437

PHYSIOLOGY TEAM

MED437

KING SAUD UNIVERSITY

PHYSIOLOGY

- Females & Males Slides
- Only Found in Males' slides
- Only Found in Females' slides
- Vary Important Notes
- Notes
- Extra Information

غيـــداء آل مصـــمع
عبدالرحمن الحيسوني

Revised by

Homeostasis I

Objectives

At the end of this session, the students should be able to:

- Differentiate between positive and negative feedback mechanisms and give examples for each in the body.
- Define a feedback mechanism and describe its components.
- Explain how homeostatic mechanisms regulated by negative feedback detect and respond to environmental changes + Define positive and negative feedback
- Describe the actions of a positive feedback loop.
- Discuss the physiologic control mechanisms that enable maintenance of the normal steady state of the body.
- Define and discuss the concept of homeostasis and its importance to the living organism.
- Define the concept of the "internal environment" and state its physiologic importance.
- Differentiate between the external and internal environments.

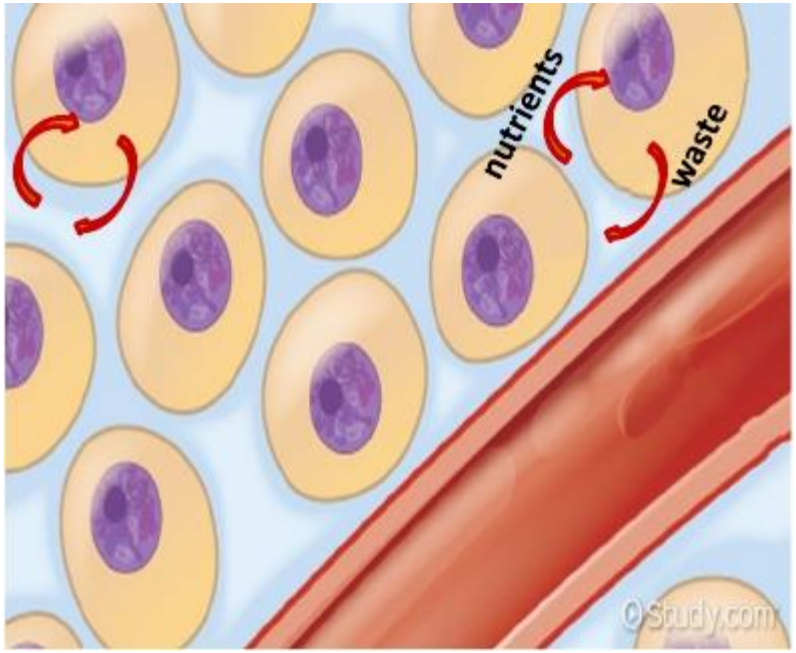
Study source for this lecture:

(Guyton & Hall Textbook of Medical Physiology, 13th ed, Chapter 4)

The Internal Environment

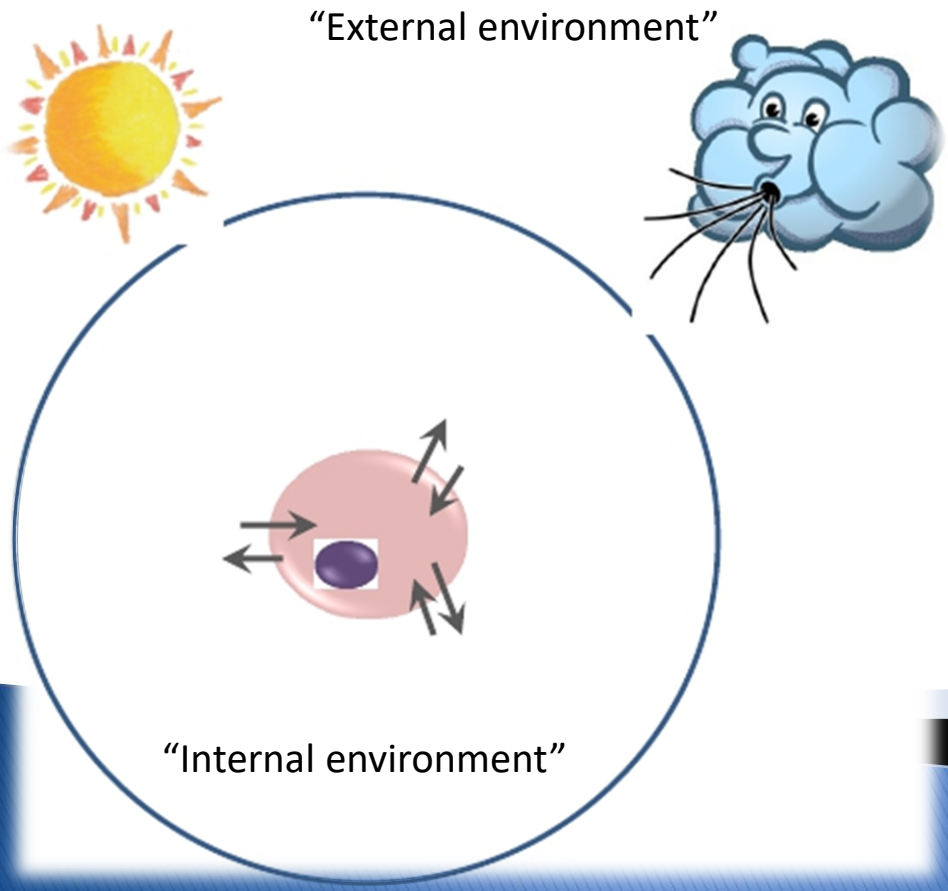
- All the cells in the body are continuously bathing in fluid , Because this fluid is ***outside*** the cell, it is called **extracellular fluid** (***ECF***).
- It is from the ECF that cells get the ions and nutrients needed to maintain life.

- All body cells live in the same environment (i.e. ECF).
- The composition of ECF is almost similar between the different species.



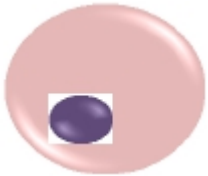
External vs Internal environment

In Multicellular organisms



In Unicellular organisms

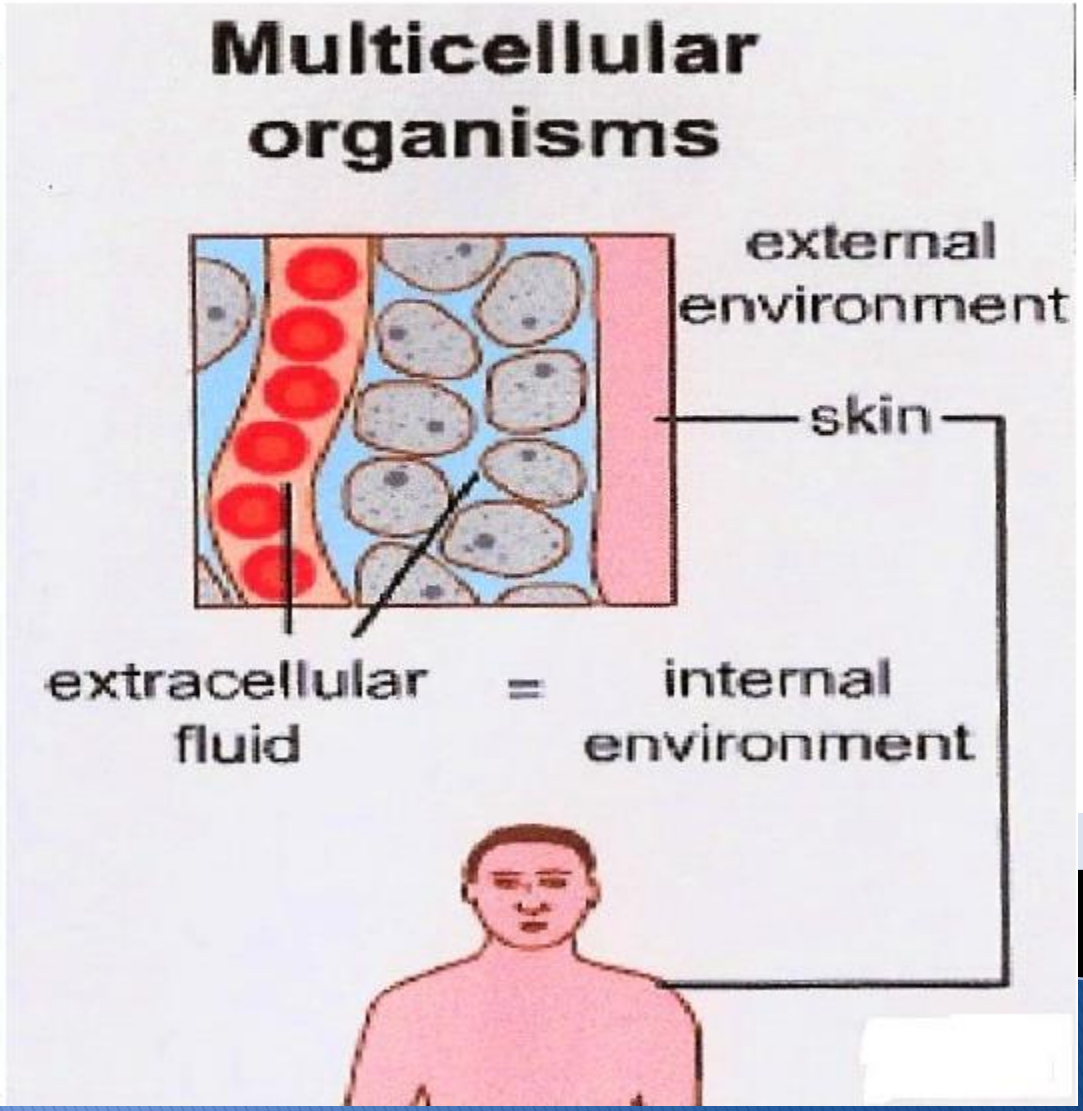
Internal environment = External environment



