

# Homeostasis (1+2)

**Red: very important.**

**Green: only found in males' slides.**

**Purple: only found in females' slides.**

**Gray: notes.**

**Physiology Team 436 – Foundation block lecture 4**

# Objectives

---

- Define and discuss the concept of homeostasis and its importance to the living organism.
- Discuss the physiologic control mechanisms that enable maintenance of the normal steady state of the body.
- 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 Edema and state its various types.

# Homeostasis

**Homeostasis is known as :-**

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

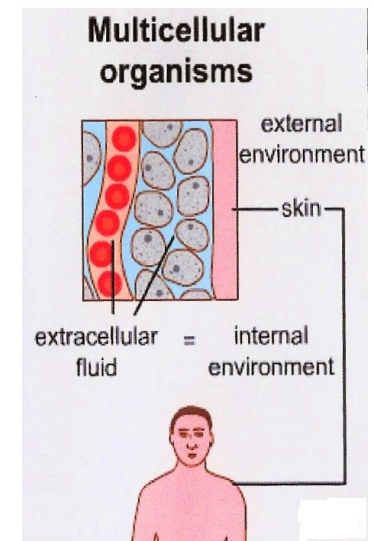
**Homeo: similar**

**Stasis: state of equilibrium**

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

**- All different body system operate in **harmony** to provide **homeostasis**** →

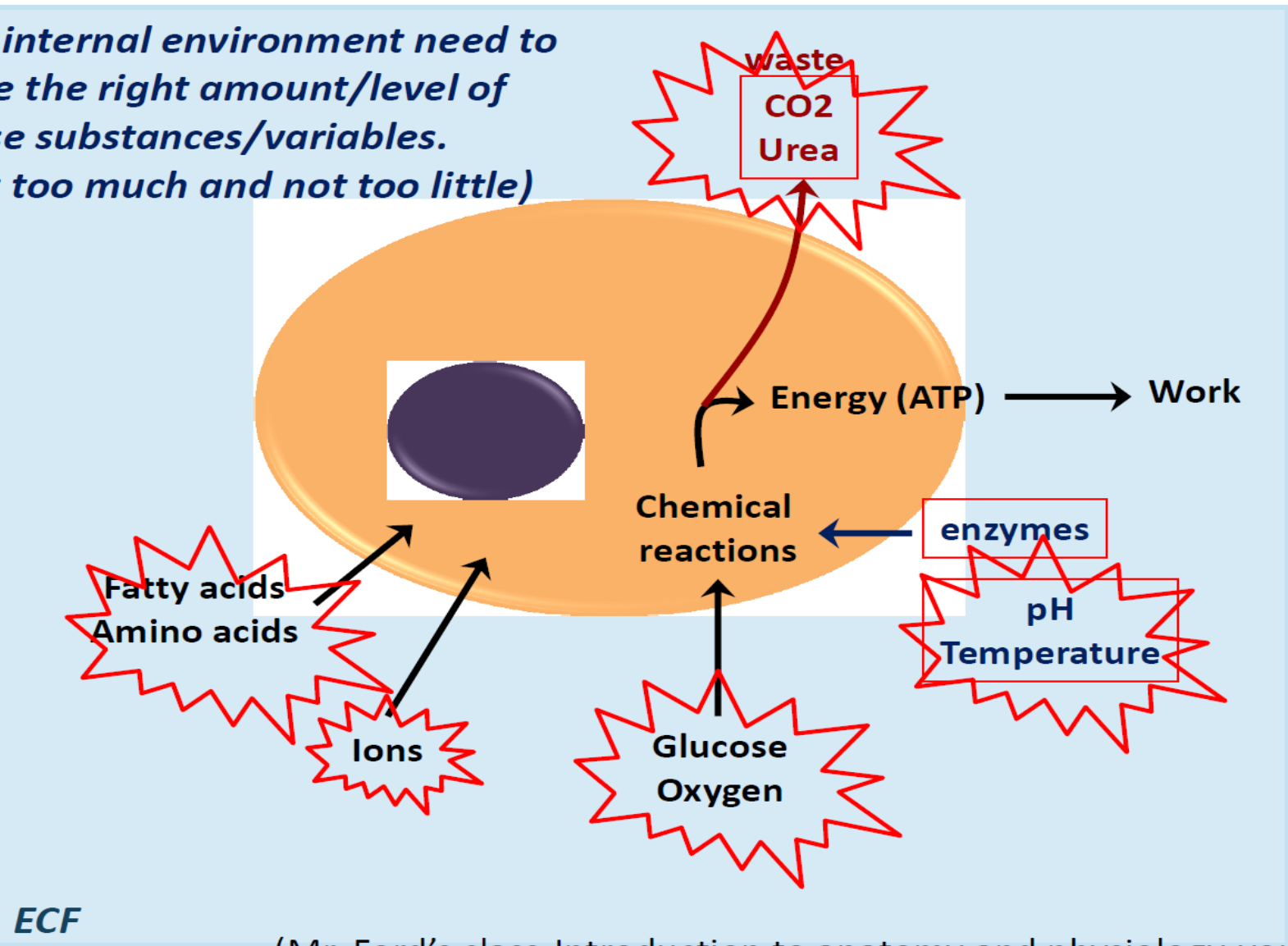
**Homeostasis :**  
↓  
**Sameness**  
↓  
**standing**



**Essentially all the functions of the body organs and tissues aim at keeping the internal environment at a nearly constant state.**

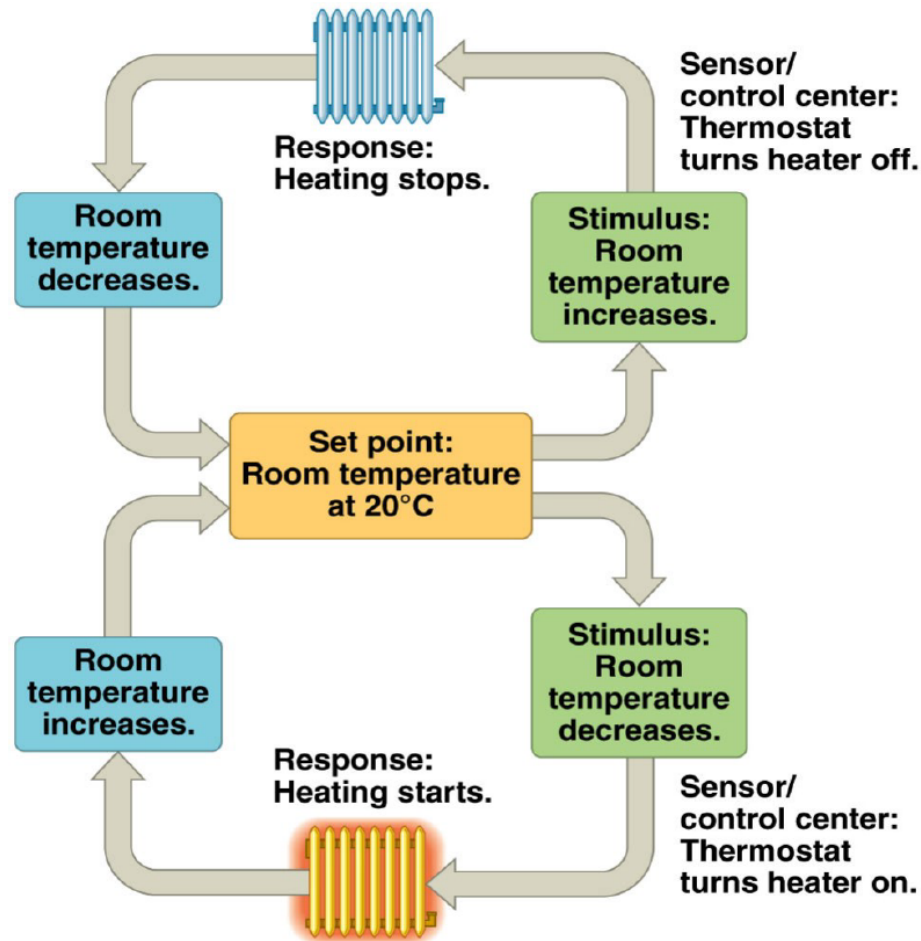
# *In order for the cell to function properly,*

*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)

# The Thermostat Analogy



© 2011 Pearson Education, Inc.

# Control system ( Teamwork 435)

---

## 1. Nervous system

- ▶ Controls the body activities that requires rapid responses (speed)
- ▶ Detects and initiates reactions to changes in external environment
- ▶ (sensory input ,central nervous system ,motor out put)
- ▶ e.g. regulation of blood pressure upon rising

## 2. Endocrine system

- ▶ Regulates the activities that requires duration.
- ▶ Endocrine gland , Pancreas, thyroid
- ▶ e.g. parathyroid hormone regulating calcium levels, insulin control glucose level.



