HOMEOSTASIS: OSMOREGULATION

HOMEOSTASIS

Homoeostasis is a process responsible for maintenance of the constant internal environment.

The control of salt and ion in body fluids level is a good example of homoeostasis.

OSMOCONFORMERS

Osmoconformers change their body fluid osmolarity to match the concentration of the medium.

OSMOREGULATION

Osmoregulation is defined as a process of maintaining the balance between water and dissolved constituents (salts in solution) in the body. It can also be stated as maintaining the osmotic balance of the body fluids in order to maintain homeostasis.

OSMOREGULATORS AND OSMOCONFORMERS

OSMOCONFORMERS

- **Osmoconformers** match their body osmolarity to their environment actively or passively.
- Most marine invertebrates are osmoconformers, although their ionic composition may be different from that of seawater.
- Osmoregulators tightly regulate their body osmolarity, which always stays constant, and are more common in the animal kingdom.
- Osmoregulators actively control salt concentrations despite the salt concentrations in the environment. An example is freshwater fish.

OSMOREGULATORY

- Some fish have evolved **osmoregulatory** mechanisms to survive in all kinds of aquatic environments.
- When they live in fresh water, their bodies tend to take up water because the environment is relatively hypotonic.
- In such hypotonic environments, these fish do not drink much water. Instead, they pass a lot of very dilute urine, and they achieve electrolyte balance by active transport of salts through the gills.
- When they move to a hypertonic marine environment, these fish start drinking sea water; they excrete the excess salts through their gills and their urine.

STENOHALINE AND EURYHALINE ANIMALS

Organisms such as goldfish that can tolerate only a relatively narrow range of salinity are **referred to as stenohaline**. About 90 percent of all bony fish are restricted to either freshwater or seawater. They are incapable of osmotic regulation in the opposite environment. Examples of stenohaline animals are **goldfish, haddock, and sea turtles.** The opposite of euryhaline organisms are stenohaline ones, which can only survive within a narrow range of salinities. Most freshwater organisms are stenohaline, and **will die in seawater,** and similarly most marine organisms are stenohaline, and **cannot live in fresh water.** Animals can be classified as either stenohaline or euryhaline.

For a few fishes like salmon to spend part of their life in fresh water and part in sea water. Organisms like the salmon and molly that can tolerate a relatively wide range of salinity are referred to as **euryhaline organisms.** Examples of euryhaline animals include the **molly fish, salmon, and eels.**

- The **main difference** between euryhaline and stenohaline is that **euryhaline organisms can adapt to a wide range of salinities, whereas stenohaline organisms can only adapt to a narrow range of salinities.**
- Furthermore, euryhaline organisms can survive either in freshwater, saltwater or brackish water, while most freshwater stenohaline organisms are unable to survive in salt water and vice versa.
- Therefore, euryhaline organisms mainly inhabit estuaries and tide pools with regularly changing salinities, and some of them migrate between freshwater and saltwater during their life cycle.
- On the other hand, stenohaline organisms are fixed into either saltwater or freshwater habitats.
- Euryhaline and stenohaline organisms are two types of aquatic organisms with adaptations to different levels of salinities.

Mechanism of osmoregulation

Fish live in variety of environments such as in fresh water, seawater and estuarine water. There are different mechanisms in different aquatic conditions for osmoregulation.

They carry out the following mechanisms for osmoregualtion:

1. Removal of excess water

2. Compensation of salt loss

3. Compensation of water loss and

4. Removal of excess salts

1. Removable of excess water

In the case of freshwater fishes, the body fluid is **hypertonic** and the fresh water is **hypotonic**. Hence **endosmosis** occurs.

- Freshwater fishes remove the excess water by the **glomerular kidneys.**

2. Compensation of salt loss

When the freshwater fishes expel the excess of water, some amount of salt also lost from the body. This loss of salt is made by the following methods:

- Crustaceans and freshwater fishes have special kind of cells in the gills called **Chloride cells**. They absorb salts from the freshwater and add to the body fluids.
- The kidney of freshwater fishes reabsorbs some salts from the urine.

