4 Homeostasis I

ملاحظة :
نظراً لاختلاف ترتيب المواضيع المندرجة تحت هذه المحاضرة ننوّه أنه تم ترتيبها وفقاً لترتيب محاضرة البنات ولكنها عمل مشترك وشامل

- Very important
- Extra information
- Terms

Simple quote

The true sign of intelligence is not knowledge but imagination. - Albert Einstein

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Objectives

- Define the components of a homeostatic system.
- Be able to recognize each of the components in representative systems.
- Define negative feedback.
- Explain how homeostatic mechanisms regulated by negative feedback detect and respond to environmental changes.
- Define positive feedback.
- Describe the actions of a positive feedback loop.

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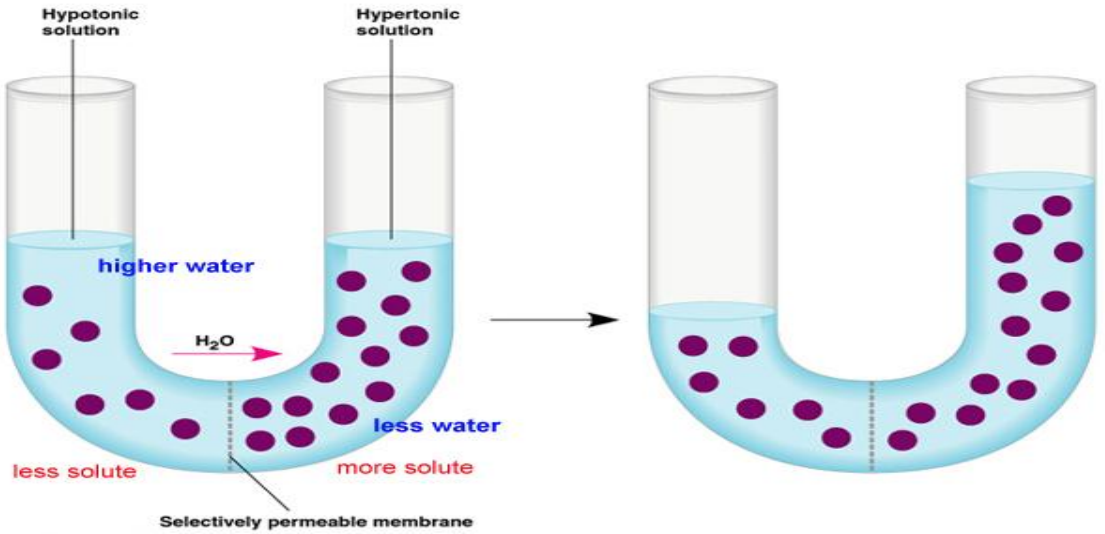
Osmosis

Osmosis Is the flow of water across a semipermeable membrane because of differences in solute concentration.

Net diffusion of water from a region of high water concentration to region of low water concentration.



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Osmosis

- **Osmotic equilibrium is maintained between intracellular and extracellular fluids.**

- **Small changes in concentration of solutes in the extracellular fluid (ECF) can cause tremendous change in cell volume.**

(تغير ضئيل في تركيز المُذاب بإمكانه أن يُحدث تغيراً هائلاً في حجم الخلية)

- **Intracellular Osmolarity = Extracellular Osmolarity ≈ 300 mosm/L**

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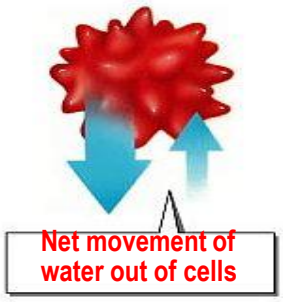
The concentration of dissolved materials in a cell's environment compared to the concentration within the cell

Hypertonic solution

- MORE solutes outside cell
- MORE water inside cell
- Over time, cell loses water and Shrink. (تنكمش)
- ↑ 0.9% NaCl

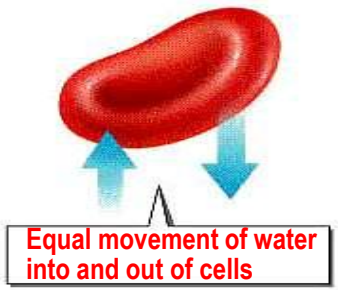


Isotonic solution

- Same , no change in cell volume.

