National Qualifications 2026

X807/77/11

Biology
Supplementary sheet

TUESDAY, 28 APRIL
9:00 AM – 12:00 NOON

Supplementary sheet for question 1

X8077711

Qualifications Scotland
Teisteanasan Alba

1. Marine mammals display several physiological adaptations to their marine environment. Their cells contain the molecule myoglobin, which can associate with oxygen in a similar way to haemoglobin, providing an oxygen store within cells. Higher myoglobin concentrations in the muscles of marine mammals allows them to increase their internal oxygen stores, increasing the time available to dive.

Dolphins are marine mammals that spend much time at the surface of the oceans. They often dive to catch their prey, with the dive depth determining their prey species.

Three species of dolphin were studied to identify the levels of myoglobin in different muscles within the dolphins' bodies.

Information about the three dolphin species studied is shown in **Figure 1**.

Figure 1

- Striped dolphin (*Stenella coeruleoalba*)

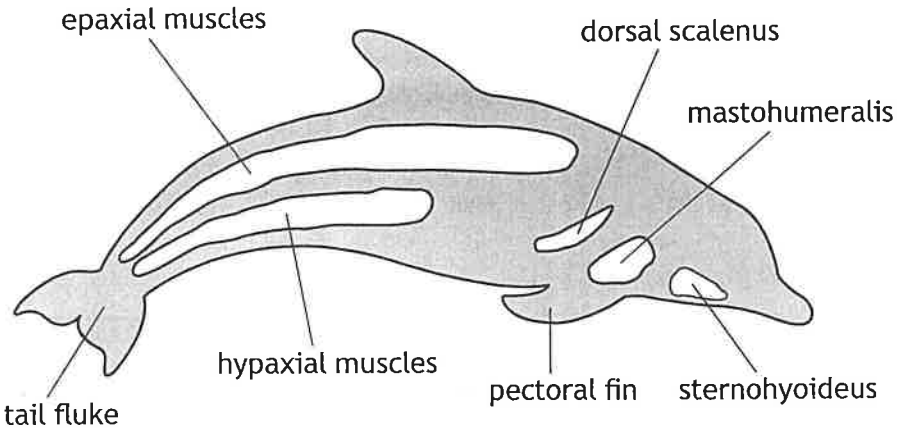
  Widely distributed across the oceans, feeding mainly in the open ocean, and can dive to depths of up to 700 m to hunt deeper dwelling prey. It can grow to 160 kg in mass.
- Atlantic spotted dolphin (*Stenella frontalis*)

  Found across the North and South Atlantic, eating mainly small fish, invertebrates and squid. It can dive up to 60 m and grow to a body mass of 140 kg.
- Common dolphin (*Delphinus delphis*)

  Lives in warmer coastal waters, eating mainly fish and squid. It dives up to 200 m and can grow to a body mass of 150 kg.

Some dolphin muscles are shown in **Figure 2**.

Figure 2



1. (continued)

Samples of muscles from all three dolphin species were taken from animals that had died naturally and washed up on seashores. No live animals were tested.

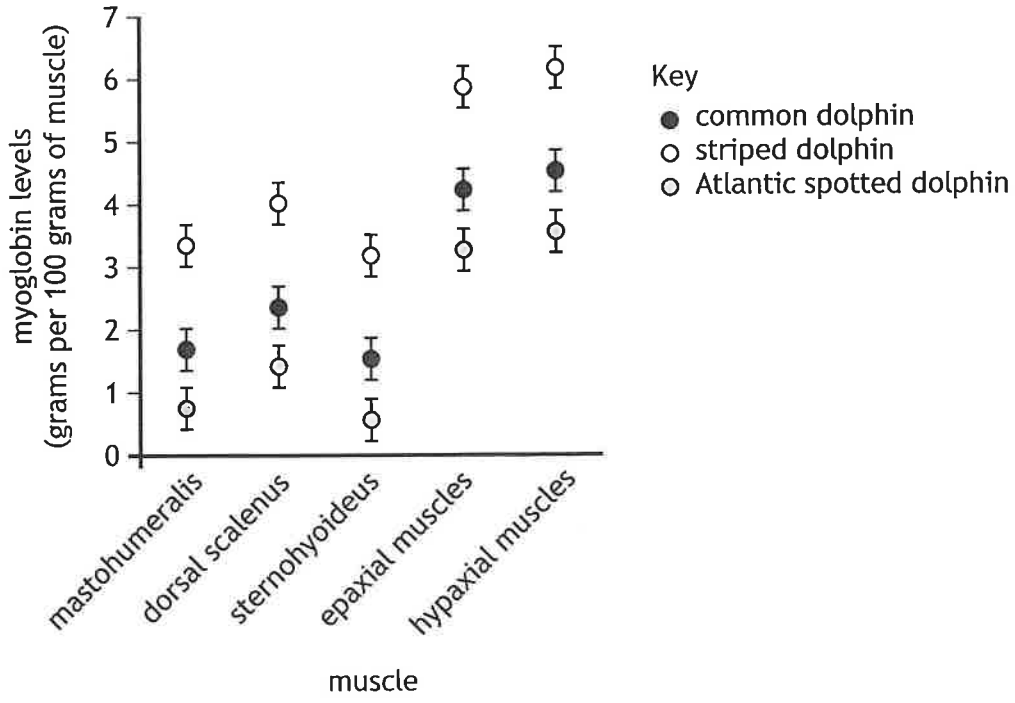
Figure 3 shows muscle functions and the mean myoglobin levels in muscle samples of the common dolphin.

