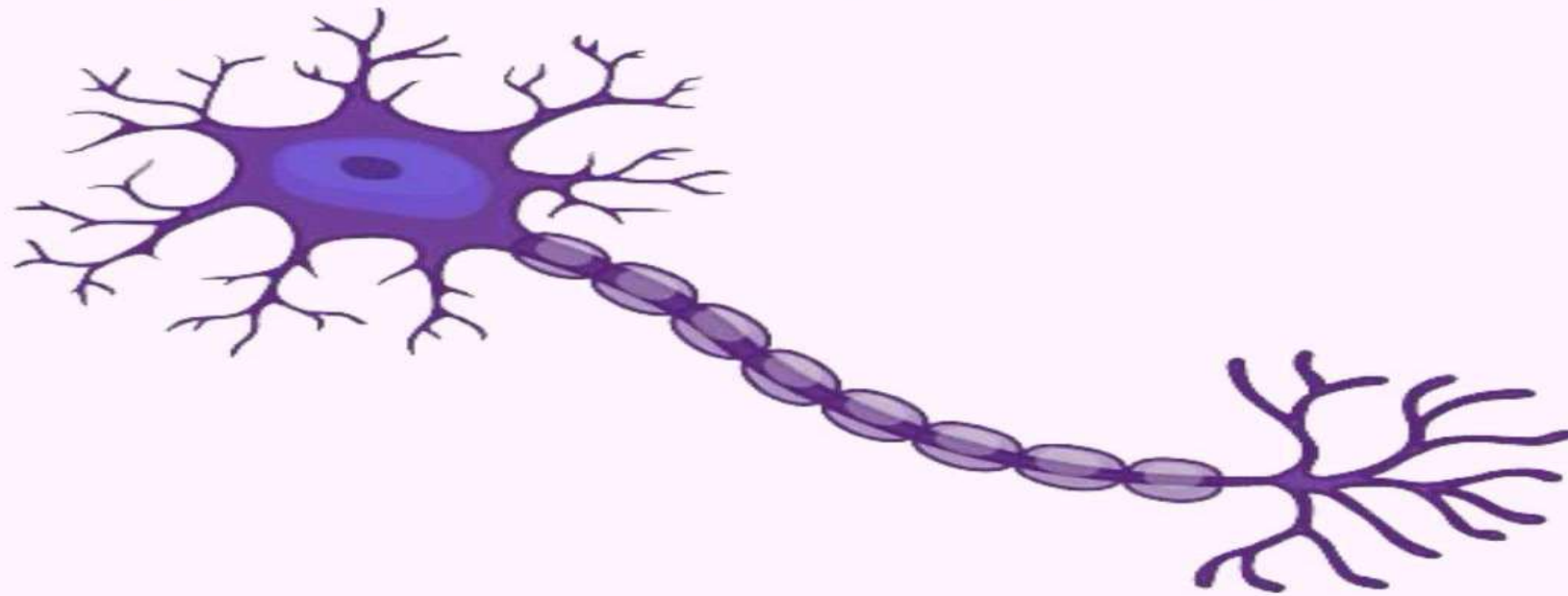




PHYSIOLOGY



LEC NO. : 1
DONE BY : Nour Al-amoush.

وَقُلْ رَبِّ زِدْنِي عِلْمًا

Introduction to Physiology

**Course: Human Physiology
Dentistry**

Lecture No. 1

- 1. Levels of organization in the body**
 - 2. Levels of Homeostasis and body fluids**
- Prepared by: Prof. Said Khatib

Presented by: Prof. Said Y Khatib
sykhatib@just.edu.jo

What is Anatomy?

دراسة أجزاء الجسم وكيف ترتبط العلاقات بينهم .

The study of body structures and the relationships among them

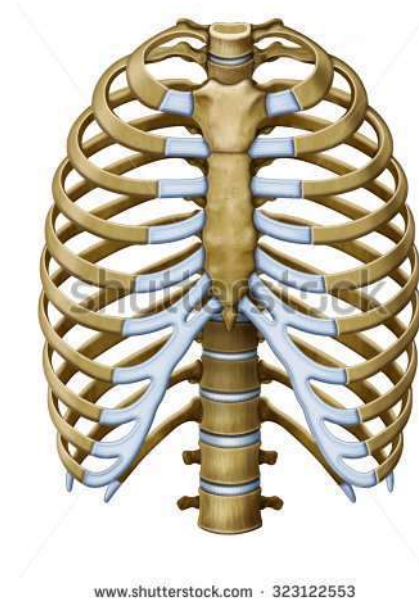
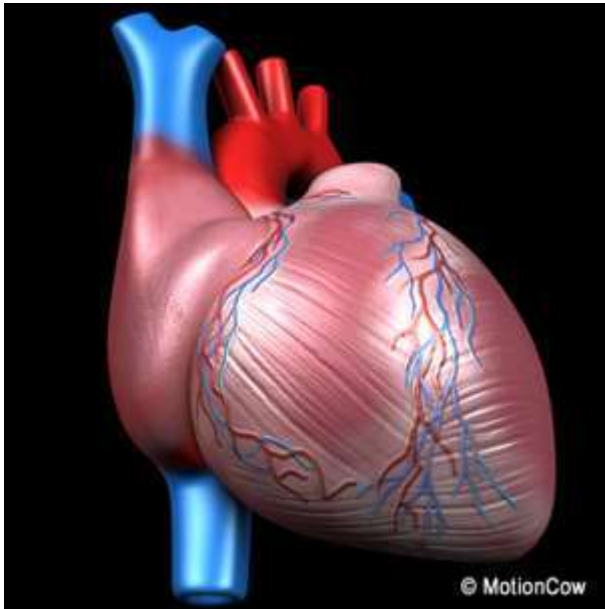
What is Physiology?

دراسة وظائف الأعضاء .

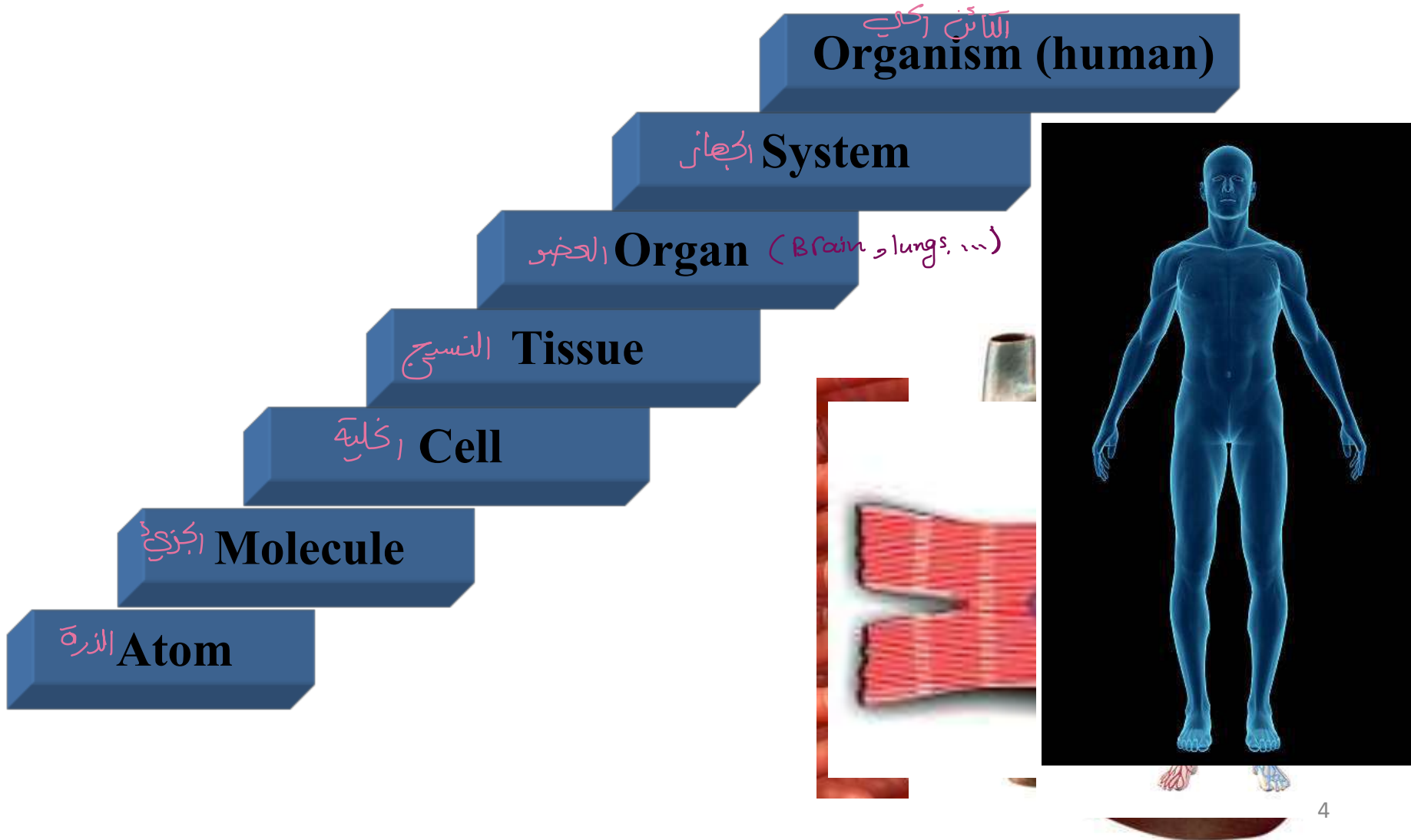
The study of body ^{وظيفة} functions

Structure-Function Relationship

Physiological mechanisms are possible through structural design



Levels of Organization in the Human Body



Cell

❑ **The basic unit of structure and function in the human body**

whatever control the system we have, we have to maintain the cell alive, so that tissues + organs. so the origin → How to keep the cell normal in shape + function

❑ **The smallest unit capable of carrying out the processes associated with life**

كل الخلايا في حياتنا، موجودة في الخلية.

→ what are the main rules which are normally carried out on the cell?
→ metabolic processes that use carbohydrates, proteins and fat for energy, and the cell produce the enzymes we need for metabolic activity.



The amoeba above is made of only one cell and it must perform all the jobs of the organism



Sponge is multicellular, all cells are similar

Cell, basic unit of life

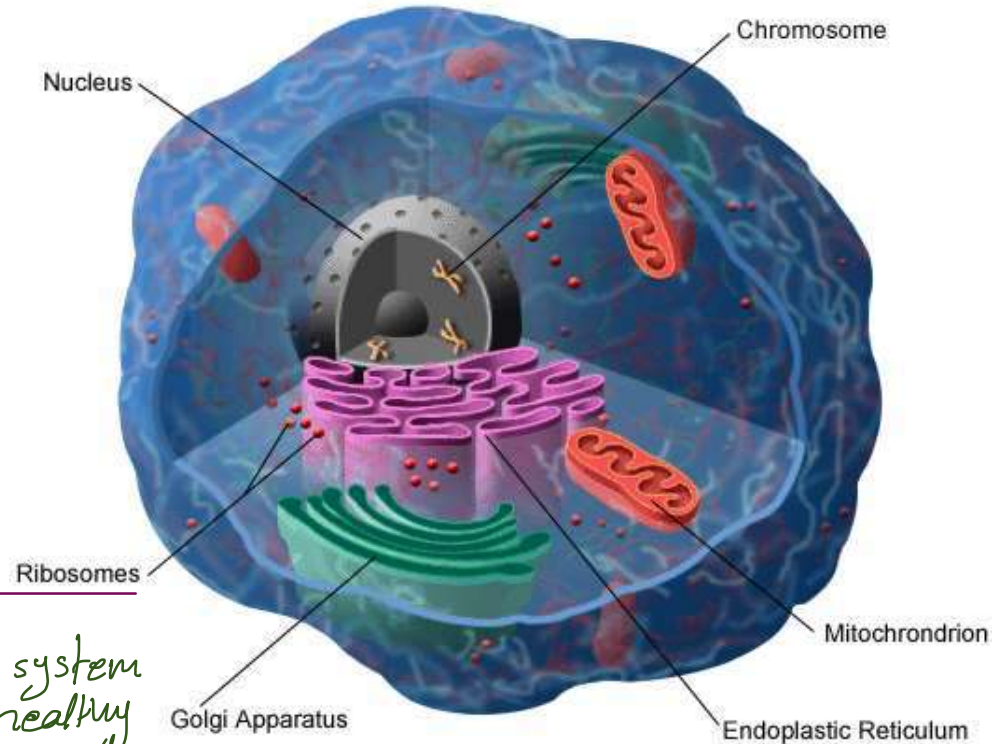
Cell functions:

1- Basic

2- Specialized

Basic cell functions:

- obtain food & O₂
- perform chemical reactions
- eliminate CO₂ & wastes
- synthesize proteins & cell components which are mostly enzymes



The cell is healthy + normal → The organ is healthy + normal → The system is healthy + normal

كيف تحلل بيانك سؤال ليس بقينا الأمراين في

يلى هو من سوء الاستنام كيمنا ، احنا نسبنا اكلية (رضا بطل healthy + normal) و حواته mechanisms غير طبيعية ، سواء من الخذاذ أو الأستحة أو غيرها.