External vs Internal environment

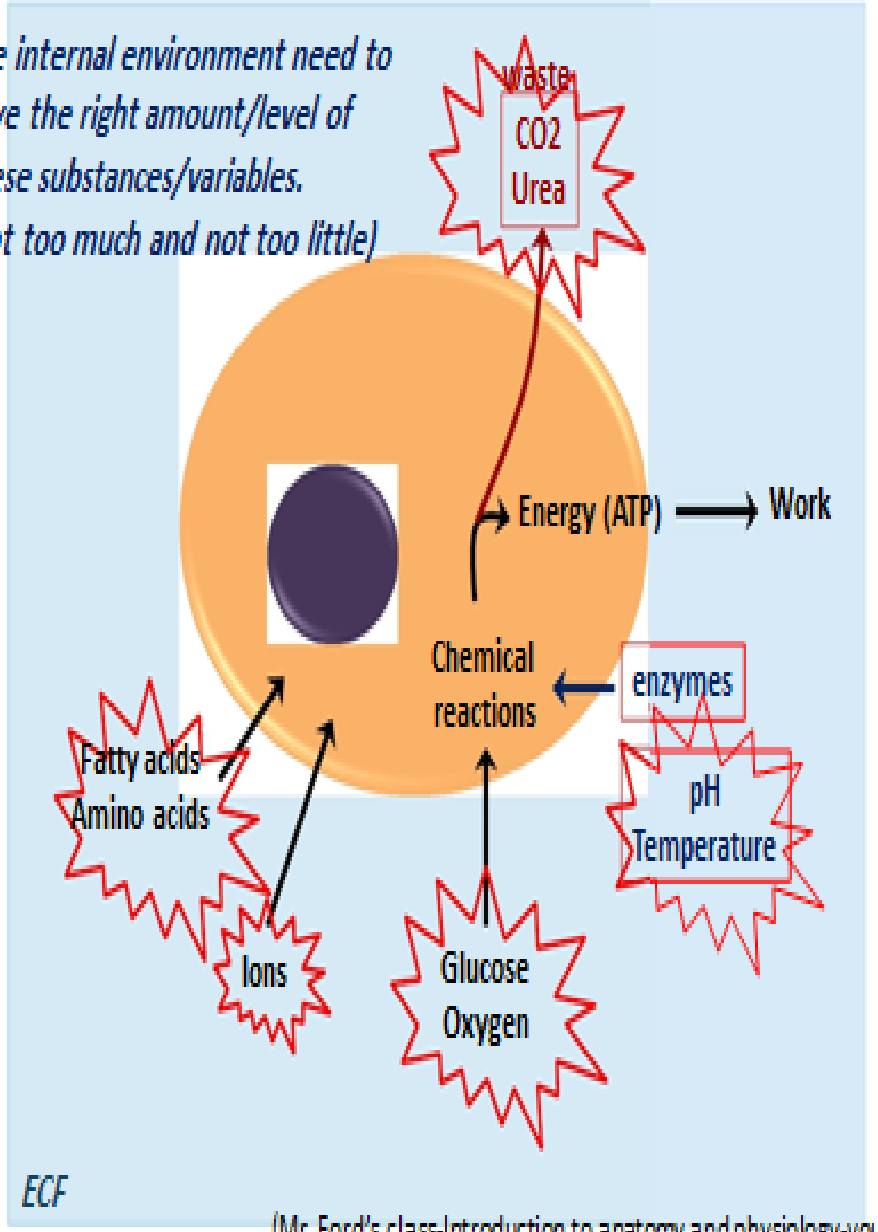
- ***ECF = the internal environment***.

- The skin separates this environment from the outside world which known as the ***external environment***.



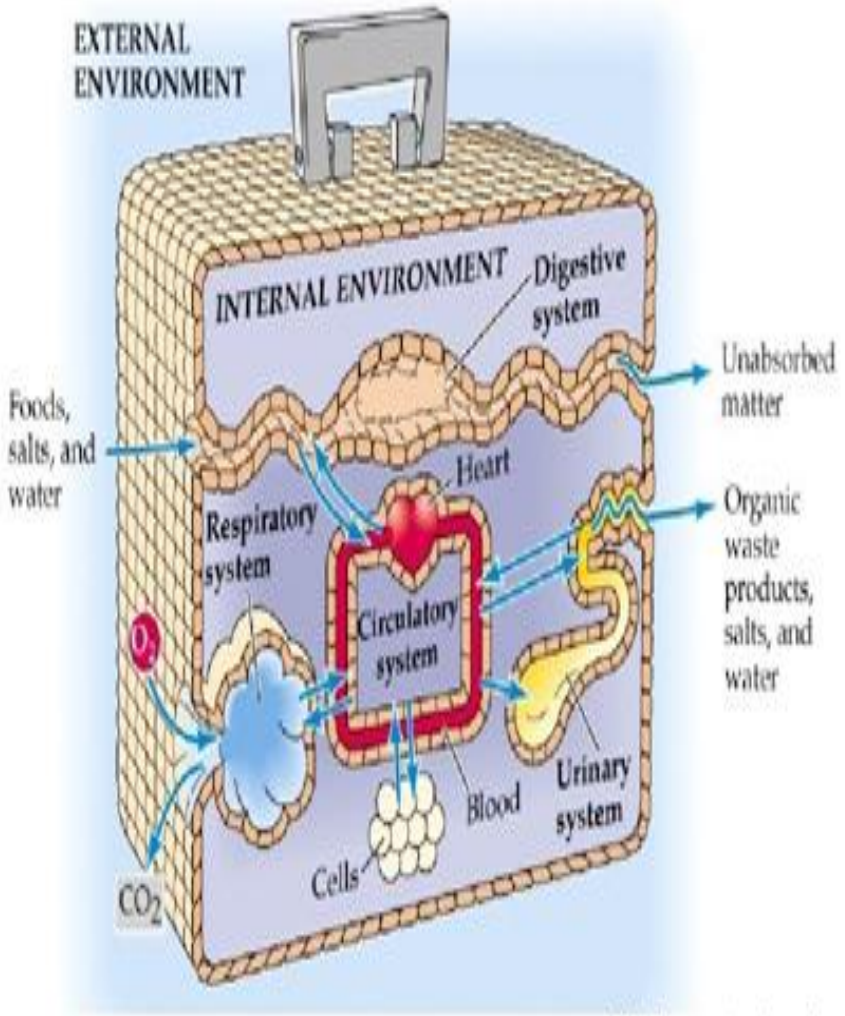
In order for the cell to function properly,

The internal environment need to have the right amount/level of these substances/variables. (not too much and not too little)



(Mr. Ford's class-Introduction to anatomy and physiology-youtube)

External vs Internal environment

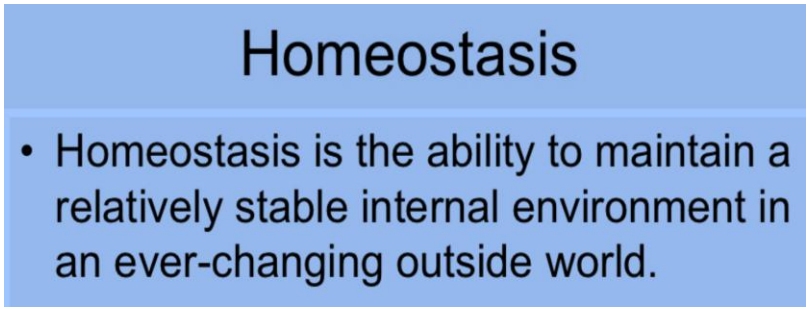


Homeostasis

- The process by which the body keeps the internal environment constant despite changes in the external environment is known as **"Homeostasis".**

– Homeo- : sameness, similarity

– stasis: standing



Essentially all the functions of the body organs and tissues aim at keeping the internal

environment at a nearly constant state.