Figure 3

Muscle	Muscle function	Mean myoglobin levels (grams per 100 grams of muscle)
Mastohumeralis	pectoral fin movement (steering)	1.696
Dorsal scalenus	breathing	2.357
Sternohyoideus	swallowing	1.524
Epaxial muscles	tail fluke upstroke	4.374
Hypaxial muscles	tail fluke downstroke	4.660

The mean myoglobin levels from the same muscles were also measured in Atlantic spotted and striped dolphins. The data for all three species are shown in **Figure 4.**

Figure 4



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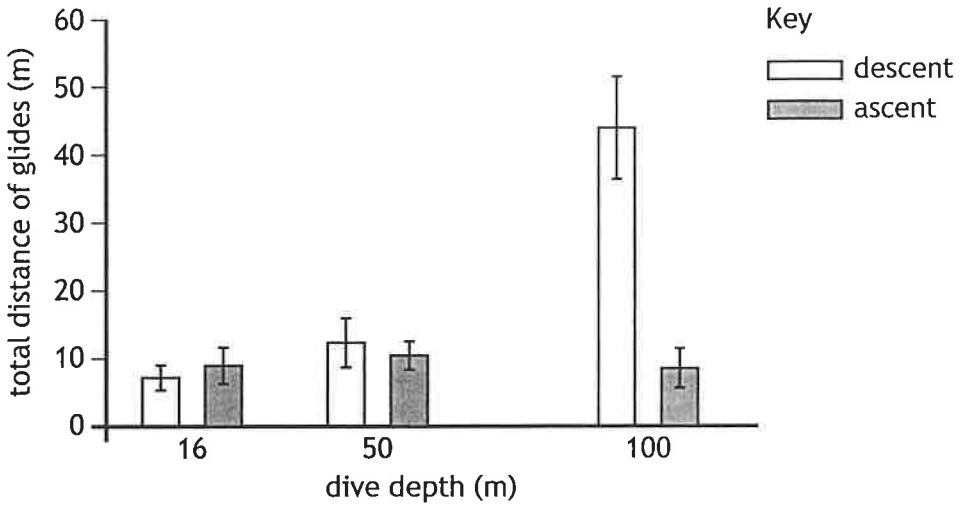
1. **(continued)**

During dives, dolphins use both epaxial and hypaxial muscles to move their tail fluke for swimming. They conserve energy by stopping the movement of their tail fluke and only gliding.

Figure 5 shows the total distance of these glides during descent (going deeper) and ascent (returning to the surface) from dives.

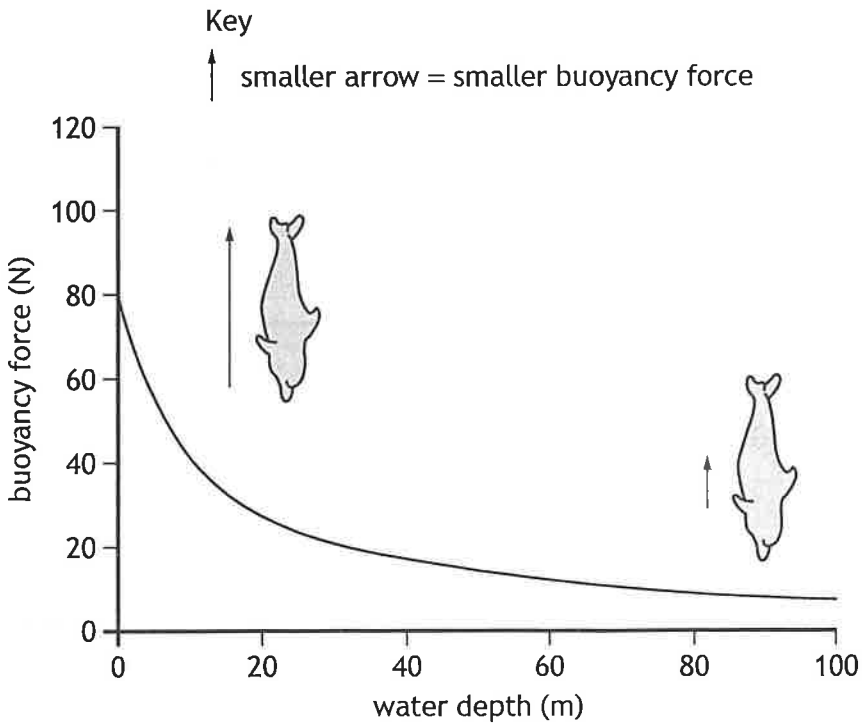
Figure 5



When diving, dolphins must overcome buoyancy forces, which would make them float towards the surface.

Figure 6 shows how the buoyancy force changes with water depth. The size of the arrow indicates the upwards buoyancy force acting on the dolphin.

Figure 6



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