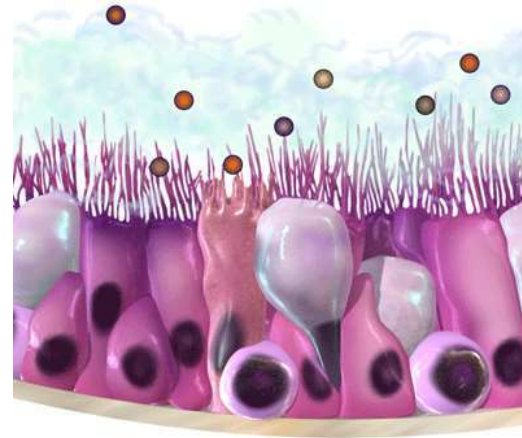
النسيج Tissue → عبارة عن cells يأتي أحياناً في منها أشكال.

- **Groups of cells of similar structure & specialized functions**
- **4 primary tissue types**

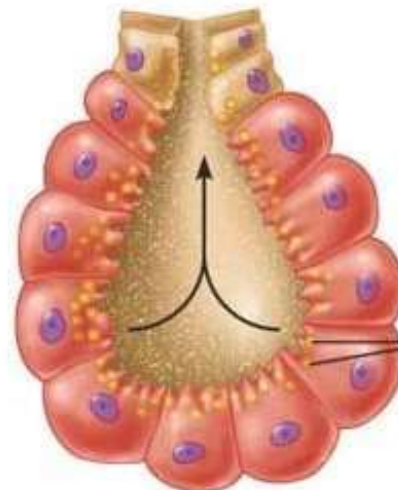
Tissue

علیٰ اُھداب
Epithelial

**Cells specialized for
exchanging materials between
cell & environment**



Sheets
Skin, digestive tract lining
بسطریہ کے

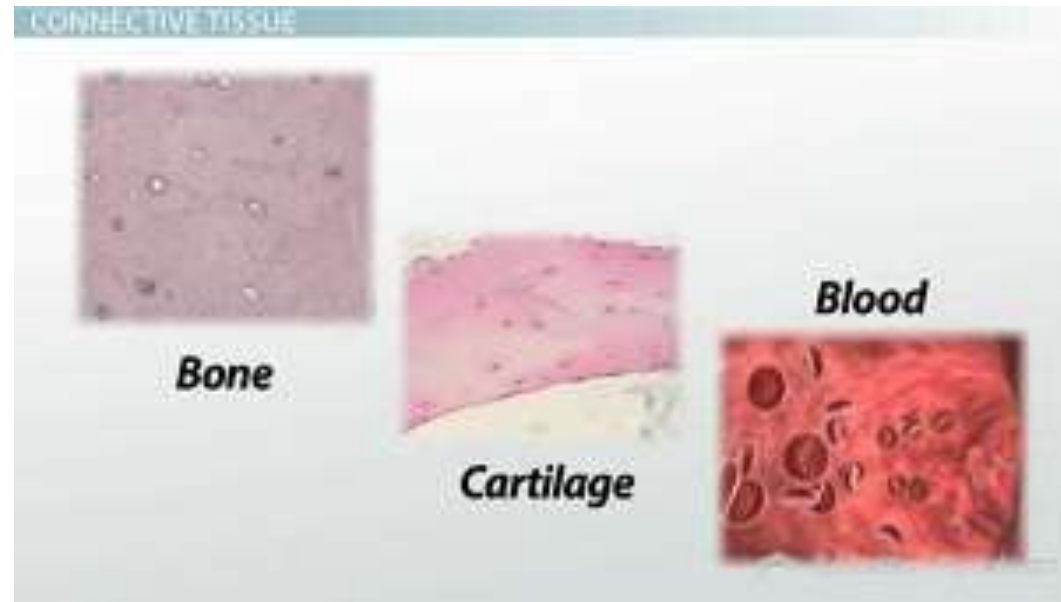


glands

Tissue

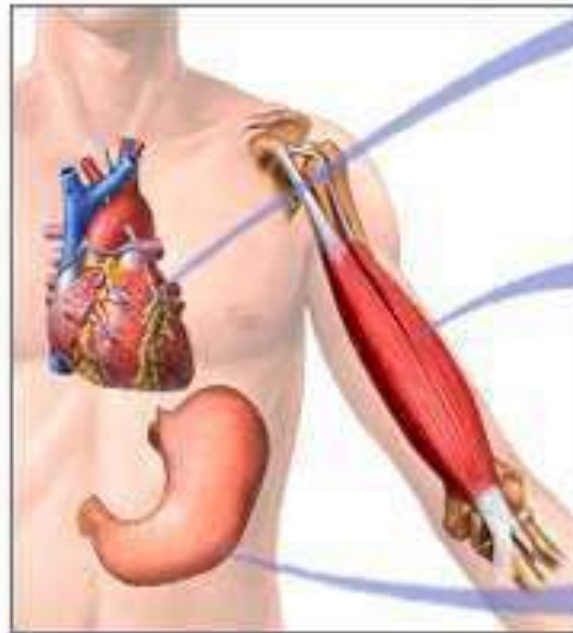
Connective

Few cells within abundant
extracellular material
Supporting/anchoring various
body parts



Tissue

Muscle

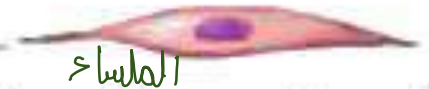


في القلب

① Cardiac muscle cell



② Skeletal muscle cell



الملساء

③ Smooth muscle cell

Tissue

Nervous

- Totally different in shape + function.
- doing all the metabolic processes.

Initiating & transmitting electrical impulses

→ we have this type of cells in the kidneys and the stomach and they adapted to do all the metabolic activity in these cells to maintain the organs healthy + normal

→ we have different type of cells, but they all perform the same metabolic activity, and they are different in the enzymes they produce.

له ينفذ الإنزيمات يلي بالحد من جزوي تكون نفسها بالتباين، وهكذا.
وكل عضو ينتج الإنزيم التي يتناسب مع وظيفته.



2 Hormones with different functions

← في بعض endocrine cells الغدد ينتج أكثر من هرمون، طيب كيف ال gland نفسها يتقدر تحطرين
← لأنه عندهم الإرتفاع اللازمة لإنتاج كل هرمون حسب حاجة الجسم واكسبم .

→ We all know that the human body has different systems and each system performs a specific function .
(all systems have been mentioned in anatomy slides)

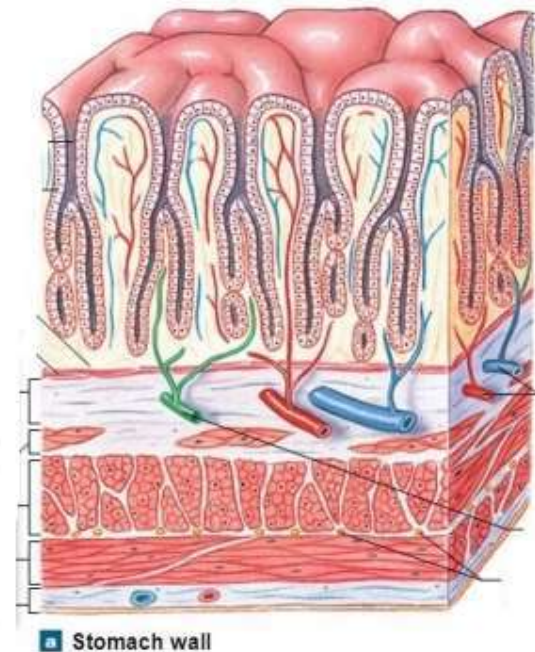
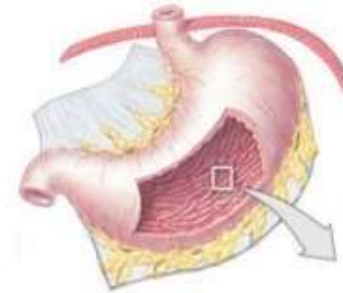
← لكن السؤال هل كل جهاز يعمل لوحده ؟ طبخاً ؟ عنا central nervous system
هو الذي ينظم وظيفة كل جهاز ، حتى مثل تنظيم عمل GI system
على central nervous system .

← لكن مثلاً function of the kidney تعتمد على cardiovascular system ، يعني لازم تكون في relationship بين أجهزة جسم الإنسان .

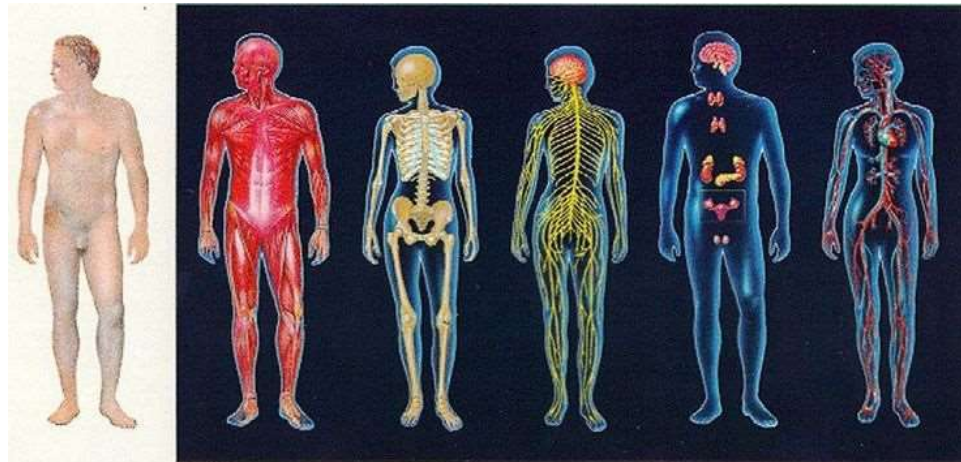
← عنا سؤال ، لما اجنا بنأكل الأكل ، هل هو موجود inside أو outside الجسم ؟ ح تكون outside ، لما يتم هضمه وامتصاصه بحسر . inside .