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

### Concentrations of Extracellular and Intracellular Electrolytes in Adults

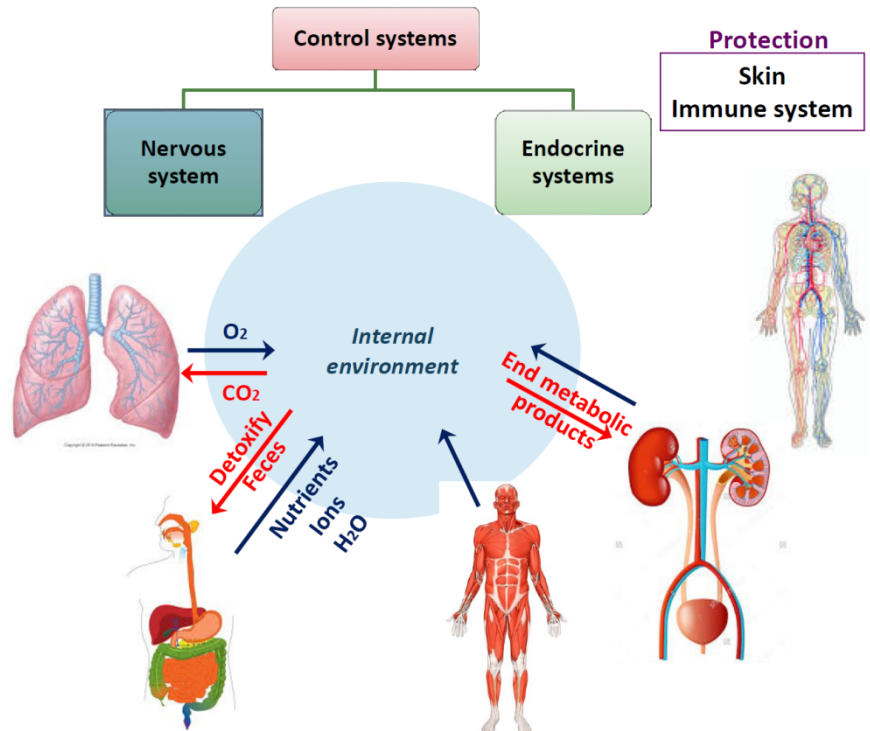
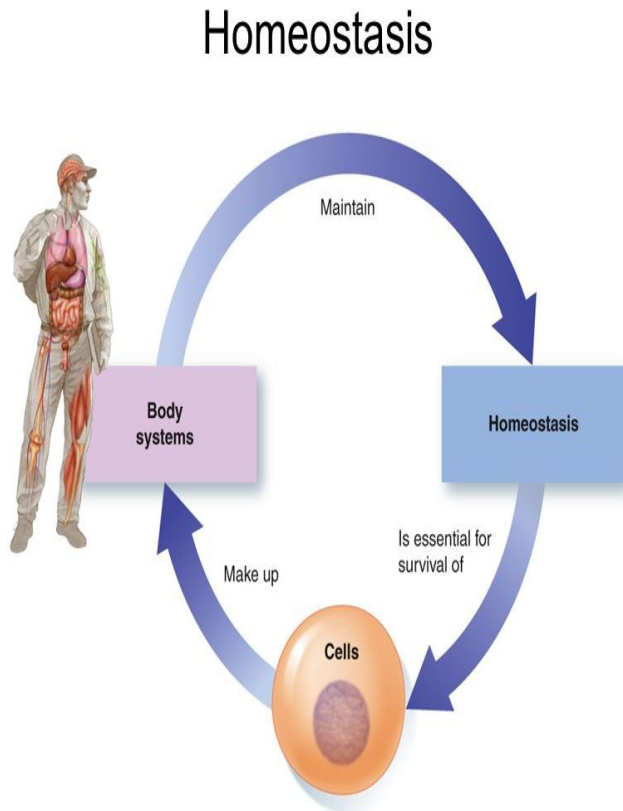
Electrolyte	Extracellular Concentration*	Intracellular Concentration*
Sodium	135–148 mEq/L	10–14 mEq/L
Potassium	3.5–5.0 mEq/L	140–150 mEq/L
Chloride	98–106 mEq/L	3–4 mEq/L
Bicarbonate	24–31 mEq/L	7–10 mEq/L
Calcium	8.5–10.5 mg/dl	< 1 mEq/L
Phosphate/ phosphorus	2.5–4.5 mg/dl	4 mEq/kg <sup>+</sup>
Magnesium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

\*Values may vary among laboratories, depending on the method of analysis used.

<sup>+</sup>Values vary among various tissues and with nutritional status.

Mentioned previously in lecture 3: Body Fluids.

# Important Diagrams

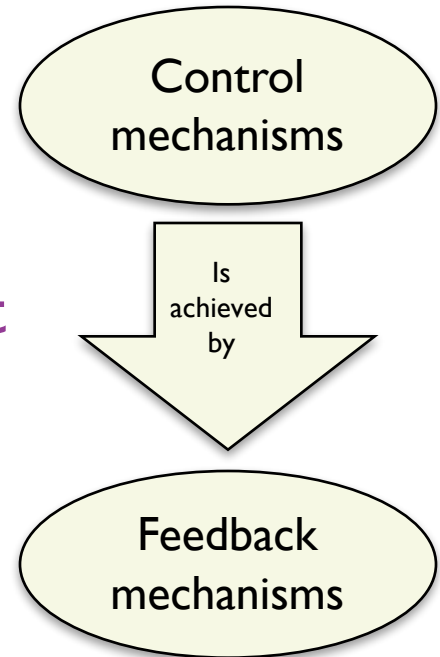




# Homeostatic control mechanisms

---

- ▶ The body maintains homeostasis by **using homeostatic control system**
- ▶ The body has thousand of control systems
- ▶ They function to restore balance when it lost
- ▶ Control systems operate:
  - **Within the organ** itself
  - Throughout the body to control **interrelation between organs**



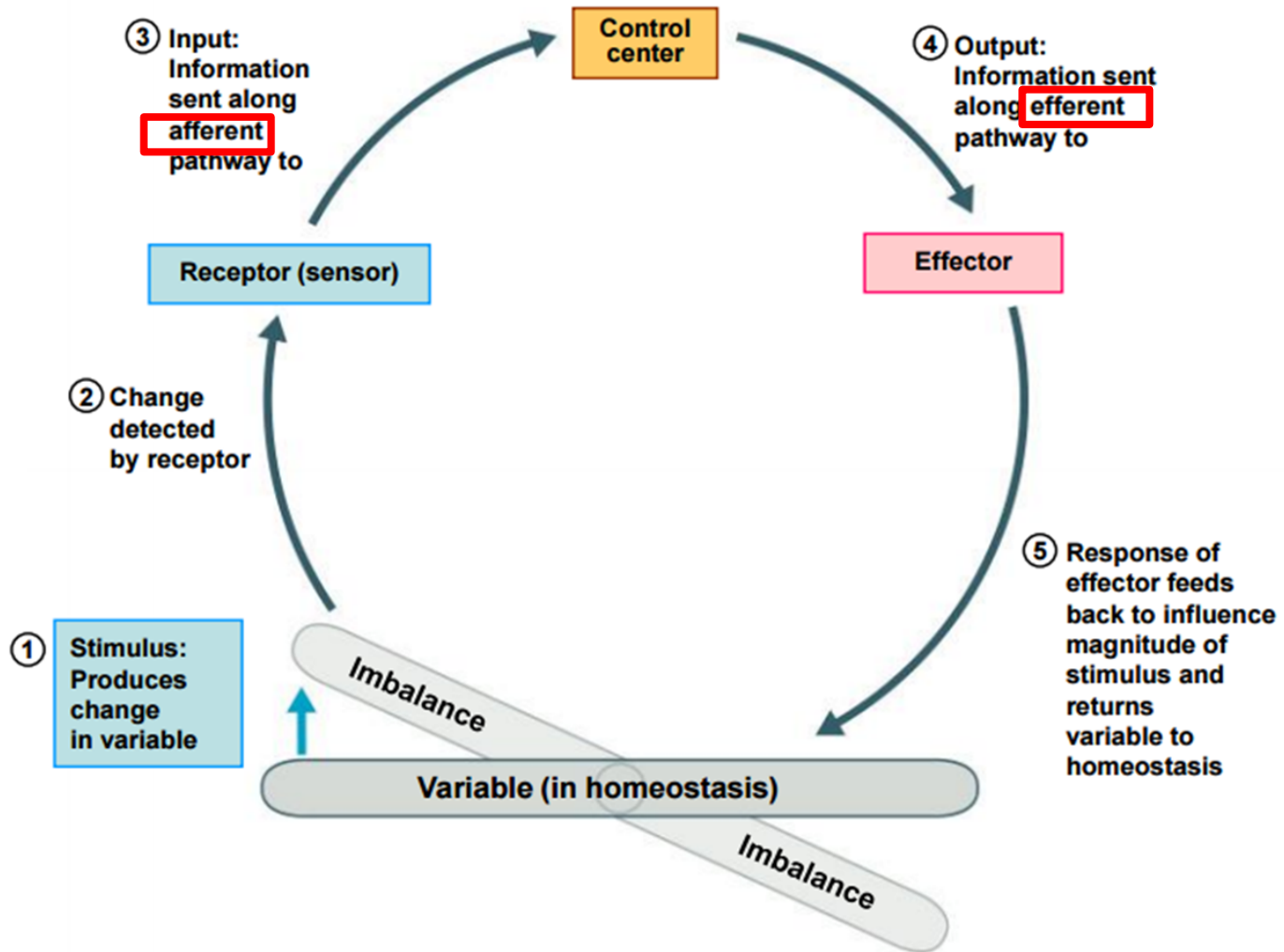
# Control Mechanism Component ( Team work 345 )

- **Three** independent components of control mechanisms :

Receptor	Control center	Effector
Monitor the environments and responds to changes (stimuli)	Determine the set point at which the variable is maintained	Provide the means to respond to the stimulus
الكشف عن التغيير بواسطة مستقبلات	تحديد القيم التي يعود بها الجسم لحالته الطبيعية	تستجيب للمؤثرات لهذه القيم لتعود للحالة الطبيعية

# Homeostatic Control Mechanisms

---



# Feedback mechanisms

Feedback mechanisms mean :

Loop system in which the system responds to changes

## Positive feedback

- Resulting action on the same direction of the stimulus
- If stimulus increases ,homeostasis control system activated to cause increase in the stimulus

