

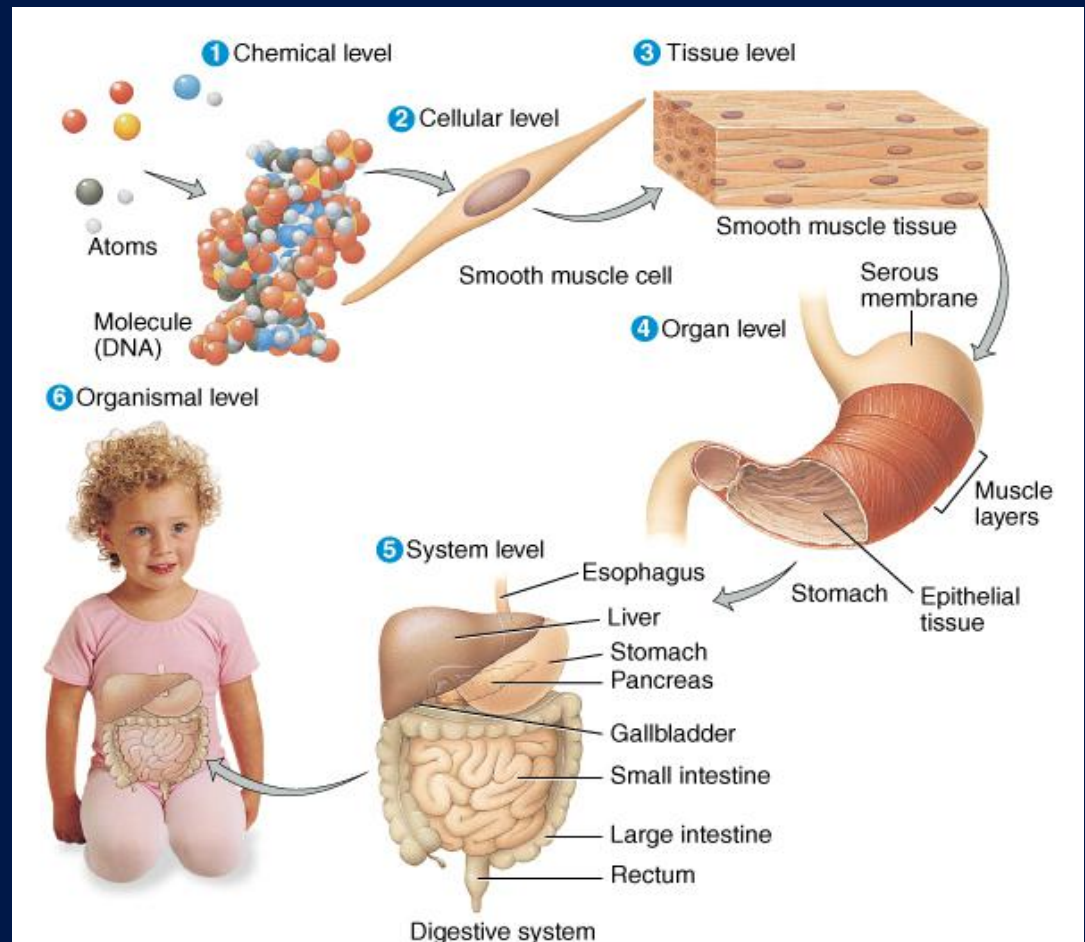
# Introduction to Physiology

# Physiology

- Science of body functions
- Teleological vs. Mechanistic views
  - Teleological – the **why**, explains *purpose* of a physiological process
  - Mechanistic – the **how**, explained in terms of *cause and effect* of physiological process
- Example: shivering
  - Teleological - shivering elevates a low body temperature
  - Mechanistic - when body temperature drops below normal, a reflex pathway causes involuntary oscillating skeletal muscle contractions which produce heat

# Levels of Organization

- Chemical
- Cellular
- Tissue
- Organs
- System Level
- Organismic Level



# Levels of Structural Organization

- Chemical Level - atomic and molecular level
- Cellular level - smallest living unit of the body
- Tissue level
  - Group of cells and the materials surrounding them that work together on one task
  - 4 basic tissue types: epithelium, muscle, connective tissue, and nerve



