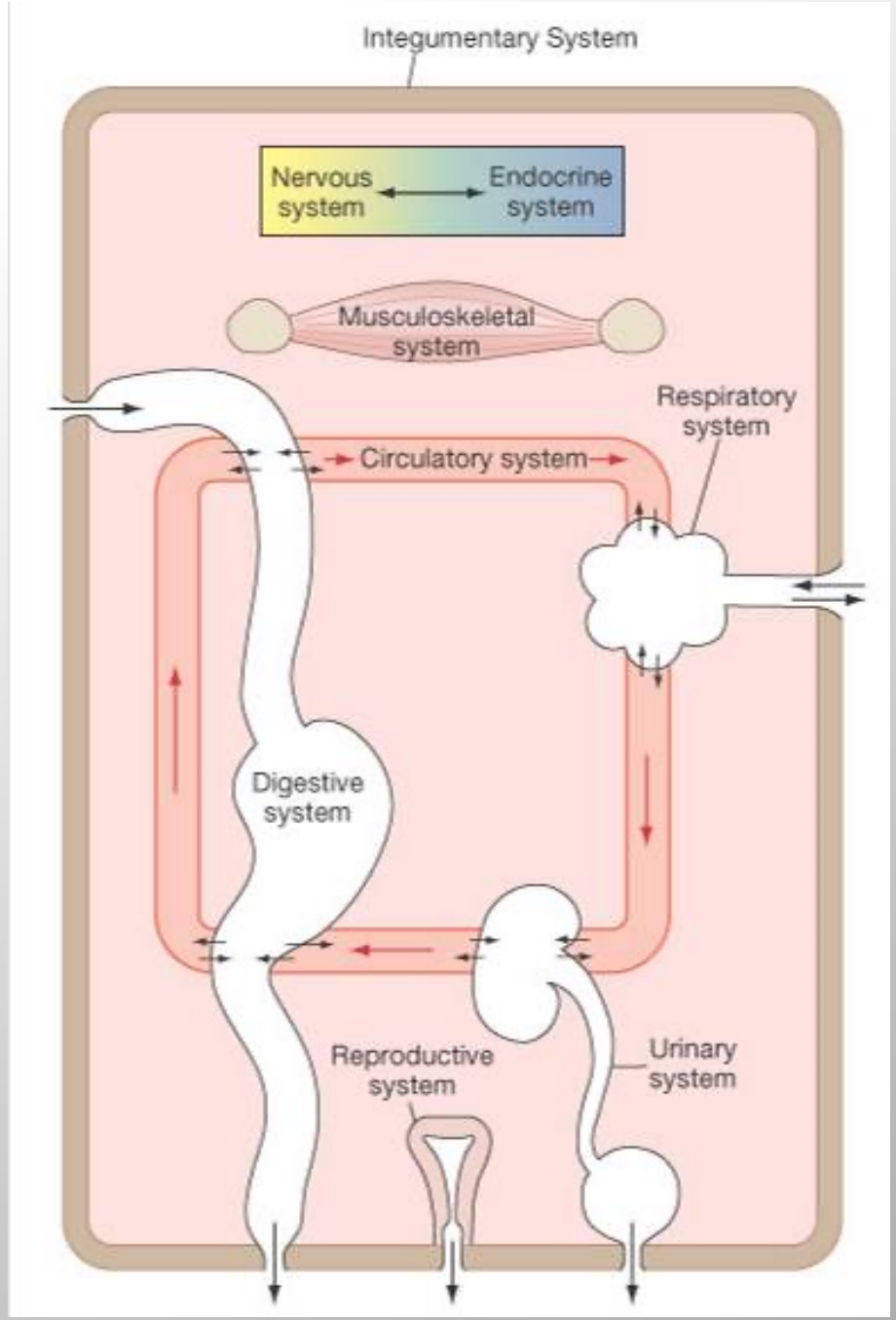
Lesson 2:

Homeostasis

The integration between systems of the body

- Many systems combines to form ORGANISM
- An individual can survive only if all the systems of the body works harmony



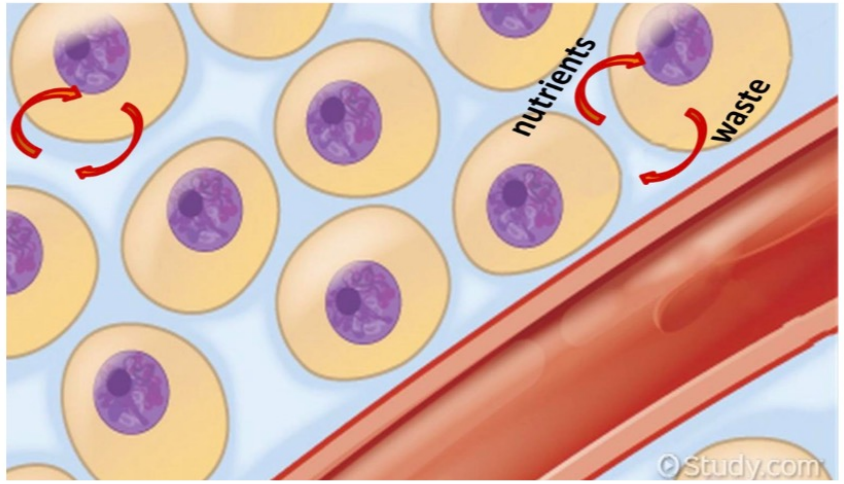
Objectives

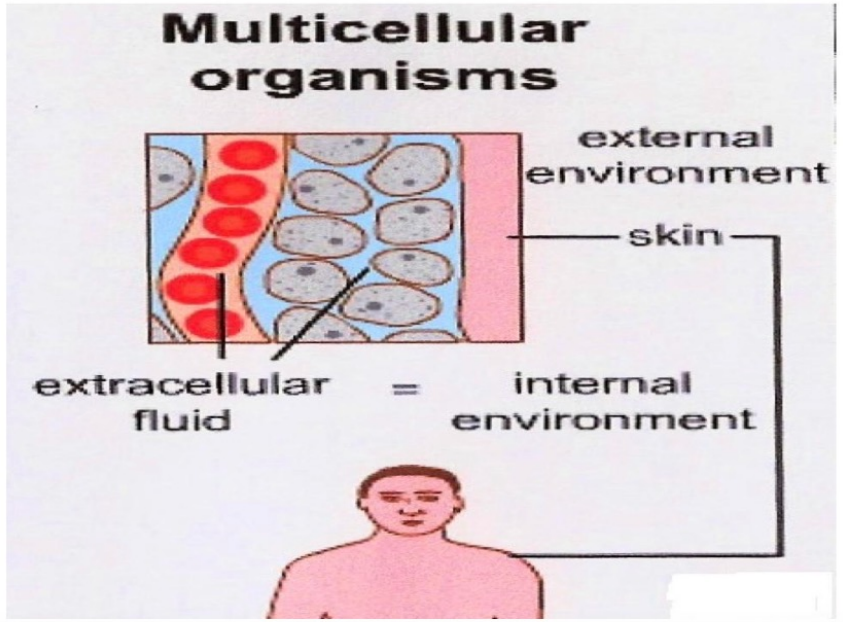
- Understand the concept and importance of homeostasis.
- Understand how the steady state is monitored.
- Discuss the physiological control mechanisms that enable maintenance of the normal steady state of the body.
- Identify and describe the compensatory responses to any change in the steady state.
- Define a feedback mechanism and describe its components.
- Differentiate between positive and negative feedback mechanisms and give examples for each in the body.
- Apply the knowledge gained in feedback mechanisms to disturbances in the disturbances in ECF volume and osmolarity.
- Define the concept of the “internal environment” and state its physiological importance and differentiate between the external and internal environment.

What is the Internal Environment?


idea

The concept of Internal Environment





The concept of Internal Environment

All the cells in the body are continuously bathing in fluid which called "Extracellular fluid" = ECF

It was named "the internal environment" = ECF
By french physiologist claude bernard

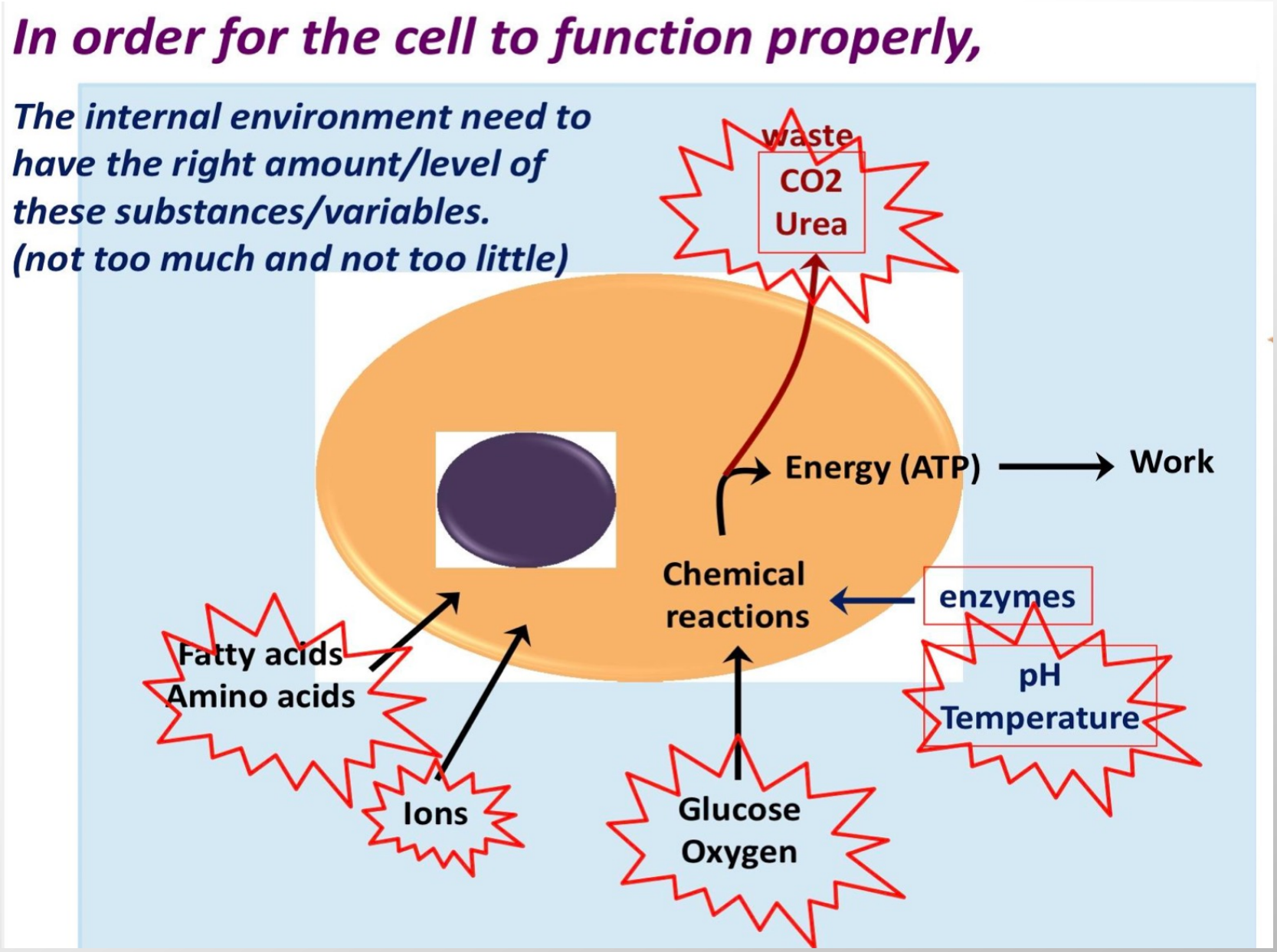
We have external and internal environment, The skin separate them.

All body cells live in the same environment and that means; composition of ECF is almost similar between the different species.

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

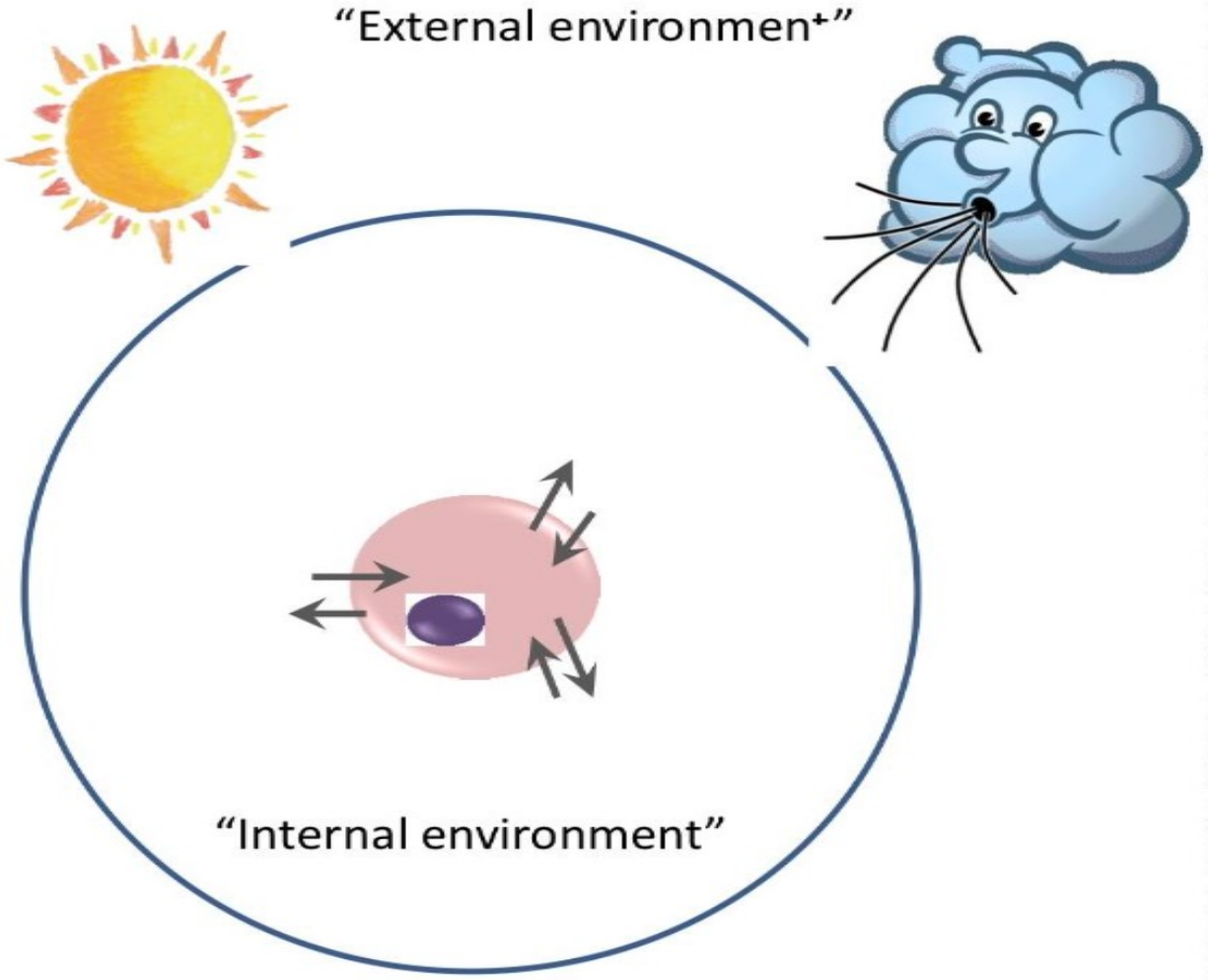
It's from the ECF that cells get the ions nutrients needed to maintain life.

External vs Internal Environment



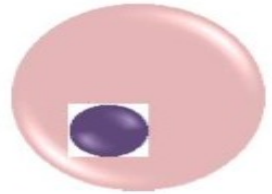
External vs Internal Environment

In Multicellular organisms



In Unicellular organisms

Internal environment = External environment



HOMEOSTASIS:

- What is Homeostasis?