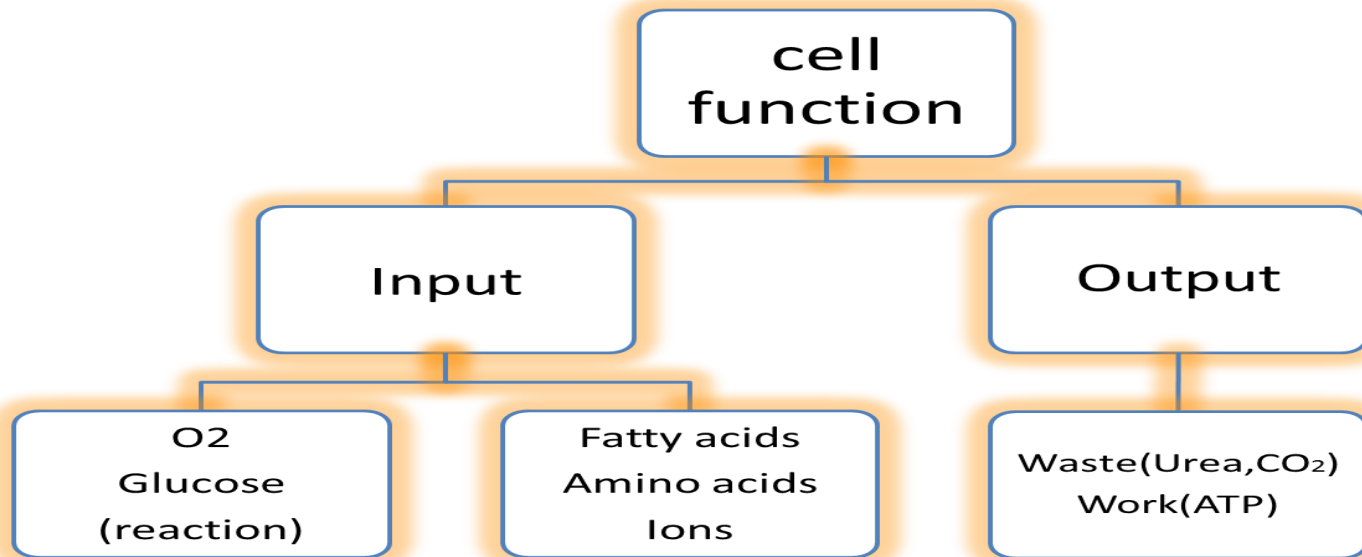
## Negative feedback

- original stimulus reversed (resulting action in the opposite direction of stimulus)
- most feedback system in the body are negative
- If stimulus increases, homeostatic control system activated to cause a decrease in the stimulus and vice versa.

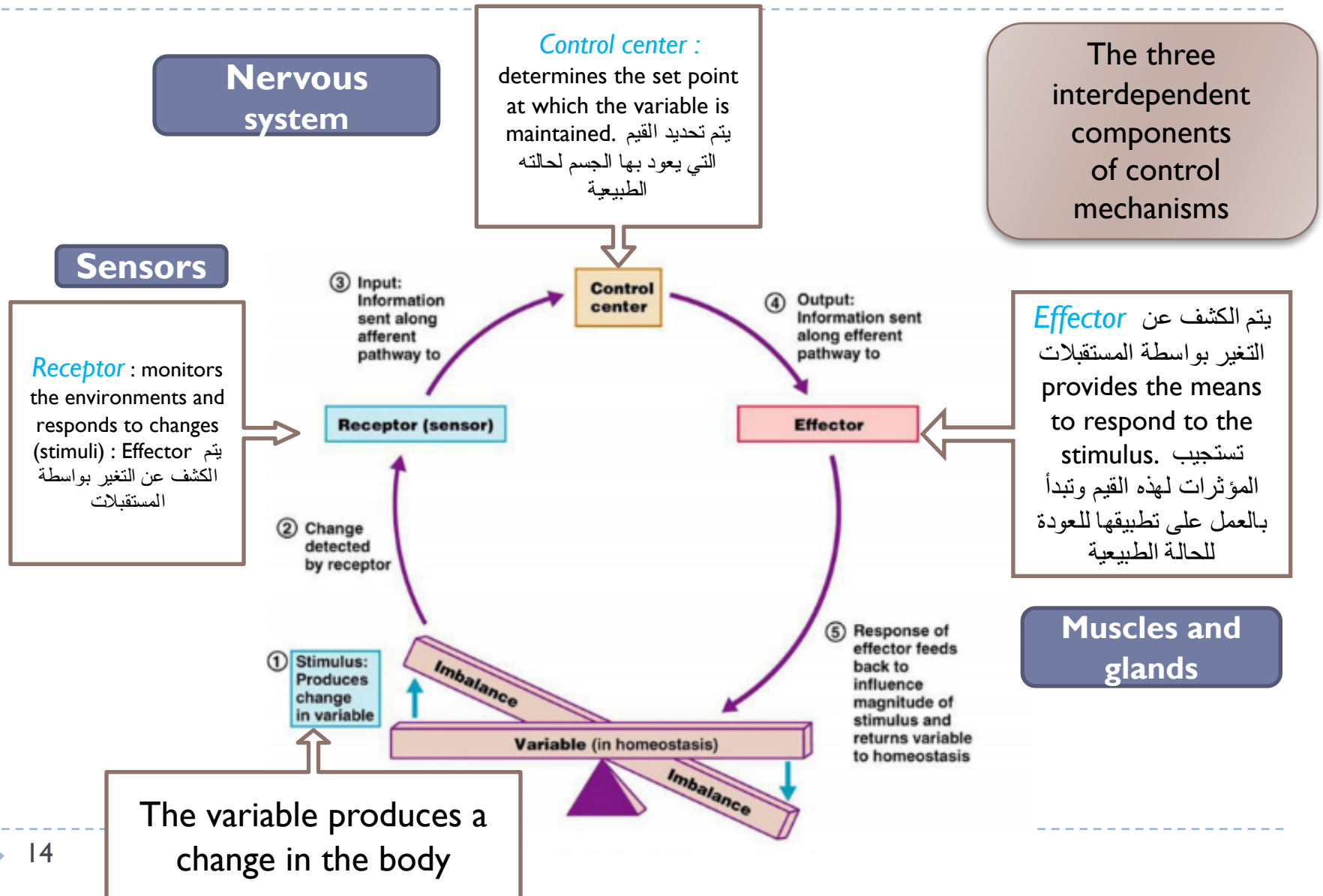
# The Internal environment

---

- ▶ the internal environment of the body is the extracellular fluid and all body cells live in this environment
- ▶ It separated from the external environment by the skin
- ▶ The internal environment must be kept constant in the face of an ever changing external environment.



# What are the components of a feedback mechanism?





# Type of feedback mechanisms (Girls' slides & teamwork435)

## Feedback

### Negative feedback

- The effector response of the system is in the **opposite direction** to stimulus that initiated the response.
- **Most** of the control systems of the body act by **negative feedback**.

### Positive feedback

- The effector response of the system is in the **same direction** to stimulus that initiated the response.
- Only few systems display positive feedback.

High temperature

Make temperature **LOWER**

Make temperature **HIGHER**

مثال  
لتوصيل  
الفكره  
فقط.

## 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 والعكس صحيح

Ex) **A high level of in CO<sub>2</sub>** in the ECF will increase pulmonary ventilation, increasing the amount of CO<sub>2</sub> expired which will **bring the level of CO<sub>2</sub> in ECF down.**

\*ECF= Extra Cellular Fluid

<https://youtu.be/SRgHeHQ9ud0'4> الشرح من دقيقة

- Other examples of negative feedback:
  - ✓ withdrawal reflex in response to injury.
  - ✓ changing breathing rate in response to increased carbon dioxide.
  - ✓ parathyroid hormone release in response to decreased calcium.

## Positive Feedback

Not common. **WHY?**

- يزيد التأثير ( تزيد المشكلة غالباً).
- لا يساعد بالـ balance
- لا يحقق الـ homeostasis
- **Mostly causes vicious circle.**

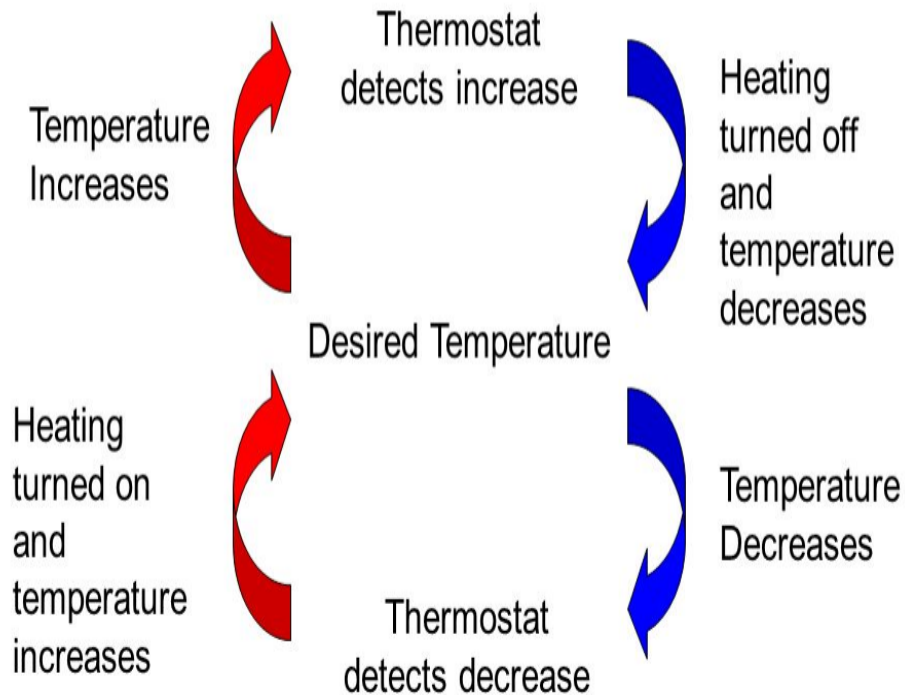
Ex) In nerve signaling, **entry of a small amount of Na<sup>+</sup>** into the cell will open more Na<sup>+</sup> channels **causing more Na<sup>+</sup> to enter the cell.**

- Other examples of positive feedback:
  - ✓ blood clotting cascade.
  - ✓ uterine contractions of labor.

