

MODULE B4: HOMEOSTASIS

B4.1 What is homeostasis?

1. recall that homeostasis is the maintenance of a constant internal environment;
2. understand that automatic control systems throughout the body maintain a range of factors at steady levels, which are required for cells to function properly (limited to temperature and water);
3. understand that strenuous exercise, survival in hot or cold climates: **scuba-diving** and **mountain climbing** affect homeostasis (temperature, **blood oxygen levels**, hydration and **salt levels**);
4. understand how artificial systems, such as the temperature control system in an incubator, are similar to body control systems;
5. understand that artificial and body systems have:
 - receptors to detect stimuli;
 - processing centres to receive information and coordinate responses;
 - effectors which produce the response automatically;
6. **understand the principle of negative feedback;**
7. **recall that negative feedback between the effector and the receptor of a control system reverses any changes to the systems steady state;**
8. **understand that some effectors work antagonistically, which allows a more sensitive response.**

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B4.2 Why is homeostasis important for a cell?

1. understand that diffusion is the passive overall movement of molecules from a region of their high concentration to a region of their low concentration;
2. understand that osmosis (a specific case of diffusion) is the overall movement of water from a dilute to a more concentrated solution through a partially permeable membrane;
3. recall some examples of chemicals, such as O_2 , CO_2 and dissolved food, which move in/out of cells by diffusion;
4. **understand that some chemicals (for example, glucose) are also moved by active transport;**
5. **understand that if excess water moves into animal cells by osmosis the cell membrane may rupture and if too much water moves out of cells they are unable to function correctly;**
6. recall that enzymes are proteins that speed up chemical reactions in cells;
7. recall that enzymes need a specific constant temperature to work at their optimum;
8. explain how, at low temperatures, small increases in temperature increase the frequency and energy of collisions between an enzyme and other molecules, so the rate of reaction increases;
9. recall that at higher temperatures enzymes stop working (denature);
10. understand that only molecules with the correct shape can fit into the enzyme. This is known as the 'lock and key' model;
11. **recall that enzymes have a small part called the active site where certain molecules bind to the enzyme and the reaction occurs;**
12. **understand that the shape of the active site is can be changed by heating above a certain temperature and altering the pH, so that the molecules can no longer fit and the reaction cannot happen.**

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B4.3 How is our body temperature kept constant?

1. recall that energy gain and loss must be balanced in order to maintain a constant body temperature;
2. recall that body extremities tend to be cooler than the core body temperature, and that energy is transferred from the blood to the tissues when blood reaches cooler parts;
3. recall that temperature receptors in the skin detect external temperature;
4. recall that temperature receptors in the brain (**hypothalamus**) detect the temperature of the blood;
5. understand that the brain (**hypothalamus**) acts as a processing centre, receiving information from the temperature receptors, and triggering the effectors automatically;
6. recall that effectors include sweat glands and muscles;
7. understand that at high body temperatures:
 - more sweat is produced by sweat glands which cools the body when it evaporates;
 - **blood vessels supplying the capillaries of the skin dilate (vasodilation) allowing more blood to flow through skin capillaries which increases energy loss;**
8. recall that heat stroke is an uncontrolled increase in body temperature;
9. recall the common causes, symptoms and initial treatment of heat stroke;
10. explain how exposure to very hot temperatures produces increased sweating, and can produce dehydration, which may lead to reduced sweating and further increase of core body temperature;
11. understand that when core body temperature becomes too high the normal mechanisms for controlling body temperature break down;
12. understand that at low body temperatures:
 - the increased rate of respiration stimulated when muscles contract rapidly (shivering) results in some of the energy transferred in respiration warming the surrounding tissues;
 - **blood vessels supplying the capillaries of the skin constrict (vasoconstriction) restricting blood flow through skin capillaries which reduces energy loss;**
13. recall that hypothermia is when core body temperature falls below 35°C;
14. recall the cause, symptoms and initial treatment of hypothermia;
15. understand that in hypothermia body heat cannot be replaced as fast as it is being lost.

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B4.4 How does the body control water balance?

1. recall that water is gained from drinks, food and respiration and is lost through sweating, breathing, faeces and the excretion of urine;
2. understand that a balanced water level is important for maintaining the concentration of cell contents at the correct level for cell activity;
3. describe how the kidneys play a vital role in removing waste urea from the blood and in balancing levels of other chemicals in the blood by:
 - filtering small molecules from the blood to form urine (water, salt and urea);
 - reabsorbing all the sugar;
 - reabsorbing as much salt as the body requires;
 - reabsorbing as much water as the body requires;
 - excreting the remaining urine, which is stored in the bladder;
- ① Candidates are not expected to recall details of kidney structure.
4. understand that the kidneys balance water levels by producing dilute or concentrated urine as a response to concentration of blood plasma, which varies with external temperature, exercise level, intake of fluids and salt;
5. **recall that concentration of urine is controlled by a hormone called ADH, which is released into the bloodstream by the pituitary gland;**
6. **understand how ADH secretion is controlled by negative feedback;**
7. understand that alcohol results in a greater volume of more dilute urine, **due to ADH suppression**, which can lead to dehydration;
8. understand that the drug Ecstasy results in a smaller volume of less dilute urine, **due to increased ADH production**.