CLUE:

Homeo= sameness, similarity

stasis=standing

HOMEOSTASIS:

-It is the ability to maintain a relatively stable internal environment in an ever-changing outside world.

- The internal environment of the body (ECF) is in (a dynamic state of equilibrium).

-The process by which the body keeps the internal environment constant despite changes in the external environments

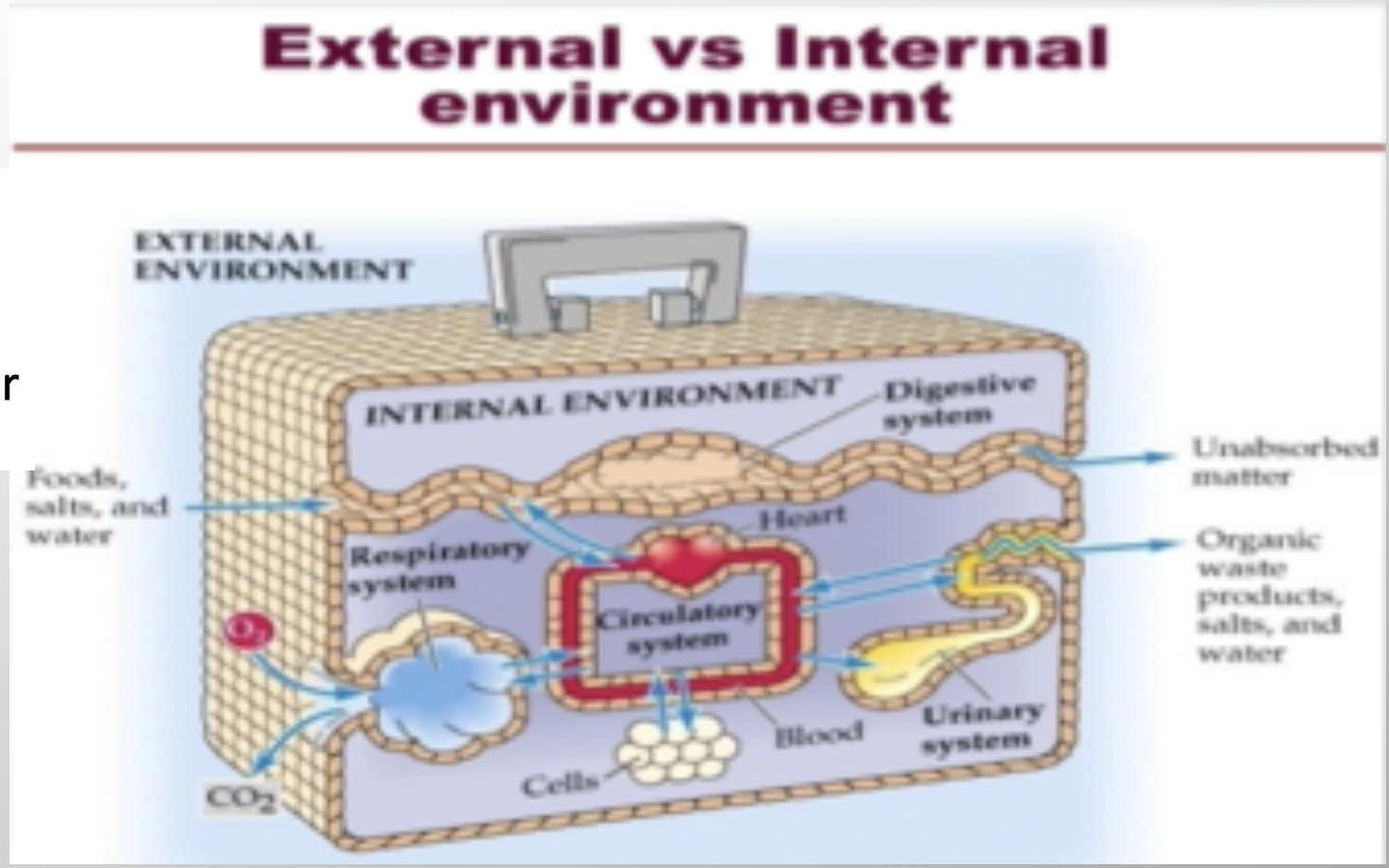
-All different body systems operate in harmony to provide homeostasis.

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

HOMEOSTASIS:

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

- Organ systems work together to maintain homeostasis
- Deviations from normal can cause damage or death



HOMEOSTATIC CONTROL MECHANISMS:

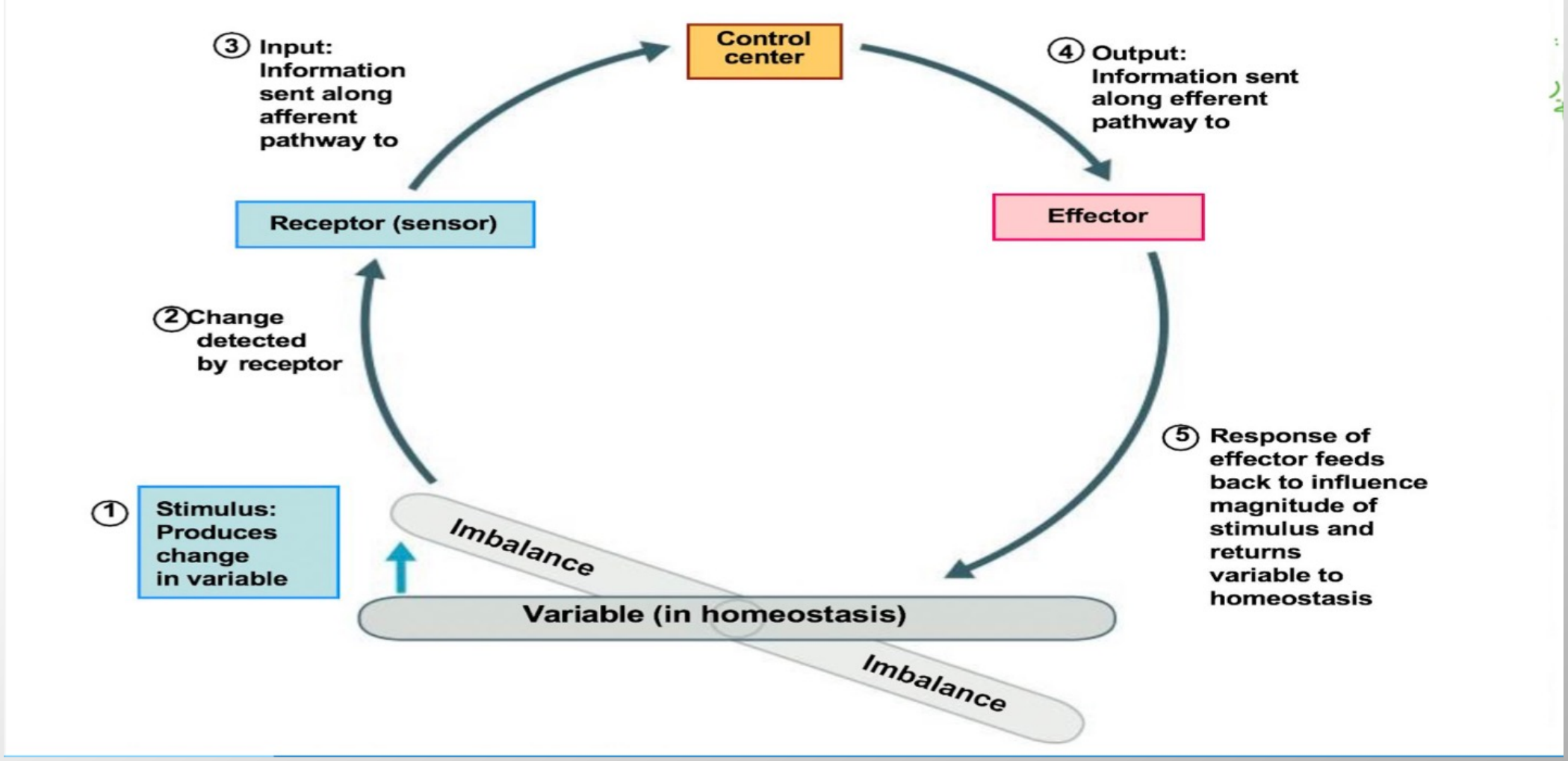
- Variable->Change in the body (Stimuli).
- There are three interdependent components of control mechanisms:

- Receptor: monitors the environments and responds to changes (stimuli).

- Control center: determines the set point at which the variable is maintained.

- Effector: provides the means to respond to the stimulus.

HOMEOSTATIC CONTROL MECHANISMS:



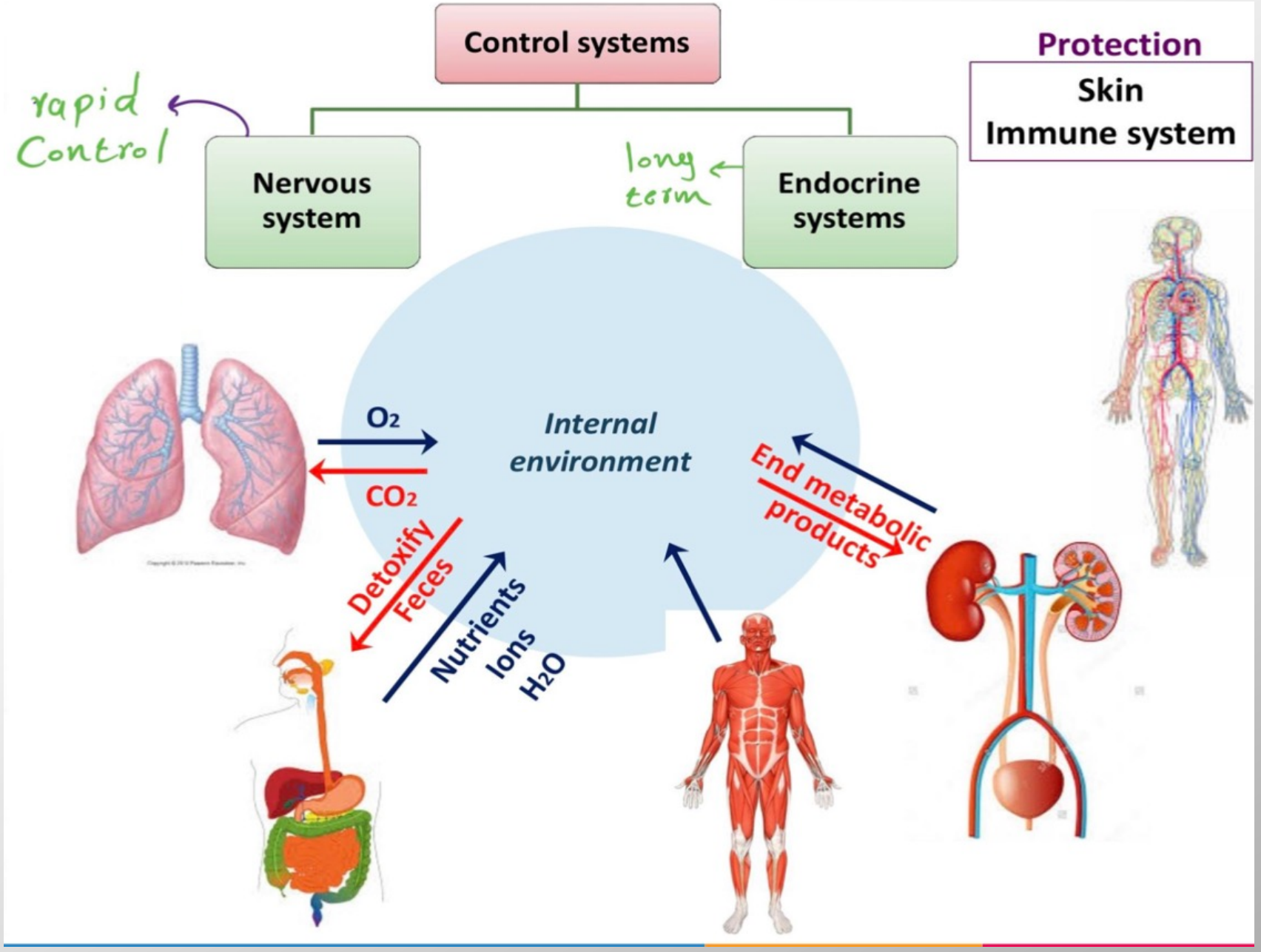
HOMEOSTATIC CONTROL MECHANISMS:

- The body has thousands of control systems
- They function to restore balance when it is lost.
- Control systems operate:

  - Within the organ itself

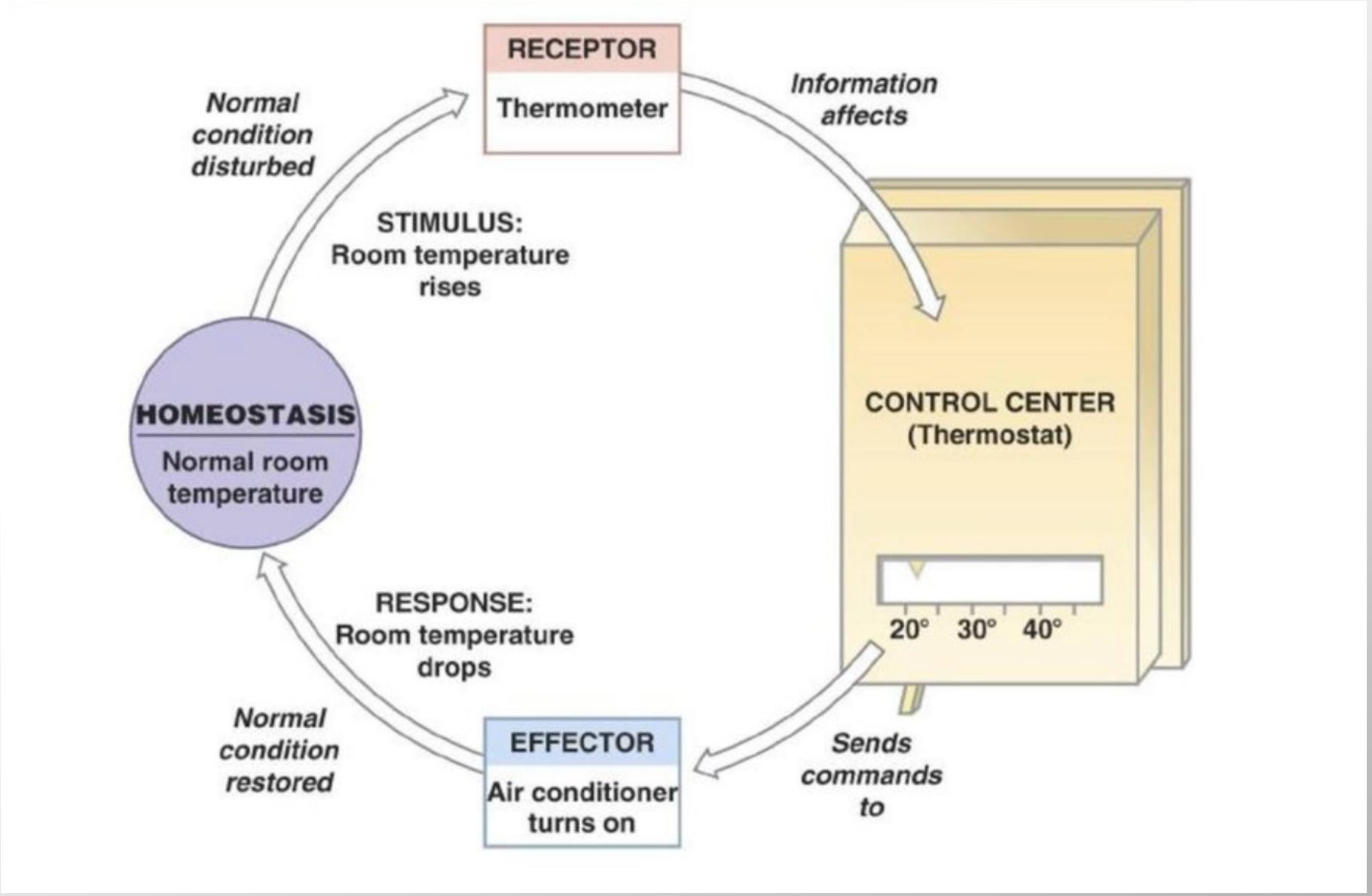
  - Throughout the body : to control interrelations between organs

HOMEOSTATIC CONTROL MECHANISMS:



EVERY DAY ANALOGY….

