Homeostatic Control Systems

- In order to maintain homeostasis, control system must be able to
  - Detect deviations from normal in the internal environment that need to be held within narrow limits
  - Integrate this information with other relevant information
  - Make appropriate adjustments in order to restore factor to its desired value

Homeostatic Control Systems

A. Control systems are grouped into two classes
- Intrinsic controls
  - Local controls that are inherent in an organ, tissue, or cell; act in and on local environment
    - Paracrine and autocrine chemical messengers never leave the local environment
    - Local conditions effect local cells
- Extrinsic controls
  - Regulatory mechanisms initiated outside an cell, tissue, or organ influence it
  - Accomplished by nervous and endocrine system chemical messengers
    - Hormones, neurotransmitters, neurohormones

Homeostatic Control Systems

B. Control systems operated according to one of three main schemes
1. Negative Feedback
   a. Bring variable back to normal by taking it in opposite direction of original upset
      i. If variable lower than normal, raise it to normal level
      ii. If variable higher than normal, decrease it to normal level
2. Feed forward Control
   a. Anticipate and prevent change in variable
      i. Create condition that will oppose change that will occur
3. Positive Feedback Control
   a. Keep the change going in the direction it is already moving
      i. Produce more of the product that is accumulating

Homeostatic Control Systems Operational Principals

- Negative feedback system
  - Primary type of homeostatic control
    - negative is not bad
    - NEGATIVE fixes or opposes the initial change
      - if x increases, negative feedback operates to decrease x
      - if x decreases, negative feedback operates to increase x
        - » If (controlled homeostatic variable) is above set point, lower it

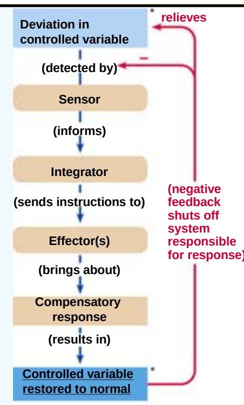
          CORE TEMPERATURE supposed to be 37ºC (SET POINT)

          CORE TEMPERATURE is 36ºC

          THERMOREGULATORY Control System will cause changes that try to bring CORE TEMPERATURE back to the 37ºC SET POINT

Homeostatic Control System Components

- Controlled Variable (something a sensor can detect)
- Sensor (detects the amount of a controlled variable present in the environment)
- Control Center (Compares sensor's input with a set point)
  - Integrator (know how it accomplishes comparison)
  - Black Box (not sure of details of how it operates)
- Effector: initiates a response that influences controlled variable

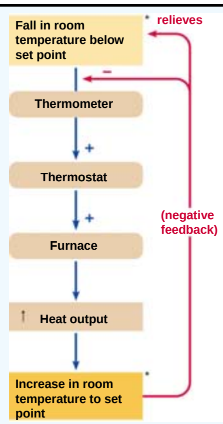


(a) Components of a negative-feedback control system

KEY

Flow diagrams throughout the text
+ = Stimulates or activates
– = Inhibits or shuts off
= Physical entity, such as body structure or a chemical
= Actions
= Compensatory pathway
= Turning off of compensatory pathway (negative feedback)
* Note that lighter and darker shades of the same color are used to denote, respectively, a decrease or an increase in a controlled variable.

Fig. 1-8a, p. 14



(b) Negative-feedback control of room temperature

KEY

Flow diagrams throughout the text
+ = Stimulates or activates
– = Inhibits or shuts off
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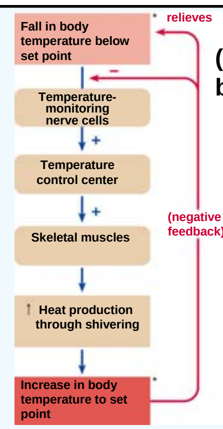
Fig. 1-8b, p. 14



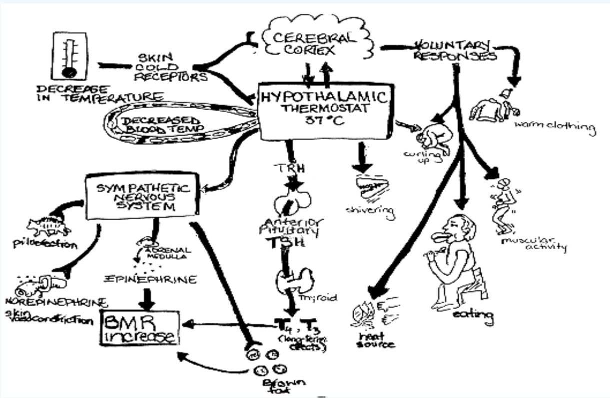
(c) Negative-feedback control of body temperature

KEY

Flow diagrams throughout the text
+ = Stimulates or activates
– = Inhibits or shuts off
= Physical entity, such as body structure or a chemical
= Actions
= Compensatory pathway
= Turning off of compensatory pathway (negative feedback)
* Note that lighter and darker shades of the same color are used to denote, respectively, a decrease or an increase in a controlled variable.