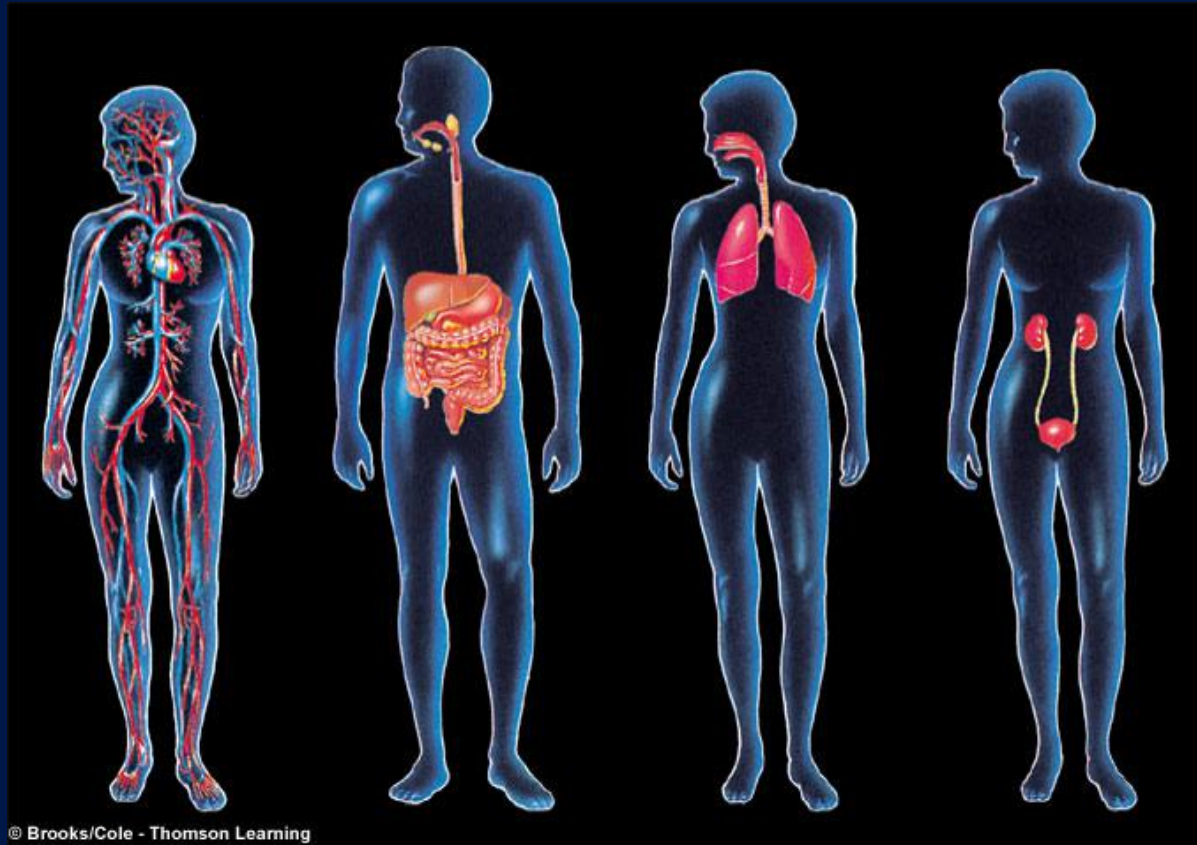
# Levels of Structural Organization

- Organ level - consists of two or more types of primary tissues that function together to perform a particular function or functions
  - Example: Stomach
    - Inside of stomach lined with epithelial tissue
    - Wall of stomach contains smooth muscle
    - Nervous tissue in stomach controls muscle contraction and gland secretion
    - Connective tissue binds all the above tissues together
- System - collection of related organs with a common function; sometimes an organ is part of more than one system
- Organismic level - one living individual

# Body Systems

- Groups of organs that perform related functions and interact to accomplish a common activity essential to survival of the whole body
- Do not act in isolation from one another
- Human body has 11 systems, we will focus on 8

# Body Systems



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## **Circulatory system**

heart, blood,  
blood vessels

## **Digestive system**

mouth, pharynx,  
esophagus, stomach,  
small intestine, large  
intestine, salivary  
glands, exocrine  
pancreas, liver,  
gallbladder

## **Respiratory system**

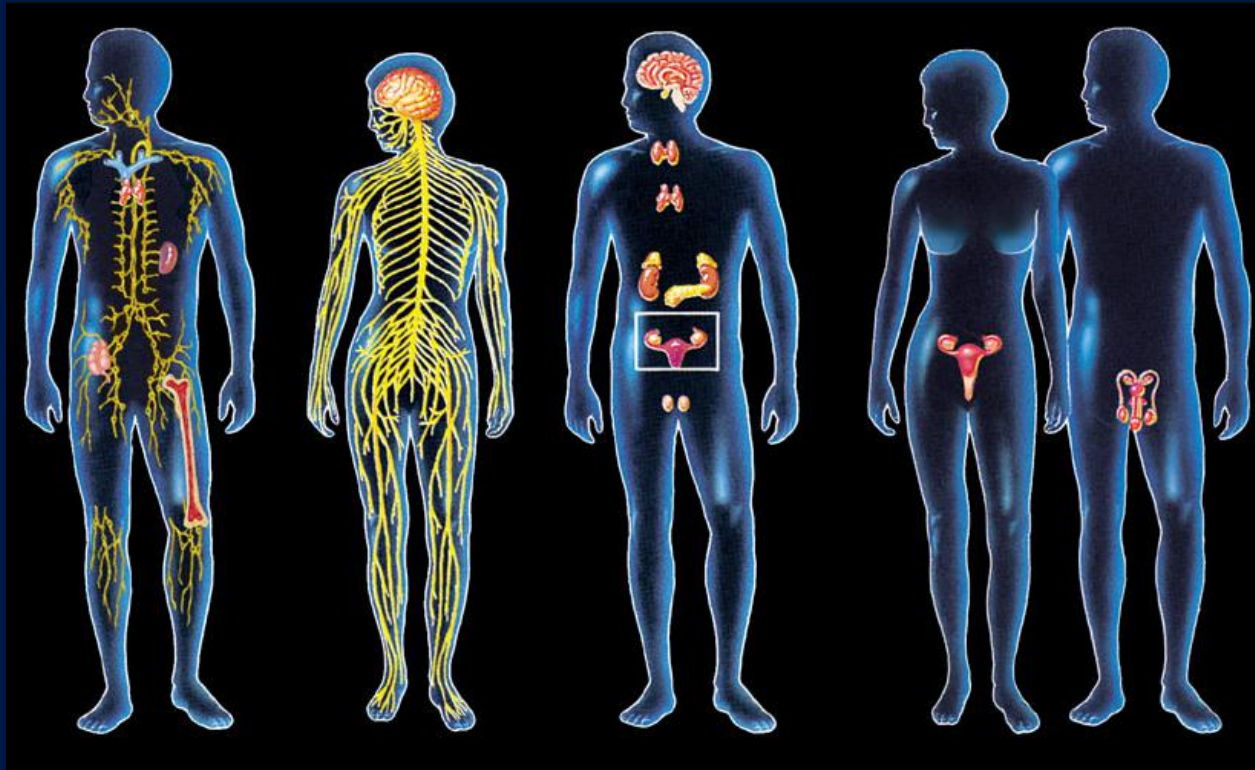
Nose, pharynx, larynx,  
trachea, bronchi, lungs

