral solutions are pH 7**
    - **Pure water is pH neutral**
        - **pH of pure water = pH 7: [H^+] = 10^{-7} m**
- **Alkaline (basic) solutions have low [H^+] but high pH**
    - **Alkaline pH range is 7.01–14**

What is considered to be acidic? Basic? Neutral?

- **Acidic pH range is 0–6.99**
- **All neutral solutions are pH 7**
- **Alkaline pH range is 7.01–14**

How does an increasing pH affect acidity? Alkalinity?

- Less acidic more alkaline(basic)

How does a decreasing pH affect acidity? Alkalinity?

- More acidic less alkaline(basic)

<DRAW THE PH SCALE>

Organic Compounds

What is a monomer?

- **smallest unit of carbohydrate**

What are polymers?

- **made up of monomers of monosaccharides**

What is dehydration synthesis?

- **The formation process of organic compounds**

What is hydrolysis?

- **The break down process of organic compounds**

What are carbohydrates?
include sugars and starches

- **Contain C, H, and O**
- **Hydrogen and oxygen are in 2:1 ratio**

Three classes
Monosaccharides: **one single sugar**

- Pentose: **Ribose and deoxyribose**
- Hexose: **Glucose (blood sugar), Fructose**

Disaccharides: **two sugars**

- Important disaccharides: **Sucrose, maltose, lactose**

Polysaccharides: **many sugars**

- Starch: **carbohydrate storage form used by plants**
- Glycogen: **carbohydrate storage form used by animals**

How are carbohydrates formed and broken down?
Dehydration Synthesis - formation Hydrolysis - break down

How are carbohydrates stored in plants and animals?

- **Plants - Starch**
- **Animals - Glycogen**

What are lipids?

- **Contain C, H, O, but less than in carbohydrates, and sometimes contain P**
- **Insoluble in water**

What are the three types of lipids?

- **Triglycerides**
- **Phospholipids**
- **Steroids**

What are triglycerides?

- **Called *fats* when solid and *oils* when liquid**
- **Composed of three fatty acids bonded to a glycerol molecule**

What is the difference between saturated and unsaturated triglycerides?
Saturated - **All carbons are linked via single covalent bonds, resulting in a molecule with the maximum number of H atoms (saturated with H)**

- **Solid at room temperature (Example: animal fats, butter)**

Unsaturated - **One or more carbons are linked via double bonds, resulting in reduced H atoms (unsaturated)**

- **Liquid at room temperature (Example: plant oils, such as olive oil)**
- **Trans fats – modified oils; unhealthy**
- **Omega 3 fatty acids – "heart healthy"**

What is the use of triglycerides in the human body?
Storage and Insulation

What are phospholipids? **<DRAW THE BILAYER>**

- **Modified triglycerides**
  - **Glycerol and two fatty acids plus a phosphorus-containing group**
- **"Head" and "tail" regions have different properties**
  - **Head is a hydrophilic (polar) region and is attracted to water**
  - **Tails are hydrophobic (nonpolar) and are repelled by water**

What are steroids? And what is their purpose?

- **Consist of four interlocking ring structures**
- **Common steroids: cholesterol, vitamin D, steroid hormones, and bile salts**
- **Most important steroid is cholesterol**
    - **Is building block for vitamin D, steroid synthesis, and bile salt synthesis**
    - **Important in cell plasma membrane structure**

What are proteins?

- **Have most varied functions of any molecules**
    - **Structural, chemical (enzymes), contraction (muscles)**
- **Contain C, H, O, N, and sometimes S and P**
- **Polymers of amino acids monomers held together by peptide bonds**
- **Shape and function due to four structural levels**

What are amino acids and peptide bonds?

- **All proteins are made from 20 types of amino acids**
    - **Joined by covalent bonds called peptide bonds**
    - **Contain both an *amine* group and *acid* group**
    - **Can act as either acid or base**
    - **Differ by which of 20 different R groups present**
        - **R group is unique**

What are the structural levels of proteins?

1: **linear sequence of amino acids (order)**
2: **how primary amino acids interact with each other**
    - **Alpha helix coils resemble a spring**
    - **Beta pleated sheet resemble accordion ribbons**
3: **how secondary structures interact**
4: **how 2 or more different polypeptides interact with each other**

What are fibrous proteins? →structural

- **Strand-like, water-insoluble, and stable**
- **Most have tertiary or quaternary structure (3-D)**
- **Provide mechanical support and tensile strength**
    - **Examples: keratin, elastin, collagen (single most abundant protein in body), and certain contractile fibers**

What are globular proteins? → functional

- **Compact, spherical, water-soluble, and sensitive to environmental changes**
- **Tertiary or quaternary structure (3-D)**
- **Specific functional regions (active sites)**
    - **Examples: antibodies, hormones, molecular chaperones, and enzymes**

What are enzymes? And why are they important in the human body?

- **globular proteins that act as biological *catalysts***
- **Catalysts regulate and increase speed of chemical reactions without getting used up in the process**
- **Lower the energy needed to initiate a chemical reaction**
    - **Leads to an increase in speed of a reaction**
    - **Allows for millions of reactions per minute!**
- **Enzymes are specific**
    - **Act on a very specific substrate**
- **Names usually end in *–ase* and are often named for the reaction they catalyze**
    - **Example: hydrolases, oxidases**

What are the three steps in enzyme action?

- **Substrate binding to active site**
- **Complex undergoes rearrangement of substrate**
- **Product released from enzyme**

What are nucleic acids?

