SLE211 - Principles of Physiology

S1 2020 Deakin University

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Internal Environment & Homeostasis

Describe the different fluid compartments of the body and their composition

Water is essential in all human structures. It has a major functional role by being separated into fluid compartments where is acts as a universal solvent.

Intracellular fluid (ICF)

Extracellular fluid (ECF)

- Comprised of interstitial fluid and plasma
- Composed of water, dissolved gases, nutrients and waste products, plasma proteins (plasma only) and water-soluble electrolytes

Explain the terms isotonic, hypotonic and hypertonic and explain the difference between osmolarity and the tonicity of a solution

Osmolarity of a solution is a measure of the concentration of the dissolved particles in that solution – total number of solutes per litre

- Expressed as mOsmol/L or mM
- Osmolarity of ECF and ICF is ~300 mOsmol/L (different solutes that contribute to this)

Tonicity refers to how a solution affects the volume (shape) of the cells when they are immersed in varying concentrations

- Isotonic solution has the same concentration of non-penetrating solutes as normal body cells
    - No change in cell shape
- Hypotonic solution has a lower concentration of non-penetrating solutes than normal body cells
    - Cells expand (Lower concentration of solutes = higher concentration of water hence water diffuses into the cell)
- Hypertonic solution has a higher concentration of non-penetrating solutes than normal body cells
    - Cells shrink (Higher concentration of solutes = lower concentration of water hence water diffuses out of the cell)

Describe the movement of water by osmosis

Water moves from areas of high water concentration (low solute concentration) to areas of low water concentration (high solute concentration)

Explain how different molecules move across a cell membrane and how this is related to the rate of diffusion

Three major routes:

1. Pass directly through the bilayer (unassisted)
    - Small, non-polar molecules (O2)
    - Uncharged polar molecules (water, urea)
2. Channels
    - Charged molecules (K+, Na+)
3. Carrier mediated transport
    - Large, non-charged polar molecules (sugars)

Understand that homeostasis is achieved by balancing the inputs and outputs to a system

Cell survival depends on maintaining a relatively stable internal fluid environment. To do this, the control system must be able to:

- Detect deviations from normal
- Integrate this information with other information
- Make adjustments to restore the factor to normal

Examples of factors maintained homeostatically:

- Concentration of nutrients

- Concentration of O2 and CO2
- Concentration of waste products
- pH
- Concentration of electrolytes
- Blood volume and pressure
- Temperature

Homeostatic control systems must detect and resist change

- A change in a controlled variable triggers a response that drives the variable in the opposite direction of the initial change, thus opposing the change

Provide examples of negative and positive feedback mechanisms that operate in the body and understand the underlying mechanisms for how these systems work

Negative feedback

- Fall in body temperature below set point -> Temperature monitoring nerve cells -> Temperature control centre -> Skeletal muscles (and other effectors) -> Increase heat production through shivering and other means -> Increase in body temperature to set point -> (negative feedback) -> Temperature monitoring nerve cells

Positive feedback

- Positive feedback amplifies an initial change
- Much less common in the body than negative feedback
- Examples:
    - Blood clotting cascade
    - Opening of voltage gated Na+ channels in the depolarization phase of an action potential
    - Oestrogen release during ovulation
    - Oxytocin release during childbirth (Oxytocin causes contraction of the uterus. Contractions push baby's head against the cervix. Pressure on the cervix causes the release of MORE oxytocin)

Neuronal Physiology

Identify the major components of a neuron – cell body, dendrites, axon, axon terminals

- Cell body – Houses the nucleus and the organelles
- Dendrites – Protrude from the cell body
    - Increase the surface area available for receiving signals from other nerve cells
    - Dendrites carry information towards the cell body
    - Dendrites and cell body are the neurons input zone
- Axon – Nerve fibre
    - Single tubular extension of the cell body which carries information away from the cell body
    - Axons terminate at other cells