## **Urinary system**

kidneys, ureters,  
urinary bladder,  
urethra



# Body Systems



## **Immune system**

lymph nodes, thymus, bone marrow, tonsils, adenoids, spleen, appendix, and, not shown, white blood cells, gut-associated lymphoid tissue, and skin-associated lymphoid tissue

## **Nervous system**

brain, spinal cord, peripheral nerves, and, not shown, special sense organs

## **Endocrine system**

all hormone-secreting tissues, including hypothalamus, pituitary, thyroid, adrenals, endocrine pancreas, gonads, kidneys, pineal, thymus, and, not shown, parathyroids, intestine, heart, and skin

## **Reproductive system**

**Male:** testes, penis, prostate gland, seminal vesicles, bulbourethral glands, and associated ducts

**Female:** ovaries, oviducts, uterus, vagina, breasts



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

SYSTEM	MAJOR ORGANS OR TISSUES	PRIMARY FUNCTIONS
<i>Circulatory</i>	Heart, blood vessels, blood (Some classifications also include lymphatic vessels and lymph in this system.)	Transport of blood throughout the body's tissues
<i>Respiratory</i>	Nose, pharynx, larynx, trachea, bronchi, lungs	Exchange of carbon dioxide and oxygen; regulation of hydrogen ion concentration
<i>Digestive</i>	Mouth, pharynx, esophagus, stomach, intestines, salivary glands, pancreas, liver, gallbladder	Digestion and absorption of organic nutrients, salts, and water
<i>Urinary</i>	Kidneys, ureters, bladder, urethra	Regulation of plasma composition through controlled excretion of salts, water, and organic wastes
<i>Musculoskeletal</i>	Cartilage, bone, ligaments, tendons, joints, skeletal muscle	Support, protection, and movement of the body; production of blood cells
<i>Immune</i>	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
<i>Nervous</i>	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
<i>Endocrine</i>	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
<i>Reproductive</i>	Male: Testes, penis, and associated ducts and glands Female: Ovaries, fallopian tubes, uterus, vagina, mammary glands	Production of sperm; transfer of sperm to female Production of eggs; provision of a nutritive environment for the developing embryo and fetus; nutrition of the infant
<i>Integumentary</i>	Skin	Protection against injury and dehydration; defense against foreign invaders; regulation of temperature

# Homeostasis

- Defined as maintenance of a relatively stable internal environment
  - Does not mean that composition, temperature, and other characteristics are absolutely unchanging
- Homeostasis is essential for survival and function of all cells
- Each cell contributes to maintenance of a relatively stable internal environment