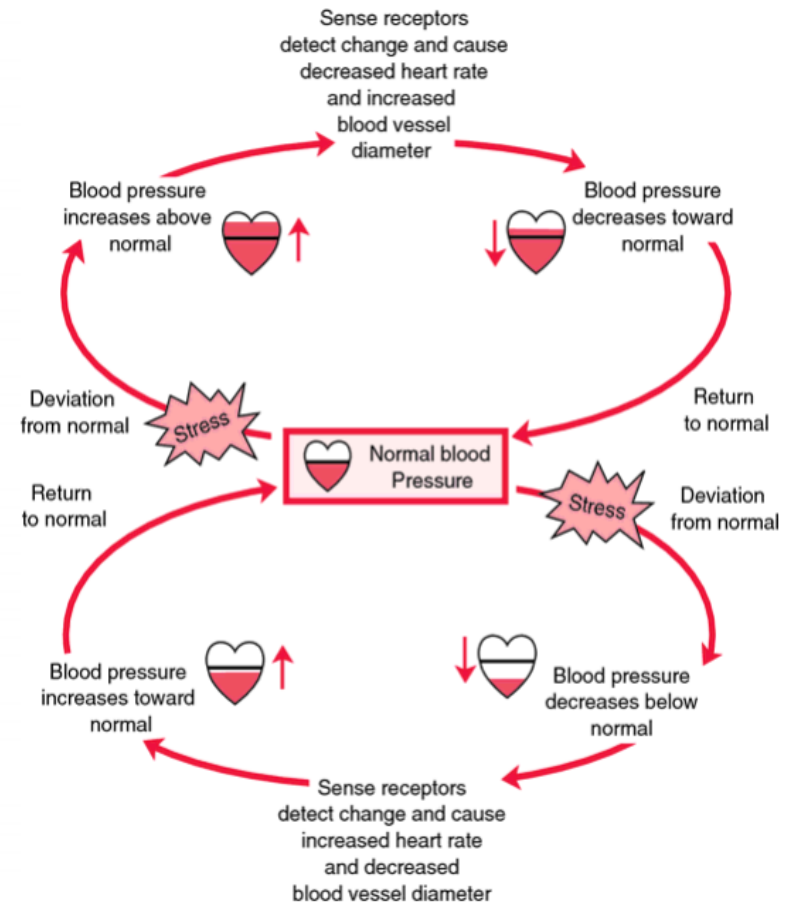
teamwork435

# Examples of Negative Feedback Mechanisms

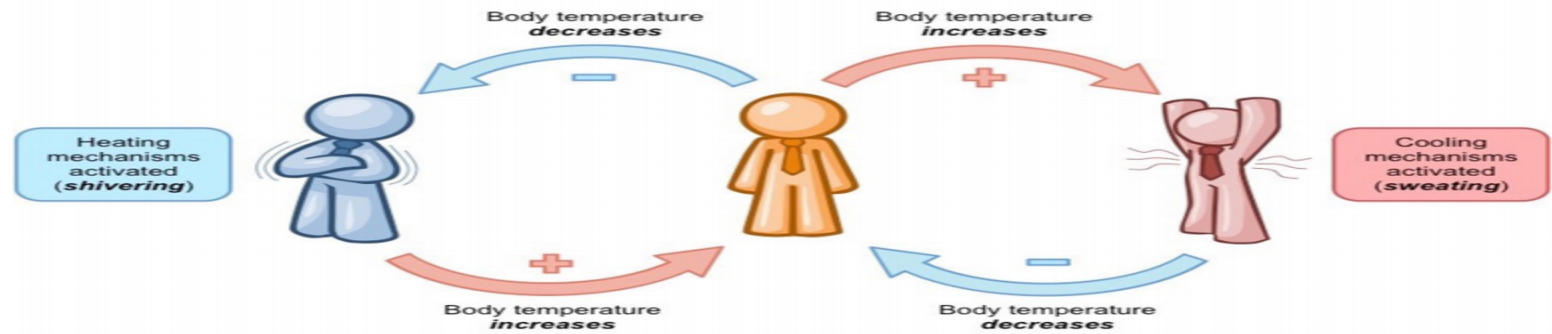
## Negative Feedback (thermostat analogy)



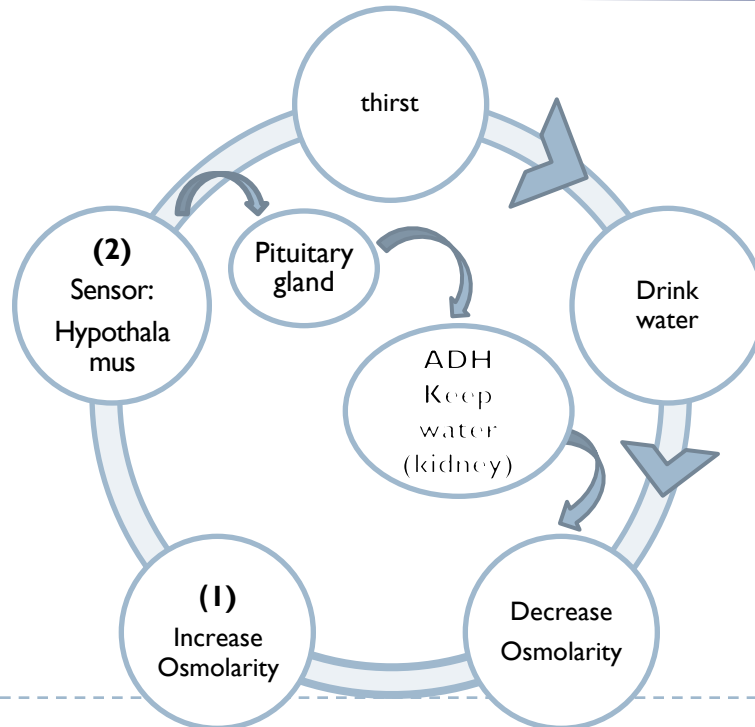
## Blood pressure control



# Examples of Negative Feedback Mechanisms



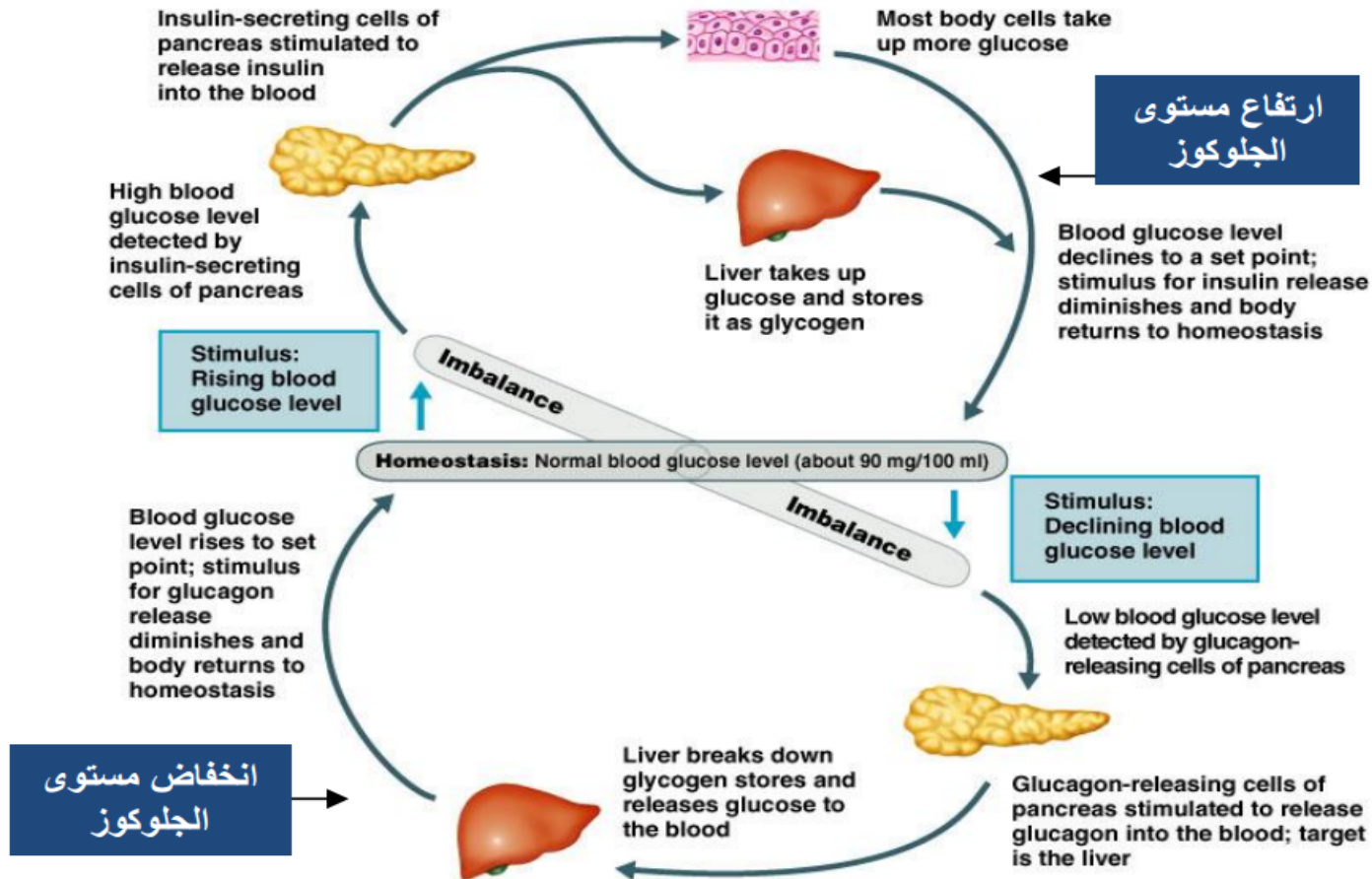
**Ate too much salty food**



مثال من  
الدكتورة

# Examples of Negative Feedback Mechanisms

(Note)