Organ, made up of several tissue types

- The inside surface of the stomach is lined with epithelial tissue
- The wall of the stomach contains smooth muscle
- Nerve tissue in the stomach controls muscle contraction
انقباضه والحركات
- These tissues are bound together by connective tissue



Body system, a group of related organs



Integumentary System

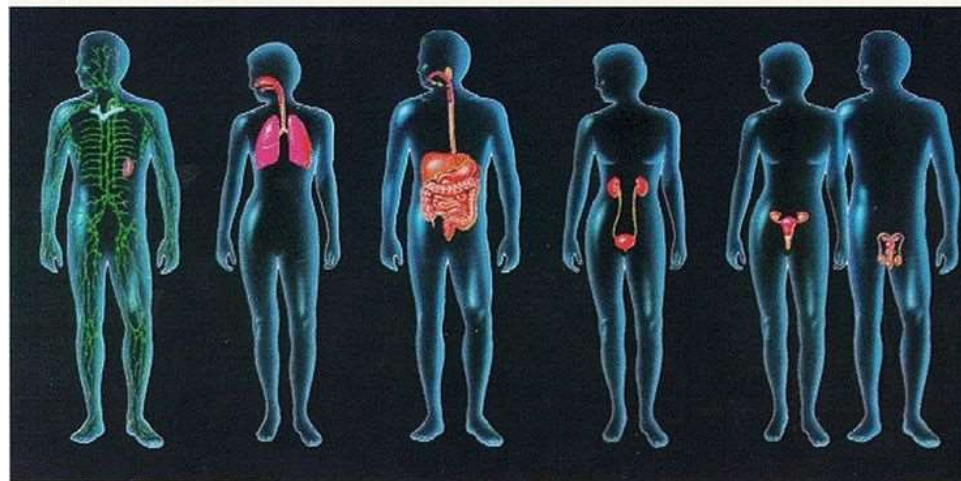
Muscular System

Skeletal System

Nervous System

Endocrine System

Circulatory System



Lymphatic System

Respiratory System

Digestive System

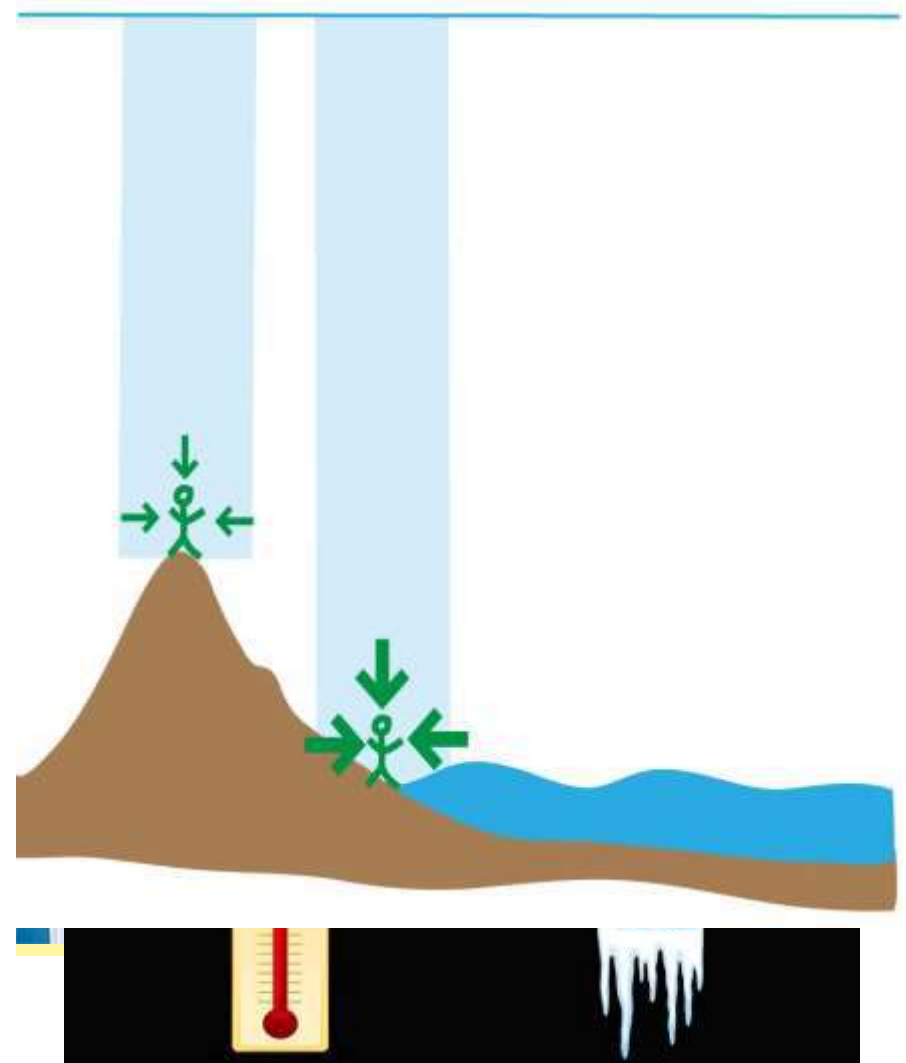
Urinary System

Reproductive System

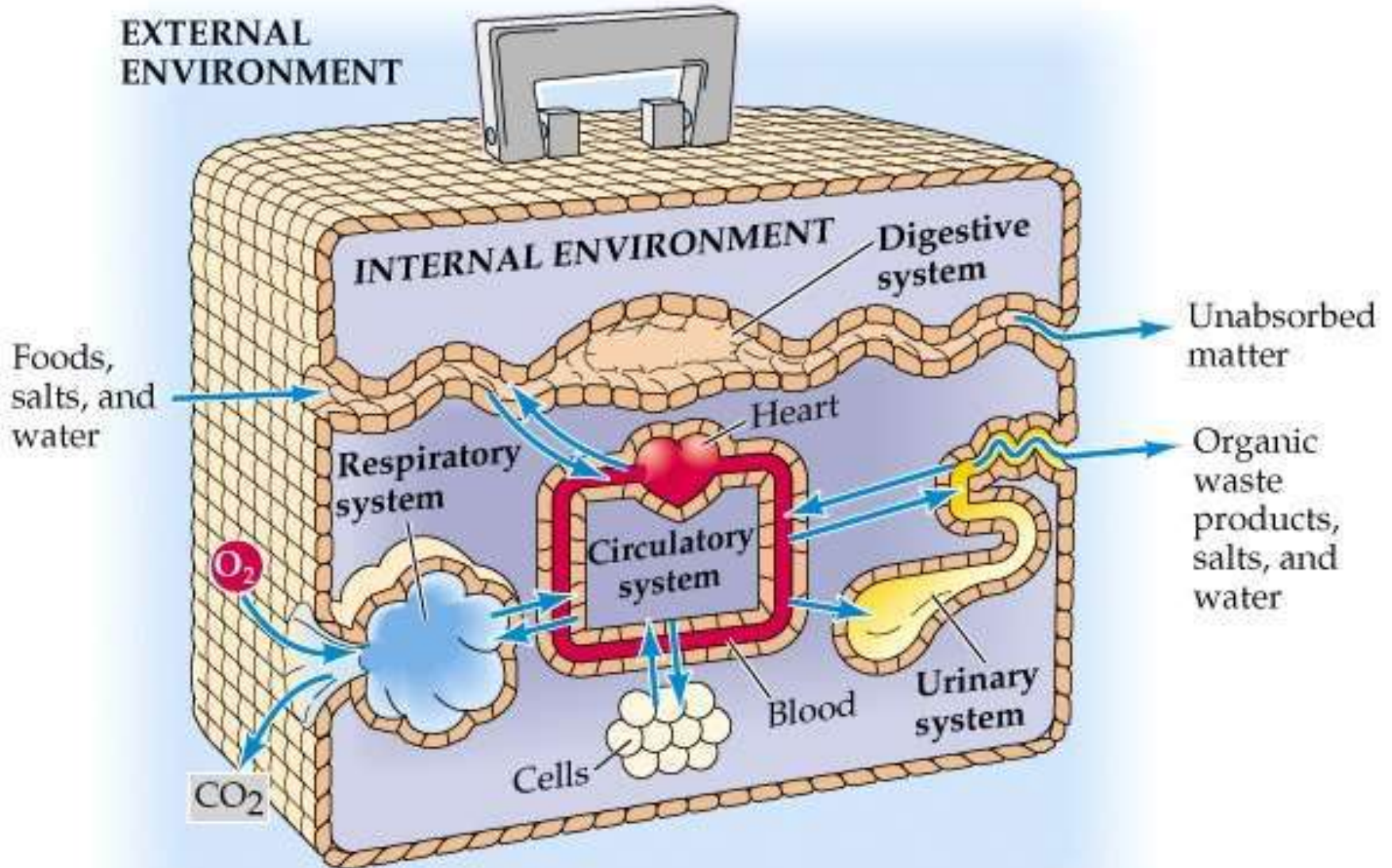
Characteristics of the Living Human Organism

- **Survival Needs**

1. **Nutrients**
2. **Oxygen**
3. **Water**
4. **Normal body temperature**
5. **Atmospheric pressure**



Plan of Human Body



External & Internal Environments

– Interior of body separated from external environment by a **layer** of epithelial tissue

– Exchange between blood and external environment

- **Lungs** الرئتين
- **Gastrointestinal tract** القناة الهضمية
- **Kidneys** الكلى

– Lumens of respiratory, gastrointestinal, & urinary systems are part of **external environment**

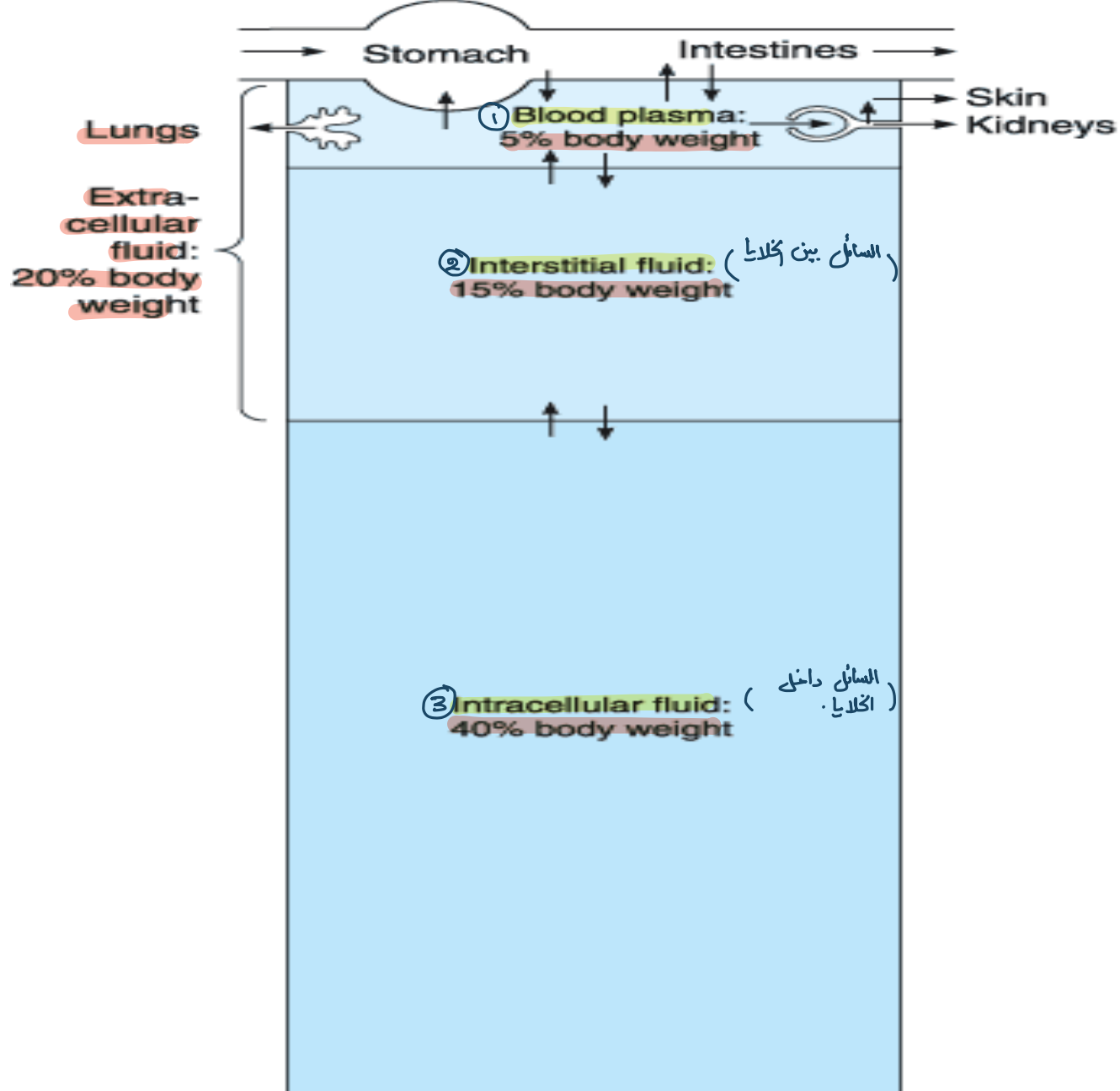
القناة الهوائية

الجهاز الهضمي

الجهاز البولي

specific cavities are outside the body
as lung cavity, esophagus cavity,

هذا يعني سؤال إنه الأمل
يكون outside the body



Source: Ganong WF: *Review of Medical Physiology*, 22nd Edition: <http://www.accessmedicine.com>

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Lymphatics

Lymphatic Failure = Edema ^{وذمة}

→ we have filtration in the capillaries
 ف يوجد التسك من الدم إلى النسيجة و ههنا تتم
 عملية التبادل .

