HL Paper 3

b. Outline the endosymbiotic theory. [2]

c (ii)Define *gene pool*. [1]

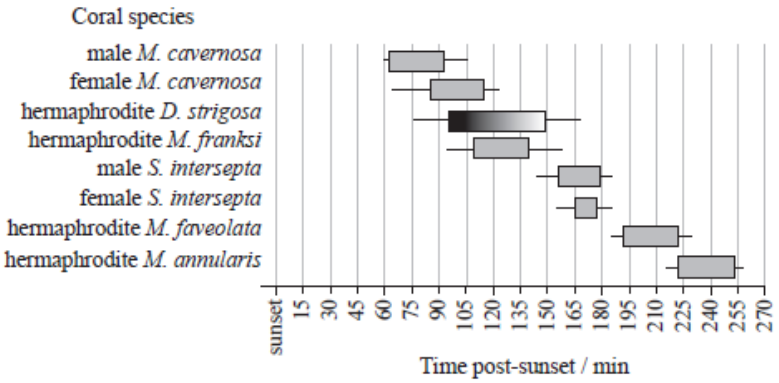
b. Define analogous characteristics using **one** example to illustrate your answer. [1]

c. Outline **two** pieces of evidence that support the endosymbiotic theory for the origin of eukaryotes. [2]

d. List **two** anatomical features that define humans as primates. [2]

Discuss the endosymbiotic theory for the origin of eukaryotes.

Corals can be male, female or hermaphrodite (both male and female) and the release of their gametes is called spawning. Data was collected to study the spawning behaviour in the Gulf of Mexico of three genera of coral: *Montastraea*, *Stephanocoenia* and *Diploria*. The spawning behaviour is expressed in minutes post-sunset. Peak spawning windows are shown as grey bars and the range as black bars.



[Adapted from P. D. Vize, J. A. Embesi, M. Nickell, D. P. Brown and D. K. Hagman (2005) "Tight temporal consistency of coral mass spawning at the Flower Garden Banks, Gulf of Mexico, from 1997–2003." _Gulf of Mexico Science_, 1, pp. 107–114.
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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.

	①				⑤				⑩							⑮
E. coli (Fe)	Ser	–	Phe	–	Glu	–	Leu	–	Pro	–	Ala	–	Leu	–	Pro	–
E. coli (Mn)	Ser	–	Tyr	–	Thr	–	Leu	–	Pro	–	Ser	–	Leu	–	Pro	–
Mitochondrial (Mn)	Lys	–	His	–	Thr	–	Leu	–	Pro	–	Asp	–	Leu	–	Pro	–
Cytoplasmic (Cu-Zn)	AcAla	–	Thr	–	Lys	–	Ala	–	Val	–	Cys	–	Val	–	Leu	–

E. coli (Fe)	Tyr	–	Gly	–	Ala	–	Leu	–	Glu	–	Ala	–	Gly	–	Asp	–
E. coli (Mn)	Asp	–	Ala	–	Leu	–	Glu	–	Ala	–	Gly	–	Asp	–	Thr	–
Mitochondrial (Mn)	Tyr	–	Gly	–	Ala	–	Leu	–	Glu	–	Ala	–	Gly	–	Asp	–
Cytoplasmic (Cu-Zn)	Lys	–	Gly	–	Asp	–	Gly	–	Pro	–	Val	–	Gln			

	⑱				⑳						㉙					
E. coli (Fe)	Pro	–	His	–	Ile	–	Ser	–	Ala	–	Glu	–	Thr	–	Ile	–
E. coli (Mn)	Pro	–	His	–	Phe	–	Asp	–	Lys	–	Gln	–	Thr	–	Met	–
Mitochondrial (Mn)	Pro	–	His	–	Ile	–	Ser	–	Ala	–	Glu	–	Ile	–	Met	–
Cytoplasmic (Cu-Zn)	Gly	–	Thr	–	Ile	–	His	–	Phe	–	Glu	–	Ala	–	Lys	–

