

AS Level Biology A
H020/02 Depth in biology

Question Set 10

1. (a) (i) Ions have a number of important roles in living organisms.

Complete the table below by identifying the ion that plays each of the roles. Choose from the following list.

Important role	Ion
Production of nitrate ions by bacteria	NH_4^+
Loading of phloem	H^+
DNA structure	PO_4^{3-}
Cofactor for amylase	Cl^-

[2]

- (ii) Dissolved ions diffuse between blood plasma and tissue fluid.

Pressure differences at the arterial and venous ends of capillaries are responsible for the formation of tissue fluid. The following measurements were made in one capillary:

- Net hydrostatic pressure at the arterial end was 4.6 KPa
- Net oncotic pressure was -3.0 KPa
- Net hydrostatic pressure at the venous end was 2.3 KPa.

Use this information to explain the movement of fluid in and out of a capillary.

[2]

At the arterial end, hydrostatic pressure (4.6 kPa) is greater than oncotic pressure (-3 kPa) so fluid is forced out of the capillary and into the surrounding area. At the venous end, hydrostatic pressure (2.3 kPa) is less than oncotic pressure (-3 kPa) so tissue fluid is drawn back into the capillary.

- (b) Copper (II) ions act as irreversible non-competitive inhibitors of the enzyme catalase.

- (i) Describe how a non-competitive inhibitor works to inhibit the activity of an enzyme.

[2]

Inhibitor binds to the allosteric site of the enzyme, changing its tertiary structure and the shape of the active site. Substrate molecules can no longer bind to the active site, reducing the rate of reaction.
↳ complementary

- (ii) Catalase is found in all living things that are exposed to oxygen. It protects cells from oxidative damage by breaking down hydrogen peroxide to water and oxygen.

Catalase is a useful biomarker of oxidative stress in fish exposed to water contaminated with copper ions.

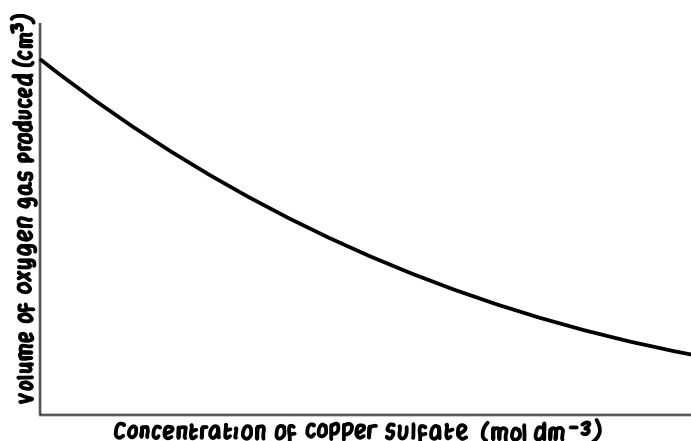
A group of students carried out an experiment to explore the effects of copper sulfate on the action of catalase. They measured the activity of catalase exposed to different concentrations of copper sulfate.

The results of their experiment are shown in Table 1.

Concentration of copper sulfate (moles dm ⁻³)	Volume of oxygen gas produced (cm ³)
0.00	14.50
0.05	10.50
0.10	7.55
0.15	5.80
0.20	4.20

Table 1

In the space provided below, **sketch** a graph of the results in Table 1.



[2]

- (iii) What can the students conclude from their results?

As the concentration of copper sulfate increases, the rate of hydrogen peroxide breakdown decreases because copper sulfate inhibits catalase activity.

[2]

- (iv) Three rivers in the Himalayan foothills were polluted with copper, which affected the aquatic wildlife. Scientists were provided with one dead Indian Barb fish, *Esomus danricus*, from each of the rivers.

Scientists were unable to take a direct measurement of the copper ion concentration in the fish.

Using the information provided in 1(b)(ii), suggest how the scientists could use the fish tissue to compare the copper ion pollution in the three rivers.

[3]

The scientists could compare the volume of oxygen produced as a result of hydrogen peroxide breakdown in each of the three fish. For example a tissue sample of a specific size could be taken from each of the fish and blended. A known volume and concentration of H₂O₂ could be added and the volume of O₂ gas released in a given period of time measured using a gas syringe. The greater the volume of O₂ collected, the greater the catalase activity and the less the copper pollution.

Total Marks for Question Set 10: 13

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