THE THERMOSTAT ANALOGY

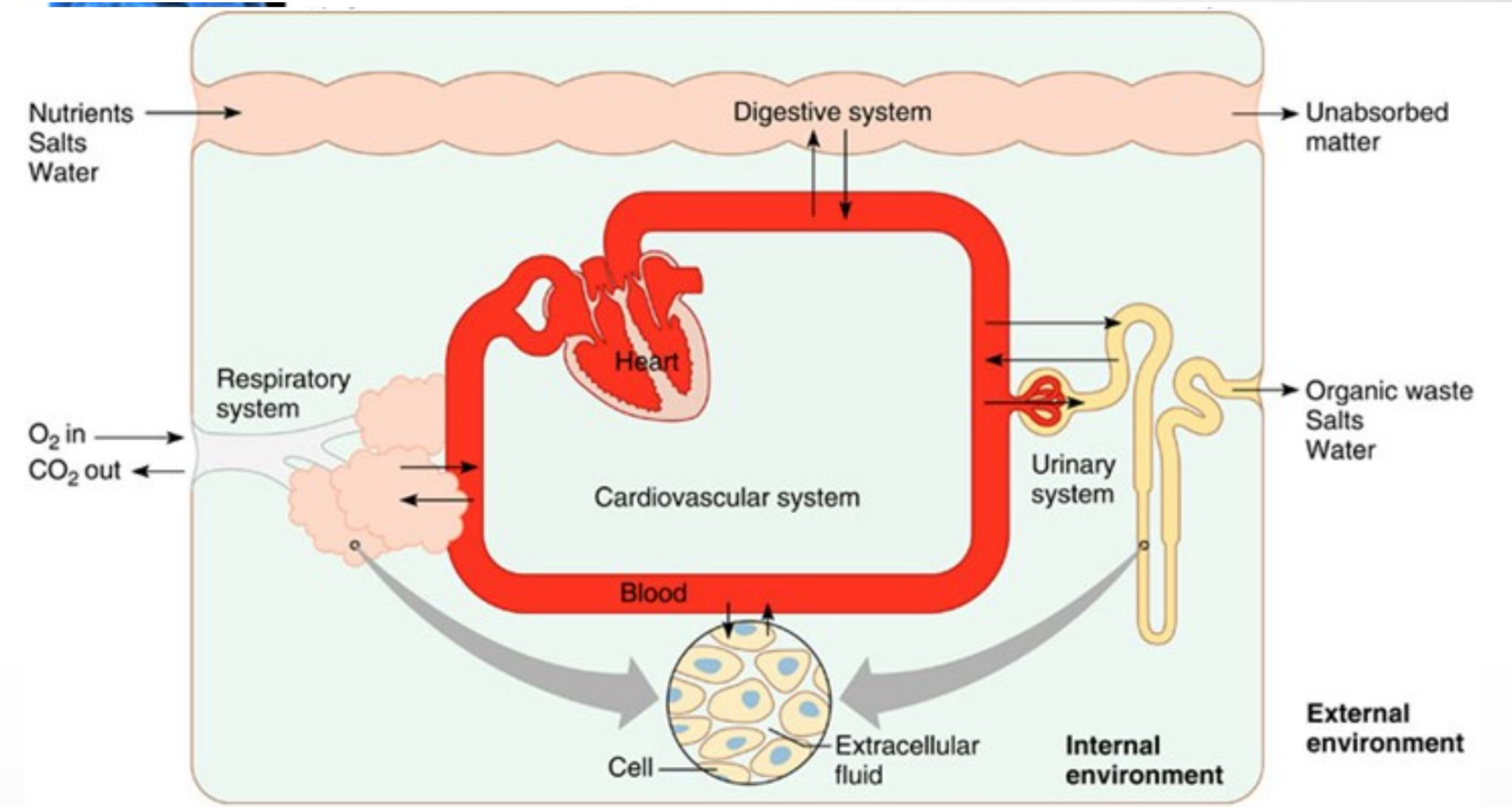


HOMEOSTATIC CONTROL MECHANISMS:

- Control of homeostasis is constantly being challenged by:
  - **Physical insults** such as intense heat or lack of oxygen
  - **Changes in the internal environment** such as a drop in blood glucose due to lack of food
  - **Physiological stress** such as demands of work or school
- Disruptions are mild if balance is quickly restored.

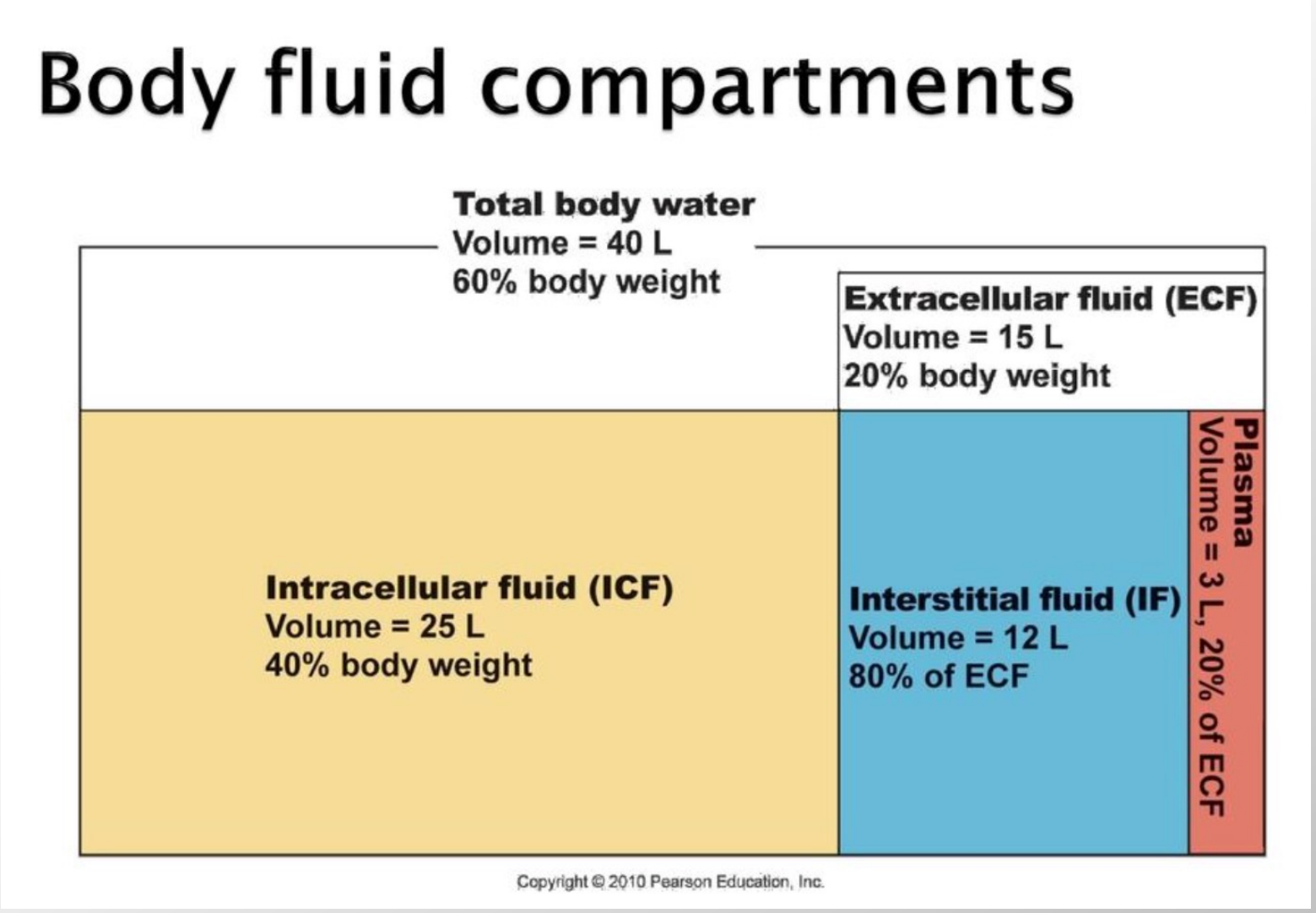
THE BODY'S INTERNAL ENVIRONMENT:

Interactions occur between compartments in the body

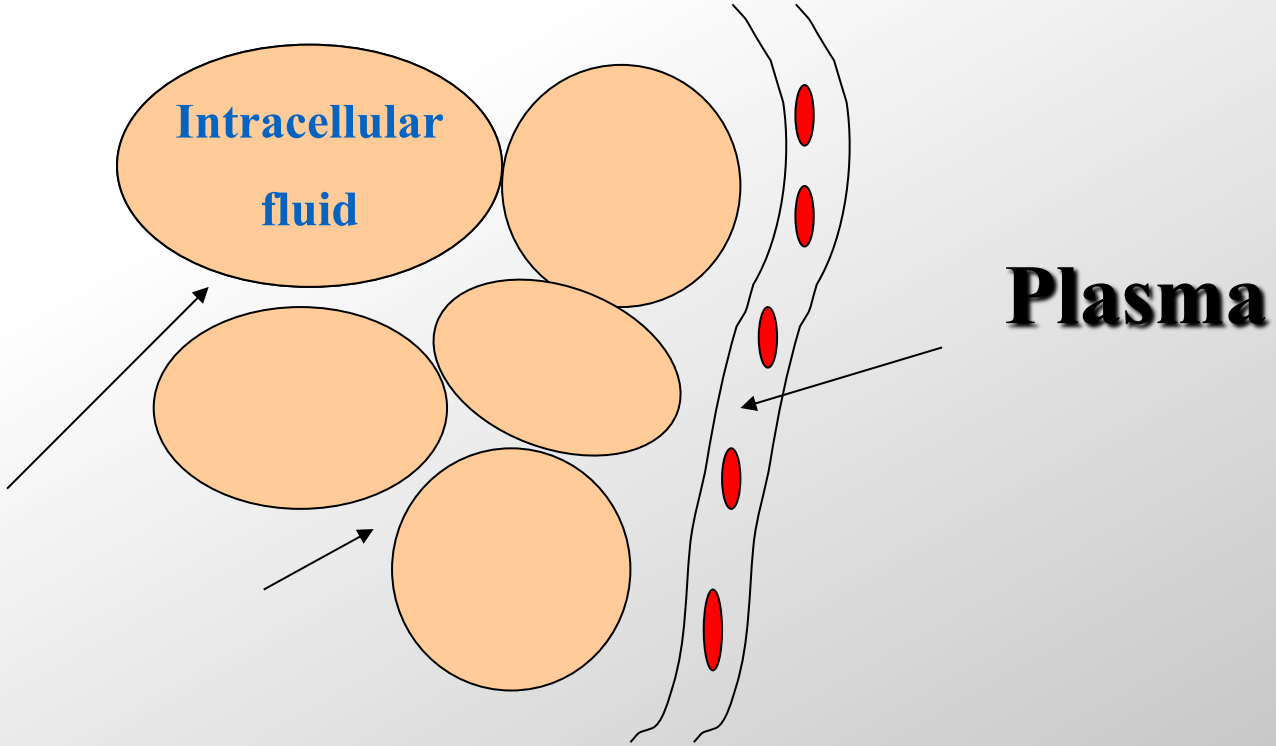


Internal Environment and Homeostasis

Total body water = 60 % BW



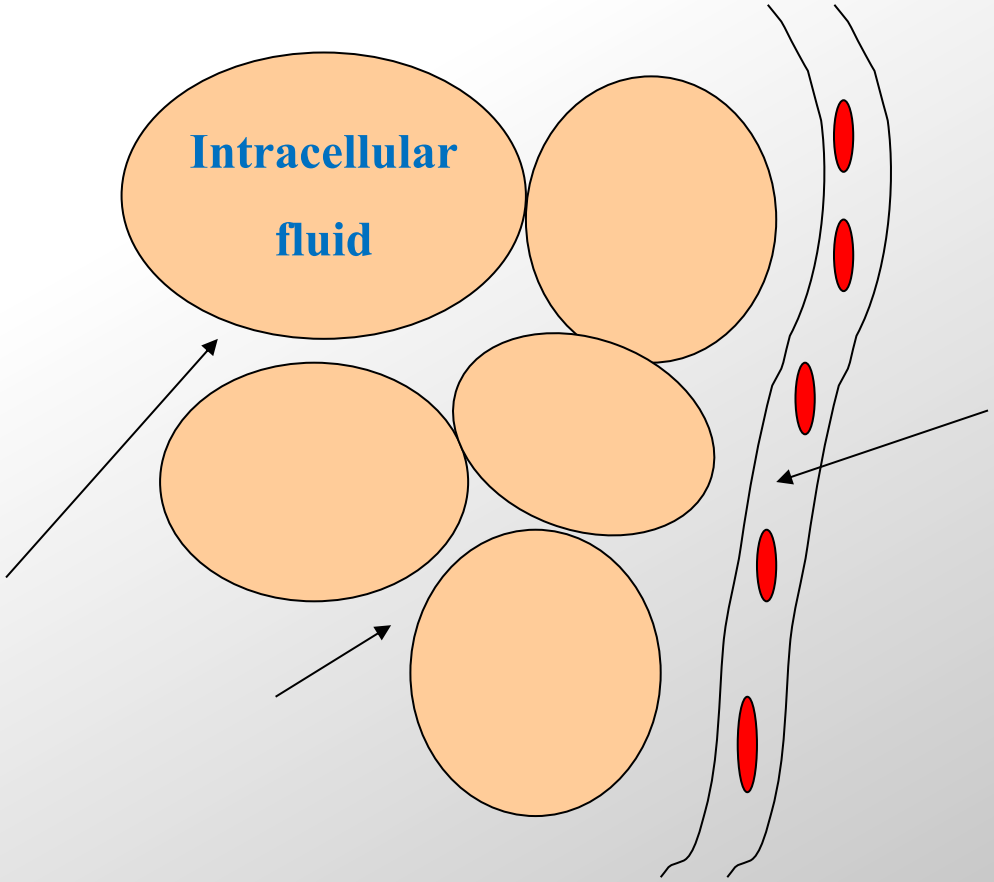
Internal environment



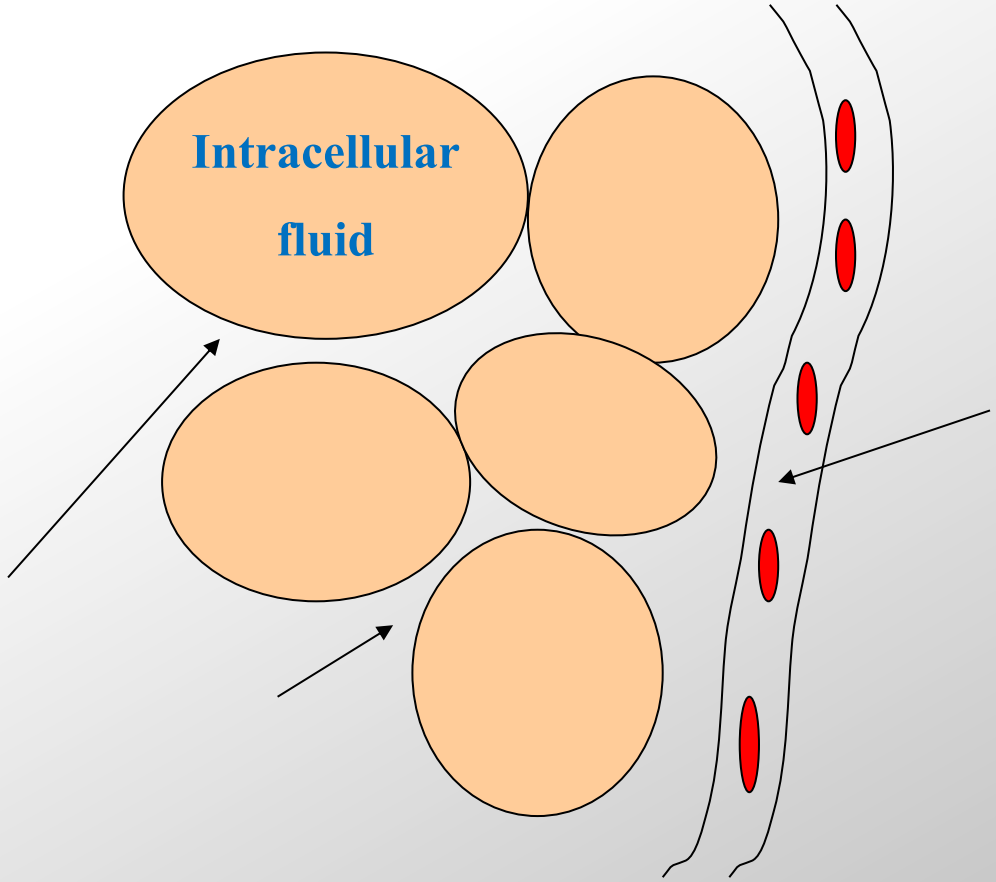
Extracellular fluid directly baths body cells

Internal environment = Extracellular fluid

Extracellular fluids?