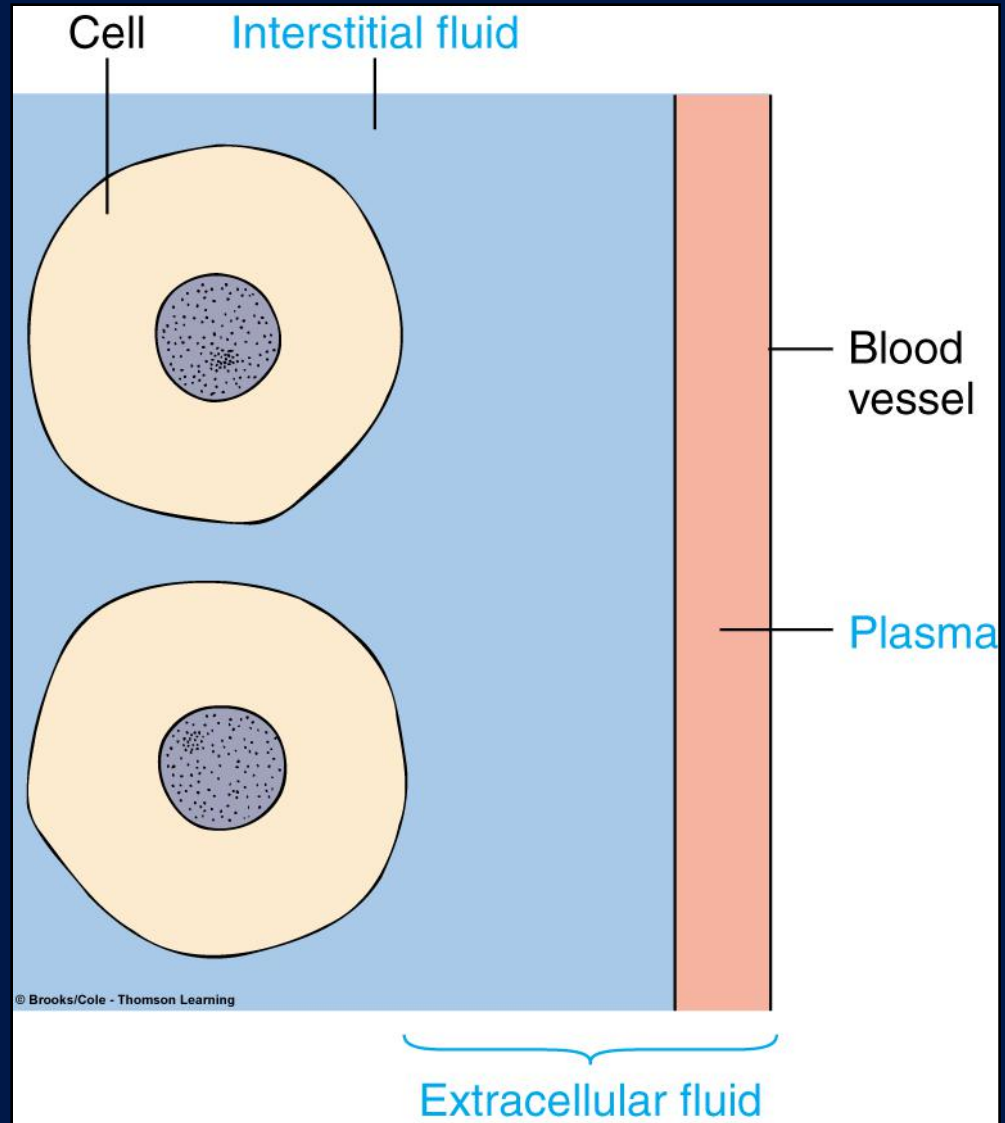
# Basic Cell Functions

- Sensing and responding to changes in surrounding environment
- Control exchange of materials between cell and its surrounding environment
  - Obtain nutrients and oxygen from surrounding environment
  - Eliminate carbon dioxide and other wastes to surrounding environment
- Perform chemical reactions that provide energy for the cell
- Synthesize needed cellular components



# Homeostasis

- Body cells are contained in watery internal environment through which life-sustaining exchanges are made
- Extracellular fluid (ECF) - Fluid environment in which the cells live (fluid outside the cells)
  - Two components:
    - Plasma
    - Interstitial fluid
- Intracellular fluid (ICF) - Fluid contained within all body cells





# Balancing the Internal and External Environment

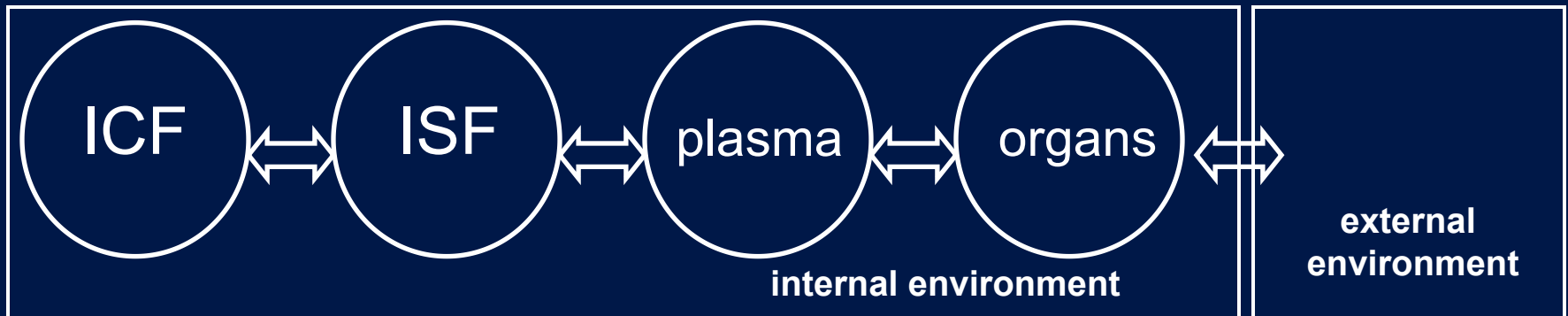
Cells, the fundamental units of life, exchange nutrients and wastes with their surroundings:

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.



# Homeostasis

- Homeostasis involves 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.
- Two systems that maintain homeostasis are the *nervous system* & *endocrine system*

# Maintenance of Homeostasis

- Nervous system
  - Controls and coordinates bodily activities that require *rapid* responses
  - Detects and initiates reactions to changes in external environment
- Endocrine system
  - Secreting glands of endocrine regulate activities that require *duration* rather than speed
  - Controls concentration of nutrients and, by adjusting kidney function, controls internal environment's volume and electrolyte composition

# Homeostasis

Factors homeostatically regulated include

- Concentration of nutrient molecules
- Concentration of water, salt, and other electrolytes
- Concentration of waste products
- Concentration of  $O_2 = 100\text{mmHg}$  and  $CO_2 = 40\text{mmHg}$
- $\text{pH} = 7.35$
- Blood volume 4-6 L and pressure 120/80mmHg
- Temperature =  $37^\circ\text{C}$