- Chemical, thermal, and neural factors interact to maintain homeostasis.

-**Hemostasis : Is the tendency to the internal balance or is the maintenance of nearly constant conditions in the internal environment.**

Concept of Homeostasis

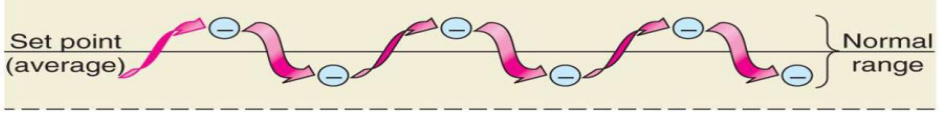
- The internal environment must be kept ***constant*** in the face of an ever changing external environment.

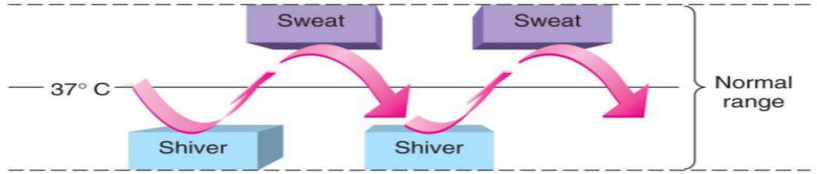
من سلايدات البنات

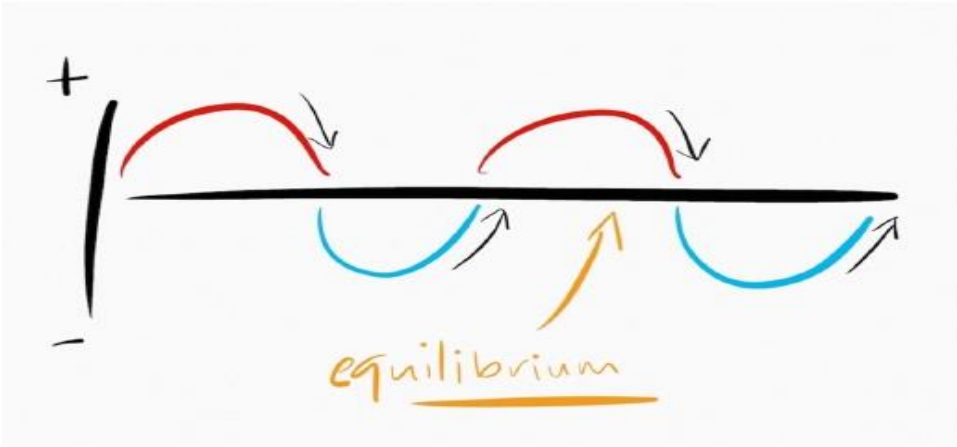
- The internal environment of the body (ECF) is in a dynamic state of equilibrium
- All different body systems operate in harmony to provide homeostasis
- Extreme dysfunction leads to death; moderate dysfunction leads to sickness.

-Internal environment is always in dynamic state to maintain hemostasis

من سلايدات الاولاد

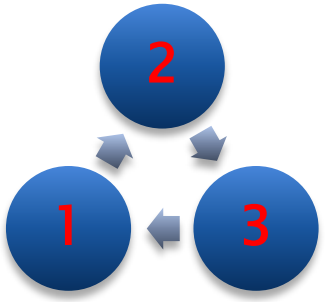






Components of Homeostatic Systems

- The body maintains homeostasis by using homeostatic control systems
  - Three components associated with each system:
    - **1**-Receptor **2**-control center **3**-effector



Receptor

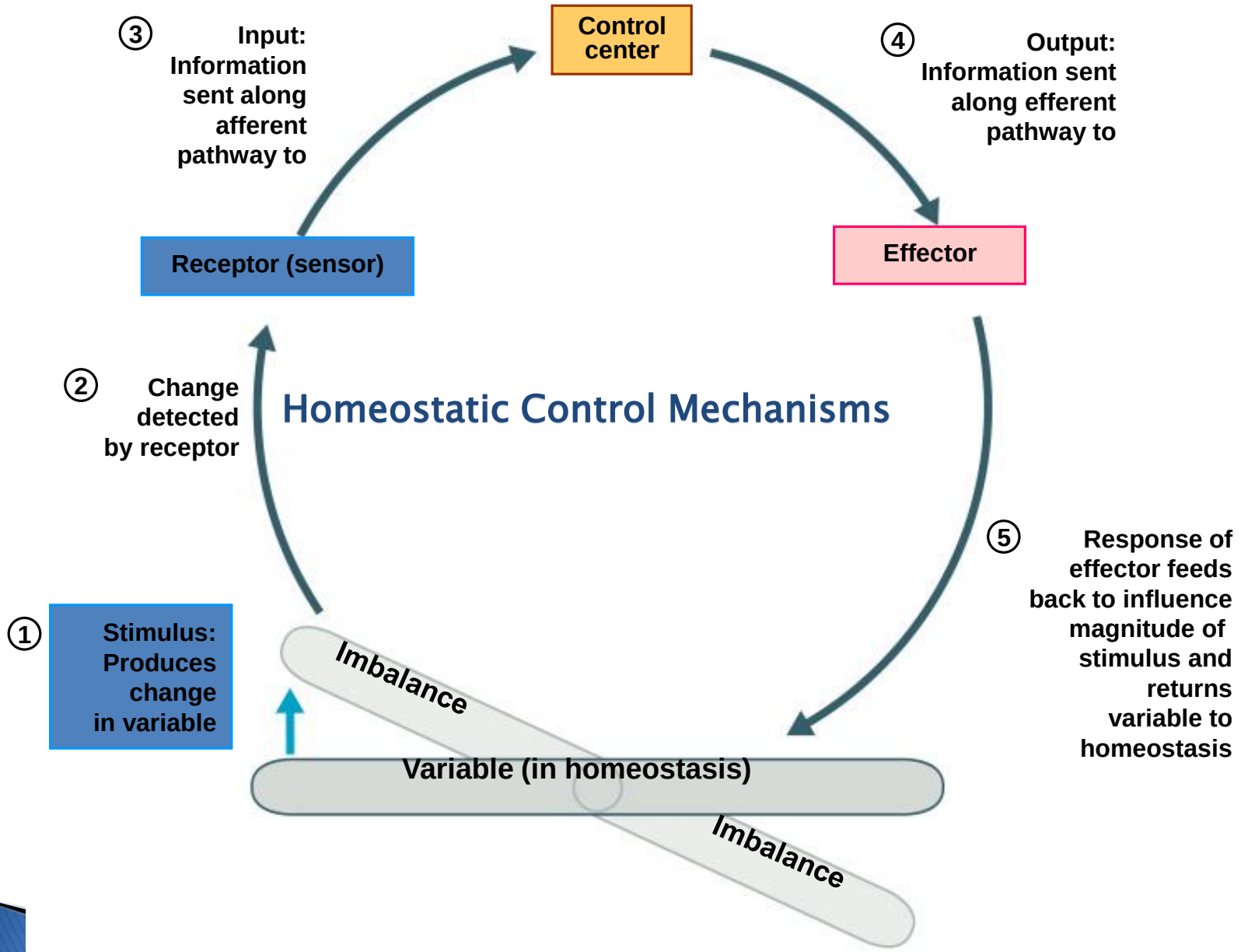
- The structure that detects changes in a variable, the **stimulus**
  - e.g., a change in temperature
- Consists of sensory nerves

