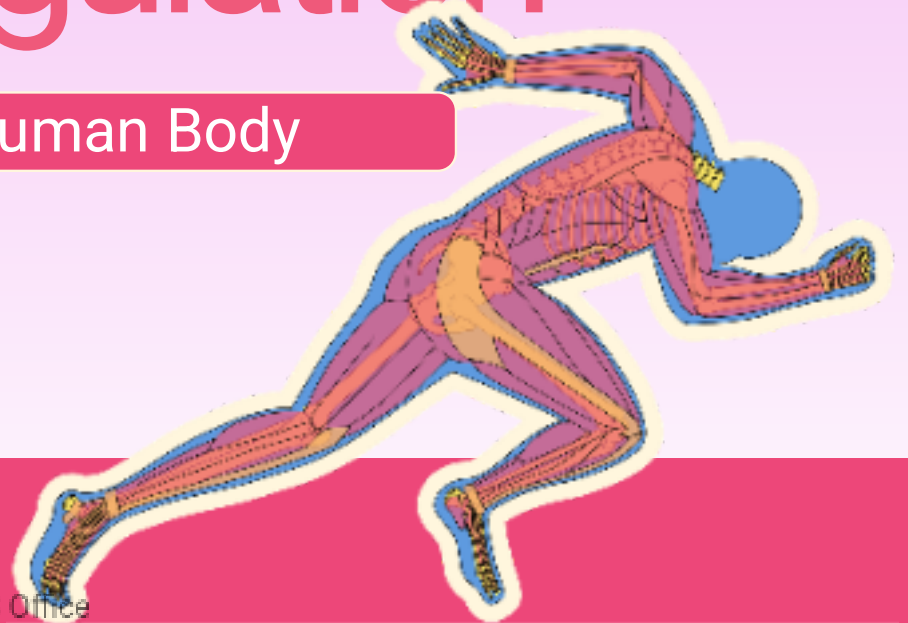




# Internal Regulation

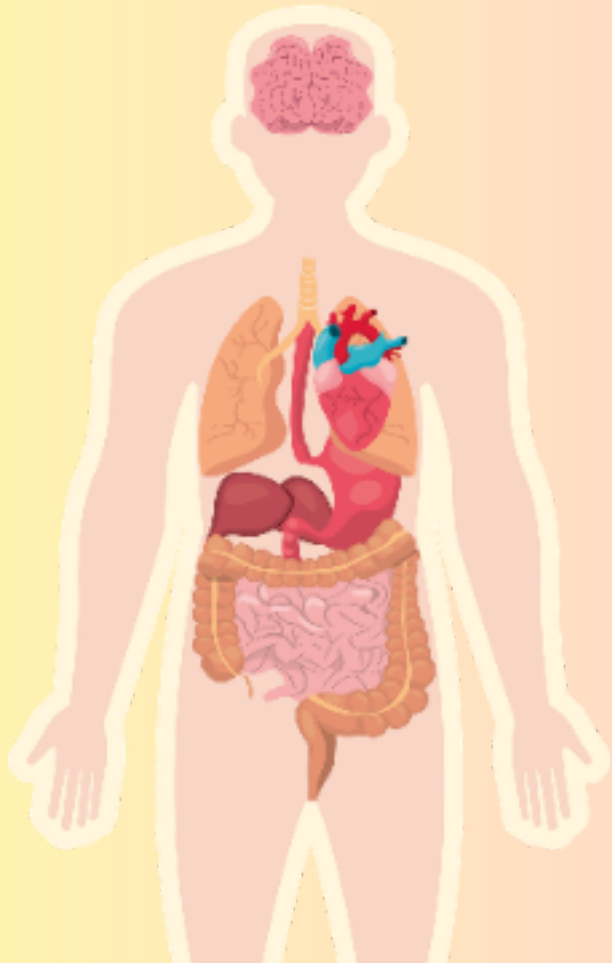
Maintaining Balance in the Human Body



# Temperature

Several studies on animals and humans indicate the necessity of temperature for behavior, learning, development etc.

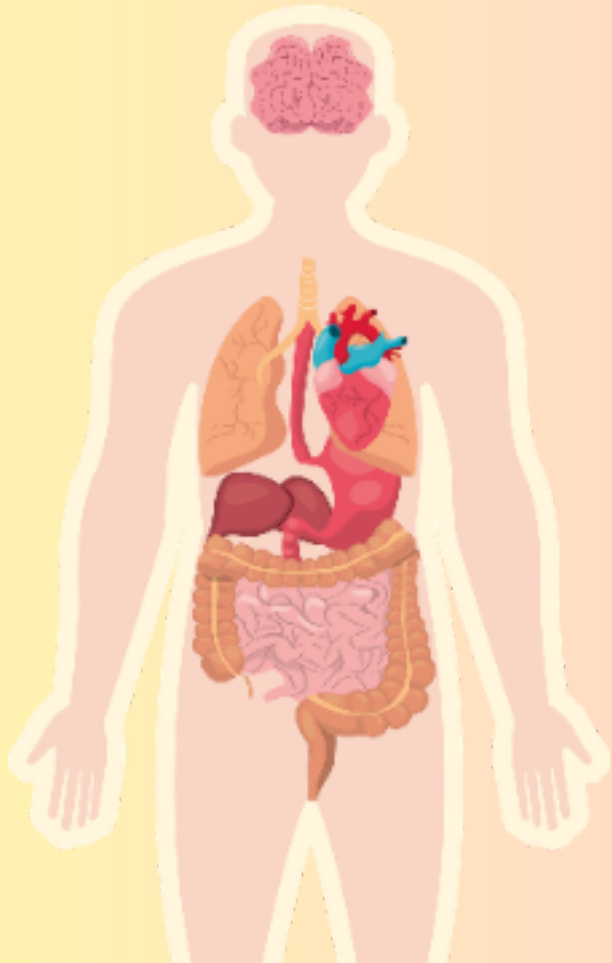




# What Is Homeostasis?

refers to biological processes which keep the body in a stable, constant condition. The body has a range within values have to fit, usually this range is so narrow that it is also called **a set point.**