Extracellular fluids



2. Plasma

1. Interstitial fluid

3. Fluid of special compartments: pericardial fluid, pleural fluid, cerebrospinal fluid

THUS….HOMEOSTASIS:

- Maintenance of Relatively Constant Chemical/Physical Conditions **of the internal environment.**

- **Claude Bernard__(1813-1878) France**

…The internal environment remains relatively constant though there are changes in the external environment

HOMEOSTASIS:

- Walter Bradford Cannon, (1871– 1945),
- The concept of Homeostasis

- stable =/= rigidity, can vary within narrow limit (normal physiological range)
- The golden goal of every organ :
  - to maintain homeostasis
    - (concept of REGULATION)

Normal Physiological ranges

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

In fasting blood

pH 7.35-7.45

Bicarbonate 24-28 mEq/L

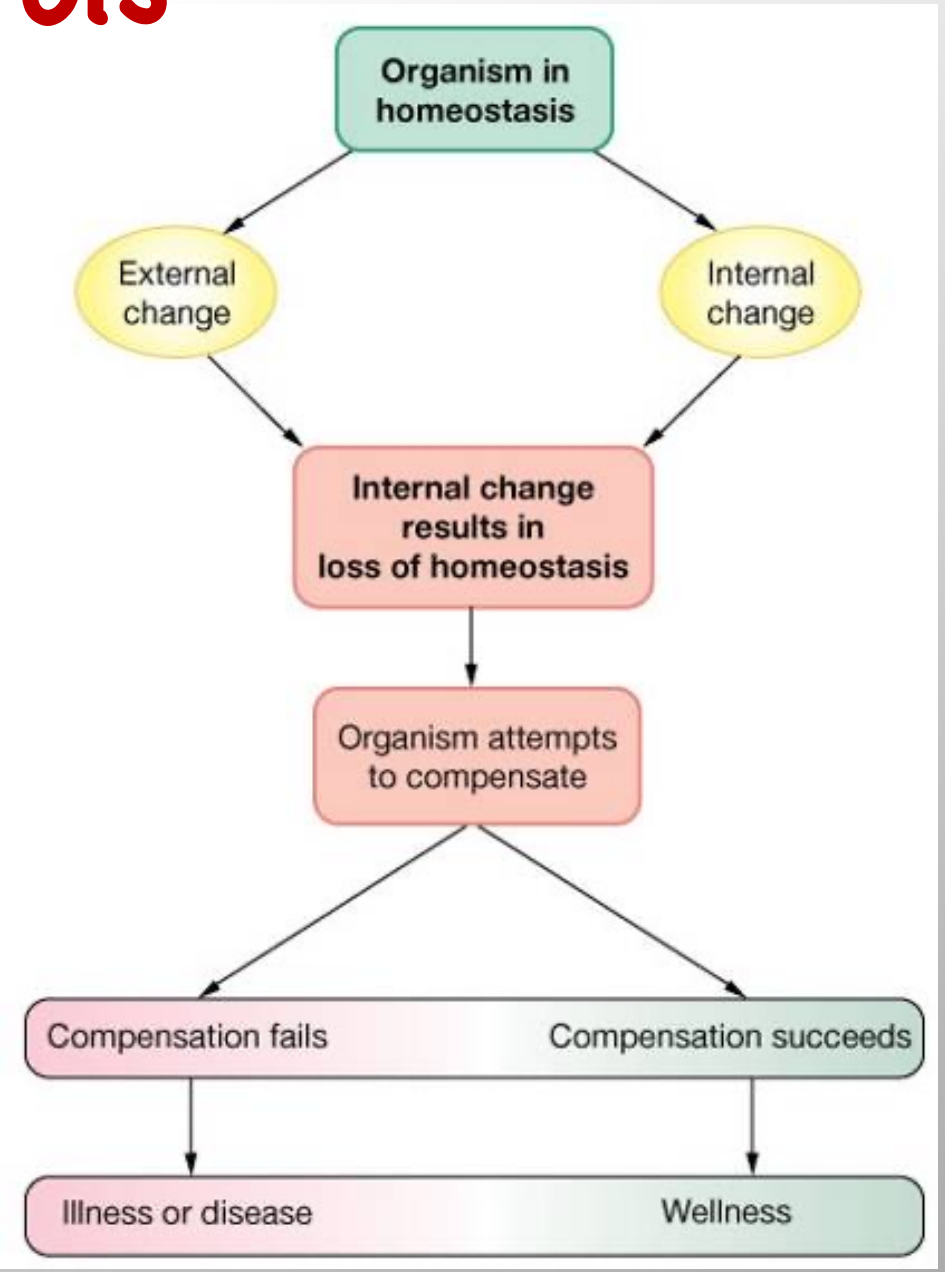
O2 content 17.2-22.0 ml/100 ml

Total lipid 400-800 mg/100 ml

Glucose 75-110 mg/100 ml

Homeostasis & Controls

- Successful compensation
  - Homeostasis reestablished
- Failure to compensate
  - Pathophysiology
    - Illness
    - Death

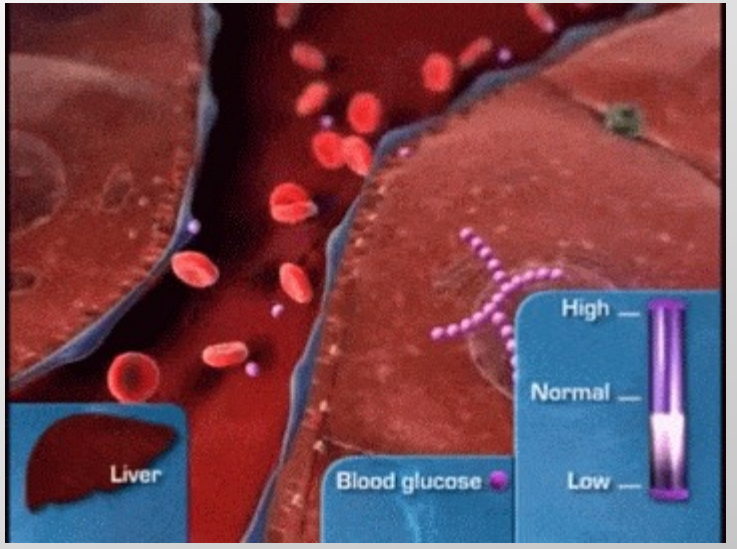


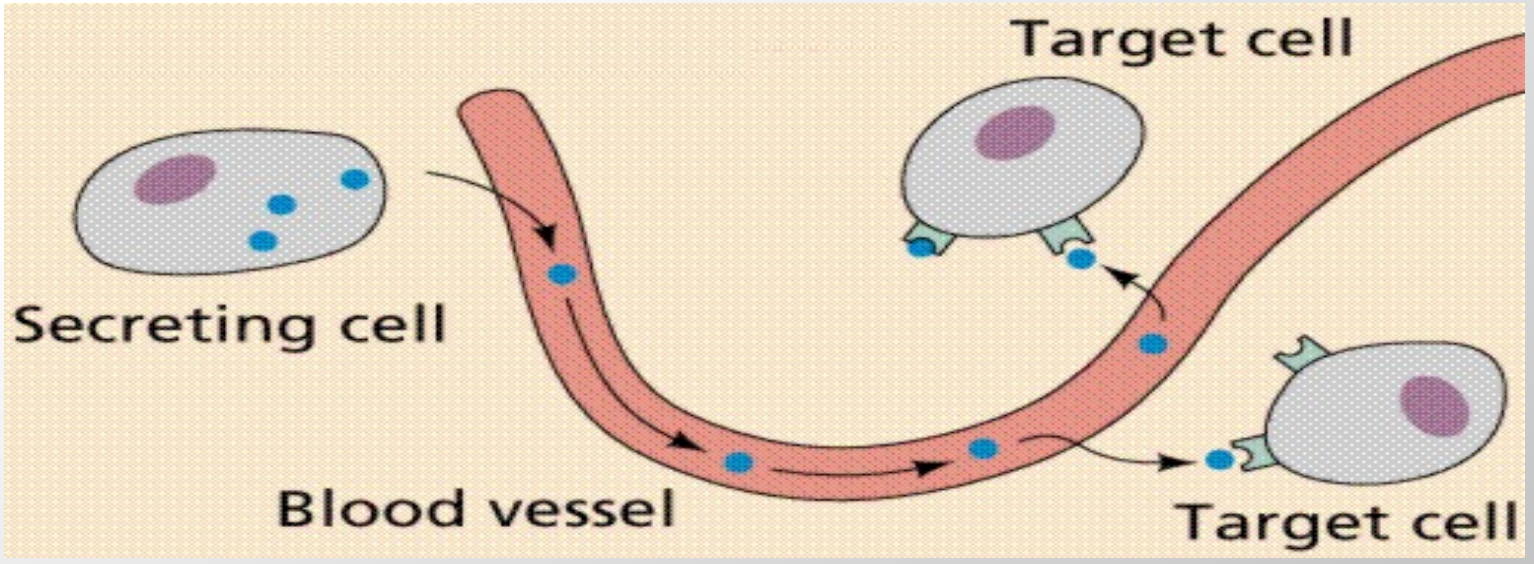
Regulation of the Body Functions

- Regulation- the ability of an organism to maintain a stable internal conditions in a constantly changing environment
  - Three types:
    - 1. Chemical (hormonal) Regulation
    - 2. Nervous Regulation
    - 3. Autoregulation

Chemical (hormonal) Regulation

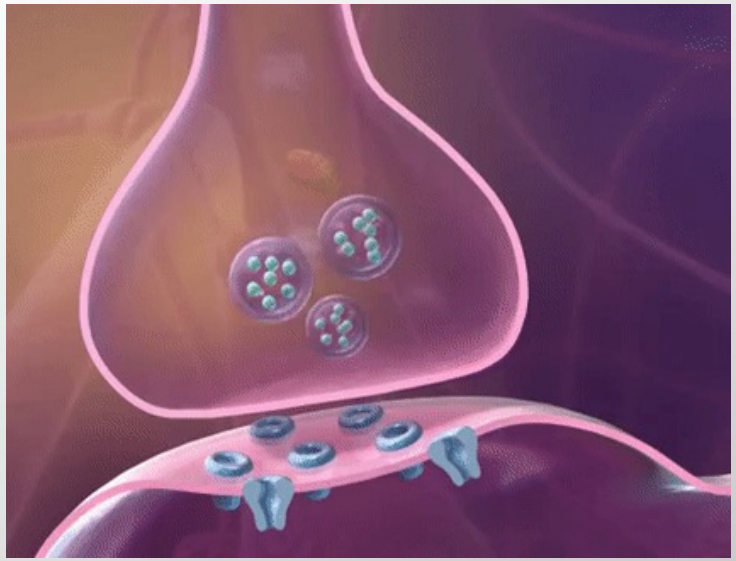
- a regulatory process performed by **hormone** or **active chemical substance** in blood or tissue.
  - response slowly
  - acts extensively
  - lasts for a long time.

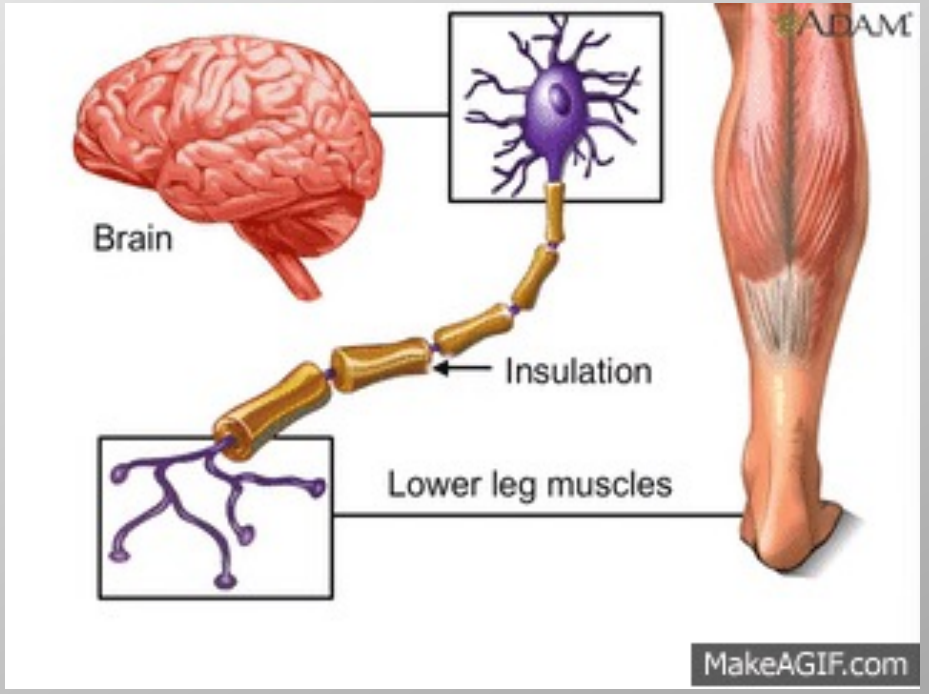




Nervous Regulation

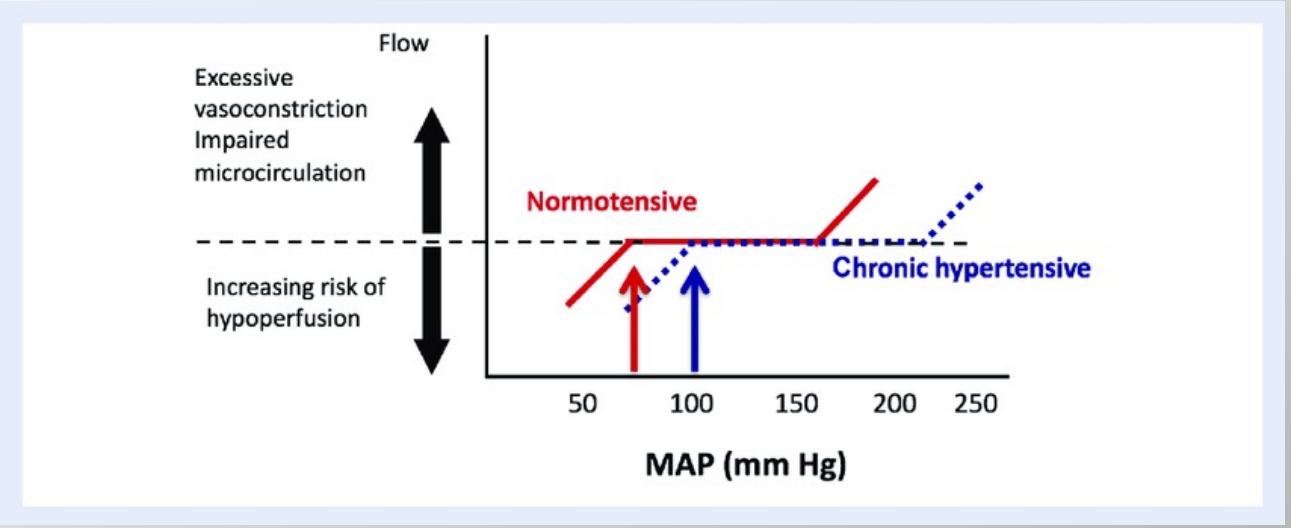
- a process in which body functions are controlled by nerve system
    - Pathway: nerve reflex
    - Types: unconditioned reflex and conditioned reflex
    - Example: baroreceptor reflex of arterial blood pressure
- Characteristics:
    - response fast
    - acts exactly or locally
    - last for a short time





Autoregulation

- a tissue or an organ can directly respond to environmental changes
  - independent of nervous and hormonal control
  - Characteristics：
    - Amplitude of the regulation is smaller than other two types.
    - Extension of the effects is smaller than other two types.



