Activity 8.5

A208ACT05

Mitochondrial diseases

Go through the animation that accompanies this activity before you start.

Cytochrome oxidase is a protein that spans the inner mitochondrial membrane. When cells break down carbohydrates, amino acids and fats, electrons are removed from the molecules in these foods and channelled along the mitochondrial electron transport chain. Energy is released during electron transport and converted to chemical energy in the form of ATP, the energy currency of all cells. Cytochrome oxidase is the final protein of the

electron transport chain. This enzyme is where the electrons meet molecular oxygen and hydrogen ions to form water. Cytochrome oxidase abnormality or deficiency means less ATP production, and also higher levels of circulating free radicals. When cytochrome oxidase does not work properly, the electrons passing down the electron transport chain are passed to oxygen to form superoxide radicals. These highly reactive molecules can cause cell and genetic damage.

1 a) What are Georgina's main symptoms?

b) Which tissues are most affected?

2 The data in the table below show the oxygen consumption of some tissues and organs.

Organ	Oxygen consumption of organ/tissue (ml O_2 h^{-1})	Oxygen consumption per mass of tissue (ml O_2 g^{-1} h^{-1})
Brain	1.11	3.08
Bone	0.30	0.28
Heart	0.14	1.27
Skeletal muscles	8.63	1.26
Skin	1.37	0.48

Use the data in the table above to explain Georgina's symptoms as described by her GP.

3 Georgina's consultant describes how high levels of free oxygen radicals can result from deficiencies in cytochrome oxidase. Use your knowledge from Topic 1 to describe some of the possible health risks associated with free radicals.

4 Read the three statements below:

A Mutations in mitochondrial DNA leading to defects in cytochrome oxidase have been associated with Alzheimer's disease and 'normal' ageing processes.

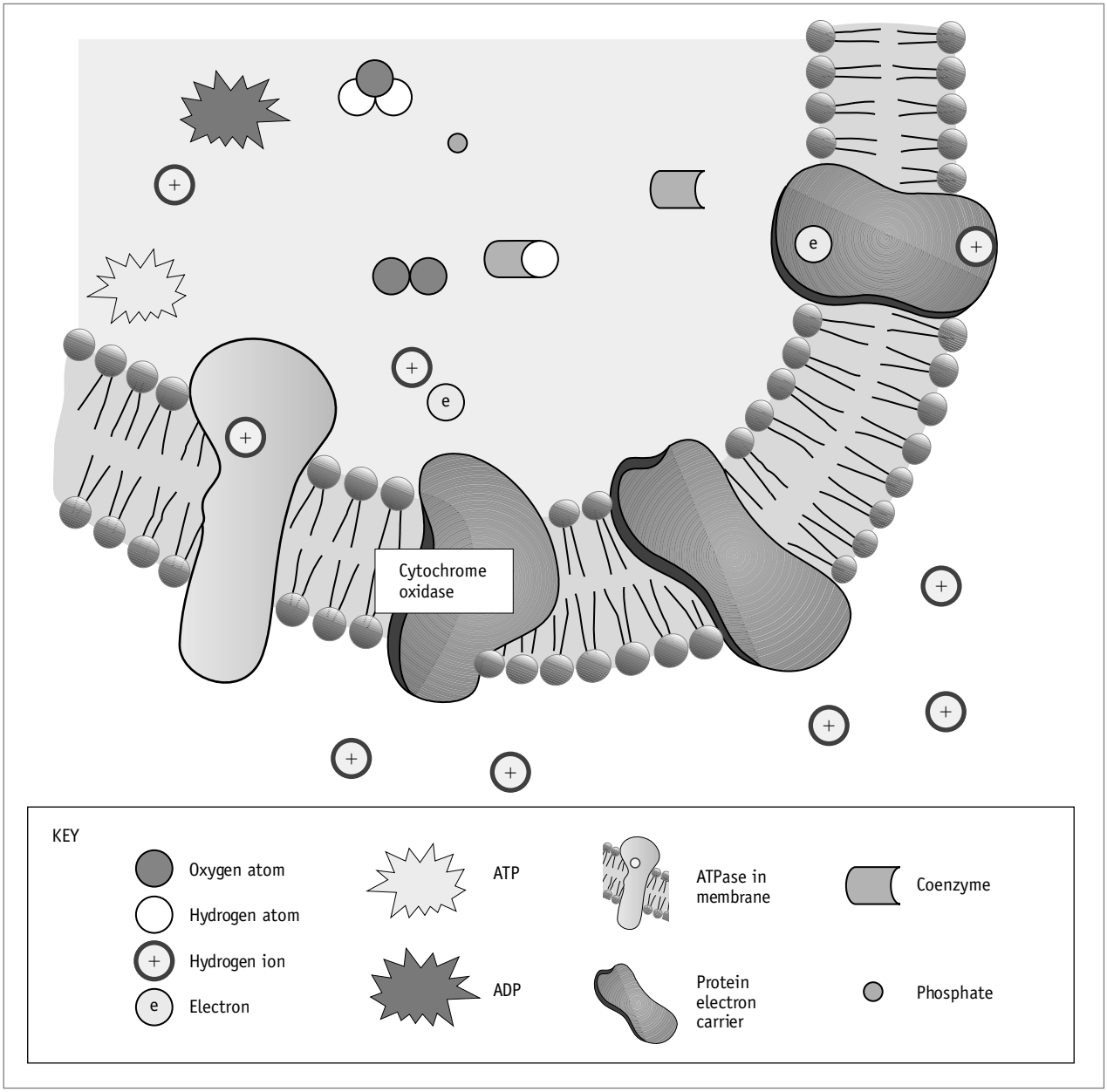
B Curcumin, a chemical in the spice turmeric that is present in most curries, has been shown to neutralise free radicals.

C Some studies show that the incidence of Alzheimer's disease in the ageing population of India is lower than in the West.

a) Suggest a theory that could link statements A, B and C.

b) What advice would you give to Georgina's mother about Georgina's diet?

5 Georgina's consultant needs to explain to the first year medical students she teaches why Georgina is not able take part in sport. Annotate the diagram below to explain the role of cytochrome oxidase in ATP production, which is necessary for muscle contraction. The animation with this activity shows the events on the mitochondrial inner membrane.



6 Georgina's blood tests show that the levels of pyruvate and lactate in her body are higher than normal. Use your knowledge of the pathways involved in cellular respiration to explain these results.