A Level Biology A

H420/01 Biological Processes

Question Set 18

18 (a)* Mammals and fish both need circulatory systems to transport oxygen to respiring tissues. Theyhave different circulatory systems because they have different oxygen requirements.

Compare and contrast the circulatory systems of mammals and fish. **[6]**

Fish possess single circulatory systems in which blood travels through the heart once for each complete circulation of the body. The blood passes through two sets of capillaries, travelling from the heart to capillaries in the gills, where exchange occurs, and then from the gills to capillaries in the tissues. In comparison, mammals possess double circulatory systems in which blood travels through the heart twice for each complete circulation of the body. As in fish, blood passes through two sets of capillaries. Blood is pumped from the heart to capillaries in the lungs before returning to the heart (pulmonary circuit). It is then pumped from the heart to capillaries in the tissues and then back to the heart again (systemic circuit). This system is advantageous in active mammals by enabling a high pressure and fast blood flow to be maintained. Although the pressure and rate of blood flow is limited in fish, a countercurrent exchange mechanism in the gills and reduced metabolic demands enable fish to remain relatively active. Whilst the countercurrent exchange system in the gills of fish maintains a steep concentration gradient for gaseous exchange, efficient pulmonary ventilation and circulation in mammals maintains a steep diffusion gradient between the air in the alveoli and blood in the capillaries. The heart of fish only has two chambers, an atrium and a ventricle, whereas the heart of mammals consists of four chambers, two atria and two ventricles. This enables the separation of oxygenated and deoxygenated blood. Moreover, both fish and mammals possess closed circulatory systems in which blood moves within vessels and is maintained at pressure.

18 (b) Mammals and fish both need circulatory systems to transport oxygen to respiring tissues. They have different circulatory systems because they have different oxygen requirements.

Acetylcholine (ACh) is a neurotransmitter in mammals. Studies have suggested that it also functions as a hormone in some invertebrate species, such as squid.

When ACh comes into contact with specialised cells in squid skin, it causes them to change colour. These colour changes allow the squid to communicate and to camouflage itself.

ACh is made by cells in the centre of the squid's body.

Explain how it is possible for ACh to have an effect on cells in the skin of the squid. **[2]**

Ach may be secreted from cells in the centre of the squid's body into the bloodstream. It may bind to specific complementary receptors on the surface of target skin cells, initiating a secondary messenger cascade. This may lead to the activation of gene transcription and increased production of target pigment proteins.

18 (c) Mammals and fish both need circulatory systems to transport oxygen to respiring tissues. They have different circulatory systems because they have different oxygen requirements.

Squid blood contains a blue oxygen-carrying protein called haemocyanin.

High partial pressures of carbon dioxide reduce the affinity for oxygen of haemocyanin.

Suggest a mechanism by which carbon dioxide could reduce the affinity for oxygen of haemocyanin. **[2]**

Bohr effect. When pCO_2 is high, H^+ levels rise as $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ H^+ may combine with haemocyanin, leading to a conformational change in its shape. This may reduce the affinity of haemocyanin for O_2 so O_2 dissociates more easily.

Total Marks for Question Set 18: 10