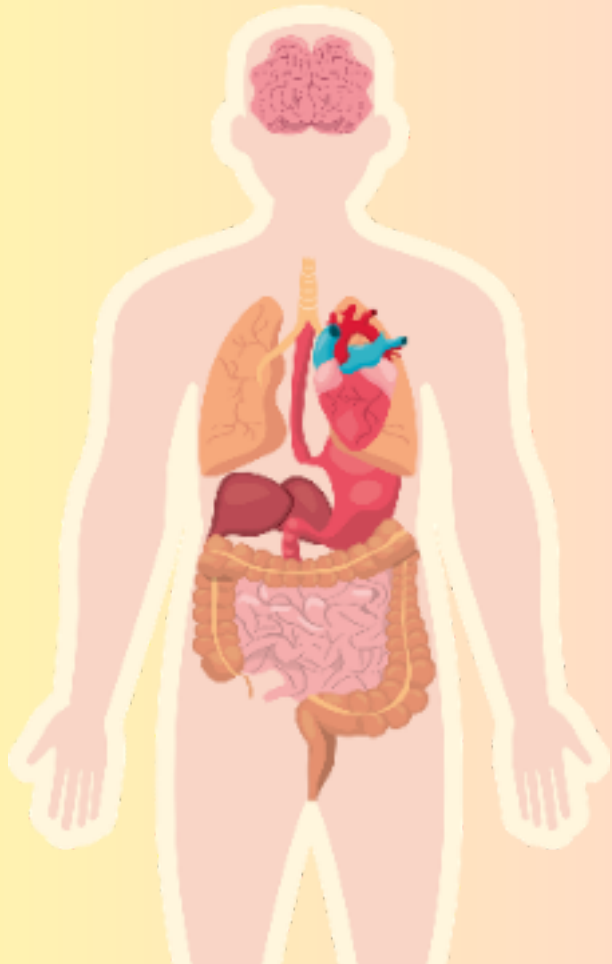
For example blood levels of oxygen, glucose, sodium chloride, protein, fat and acidity need to be stable.



# Set points can have seasonal changes

- Example: many animals increase their body fat before cold winter.
- Allostasis
  - refers to this adaptive mechanism the body uses to change its set points.
  - maintaining stability through change





# aLLOSTOSIS

- continuous process of energy balance instantiated by the brain to anticipate, regulate, and perform adaptive responses to environmental stressors.



# FEEDBACK MECHANISM

- Is a physiological regulation system in a living body that works to return the body to its normal internal state, commonly known as homeostasis.



# FEEDBACK MECHANISM

- is triggered when the system undergoes a change that causes an output.
- The biochemical control system is made up of a variety of components, including chemicals, genes, and their regulatory connections.



# FEEDBACK LOOP

- **is a system that uses an identified**
  - **receptor /sensor** (*detector of physiological value*)
  - **control center** (*integrator or comparator*)
  - **effectors** (*bring about change*)
  - **communication** (*means to control the level of a variable through nerves or hormones*)

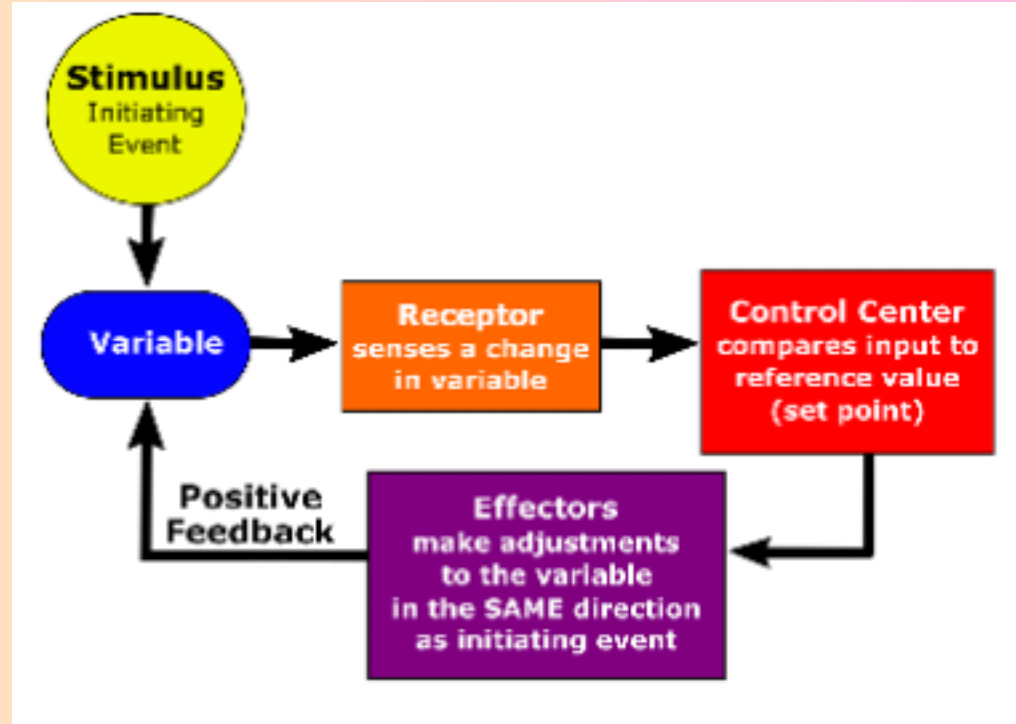


# TYPES OF FEEDBACK MECHANISM

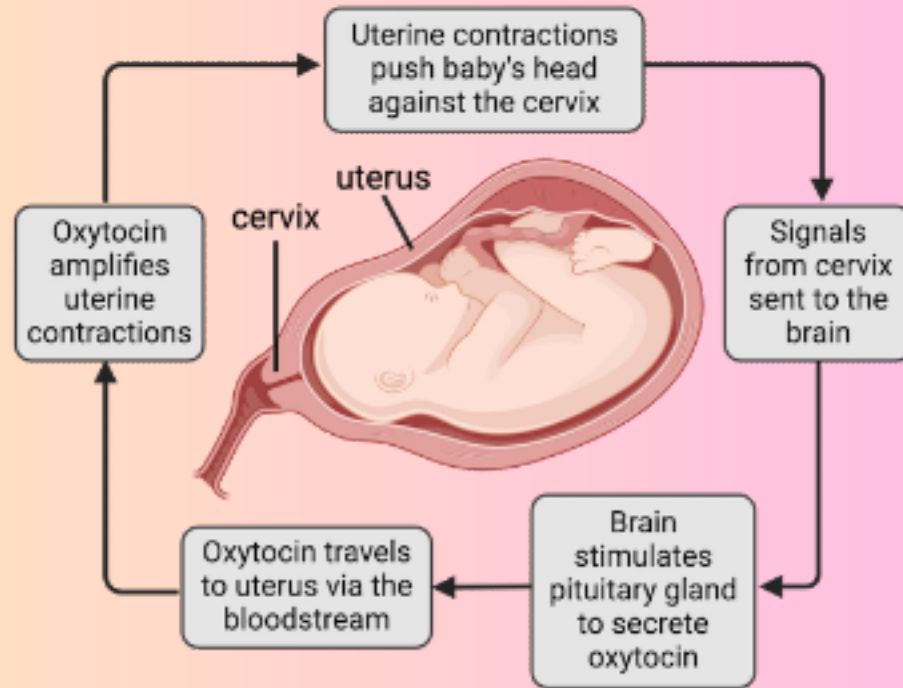
- **POSITIVE** - activation of one component leads to the activation of another
- **NEGATIVE** - the activation of one component results in the inactivation of another