Control center

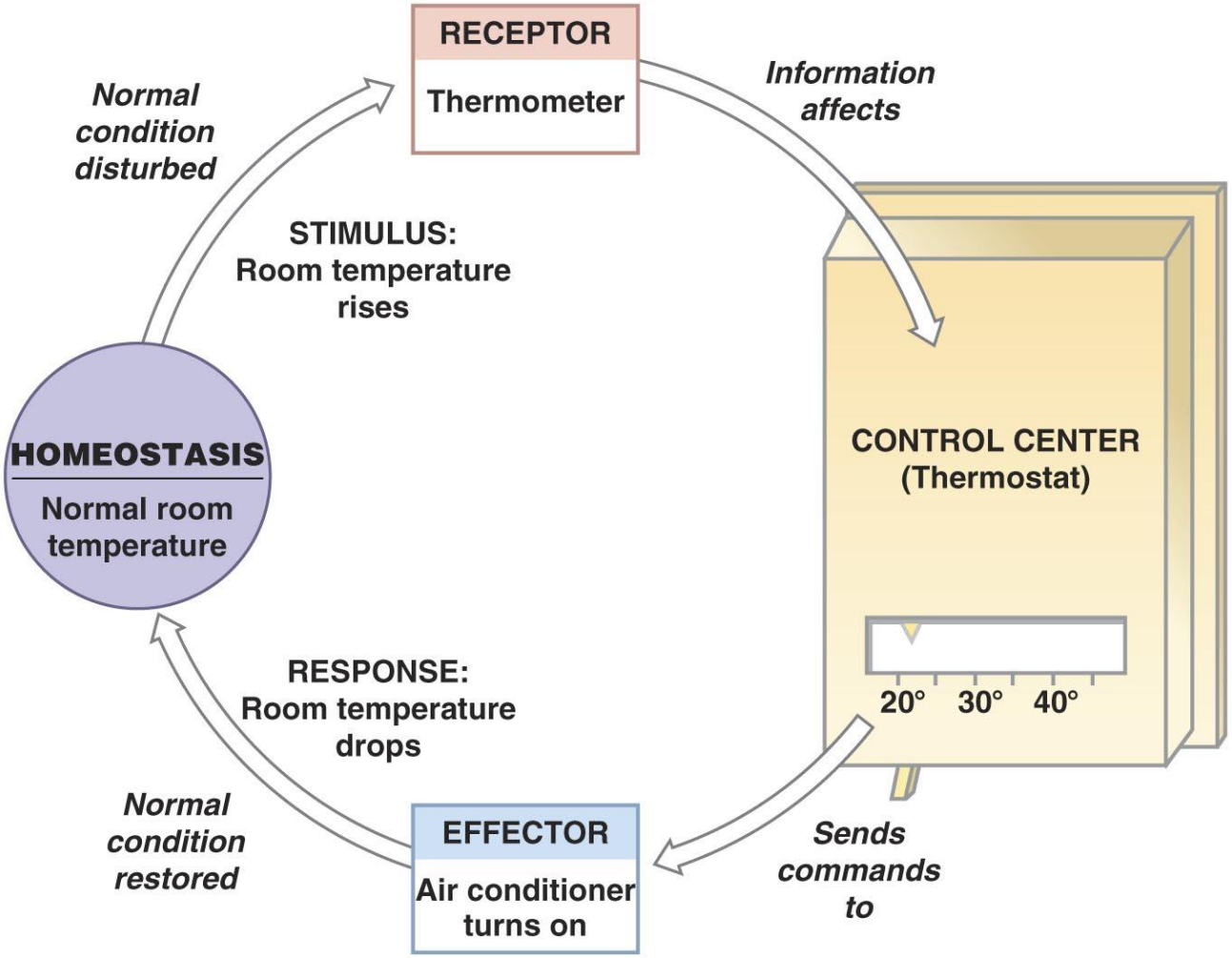
- The structure that interprets input from the receptor
- Initiates changes through the effector
- A portion of the nervous system or an endocrine organ

Effector

- The structure that brings about change to alter the stimulus
- Most body structures. e.g., muscles or glands


Homeostatic Control Mechanisms
Control center
③ Input: Information sent along afferent pathway to
④ Output: Information sent along efferent pathway to
Receptor (sensor)
Effector
② Change detected by receptor
⑤ Response of effector feeds back to influence magnitude of stimulus and returns variable to homeostasis
① Stimulus: Produces change in variable
Imbalance
Variable (in homeostasis)
Imbalance

The Control of Room Temperature



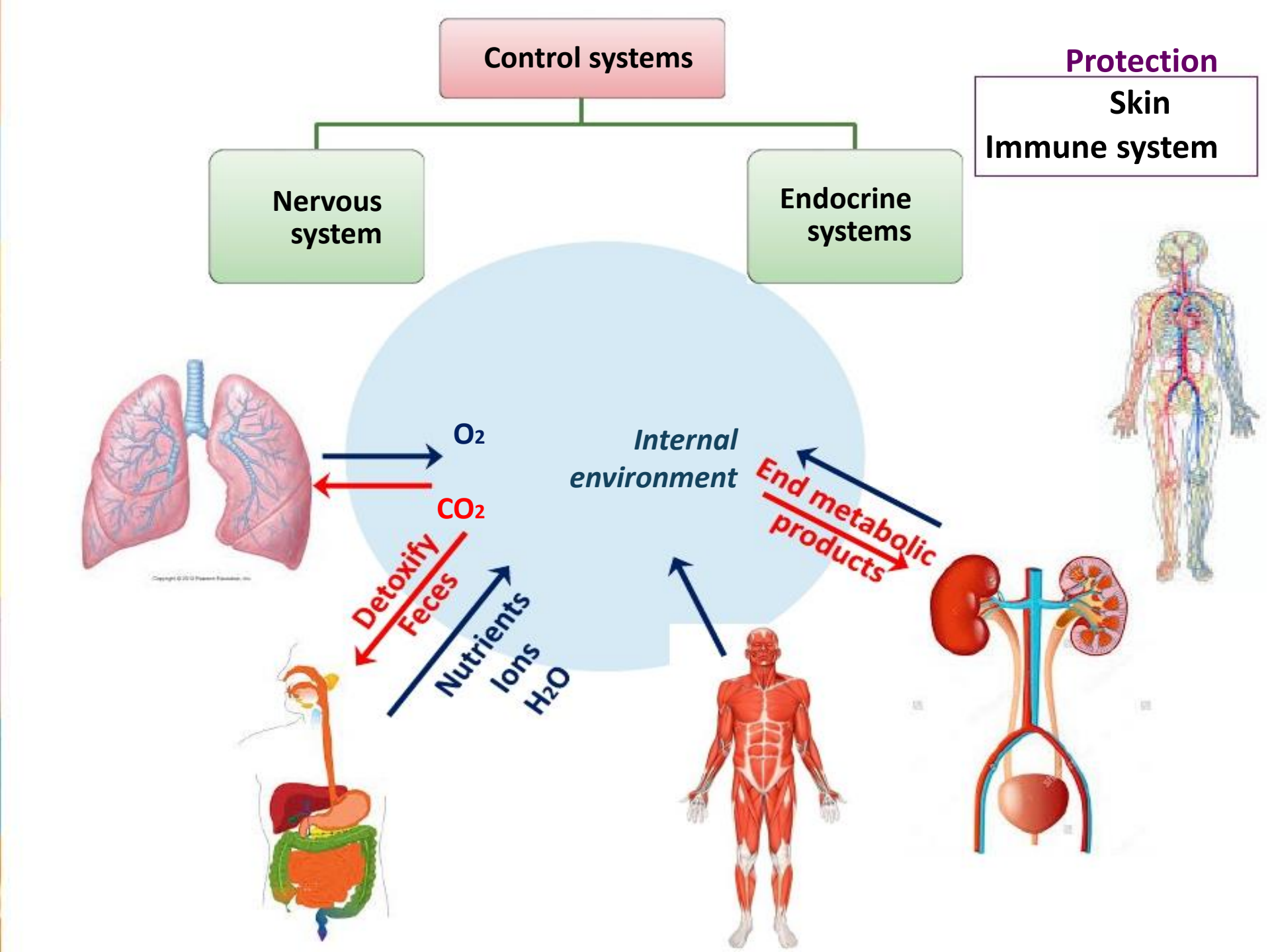
Maintenance of Homeostasis

- Nervous system:
  - Controls and coordinates bodily activities that require rapid responses.
  - Detects and initiates reactions to changes in external environment.
  - e.g., regulation of blood pressure upon rising.

- Response faster than endocrine system

- Endocrine system:
  - Secreting glands of endocrine regulate activities that require duration rather than speed.
  - e.g., parathyroid hormone regulating calcium levels.

- Response slower than nervous system


Control systems
Nervous system
Endocrine systems
Protection
Skin
Immune system
O2
CO2
Internal environment
End metabolic products
Detoxify
Feces
Nutrients
Ions
H2O

Factors Homeostatically Regulated

- Concentration of nutrient molecules. Ex: Glucose
- Concentration of water, salt, and other electrolytes
- Concentration of waste products
- Concentration of O_2 = 100mmHg and CO_2 = 40 mmHg
- pH = 7.35
- Blood volume 4-6 L and pressure 120/80
- Temperature = 37° C

Body constituents are normally regulated within a range rather than a fixed value.

Concentrations of Extracellular and Intracellular Electrolytes in Adults

Electrolyte	Extracellular Concentration*	Intracellular Concentration*
Sodium	135–148 mEq/L	10–14 mEq/L
Potassium	3.5–5.0 mEq/L	140–150 mEq/L
Chloride	98–106 mEq/L	3–4 mEq/L
Bicarbonate	24–31 mEq/L	7–10 mEq/L
Calcium	8.5–10.5 mg/dl	< 1 mEq/L
Phosphate/ phosphorus	2.5–4.5 mg/dl	4 mEq/kg†
Magnesium	1.8–2.7 mg/dl	40 mEq/kg†

*Values may vary among laboratories, depending on the method of analysis used.
†Values vary among various tissues and with nutritional status.