(Not swell or shrink)

- 0.9% solution of sodium chloride or 5% glucose.
- same in and out.



Hypotonic solution

- LESS solutes outside the cell.
- LESS water in the cell , more solutes in the cell.
- ↓ 0.9% NaCl
- Over time , cell gains water and Sewll. (تنتفخ)

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MORE EXPLINATION :

Hypotonic environment:

Cell gains water from surrounding environment.

"Hypo-" means below (below the concentration in the cell).

Hypertonic environment:

Cell looses water to surrounding environment.

"Hyper-" means above (above the concentration in the cell).

Isotonic environment:

No change in cell volume.

"Iso-" means same as

NOTE : water will flow from the Hypotonic solution to the Hypertonic solution.

- **Glucose and other solutions administered for nutritive purposes : Prepared in isotonic solution, for people who can not take adequate amount of food.**

Homeostasis

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

- Chemical , thermal , neural factors interacts to maintain homeostasis.

- **Extreme dysfunction** (اختلال وظيفي عالي)leads to death , while **moderate dysfunction** (اختلال وظيفي متوسط) leads to sickness.

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

- All different body systems operate in **harmony** (انسجام وتناسق) to provide **homeostasis.**

لترسيخ مصطلح Homeostosis :
نلاحظ أن المقطع الأول منها هو Home
فالمنزل يعني الاستقرار مما يعني أن جميع أنظمة الجسم تحتاج للاستقرار