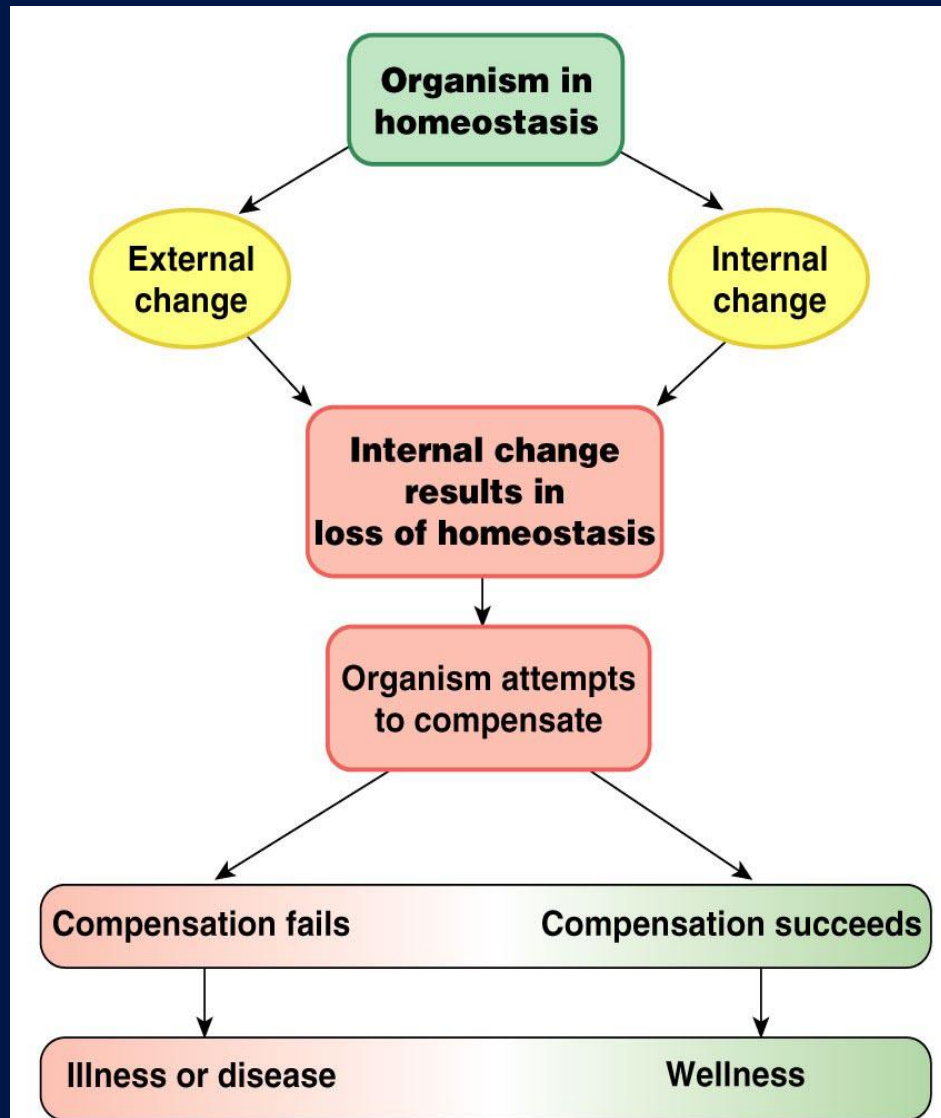


# Control of Homeostasis

- Homeostasis is continually being disrupted by
  - External stimuli
    - heat, cold, lack of oxygen, pathogens, toxins
  - Internal stimuli
    - Body temperature
    - Blood pressure
    - Concentration of water, glucose, salt, oxygen, etc.
    - Physical and psychological distresses
- Disruptions can be mild to severe
- If homeostasis is not maintained, death may result



# Control of Homeostasis



# Homeostatic Control Systems

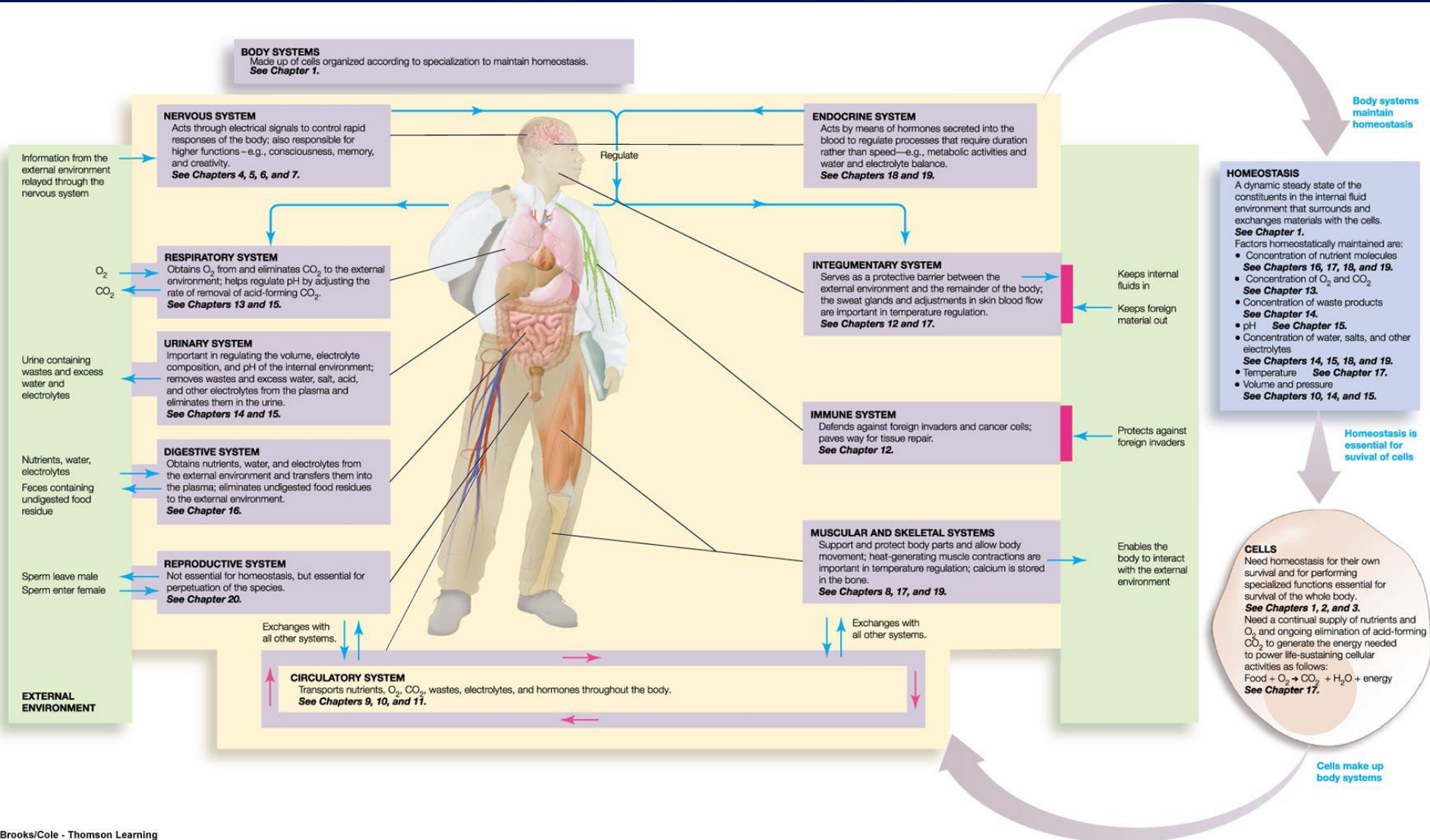
- In order to maintain homeostasis, control system must be able to
  - Detect deviations from normal in the internal environment that need to be held within narrow limits
  - Integrate this information with other relevant information
  - Make appropriate adjustments in order to restore factor to its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

