

**10** Nandrolone is an anabolic steroid, it is a molecule with a similar shape to testosterone. Nandrolone has been used as a performance-enhancing substance by athletes in the past.

(a) A number of investigations with mice have been carried out to study the effect of nandrolone on the structure and function of the aorta.

In these investigations, all the mice were of one type and were all supplied with the same amount of food and water. These mice were placed into four groups.

Each group was treated differently for eight weeks. The treatments are shown in the table.

Group	Treatment	
	Allowed to exercise	Given nandrolone
P	No	No
Q	No	Yes
R	Yes	No
S	Yes	Yes

After eight weeks, the aorta of each mouse was studied.

(i) In investigation 1, samples of aorta were put under tension to test elastic recoil. The tension was removed and the mean maximum percentage recoil for each group was found.

The results are shown in the table.

Group	Mean maximum percentage recoil (%)
P	57
Q	38
R	80
S	53

The use of nandrolone has been linked to a variety of cardiovascular conditions. 2 Q10ai

Explain how the use of nandrolone could lead to atherosclerosis.

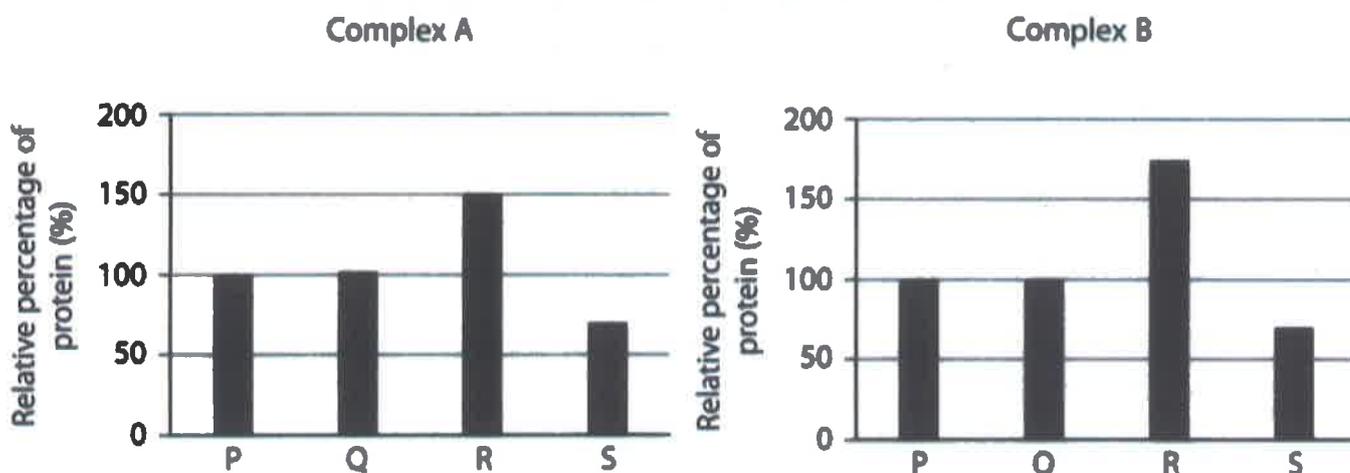
(3)

Nandrolone does not allow the aorta to recoil. This means it cannot stretch either when the mouse does exercises\*. This will increase the blood pressure. As the blood pressure increases, the chance to damage the endothelium of arteries. This will result in ~~pl~~ an inflammatory reaction where platelets burst and stick to the damaged endothelium, ~~block~~ the flow of blood narrowing the arteries and slowing the flow of blood.  
\* because of a reduction in aorta's elasticity.

(ii) In investigation 2, some of the cells from the middle layer of the aortas of the mice were removed.

Two protein complexes, A and B, are found in the cells of the middle layer. These protein complexes are involved in the electron transport chain.

The graphs show the relative percentage of these two protein complexes in each group of mice.



Comment on the effects of nandrolone on the production of ATP.

(3B Q10aii)

When given nandrolone but not allowed to exercise, the percentage of complex A and B is the same as not being given nandrolone and not being allowed to exercise. However, when being given nandrolone and allowed to exercise, the percentage of A and B decreases. This means that there is less in the electron transport chain will be less effective and produce less ATP compared to if you were not given nandrolone.

(iii) The transcription factor Tfam is involved in the production of mitochondria.

In investigation 3, some of the cells from the middle layer of the aortas of the mice were removed. The quantity of mRNA per cell coding for Tfam was measured.

The results are shown in the table.

⊂

Group	Quantity of mRNA per cell coding for Tfam / a.u.
P	$100 \pm 20$
Q	$75 \pm 10$
R	$170 \pm 25$
S	$85 \pm 15$

⊃

Handwritten notes around the table: 'NB, X Z' on the left and 'Z N Y X' on the right.

A student concluded that nandrolone affects the quantity of mRNA per cell coding for Tfam.

Explain why this conclusion is not valid for all the mice.

(2) 1 10aiii

When looking at group P which did not have nandrolone and S which did, the standard deviation range is so large that they overlap. e.g. P could go down to 80 and S could rise to 100. This means that there is change that could affect the outcome.



\* (b) Analyse the data from these three investigations to discuss the advantages of an exercise programme without nandrolone.

16B Q10b

From investigation 1, it is evident that nandrolone can affect the recoil of aortas. This will then result in heart conditions like CVD and increase the chance of heart attack.

In investigation 2, it was proven that when exercising on nandrolone, less ATP is produced in the electron transport chain as well as fewer mitochondria being made from investigation 3, mostly. This will dramatically reduce the ATP production and muscle cells will not get the correct amount of ATP to function normally. Instead this will result in a fat feeling of tiredness and feeling faint. Not taking nandrolone will allow you to exercise more efficiently and for longer, and also reduce the risk of developing cardiovascular diseases.

(Total for Question 10 = 14 marks) 9

TOTAL FOR PAPER = 100 MARKS

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