Regulation of the Body Functions

- **The three regulations have coordinated and acts as one system, “feedback control system”.**

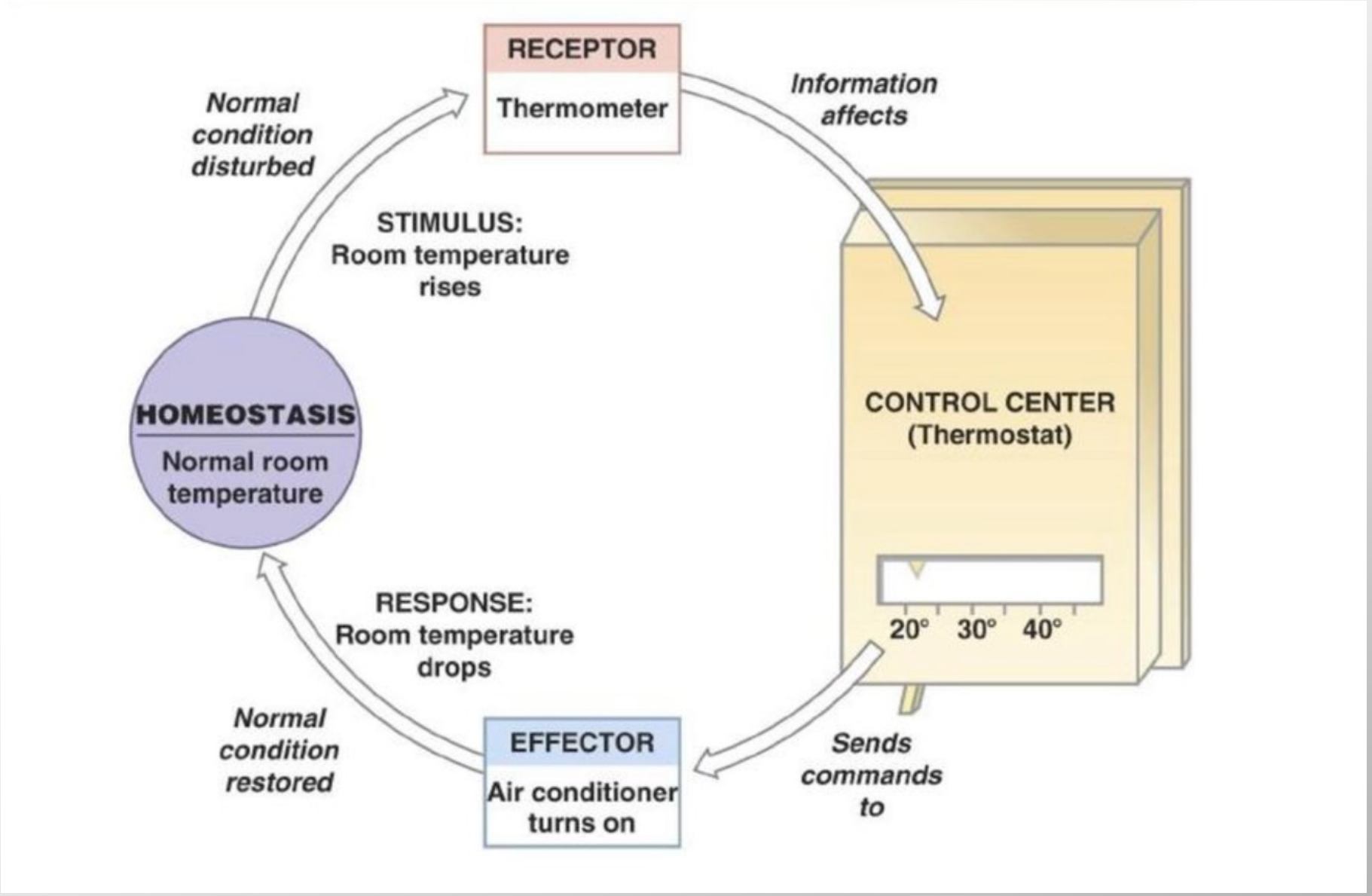
•Feedback Mechanism

- What is meant by feedback?

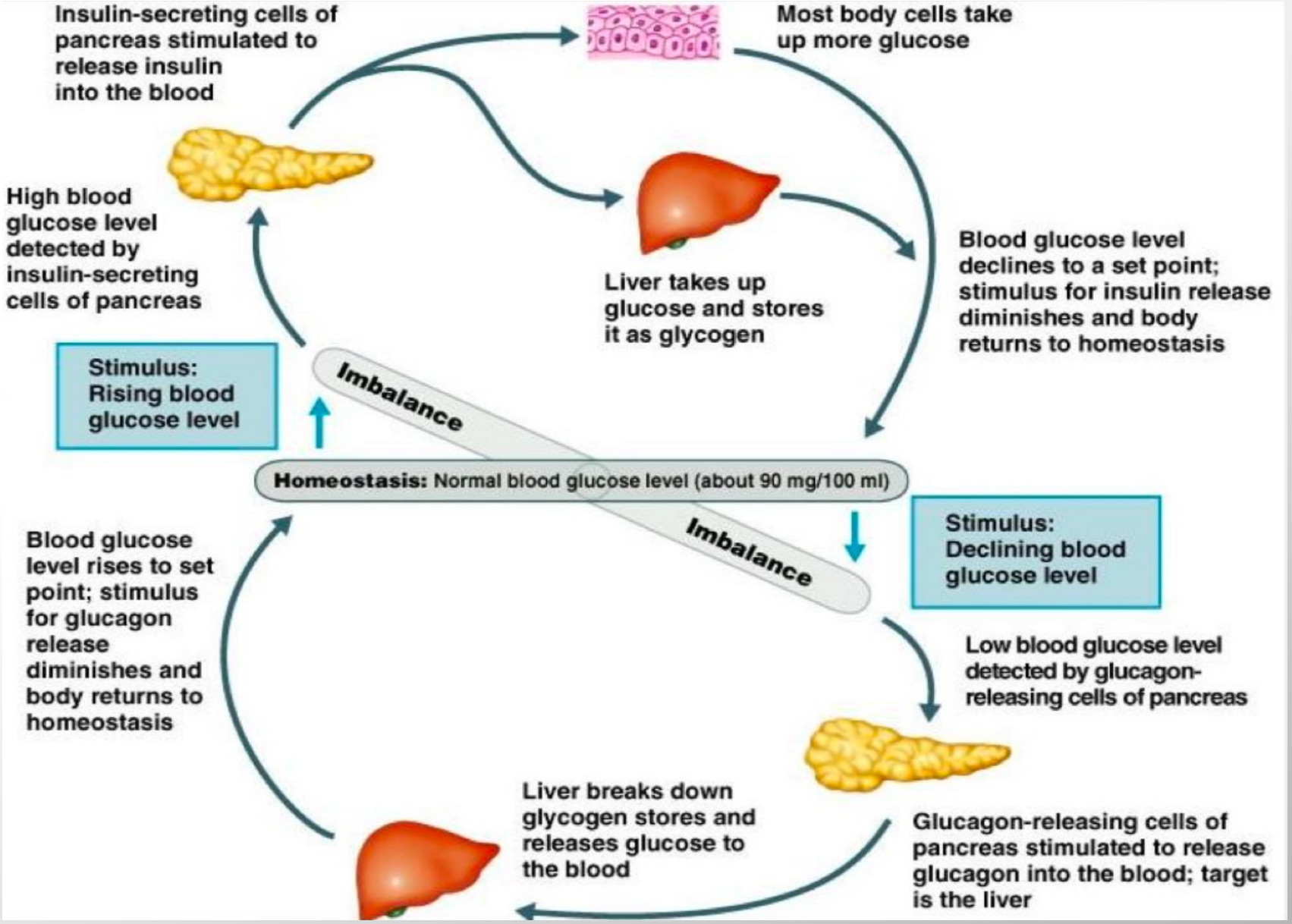
Feedback Mechanism:

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

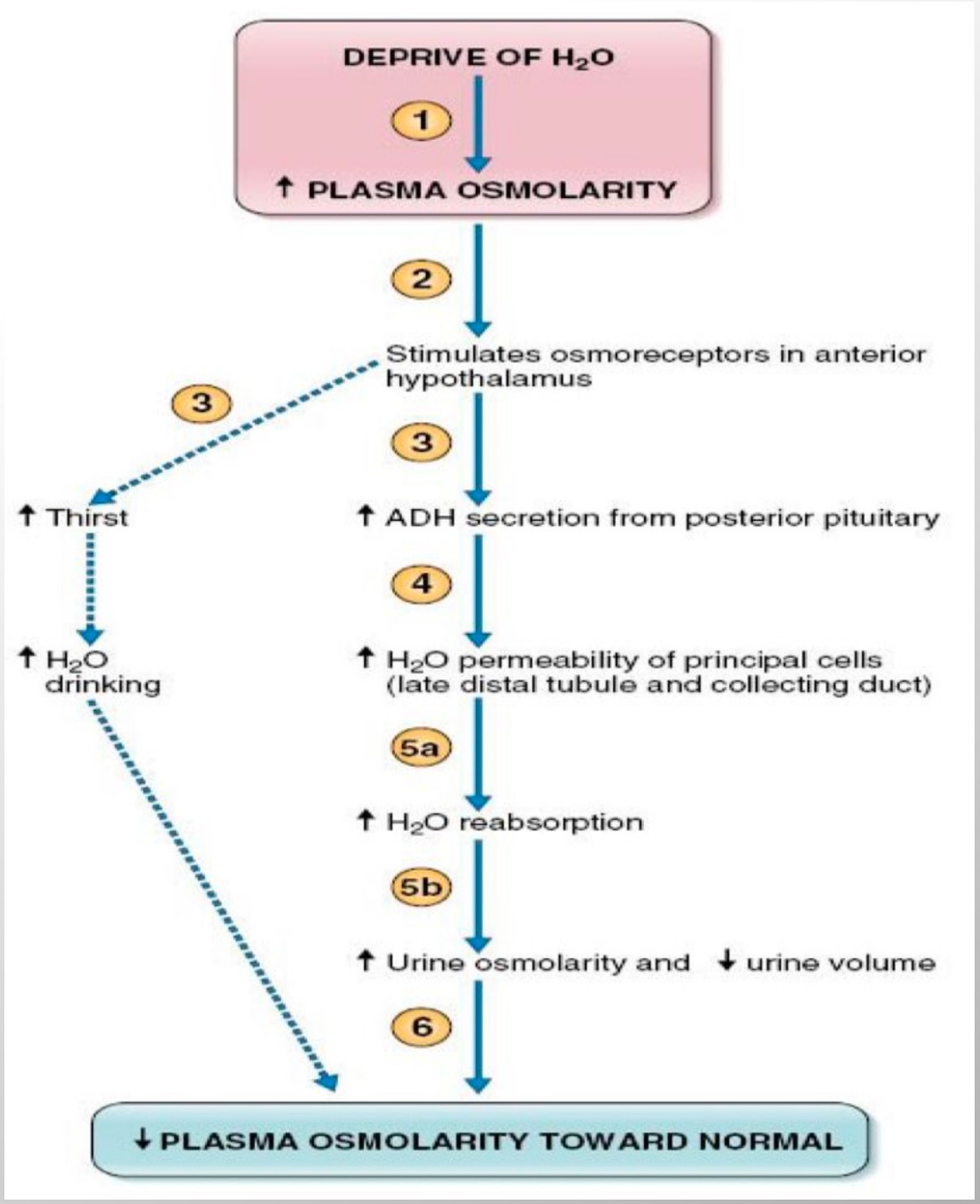
THE THERMOSTAT ANALOGY



THE BLOOD GLUCOSE CONTROL



Feedback Mechanism



Feedback Control

Negative 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.

Positive 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?***

Negative feedback

- The feedback signals from controlled system produces effect opposite to the action of the control system.
- The opposite effect is mainly “inhibitory action”.

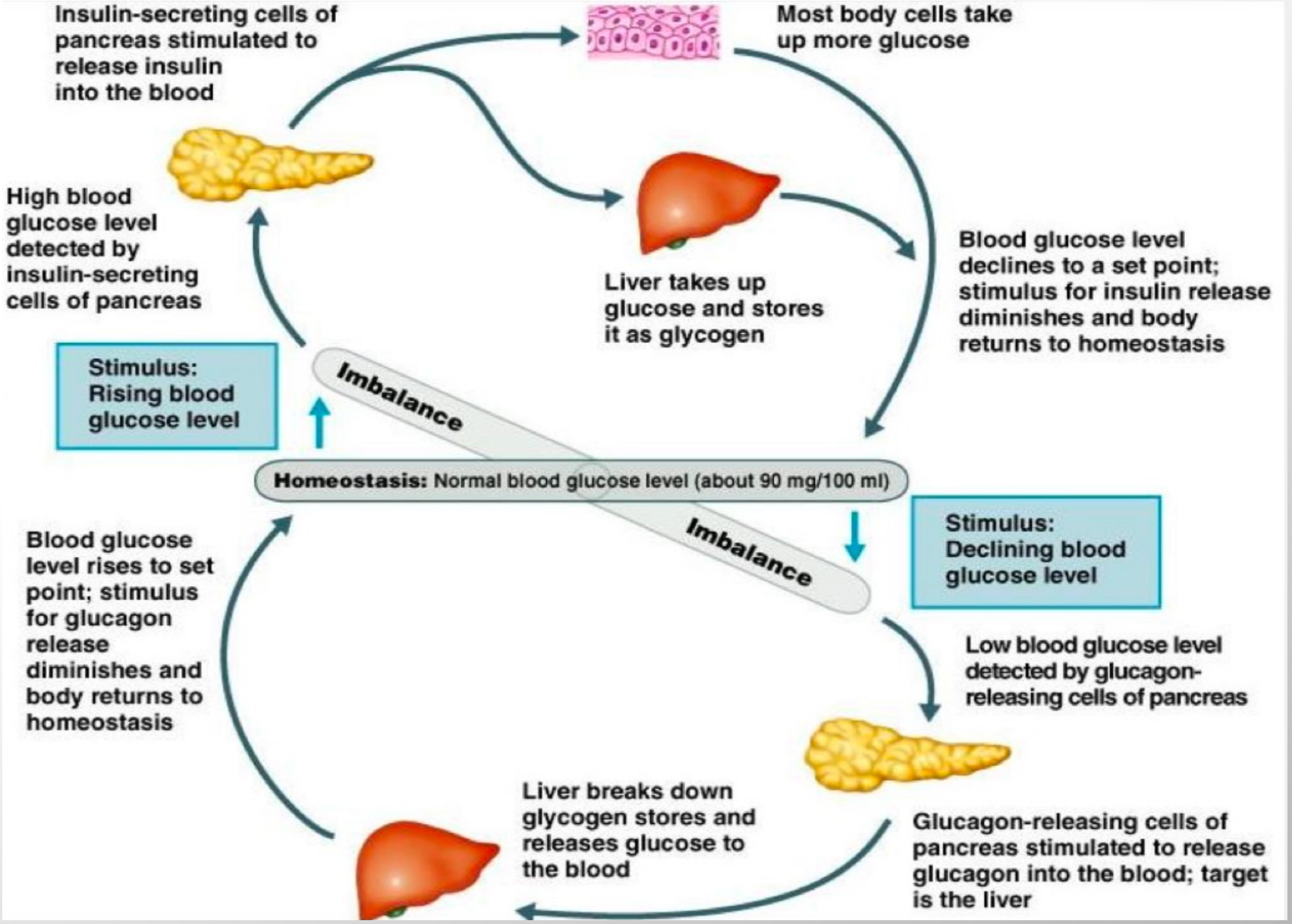
Examples of negative feedback?

