

Simplified View of Overall Plan of Human Body

Biology 2A03
Lecture 2

Homeostatic Control Systems
&
Cell, tissue and compartments

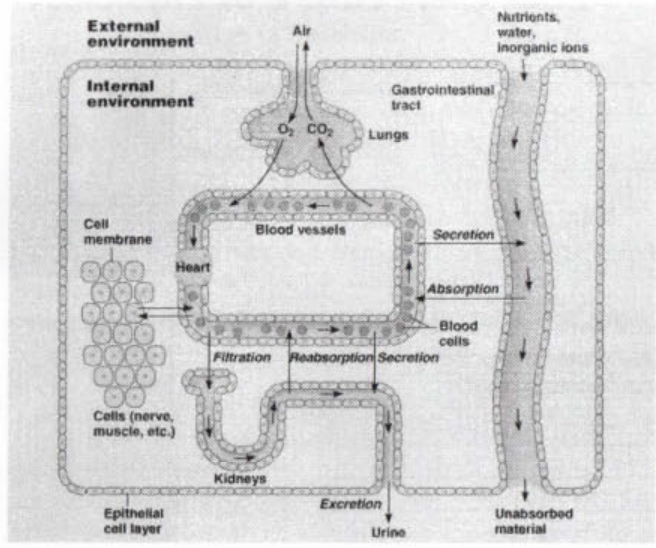


Fig 1.4

→ a layer of epithelial cells used to separate the outside fr. the inside → lines GI tract, kidneys, lungs, skin.
→ our internal env. is made of fluids that bathe tissues & our blood

The Internal Environment

Total Body Water = Intracellular H₂O 28 L ICF 2/3
 btw the cells ← Interstitial H₂O 11 L } ECF 1/3
 Plasma H₂O 3 L }
 maj. component of blood
 42 L or 60% body wt
 similar composition except plasma has more protein

Extracellular fluid is rapidly transported by the circulation and mixes between blood and tissues by diffusion through capillary walls

Bathes tissues and makes up the internal milieu of the body

Proper cellular function depends on tight control of ECF components

Ext. cellular has high sodium and low protein conc vs. intracellular

See Fig. 1-5

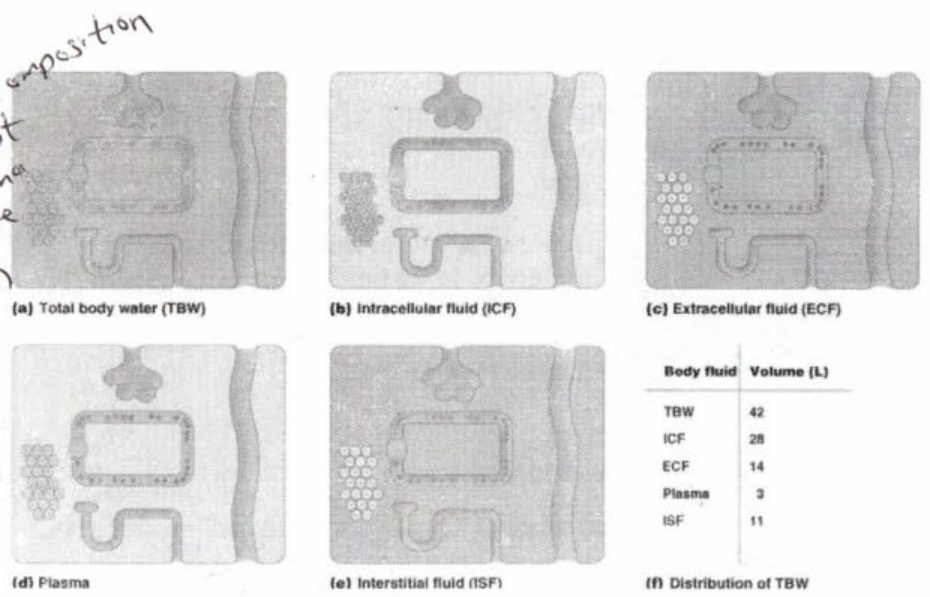


Fig. 1-5

Homeostasis

A Defining Feature of Physiology

Noted that mammals are able to regulate their internal environment within a narrow range.



