BMA1011- Table of Contents

Sample

Week One- A Toolbox for the Human Body

- Human body is broken up into 6 different levels of organisation
    - 1. **Chemical**
        - Atoms are the building blocks of life
        - Atoms combine to form larger molecules and compounds
        - Where we study the different elements (e.g. Carbon, oxygen, nitrogen etc.)
        - The level at which we also study DNA and proteins
    - 2. **Cellular**
        - Contain organelles
        - Different types of cells (some have similar functions but the size, shape and composition of each cell will determine the specific cell's function)
            - E.g. a smooth muscle cell has a different function to a nerve cell or a blood cell
            - The make-up of a cell will determine its function
    - 3. **Tissue**
        - A collection of cells of similar function form a tissue
        - 4 types of tissue
            - Muscle tissue
            - Nervous tissue
            - Connective tissue
            - Epithelial tissue
    - 4. **Organ**
        - A collection of tissue forms an organ
        - Can be made up of various types of tissue
            - E.g. a blood vessel is made up of smooth muscle tissue, connective tissue and epithelial tissue that work together to allow the organ to function
    - 5. **Organ system**
        - Each organ must be part of a system; working together with other organs that each play their own part
    - 6. **Organism**
        - A collection of systems that work together to form an organism
    - Key points
        - Structure determines function
        - The body is organised into six different levels
        - Changes (or problems) at one level can affect other levels
        - The organ systems work independently (together)
- Functions of life
    - There are 11 organ systems that work together to maintain life
        - **Skeletal System**
        - **Reproductive System**

        - **Lymphatic System**
        - **Nervous System**
        - **Urinary System**
        - **Digestive System**
        - **Respiratory System**
        - **Cardiovascular System**
        - **Endocrine System**
        - **Muscular System**
        - **Integumentary System**
    - The organ systems work together to maintain life by performing the necessary life function. These include:
        - **Maintain boundaries**- separate the internal and external environments (e.g. our skin)
        - **Movement**- using our bones and muscles to move our bodies (e.g. walk or run) or to move substances and fluids (e.g. blood, urine) within our bodies
        - **Responsiveness**- responding to changes in our environment (e.g. removing your hand from a hot surface)
        - **Digestion**- break down our food into smaller substances that we can use (e.g. converting complex carbohydrates to simpler sugars)
        - **Metabolism**- all the chemical reactions in our bodies (e.g. producing energy)
        - **Excretion**- the removal of wastes (e.g. urea in urine)
        - **Reproduction**- replication or replacement of cells and the continuation of life (e.g. conceiving a child)
        - **Growth**- increase the number or size of cells (e.g. child to adolescent)
- Homeostasis
    - The process by which the body maintains a stable internal environment within narrow limits
    - Accomplished using feedback mechanisms
        - **NEGATIVE FEEDBACK** (To reverse/stop/cease the stimulus)
            - **Stimulus-** alters internal environment
            - **Receptor-** detects stimulus
            - **Control centre-** receives message from receptor through nerve impulses
            - **Effector-** receives message from control centre through nerves or hormones; responds by altering the internal environment to reverse or cease the stimulus
            - **HOMEOSTASIS** is achieved
            - **E.g. body temp increases above normal → stimulus detected by thermoreceptors → message via nerve impulses to brain (control centre) → message sent via nerve impulses to sweat glands → sweat glands release heat through sweat and brings body temp back down**
            - Above cycle will continue until homeostasis is achieved

        - **POSITIVE FEEDBACK** (enhances/prolongs the stimulus)
            - **E.g. labour/child birth**
                - **Baby' head pushes on cervix → stretch-sensitive receptors in uterus send message to brain (control centre) via nerve impulse → brain sends message to muscles in wall of uterus via hormones → baby pushed further into birth canal**
                - Above cycle will continue until baby is born
    - Control of homeostasis
        - Two systems mainly responsible for bringing about changes to maintain homeostasis
            - **Nervous system**
                - electrical pulses
                - rapid and very short lived
            - **Endocrine system**
                - Hormones
                - Slower acting/longer effect
        - Internal conditions controlled mostly by negative feedback
    - When is homeostasis required?
        - Temperature
        - Blood pressure
        - pH
        - Many others
        - Some things do not require homeostasis and are controlled locally
            - E.g. intracellular regulation
- The internal environment (inside of our body)
    - Separated from the external environment by our skin
    - Body is full of cells
        - **Extracellular fluid (ECF)**
            - Around and between the cells
            - Made up of **interstitial fluid (ISF)** and plasma
            - **ISF** specifically surrounds the cells
            - What is in ECF that we need to regulate?
                - Gases (e.g. oxygen and carbon dioxide)
                - Water volume and pressure
                - Ion levels, pH and temperature
                - Waste products
            - Conditions in ECF need to be **maintained within narrow limits-** this is done through **HOMEOSTASIS**
        - **Intracellular fluid (ICF)**- inside the cells
- Chemical reactions
    - Breaking, forming or rearranging chemical bonds
        - Involve reactants (substrates) that body together to form products
            - **E.g. Reactant A + Reactant B → Product AB**