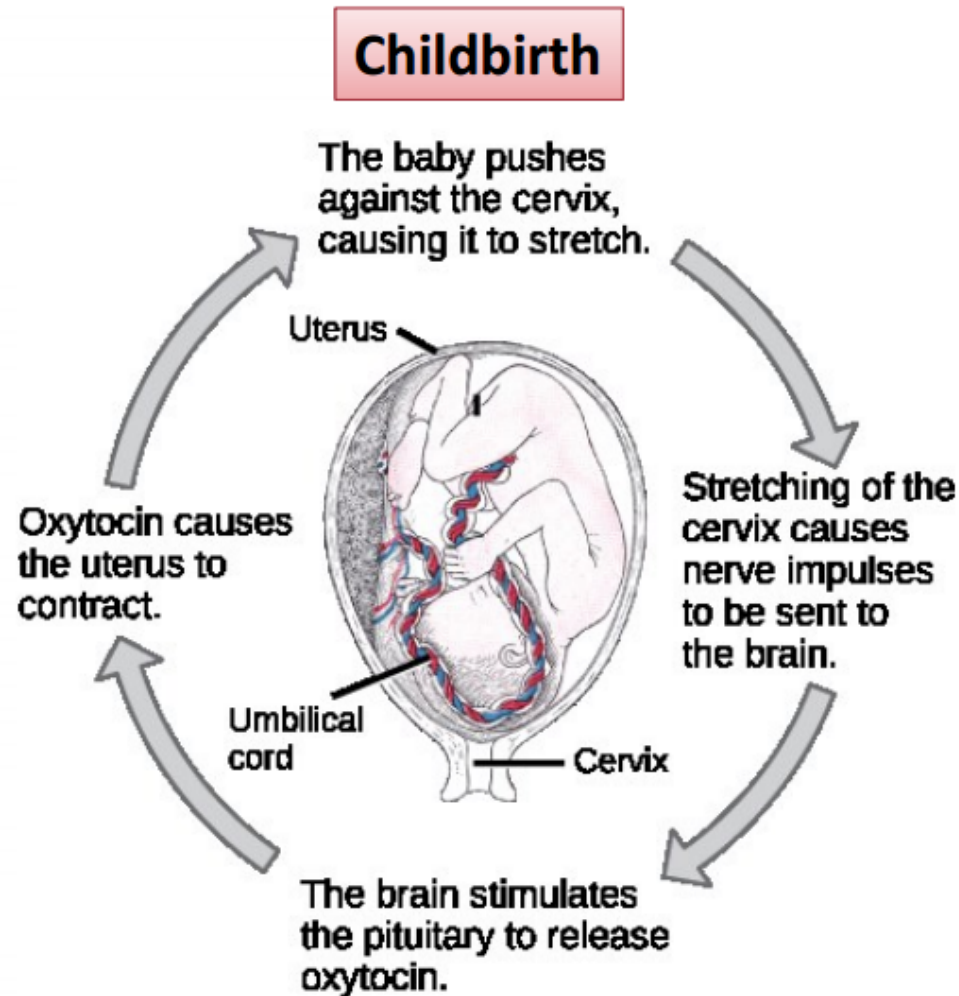


إذا ارتفع مستوى الجلوكوز في الدم سيتم فرز الانسولين من خاليا البنكرياس لإعادة مستوى الجلوكوز بالدم لحالته الطبيعية

إذا كان مستوى الجلوكوز في الدم منخفض سيتم تحويل الجلايكوجين إلى جلولوكوز بواسطة هرمون الجلوكاجون لإعادة مستوى الجلوكوز بالدم لحالته الطبيعية

# Examples of **Positive** Feedback Mechanisms

(note)



يكون فيه  
Contractions to  
push baby out  
لكن قليله, الى ان يصل  
رأس الطفل لعنق الرحم  
يحفز الدماغ الغده النخاميه  
لترسل هرمون الـ  
Oxytocin  
وبكذا تزيد الـ  
Contractions  
ويطلع البيبي.