Claude Bernard (1813-1878)

Extended Bernard's notion to the organization of cells, tissues and organs. First to coin the term "homeostasis"



Walter Cannon (1871-1945)

* "The maintenance of static or constant conditions in the internal environment"

→ automatic patterned response to a stimulus

Reflexes: a key component of control systems

Strictly defined as:

→ Involuntary, unpremeditated, unlearned response to a stimulus

Some are:

→ Learned or acquired

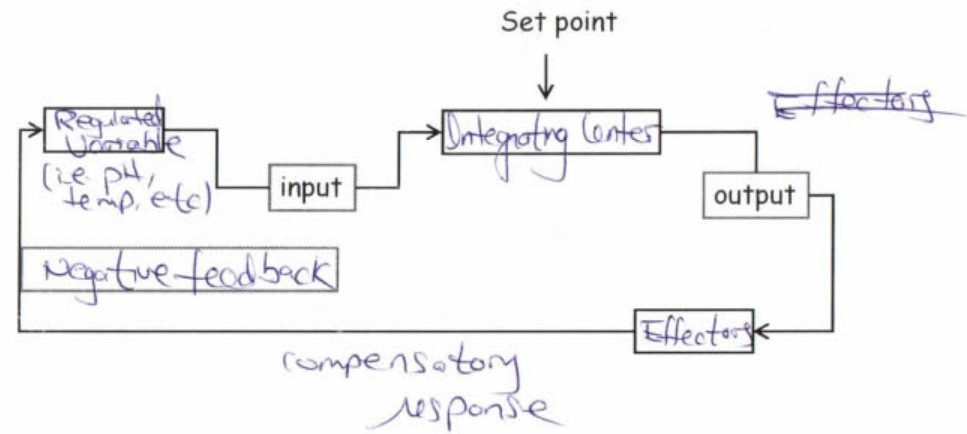
Most are:

→ Altered by learning

regulated variable → stimulus / error signal

homeostatic regulatory systems in the response of a system goes opposite to the change that set it in motion. which in a direction