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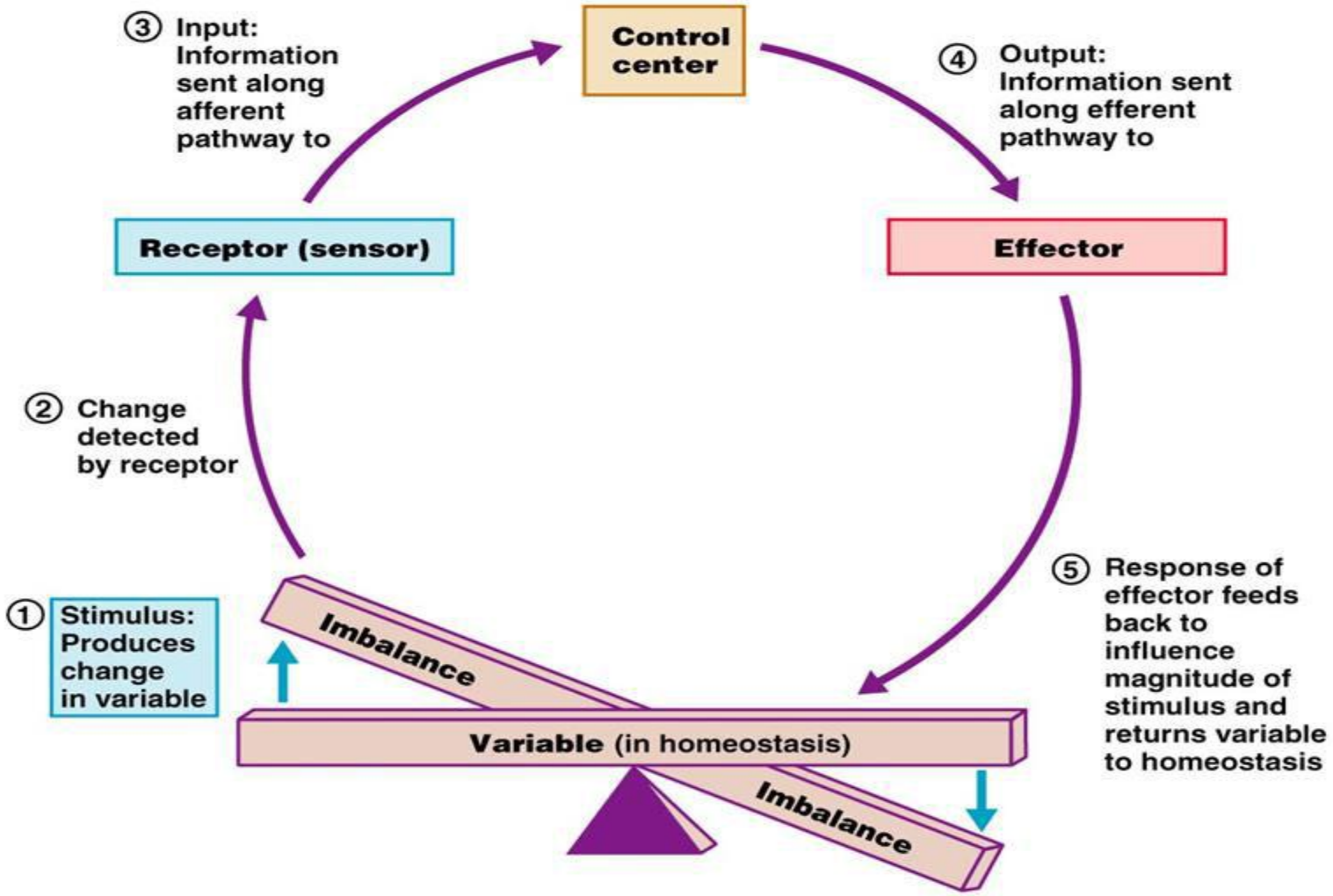
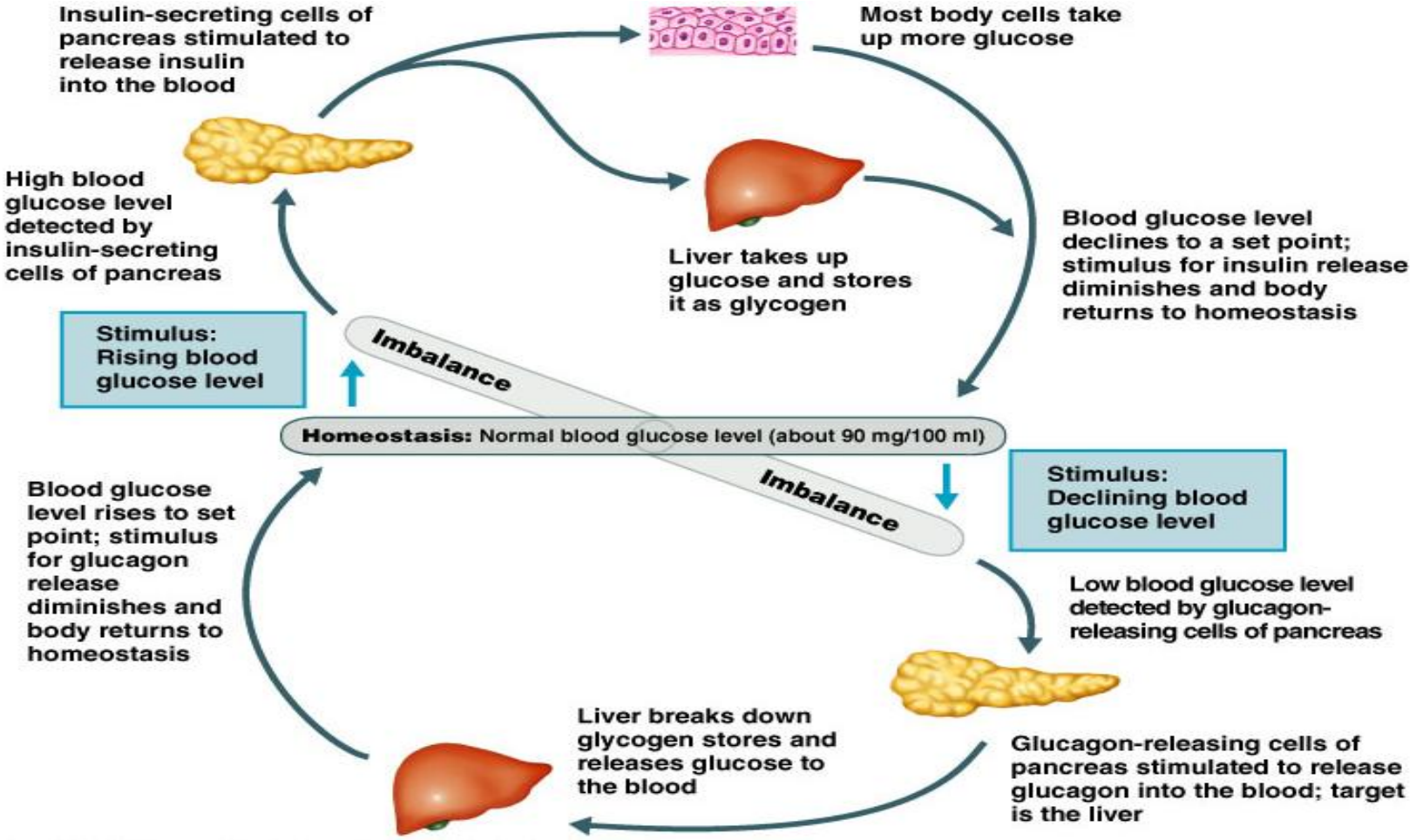
The body maintains homeostasis by using homeostatic control systems (Three components associated with each system) :