Control Mechanisms

- The body has thousands of control systems.
- They function to restore balance when it is lost.
- Control systems operate;
  - *Within the organ* itself
  - Throughout the body → to control *interrelations between organs*.

How is this achieved?

By feedback mechanisms

What is meant by feedback?

A loop system in which the system responds to perturbation either in the **same direction** (positive feedback) or in the **opposite direction** (negative feedback).

Response of a homeostatic system occurs through a feedback loop:

- Stimulus
- detection of stimulus by a receptor
- information relayed to the control center
- integration of the input by control center and initiation of change through effectors
- return of homeostasis by the actions of effectors

Feedback Loops: Types

-Negative feedback loop

1. original stimulus reversed.
2. used for conditions that need frequent adjustment.
3. Most feedback systems in the body are negative

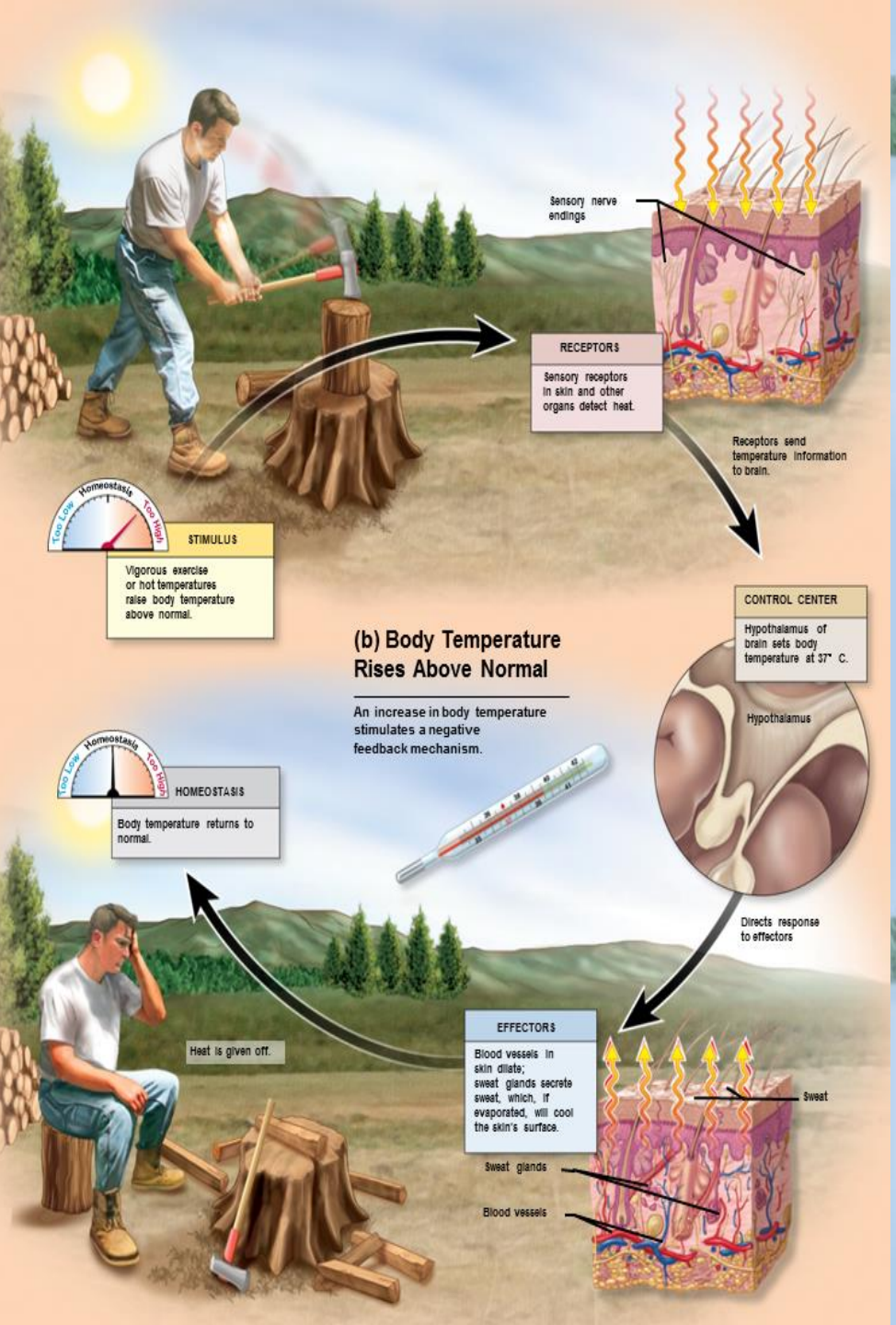
-Positive feedback loop

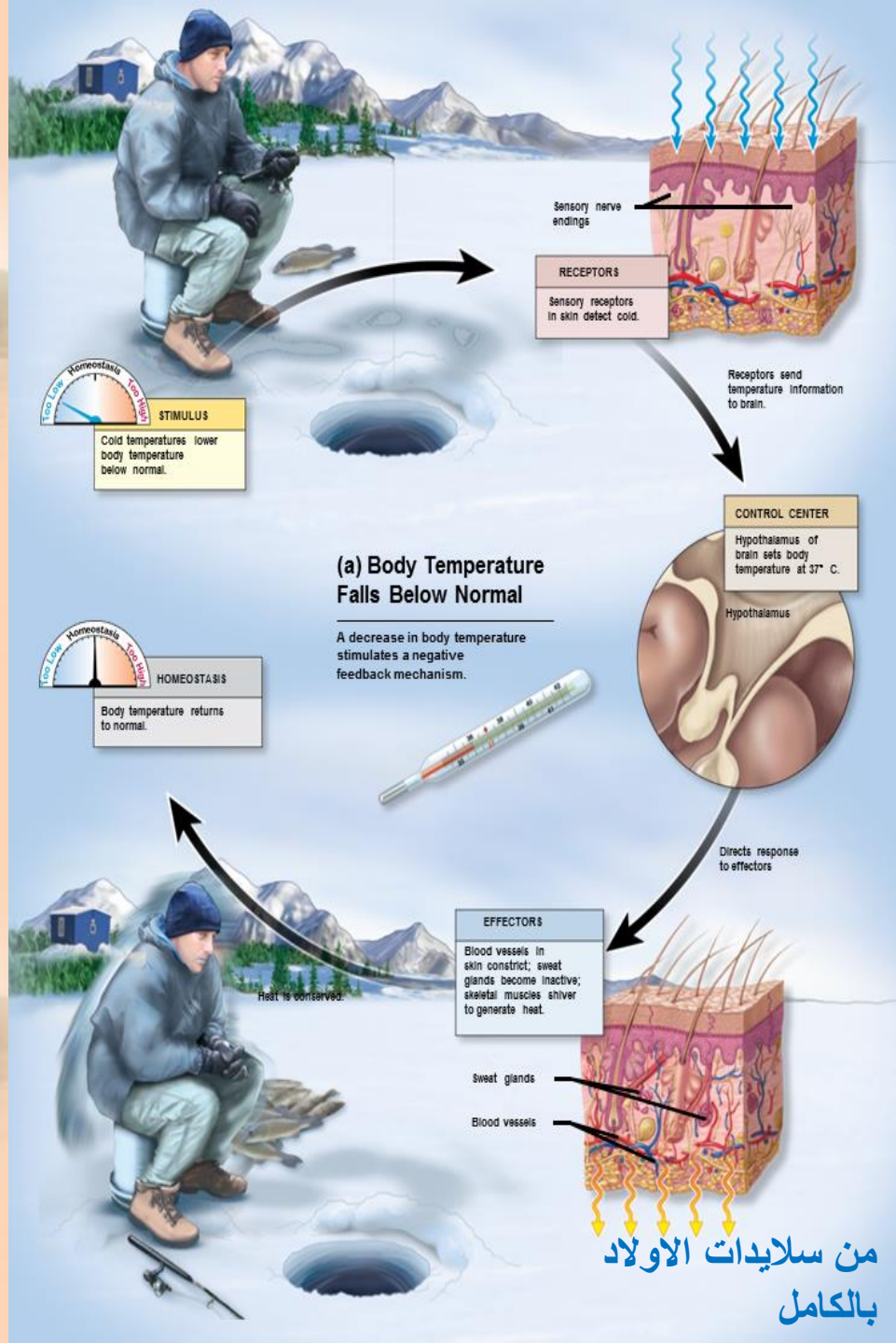
1. original stimulus intensified.
2. seen during normal childbirth.