        - Types of reactions
            - Anabolic (synthesis): Joining together
                - **E.g. A + B → AB**
            - Catabolic (decomposition): Breaking apart
                - **E.g. AB → A + B**
            - Exchange: Switching partners
                - **E.g. AB + CD → AC + BD**
            - Reversible: Can go either way
                - **E.g. A + B ←→ AB**
        - Rate of chemical reactions
            - Various things that affect the rate of chemical reactions that occur in the body
                - Temperature
                - Size
                - Concentration
                - **Catalysts (Enzymes)**
                    - Two substrates bind to the active site of an enzyme → forms an enzyme substrate complex → internal rearrangement occurs forming a bond between the two substrates (using water) →product is created and released → enzyme is free to bind again
                    - Enzymes are **re-useable**
                    - Are site specific (only react with one particular type of substrate/reactant)
- Inorganic compounds, electrolytes and pH
    - Inorganic compounds
        - Water H^2O
        - Electrolytes
            - Acids
            - Bases
            - Salts
- Atoms and elements
    - Atoms are the smallest units of elements
        - 20 elements in the body
        - Carbon (C), Hydrogen (H), Oxygen (O) and Nitrogen (N)
        - Sodium (Na), Calcium (Ca), Magnesium (Mg), Iron (Fe)
    - Ions: atoms with electrical charge
        - **Cations (positive charge)**
            - Hydrogen ion (H^+)
            - Sodium ion (Na^+)
            - Potassium ion (K^+)
            - Calcium ion (Ca^{2+})
        - **Anions (negative charge)**
            - Chloride ion (Cl^-)

        - Iodine ion (I^-)
        - Hydroxyl ion (OH^-)
        - Bicarbonate ion (HCO_3^-)
    - Opposite charges attract
- Electrolytes
    - Compounds that release ions in water
    - **Acids**
        - Release hydrogen ions (H^+) when they're placed in water/solution
        - Makes the solution it's been placed in more acidic
    - **Bases**
        - Releases ions that bind with H^+ (e.g. OH^-)
        - Makes the solution less acidic (alkaline/basic)
    - **Salts**
        - Releases ions other than H^+ or OH^-
- pH
    - Measured in pH units on a scale of 1-14 (7 being neutral)
        - How many H^+ is present
        - 7 = neutral (equal H^+/OH^-)
        - < 7 = more hydrogen ions (H^+) than hydroxyl ions (OH^-) so increasingly **ACIDIC**
        - > 7 = less hydrogen ions (H^+) than hydroxyl ions (OH^-) so increasingly **BASIC/ALKALINE**
    - **Blood homeostatic range: 7.35- 7.45**
        - < 7.35 = acidosis
        - > 7.45 = alkadosis

- Organic compounds
    - Differ from inorganic compounds in that they
        - **Contain Carbon (C)**
        - **Are complex (inorganic compounds are simple)**
    - Carbohydrates
        - Sugars and starches
            - Monosaccharides (e.g. glucose), disaccharides (e.g. sucrose, lactose) and polysaccharides (e.g. glycogen)
        - Functions
            - **Energy**
            - Building materials
        - Dietary sources (e.g. breads/pasta, fruits)
    - Lipids
        - Commonly known as fats
        - **Hydrophobic (e.g. oil in water)**
            - This makes them a great building material in the body
        - Diverse family with diverse functions
            - Triglycerides (solid or liquid depending on temperature)
                - Saturated fats

        - Unsaturated fats
    - Phospholipids
    - Steroids (cholesterol, hormones)
    - Others
  - Dietary sources
- Proteins
  - 10-30% of our cell mass
  - Polypeptide of amino acids
  - Function of a protein is dependent on structure
  - Many functions
    - Structure and movement
    - Enzymes
    - Transport
    - pH and metabolism
    - Defence
  - Changes in body temperature and pH denature proteins
- Nucleic acids
  - Largest molecule in the body
    - Deoxyribonucleic acid (DNA)
      - Where our genes are found, instructions for all our cells/body
    - Ribonucleic acid (RNA)
      - DNA is copied into RNA to make things like proteins
    - Packaged into chromosomes
  - Four nucleotides
    - Pairing = genetic code
    - Adenine (A) + Thymine (T)
    - Cytonine (C) + Guanine (G)

- Adenosine Triphosphate (ATP)
  - The energy that is stored within our cells
  - Powers cellular work
    - ATP is stored in mitochondria
  - Conversion to ADP
    - Starts as Adenosine with three phosphate molecules attached
    - Water is added to the system which causes a phosphate to release; this also releases energy
    - ATP thus becomes ADP
  - ATP replenished
    - Energy from catabolism is used to reattach phosphate to ADP
      - E.g. glucose
    - ADP becomes ATP again
    - Cycle continues