Receptors	Control center	Effector
- Detects changes in a variable. - Consists of sensory nerves. Example : a change in temperature يتم الكشف عن التغير بواسطة المستقبلات	- Interprets input from the receptor , determines the set point at which the variable is maintained. - Initiates changes through the effector. - a portion of a nervous system or an endocrine organ. يتم تحديد القيم التي يعود بها الجسم إلى حالته الطبيعية	Provides the means to respond to the stimulus. Example : muscles or glands تستجيب المؤثرات لهذه القيم وتبدأ بالعمل على إعادتها إلى حالتها الطبيعية


③ Input: Information sent along afferent pathway to
Control center
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



- في حال ارتفاع الجلوكوز في الدم : يقوم البنكرياس بإفراز الأنسولين بالتالي يعود المستوى الطبيعي للجلوكوز في الدم.

- في حال انخفاض الجلوكوز : يقوم البنكرياس بإفراز الجلوكاجون والذي يقوم بدوره بتحويل الجلايكوجين المخزن في الكبد إلى جلوكوز.

Maintenance of homeostasis

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 (Hormonal system)

- **Regulates the activities that requires duration.**

- **Endocrine gland , Pancreas, thyroid**

e.g. parathyroid hormone regulating calcium levels, insulin control glucose level.

Factors Homeostatically Regulated

- **Concentration of nutrient molecules**
- **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**

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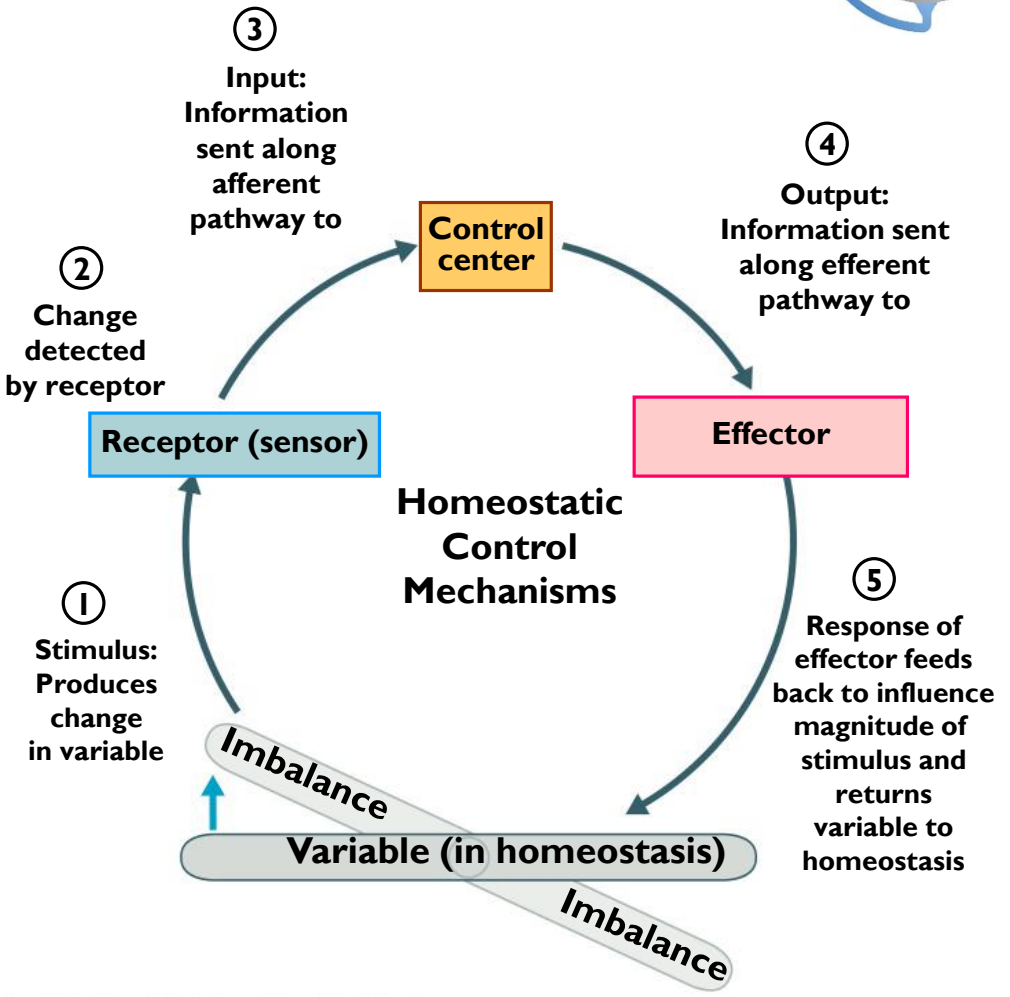
Response of a homeostatic system occurs through a feedback loop :