3. Compensation of water loss

In the case of marine animals the body fluid is **hypotoni**c and the seawater is **hypertonic.** Hence **exosmosis** occurs in marine fishes. As a result the marine fish are **dehydrated**.

- The loss of water is compensated by **drinking seawater** and getting water from **marine foods**.

4. Removal of excess salts

When the marine animals drink seawater to compensate water loss, the salt content of the body fluids increases. The excess salts is removed by the following methods:

- The marine fishes have chloride secreting cell in their gills and secretes out excess salts.

Osmoregulation in Fishes

Aquatic vertebrates.
Live in fresh water, seawater and brackish water.
Homeo-osmotic animals
Maintain a constant concentration of body fluids
They are osmoregulators.
They are osmotically stable-stable internal environments
They are euryhaline-tolerate wide changes in salinity

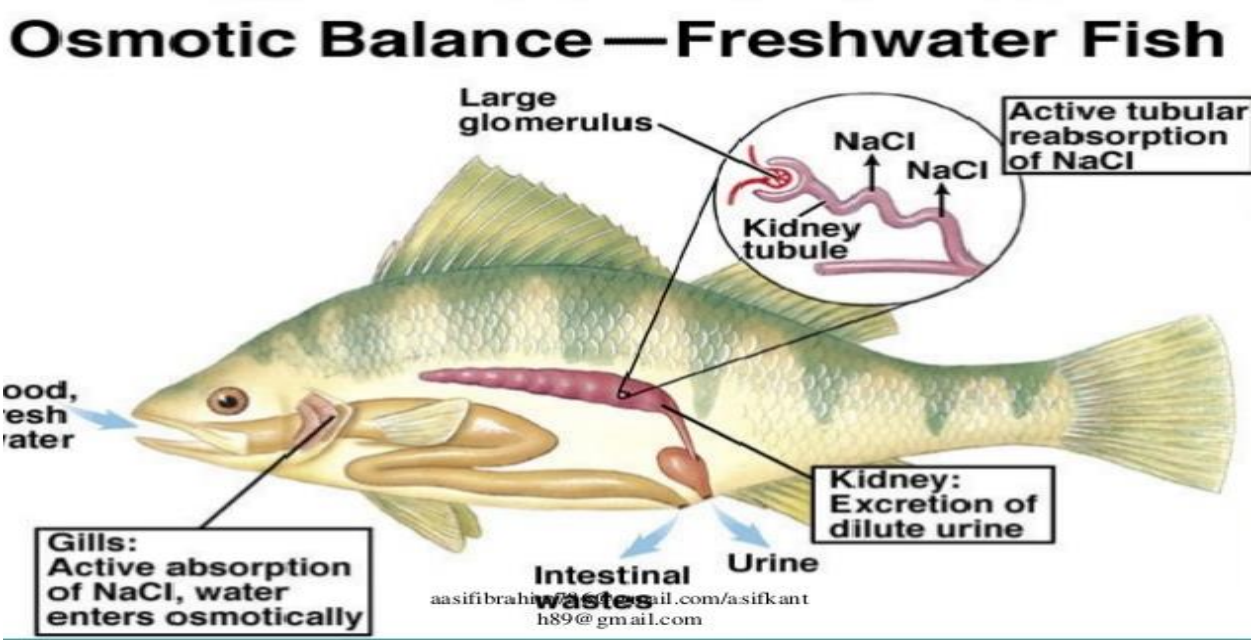
Osmoregulation of fishes can be divided to following headings:

1. Osmoregulation in freshwater Teleosts
2. Osmoregulation in Marine teleosts
3. Osmoregulation in migratory fishes
4. Osmoregulation in Marine Elasmobranchs
5. Osmoregulation in freshwater Elasmobranchs

