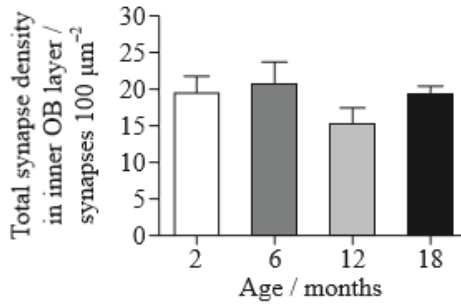
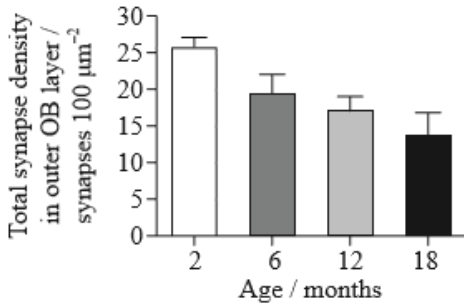
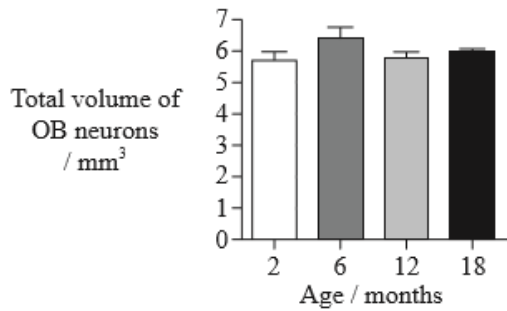


SL Paper 3

- a. The spontaneous origin of life on Earth is thought to have involved the non-living synthesis of simple organic molecules. [2]
List **two** other processes needed for the spontaneous origin of life.
- c. Outline the role of prokaryotes in the development of an oxygen-rich atmosphere on the Earth. [2]

The hypothesis that aging involves loss of brain cells was investigated in mice. The olfactory bulb (OB) of the brain was studied because its layered arrangement of neurons resembles large regions of the human brain. Sensory input about smell is sent to the OB by axons of receptor cells that line the upper nasal cavity. These axons synapse with relay neurons in the OB where interpretation of smell perception begins. The bar charts show the total volume of neurons in the OB and the density of synapses (number of synapses per unit area) in two regions of a mouse's OB.



[Source: Marion Richard et al., "Age-induced disruption of selective olfactory bulb synaptic circuits", *PNAS* 107 (35), 15,613–15,618. Copyright 2010, National Academy of Sciences, USA.]

- a. State when the total volume of OB neurons is the greatest. [1]
- b. Compare the total synapse density of neurons in the outer and inner OB layers. [2]
- c. Evaluate, using the data in the bar charts, the hypothesis that aging involves loss of brain cells. [2]
- d. Suggest the implications of the data for humans. [2]

Discuss the endosymbiotic theory for the origin of eukaryotes.

Discuss the endosymbiotic theory for the origin of eukaryotes.

Discuss the evidence supporting the endosymbiotic theory for the origin of eukaryotes.

Outline the contribution of prokaryotes to the creation of an oxygen-rich atmosphere.

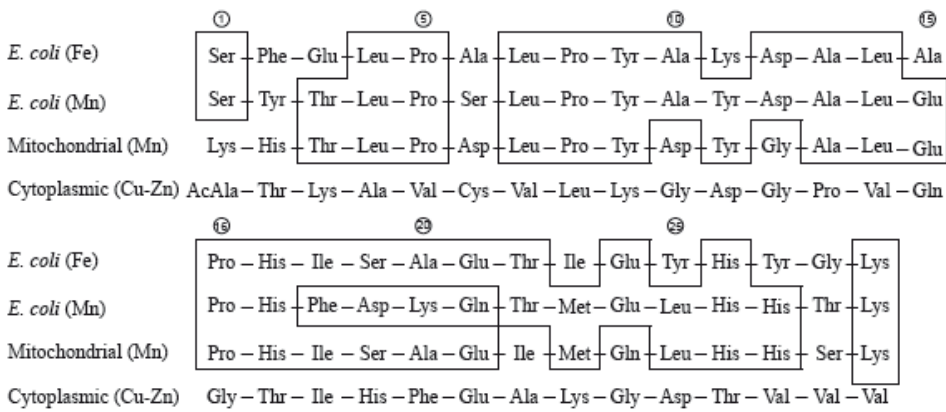
Outline **two** pieces of evidence that support the endosymbiotic theory for the origin of eukaryotes.

Superoxide dismutase is an enzyme used by cells to protect themselves against oxidative damage. These enzymes can have different metals as part of their structure.

A study to compare two dismutases from *Escherichia coli* bacteria and two dismutases from eukaryotic cells was undertaken. The following enzymes were used:

- *E. coli* dismutase with iron (Fe)
- *E. coli* dismutase with manganese (Mn)
- eukaryotic mitochondrial dismutase with manganese (Mn)
- eukaryotic cytoplasmic dismutase with copper-zinc (Cu-Zn).