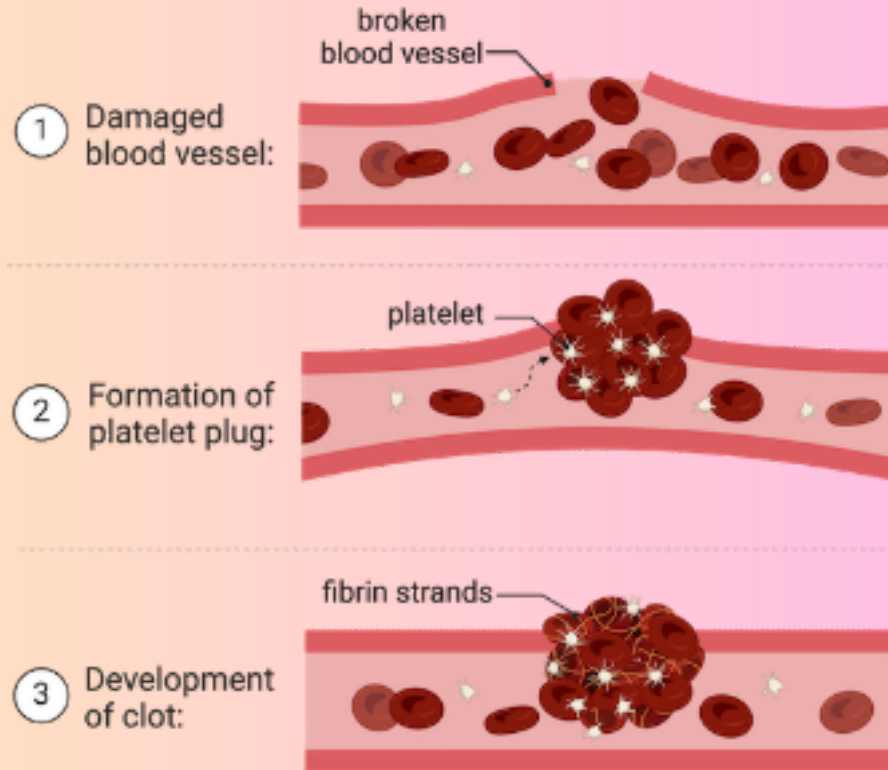
# positive feedback mechanism



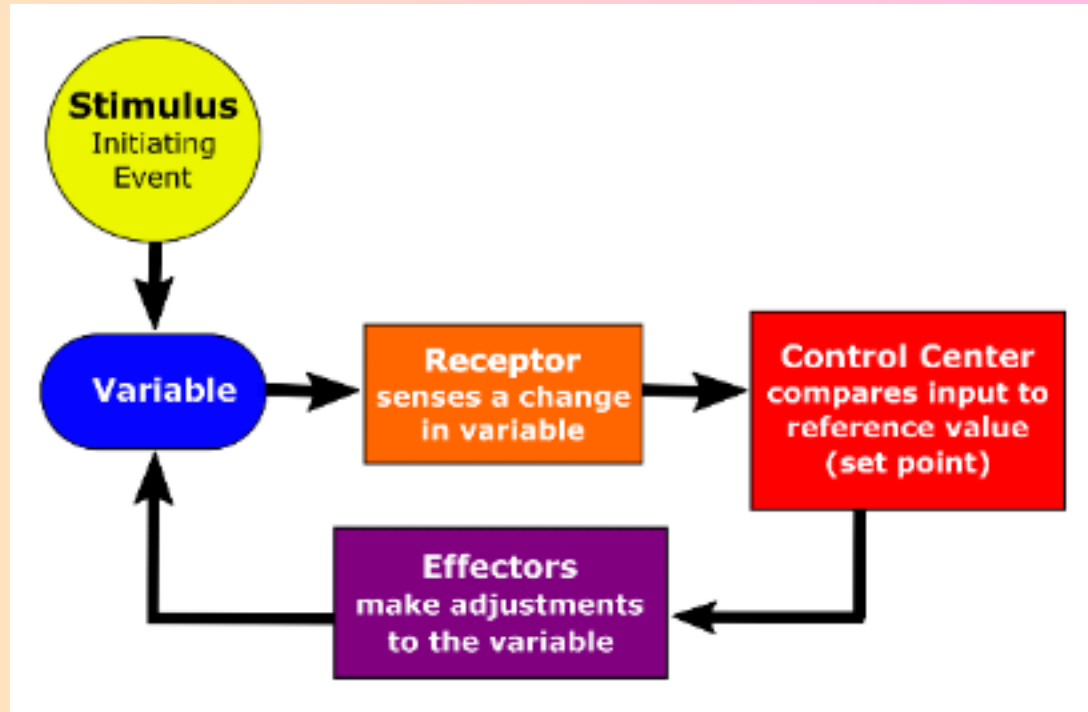
# positive feedback mechanism



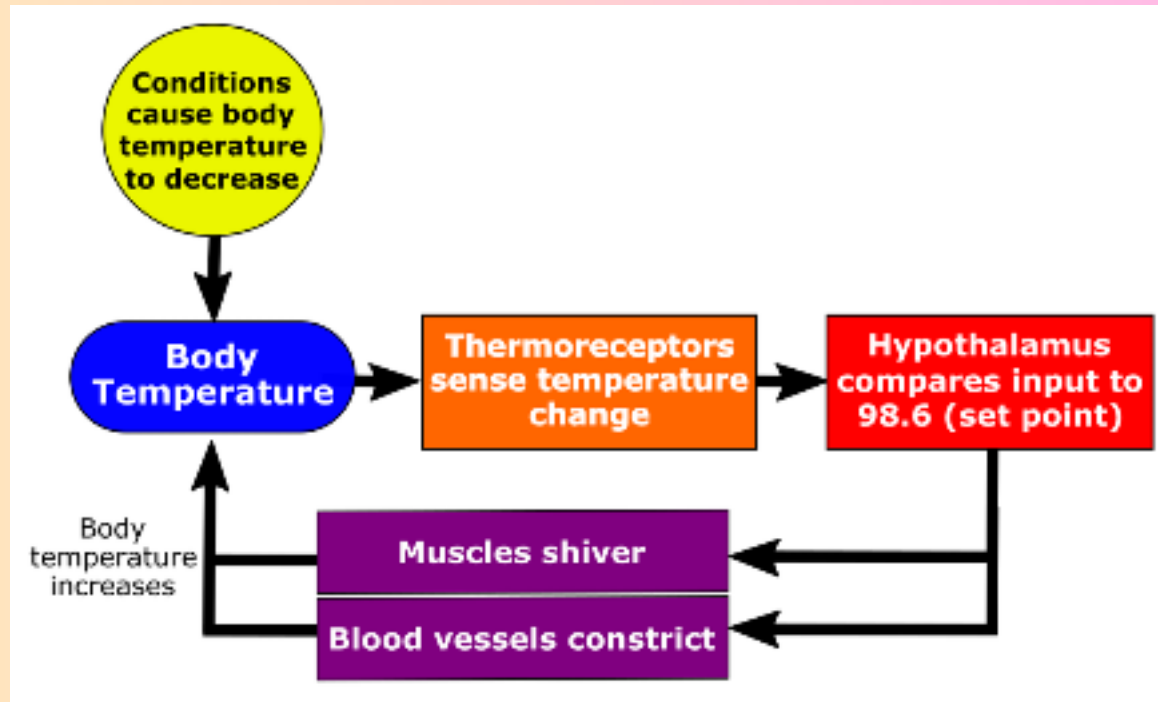
# positive feedback mechanism



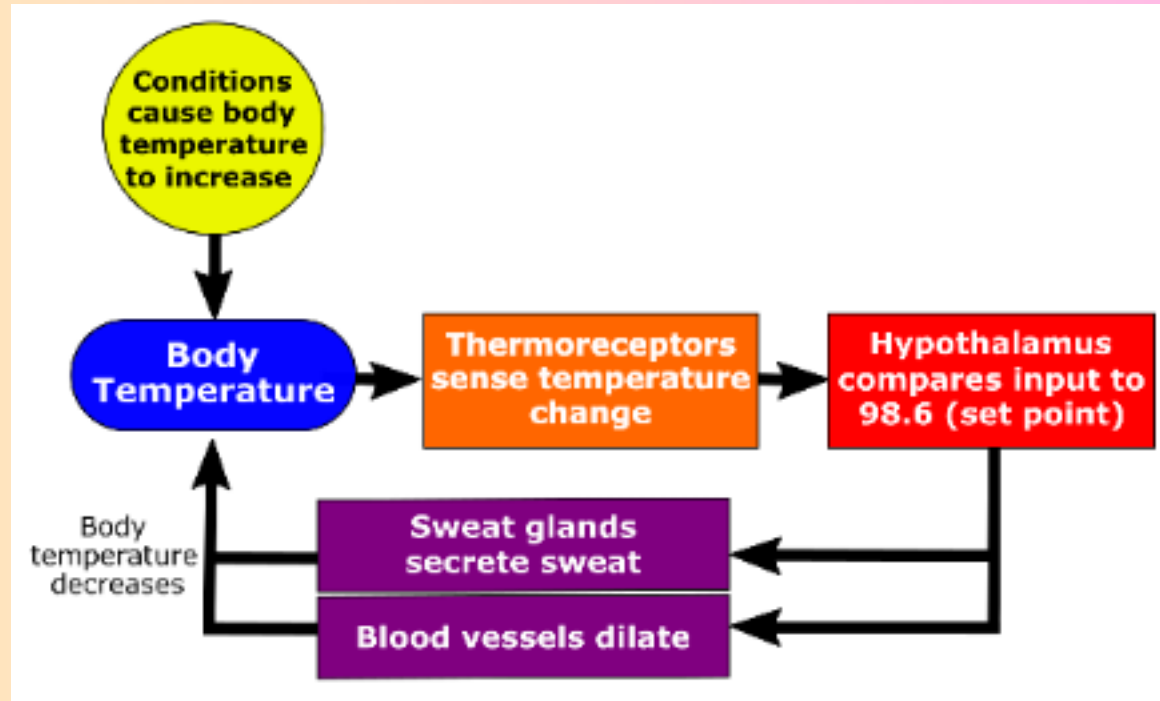
# negative feedback mechanism



# negative feedback mechanism



# negative feedback mechanism



# negative feedback

- Negative feedback is a process that reduces alterations from the set point.
- Maintenance of homeostasis (basal metabolism) consumes a lot of energy: approximately 2/3 of total energy consumption.