1 - stimulus.
2 - detection of stimulus by a receptor.
3 - information relayed to the control center.
4 - integration of the input by control center and initiation of change through effectors.
5 - return of homeostasis by the actions of effectors.



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Homeostatic Control Systems

Feedback

"responses made after change has been detected"

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.

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Homeostatic Systems Regulated by Negative Feedback

Homeostatic Systems Regulated by

Negative Feedback :

- A type of homeostatic control system that maintains the variable within a normal range
- Resulting action in the opposite direction of stimulus
- Controls most processes in the body
- 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.

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

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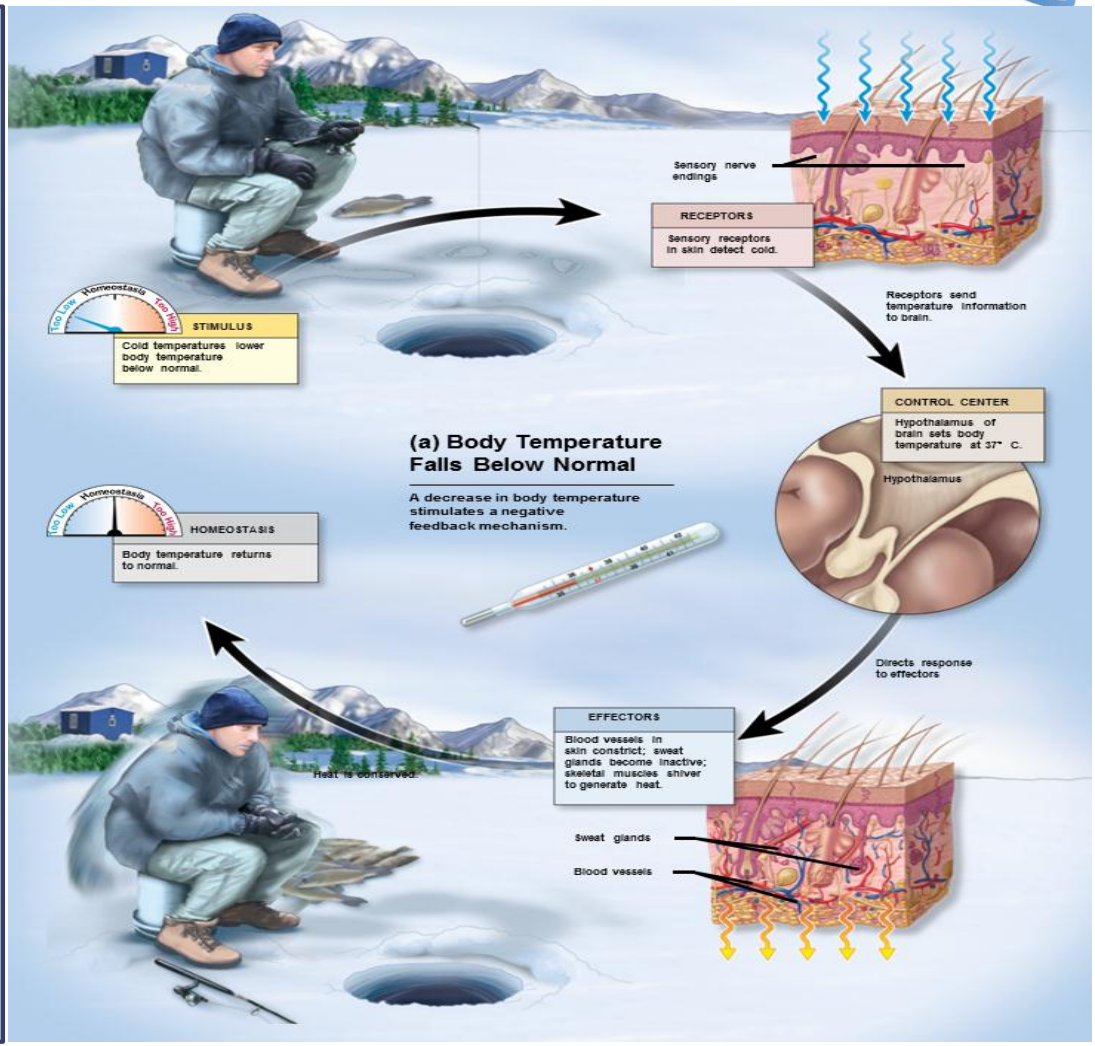
Negative Feedback

