Student 6: High Not Achieved

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The word ‘homeostasis’ originates from the Greek word meaning ‘staying the same’, and involves the balance and consistency of certain conditions. An example is the control of body temperature by thermoregulation in warm blooded animals like humans. Homeostasis can be an open or closed system. Homeostasis is important to fish like Chinook salmon. Osmoregulation is also an example of homeostasis and is the way by which salmon regulate their body water. 1

Salmon live in both fresh water and salt water during their lives. They are born in in fresh water and migrate out to marine waters for most of their life. They return to the place they were born in fresh water to reproduce. Changing between fresh water and salt water changes the amount of water in their body. They are adapted to the changes by osmoregulation. 1

When an imbalance occurs, osmoregulation works by negative feedback. This system detects any changes and initiates changes to restore the concentration of water in the body. 3 This control system detects changes in the salt concentration of the water Chinook salmon live in. The feedback mechanism works differently when they are in fresh water and salt water environments.
Feedback systems are made up of components which detect the change, followed by a process to reverse the change. The components (see diagram below) in the system include: the **stimulus**, the **receptor**, the **control centre** and the **effector**. The stimulus causes the fish’s response. In this case it is the change in salt level within the body. The receptor senses the stimulus and sends information to the control centre. In salmon the receptor is the hypothalamus - part of the brain. The hypothalamus detects how concentrated the blood is inside the fish. The hypothalamus stimulates the pituitary gland, which is the control centre. The control centre responds to the stimulus. The effector includes the kidneys and gills, which respond to the commands set by the pituitary gland. 2

When salmon are in salt water (hypertonic):

1. water is lost through the gills and skin
2. water and salt are gained by drinking
3. salt is removed by the chloride cells, and lost via the faeces
4. salt and little water is lost via the urine

3

The kidneys of salmon have fewer and smaller glomeruli which reabsorb glucose in convoluted tubules. Osmosis is the process of diffusion of water molecules through a semi-permeable membrane. Water has the ability to go through a number of different membranes. The concentrations can be categorised in three different sections:
Isotonic - the concentration of water is the same as the concentration of salt
Hypotonic - less concentration of salt in comparison to a greater concentration of water
Hypertonic - more concentration of salt in comparison to a lesser concentration of water

In salt water there is more water inside the body than outside the body, so water moves out of the body. Receptors in the hypothalamus detect that there is a high concentration of salts in the blood, and stimulate the pituitary glands to release a hormone that causes the transport of ions to take place in the gill membrane .The high salt concentration in the ocean

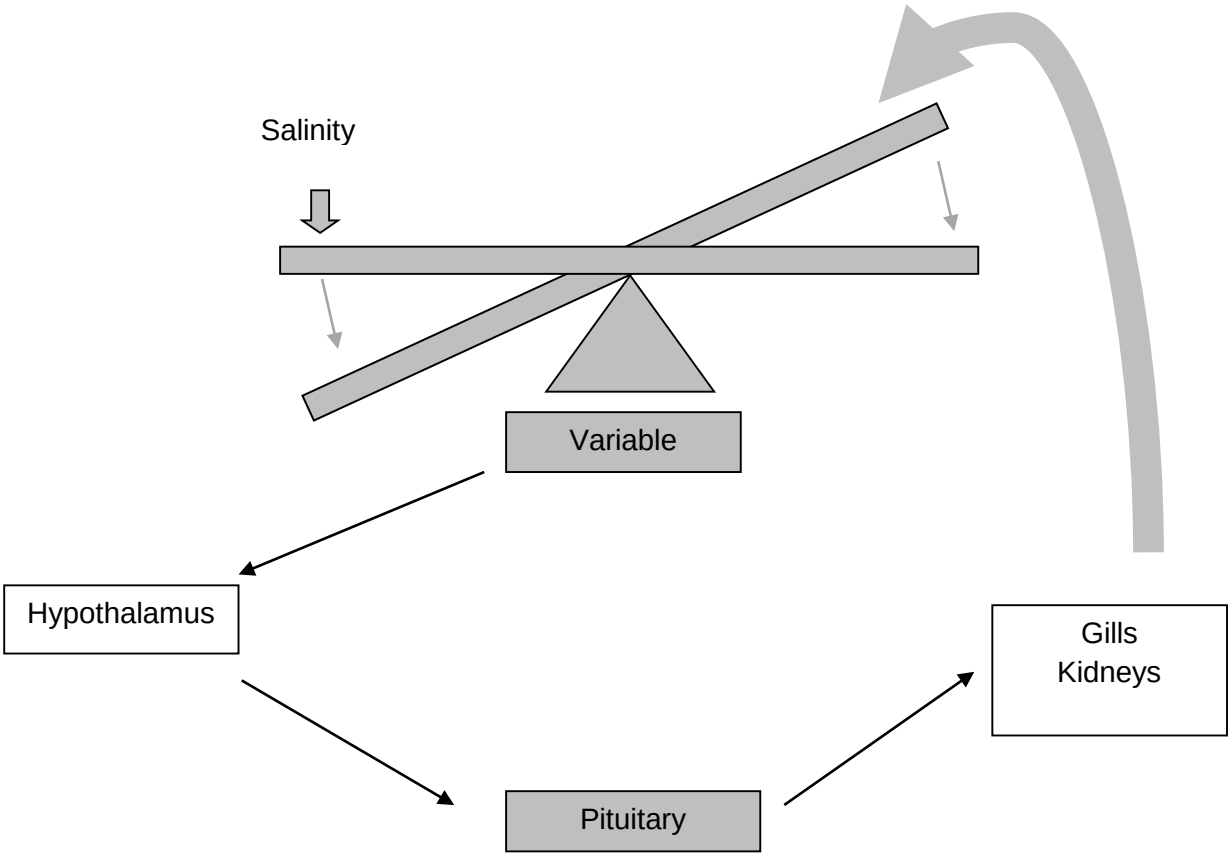
3 means that salt will also be constantly diffusing into the salmon's body, which means that salmon suffer from dehydration and salt loading.

When salmon are in fresh water (hypotonic):

1. water is absorbed through the gills and skin
2. salt is obtained through 'chloride cells' and with food
3. water is removed via copious urine

The kidneys have numerous large glomeruli which reabsorb salts along convoluted tubes.

3 In fresh water there is more water and lower levels of salt outside the body than inside the body, so water moves inside the body. Receptors in the hypothalamus detect that there is a high concentration of water in the blood, and stimulate the pituitary glands to release a hormone that causes less water to be absorbed back into the blood in the kidneys.



2

Disruptions to the system happen as the result of toxicants and micro-organisms which fish gills are sensitive to. Pollutants clog the gills directly. Damage to the kidney through bacterial infection can be serious. If the toxicity cannot be removed the organs are not able to function properly. If salmon become diseased by losing their ability of osmoregulation, they may even die. When the control system breaks down, salmon are under stress and may not be able to break down food or carry out essential life processes. For example, the excretion of waste products which can then build up and cause harm to the fish. 4