B.Sc Second year Zoology (Honours) Paper – 4

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Osmoregulation

What is Osmoregulation?

Osmoregulation is a process that regulates the osmotic pressure of fluids and electrolytic balance in organisms. In animals, this process is brought about by osmoreceptors, which can detect changes in osmotic pressure. Humans and most other warmblooded organisms have osmoreceptors in the hypothalamus. Besides the brain, osmoregulators are also found in the kidneys.

Types of Osmoregulation

There are two major types of osmoregulation:

- Osmoconformers

Osmoconformers are organisms that try to match the osmolarity of their body with their surroundings. In other words, these organisms maintain the same osmotic pressure inside the body as outside water. They conform either through active or passive means. Most marine invertebrates such as starfish, jellyfish and lobsters are osmoconformers.

- Osmoregulators

Osmoregulators are organisms that actively regulate their osmotic pressure, independent of the surrounding environment. Many vertebrates, including humans, are osmoregulatory. Most freshwater fish are considered to be osmoregulatory too.

Osmoregulation in Different Organisms

Different organisms exhibit different types of osmoregulation. Following are some of the osmoregulation processes in different organisms:

Osmoregulation in Fish

Freshwater fish and marine fish osmoregulate in different ways. The environments which they have varying levels of salinity, hence the process of osmoregulation is different.

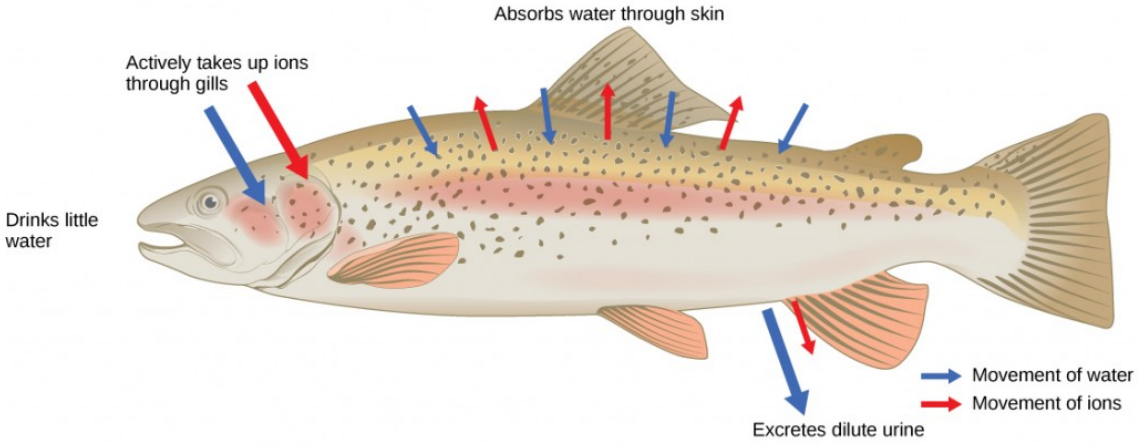
- Osmoregulation in Freshwater Fish

Freshwater fishes are hypertonic to their surrounding environment, which means that the concentration of salt is higher in their blood than their surrounding water. They absorb a

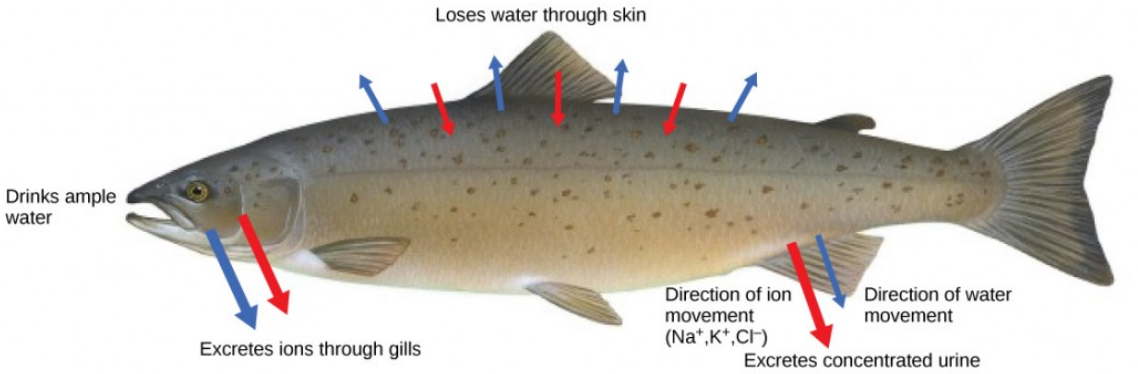
controlled amount of water through the mouth and the gill membranes. Due to this intake of water, they produce large quantities of urine through which a lot of salt is lost. The salt is replaced with the help of mitochondria-rich cells in the gills. These cells absorb salt into the blood from the surrounding water.

- Osmoregulation in Marine Fish

Compared to freshwater fish, marine fish face the opposite problem. They have a higher concentration of water in their blood than their surrounding environment. Consequently, it results in the tendency to lose water and absorb the salt. To get around this problem, marine fish drink large quantities of water and restrict urination. Another additional energy expenditure also arises as these organisms actively need to expel salt from the body (through the gills).



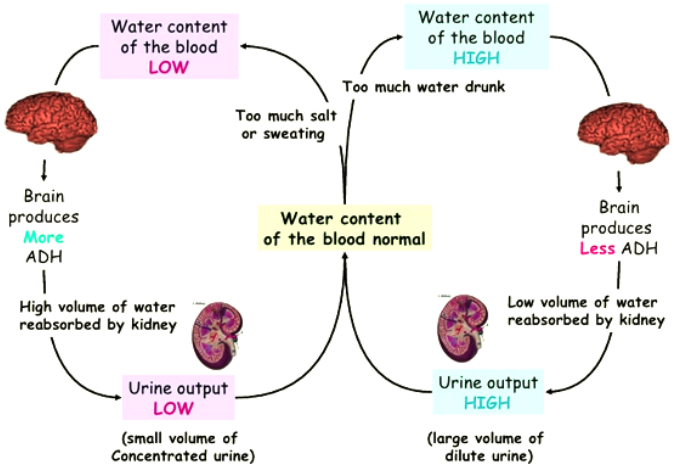
(a) Osmoregulation in a freshwater environment



(b) Osmoregulation in a saltwater environment

Osmoregulation in Humans

The kidney is the main organ responsible for osmoregulation in humans. Water, amino acids and glucose are reabsorbed by the kidneys. When the water level in the body is high, it releases a large amount of hypotonic urine. When the water level is low, it retains water and produces a low amount of hypertonic urine. Thus, the kidneys maintain the electrolytic balance of the body.



Osmoregulation in humans

Aldosterone, angiotensin II, and antidiuretic hormones control the absorption process. Some water and electrolytes are also lost by perspiration.

Osmoreceptors in the hypothalamus of the brain control the thirst and secretion of ADH. ADH opens the water channels of aquaporins allowing the water to flow. Thus, the kidneys keep absorbing water until the **pituitary gland** stops releasing ADH.