# Homeostatic Control Systems

- Control systems are grouped into two classes
  - **Intrinsic** controls
    - Local controls that are inherent in an organ
  - **Extrinsic** controls
    - Regulatory mechanisms initiated outside an organ
    - Accomplished by nervous and endocrine systems



# Role of Body Systems in Homeostasis



# Homeostatic Control Systems

- Feedforward - term used for responses made in anticipation of a change
- Feedback - refers to responses made after change has been detected
  - Types of feedback systems
    - Negative
    - Positive

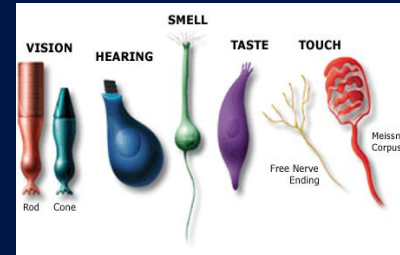
# Feedback Loops: Types

- Negative feedback loop
  - original stimulus reversed
  - most feedback systems in the body are negative
  - used for conditions that need frequent adjustment
- Positive feedback loop
  - original stimulus intensified
  - seen during normal childbirth

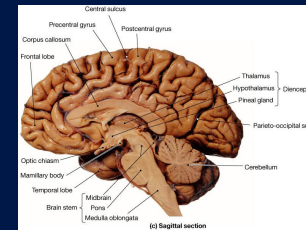


# Negative Feedback Loop

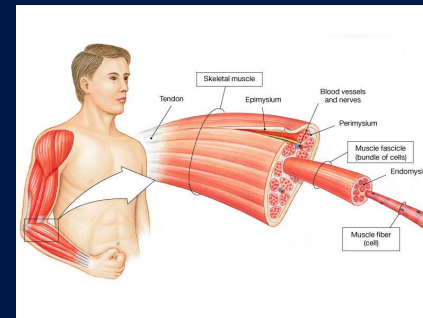
- Negative feedback loop consists of:
- Receptor - structures that monitor a controlled condition and detect changes



