# Chapter 1 Homeostasis:
# A framework for human physiology

1. Cells, the fundamental units of life, exchange nutrients and wastes with their surroundings:

The intracellular fluid is “conditioned by”…

the interstitial fluid, which is “conditioned by” …

the plasma, which is “conditioned by” …

the organ systems it passes through.

# Chapter 1 Homeostasis:
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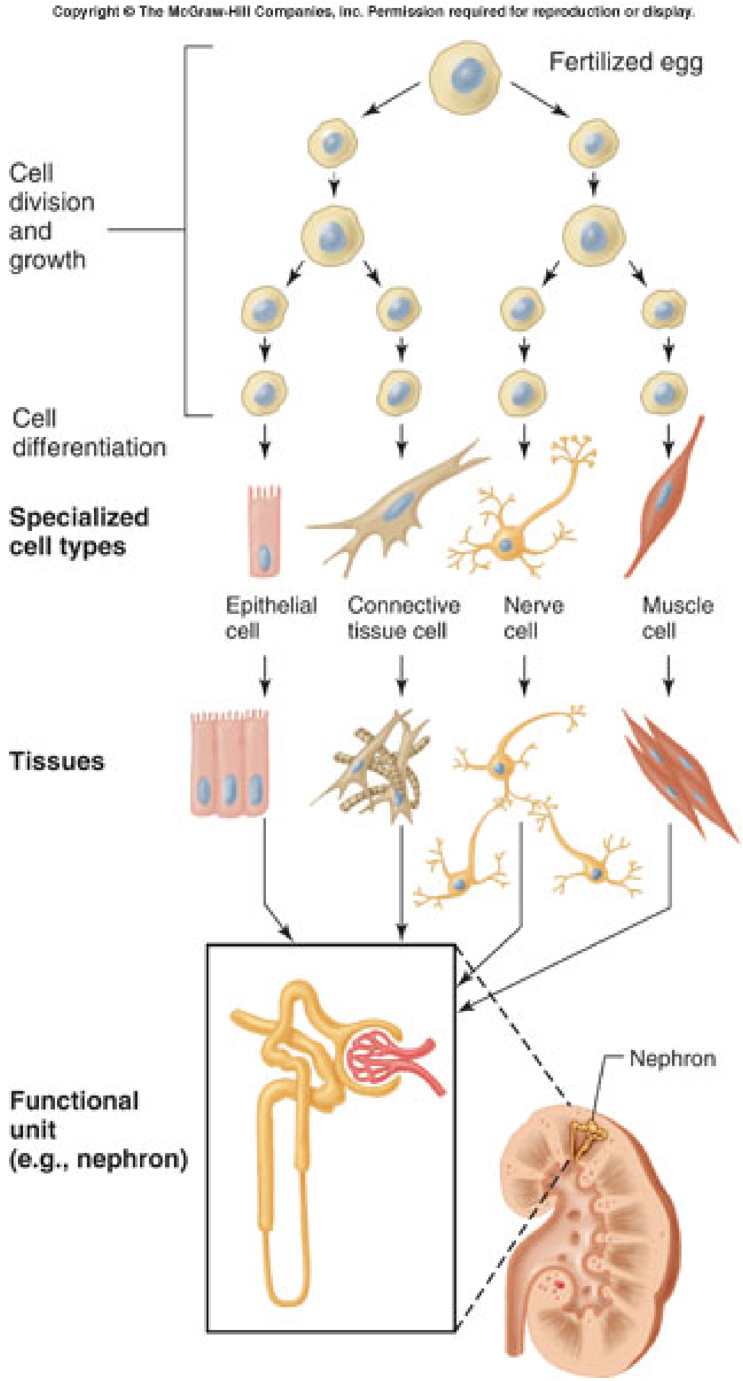
2. **Homeostasis refers to the dynamic mechanisms that detect and respond to deviations in physiological variables from their “set point” values by initiating effector responses that restore the variables to the optimal physiological range.**

# Figure 1-1



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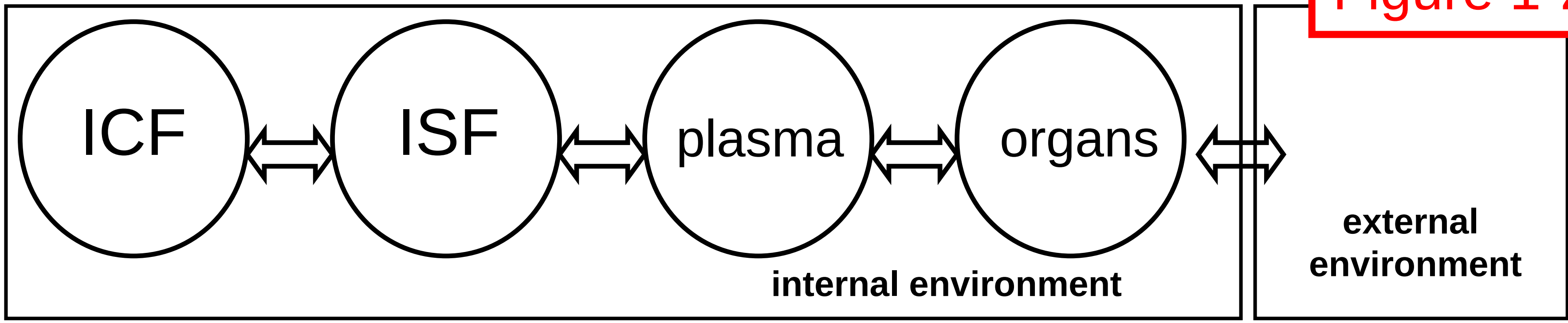
Fertilized egg
Cell division and growth
Cell differentiation
Specialized cell types
Epithelial cell
Connective tissue cell
Nerve cell
Muscle cell
Tissues
Functional unit (e.g., nephron)
Nephron