1.THE BLOOD GLUCOSE CONTROL

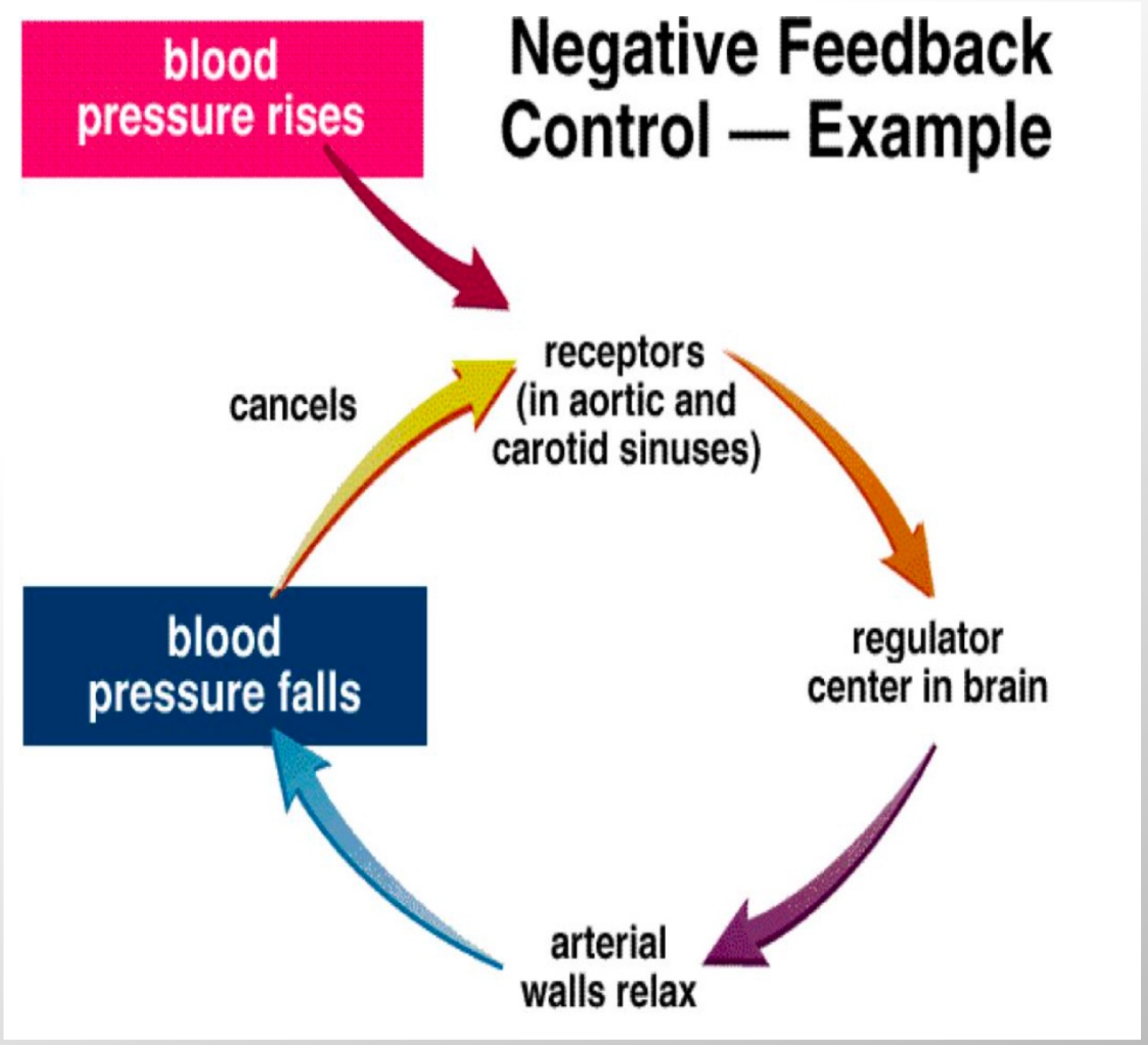
2……

3……

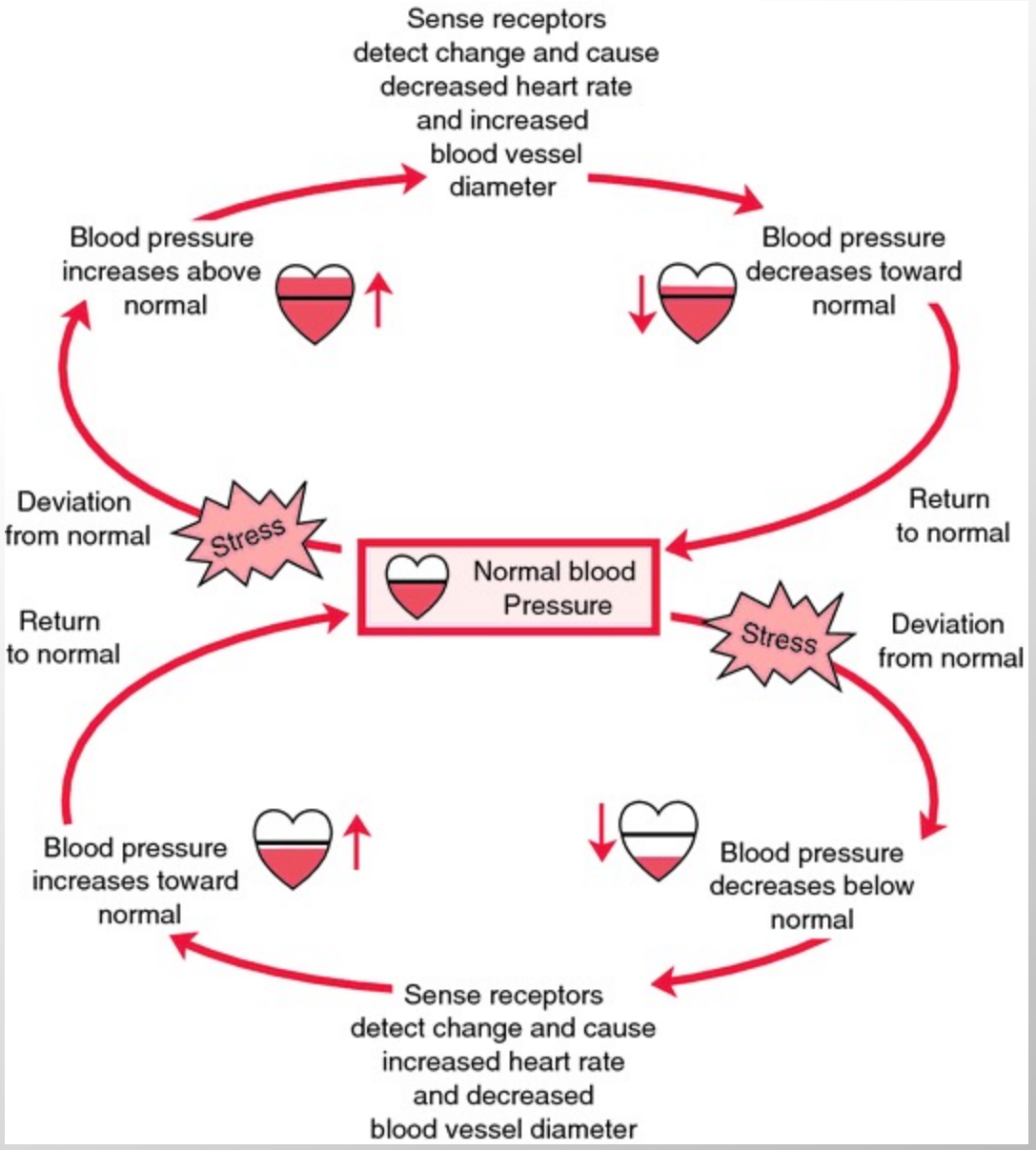
Examples of negative feedback (1)



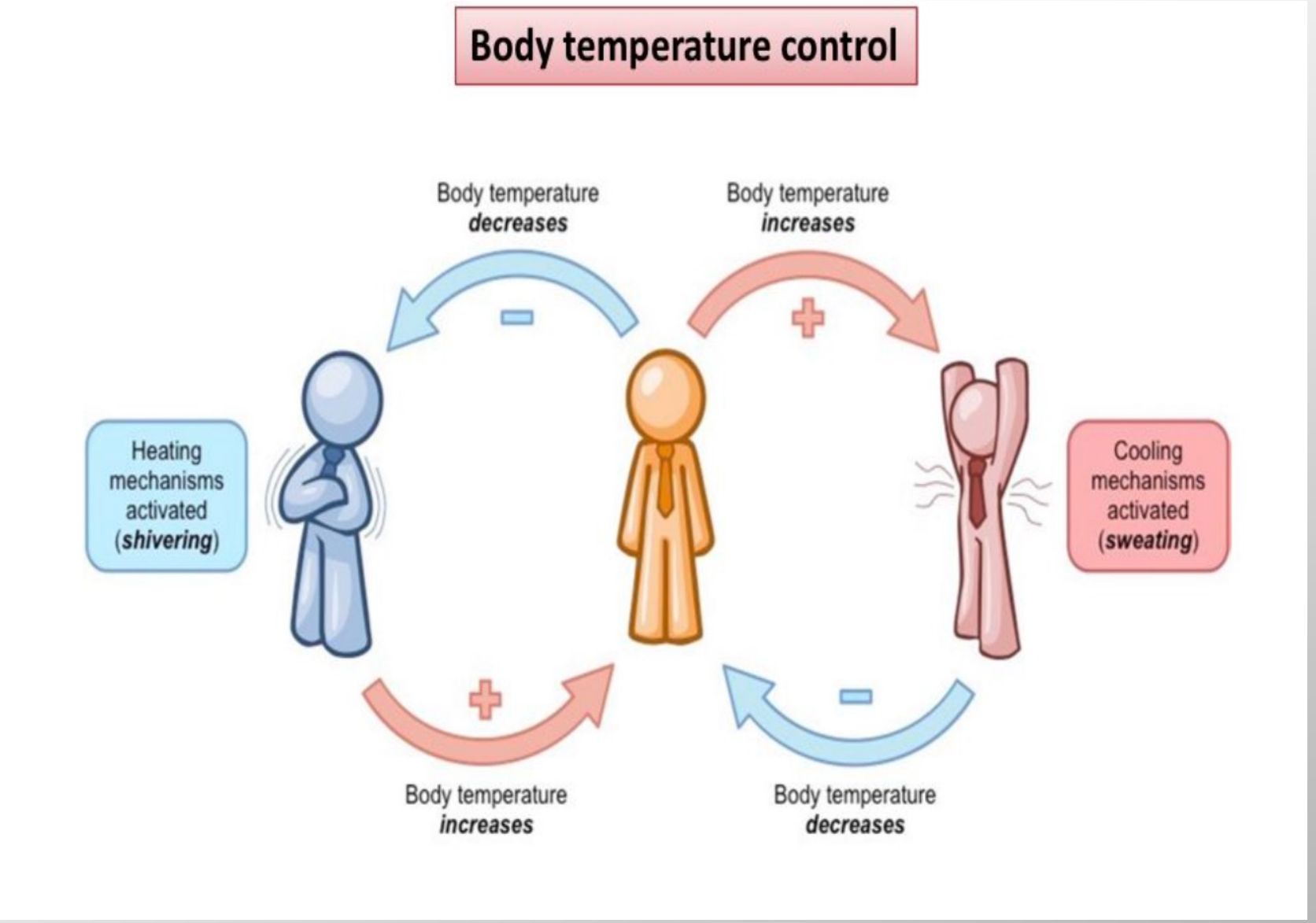
Examples of negative feedback (2)



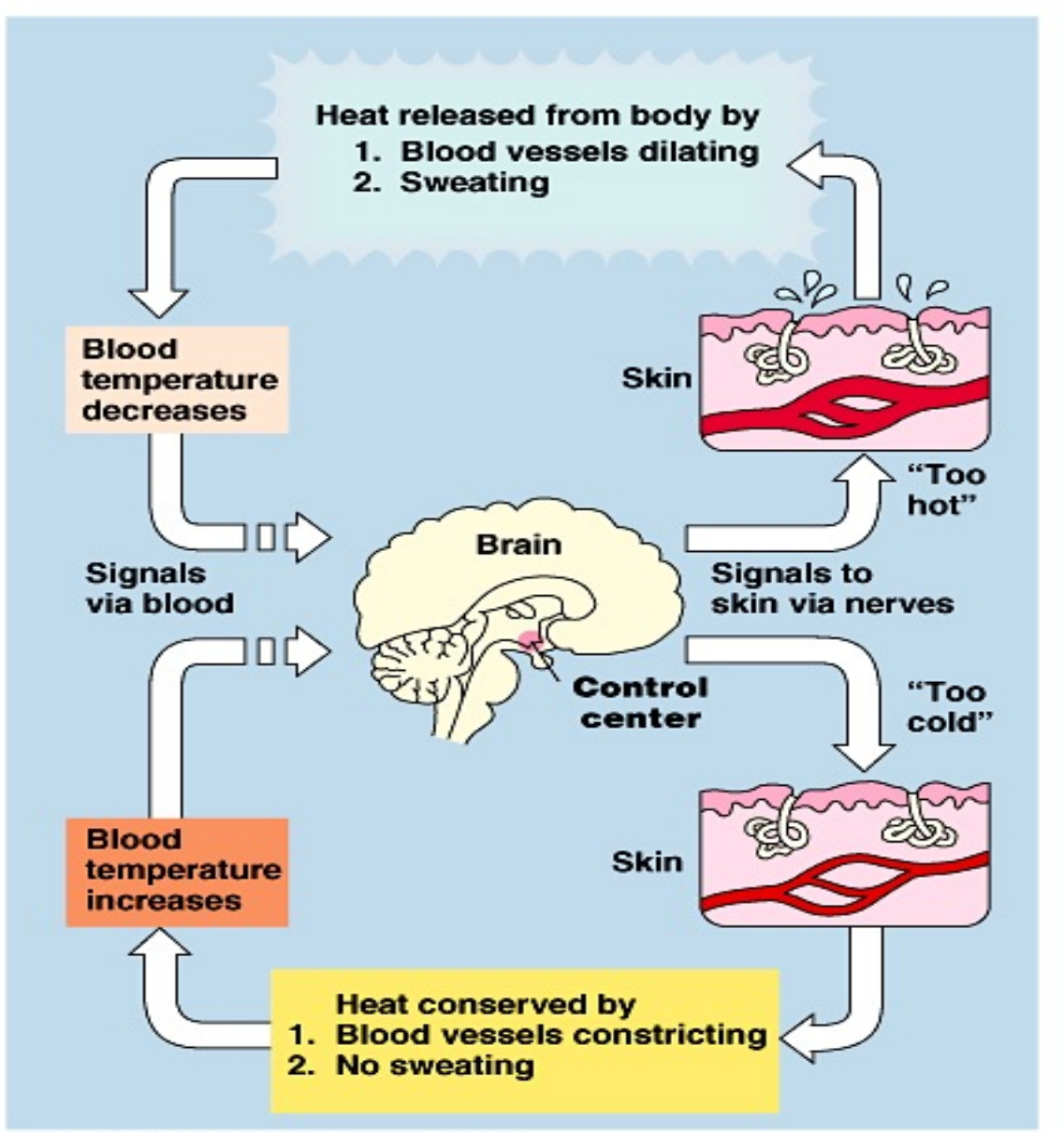
Examples of negative feedback (2)



Examples of negative feedback (3)



Examples of negative feedback (3)



(b) Control of body temperature

Examples of negative feedback?

