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# Osmoregulation

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# Osmoregulation

## Definitions

Most *marine invertebrates* have body fluids with the same osmotic pressure as the sea water; they are isosmotic or isosmotic.

One way is to change the osmotic concentration of its body fluids to conform with that of the medium, thus remaining isosmotic with the medium; such an animal is an osmo-conformer.



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The other way is to maintain or regulate its osmotic concentration in spite of external concentration changes; such an animal is called an *osmoregulator*.

Fresh-water animals have body fluids that are osmotically more concentrated than the medium; these animals are *hyperosmotic*.

Some aquatic animals can tolerate wide variations in the concentration of the water in which they live; they are called euryhaline animals.



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A marine animal that can penetrate into brackish water and survive is euryhaline.

An extremely euryhaline animal may even be able to tolerate shorter or longer periods in fresh water.

There is no sharp separation between euryhaline and stenohaline animals.



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# Osmoregulation

Osmoregulation is a physiological activity for proper maintenance of water and salt balance of the body tissues in fishes, whether they live in fresh, marine or brackish waters.



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# Osmoregulatory problem in freshwater fishes

Animals such as invertebrates, fishes, amphibians, reptiles and mammals that live in freshwater are osmoregulators.

Their body fluids ( $1/3^{\text{rd}}$  of the concentration of seawater) have a greater concentration than their surrounding environment (**hyperosmotic**).

Skin has low permeability to water and salt ions, hence very little water is allowed to enter the body or salt to diffuse out through it.



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To counter the continuous inflow of water through gills, freshwater fishes produce a large amount of dilute urine.



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# Osmoregulatory problem in marine fishes

Marine fishes experience just the opposite effect in comparison to freshwater fishes because their internal salt content is less than that of the surrounding water.

Marine teleosts are **hypoosmotic** (body fluids 1/3 of that seawater) and live in a medium ing high concentration of salts.

marine fish has an internal osmotic concentration lower than that of the surrounding seawater, so it tends to lose water and gain salt.





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It actively excretes salt out from the gills.

Marine fishes are faced with the problem of continuous loss of water and gain salts.

As marine fish drinks seawater and Na and Cl ions are actively absorbed through the gut.

Many species are reported to drink water >25% of their body weight/day, of which 80% is absorbed.



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This excess of salt ions is excreted out into the water by the special cells in the gills, oral membrane and inner surface of the operculum.



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# Osmoregulatory problem in chondrichthyes or elasmobranchs

The chondrichthyes maintain osmotic concentration of blood nearly at the same level as that of seawater ( **isoosmotic**) and are not in danger of dehydration and do not drink seawater

This is achieved by retaining nitrogen containing compounds, mainly urea and trimethylamine oxide (TMAO) in the blood, which is slightly hyperosmotic to seawater.



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The gills of chondrichthyes are impermeable to urea so that it is retained in the blood in large quantity to raise the osmotic concentration of blood to a slightly higher level than seawater.

The osmotic balance in these fishes is maintained by retention of high level of urea in the blood.

Whereas, freshwater sharks have a lowered concentration of urea in the blood.



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**Rectal gland** is a structure found in marine elasmobranchs which helps in osmoregulation by excreting NaCl.



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**Migratory** fish are hyperosmotic to their environment during some periods and hypoosmotic at other times.

To complete their life cycle, amphihaline fishes show remarkable adaptation in being able to migrate from the sea to freshwater bodies or vice versa.

They have to survive in 2 different environments for the sake of their progeny.



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One lives in seawater, grows there and after becoming reproductively mature starts migrating to breed in riverine or land locked freshwater.

The young born in freshwater migrate into seawater and live there until they are in turn mature and ready to spawn in freshwater.

These fish eg. Salmon and hilsa are known as amphihaline potemotocous.



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The young salmon, which is born in freshwater spends several years in these surroundings and undergoes important morphological, biochemical and physiological modifications before undertaking downstream migration to marine feeding grounds.