Fig. 1-8c, p. 14

Most controlled variables of homeostasis have redundant loops to assure promote survival of the organism



Chapter 2

Cell Physiology

Cell Physiology

- Cells are living building blocks of all multicellular organisms
  - Size of cells same across different organisms
  - 100 average-sized cells lined up would stretch a distance of 1mm
  - Difference in number and specific types of cells between species
    - 10-14 trillion cells make average human body
    - 4 main types of cells
      - 200 sub types based on structure and function

Cell Physiology

- Regardless of subtype
  - Cell is smallest structural and functional unit capable of carrying out life processes
  - Cells are composed of specific macromolecules that participate is similar chemical reactions or processes
    - Functional activities of each cell depend on specific structural properties and protein content of the cell
    - In cells from all living organisms genes are stored in DNA written in the same chemical code
    - Cells use the machinery of DNA transcription and RNA translation to produce *protein* molecules that make up and control the cell
    - The proteins expressed give function to the cell

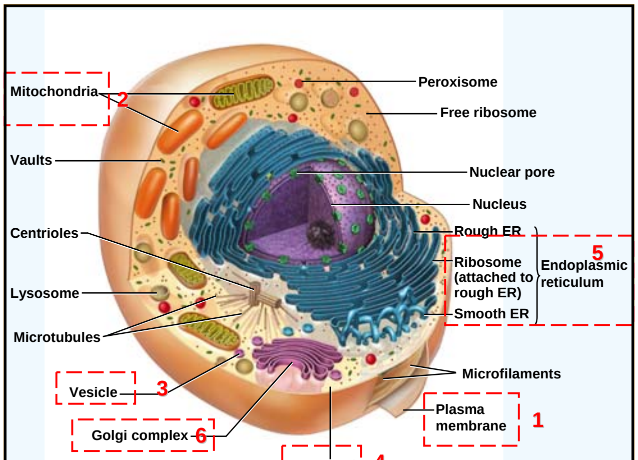


Fig. 2-1, p. 20

Plasma Membrane

- Also called the cell membrane
- Surrounds every cell
- Separates cell contents from its surroundings
  - Separates ICF and ECF
  - Not a line on a page
  - A selectively permeable structure comprised of protein, lipid, and other macromolecules that
    - controls movement of molecules into and out of cell
    - contains receptors for communication with other cells

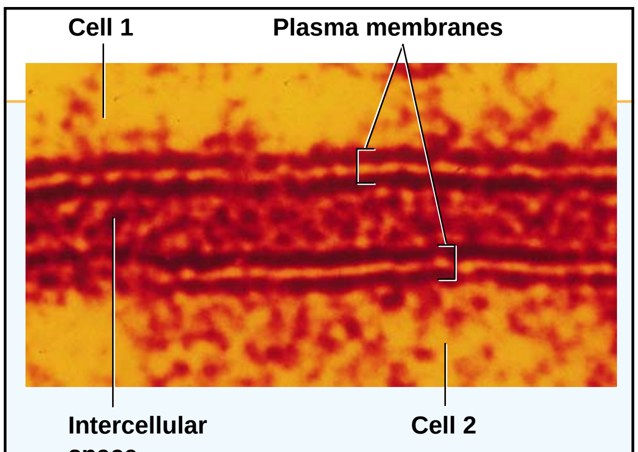


Fig. 3-1, p. 44

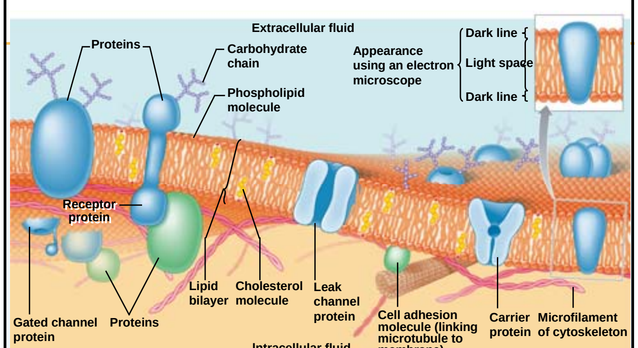


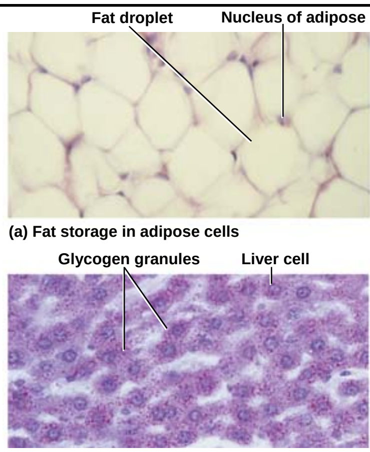
Fig. 3-3, p. 45

Cytoplasm

- Portion of cell interior not occupied by the nucleus
- Consists of
  - Organelles (“little organs”)
    - Distinct named, highly organized, membrane-enclosed structures
  - Cytoskeleton
    - immersed in complex, gel-like liquid called the Cytosol