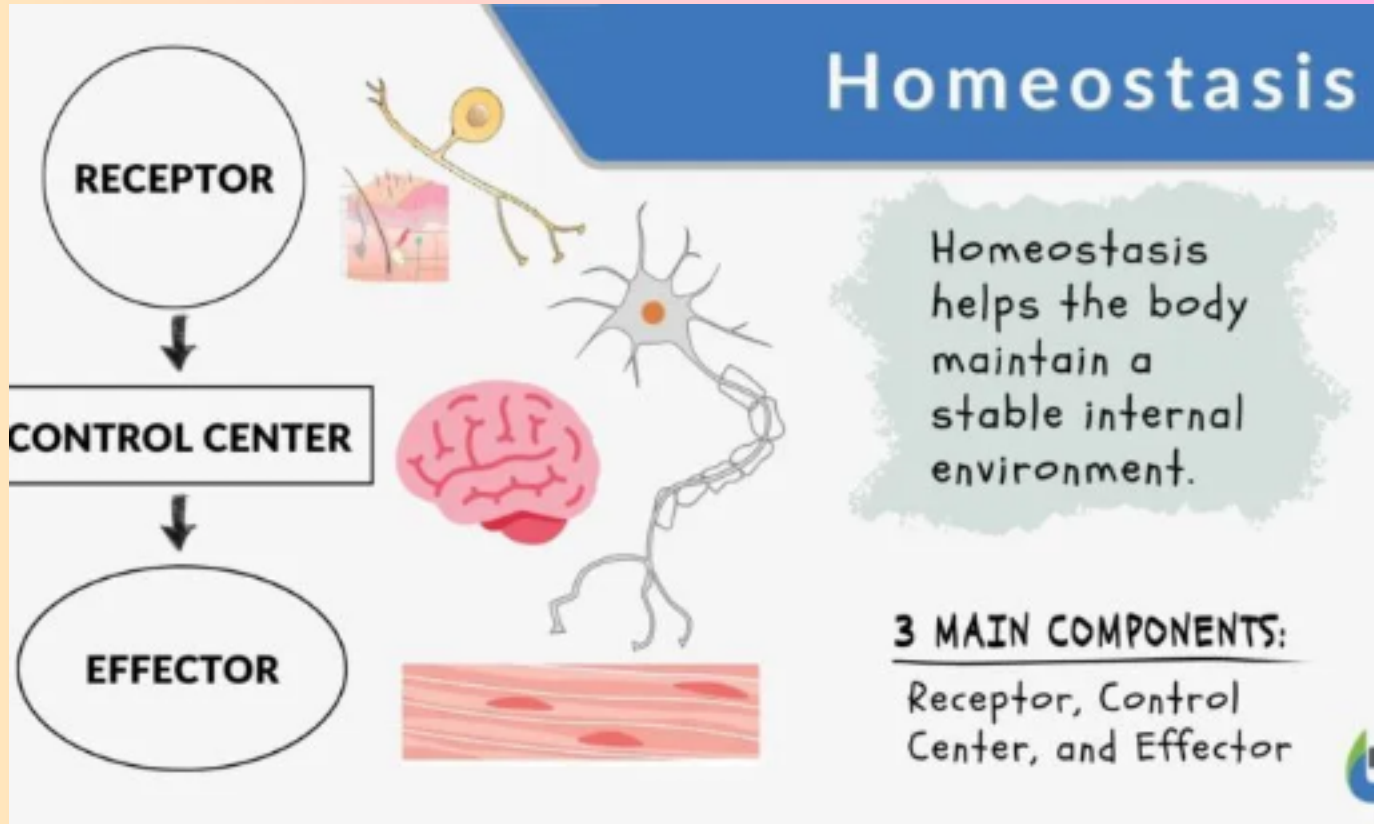


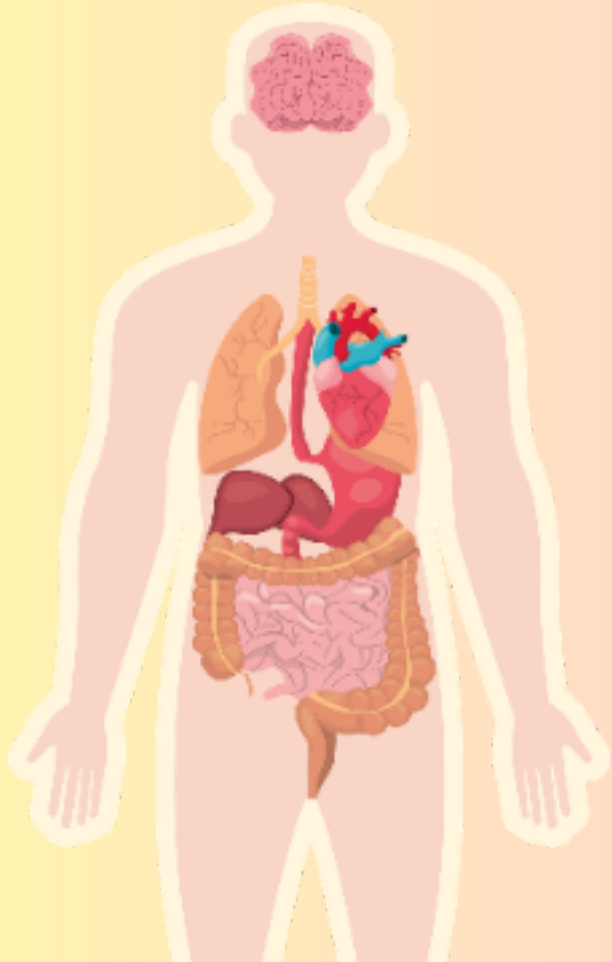
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# FEEDBACK LOOP





We have two kinds of mechanisms to control body temperature:

- **Behavioral:** putting more clothes or taking them off, cuddling with other people or animals or other warm objects, increasing or decreasing activity.
- **Physiological:** when hot, we sweat. (Other animal can also pant or lick themselves).
  - When cold, we shiver, decreasing blood flow in the skin.



# thermoregulatory classifications of animals

- If an animal is **poikilothermic**, its internal temperature *varies considerably*.
- It is the opposite of a **homeothermic** animal which *maintains thermal homeostasis*.
- Humans, as most of the other mammals, are homeothermic, we generate heat in respect to our total mass and radiate in respect to our surface area.



# thermoregulatory classifications of animals



## 1. Poikilothermic

- Definition: An animal whose internal body temperature varies with environmental temperature
- Body temperature can change widely
- Common in reptiles, amphibians, most fish, and insects



# thermoregulatory classifications of animals



## 2. Homeothermic

- Definition: An animal that maintains a relatively constant internal body temperature
- Uses physiological regulation (metabolism, insulation, circulation)
- Examples: humans, birds, most mammals

# thermoregulatory classifications of animals

## Endothermic vs Ectothermic

*This describes the source of heat, not temperature stability.*



# thermoregulatory classifications of animals

## Endothermic

- Generate most of their heat internally (metabolism)
- Usually homeothermic
- Heat production scales with body mass
- Heat loss scales with surface area
  - *Example: Humans and most mammals*



# thermoregulatory classifications of animals



## Endothermic

- Generate most of their heat internally (metabolism)
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  - *Example: Humans and most mammals*

# thermoregulatory classifications of animals



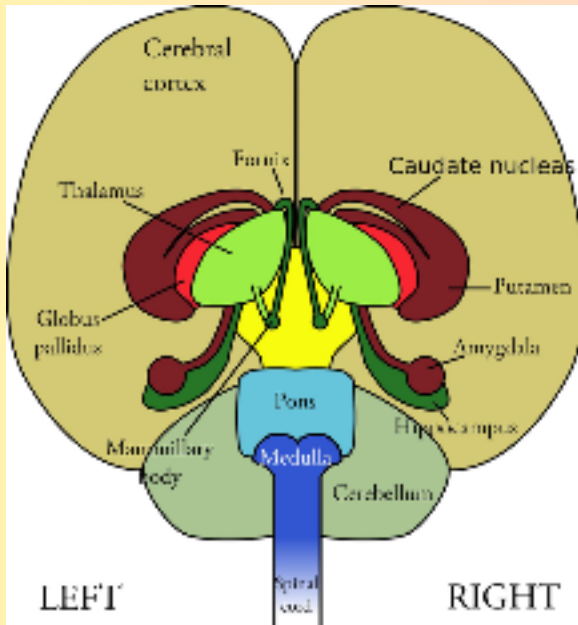
## Ectothermic

- Rely mainly on environmental heat
- Usually poikilothermic
- Body temperature depends on surroundings
- Examples: Reptiles, fish, insects

# NEUROBiological basis of thermoregulation



• preoptic area/ anterior hypothalamus (or POA/AH).