Negative feedback	Positive feedback
The effector response of the system is in the **opposite direction** to the stimulus that initiated the response. E.g; • A **high level of in CO_2** in the ECF will increase pulmonary ventilation, increasing the amount of CO_2 expired which will **bring the level of CO_2 in ECF down**. • Most of the control systems of the body act by negative feedback.	The effector response is in the **same** direction of the stimulus that initiated the response. E.g; • In nerve signaling, **entry of a small amount of Na+** into the cell will open more Na+ channels **causing more Na+ to enter the cell**. • Only few systems display positive feedback mechanisms.. **WHY?**

Homeostatic Systems Regulated by Negative Feedback

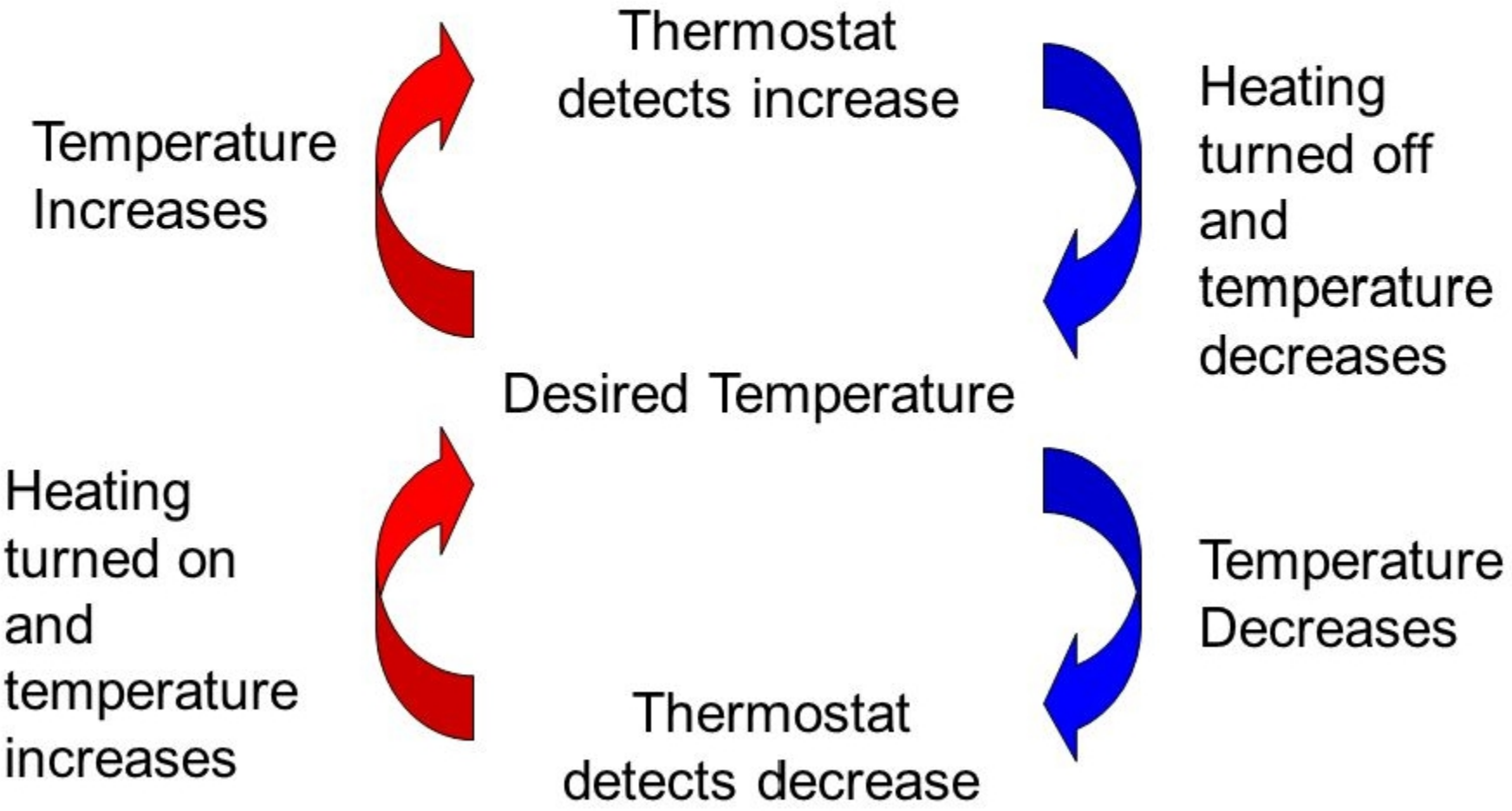
- Negative feedback
  - A type of homeostatic control system that maintains the variable within a normal range
  - Variable maintained within a normal level, its **set point**
    - fluctuates around the set point
  - If stimulus increases, homeostatic control system activated to cause a decrease in the stimulus
  - If stimulus decreases, homeostatic control system activated to cause an increase in the stimulus





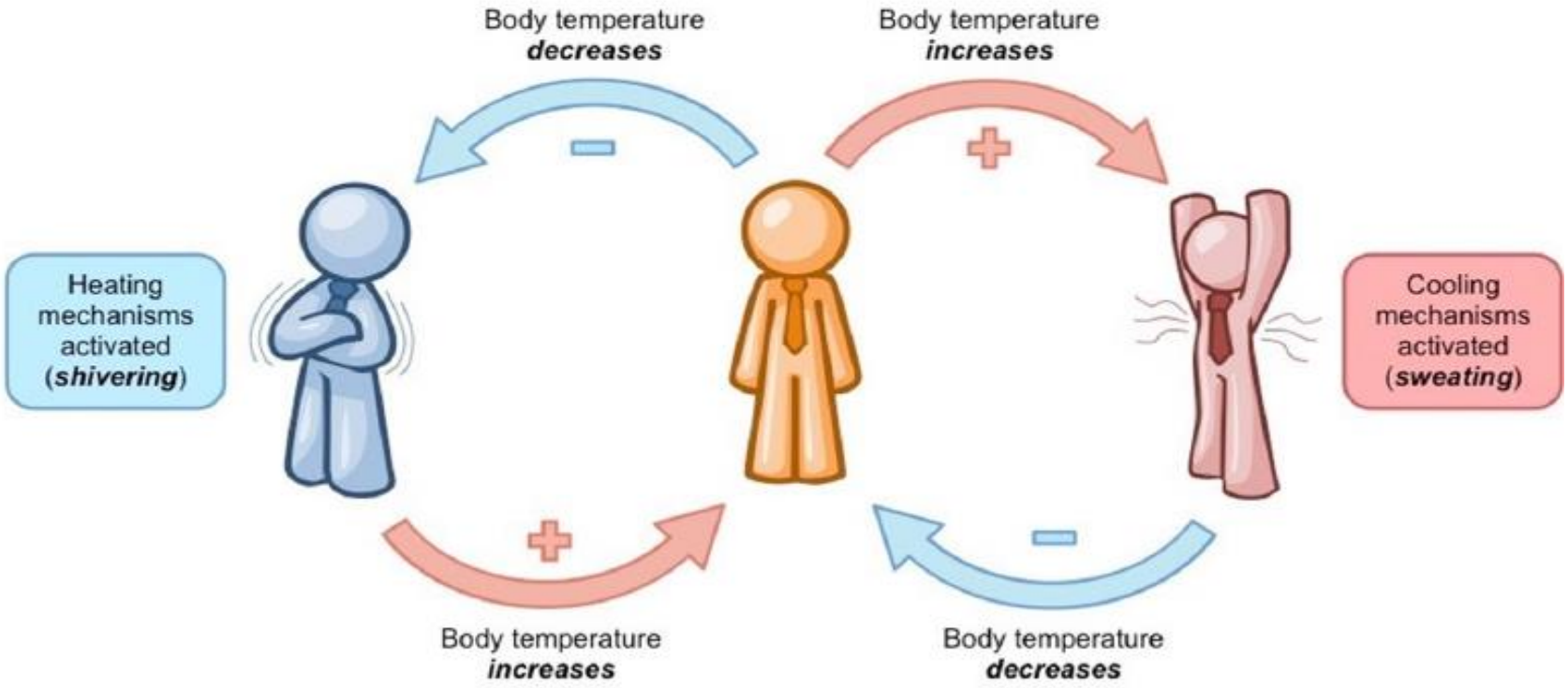
Negative Feedback

(thermostat analogy)