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"



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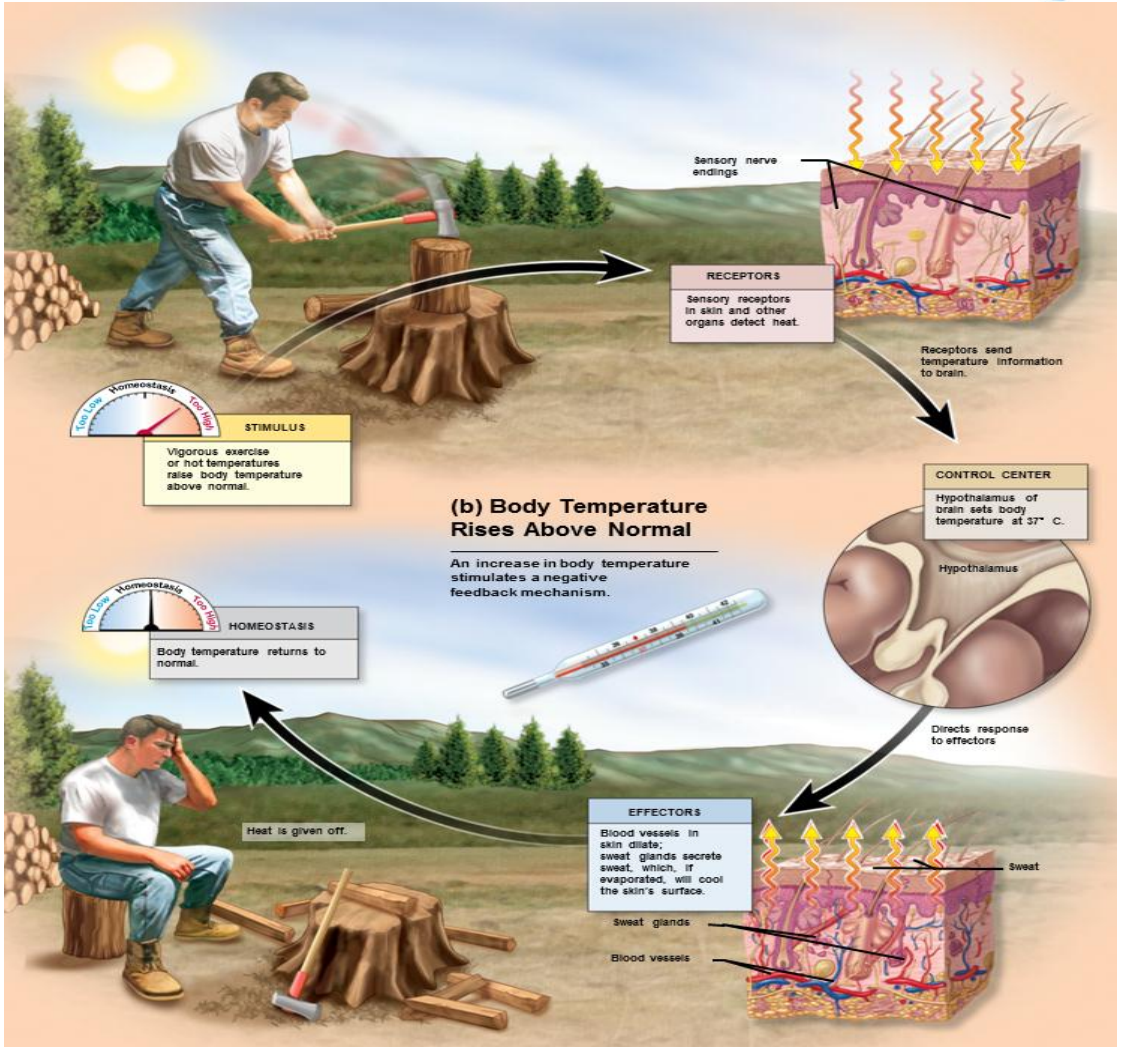
Negative Feedback