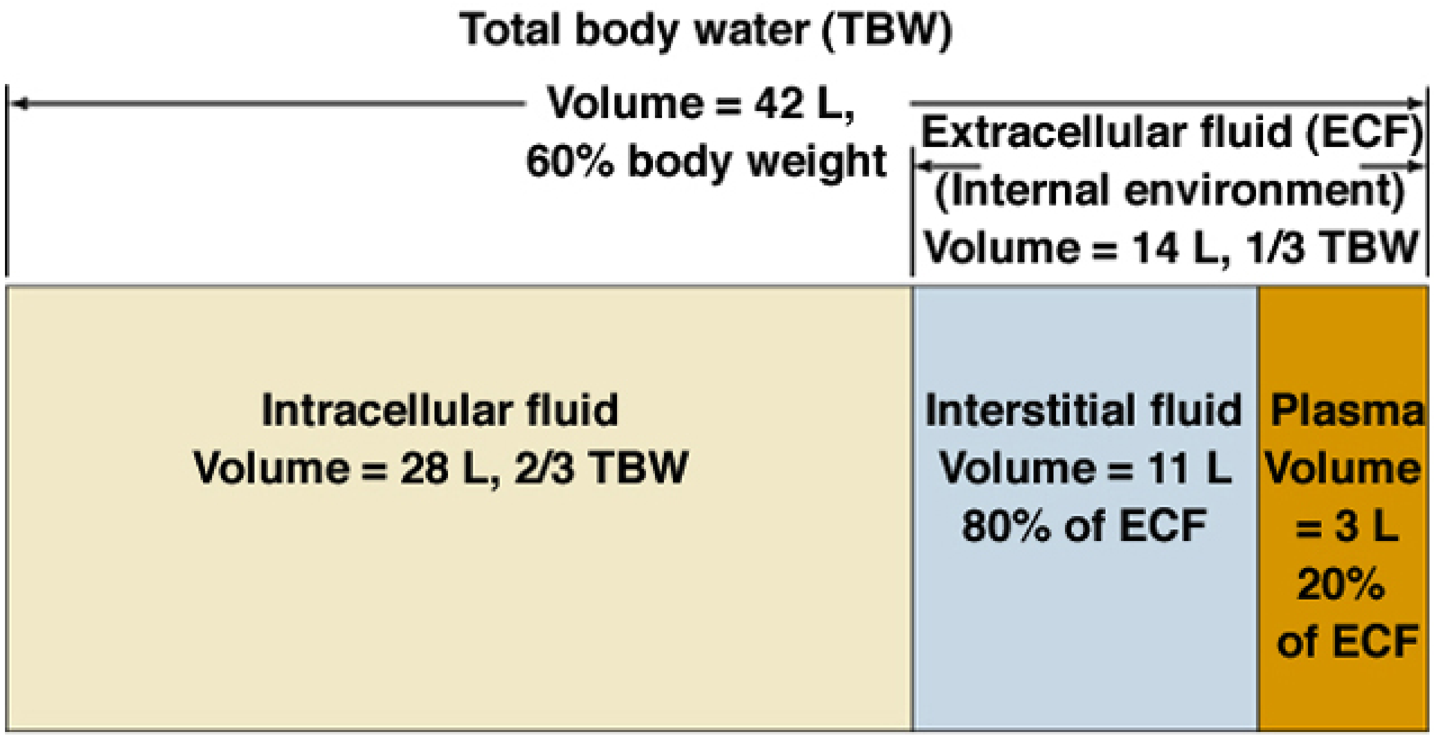
**Table 1-1, on page 5 in the text, outlines the structural components and functions of the major organ systems in the body.**

**TABLE 1–1** Organ Systems of the Body

| SYSTEM | MAJOR ORGANS OR TISSUES | PRIMARY FUNCTIONS |
|---|---|---|
| *Circulatory* | Heart, blood vessels, blood (Some classifications also include lymphatic vessels and lymph in this system.) | Transport of blood throughout the body's tissues |
| *Respiratory* | Nose, pharynx, larynx, trachea, bronchi, lungs | Exchange of carbon dioxide and oxygen; regulation of hydrogen ion concentration |
| *Digestive* | Mouth, pharynx, esophagus, stomach, intestines, salivary glands, pancreas, liver, gallbladder | Digestion and absorption of organic nutrients, salts, and water |
| *Urinary* | Kidneys, ureters, bladder, urethra | Regulation of plasma composition through controlled excretion of salts, water, and organic wastes |
| *Musculoskeletal* | Cartilage, bone, ligaments, tendons, joints, skeletal muscle | Support, protection, and movement of the body; production of blood cells |
| *Immune* | White blood cells, lymph vessels and nodes, spleen, thymus, and other lymphoid tissues | Defense against foreign invaders; return of extracellular fluid to blood; formation of white blood cells |
| *Nervous* | Brain, spinal cord, peripheral nerves and ganglia, special sense organs | Regulation and coordination of many activities in the body; detection of changes in the internal and external environments; states of consciousness; learning; cognition |
| *Endocrine* | All glands secreting hormones: Pancreas, testes, ovaries, hypothalamus, kidneys, pituitary, thyroid, parathyroid, adrenal, intestinal, thymus, heart, and pineal, and endocrine cells in other locations | Regulation and coordination of many activities in the body, including growth, metabolism, reproduction, blood pressure, electrolyte balance, and others |
| *Reproductive* | Male: Testes, penis, and associated ducts and glands<br>Female: Ovaries, fallopian tubes, uterus, vagina, mammary glands | Production of sperm; transfer of sperm to female<br>Production of eggs; provision of a nutritive environment for the developing embryo and fetus; nutrition of the infant |
| *Integumentary* | Skin | Protection against injury and dehydration; defense against foreign invaders; regulation of temperature |