Examples of Negative Feedback Mechanisms

Body temperature control



Homeostatic Systems Regulated by Negative Feedback

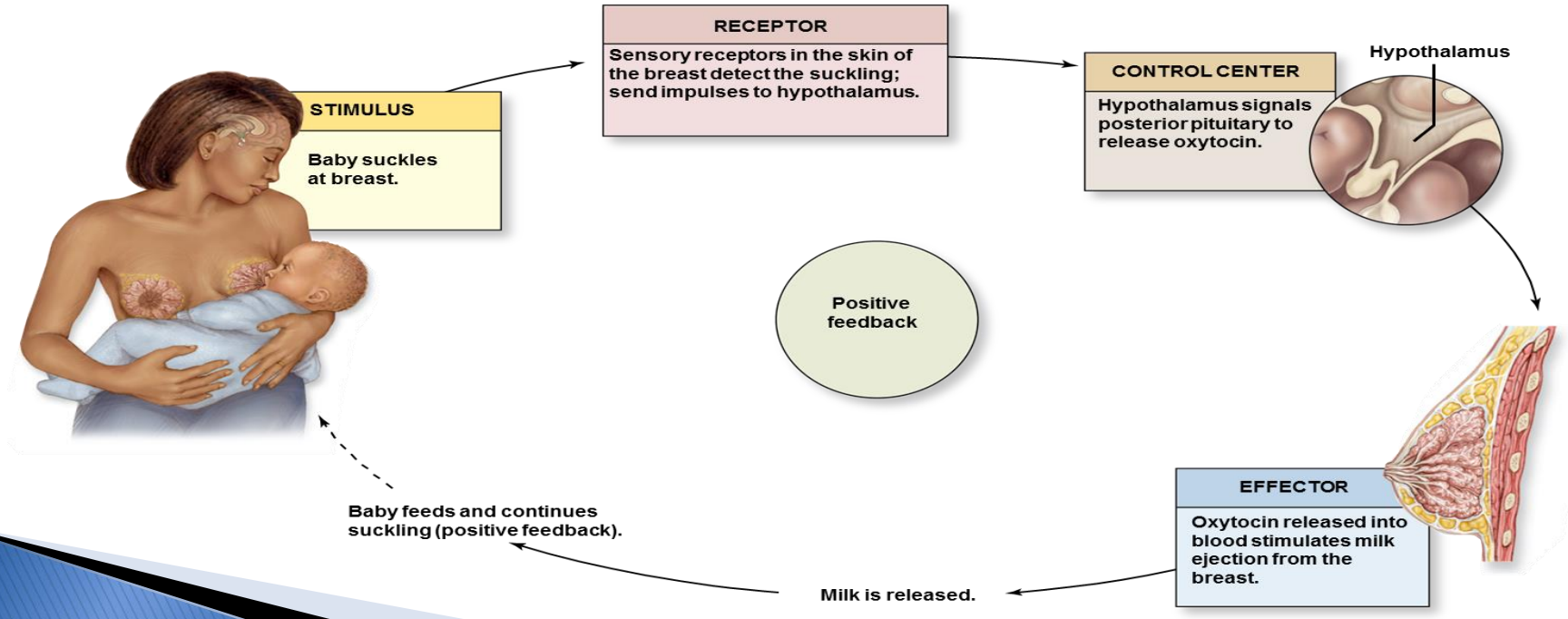
- Other examples of homeostatic regulation:
  - withdrawal reflex in response to injury
  - regulating heart rate and blood pressure during exercise
  - changing breathing rate in response to increased carbon dioxide
  - parathyroid hormone release in response to decreased calcium
  - release of insulin by the pancreas in response to increased blood glucose

Homeostatic Systems Regulated by Positive Feedback

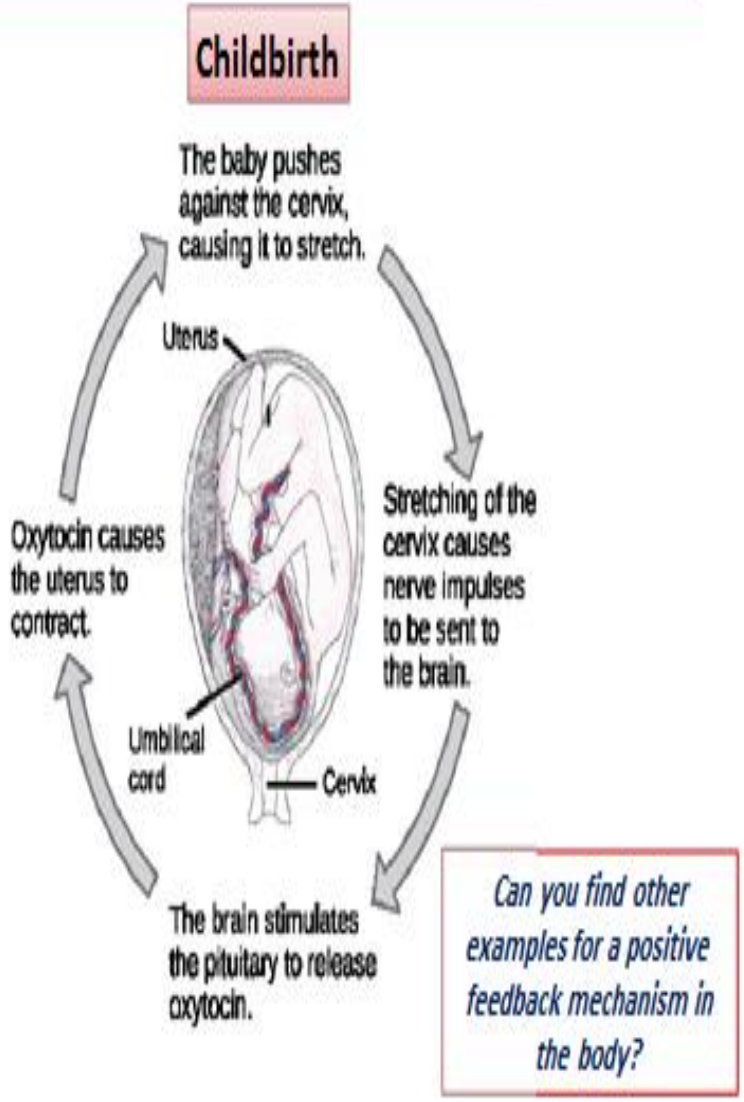
- **Positive feedback during breastfeeding**
  - **Sensory detectors detect baby suckling**
  - **Message is transmitted to the hypothalamus**
  - **Hypothalamus signals posterior pituitary to release the hormone oxytocin**
  - **Oxytocin stimulates the mammary gland to eject breast milk**
  - **Cycle repeats as long as the baby suckles**
- **Other examples of positive feedback:**
  - **blood clotting cascade**
  - **uterine contractions of labor**

Positive Feedback during Childbirth

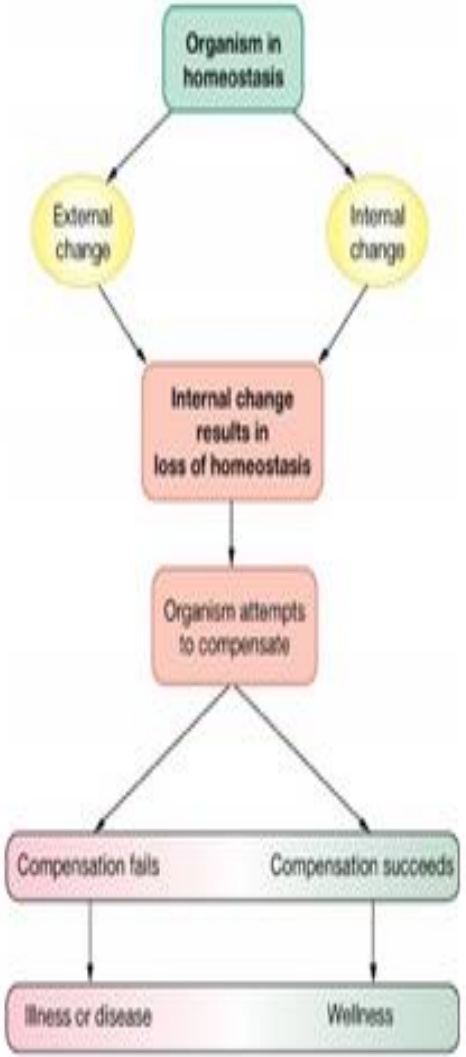
- Stretch receptors in walls of uterus send signals to the brain
- Brain induces release of hormone (oxytocin) into bloodstream
- Uterine smooth muscle contracts more forcefully
- More stretch, more hormone, more contraction etc.
- Cycle ends with birth of the baby & decrease in stretch