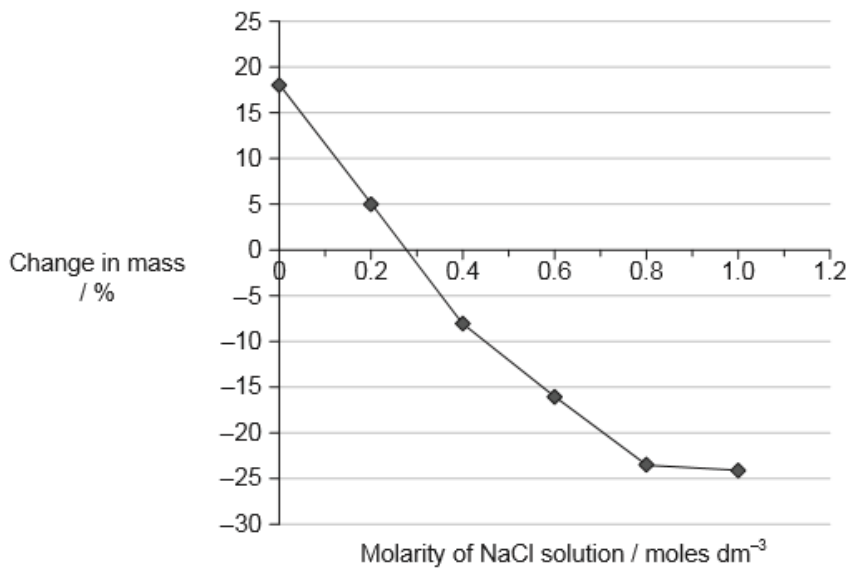
The following shows part of the amino acid sequences of these enzymes. Boxes enclose identical amino acids in the sequence of the two *E. coli* and mitochondrial dismutases.



[H. M. Steinman and R. L. Hill (1973) "Sequence homologies among bacterial and mitochondrial superoxide dismutases". PNAS journal (USA), 70 (12), pp. 3725–3729. Used with the permission of the authors.]

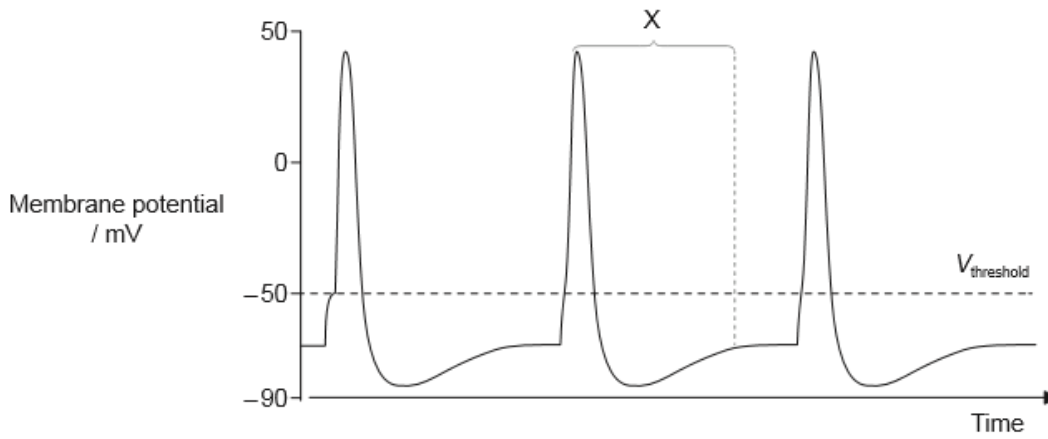
- a. State how many amino acids are in the same position in the *E. coli* (Fe), *E. coli* (Mn) and the mitochondrial dismutase sequences shown. [1]
- b. State the amino acids which are present in the same position in **at least one** bacterial dismutase and in **both** eukaryotic dismutases. [1]
- c. Compare the *E. coli* (Mn) and the mitochondrial dismutases. [2]
- e. The sequences of the two bacterial dismutases and the mitochondrial dismutase show a high degree of homology. Discuss how this supports the endosymbiotic theory for the origin of mitochondria. [2]

- a. Solutions of ions, for example NaCl dissolved in water, can be used to investigate the concentration of solutes in plant tissues. After immersion in solutions of varying concentration, the percentage changes in mass of potato samples were measured. The graph shows the results. [3]



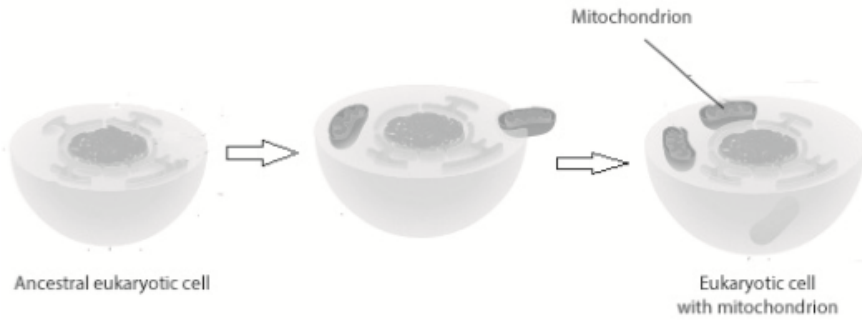
- (i) Estimate the osmolarity of the plant tissue.
.....moles dm⁻³
- (ii) Identify which part of the graph represents samples measured in a hypotonic solution.
- (iii) State **one** possible source of error when collecting data during this experiment.

b. Ions move across the plasma membrane of a neuron during an action potential. The oscilloscope trace shows voltage changes generated in a [3]
neuron during three action potentials.