→ we have forces that push components out
 of the blood into the cells , and forces to draw
 back some materials.

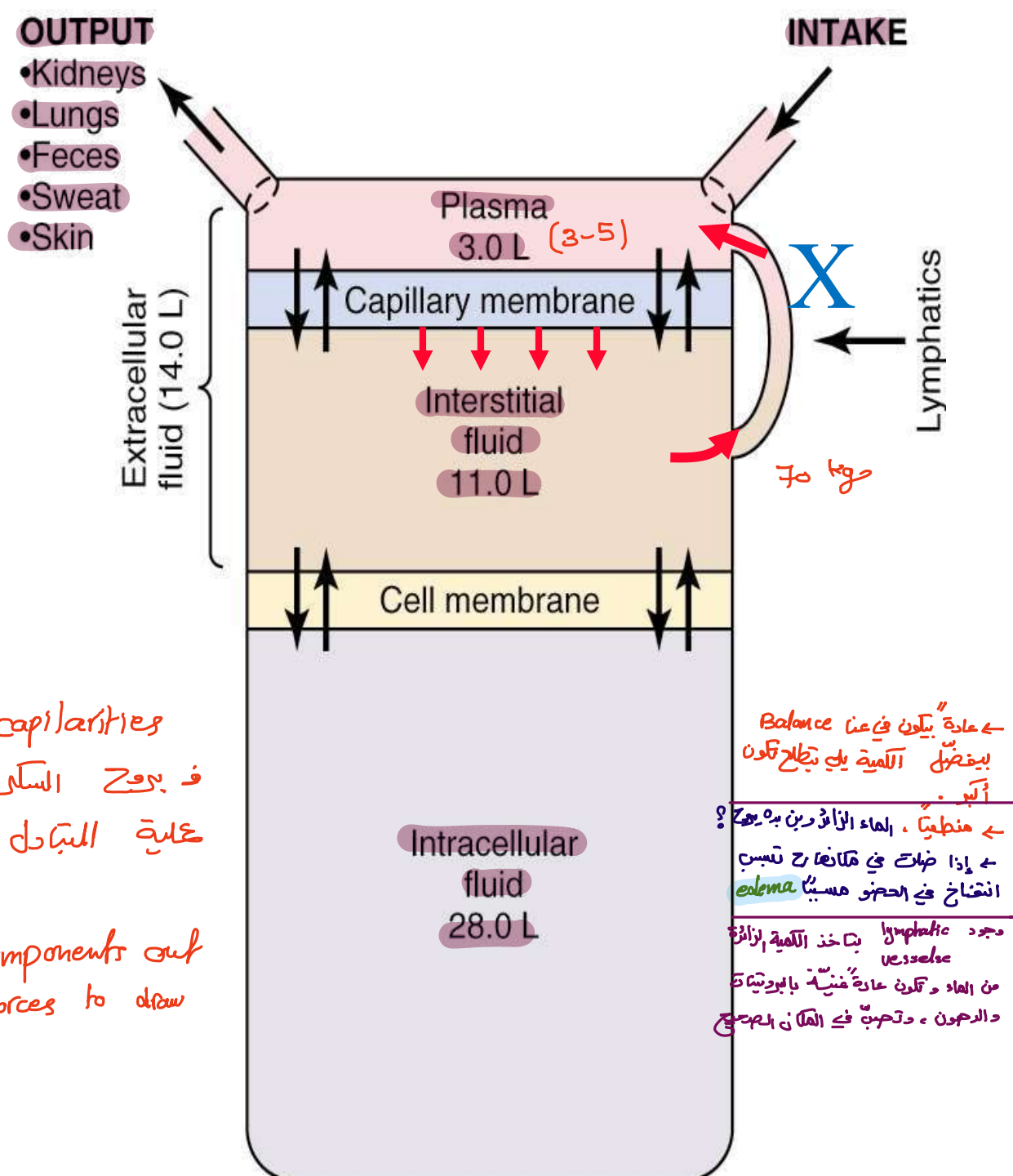


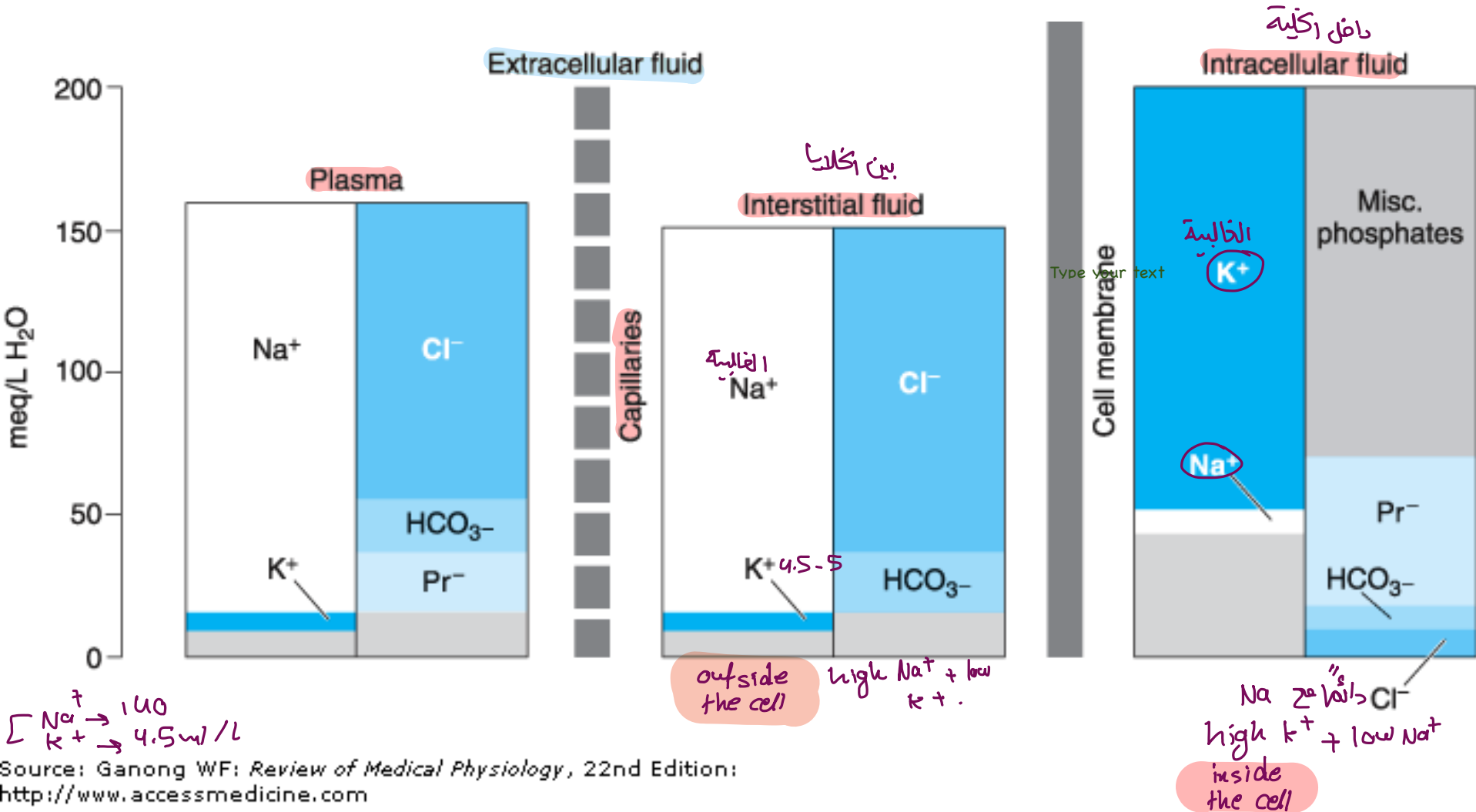
Table 1-1. Total Body Water (As Percentage of Body Weight) in Relation to Age and Sex.

Age (years)	Male (%)	Female (%)
10-18	59	57
18-40	61	51
40-60	55	47
Over 60	52	46

مع كل ما زاد العمر، قلّت نسبة المياه في الجسم، برضو Volume الـ بحسب العمر.

الهدف من عمل هاد التبادل هو الحفاظ على الخلية بالحالة الطبيعية

بنرجع هون بنتذكر موضوع لو حطيت خلية ب تراكيز مختلفة و كيف رح تنتقل الماء من مكان لآخر و اذا رح يصير للخلية انتفاخ او انكماش



Source: Ganong WF: Review of Medical Physiology, 22nd Edition: <http://www.accessmedicine.com>

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→ The membrane of the cell is freely permeable for K⁺, but not for the Na⁺.

→ next lecture explained this section.

ينرجع نتذكر resting membrane potential يلي هو بيختلف من عضو لعضو،
في الدماغ تقريبا بكون -١٥ اما بالقلب -١٠٠ ملّي قولت و طبعًا هاد مش ثابت
لجميع الانسجة

طيب شو وظيفته؟ اذا راح هاد ال potential الخلايا ماتت،
لما تصير خلية ميتة يعني ما بتحسّ فيها ف اكيد ما رح تكون
nerves، هي بتكون ب nails+hair اكثر شي لانه ما عنا
فيهم احساس، ف كلاهما ميّت، ما بتقدر تحفزهم يعني.

This potential is very essential to stimulate the
cell, so that cell can do its functions such as
releasing of hormones.

الخلية عشان اعملها stimulation لازم تولّد action
potential و لازم يكون في عنا Negative resting
membrane potential للخلية الهرمونية ولا ما بنقدر ابدأ ننتج
الهرمونات.

طبيب عنا سؤال، كيف نعمل على تثبيت هاد ال potential؟

هل الخلية static or dynamic؟

اللي بحافظ على resting membrane potential هو Na/K

pump يلي هي اصلاً هاي وظيفتها، بدونها الخلية ما الها فايده و بتكون ميتة، لما يصير اي تغيير بال distribution بسرعة بترجعه للحالة الطبيعية،

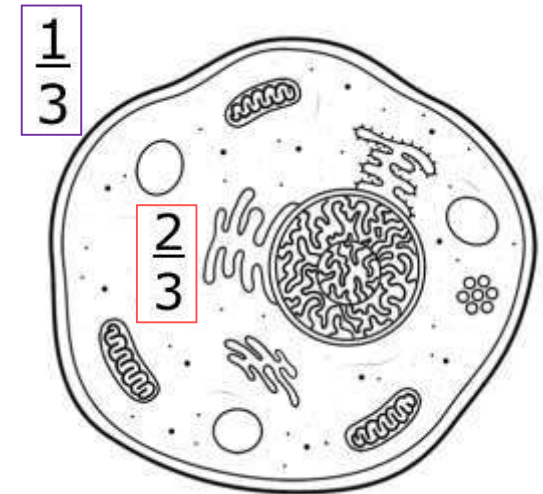
Stimulation occurs with small change in the distribution of this ions (k/Na)

How to restore back this potential?

الصوديوم يلي دخل لازم اطلعه لبرا، و البوتاسيوم يلي طلع لازم ارجعه لجوا.

Body Fluids

☐ Mostly water



The Internal Environment

□ The interior of body, the environment of cells inside the body

□ Internal environment = fluid surrounding cells

→ To maintain the internal environment and the normal osmotic pressure should equal the outside.

