Introduction

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What is physiology?

- **Definition**
  - Study of body’s vital functions
  - Used to refer to “healing”
- **Structure vs function**
- **Mechanists approach**
- **Scientific method**
Scientific method

- **Steps**
  - Observations lead to questions
  - Formulate hypothesis
    - Educated guess
    - Statement, not a question!
  - Testing the hypothesis
    - Experiments
    - Research
  - Analyze results
    - Select valid statistical tests
  - Draw conclusion
Example

- Endemic nephropathy (EN) occurs only in Balkan farming villages along tributaries of the Danube River. This disease rapidly leads to chronic kidney failure and cancer of transitional cells of the upper urinary tract. A cluster of cases of this disease occurred last year among women in England taking “slimming pills”, purchased OTC.
What is causing this disease?

Formulate an hypothesis
What if your hypothesis is that a chemical in the diet is responsible for this disease? How would you proceed?
A. clematitis
What is life?
Necessary Life Functions

- Maintaining boundaries
- Movement
- Responsiveness to stimuli
- Digestion
- Metabolism
- Excretion
- Reproduction
- Growth
Integrated Systems

- Circulatory
- Digestive
- Endocrine
- Immune
- Integumentary
- Musculoskeletal
- Nervous
- Reproductive
- Respiratory
- Urinary
Ten physiological integrated systems
Survival

- Water
- Oxygen
- Homeostasis
  - Body temperature
  - pH
Homeostasis

- Definition
- External vs. internal environment
- Extrinsic vs. intrinsic controls

![Image of tissue cells]
Neural and endocrine regulation

- Nervous system
- Endocrine system
- Relationship
Feedback Loops: components

- **Sensor**
  - Detects deviation from set point.
- **Integrating center**
  - Determines the response.
- **Effector**
  - Produces the response.
Negative Feedback Loops

- moves in the opposite direction toward the original value
- Inhibitory signals

- eat
  - Increase in blood glucose
  - Increase in insulin secretion
  - Increase cellular uptake of glucose
  - Decrease in blood glucose
Positive feedback loops

• Moves in the same direction as the initial disturbance = build effect = stimulatory signals

• Examples
  - clotting cascade
  - labor
  - heat stroke

Damage to blood vessel
Platelets adhere to site
Chemicals attract more platelets
Accumulating platelets form clot
Body Temperature Regulation

- Average body temperature 36.2°C (35.6-37.8°C)
- Effect of body temperature on metabolic rate
- Core vs. shell body temperature
- Mechanisms of heat transfer
  - Evaporation
    - Changing from liquid to vapor
  - Convection
    - Transferring heat by currents in liquids or gases
  - Radiation
    - Emission of heat in all directions from a common source
Fever: resetting the set point

• Role of hypothalamus
• Controlled hyperthermia
  - Release of pyrogens from WBC’s, damaged tissues, macrophage
  - Increased release of prostaglandins reset hypothalamus
  - New set point is maintained
    • Vasoconstriction
    • Shivering = chills
Feedforward regulation

- Anticipates changes
  - Minimizes fluctuations in variable
  - Ensures rapid response to change
  - Reduces amount of deviation from set point

- Examples
  - Effect of sight and smell of food on digestion
Homeostatic principles

• 1) Variables are stabilized by balancing inputs and outputs.
• 2) Narrow range of values is determined by external environmental conditions.
• 3) Some set points can be reset.
• 4) Homeostatic hierarchy determines which variables are maintained at the expense of others.
Homeostatic control mechanisms

- Reflexes
  - Specific, involuntary response to specific stimulus
- Stimulus
  - Detectable change in internal or external environment
- Set point or operating point
- Reflex arc
  - Pathway of reflex
  - Components
    - receptor
    - integrating center
    - effector
Local homeostatic responses

- Change stimulates alteration in cellular activity in one specific area
  - Example: reactive hyperemia
- Results: self-regulation in specific area of body
- Example
  - Paracrine agents
  - Autocrine agents
Adaptation and Acclimatization

• **Adaptation** = characteristic favors survival in a given environment

• **Acclimatization** = type of adaptation: improved functioning of already existing homeostatic mechanism
  - Reversible
    • Move to hot or cold climate for awhile
  - Irreversible
    • Developmental acclimatization
      - Effect of high altitude on natives = ↓ oxygen = barrel shaped chest
Biological Rhythms

• Circadian rhythms (24 hour cycles)
  - Activates homeostatic mechanisms when change likely to occur
  - Anticipatory = feedforward
  - Internally driven
  - Entrainment = setting hours

• Types
  - Free running rhythms
    • Sleep/wake cycles = 23-27 hours
    • Stable rhythm cannot be established by those who work longer hours
  - Phase shift rhythms
    • Environmental time cues can reset internal clock (travel)
    • Adjustment is not immediate = jet lag
States of total body balance

• Balance of substances matches inputs and outputs
• Negative
  - Loss exceeds gain
• Positive
  - Gain exceeds loss
• Stable
  - Loss = Gain
Balance diagram

**Net gain**
- Food → Gi tract
- Air → Lungs
- Synthesis

**Distribution within body**
- Storage
- Conversion

**Net loss**
- Metabolism
- Excretion
Summary

- Homeostasis is complex and dynamic
- Response to changes in the internal/external environment
- Must be able to detect change and respond
- Requires the expenditure of energy
Body water compartments
Body water compartments

Extracellular = 1/3

14 L

Adults approx 60% water

28 L

Intracellular = 2/3

Internal environment

Interstitial Fluid 80%

Plasma 20%

11 L

3 L