

# 11.2 Movement

## Question Paper

Course	DP IB Biology
Section	11. Animal Physiology (HL Only)
Topic	11.2 Movement
Difficulty	Hard

**Time allowed:** 70  
**Score:** /57  
**Percentage:** /100

**Question 1a**

a)

Malignant hyperthermia (MH) is a dangerous condition during which a patient's skeletal muscles become contracted and rigid. It is caused by a mutation in the gene that codes for intracellular calcium channels. MH is difficult to diagnose until it is triggered by the administration of an anaesthetic.

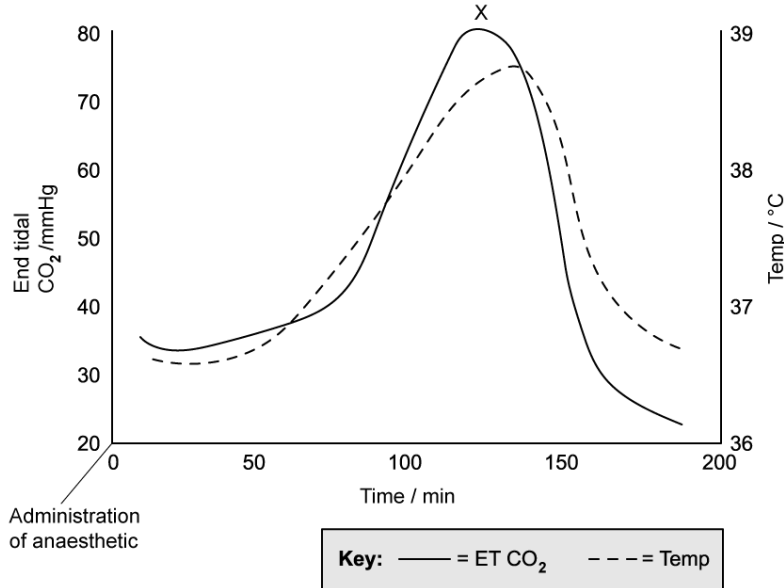
Suggest how the anaesthetic combined with the MH mutation could lead to contracted skeletal muscles in a patient.

**[5 marks]****[5 marks]**

**Question 1b**

b)

The graph shows some of the physiological effects that take place after the administration of an anaesthetic to a patient who is MH susceptible. End Tidal Carbon Dioxide refers to the amount of carbon dioxide released during an exhaled breath.



Use your knowledge of the events taking place inside a contracting skeletal muscle to explain the effects on the graph between 0 and 150 minutes after the administration of an anaesthetic.

[3 marks]

[3 marks]

**Question 1c**

c)

MH is a very dangerous condition that can be fatal if not treated quickly.

Use the information provided and your own knowledge to explain why MH can be fatal.

[2 marks]

[2 marks]

### Question 1d

d)

At point X on the graph in part a), a life-saving drug called dantrolene was administered.

Suggest how dantrolene might counteract the effects of the anaesthetic.

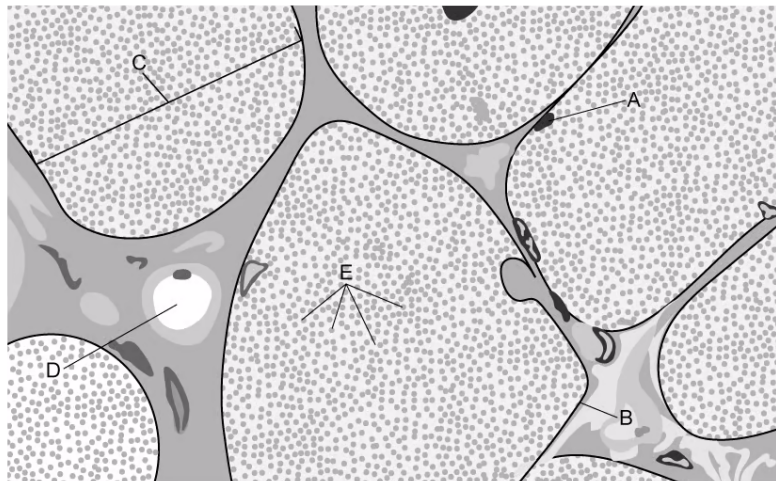
[2 marks]

[2 marks]

### Question 2a

a)

The diagram shows a cross section through a skeletal muscle.



Identify the structures labelled A – D in this diagram.