# Homeostatic Imbalance

---

**Disturbance** of homeostasis or the body's normal equilibrium.



# Disease is a state of disturbed homeostasis

---

- **Successful compensation**

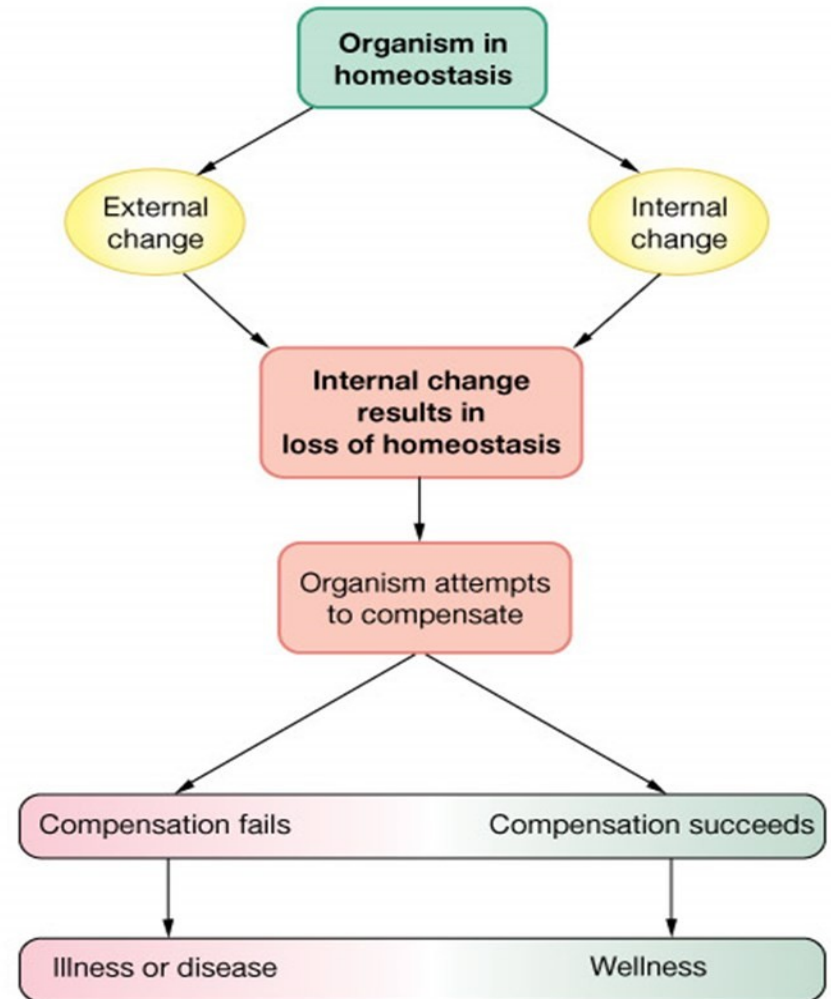
- ▶ **Homeostasis reestablished**

- **Failure to compensate**

- ▶ **Pathophysiology**

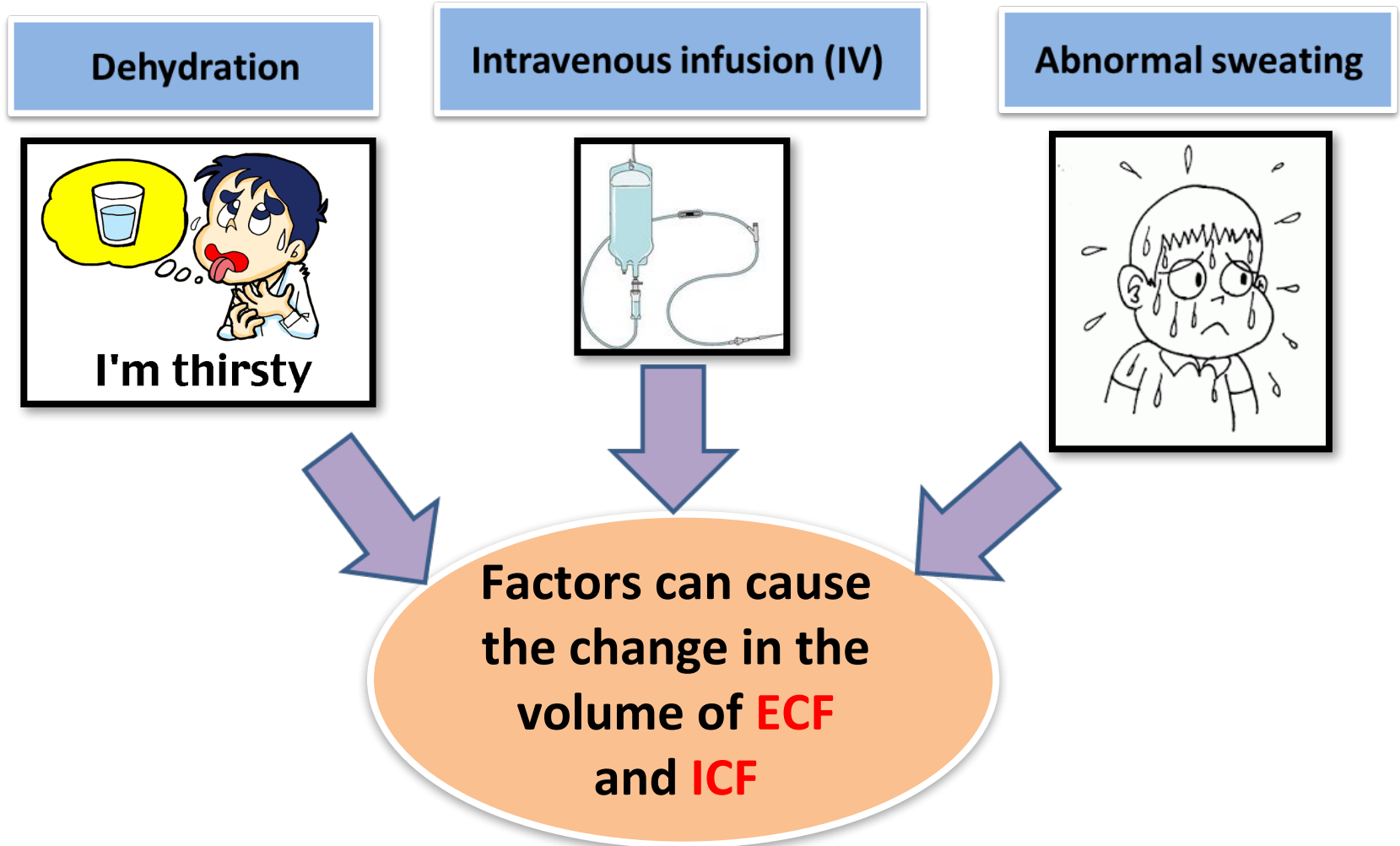
- **Illness**

- **Death**

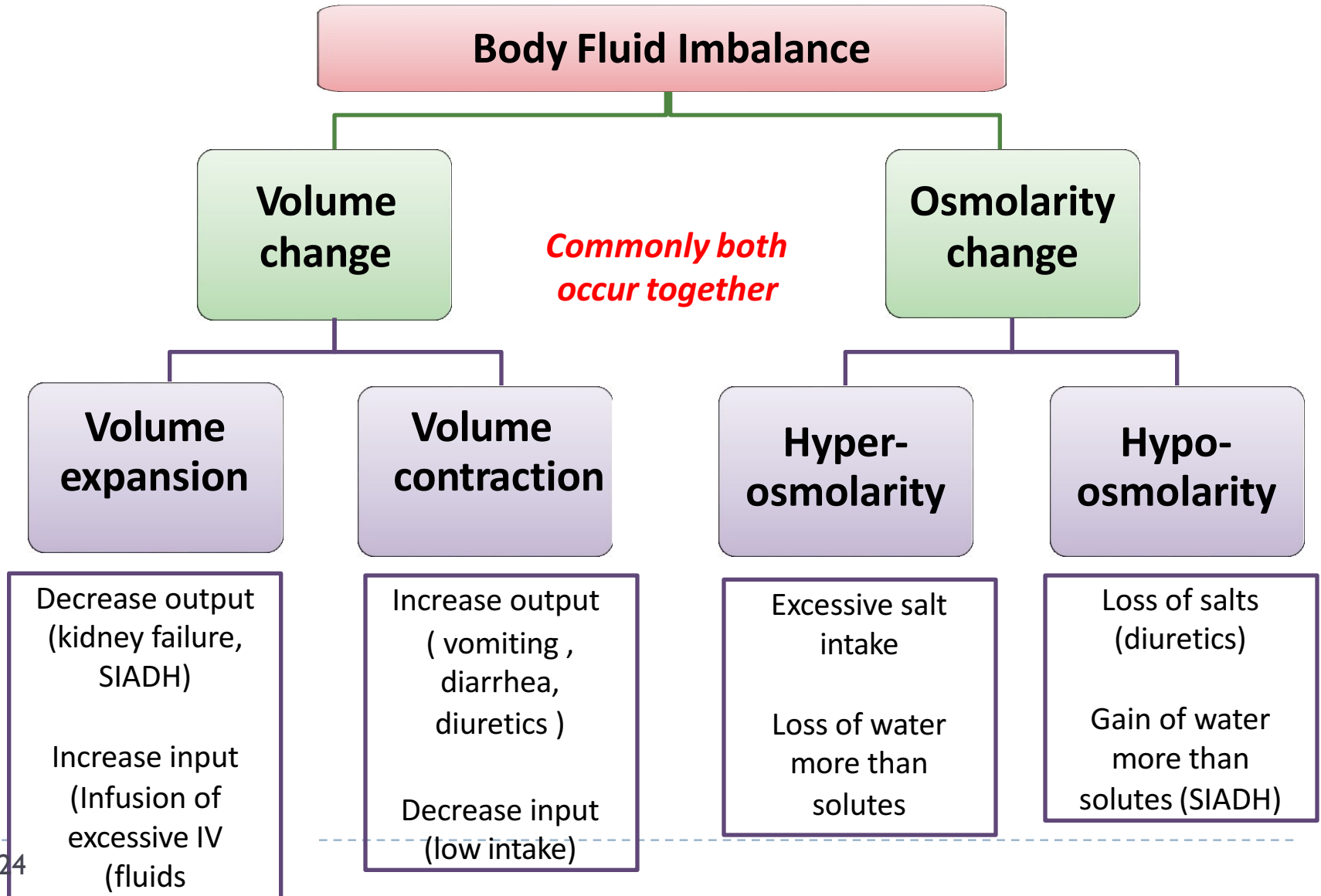


# Volumes and osmolarity of ECF and ICF in abnormal state

---



# Body Fluid Imbalance



# Disturbances in Fluid Balance

## Water/fluid intake

- ▶ Intake is variable
- ▶ Depends on:
  - ▶ Climate
  - ▶ Habits
  - ▶ Physical activity.



## Water/fluid output

- ▶ Burns
- ▶ Exercise
- ▶ Hot weather.
- ▶ Diarrhea
- ▶ Vomiting
- ▶ Blood loss
- ▶ Diabetes

# Volume contraction (Decrease in the ECF volume )

## 1. Diarrhea:

2. Osmolarity of fluid lost  $\approx$  Osmolarity of ECF (loss of isosmotic fluid).

-  volume in **ECF**.
-  arterial pressure.

## 2. Water deprivation:

- Water and NaCl


-  Osmolarity in both **ECF** and **ICF**


-  Volume in both **ECF** and **ICF**

- **Hyposmotic** fluid ( small NaCl large water )

## 3. Adrenal insufficiency:

- Aldosterone deficiency.

-  Na in the **ECF**.

-  Osmolarity in both .

-  in **ECF** volume.

-  in **ICF** volume.



# Volume Expansion

## 1. Infusion of isotonic NaCl .

- **↑** ECF volume.
- No change in osmolarity.
- Isotonic expansion .

## 2. High NaCl intake.

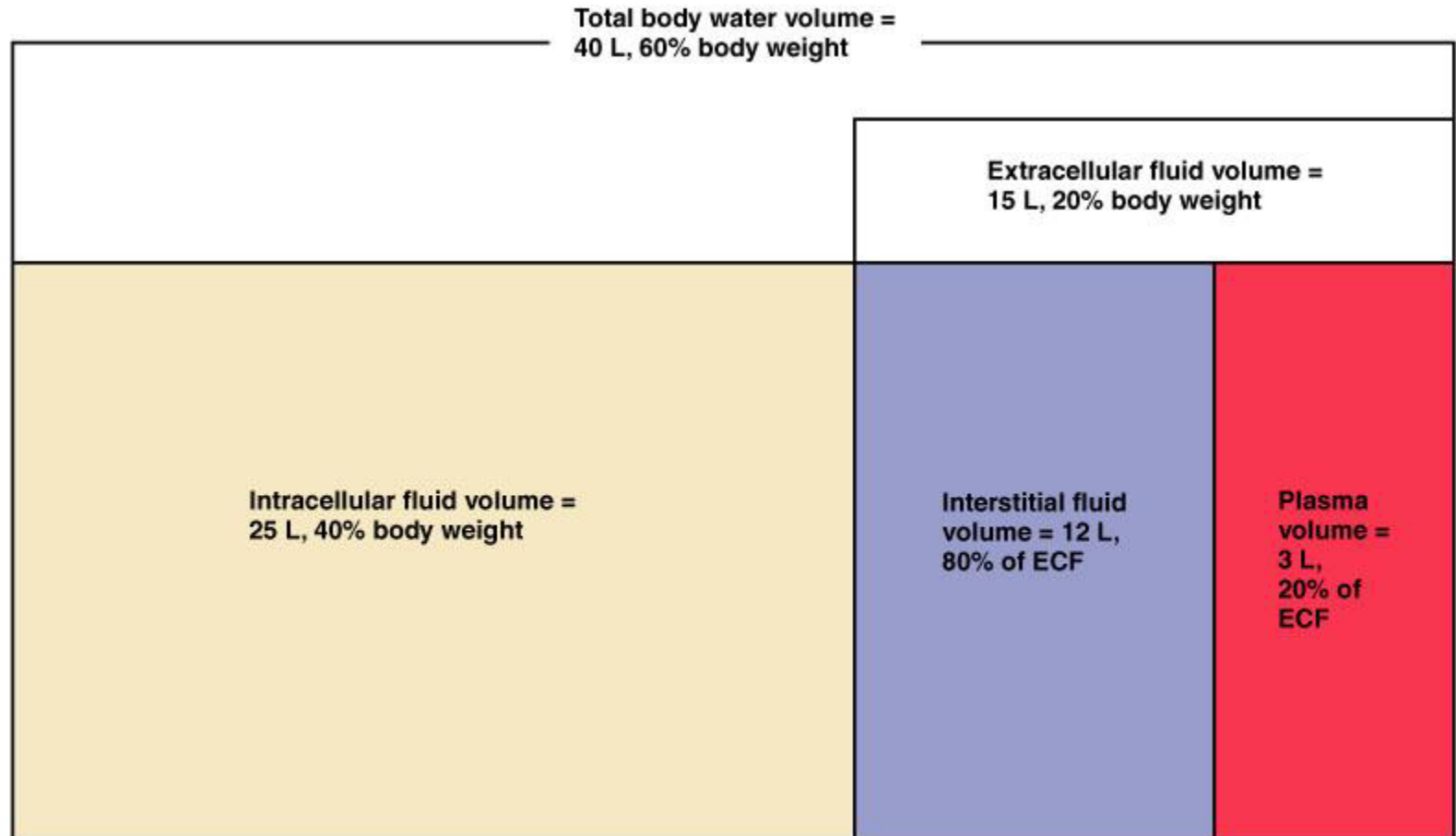
- **↑** eating salt.
- **↑** Osmolarity in both.
- **↓** volume of ICF .
- **↑** volume of ECF .
- hyperosmotic volume expansion.

