Yıldırım Beyazıt University School of Medicine
Department of Physiology

Introduction to Physiology: Homeostasis and Physiological Control Systems

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Meet your physiology lecturer

- **Sinan Canan (PhD)**
  - Graduated biologist
  - Former histologist (MSc)
  - PhD in Medical Physiology
  - *Now*, Assoc. Prof. in YBU Medical School, Physiology Dep.
Meet your physiology lecturer

- **My areas of interest:**
  Neuroscience,
  human behavior,
  chaos and complexity,
  fractal geometry,
  science philosophy,
  medical education
  *and everything about life and human...*

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Suggested books & resources

- **Medical Physiology (A.C. Guyton)**
Suggested books & resources

- **Human Physiology 2 or 3rd Ed.** (D. U. Silverthorn)

![Human Physiology book cover]

Suggested books & resources

- **Review of Medical Physiology, 23th Ed.** (W.F. Ganong)

![Review of Medical Physiology book cover]
Suggested books & resources

- Vander’s Human Physiology, 11th Ed. (Widmaier, Raff, Strang)

PHYSIOLOGY

What is physiology?
## What is Physiology?

- **Physics + Biology = Physiology**
- The branch of science dealing with the basic functions of living organisms
- Science of “function”
  - Physiological: “Normal”; not pathological; properties belonging to normal functions of tissues, organs or body...

## What is Physiology?

- All things in physiology are about **YOURSELF!**
What is LIFE?

Basic properties of life

The Seven Properties Of Life:
1) Cellular organization,
2) Reproduction,
3) Metabolism,
4) Homeostasis,
5) Heredity,
6) Responsiveness,
7) Growth and development...
Emergence is the way that “complex systems” and “patterns” arise, out of a multiplicity of relatively simple and seemingly unrelated interactions.

Complex: Something with many parts in intricate arrangement.
Complexity and “emergence”
Life is the most complex thing in this universe...

Emergent Properties Of Life:
Order
Reproduction
Growth and Development
Energy Utilization
Response to Environment
Homeostasis
Adaptation
Structural and functional hierarchy

- **Physiological terms;**
  - **Function:** Things to do...
  - **Mechanism:** How to do...
- **Organization of life:**
  - **Cell** is the basic unit of life
- **Hierarchical organization:**
  Cells, tissues, organs, organ systems and organism

1. **Cellular level**
   Cells are made up of molecules

2. **Tissue level**
   Tissues consist of similar types of cells

3. **Organ level**
   Organs are made up of different types of tissues

4. **Organ systems level**
   Organ systems consist of different organs that work together closely
Organ Systems

- Cardiovascular System
- Respiratory System
- Digestive System
- Urinary System
- Reproductive System
- Musculoskeletal System
- Nervous System
- Endocrine System
- Immune System
Basic concepts in physiology

“Internal milieu”

Claude Bernard (1813–1878)

“La fixité du milieu intérieur est la condition de la vie libre.”
Evolution of Physiological Systems

Substance exchange between body fluids
Homeostasis

- Keeping the internal environment stable, against constantly changing circumstances...

- A *dynamical balance* of the internal environment
Homeostasis and its control

- External or internal changes
- Drifting away from Homeostasis
- Necessary adjustments:
  - Receptors, integration centers
  - Cell and tissue responses
Homeostasis and its control

(c)

Body temperature normal → Body temperature rises; error signal increases → Regulatory mechanism activated → Body temperature decreases; error signal decreases → Body temperature normal

(d)

Body temperature (°C)

Error signal

Set point (normal)

Time

Homeostasis and its control

Regulated variable

Body temperature

Sensors

Input

Integrating center

Brain thermoregulatory centers (compare actual temperature to set point and send appropriate signals to effectors)

Output

Normal body temperature

Set point

Sweat glands, skin blood vessels, and skeletal muscles

Effectors

Negative feedback

Body temperature

Set point
Homeostasis and its control

(a) Environmental temperature (°C)

(b) Body temperature (°C)

(c) Temperature of external environment → Body temperature

Thermoreceptors (sensors) → Input

Brain thermoregulatory centers (integrating center) → Output

Sweat glands (effectors) → Constriction

Blood vessels in skin (effectors) → Constriction

Skeletal muscles (effectors) → Shivering

Heat loss → Body temperature

Heat generation → Body temperature

Negative feedback
**Homeostasis**

- Successful compensation
  - Homestasis re-established
- Unable to compensate
  - Pathophysiology
    - Sickness
    - Death

**Principles of “feedback”**

(a) Negative feedback
- Initial stimulus
- Response
- Stimulus

(b) Positive feedback
- Initial stimulus
- Response
- Feedback cycle
- Stimulus

Outside factor required to shut off positive feedback cycle
Negative Feedback

• **Response attenuates the stimulus**
• Examples:
  • Control of blood glucose
  • Control of blood oxygen and carbon dioxide levels
  • Maintainence of sodium and fluid content of blood
  • Control of body temperature
  • Control of acidity of body fluids
  • Control of body weight
  • .....................

*Figure 1-4*  Negative feedback and body temperature. Body temperature is kept at a set point of 37°C by negative feedback acting on a center in the brain.
Compensation limits in bleeding

![Graph showing compensation limits in bleeding](image)

Positive Feedback

- **Response enhances the stimulus**
- **Examples:**
  - Blood coagulation
  - Birth
  - Generation of action potentials
Adaptive control systems

- **Feed-forward controls (preparing the body for an anticipated change):**
  - Control of movement and balance
  - Monitoring the external environment
  - Learning
# Processes related to Homeostasis

- Adaptation and acclimatization
- Biological rythms
- Regulation of cell death-Apoptosis

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# Homeostatic imbalance

- Disruption of homeostasis results in diseases.
- Destructive positive feedback loops can be repressed by *negative feedback* loops.
Some links...

- Web Resources
  - http://en.wikipedia.org/wiki/Physiology
  - http://www.wisegeek.com/what-is-a-physiologist.htm
  - http://www.youtube.com/watch?v=H_MmgaWYQfc
- Inner life of a cell:
  - http://www.youtube.com/watch?v=wJyUtbn0O5Y
  (We will talk the details of this video later)

That’s all for now...

- Lecture notes in pdf format:
  - http://www.sinancanan.net.tr/p/english.html