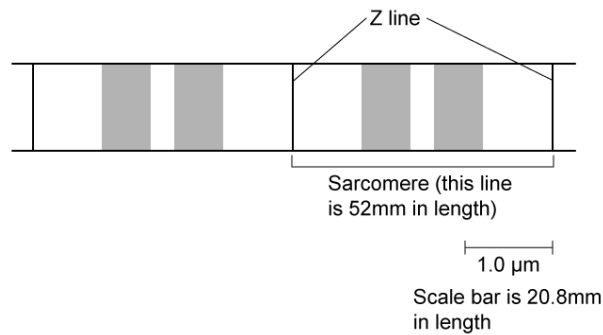
[4 marks]

[4 marks]

### Question 2b

b)

The structures labelled E in the diagram in part a) above are called myofibrils. When myofibrils are viewed in longitudinal section they have a striped, or striated, appearance and are made up of many sarcomeres. Two sarcomeres are shown in the diagram below.



The myofibril is 4.5cm in length when it is relaxed, while a contracted sarcomere measures  $1.9\mu\text{m}$ .

Use the scale on the diagram above to calculate the length of a contracted myofibril (the image measurements are provided for you).

State your answer in mm.

[3 marks]

[3 marks]

### Question 2c

c)

The striated pattern visible on the sarcomeres is due to the presence of two types of filament within the myofibril. These filaments are known to be involved with muscle contraction, but a relatively recent discovery has shown that a third protein filament known as titin, is also present. The role played by titin is still being investigated, but one study was carried out in mice that looked at the effects of removing titin from their muscles.

To remove the titin protein, the mice had their muscles modified so that their titin filaments contained a cutting site for a plant enzyme called TEV protease.

Suggest why the plant enzyme TEV was used rather than an animal protease.

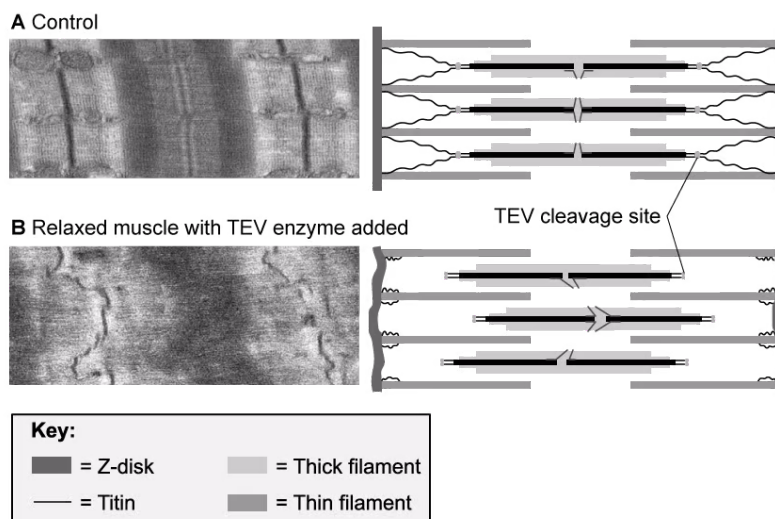
[2 marks]

[2 marks]

### Question 2d

d)

The diagram below shows the location of titin within the sarcomere, as well as some of the results gained from the study described in part c) above.



Use information from the diagram and your existing knowledge to suggest 3 possible functions of titin filaments.

[3 marks]

[3 marks]

### Question 3a

a)

Flexion of the elbow involves contraction of the biceps to bring the hand upwards when performing a manual action, for example when scratching the nose.

Aside from the role played by the triceps in extending the arm afterwards, suggest **two** advantages to having the system of an antagonistic pair of muscles in arm movement.

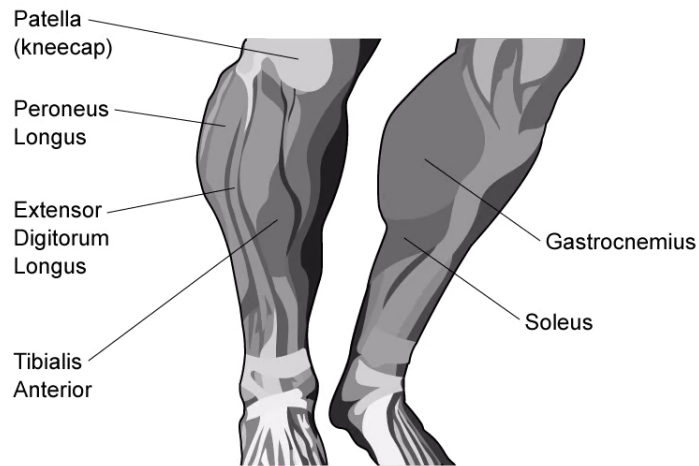
[2 marks]

[2 marks]

### Question 3b

b)

The image below shows some of the muscles in the human lower leg.