The ECF is the internal environment

Extracellular fluids

→ intake = out
إذا بطلوا متساويين يكون
عندي مشكلة

What is in the ECF?

- Ions

- O₂

- Nutrients (glucose, f.a, a.a)

- Waste products (CO₂, garbage)

Fluid Compartments

≈ 60% of body weight

Extracellular fluid (ECF)

(≈ 1/3)

20% of body weight

Intracellular fluid (ICF)

(≈ 2/3)

40% of body weight

Plasma

25% of ECF

5% of body wt

Interstitial fluid

75% of ECF

15% of body wt

Transcellular fluid

CSF

Intraocular

Pleural

Peritoneal

Pericardial

Synovial

Digestive secretions

تباين دوائر بين الخلايا

The maintenance of the normal internal environment which the cell can live in

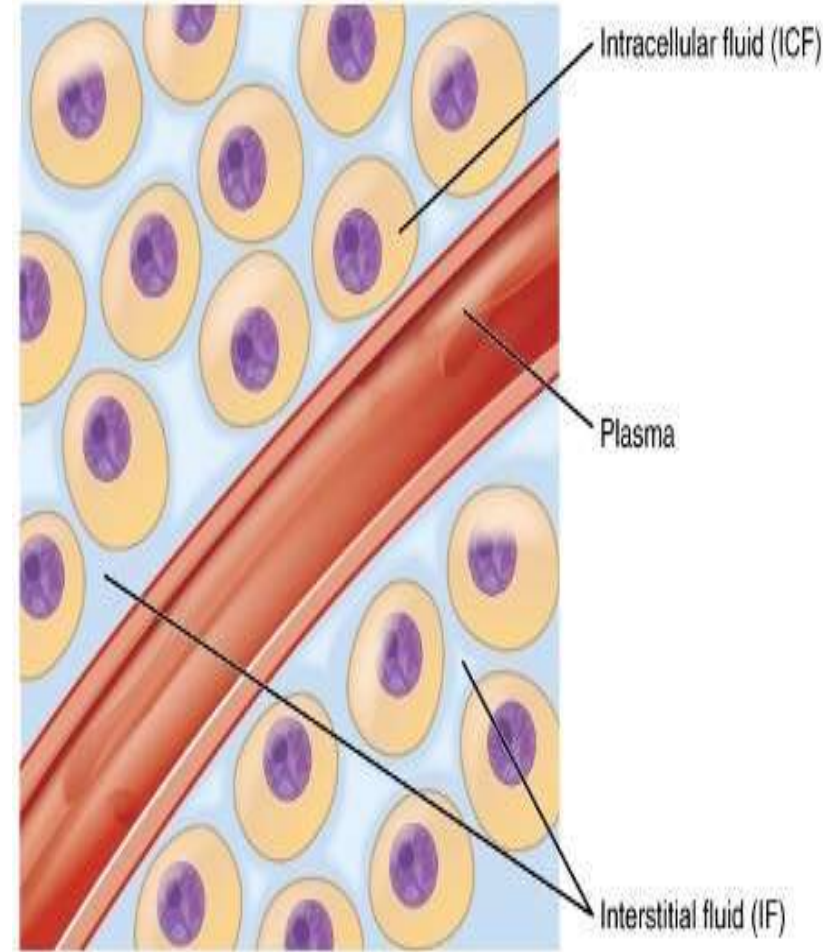
← Homeostasis →

التوازن

- Body cells are surrounded by 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

فارج اكلية

داخل اكلية



Homeostatic mechanisms vary according to the system, each system has its own mechanism

Homeostasis

For example: blood pressure 120/80

= **State of constancy of conditions within the body**

= **Maintaining a dynamic steady state of the internal environment**

“Essential for cell survival”

Factors Homeostatically Regulated



We have chemo receptors which control the mechanisms.
And they are connected to the central nervous system
O₂ increase ~ respiration increases
O₂ decrease ~ rate increases

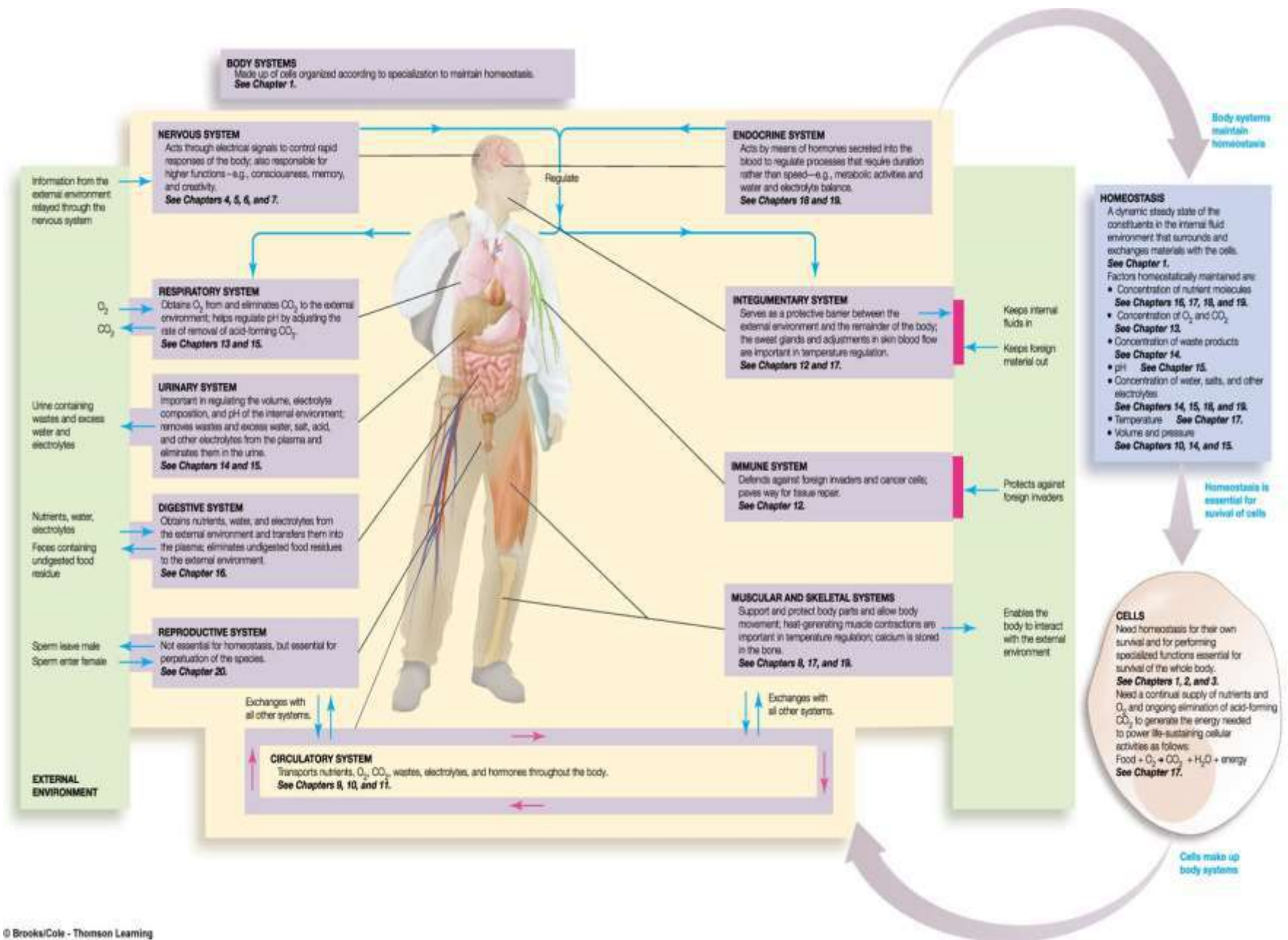
K is so important, so if it increases to 6.5
for e.g could cause death at any moment, so
that controlling this is so important

1. **Concentration of nutrient molecules** (fat, $\text{C}_6\text{H}_{12}\text{O}_6$, ---)
2. **Concentration of gases in blood (O₂ and CO₂)**
3. **Concentration of waste products** (lactic acid)
4. **pH of blood plasma** 7.35 - 7.45
5. **Concentration of water, salt, and other electrolytes**
6. **Volume of body fluids and vascular pressure**
7. **Body Temperature**

The Human Body Systems Contribute to Homeostasis

- ✓ **circulatory** - transports materials (e.g., nutrients, gases)
- ✓ **digestive** - breaks dietary food into small nutrient molecules
- ✓ **respiratory** - obtains oxygen and eliminates carbon dioxide
- ✓ **urinary** - removes and eliminates wastes from the plasma
- ✓ **skeletal** - provides support and protection for soft tissues
- ✓ **muscular** - moves the bones
- ✓ **integumentary** - serves as an outer protective barrier
- ✓ **immune** - defends against foreign invaders
- ✓ **nervous** - controls and coordinates activities rapidly
- ✓ **endocrine** - regulates activities that require duration
- ✓ **reproductive** - ??? perpetuation of the species

Role of Body Systems in Homeostasis



Homeostatic Control Systems

within the organ its self.

- **Intrinsic (local) - inherent in an organ**

- **Extrinsic (body-wide) - outside the organ to alter the activity of the organ**

لما ناكل، بزيد معدل نبضات القلب، طيب كيف بزيد؟ في عنا neurons بتطلع من الدماغ بتوصل للقلب ف بتحفز القلب ليصير ينبض اكثر و اسرع، على العكس بحالة الراحة و لما ما يكون بعمل عمليات هضم او هيك.

1. **Nervous system**
2. **Endocrine system**

Homeostatic Control Systems

- Control systems are grouped into two classes
 - Intrinsic (within) controls**: Local controls that are inherent in an organ
 - Example exercising skeletal muscle consumes more oxygen leading to fall in oxygen concentration in the skeletal muscle (local). This local decrease in oxygen acts directly on smooth muscle of blood vessels of skeletal muscle causing dilatation of these blood vessels (more blood flow means more oxygen supply and thus maintain oxygen level in exercising skeletal muscle.

هون عم يحكيلى انه الجسم لما بيعمل تمارين رح يفقد اكسجين، فقداه للاكسجين رح يسبب negative feedback رح تخلي الخلايا تتسع و لما تتسع رح يصير انتقال للدم اكثر كل ما انتقل الدم اكثر انتقل

Extrinsic (outside) controls: Regulatory mechanisms initiated outside an organ

- Accomplished by **nervous and endocrine systems**
- Example: when blood pressure falls, the nervous system acts on heart (increases heart rate and contractility) and on blood vessels (vasoconstriction). Both effects can increase blood pressure to normal.

نفس المبدأ هون، عم بحكيلى انخفض ضغط الدم، ف الجهاز العصبي رح يحفز القلب ليزيد نبضاته و معدل الضربات لما يزيدوا رح يزيد ضغط الدم عشان يرجع للطبيعي يلي هو

Mechanisms to maintain homeostasis

1. **Negative Feedback** (تخذية راجعة)

2. **Positive Feedback**

3. **Feedforward**

Homeostatic Control Systems

- **Negative feedback system**

- **Primary type of homeostatic control**

- **Opposes initial change**

- **Components**

①

- **Sensor**

Which will sense the level of the value which you want to control
Should be connected to a control box which will analyse the
signals coming from the sensor and sense if it is above or below
the level you want.