Figure 1-2




**Exchange and communication are key concepts for understanding physiological homeostasis.**

Figure 1-3

**Interpret the arrows ⇩ in textbook's flow charts as "leads to" or "causes."**

**e.g., decreased room temperature causes increased heat loss from the body, which leads to a decrease in body temperature, etc.**

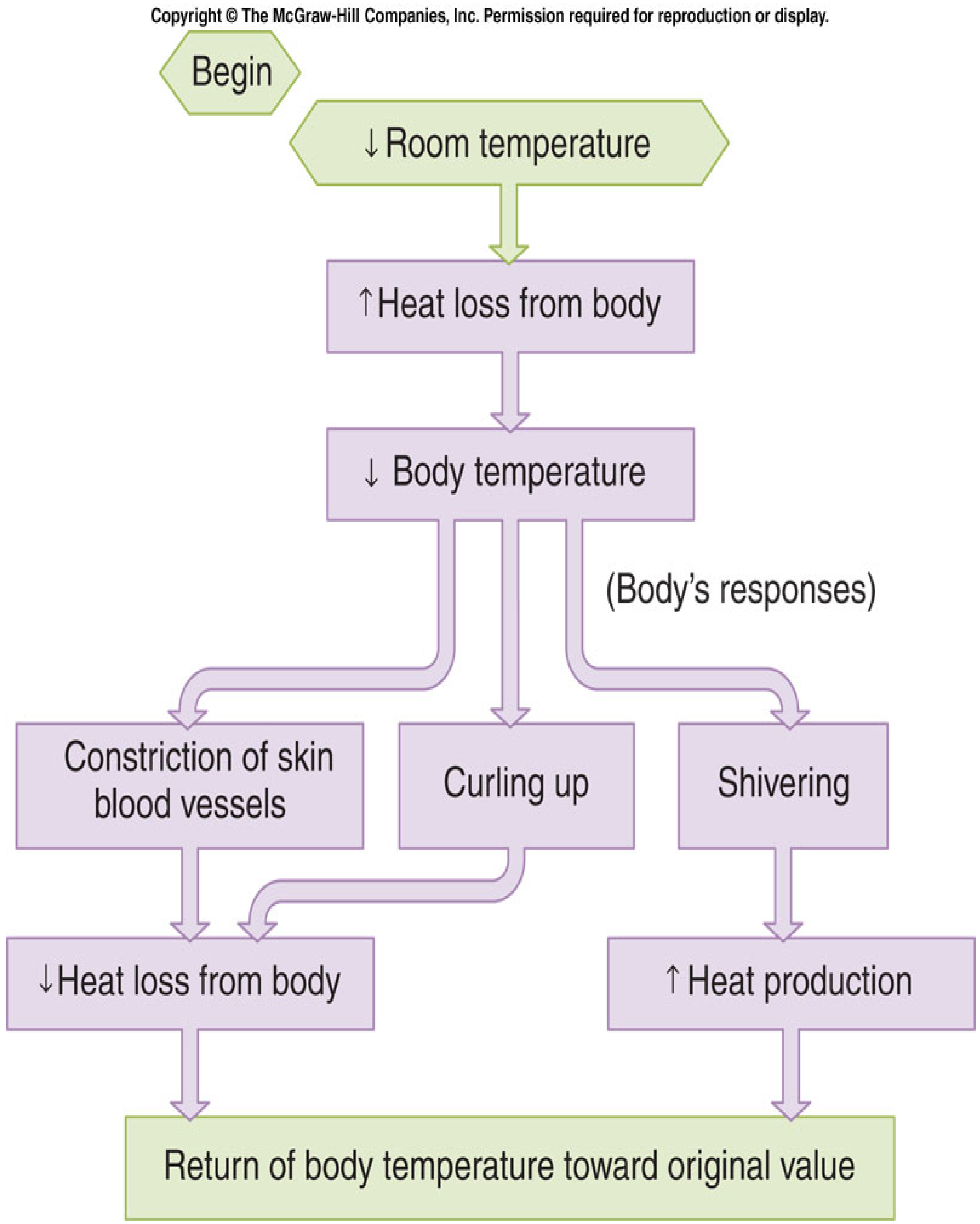


Figure 1-4



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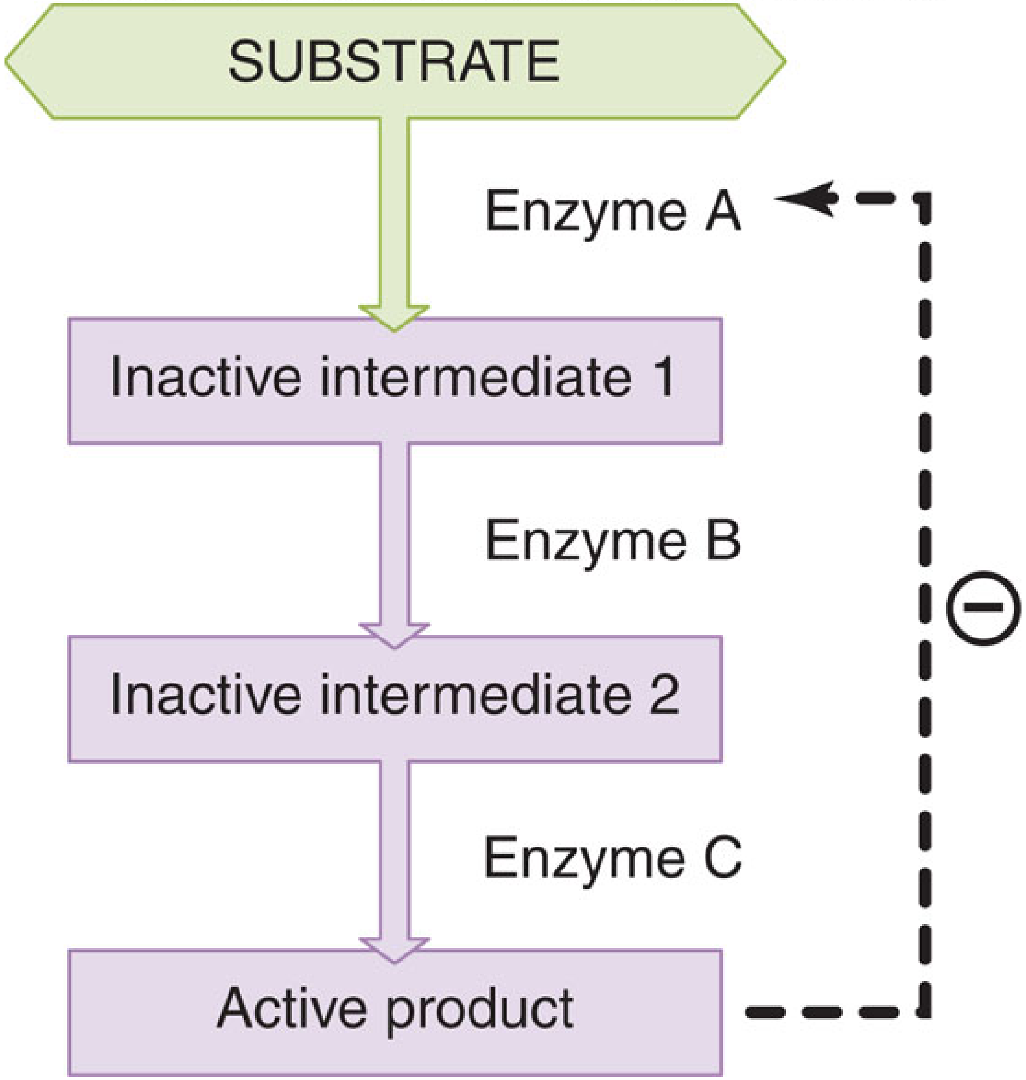


**"Active product" controls the sequence of chemical reactions by inhibiting the sequence's rate-limiting enzyme, "Enzyme A."**

# A strategy for exploring homeostasis (see Tables 1-2 & 1-3)

- **Identify the internal environmental variable.**

  *example: concentration of glucose in the blood*

- **Establish the "set point" value for that variable.**

  *example: 70 to 110 mg glucose/dL of blood*

- **Identify the inputs and outputs affecting the variable.**

  *example: diet and energy metabolism*

# A strategy for exploring homeostasis (see Tables 1-2 & 1-3)

- **Examine the balance between the inputs and outputs.**

  *example: resting versus exercising*

- **Determine how the body monitors/senses the variable.**

  *example: certain endocrine cells in the pancreas "sense" changes in glucose levels*

- **Identify effectors that restore the variable to its set point.**

  *example: a hormone that increases glucose synthesis by the liver*

**Many homeostatic mechanisms utilize neural communication.**

## TABLE 1–2 Some Important Generalizations About Homeostatic Control Systems

1. Stability of an internal environmental variable is achieved by balancing inputs and outputs. It is not the absolute magnitudes of the inputs and outputs that matter but the balance between them.
2. In negative feedback systems, a change in the variable being regulated brings about responses that tend to move the variable in the direction opposite the original change—that is, back toward the initial value (set point).
3. Homeostatic control systems cannot maintain complete constancy of any given feature of the internal environment. Therefore, any regulated variable will have a more-or-less narrow range of normal values depending on the external environmental conditions.
4. The set point of some variables regulated by homeostatic control systems can be reset—that is, physiologically raised or lowered.
5. It is not always possible for everything to be maintained relatively constant by homeostatic control systems in response to an environmental challenge. There is a hierarchy of importance, such that the constancy of certain variables may be altered markedly to maintain others at relatively constant levels.

| TABLE 1–3 | Questions to Be Asked About Any Homeostatic Reflex |
|---|---|
| 1. What is the variable (for example, plasma potassium concentration, body temperature, blood pressure) that is maintained relatively constant in the face of changing conditions? | |
| 2. Where are the receptors that detect changes in the state of this variable? | |
| 3. Where is the integrating center to which these receptors send information and from which information is sent out to the effectors, and what is the nature of these afferent and efferent pathways? | |
| 4. What are the effectors, and how do they alter their activities so as to maintain the regulated variable near the set point of the system? | |