Basic Negative Feedback Control

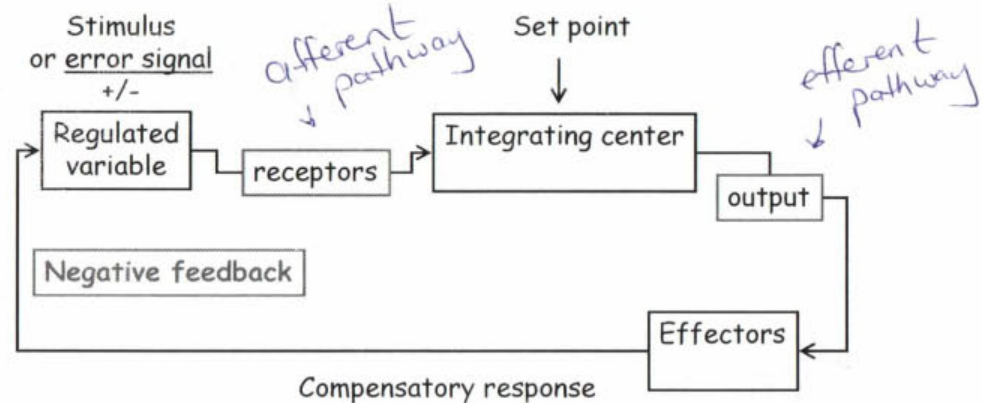


Examples: arterial blood pressure, body temperature, pH, PCO₂

See Fig 1.7

The neural pathway that mediates a reflex action

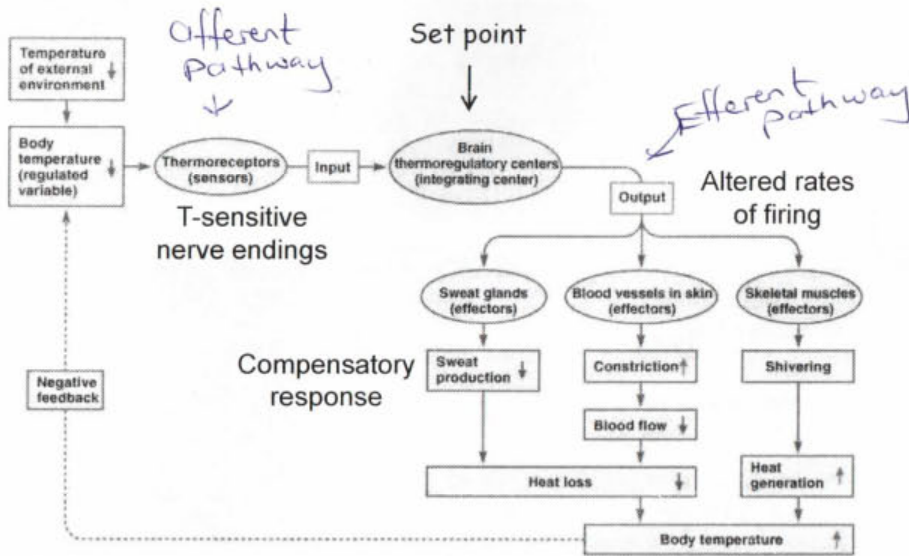
Homeostatic Control Systems - reflex arc



Restoration of set point never complete of exact and a persistent error signal keeps feedback loop in operation

Hence the term "relatively" stable in the definition of homeostasis

Homeostatic Control Systems - Body Temp



Afferent pathway → nerve structures thru which impulses are conducted from a peripheral part toward a nerve center. Fig 1.9 Fig 21.9 (4th Ed)

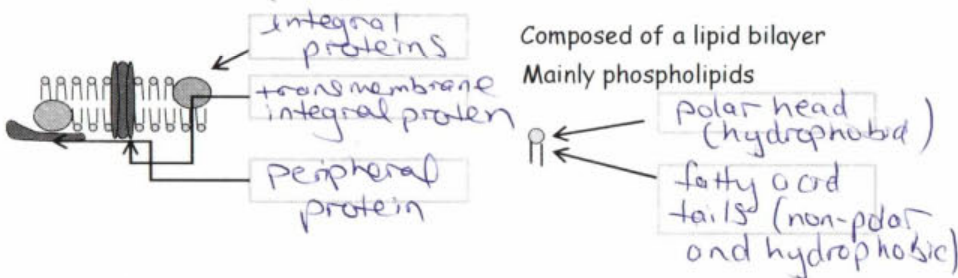
Efferent pathway → nerve structures thru which impulses are conducted from a nerve center toward a peripheral site.

Cells and compartments

Review 1st year material on cell organelles:
 -nucleus, ER, Golgi, endosomes, lysosomes, peroxisomes
 mitochondria

Membranes:

- 1) important as selective barrier to movement in and out of cells and organelles
- 2) detect chemical messengers at the cell surface



Intercellular communication

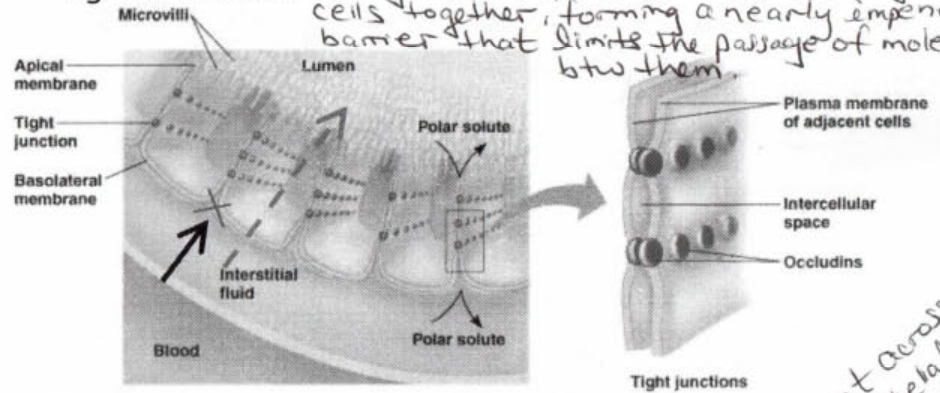
Cell to cell communication is important for homeostasis
 Performed by intercellular chemical messages

- 1) Hormones: Hormone secreting cells -target cells through blood
 - slow acting
 -Example: insulin and glucose homeostasis
- 2) Neurotransmitters: Nerve - nerve; nerve - effector cell
 - fast acting
 -Example: Acetylcholine and heart rate
- 3) Autocrine / Paracrine agents: local homeostatic responses
 -Act locally on target cell by diffusion
 -Examples includes ATP, nitric oxide (NO), fatty acid derivatives (eicosanoids)
 -Auto = same cell; para = neighbouring cells

See Fig 5.2

Cell - cell contact (adhesions)

Tight Junctions → a junction that connects two adjacent cells together, forming a nearly impenetrable barrier that limits the passage of molecules btw them.