Cytosol: Cell Gel

- Occupies about 55% of total cell volume
- Semi-liquid portion of cytoplasm that surrounds the organelles
  - Enzymatic regulation of intermediary metabolism
  - Ribosomal protein synthesis
  - Storage of fat, carbohydrate, and secretory vesicles
- Contains cytoskeleton



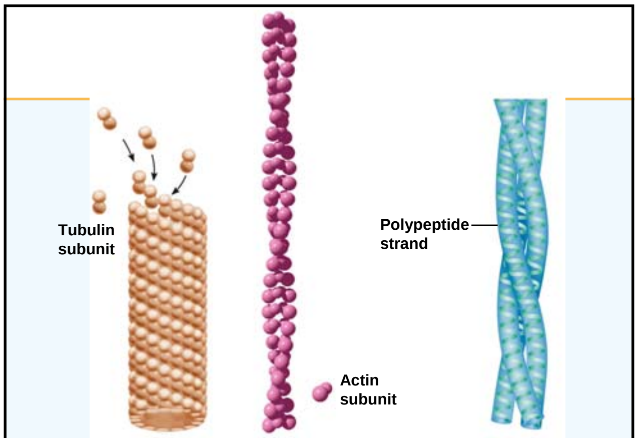
(a) Fat storage in adipose cells

(b) Glycogen storage in liver cells

Fig. 2-16, p. 34

Cytoskeleton: Cell “Bone and Muscle”

- Complex protein network protein of cytosol that acts as “bone and muscle” of cell
- Three distinct elements
  - Microtubules
  - Microfilaments
  - Intermediate filaments



(a) Microtubule (b) Microfilament (c) Keratin, an intermediate filament

Fig. 2-17, p. 35

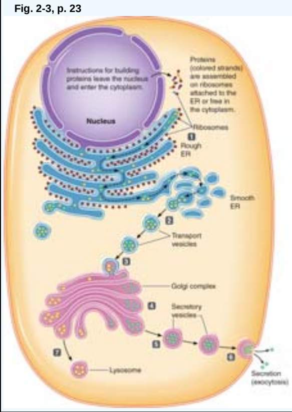
▲Table 2-1 Summary of Cytoplasm Components

Cytoplasm Component	Structure	Function
Cytoskeleton		As an integrated whole, the cell's "bone and muscle"
Microtubules	Long, slender, hollow tubes composed of tubulin molecules	Maintain asymmetric cell shapes and coordinate complex cell movements, specifically serving as highways for transport of secretory vesicles within a cell, serving as the main structural and functional component of cilia and flagella, and forming a mitotic spindle during cell division
Microfilaments	Intertwined helical chains of actin molecules; microfilaments composed of myosin molecules are also present in muscle cells	Play a vital role in various cellular contractile systems, including muscle contraction and amoeboid movement; serve as mechanical stiffeners for microvilli
Intermediate filaments	Irregular, threadlike proteins	Help resist mechanical stress

Table 2-1, p. 36

Endoplasmic Reticulum and Golgi Apparatus: synthesis, storage, and release of proteins and other cellular chemicals (example)

Fig. 2-3, p. 23



1 The rough ER synthesizes proteins to be secreted to the exterior or to be incorporated into plasma membrane or other cell components.

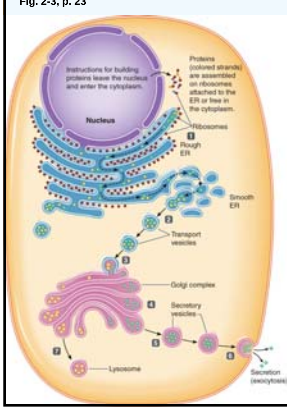
2 The smooth ER packages the secretory product into transport vesicles, which bud off and move to the Golgi complex.

3 The transport vesicles fuse with the Golgi complex, open up, and empty their contents into the closest Golgi sac.

4 The newly synthesized proteins from the ER travel by vesicular transport through the layers of the Golgi complex, which modifies the raw proteins into final form and sorts and directs the finished products to their final destination by varying their wrappers.

Endoplasmic Reticulum and Golgi Apparatus: protein synthesis, storage, and release

Fig. 2-3, p. 23



5 Secretory vesicles containing the finished protein products bud off the Golgi complex and remain in the cytosol, storing the products until signaled to empty.

6 On appropriate stimulation, the secretory vesicles fuse with the plasma membrane, open, and empty their contents to the cell's exterior. Secretion has occurred by exocytosis, with the secretory products never having come into contact with the cytosol.

7 Lysosomes also bud from the Golgi complex.