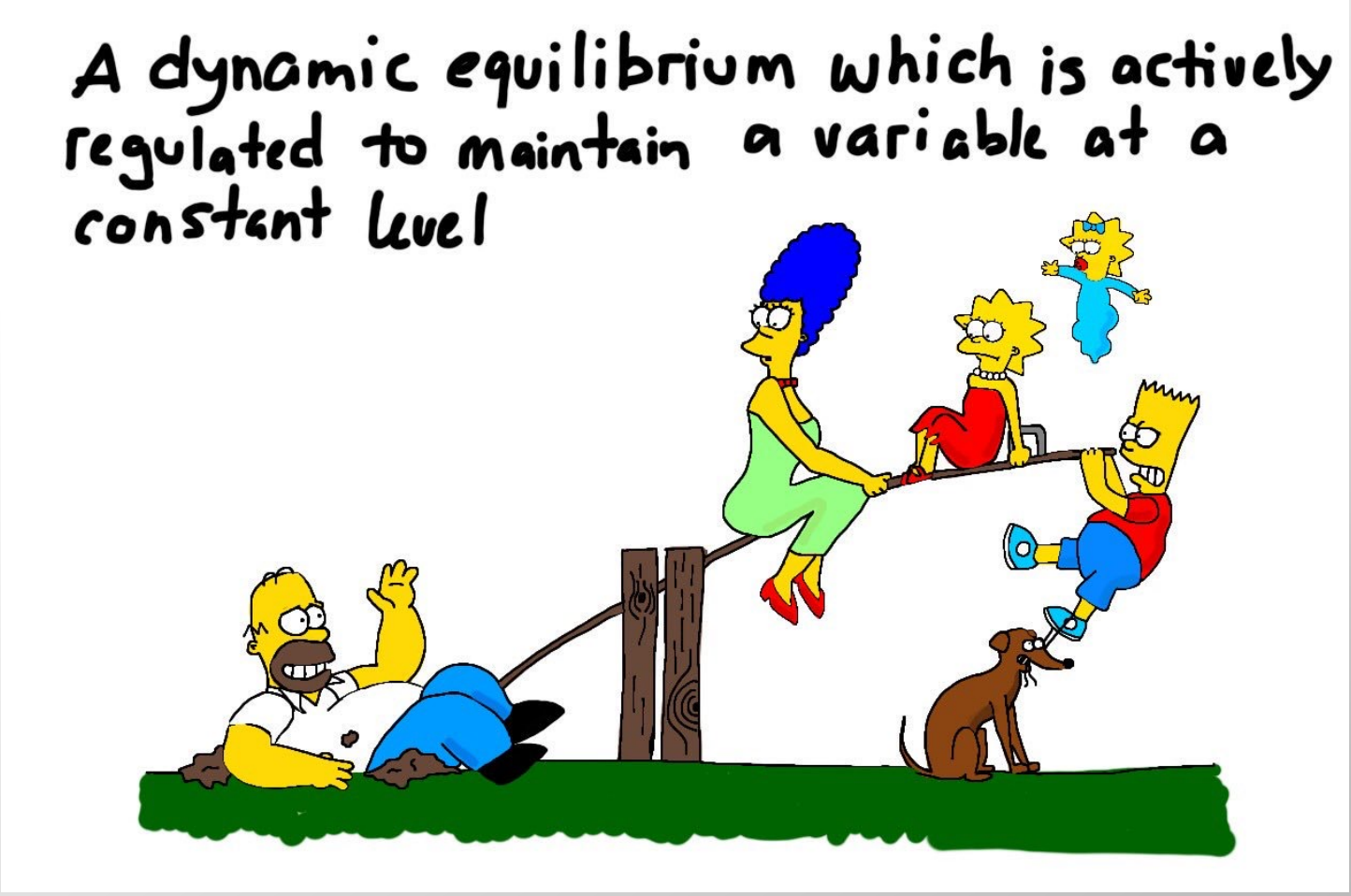
1. BLOOD GLUCOSE CONTROL
2. BLOOD PRESSURE CONTROL
3. BODY TEMPERATURE CONTROL

Stimulus triggers response to counteract further change in the same direction.

Negative-feedback mechanisms prevent small changes from becoming too large.


Importance of negative feedback?

Maintenance of the homeostasis



Positive feedback

The feedback signal or output from the controlled system increases the action of the control system

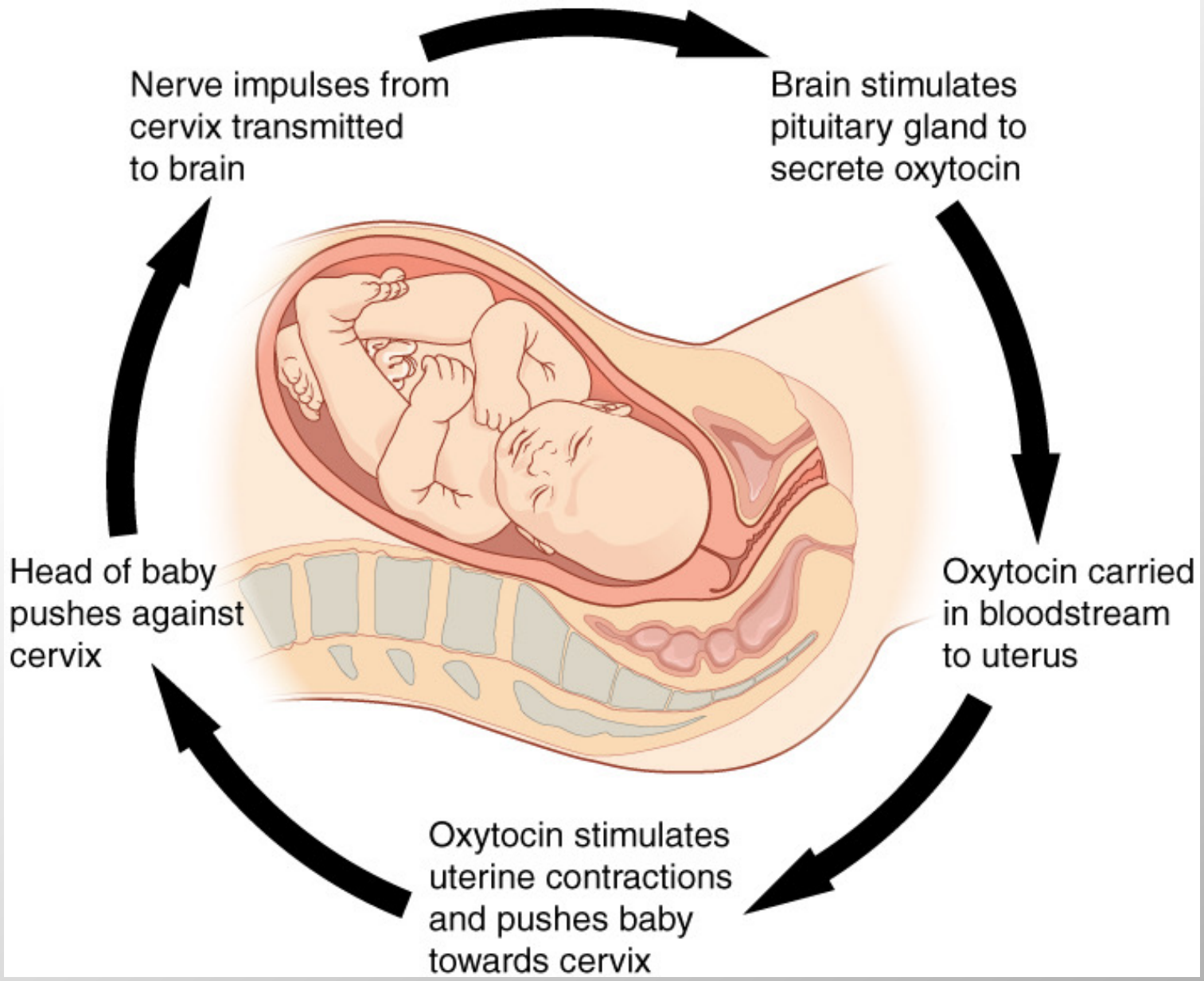
Examples of positive feedback?

1….

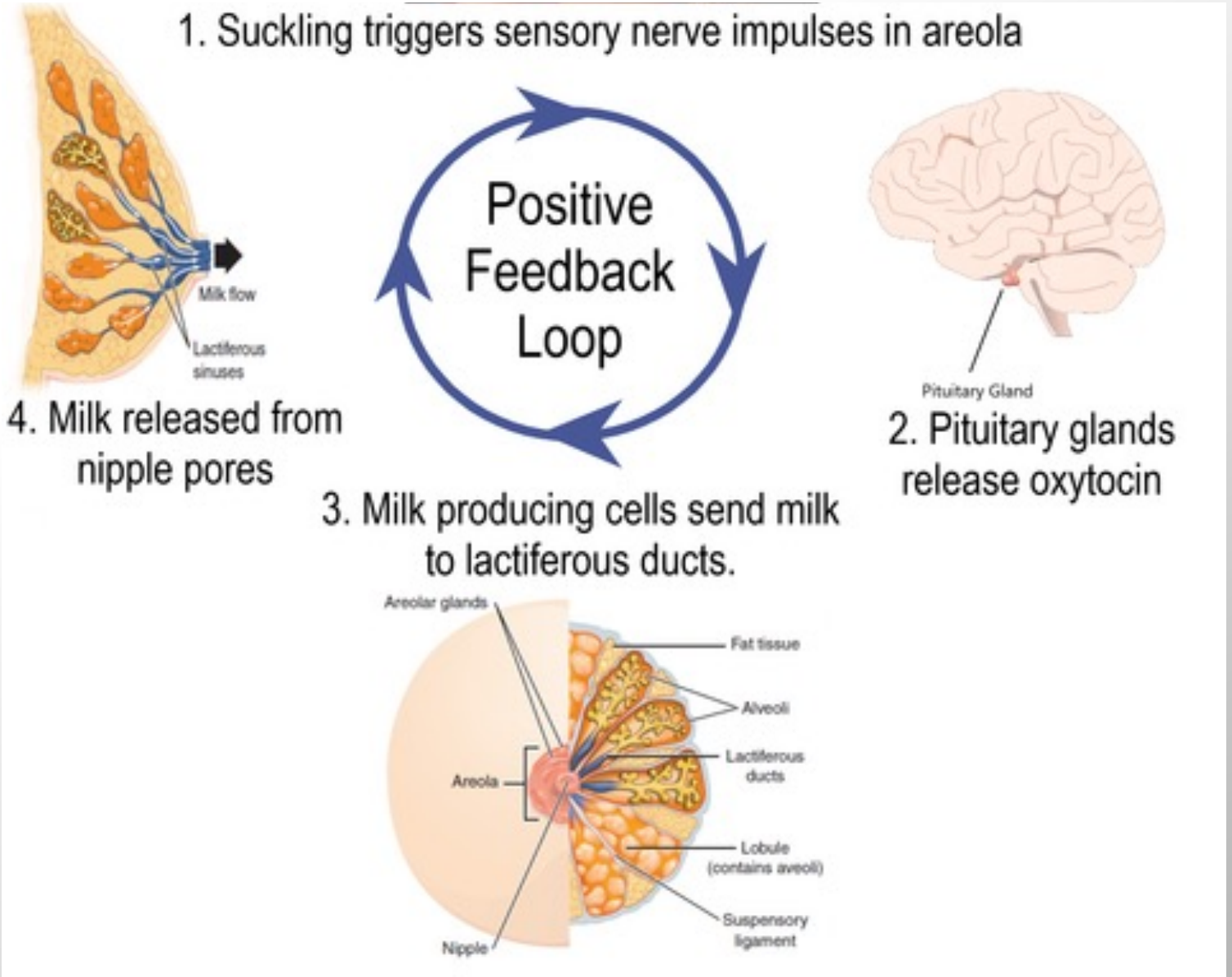
2…..

3…..

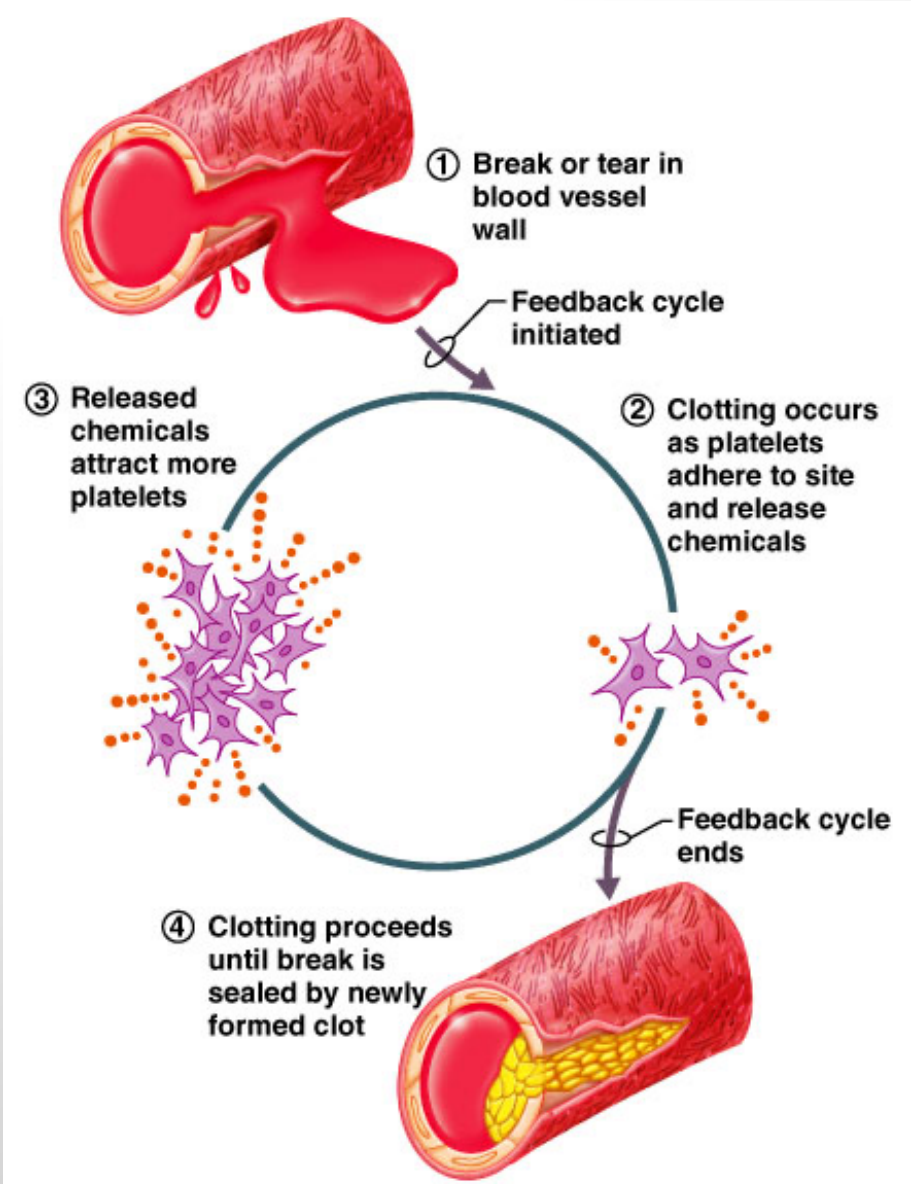
Examples of positive feedback (1)



Examples of positive feedback (2)



Examples of positive feedback (3)



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Examples of negative feedback?