Temperature regulation

- (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



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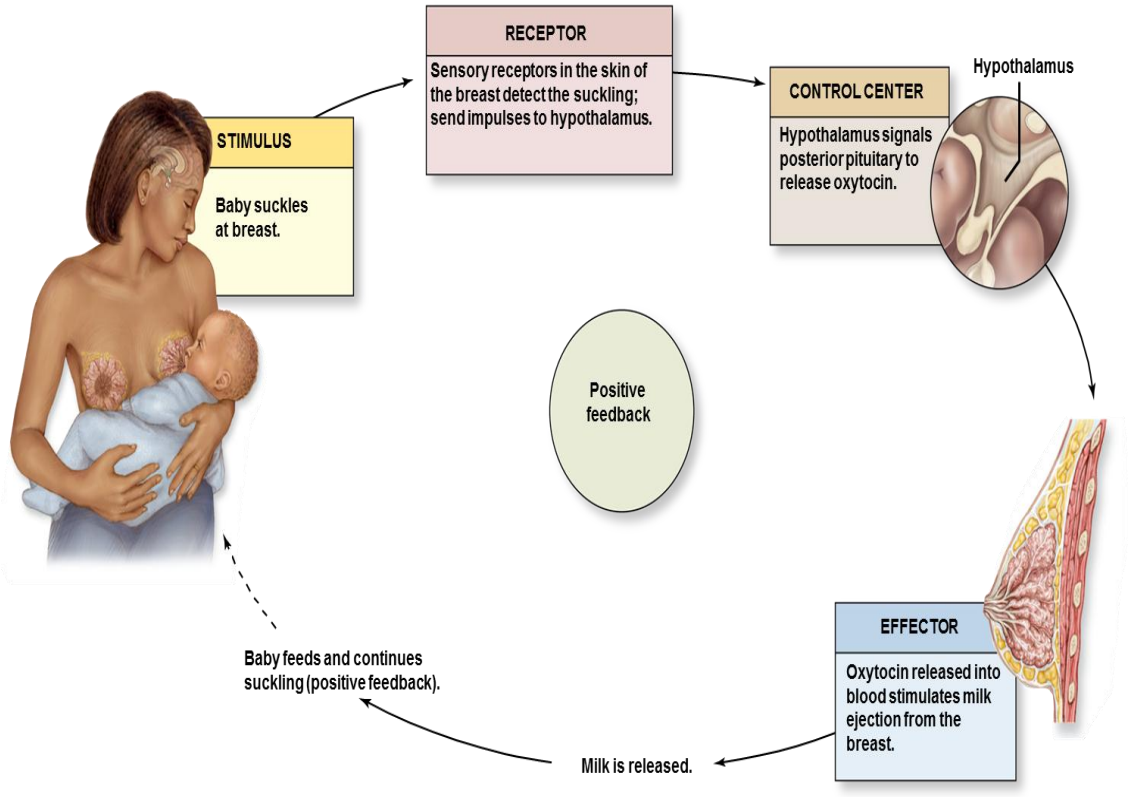
Positive Feedback

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

- **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.