1. Freshwater Teleosts

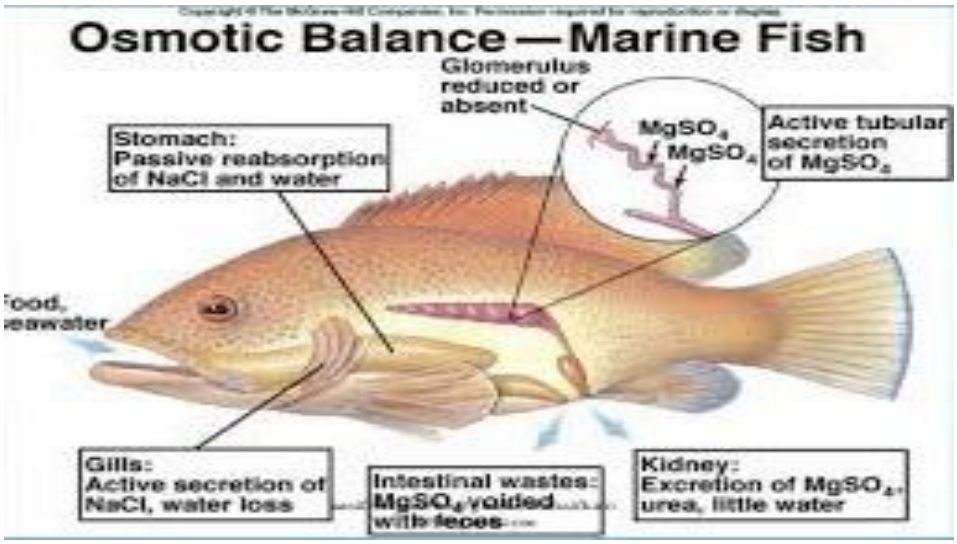
Body fluid is **hypertonic** (high concentration ions).

Aquatic medium is **Hypotonic (**Lowconcentrations of ions)
Endosmosis occurs
Freshwater enters in to the body fluid and volume of body fluid increases.
Excess of water is removed in urine the by the glomerular kidney.
Along with urine some amount of salt is lost.
Salt content of the body fluid decreases.
Salt loss is compensated by chloride cells in the gills.



2. Marine Teleosts

Body fluid is **hpotonic** and Aquatic medium is **Hypertonic**.
Exosmosis occurs.
Loss of water-compensated by drinking seawater.
Salt content of body fluid increases.
Excess salt is secreted out by chloride cells in the gills.
Excess ions in the body fluids are diffused out through skin and gills.
Marine teleosts are aglomerular and reabsorbs water from urine. As a results concentrated urine.



3. Migratory fishes

Migratory fishes are two types **Anadromous and Catadromous.**

These face two problems in osmoregulation since they to live in freshwater and seawater

i. Anadromous Fishes

Fishes migrate from the sea to freshwater for spawning. **eg.Salmon sp.**

When it is in seawater, the body fluid is **hypotonic** and the seawater is **hypertonic.**

Exosmosis occurs.

The loss of water is compensated by drinking seawater.

Salt concentration of body tends to increase.

The excess of salts is secreted out by chloride secretary cells.

When the fish in freshwater, the body fluid is hypertonic and the freshwater is hypotonic.

Endosmosis occurs.

The excess amount of water is removed by the glomerular kidney in the form of urine.

Since the salts is lost through urine is compensated by the chloride secreted cells in the gills.

ii. Catadromous Fishes

These fishes migrate from from fresh water to Seawater for spawning. Eg. **Anguilla sp.**

When it is in fresh water, the osmoregulation resembles that of Fresh water teleosts. And

When it is in seawater, the osmoregulation is that of marine teleosts.

4. Marine Elasmobranches

Marine elasmobranches retain urea and trimethylamine oxides (an amino acids) in the blood and body fluids.

Hence the concentration of body fluids is **isotonic** to seawater.

Marine elasmobranches no osmosis occurs and no loss or gain of ions.