1. CHILDBIRTH
2. LACTATION
3. BLOOD CLOTH FORMATION

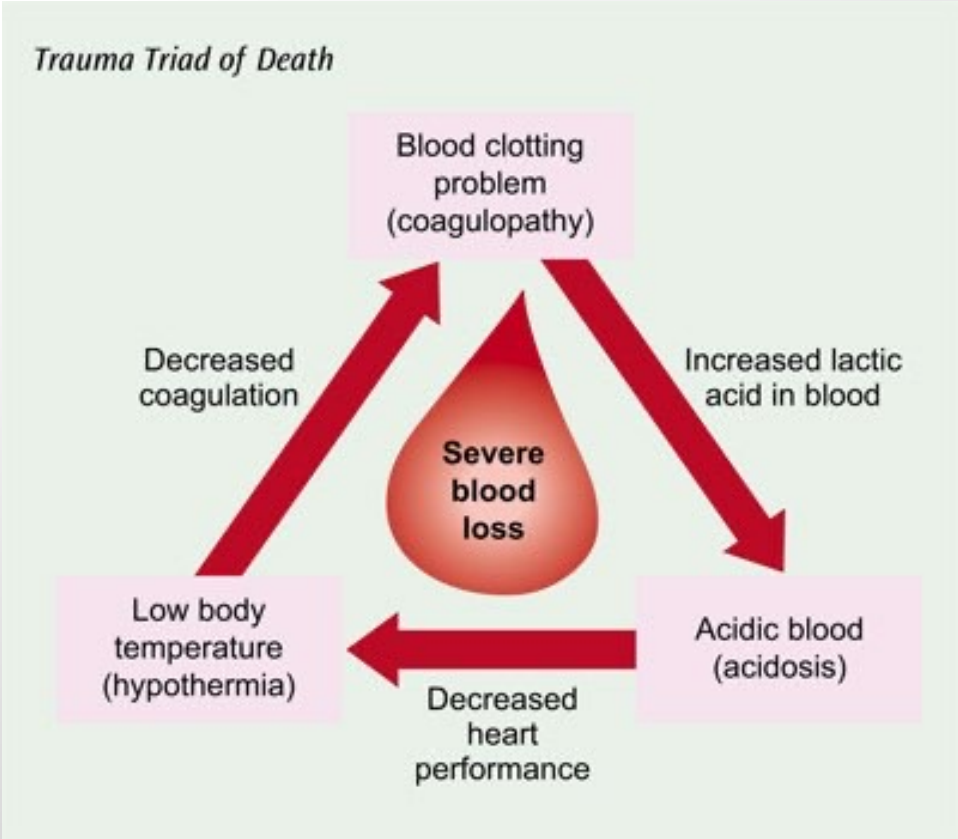

Importance of positive feedback?

PROS:

- Enhance the action of original stimulus or amplify or reinforce change
  - promote an activity to finish

CONS:

- Vicious circle - can lead to instability or even death



Control Systems in the Human Body

- Feedback Control
  - **Feedback:** **Output** (feedback signal) from **controlled organ** returns to affect or modify the action of the **control system**.
  - Feedback control mechanism consists of two forms:
    - **Negative** feedback control.
    - **Positive** feedback control

Control Systems in the Human Body

- Feedback Control
- Feedforward control

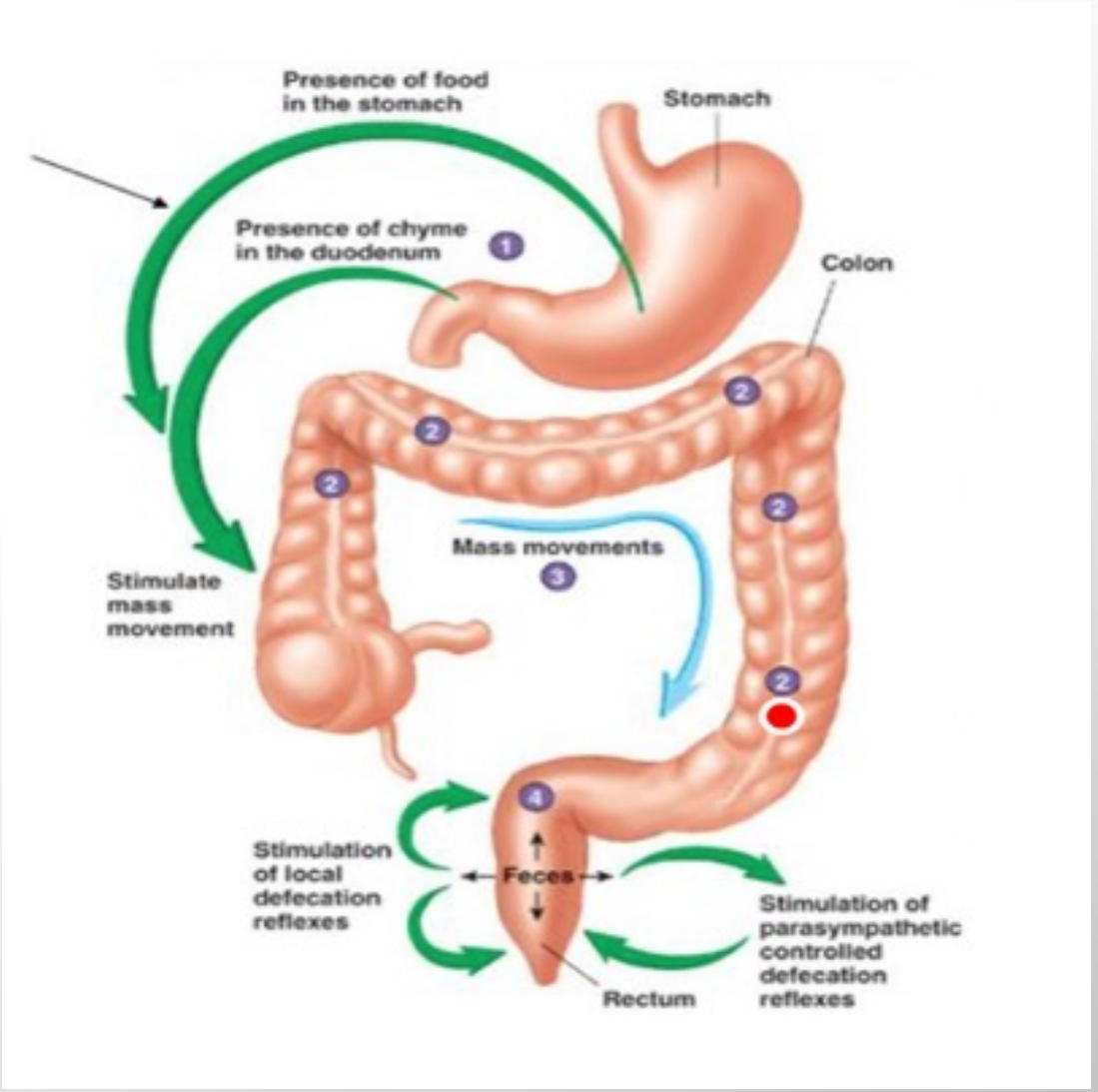
Feed-forward control

- Concept: Direct effect of stimulus on the control system **before** the action of feedback signal occurs.
  - **Disturb signal or interfere signal**.
- Example: Shivering before diving into the cold water

Feed-forward control

- Significance of **Feedback-forward** :
  - adaptive feedback control.
  - makes the human body to **foresee** and **adapt** the environment promptly and exactly
    - (prepare the body for the change).

Feed-forward control example



RECAP…

HOMEOSTATIC IMBALANCE:

- It is the disturbance of homeostasis or the body's normal equilibrium.
- It basically produces a change in the normal condition of the internal environment.

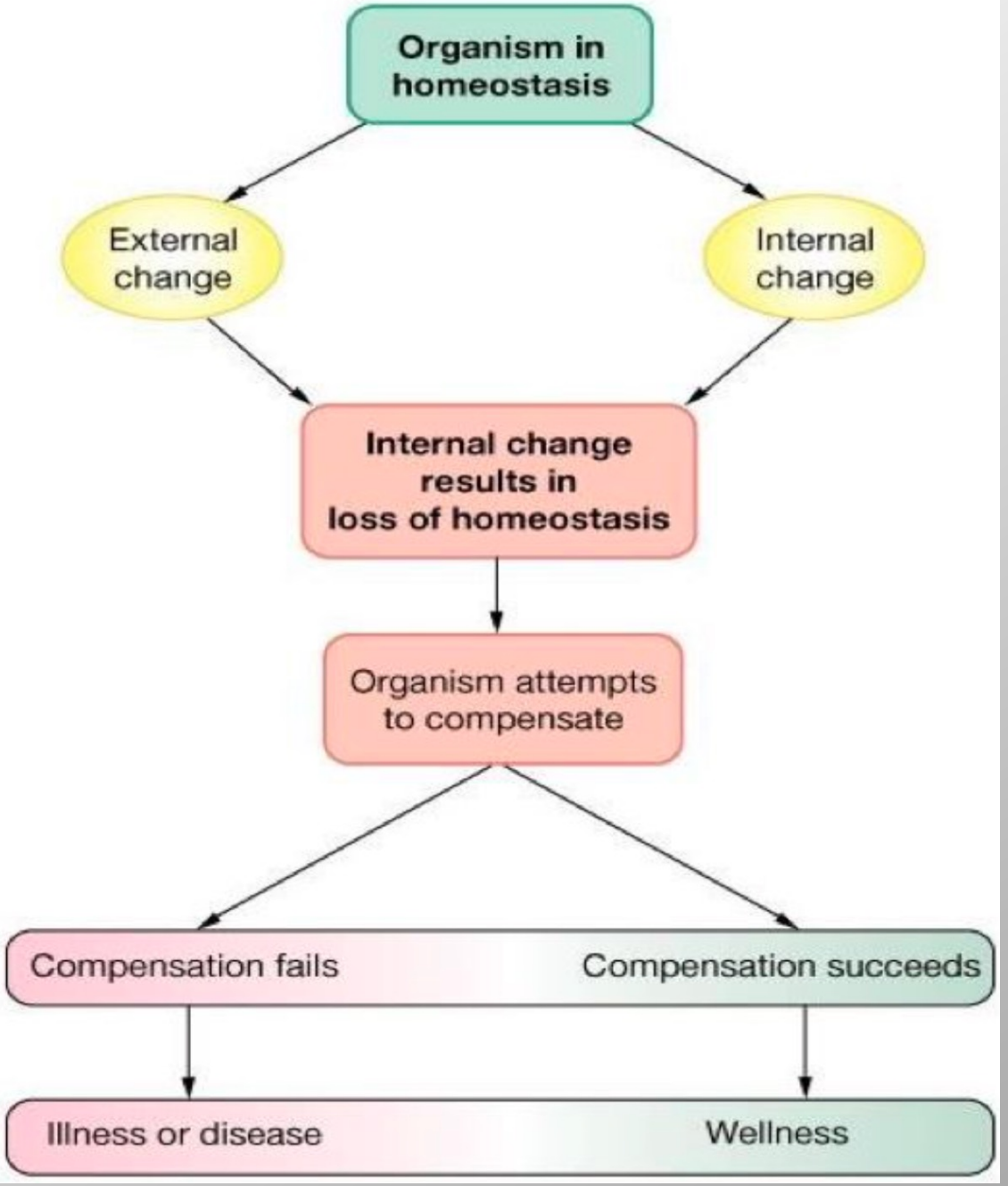
The homeostasis then will produce a reaction that will either be:

★ **Successful compensation:**

- Homeostasis reestablished.

★ **Failure to compensate:**

- Pathophysiology.
- Illness.
- Death.



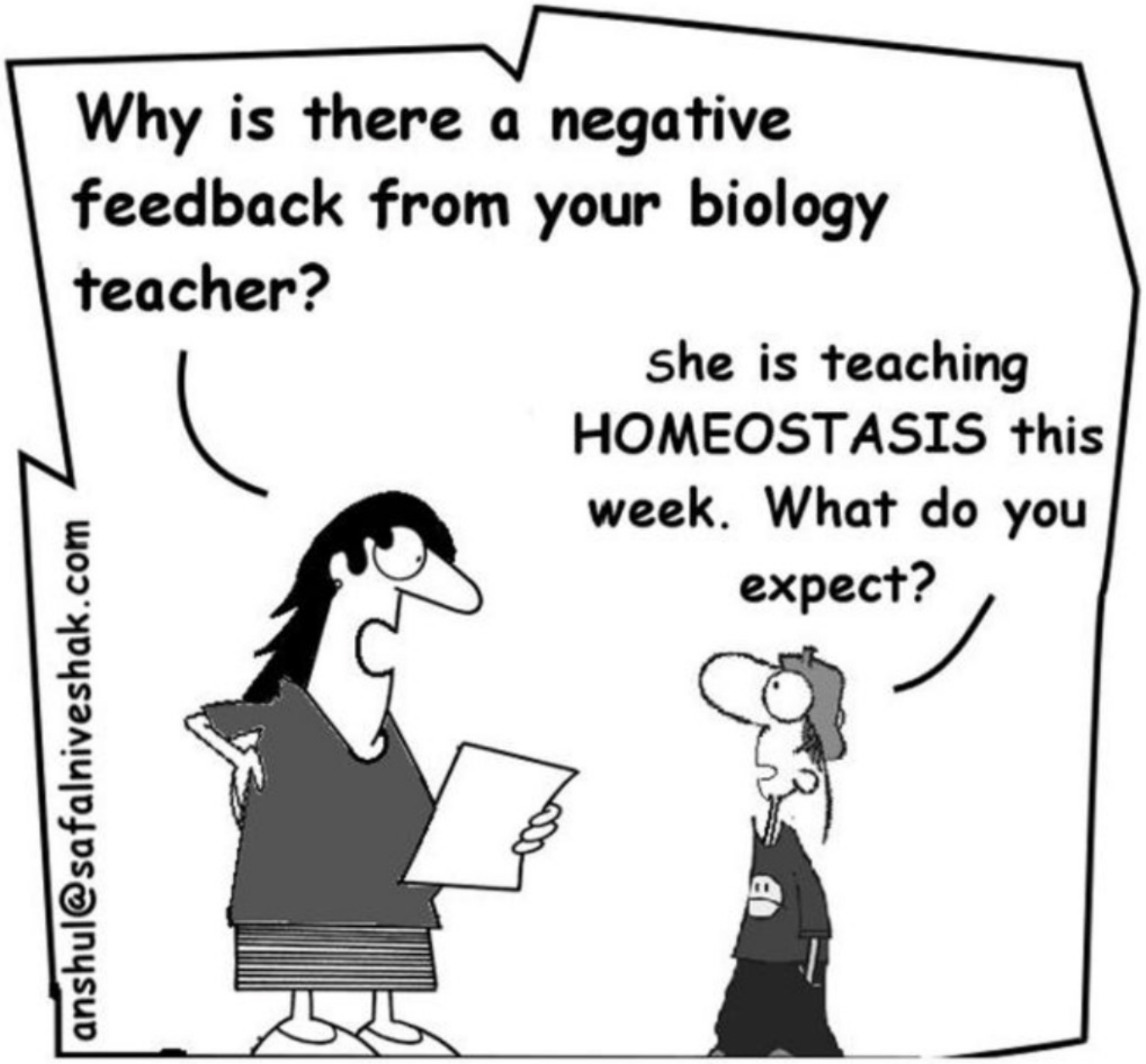
QUIZ!

Q1: control of Oxytocin secretion is a type of :			
A) Osmosis	B) Negative feedback	C) positive feedback	D) Disease
Q2: "A loop system in which the system responds to perturbation either in the same direction of the opposite direction "			
A) Positive feedback	B) negative feedback	C) A & B	D) non of these
Q3: heart/ kidney failure cause low capillary pressure			
A) True	B) False	C)	D)
Q4 : the synonym of Extracellular fluid is			
A) External environment	B) internal environment	C) intracellular environment	D) A & C

Discussion time

Describe a tome when homeostasis was disrupted in your body

which organ systems do you think were affected?


Why is there a negative feedback from your biology teacher?
She is teaching HOMEOSTASIS this week. What do you expect?
anshul@safalniveshak.com