Explain the movement of ions which causes the voltage changes observed during the interval labelled X on the graph.

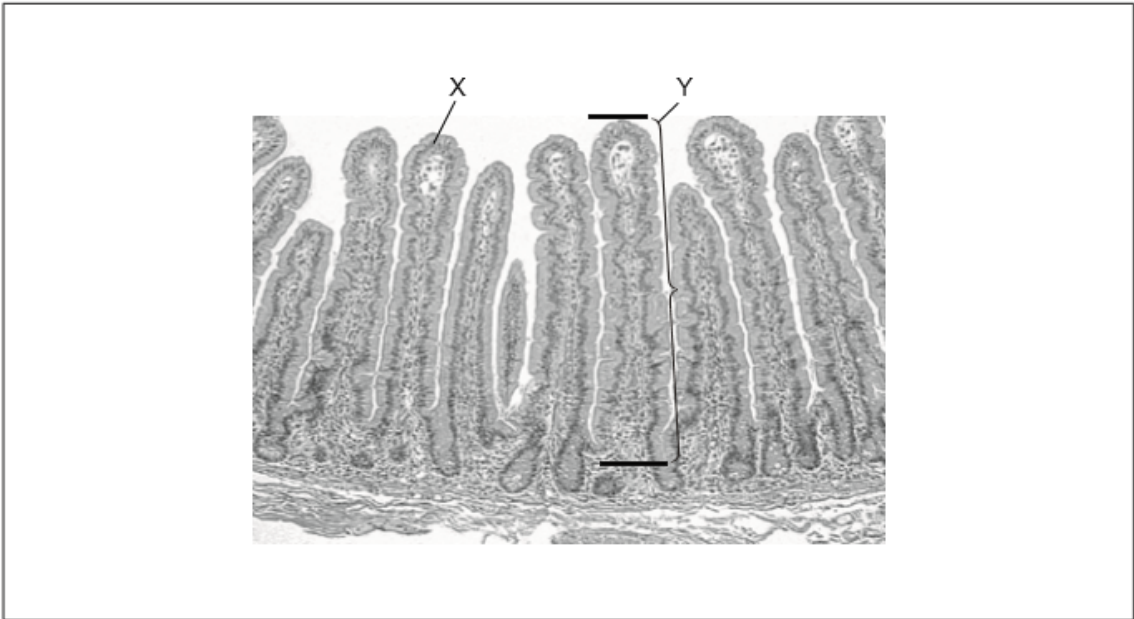
The diagram shows some of the later stages in the origin of eukaryotic cells according to the endosymbiotic theory.



[Source: "Serial endosymbiosis" by Kelvinsong - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Serial_endosymbiosis.svg#/media/File:Serial_endosymbiosis.svg]

Discuss the endosymbiotic theory including the evidence for the process shown in the diagram.

The micrograph shows a section of an organ in the human body.

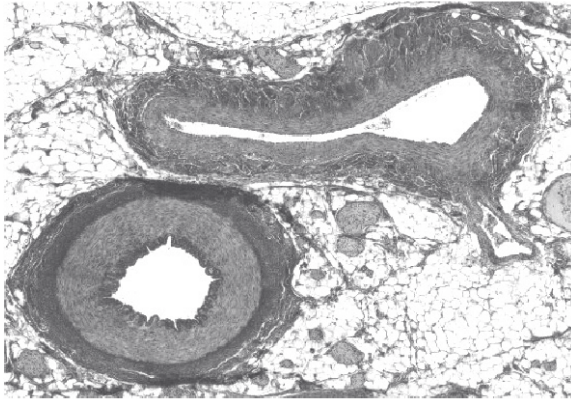


[Source: adapted from Stacey E. Mills (ed.), *Histology for Pathologists*, 3rd Edition, Copyright ©2007, Lippincott Williams & Wilkins.]

- a. State from which organ the section was taken. [1]
- b. Identify the layer of tissue found at X. [1]
- c. The actual length of the structure labelled Y is 0.8 mm between the two black lines. Calculate the magnification of the micrograph. [2]
Working should be shown.
- c. The actual length of the structure labelled Y is 0.8 mm between the two black lines. Calculate the magnification of the micrograph. Working [2]
should be shown.

.....

The micrograph shows a transverse section through blood vessels of a mammal.



[Source: This book was originally published by OpenStax College, released under the CC-BY license: <https://creativecommons.org> (<https://creativecommons.org/>) The eBook was adapted by Frank Lee.]

a. Identify the vein by labelling it with the letter V.

[1]

b. Distinguish between the vein and the artery with reference to structures visible in the micrograph.

[2]