However, the gain salts through diffusion and eating marine foods.

This excess salts is removed from the body by the rectal glands present in the gut.

Kidney removes large amounts of isotonic urine.

Kidney reabsorbs urea from the urine.

5. Freshwater Elasmobranches

Prists and carcharias gangeticus are fresh water sharks.
Since they retain urea to some extend.
Body fluid is hypertonic and freshwater is hypotonic.
Endosmosis occurs.
Compensatory mechanisms are kidney removes large quantities of dilute urine.

Osmoregulation in Crustaceans

Crustaceans are aquatic arthropods.
Both marine and freshwater animals.
Maintain a Homeo-osmotic animal.
Osmoregulators
Osmotically stable
Euryhaline animals
E.g. Seawater (Artemia Salina), Freshwater prawns and brackish water crabs.

1. Artemia salina

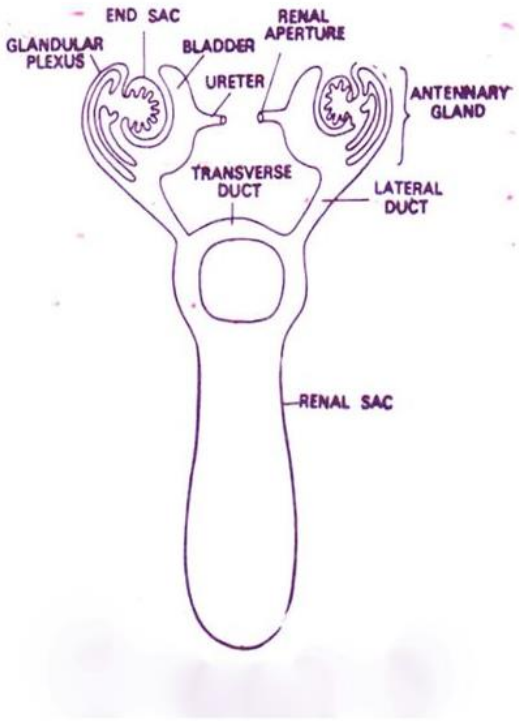
Otherwise called **brine shrimp.**
Lives in **salt pans** where salt concentration is higher than that of seawater.
External medium is **Hypertonic** and body fluid is **Hypotonic**.
Animal loses water by **exosmosis**.
To compensate water **drinks salt water**.
Excess salt is secreted out by **chloride cells** in the gills