- **Monitors magnitude of a controlled variable**

②

- **Control center**

عادةً هاد control centre يكون بالدماغ، بيحلل

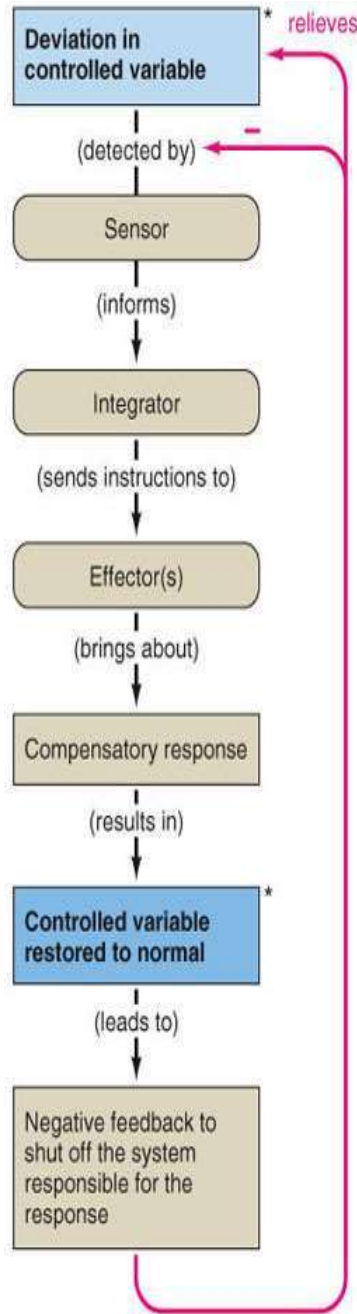
- **Compares sensor's input with a set point**

③

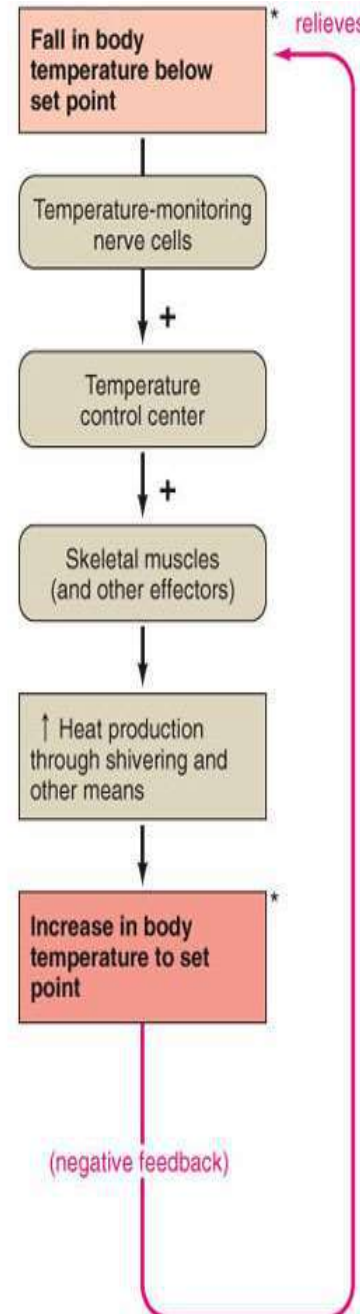
- **Effector**

- **Makes a response to produce a desired effect**

Example of negative feedback mechanism



(a)

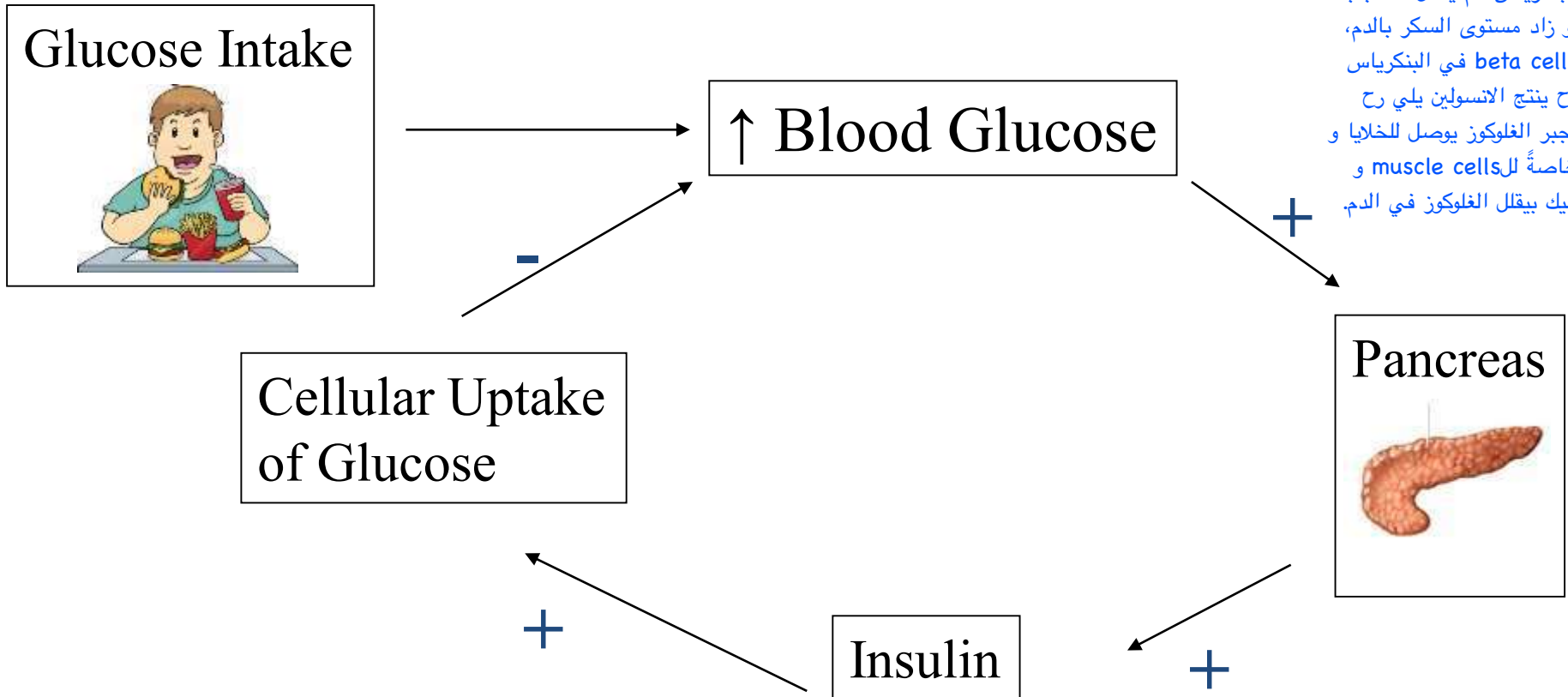


(c)

هون عم يشرحلي عن درجة حرارة الجسم و كيف يحافظ عليها، لما درجة حرارة الجسم تنخفض عن set point يلي هي 36-37 رح توصل اشارة للhypothalamus رح تستقبل هاي الاشارة و تبعث سيالات عصبية للخلايا اللي بتقدر ترفع درجة الحرارة و منها skeletal muscles عن طريق استجابة اسمها shivering ف بترتفع درجة حرارة الجسم و هاي negative feedback او ممكن عن طريق metabolic mechanisms يلي بتعطي الجسم طاقة و طبعاً هاي الطاقة رح ترفع درجة الحرارة. طيب لو درجة الحرارة ارتفعت؟ نفس المبدأ لكن حتكون تعرّق، عشان نفقد للحرارة و نرجع للset point، او بيعمل توسع للخلايا يلي بالskin رح يزيد blood flow و الحرارة رح تُفقد بهاي الطريقة.