- Control center - determines next action

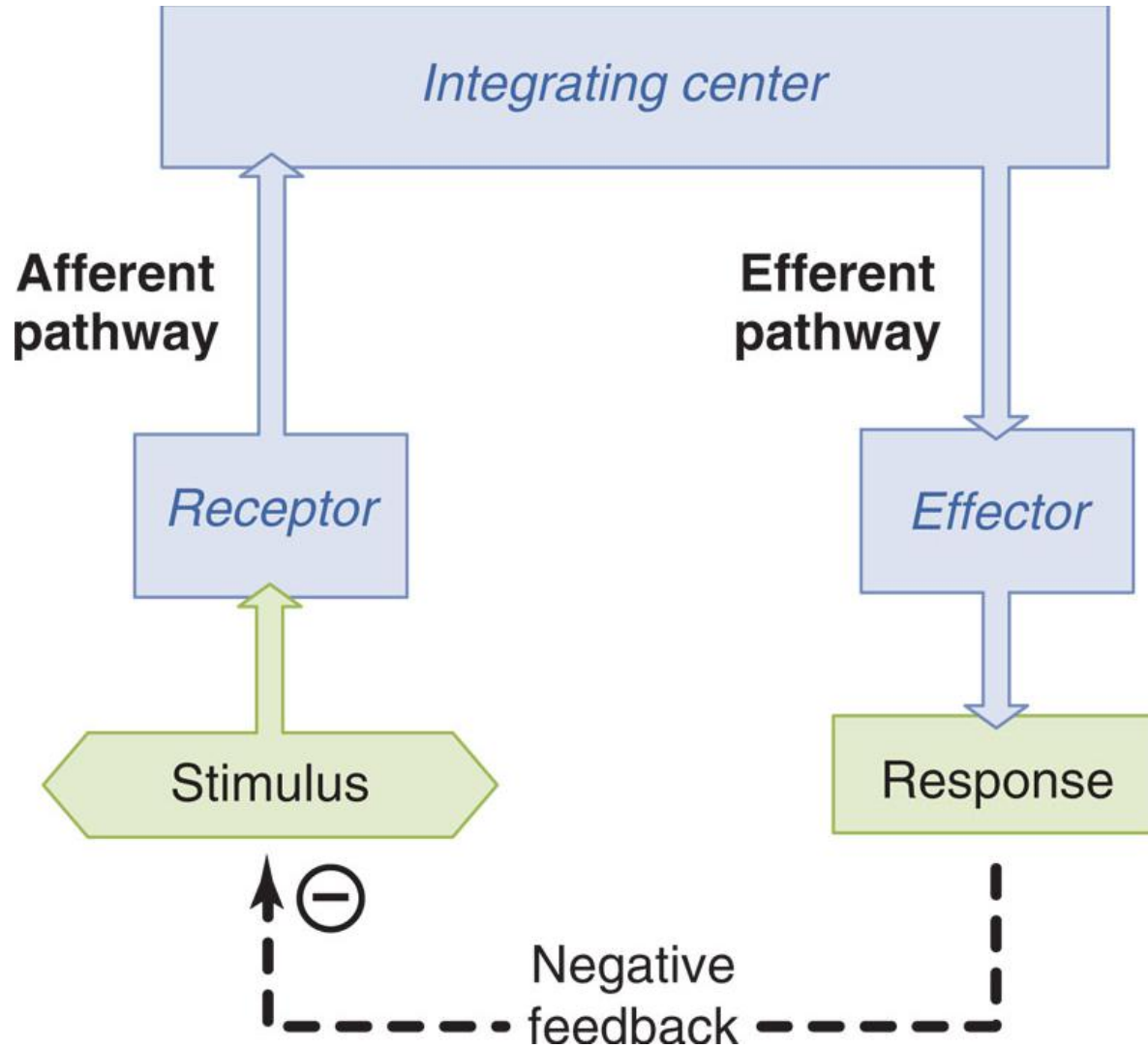


- Effector
  - receives directions from the control center
  - produces a response that restores the controlled condition