- Extracellular membranes of adjacent cells joined
- Transport pathway between cells (extracellular) blocked
- Most substances must therefore go transcellularly
- Forms a selective barrier
- E.g. most epithelial cells

must cross an epithelial cell layer thru the cells

Fig 2.26

Desmosomes

- Hold adjacent cells tightly together
- found in areas of stretching (e.g. skin) or high mechanical stress (cardiac cells)

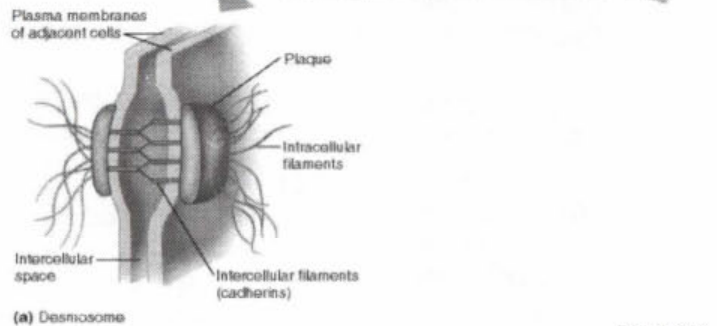


Fig 2.27

filamentous junction btw 2 adjacent cells that provides a strong physical linkage btw them; enables tissues to withstand stretching w/o cells being torn apart from one another.

Gap Junctions

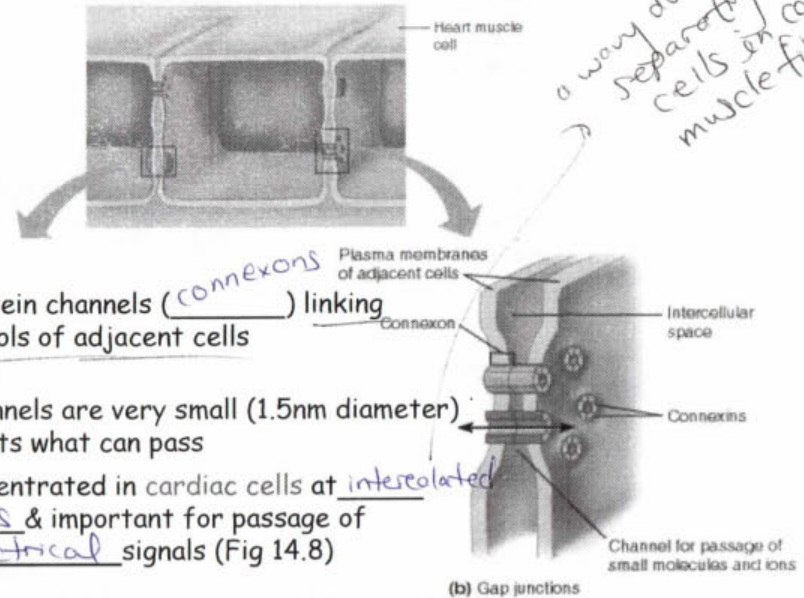


Fig 2.27

- Protein channels (connexons) linking cytosols of adjacent cells

- channels are very small (1.5nm diameter) & limits what can pass

- concentrated in cardiac cells at intercalated disks & important for passage of electrical signals (Fig 14.8)

a way double membrane separating adjacent cells in cardiac muscle fibers

→ areas where 2 adjacent cells are connected together by membrane proteins called connexons that form small channels btw the cells, enabling ions and small molecules to move freely btw them.

The five components of a reflex are: a sensory receptor that detects a stimulus, an afferent neuron that transmits info from the receptor to the CNS, an integration center (which is generally the CNS), an efferent neuron that transmits info from the integration center to the periphery, and an effector organ, which produces a response to the stimulus.

Autocrine: type of chemical msgnr for which the secretory cell and target cell are the same.

Paracrine: type of chemical msgnr that communicates w/ neighboring cells by simple diffusion