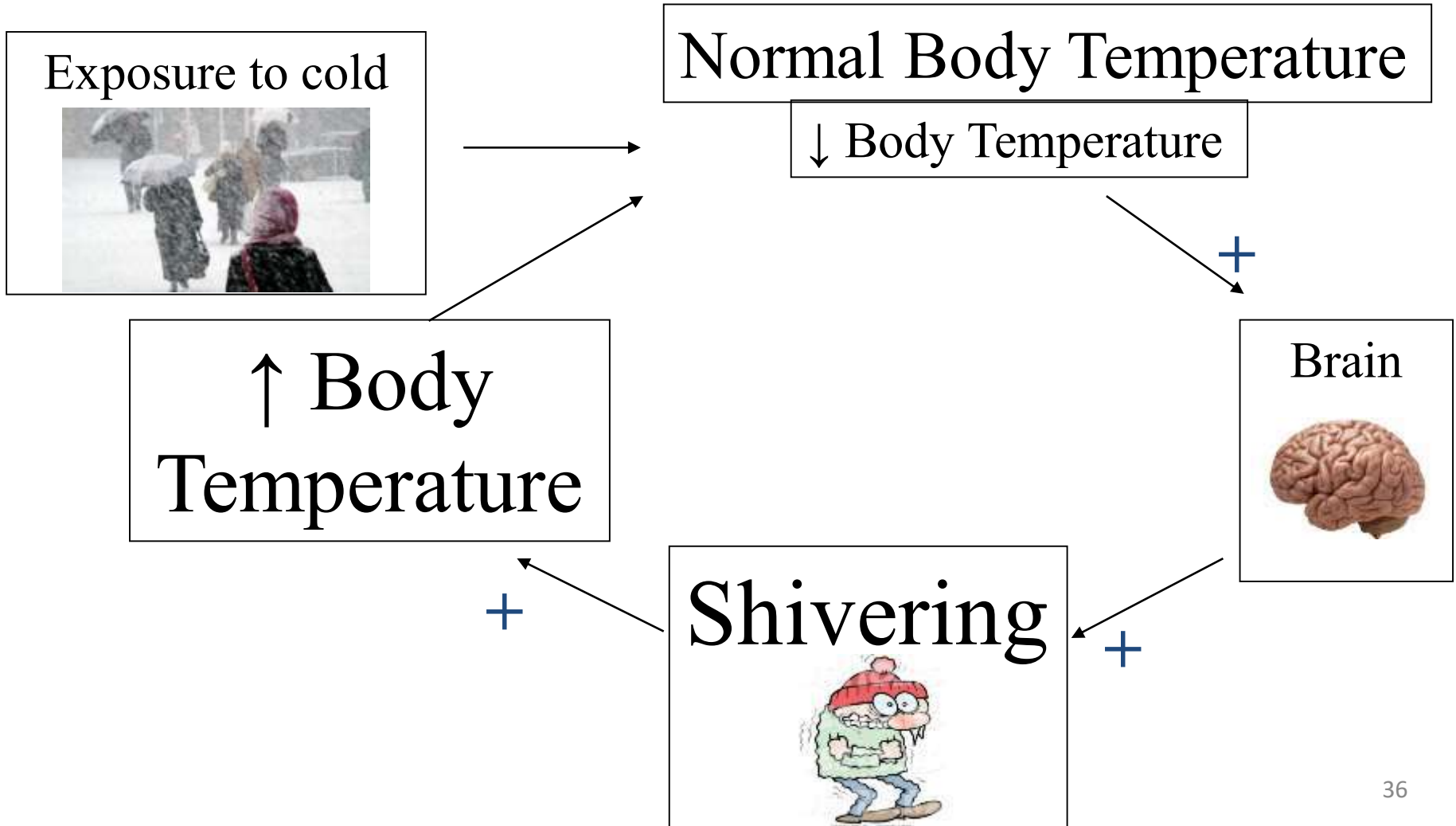
Negative Feedback

معظم الmechanisms بجسم الانسان هي positive و جداً قليلة هي negative

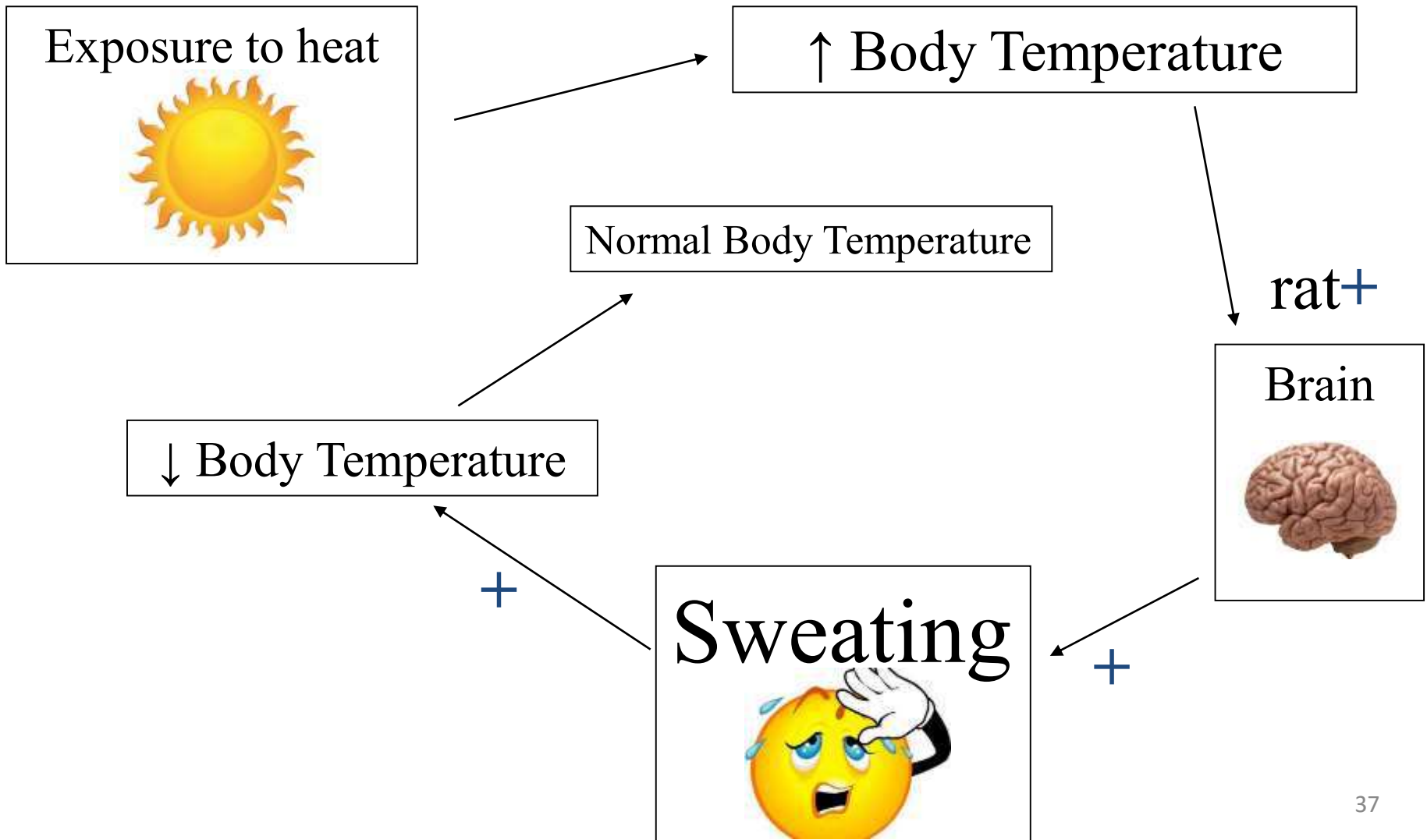


هون عم يحكي كيف البنكرياس عم يعمل استجابة، لو زاد مستوى السكر بالدم، beta cells في البنكرياس رح ينتج الانسولين يلي رح يجبر الغلوكوز يوصل للخلايا و خاصةً لل muscle cells و هيك بيقلل الغلوكوز في الدم.

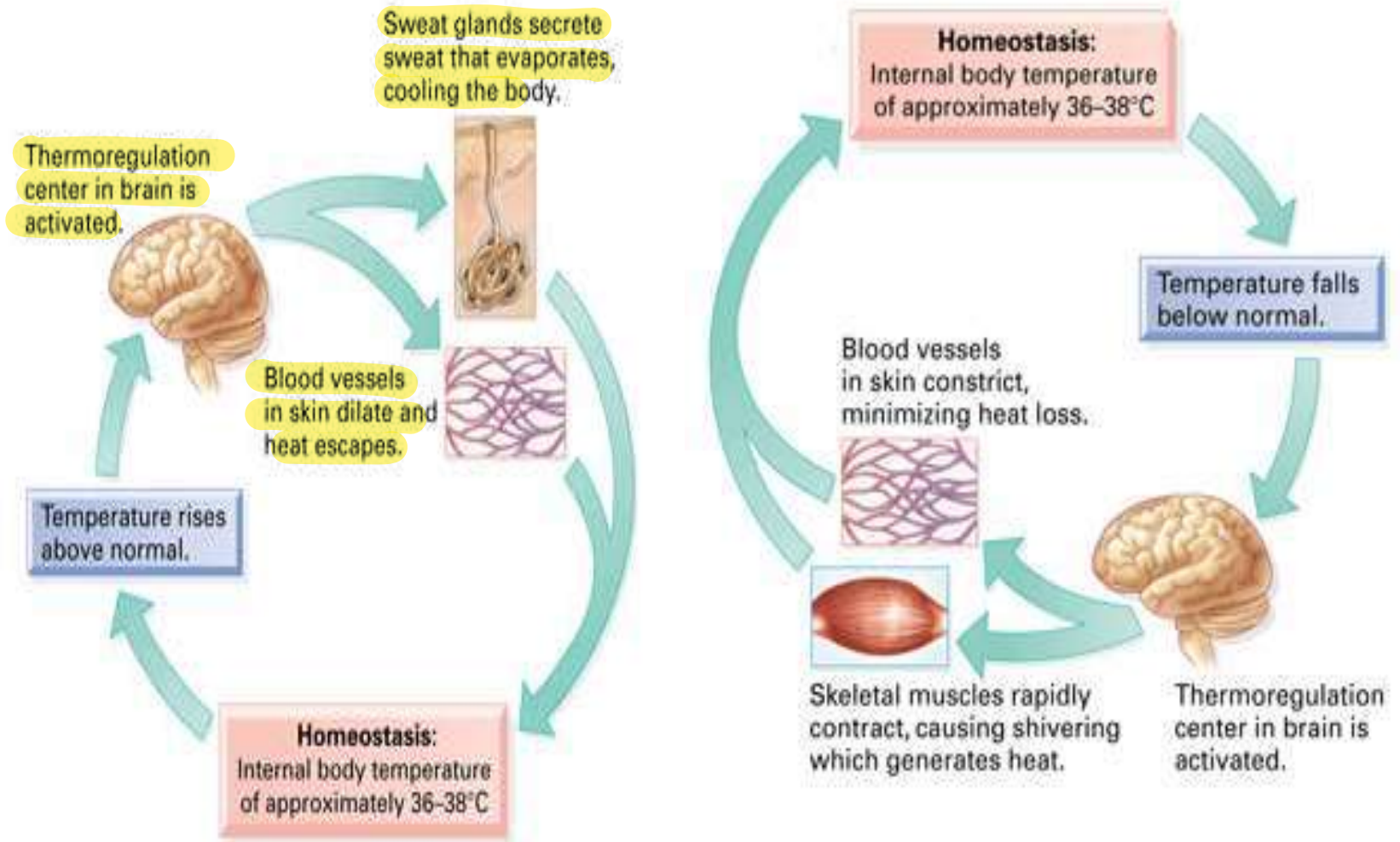
Negative Feedback تم شرحها سابقاً



Negative Feedback



Maintaining constant body temperature by negative feedback mechanism



Homeostatic Control Systems

- **Positive feedback system** It is a response which will enhance its activity to increase more and more
 - **Amplifies an initial change.**
 - **Do not occur as often as negative feedback system.**
 - **Example**
 - **Uterine contractions become increasingly stronger until the birth of the baby**

الرحم

انقباضها

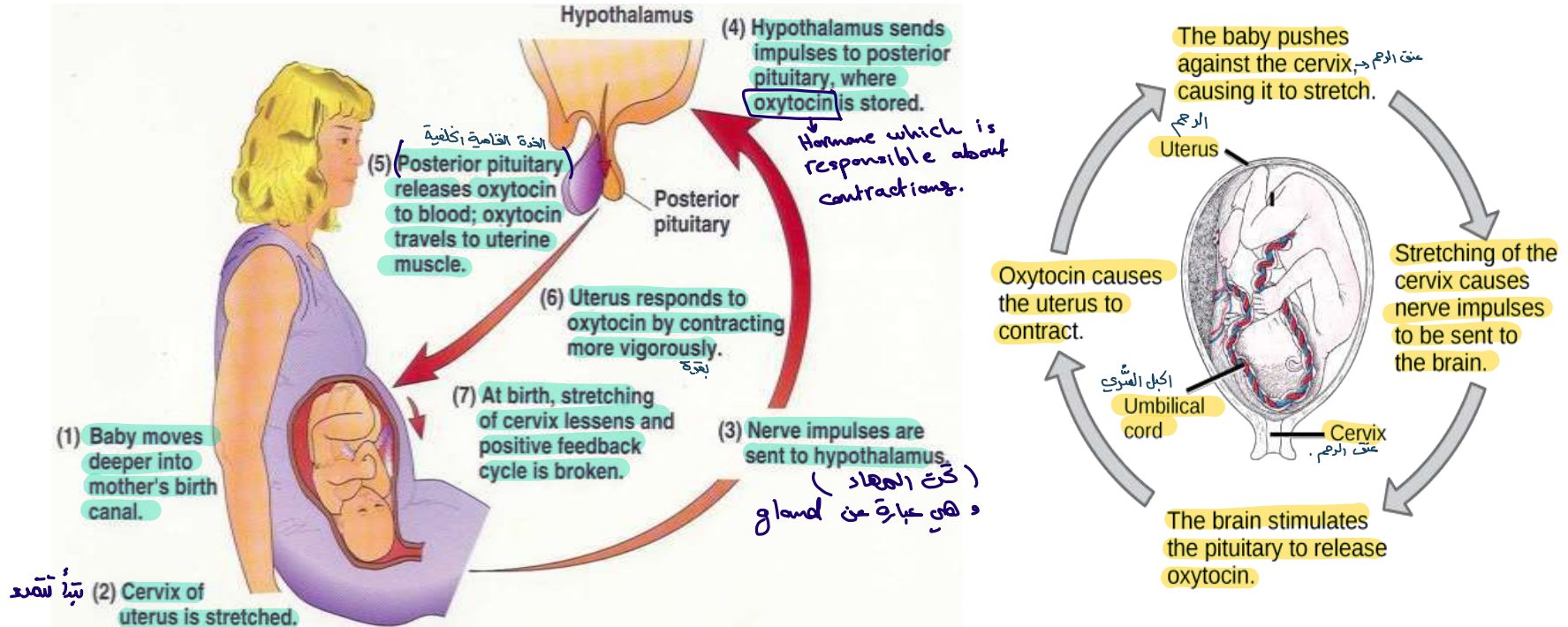
أثناء المخاض

Useful positive feedback

لما يبلىش الطفل يطلع و طبعًا هاد رح بيدأ مجرد ما هرمون البروجسترون يلي وظيفته يحافظ على الحمل و يبثه بيدأ ينخفض، ف بتبلىش للcontractions للuterine wall و رح يدفع الطفل للخارج، الcervix رح تبلىش تتمدد (stretch) و هاد رح يرسل اشارة للدماغ خصوصًا للhypothalamus و رح ترسل اشارة لإنتاج الأوكسيتوسين و هو هرمون يزيد من انقباضات جدار الرحم، يزيد التمدد، و كل ما زاد التمدد زاد انتاج الأوكسيتوسين و زاد دفع الجنين للخارج.

Childbirth

Uterine contraction pushes head to stretch cervix muscle → signals through the uterine muscle, causing even more contraction. This action is repeated until the baby is born.