Examples of Positive Feedback Mechanisms

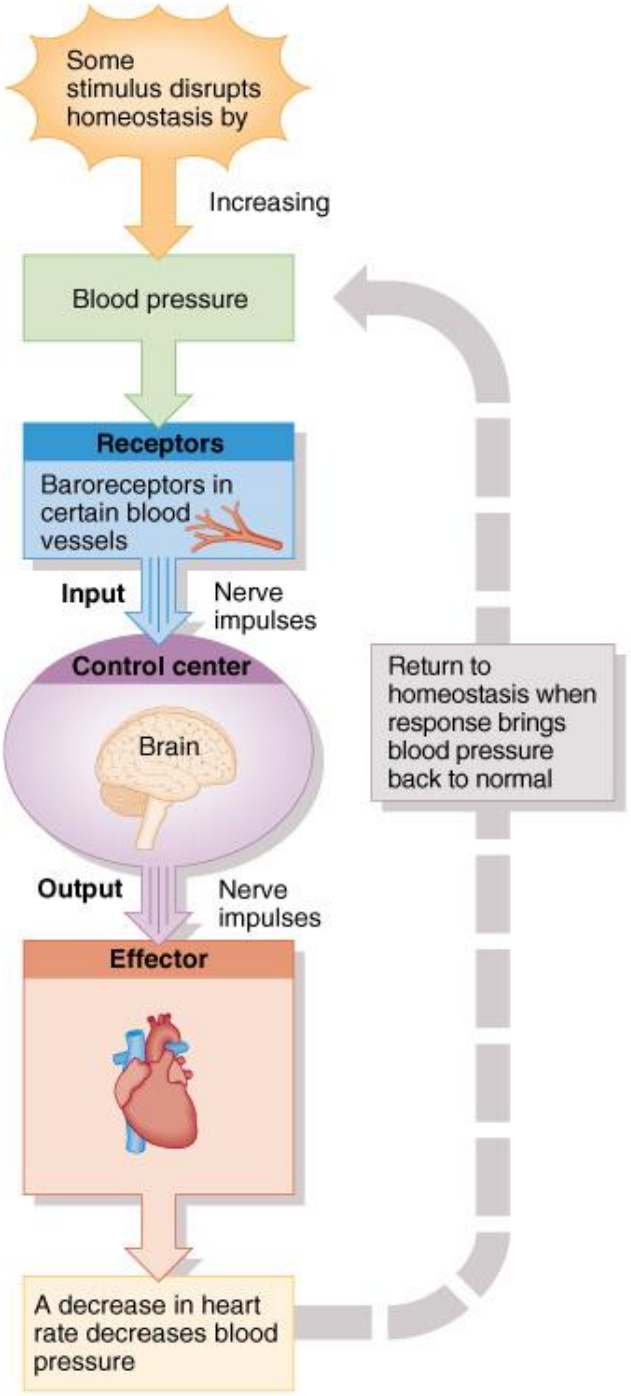


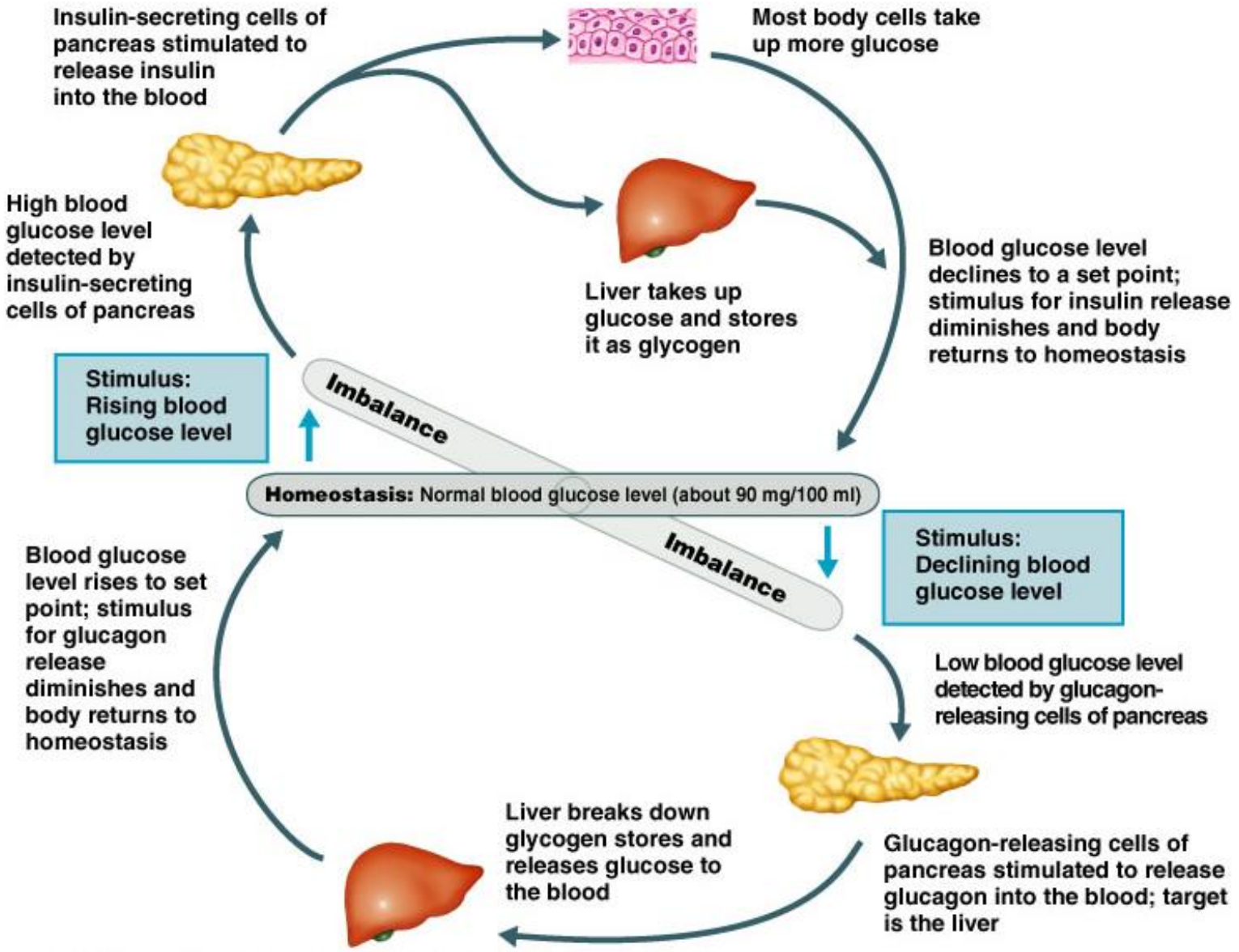
Disease is a state of disturbed homeostasis



Homeostasis of Blood Pressure

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




Insulin-secreting cells of pancreas stimulated to release insulin into the blood
Most body cells take up more glucose
High blood glucose level detected by insulin-secreting cells of pancreas
Liver takes up glucose and stores it as glycogen
Blood glucose level declines to a set point; stimulus for insulin release diminishes and body returns to homeostasis
Stimulus: Rising blood glucose level
Imbalance
Homeostasis: Normal blood glucose level (about 90 mg/100 ml)
Imbalance
Stimulus: Declining blood glucose level
Blood glucose level rises to set point; stimulus for glucagon release diminishes and body returns to homeostasis
Low blood glucose level detected by glucagon-releasing cells of pancreas
Liver breaks down glycogen stores and releases glucose to the blood
Glucagon-releasing cells of pancreas stimulated to release glucagon into the blood; target is the liver

Homeostatic Systems Regulated by Negative Feedback

Temperature regulation

- Body temperature drops
- Sensory receptors detect this and signal the hypothalamus (component of the brain)
- Hypothalamus alerts nerve impulses in blood vessels in the skin to decrease the inside opening of the vessels
- This decreases amount of amount of blood circulating to the surface of the body
- Less heat is released through skin
- Nerve impulses are sent to skeletal muscles, causing shivering
- Nerve impulses are sent to smooth muscles of hair follicles, causing "goosebumps"
- Body temperature rises
- Sensory receptors detect this and signal the hypothalamus
- Hypothalamus alerts nerve impulses in blood vessels in the skin to increase the inside opening of the vessels
- This increases the amount of blood circulating to the body surface
- More heat is released through skin

Quiz (Fill the boxes)

1

- ? body cells live in the same environment

1) Somatic
2) Nerve
3) Stimulus
4) All

2

- The body maintains homeostasis by using the ? system

1) Integumentary
2) Nervous
3) Endocrine
4) Homeostatic control

3

- A structure that detects changes in a variable is called ?

1) Stimulus
2) Skin
3) receptor
4) None of these

4

- most feedback systems in the body are ?

1) Negative
2) Positive
3) Receptors
4) None of these

5

- Essentially all the functions of the ? organs and tissues aim at keeping the internal environment at a nearly constant state

1) Internal
2) Body
3) External
4) Cardiovascular

6

- ? is an Example of a negative feedback

1) Blood clotting cascade
2) Uterine contractions of labor
3) Breast feeding
4) None of these

answers

Question	answer	Slide number
1	4	4
2	4	7
3	3	7
4	1	14
5	2	5
6	4	20

Thank you & good luck

Boys team members:

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- ريم القرني
- عهد القرين
- العنود المنصور
- مها النهدي
- بلقيس الراجحي
- سارة البليهد
- ميعاد النفيعي
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