- These are the areas within and around the hypothalamus that are responsible for controlling the temperature.
- If these areas are cold an animal acts like the environment is cold even though it was warm.

# fever



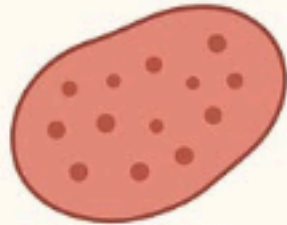
- *is the immune systems mechanism to slow down the growth of bacteria and enhance its own activity.*
  - *Leukocytes -> release cytokines -> activate the hypothalamus ->release prostaglandins.*
  - *Prostaglandins are essential for fever.*





HUMAN BIOLOGY

# MECHANISM OF FEVER



## PYROGENS

Substances that  
cause fever



## HYPOTHALAMUS

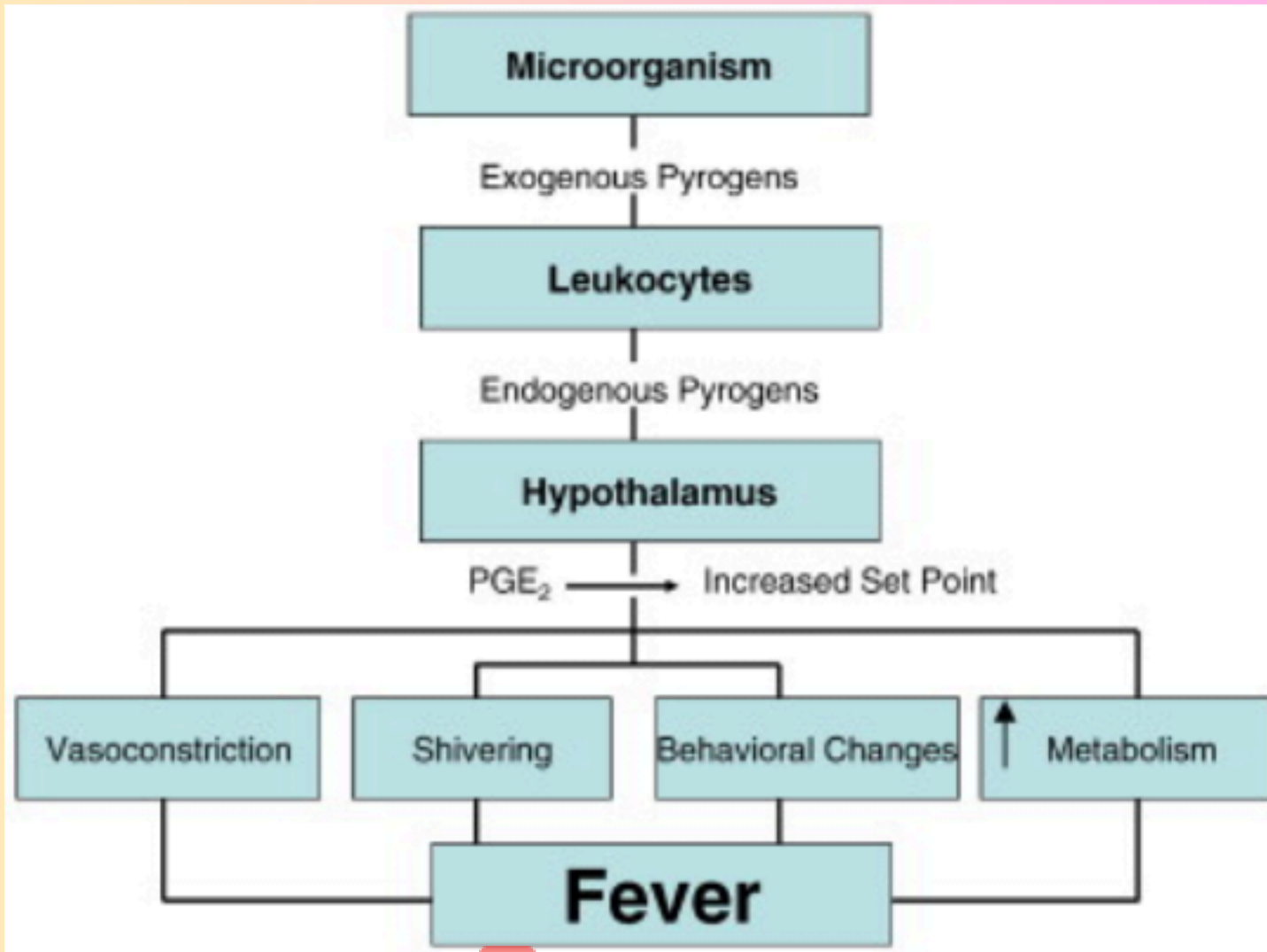
Raises body's  
set point



## FEVER

Elevated body  
temperature





# fever



- In fever the set point changes.
- If the fever is too high, it can also be dangerous: 41°C is life-threatening. In that temperature proteins start to shatter.
- Reproductive cells need a slightly cooler environment than the normal 37°C: this is the reason why men have testicles (around 34-35 °C)

## too high temperature

- *Sperm production decreases*
- *Sperm become abnormally shaped or less motile*
- *DNA damage in sperm increases*
- *Fertility can decline or stop temporarily*



thirst



# thirst

- 70% of our body is water.
- In the case of dehydration the body has several autonomic responses to control its homeostasis, e.g. producing more concentrated urine, decreasing sweating etc.
- **Vasopressin** (also antidiuretic hormone or ADH) and angiotensin II are hormones which constrict the blood vessels and thus increase blood pressure.



# thirst

- **Plasma osmolality** is the ratio of solutes to water in blood plasma.
- A person's plasma **osmolality value** reflects his or her state of hydration.
- **Dehydration**, a net loss of water that results in insufficient water in blood and other tissues.



# TYPES OF thirst

- **Osmotic thirst**, which is caused by changed concentrations.
- **Hypovolemic thirst**, (referring to low volume) which is caused by the loss of water (e.g. excessive bleeding or sweating).