EXCRETORY SYSTEM

The excretory system consists of

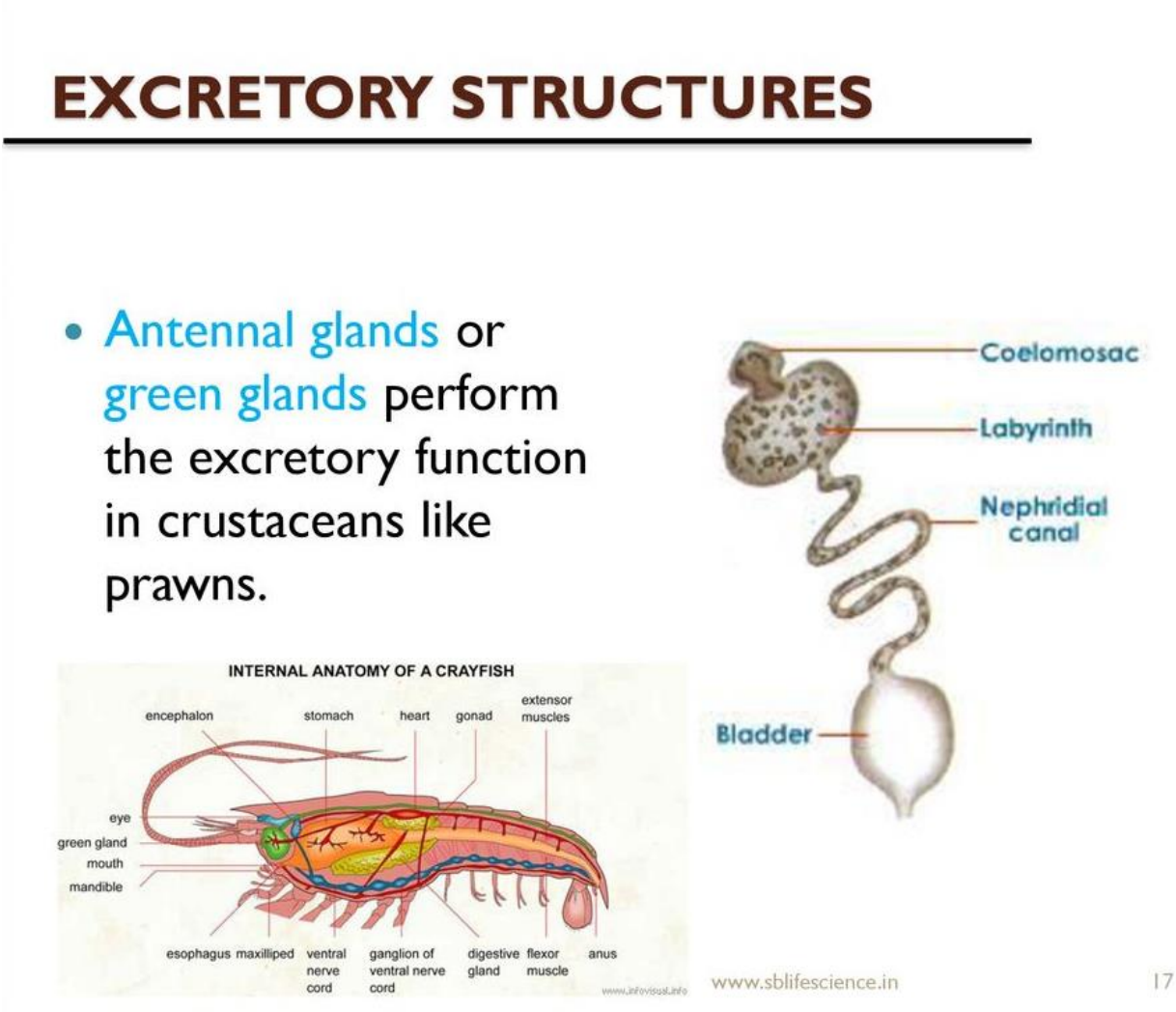
1. **Antennal glands:** There is a pair of antennal or green glands. Each lies enclosed in the proximal segment (coxa) of the antenna. Its parts are an end sac, a coiled tube and a bladder.

2. **Renal sac:** The renal sac is large, blind. It cover the cardiac stomach and reach the gonads. Anteriorly, it communicates with bladder. The tubular part is glandular and the bladder is thin walled. The bladder opens to the exterior by the excretory pore.



2. Freshwater Prawns (crayfish)-Astacus

Freshwater crayfish (Crustaceans).
External medium is Hypotonic
Body fluid is Hypertonic.
Endosmosis occurs.
Excess water is removed by the green glands (Antennary glands) in the form of urine.
Salt loss by body fluid is compensated by the surrounding media by the chloride cells in the gills.
Also compensated by reabsorbs of salts from the urine by the green glands.



3. Estuarine crabs-Carcinus

It lives in sea where river flows

i. It exposed to dilute seawater during raining seaons.

External medium is Hypotonic and body fluid is Hypertonic.

Endosmosis occurs.

Excess water is removed by the green glands in the form of urine.

Salt loss by body fluid is compensated by the surrounding media by the chloride cells in the gills.

Also compensated by reabsorbs of salts from the urine by the green glands.

ii. During summer seasons

External medium is **Hypertonic** and body fluid is **Hypotonic**.

Animal loses water by **exosmosis**.

To compensate water **drinks salt water**.

Excess salt is secreted out by **chloride cells** in the gills