# Figure 1-5



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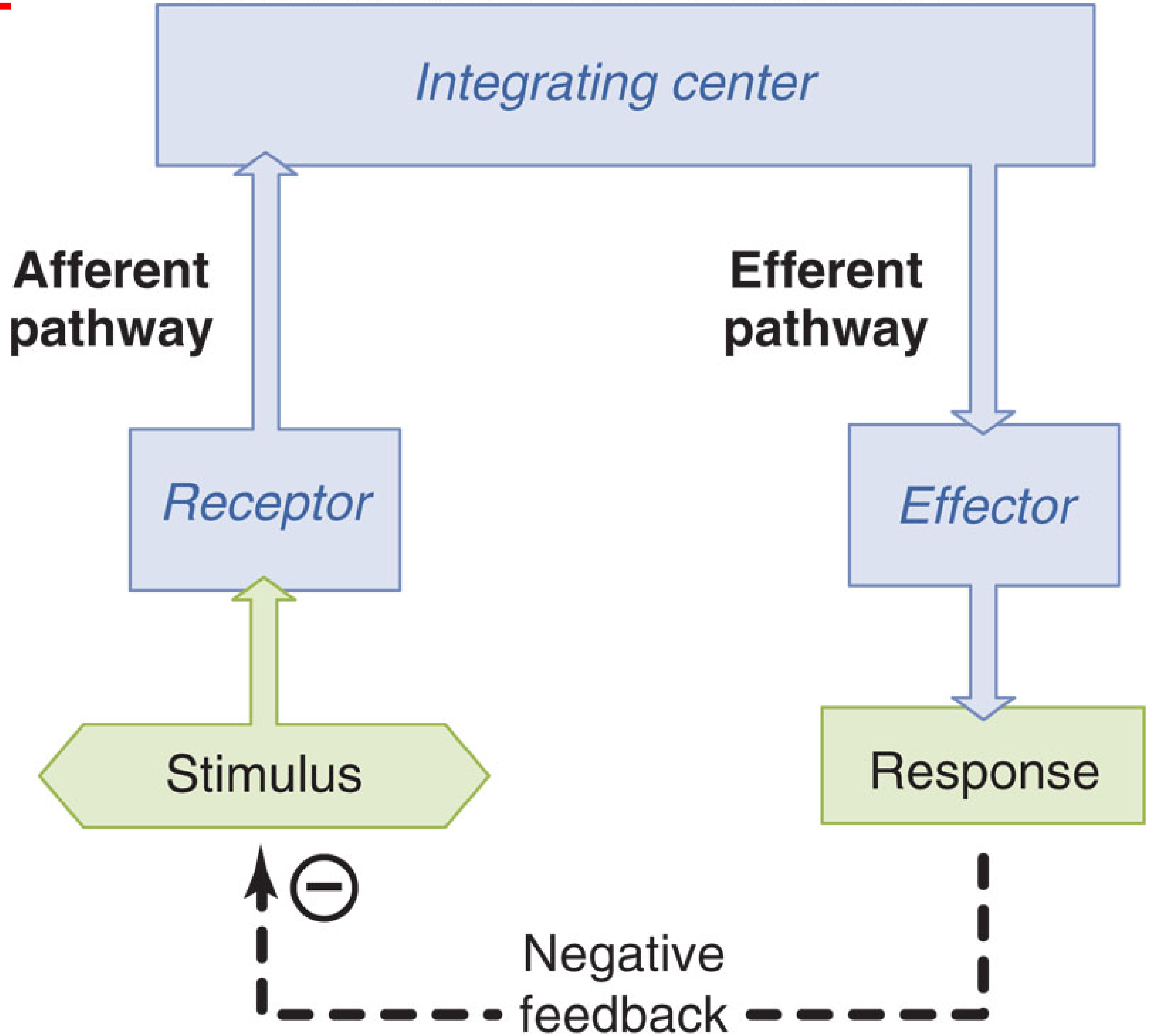
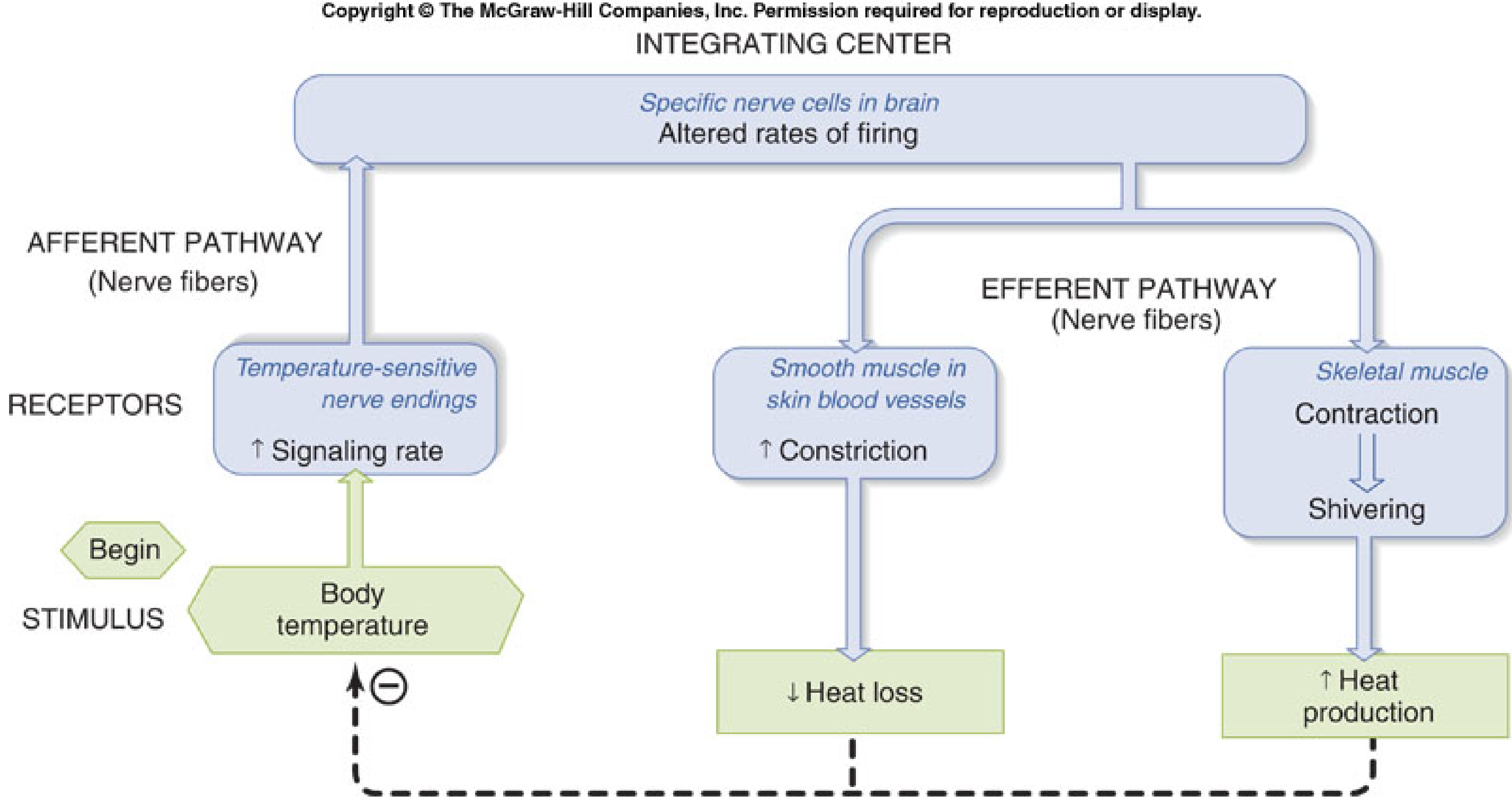