- **Nucleic acids, composed of C, H, O, N, and P, are the largest molecules in the body**
- **Nucleic acid polymers are made up of monomers called nucleotides (A<T<C<G)**
    - **Composed of a nitrogen base, pentose sugar, and a phosphate group**

DNA vs RNA

DNA

- **Double stranded helical molecule (double helix) located in cell nucleus**
- **Nucleotides contain a deoxyribose, phosphate group, and one of four nitrogen bases:**
    - **Purines: adenine and guanine**
    - **Pyrimidines: cytosine and thymine**
- **Bonding of nitrogen base from strand to opposite strand is very specific**
    - **Follows complementary base-pairing rules:**
    - **A always pairs with T**

- **C always pairs with G**

RNA

- **links DNA to protein synthesis and is slightly different from DNA**
- **Single stranded linear molecule is active mostly outside nucleus**
- **Contains a ribose (not deoxyribose)**
- **Thymine is replaced with uracil**
- **Three varieties of RNA carry out the DNA orders for protein synthesis:**
  - **Messenger RNA (mRNA)**
  - **Transfer RNA (tRNA)**
  - **Ribosomal RNA (rRNA)**

What is ATP and its function in the body?

1. **Chemical energy released when glucose is broken down is captured in ATP (adenosine triphosphate)**
2. **ATP directly powers chemical reactions in cells**
   - **Offers immediate, usable energy needed by body cells**
3. **Structure of ATP**
   - **Adenine-containing RNA nucleotide with two additional phosphate groups**

Cytology

What is the plasma membrane?

- **Active barrier separating intercellular fluid from extracellular fluid**

What is the function and structure?

- **Contains phospholipid bilayer**
- **Has enzyme system and is a site of chemical reactions**
- **Plays dynamic role in cellular activity**
- **Is a contact surface provides:**
  - **Cell adhesion**
  - **Cell identity markers**
  - **Receptors**

What are integral proteins?

- **Firmly inserted into membrane**
- **Most are transmembrane proteins**
- **Have both hydrophobic and hydrophilic regions**
  - **Hydrophobic areas interact with lipid tails**
  - **Hydrophilic areas interact with water**
- Function as:
  - **Transport proteins**
  - **Enzymes**
  - **Receptors**

What are peripheral proteins?

- **Loosely attached to integral proteins**
- **Include filaments on intracellular surface used for plasma membrane support**
- Function as:
  - **Enzymes**
  - **Motor proteins for shape change during cell division and muscle contraction**
  - **cell-to-cell connections**
  - **Part of glycocalynx, serving as identification markers for cell recognition**
  - **Receptors for recognizing molecules**

What are tight junctions?

- **Integral proteins on adjacent cells fuse to form an impermeable junction that encircles whole cell**
- **Prevent fluids and most molecules from moving in between cells**
- **between epithelial cells lining digestive tract**

What are desmosomes?

- **Rivet-like cell junction formed when linker proteins of neighboring cells interlock like the teeth of a zipper**

- **Linker proteins are anchored to their own cell on inside of plasma membrane**
- **Allow give between cells, reduce possibility of tearing due to tension**
- **Found in tissues subjected to great mechanical stress, such as oskin and heart muscle**

What are gap junctions?

- **Transmembrane proteins form tunnels that allow small molecules to pass from cell to cell**
- **Used to spread ions, simple sugars, or other small molecules between cells**
- **Allow for electrical signals to be passed from cell to cell**
- **Used in cardiac and smooth muscle cells**

What are the two types of membrane transport?

- **Passive processes**
- **Active processes**

What is passive transport?

- **Passive transport requires no energy**
- **Occurs down a concentration or pressure gradient**
    - **Moves from high to low**

    - Simple diffusion: **hydrophobic substances diffuse directly through phospholipid bilayer**
    - Facilitated diffusion: **certain hydrophilic molecules are transported passively down their concentration gradient**

        - Channel mediated: **channel filled with aqueous-filled cores, transport ions or water down their concentration gradient**
        - Carrier mediated: **transmembrane integral proteins, transport polar molecules**

            - Leakage channels: **always open**
            - Gated channels: **controlled by chemical or electrical signals**

    - Osmosis: **movement of solvent, such as water, across a selectively permeable membrane**

What is active transport?

- **Moves solutes against their concentration gradient**
- **Requires ATP (energy) to move solutes across a plasma membrane for any of these reasons:**
  - **Solute is too large for channels, or**
  - **Solute is not lipid soluble, or**
  - **Solute is not able to move down concentration gradient**

  - Primary: **Shape change causes solutes (ions) bound to protein to be pumped across membrane**
    - **Moves against concentration gradient**
    - **Resembles a revolving door**
    - **Example of pumps: calcium, hydrogen (proton), Na^+-K^+ pumps**

  - Secondary: **Depends on ion gradient that was created by primary active transport system**

  - **Energy stored in gradients used in directly to drive transport of other solutes**
    - **Low Na^+ concentration that is maintained inside cell by Na^+-K^+ pump strengthens sodium's drive to want to enter cell**
    - **Na^+ can drag other molecules with it as it flows into cell through carrier proteins in membrane**
      - **Some sugars, amino acids, and ions are usually transported into cells via secondary active transport**
  - Vesicular:

    - Endocytosis: **Cell membrane surrounds something and pinches off, bringing it *into* the cell**

      - Phagocytosis: **solids: "cell eating"**
      - Pinocytosis: **liquids: "cell drinking"**

    - Exocytosis: **Vesicle merges with plasma membrane and transports substance *out of* the cell**
    - **Substance being ejection is enclosed in a secretory vesicle**

      - **Secretion of hormones, waste, mucus, etc.**