
# HOMEOSTASIS & HYDRATION

*Homeostasis* is the great balancing mechanism of the body. When one system goes down, signals go from your brain through the nervous system, and hormones (like little sentries floating about in the blood stream and reporting back to glands) kick in.

Thus begins an amazing process of evaluation and re-allocation of resources, replacing lost minerals with what you have stored up in your skeleton or in organs of your body.

What is removed by this process (as an emergency measure during a time of bodily crisis) will eventually be needed by some other system, and unless replaced somehow will in time lead to a breakdown of the whole.

The cell and indeed all biological functions require hydration for survival. Dehydration is not to be confused simply with thirst, as that is but a late indicator of systemic dehydration. In fact, damage to cells and their function from dehydration is masked for the most part until very late and its discovery usually coincides with a visit to a doctor.

Homeostasis: A phenomenon whereby a state or process (for example, within an organism) is regulated automatically despite the tendency for fluctuations to occur. Fundamentally, homeostatic mechanisms are in place to ensure that:

- Cells are in a state of balance or dynamic equilibrium i.e., Hydration,
- The blood pH level does not drop or rise precipitously, which results in death.

Hydration is the simple act of retaining water or the creation of a Hydration shell: That is: a "covering" of water molecules, which surrounds polar or charged substances in water. The association is due to the charged regions of the polar water molecules themselves.

De-hydration is the loss of water or to make anhydrous; that is to disassociate the charged regions of the water molecules themselves.

Hydration is critical in the body: without water, we die.

In a state of dehydration, we engender aging, illness and ultimately death**.**


**HOMEOSTATIC MECHANISMS:**

**Triggered by changes in extracellular fluid.**

Act by negative feedback to restore or preserve the optimum state by producing a change in the opposite direction: too much produces less, too little produces more.

**Requirements of a homeostatic mechanism are:**

- Detectors-To monitor internal and external variables e.g., Photoreceptors, chemo and baroreceptors.
- Coordinating mechanisms - relay information. Nerves act quickly, hormones are slower but last longer.
- Integrating center - (e.g., hypothalamus, medulla) receives information., interprets and sends appropriate signals to Effectors.
- Effectors - cause changes to restore the balance e.g., muscles, heart, glands, kidneys. Any stimulus that disrupts the `steady state' of homeostasis is a stress and may be psychological (e.g., anxiety) or physiological (external e.g., heat or internal e.g., raised blood sugar).

**Temperature Control:**

The analogy is often made with domestic heating and cooling systems where a fall in temperature will trigger the thermostat, fire up the boiler and heat up the radiators until the temperature rises and then the thermostat will switch off. A rise in temperature will fire up the air conditioning until the temperature falls to the pre-set level and then the system will switch off.

We have some control over our external temperature (clothes, food, heating) but cells produce heat during metabolism and if we did nothing proteins and enzymes throughout the body would curdle and become useless.

**Heat Gain**

Peripheral thermoreceptors in skin (detectors) relay information. Via nerves (coordinating mechanism) to the temperature control center on hypothalamus (integrating center) which also contains central thermoreceptors sensitive to the heat of passing blood. This triggers the sympathetic nervous system so that:

- skin capillaries dilate - heat radiated off
- sweat glands activated - heat evaporates off

The system switches off (negative feedback) once the desired temperature is achieved.


**Heat Loss**

Heat Loss thermoreceptors in hypothalamus activate thyroid hormones → increase metabolic rate → sympathetic nervous system shuts down skin capillaries and sweat glands → food metabolized in liver to produce heat.

Should the core temperature continue to fall shivering produces heat from muscle contraction Blood flow to the skin can range from 250 ml/min to 2500 ml/min as a homeostatic mechanism.

**Blood gas levels**
Refer to respiratory physiology to see how the peripheral and central chemoreceptors maintain blood oxygen and carbon dioxide levels within very narrow limits using negative feedback mechanisms.

**Fluid Balance:**

*DECLINE in body fluid reserves* → Osmotic pressure of blood rises this is → Detected by osmoreceptors in hypothalamus which sends → Message to posterior pituitary where → ADH is released which → Acts on distal tubules of kidney and → Water is reabsorbed into blood.

(ADH is a hormone secreted from the posterior pituitary gland. It is the primary regulator of body water. ADH acts on the distal tubules in the kidneys to increase reabsorption of water. This has the effect of increasing blood volume and, secondarily, blood pressure ADH also has a vasoconstrictor effect (that is, it constricts small blood vessels), hence its alternate name, vasopressin.) The release of ADH is controlled by the hypothalamus (an area in the brain), which contains so-called osmoreceptors. These cells sense the osmolality (concentration of particles) of extracellular fluid. When the osmolality is high, the pituitary secretes more ADH, which stimulates retention of water to dilute the body fluids. When the osmolality is low, the pituitary secretes less ADH.

*RISE in body fluids* → stops release of ADH and excess water is passed as urine.

**HOMEOSTASIS EXAMPLE:**

Blood Calcium Levels:

*RISE* in blood calcium → Thyroid gland stimulated →Calcitonin released → Calcium release from bone arrested → Calcium returns to normal → Mechanism switched off.

*FALL* in blood calcium → Parathyroid stimulated → Stimulates calcium release from bone → Parathyroid hormone (PTH) released and causes calcium reabsorption from kidney → Vitamin D activated and increases calcium absorption from gut (also increases calcium release from bone) → Calcium levels return to normal → Mechanism switches off.