**Afferent and efferent pathways in temperature homeostasis.**

Figure 1-6






## Communication systems use signals that bind to receptors.

**Communication signals in three categories:**

**Endocrine:** **signal reaches often-distant targets after transport in blood.**

**Paracrine:** **signal reaches neighboring cells via the ISF.**

**Autocrine:** **signal affects the cell that synthesized the signal.**

# Figure 1-7



**A given signal can fit into all 3 categories:**

**e.g., the steroid hormone cortisol affects the very cells in which it is made, the nearby cells that produce other hormones, and many distant targets, including muscles and liver.**

**Multi-factorial control of signal release adds more complexity.**

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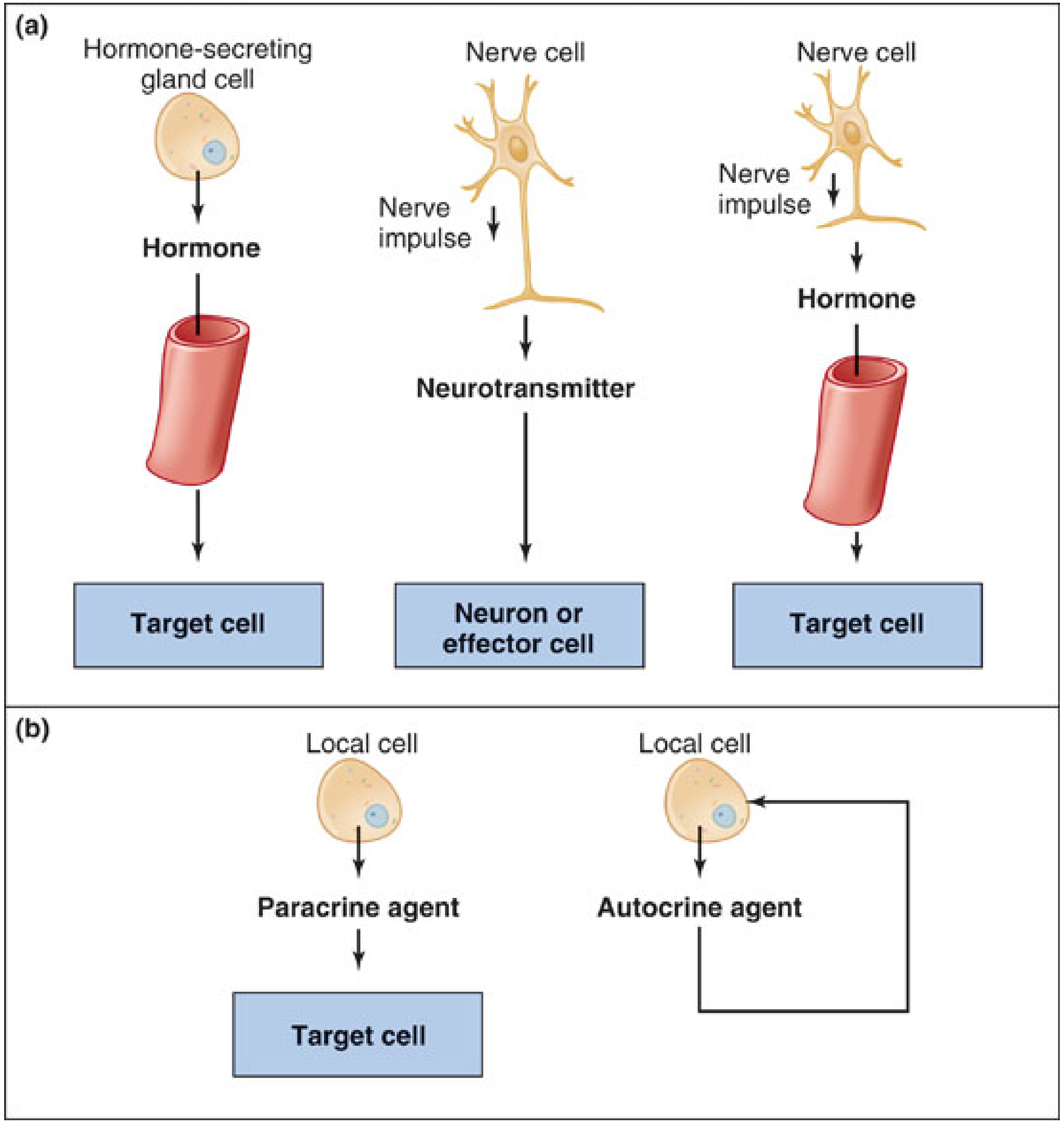
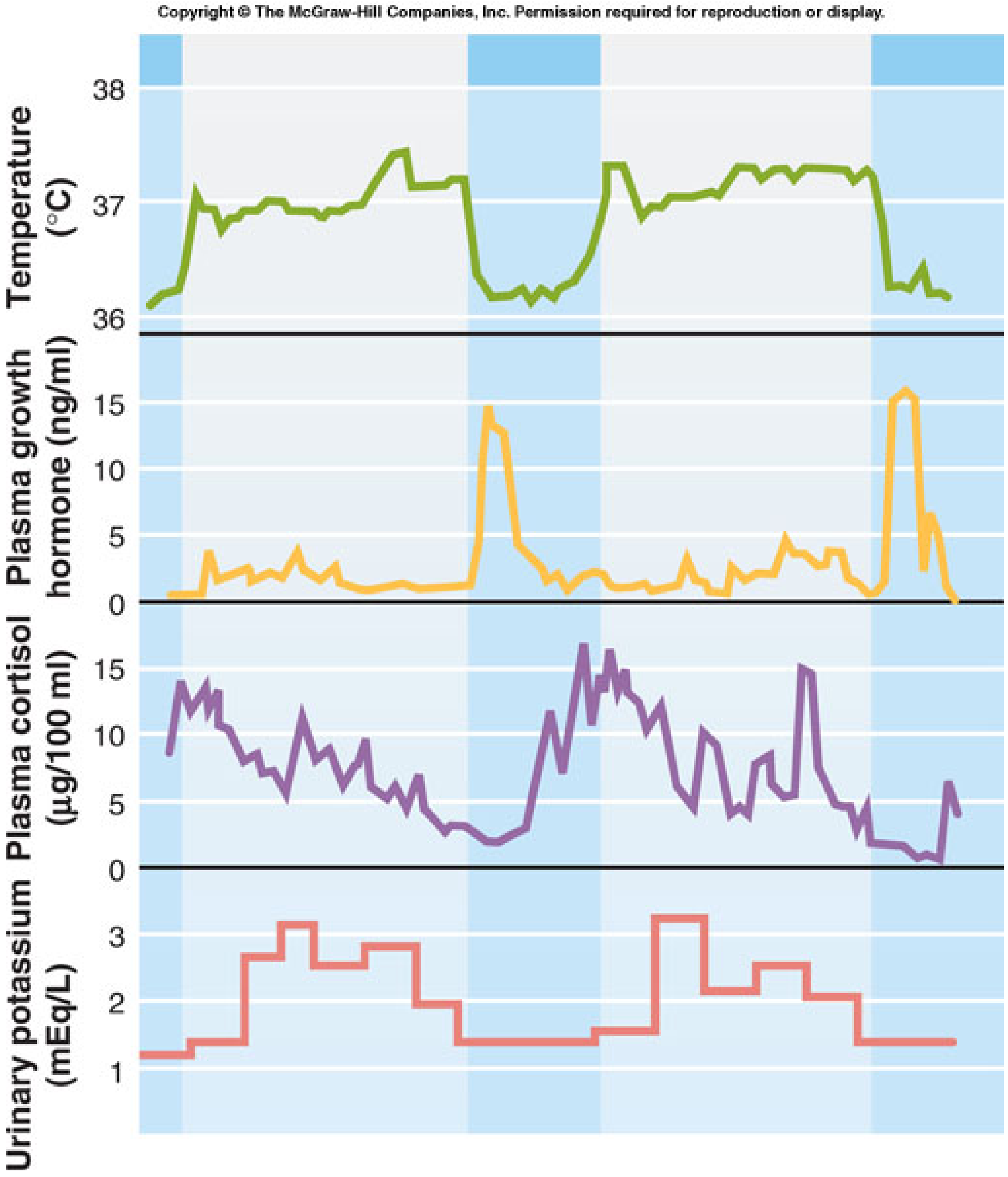