## 3- Syndrome of inappropriate antidiuretic hormone (SIADH).

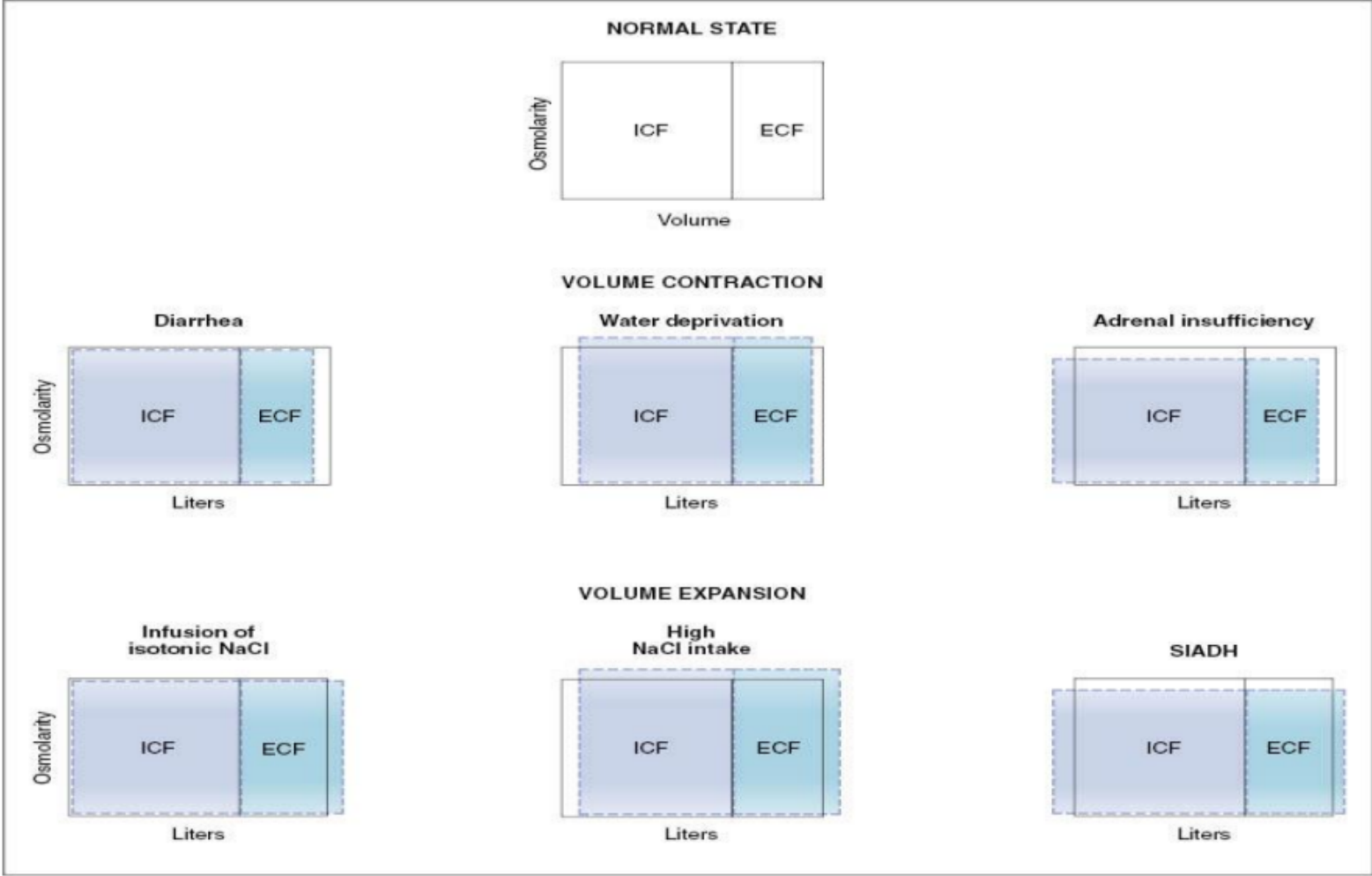
- **↑** Volume
- **↓** Osmolarity

# Body Fluid Volume

---

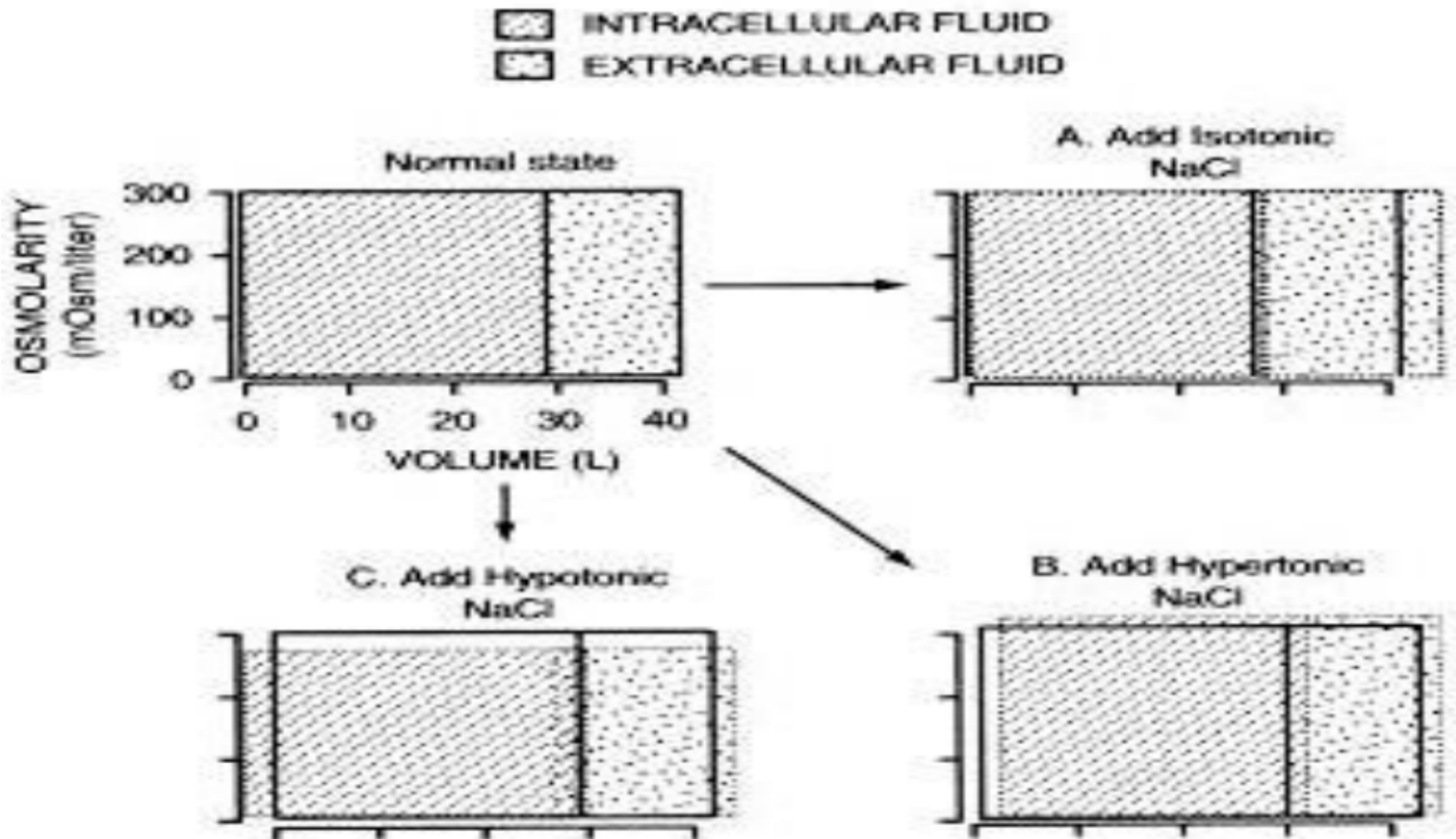


# (Girls' slides)



Copyright © 2010 by Saunders, an imprint of Elsevier Inc. All rights reserved.

# Effect of adding saline solution to the ECF



# Revision (teamwork 345)

		ECF		ICF	
		Volume	Osmolarity	Volume	Osmolarity
Volume contraction (Removing)	Isotonic solution (Diarrhea)	↓	-	-	-
	Hypotonic solution (Dehydration)	↓	↑	↓	↑
	Hypertonic solution (Adrenal insufficiency)	↓	↓	↑	↓
Volume expansion (Adding)	Isotonic solution (Infusion of isotonic NaCl)	↑	-	-	-
	Hypotonic solution (SIADH)	↑	↓	↑	↓
	Hypertonic solution (High NaCl intake)	↑	↑	↓	↑

# Oedema (Edema)

## Oedema:

It is an **Excessive fluid in the body tissues.**

- Can be **Extracellular** or **Intracellular**.
- It occurs mainly in the **ECF** **compartments**.
- The common clinical cause is **Excessive capillary fluid filtration**.