# OSMOTIC THIRST

- Osmotic pressure is caused by differences in the concentration inside and outside the membrane.



# OSMOTIC PRESSURE

- arises when there is a difference in solute concentration (such as sodium ions) on the two sides of a membrane.
  - Water moves by osmosis
  - moves from the area with lower solute concentration to the area with higher solute concentration
  - The goal is to equalize concentrations on both sides

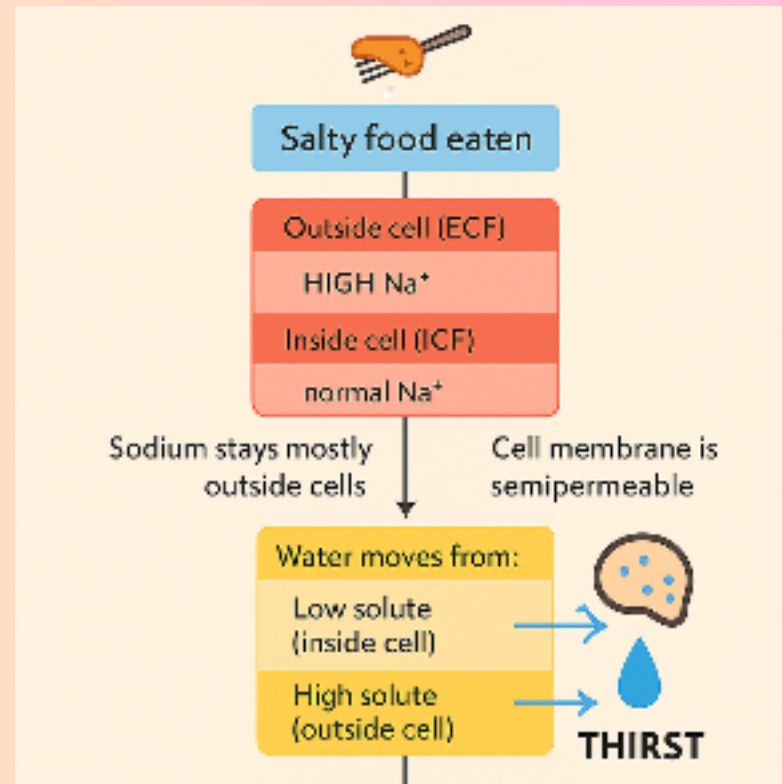


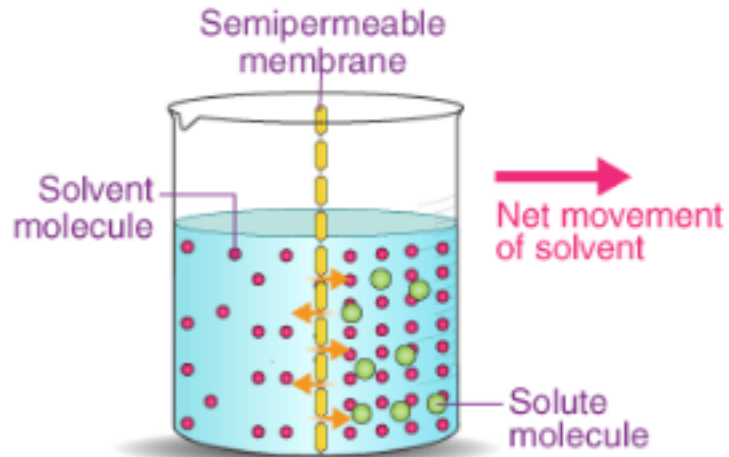
# SEMIPERMEABLE MEMBRANE

- A semipermeable membrane allows water to pass freely but not solutes.
- After eating something salty, sodium ions will increase in the extracellular fluid but not in the intracellular fluid.
- This condition draws water into the extracellular fluid and causes osmotic thirst.



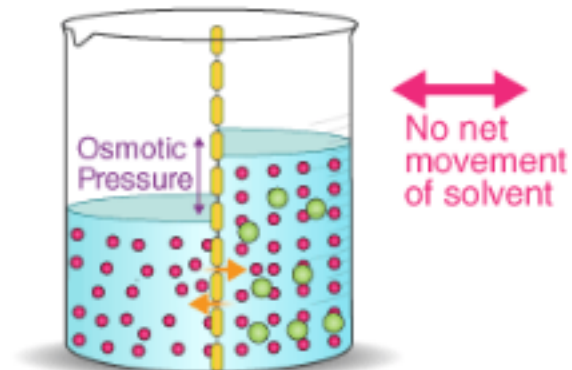
# EATING SOMETHING SALTY





### Initial state

Solute molecules partly shield membrane pores for the passage of solvent molecules from right to left