# Figure 1-8



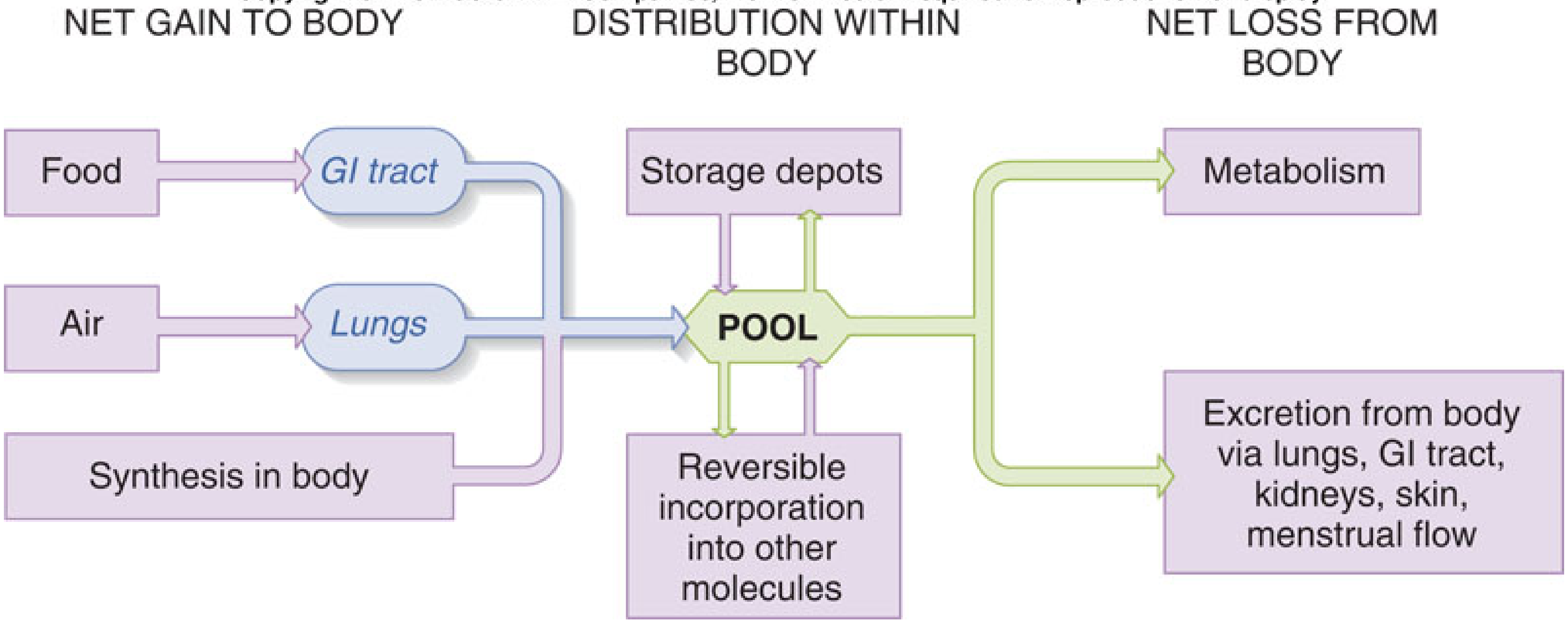



**A full analysis of the hormone cortisol requires not only knowledge of the signals that cause its synthesis and secretion but also consideration of biological rhythms.**

# Figure 1-9








**Some of the potential inputs and outputs that can affect the "pool" of a material (like glucose) that is a dynamically regulated physiological variable.**

# Figure 1-10



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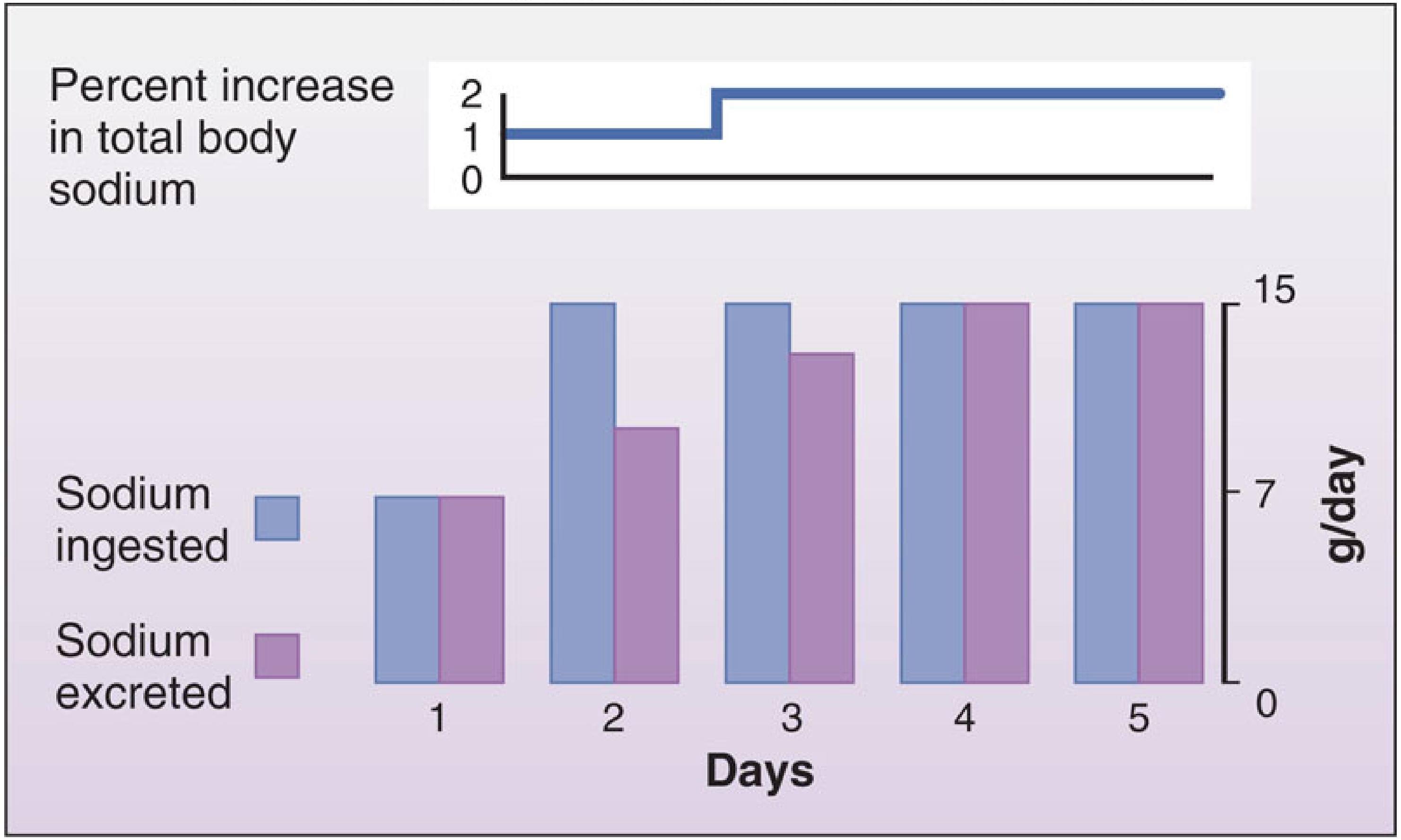


**Sodium homeostasis: Consuming greater amounts of dietary sodium initiates a set of dynamic responses that include greater excretion of sodium in the urine. Though not shown here, the amount excreted would likely exceed the amount ingested until the "set point" is restored.**

The End.