Basic Principles of Physiology

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2019-2020

- Anatomy
  - Study of the *structures* of the body
  - Ana = apart; tomy = cut

- Physiology
  - Study of the *function*s and processes of living organisms as seen under *normal* conditions.
  - physio =nature; ology =the study of

Levels of Organization

- The cell is the *unit of life*

Organisms

- *maintain their boundaries*
  - *Cell membrane – Integumentary System*
- *move*
  - *Microtubules – Muscular and Skeletal Systems*
- *respond to environmental changes*
  - *Receptors – Nervous System*
- *take in and digest nutrients*
  - *Endocytosis, lizozom --- Digestive System*
- *carry out metabolism*
  - *Mitochondria – digestive and respiratory systems*
- *dispose of wastes*
  - *Preroxisomes, exocytosis -- digestive, urinary system and skin*
- *reproduce*
  - *Mitosis – reproductive system*
- *grow*
  - *Mitosis and expansion*

- Organisms are a whole
- Organ systems do not work in isolation – Organismal Level

Homeostasis

- Homeo=the same; Stasis=standing still

- *Steady (Constant) State*
- *Dynamic*

- The body's ability to maintain relatively stable internal conditions even though the outside world is continuously changing

Body Fluid Compartments

- Intracellular Fluid (ICF)
- Extracelular Fluid (ECF)
  - Interstitial Fluid: surrounds the cells but does not circulate. ¾ of the ECF
  - Plasma: circulated as the extracellular component of blood. ¼ of the ECF

Homeostasis

- The internal environment is made up of the ECF
  - Cells that are isolated from the external environment can still exchange materials with the ECF

- **Homeostasis** is the maintenance of constant conditions in fluid surrounding cells (extracellular fluid) or internal environment by the integrated actions of various organs within the organism

- If a variable goes beyond the accepted range, it has **deviated**. The body must be able to detect variables that have deviated from the set point, and perform corrective measures.

Feed Forward Loop

- Anticipate change and responds to that change before it happens

- Cold outside temperature
  - Temperature sensitive receptors in the skin sends signals before the internal receptors (in hypothalamus) - before body temperature falls
  - Initiates heat conservation and increased heat production

- The smell of food
  - Production of gastric acids before food arrives

- Feedforward regulation anticipates changes in regulated variables, improves the speed of the body's homeostatic responses, and minimizes fluctuations in the level of the variable being regulated—that is, it reduces the amount of deviation from the set point.

Factors Homeostatically Regulated

- **Concentration of nutrient molecules-** nutrient molecules are used by the cell to produce energy
- **Concentration of O_2 and CO_2-** oxygen is needed to produce energy. Carbon dioxide is a waste product of this process and must be removed to maintain pH
- **Concentration of waste products-** accumulation of waste products causes toxic effects
- **pH-** appropriate pH levels are required for proper nerve cell and enzyme function in the body.
- **Concentration of water, salt, and other electrolyte-** regulation is essential for maintaining proper cell volume and function
- **Volume and Pressure-** ultimately affect plasma levels needed for linking intra- & extracellular environments
- **Temperature-** a narrow range allows for proper function to prevent slow down or impairment of protein function

Resetting of set points

- *Set point (reference point) :* the desired (optimal) value

- The set points for many regulated variables can be physiologically reset to a new value
  - Fever

Fever

- Fever is an adaptive response that helps the body fight pathogens. A fever is a rise in body temperature in response to molecules called pyrogens.

- The presence of a pyrogen in the body causes a rise in the hypothalamic set point for the metabolic heat production response.

- Most enzymes in humans are more stable at high temperatures than those of the bacteria that infect us, so that a moderate fever tends to denature bacterial enzymes, but not our own.

Clashing Demands

- Demands of different regulatory systems
- It is not possible for everything to be held constant by homeostatic control systems
- Because so many properties of the internal environment are closely interrelated, it is often possible to keep one property relatively constant only by moving others away from their usual set point
  - Clashing demands

Clashing Demands

- During exercise, the system that controls body core temperature sheds heat by elaborating sweat for evaporation
- The production of sweat ultimately reduces blood volume
- Because the body places higher priority on the control of blood volume than on the control of body core temperature, at some point the production of sweat will reduce
- If the individual does not stop exercising the result may be heat stroke

Drink water during exercise ☺

Heat Stroke

- 40-44 ° C
- Excess vasodilatation causes a drop in blood pressure
- This leads to hypoxia (low oxygen), then anoxia (no oxygen), in the brain, heart, and kidneys
- This leads to organ failure and death by heat stroke

Biological Rhythms

- Rhythmical changes of body functions
- Circadian rhythm; cycles approximately once every 24 h
- Waking and sleeping, body temperature, hormone concentrations in the blood, the excretion of ions into the urine…

Biological Rhythms

- What have biological rhythms to do with homeostasis?
  - They add an anticipatory component to homeostatic control systems, in effect a feed forward system operating without detectors.
- Rhythm in the urinary excretion of potassium
  - excretion is high during the day and low at night
  - we ingest potassium in our food during the day
  - the total amount of potassium in the body fluctuates less than if the rhythm did not exist

Homeostasis

- The body’s internal environment is the extracellular fluid.
- The function of organ systems is to maintain a stable internal environment—homeostasis.
- Numerous variables within the body must be maintained homeostatically. When homeostasis is lost for one variable, it may trigger a series of changes in other variables.

- Every organ system plays a role in maintaining the constancy of the internal environment.

- Communication within the body
  - Nervous and endocrine systems

Homeostasis and Controls

- **Homeostasis reestablished-** normal function is restored.
- **Failure to compensate**
  - Pathophysiology- functioning under a state of disease
    - *Illness*- a pathological condition that may result from external or internal failure of normal processes
    - *Death*- occurs when homeostasis fails and cell life cannot be sustained.