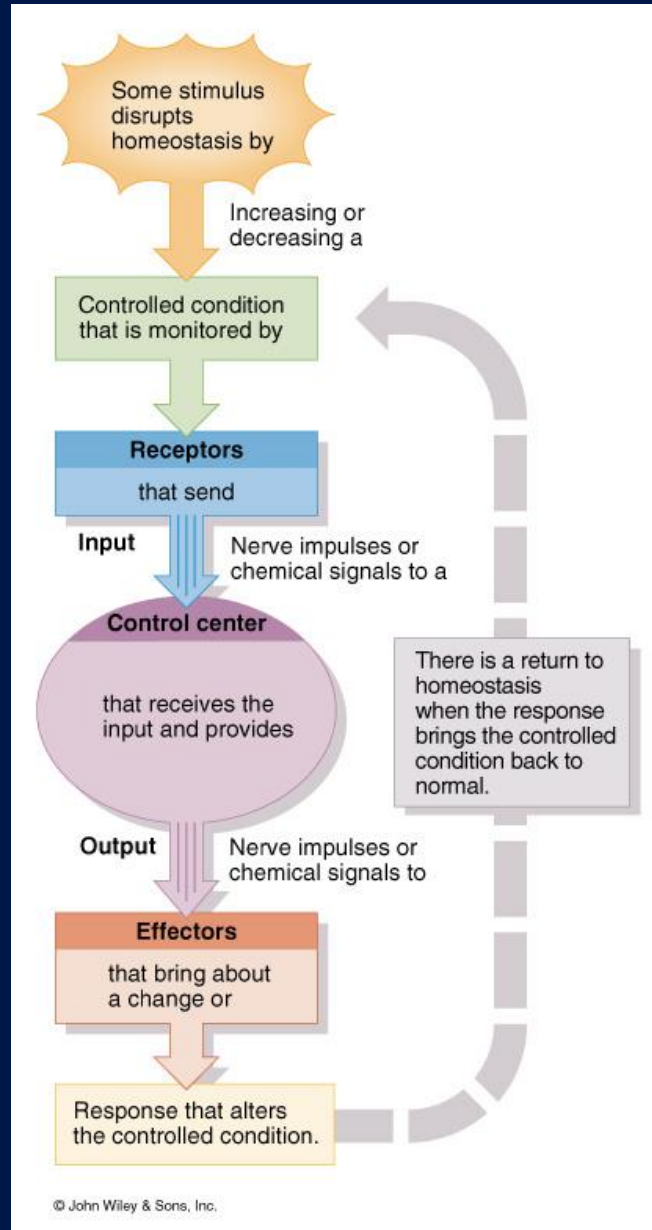




# Negative Feedback Loop

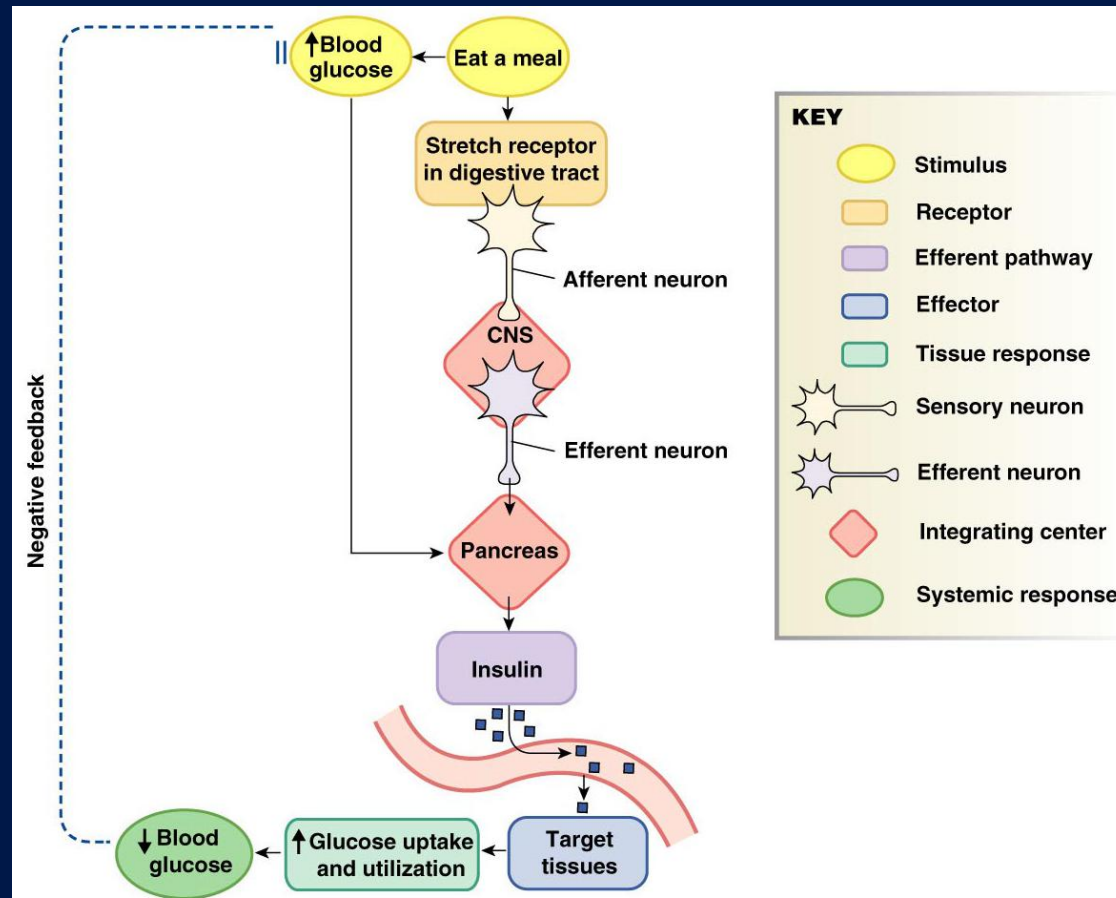


# Negative Feedback Loop



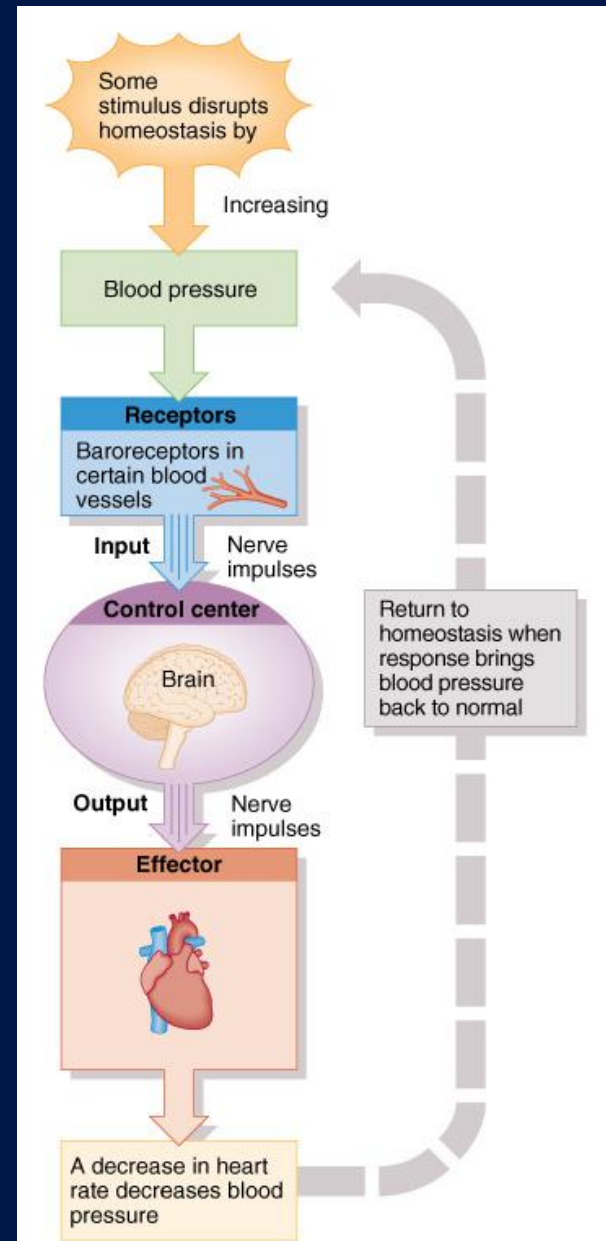
# Homeostasis – Negative Feedback Loop

- Blood glucose concentrations rise after a sugary meal (the stimulus), the hormone insulin is released and it speeds up the transport of glucose out of the blood and into selected tissues (the response), so blood glucose concentrations decrease (thus decreasing the original stimulus).



# Homeostasis of Blood Pressure

- Baroreceptors in walls of blood vessels detect an increase in BP
- Brain receives input and signals blood vessels and heart
- Blood vessels dilate, HR decreases
- BP decreases





# Positive Feedback during Childbirth

- Stretch receptors in walls of uterus send signals to the brain
- Brain induces release of hormone (oxytocin) into bloodstream
- Uterine smooth muscle contracts more forcefully
- More stretch, more hormone, more contraction etc.
- Cycle ends with birth of the baby & decrease in stretch