Use the diagram and your knowledge of antagonistic pairs to identify the muscles involved in the following motions:

Dorsiflexion - moving the toes upwards towards the shin

Plantar flexion - moving the toes away from the shin eg. when standing on tiptoe

[2 marks]

[2 marks]

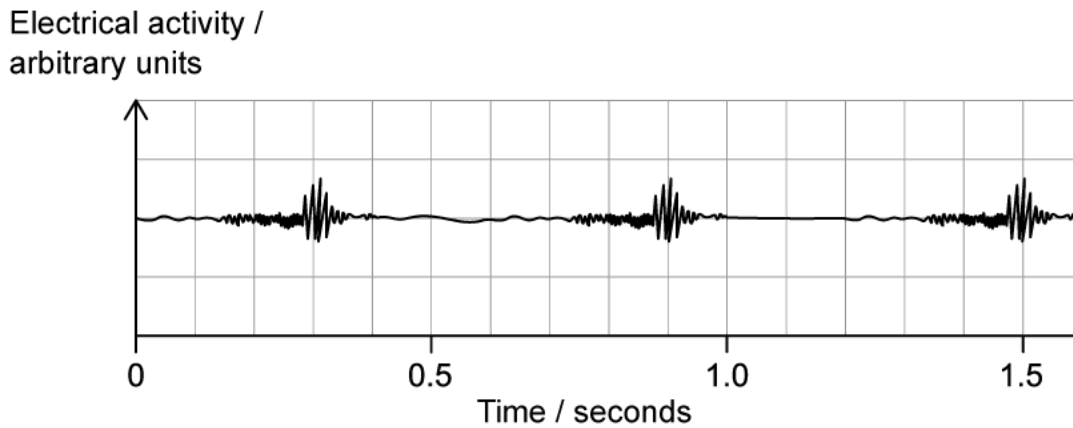


### Question 3c

c)

A technique called electromyography uses electrodes placed onto the skin close to major skeletal muscles. The electrodes measure electrical activity in those muscles and in their surrounding nervous connections.

The diagram below is an electromyograph trace combined from electrodes placed on a person's left and right gastrocnemius muscles (see diagram in part b for the location of that muscle) taken while the person was walking at an even pace.



Assuming a mean stride length of 75cm, calculate the person's walking speed.

State your answer in kilometres per hour /  $\text{kmh}^{-1}$ .

[4 marks]

[4 marks]

### Question 3d

d)

For the person walking in part c) above, state, with a reason, the stage of the respiratory pathway that would be supplying most of the ATP required for muscular contraction of the leg muscles.

[2 marks]

[2 marks]

### Question 4a

a)

Explain why tendons need to be inelastic.

[3 marks]

[3 marks]

### Question 4b

b)

Synovial fluid plays an important role in musculoskeletal movement.

One feature of synovial fluid is that it is classed as a non-Newtonian fluid. This means that it changes its viscosity according to the surrounding conditions.

Suggest and explain **one** function of a joint that is aided by synovial fluid being a non-Newtonian fluid.

[2 marks]

[2 marks]

### Question 4c

c)  
Osteoarthritis is a common condition of the joints in which cartilage becomes thinned and eventually wears away.  
Suggest **two** symptoms of osteoarthritis and a possible remedy.

[3 marks]

[3 marks]

### Question 5a

*One mark is available for clarity of communication throughout this question.*

a)  
Describe the sequence of musculoskeletal events that lead to a grasshopper jumping to catch its prey.  
Do not go into the molecular detail of the events; limit your answer to events at an organ-by-organ level.

[6 marks]

[6 marks]

### Question 5b

b)  
Describe the events that lead up to the formation of actin/myosin cross-bridges during muscle contraction.

[4 marks]

[4 marks]

### Question 5c

c)  
Duchenne muscular dystrophy (DMD) is a severe genetic disorder that affects boys and young men. It is an inherited, X-linked condition that causes progressive loss of muscle tissue, and most often causes death by asphyxiation as important breathing muscles (eg. the diaphragm) lose their function.

A mutation in the gene for a protein called dystrophin. A lack of dystrophin causes excess calcium ions to leak from the sarcolemma.

Associated changes to the ion balance within the sarcoplasm also cause water to enter mitochondria by osmosis.

Suggest how these descriptions of events with DMD cause a loss of muscular function.

[5 marks]

[5 marks]