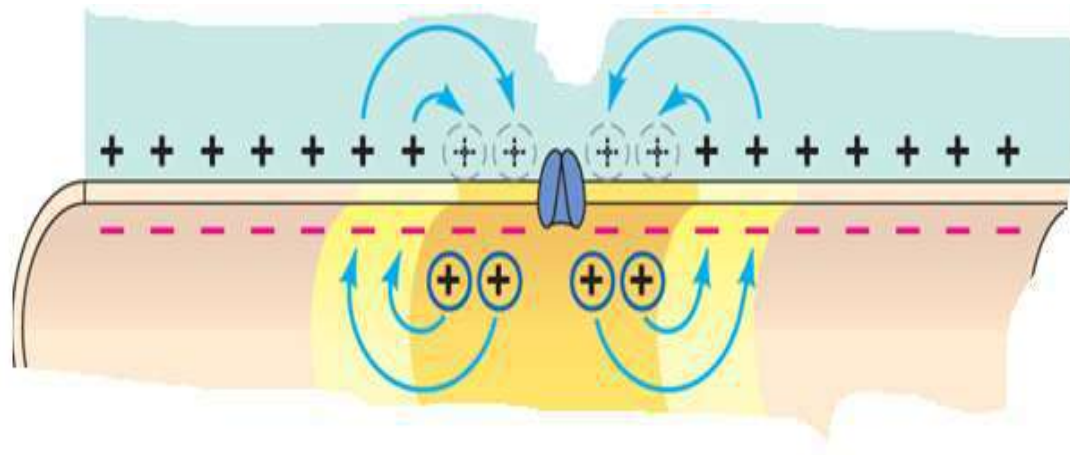


Useful positive feedback

Reminder : all cells have negative resting membrane

Generation of nerve signals:

Stimulation nerve fiber → causes slight leakage of sodium ions
→ more sodium move in causes change in membrane potential
→ that will cause more & more sodium channels to open and
producing Na influx → more change in membrane potential →
more opening → until action potential is created and spread all
the way to the end of fiber.



The cell must have negative resting membrane potential , in the neurons about -60, what happens. The stimulus such as temperature or touching, they open sodium gates in the membrane of the cell, whatever the cell is

Membrane have a lot of sodium channels and most of them are normally closed, how to open them? By stimulation, some sodium will enter into the cell from high concentration (140)to low concentration (10)

This is called depolarisation.

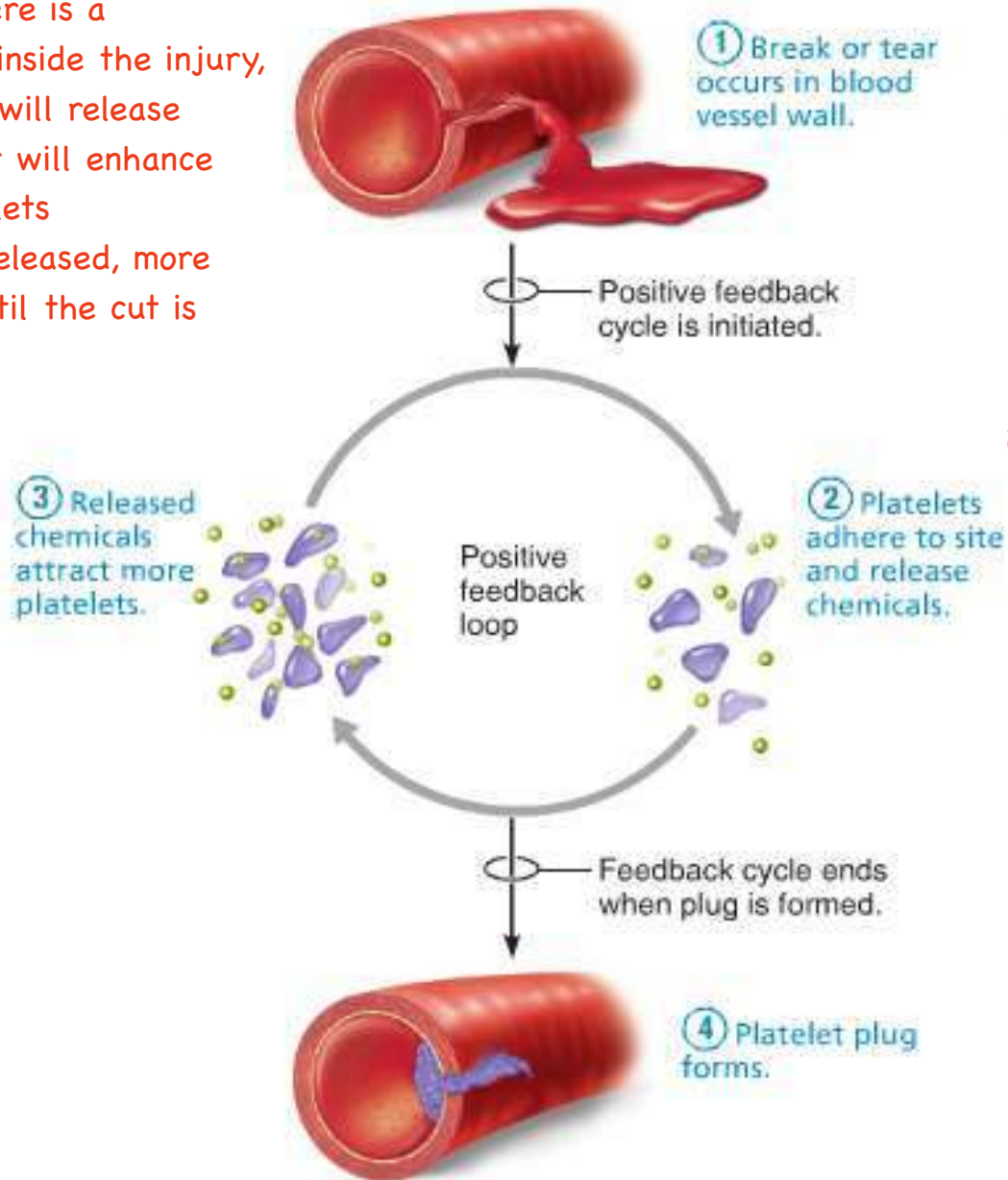
Once the sodium enters that enhance more and more sodium channels to open and the sodium will enter the cell until a full depolarisation is produced

كل خلية الها جهد خاص،
مجرّد ما تعرضت الخلية لمحفز
خارجي، رح تفتح بوابات
الصوديوم و رح يدخل
الصوديوم من برا يلي هو من
التركيز الاعلى الى التركيز
الاقل، مجرد ما دخل
الصوديوم، رح يحفز فتح

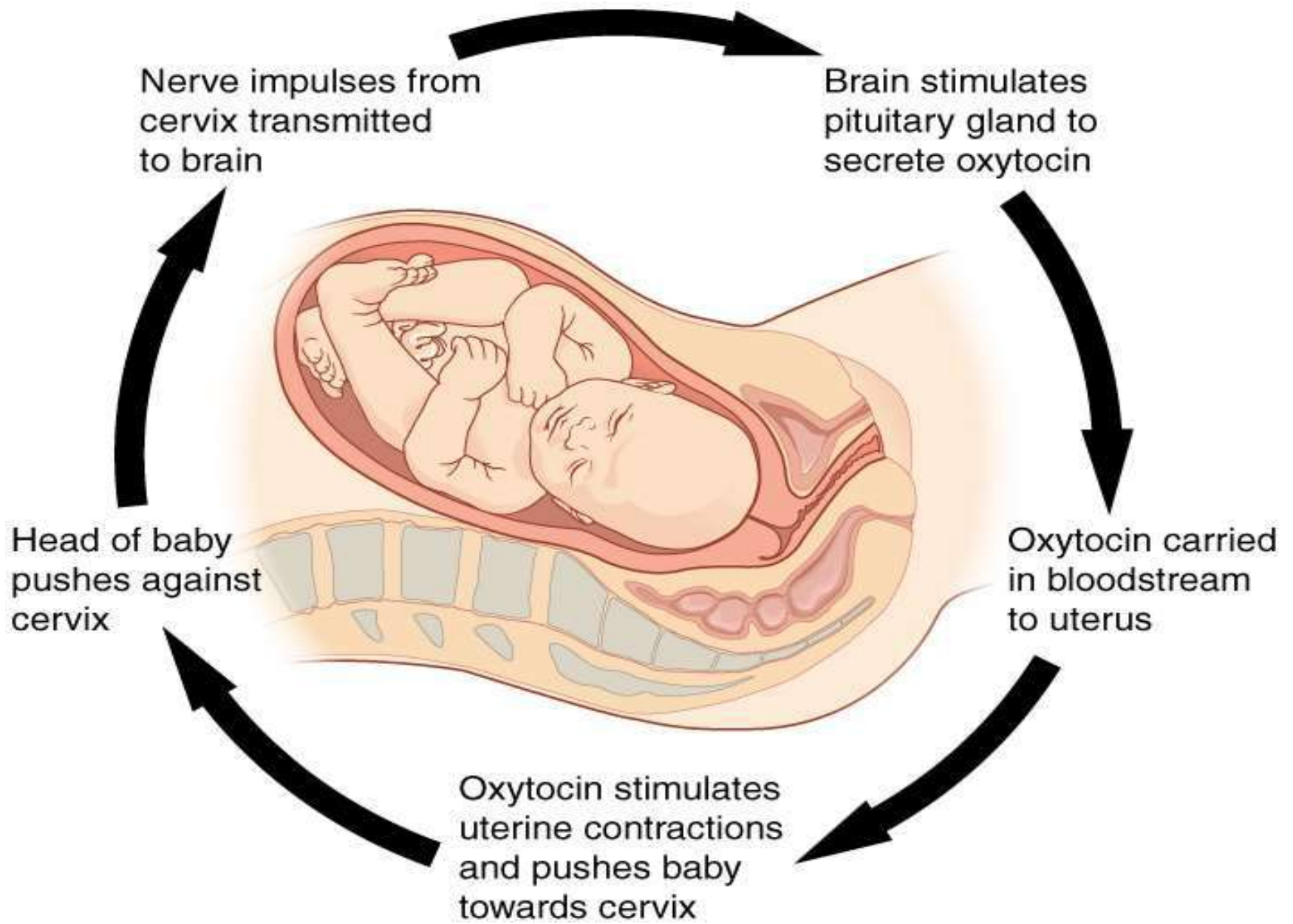
Positive feed back mechanism of blood clotting

تخثر الدم

When a person is cut, there is a accumulation of platelets inside the injury, the adhesion of platelets will release chemicals in the site, that will enhance further adhesion of platelets
The more chemicals are released, more accumulation platelets, until the cut is shut(plug)



لما شخص يتعرض لجرح، رح تبلش صفائح الدم تتجمع و تتراكم عشان تسدّ مكان هاد الجرح، و تبلش تلتصق ببعض، مجرد ما التصقت رح تحفز انتاج و تراكم صفائح دموية اكثر، لحد ما توصل لمرحلة اغلاق الجرح يلي احنا بنسميها plug و



Disruption in Homeostasis

دائمًا سبب الأمراض هو سوء استخدامنا لجسمنا،
سواء من قلة النشاط أو من الطعام غير الصحي.

الأعراض

الموت

can lead to illness and death

What is the disease ? abnormality
in the homeostatic mechanisms
which failed to keep the factor at
the normal level such as fever,
hypertension(increasing in the
blood pressure)

Pathophysiology

*the abnormal functioning of the body
during disease*

End of lecture 1

Contributions of Body Systems to Homeostasis (cont.)

- 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
- Reproductive system
 - Not essential for homeostasis (not essential for survival of individual)
 - Is essential for perpetuating the species

Contributions of Body Systems to Homeostasis

- Circulatory system
 - Carries materials from one part of the body to another.
- Digestive system
 - Breaks down dietary food into smaller molecules that can be distributed to body cells.
 - Transfers water and electrolytes from external environment to internal environment.
 - Eliminates undigested food residues to external environment in the feces.

Contributions of Body Systems to Homeostasis (cont.)

- Respiratory system
 - Gets O₂ from and eliminates CO₂ to the external environment
 - Important in maintenance of proper pH of internal environment
- Urinary system
- Removes excess water, salt, acid, and other electrolytes from plasma and eliminates them in urine.

- Skeletal system
 - Provides support and protection for soft tissues and organs
 - Serves as storage reservoir for calcium
 - Along with muscular system enables movement of body and its parts
 - Bone marrow is ultimate source of all blood cells

Contributions of Body Systems to Homeostasis (cont.)

- Muscular system
 - Moves the bones
- Integumentary system
 - Serves as outer protective barrier
 - Important in regulating body temperature
- Immune system
 - Defends against foreign invaders and against body cells that have become cancerous
 - Paves way for repairing or replacing injured or worn-out cells