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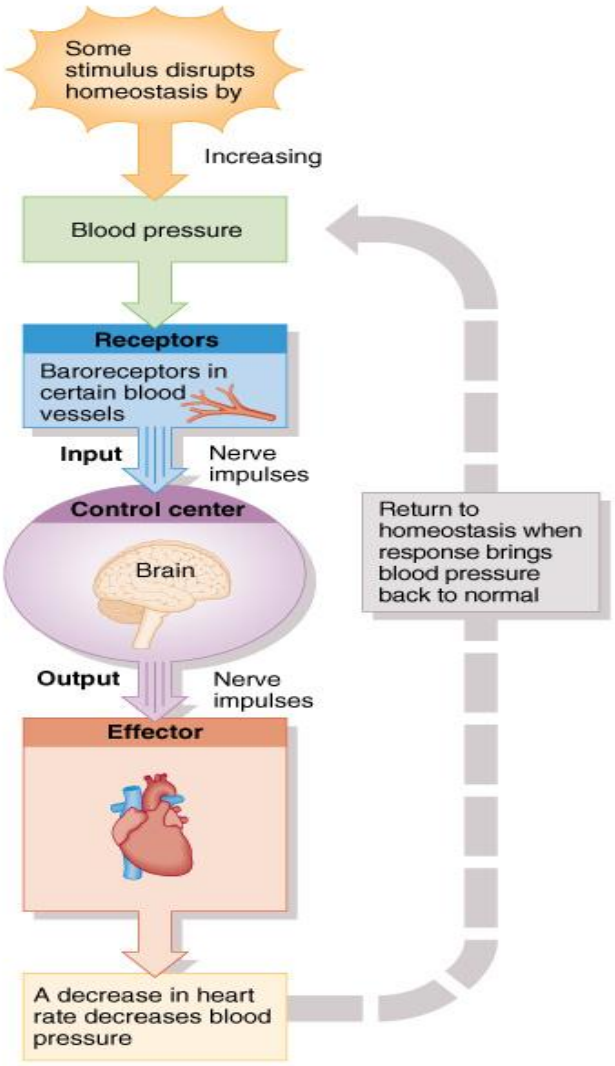
Homeostasis of Blood Pressure

- Baroreceptors (sensors in the vascular system that respond to changes in pressure with in blood vessels) 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



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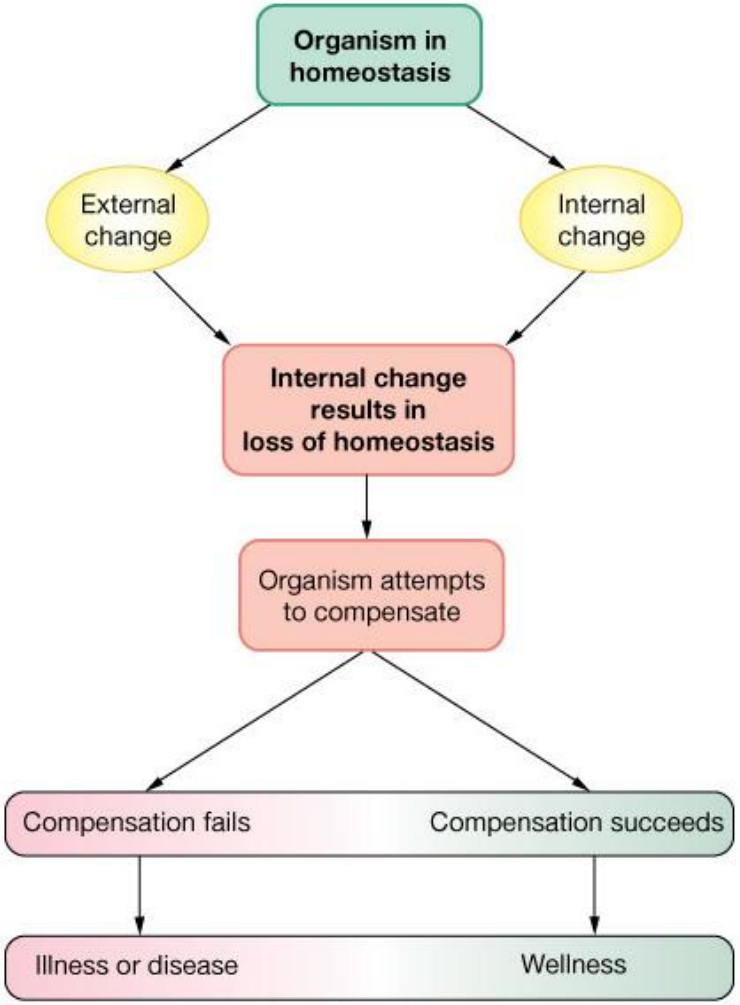
Homeostasis & Controls

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



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Some videos & quiz

1) Concept of Homeostasis :
https://www.youtube.com/watch?v=5HS66q_OA8g

2) Examples of Homeostasis :
https://www.youtube.com/watch?v=XZxuQo3ylII

3) QUIZ

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