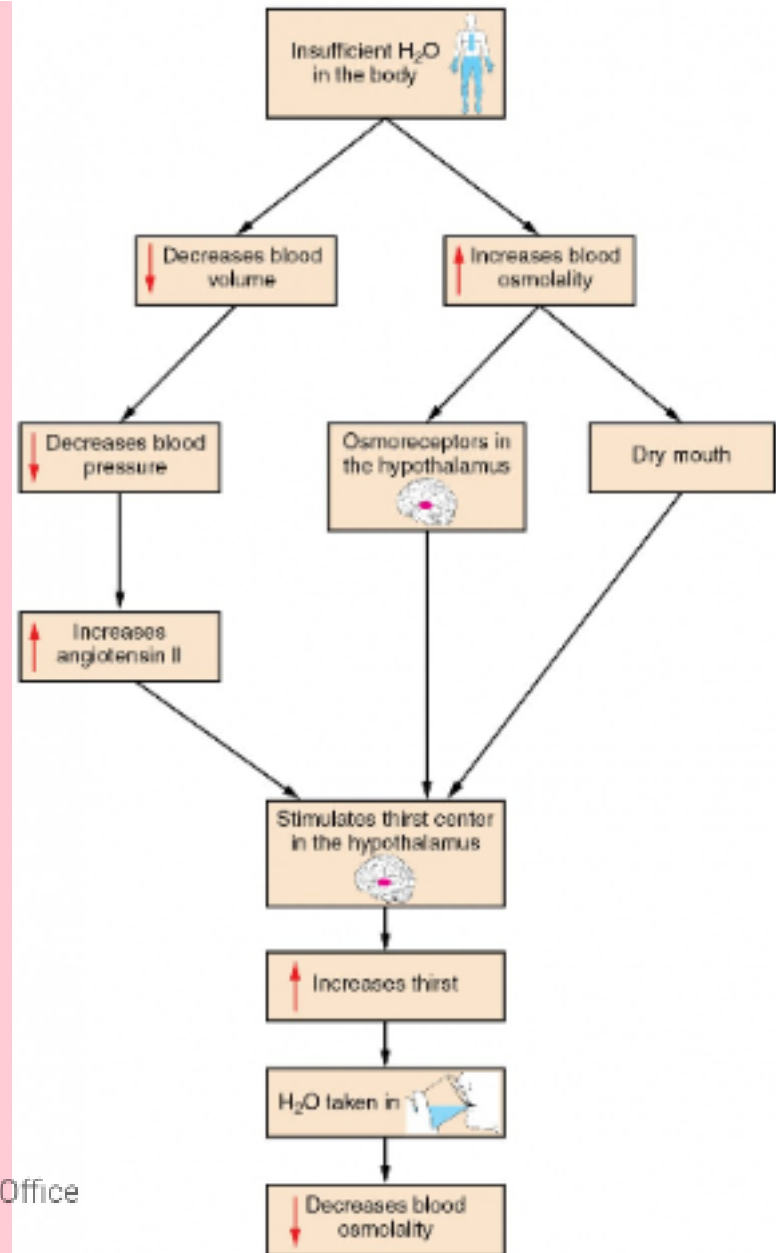


### Final state

The compensating pressure impedes the passage of solvent molecules from left to right



# HYPOVOLEMIC THIRST



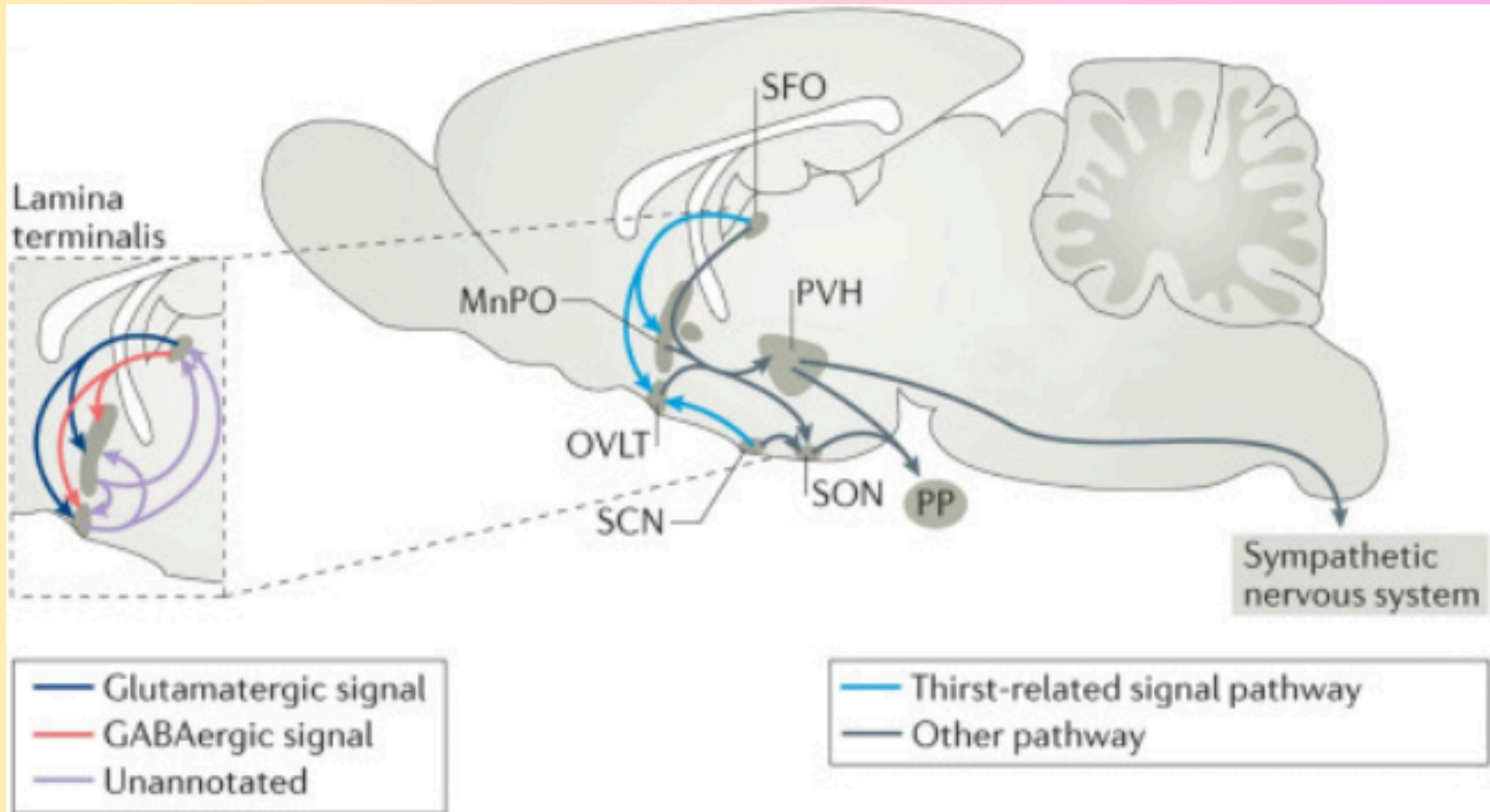
# NEUROBiological basis of thIRST



# 1. Detecting salt and water balance

- *The brain needs to know how salty (osmotic pressure) the body fluids are.*
- *Two special brain areas do this:*
  - *OVL (organum vasculosum of the lamina terminalis)*
  - *SFO (subfornical organ)*
- *These areas can directly sense changes in salt and water levels in the blood.*





## *2. Other detectors outside the brain*

- *The stomach and digestive system also have receptors that:*
  - *Detect sodium levels*
  - *Help stop you from drinking too much water*



# 1.. Controlling vasopressin (ADH)

- OVLT and SFO send signals to other brain areas:
  - Supraoptic nucleus (SON)
  - Paraventricular nucleus (PVN)
    - These nuclei release vasopressin (ADH).
- Vasopressin:
  - Helps the kidneys retain water
  - Keeps fluid balance stable



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## *4. Preventing overdrinking*

- *The digestive system detectors give feedback that:*
  - *Helps stop drinking before blood becomes overly diluted*
  - *Protects the body from water imbalance*



## 5. Sodium-specific hunger (salt appetite)

- Salt hunger happens when the body lacks sodium
- The hormone angiotensin II:
  - Increases the desire to eat salty foods
  - Helps restore sodium balance