# Types Of Oedema

## Intracellular Edema:

Inflammation of tissues

↑ Membrane permeability

Na inside cells

water

## Extracellular Edema:

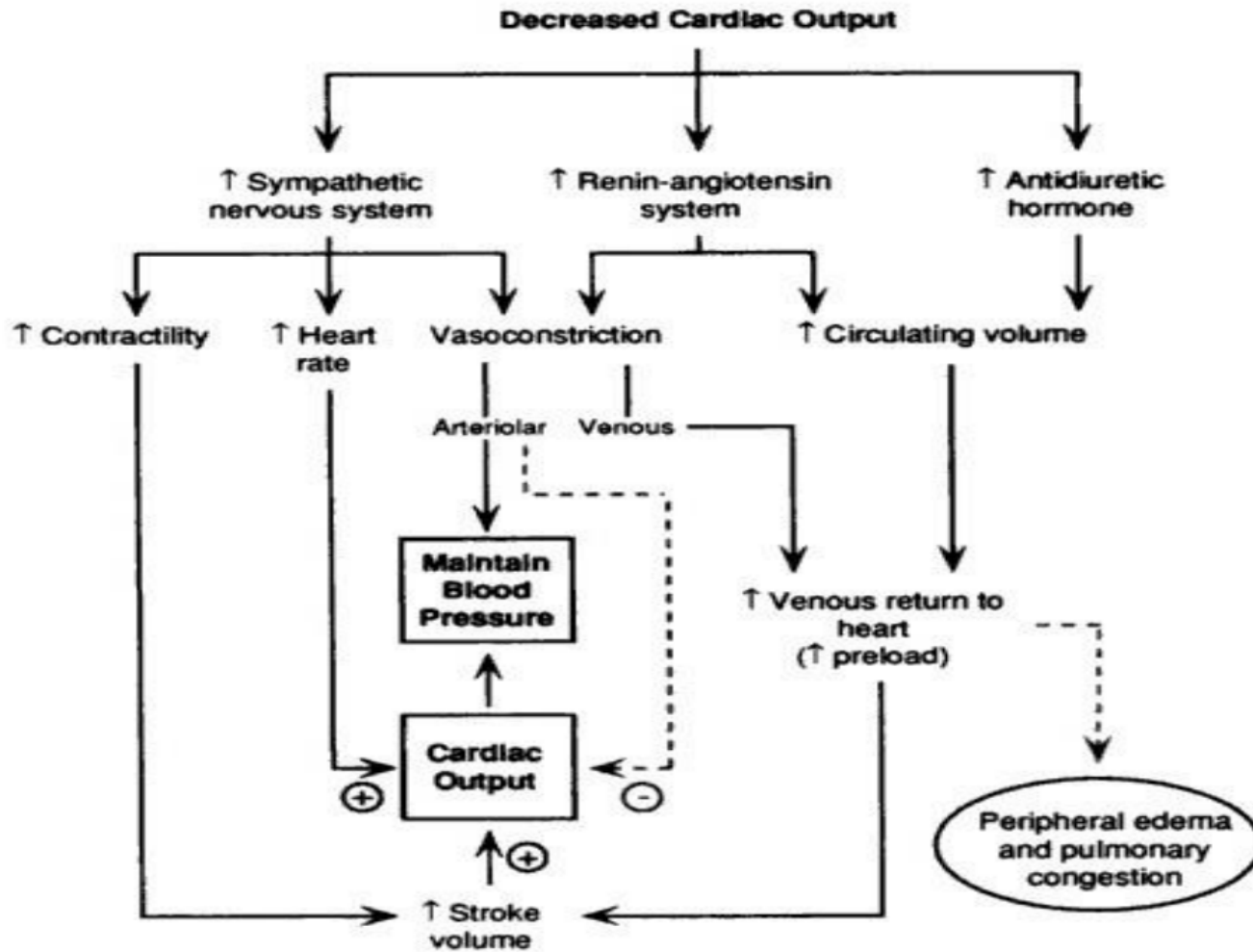
Heart failure

↑ capillary pressure

↑ filtration.

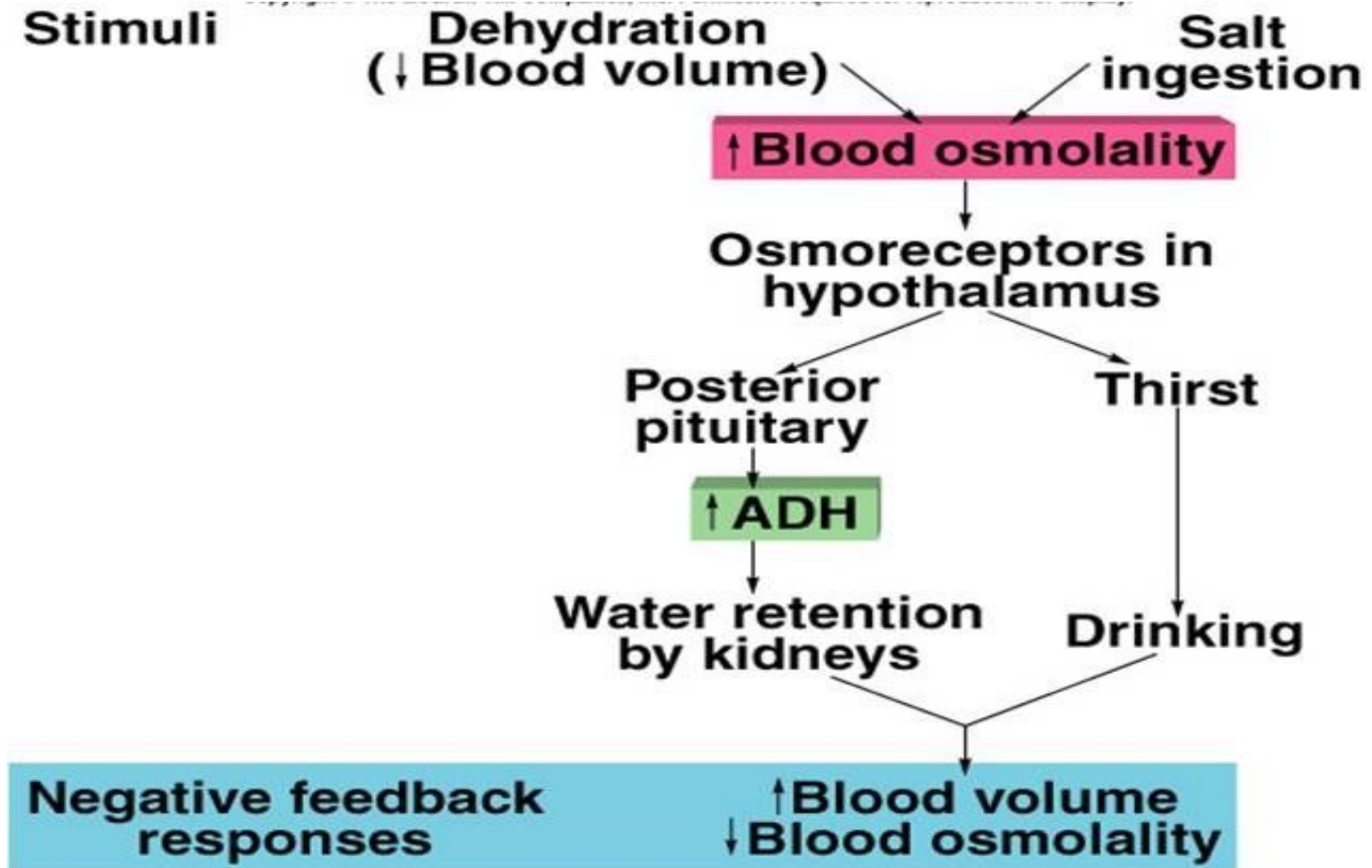
Oedema

# (Boys' slides)





# What are the feedback mechanisms operating in Fluid balance control?



# Videos

---

- Homeostatic Control Mechanisms : <https://youtu.be/kCWCuztwlkk>
- Homeostasis Positive Feedback Control of Labor Pregnancy:  
<https://www.youtube.com/watch?v=heVWOEkjutHc>
- Homeostasis and Feedback Mechanism:  
[https://m.youtube.com/watch?v=\\_obgJ2zc3ZU](https://m.youtube.com/watch?v=_obgJ2zc3ZU)



# Thank you!

---

اعمل لترسم بسمة، اعمل لتمسح دمة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

## The Physiology 436 Team:

Lina Alwakeel

Dina Aldossary

Rana Barassain

Heba Alnasser

Munira Aldofayan

Sara Alshamrani

Sundus Alhawamda

Ruba Ali

Rehab Alanazi

Norah Alshabib

Nouf Alaqeeli

Buthaina Almajed

Fahad Al Fayez

Ibrahim Al Deeri

Hassan Al Shammari

Abdullah Al Otaibi

Abdullah Al Subhi

Ali Al Subaei

Omar Al Babteen

Foad Fathi

Faisal Al Fawaz

Muhammad Al Aayed

Muhammad Al Mutlaq

Nasser Abu Dujeen

Waleed Al Asqah

### Team Leaders:

Qaiss Almuhaideb

Lulwah Alshiha

### Contact us:

[Physiology436@gmail.com](mailto:Physiology436@gmail.com)

@Physiology436