E. coli (Fe)	Glu	–	Tyr	–	His	–	Tyr	–	Gly	–	Lys					
E. coli (Mn)	Glu	–	Leu	–	His	–	His	–	Thr	–	Lys					
Mitochondrial (Mn)	Gln	–	Leu	–	His	–	His	–	Ser	–	Lys					
Cytoplasmic (Cu-Zn)	Gly	–	Asp	–	Thr	–	Val	–	Val	–	Val					

[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 the range of the time of spawning for the male *M. cavernosa*. [1]

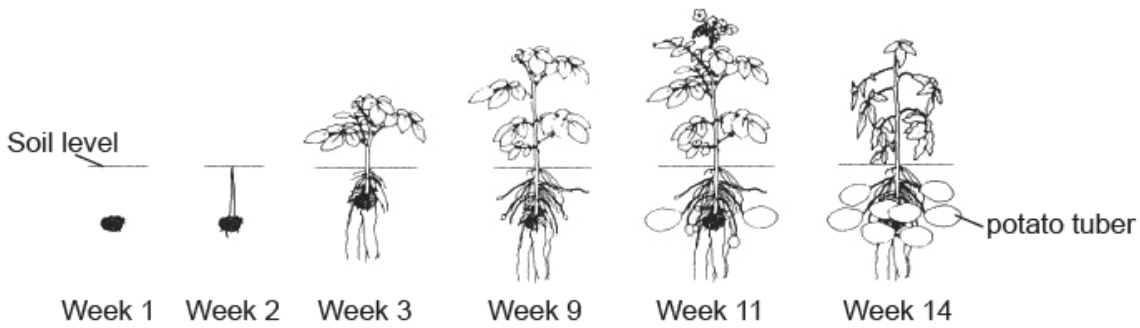
a. State how many amino acids are in the same position in the *E. coli* (Fe), *E. coli* (Mn) and the mitochondrial dismutase sequences shown. [1]

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]

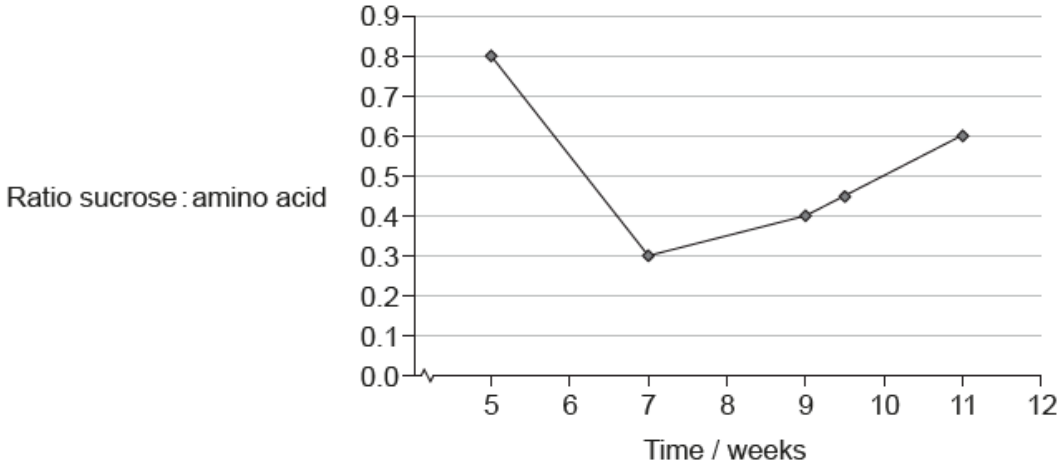
e. The sequences of the two bacterial dismutases and the mitochondrial dismutase show a high degree of homology. Discuss how this supports the endosymbiotic theory for the origin of mitochondria. [2]

The diagram shows the development of potato plants (*Solanum tuberosum*) over 14 weeks. New tubers start growing from week 9. These are modified underground stems serving as a starch reserve and bearing buds from which new plants arise.



[Source: adapted from http://humanitiespotato.weebly.com/potato-production.html]

Scientists planted several potato plants in a greenhouse. The sucrose and amino acids in potato plant phloem exudates were measured during several weeks.

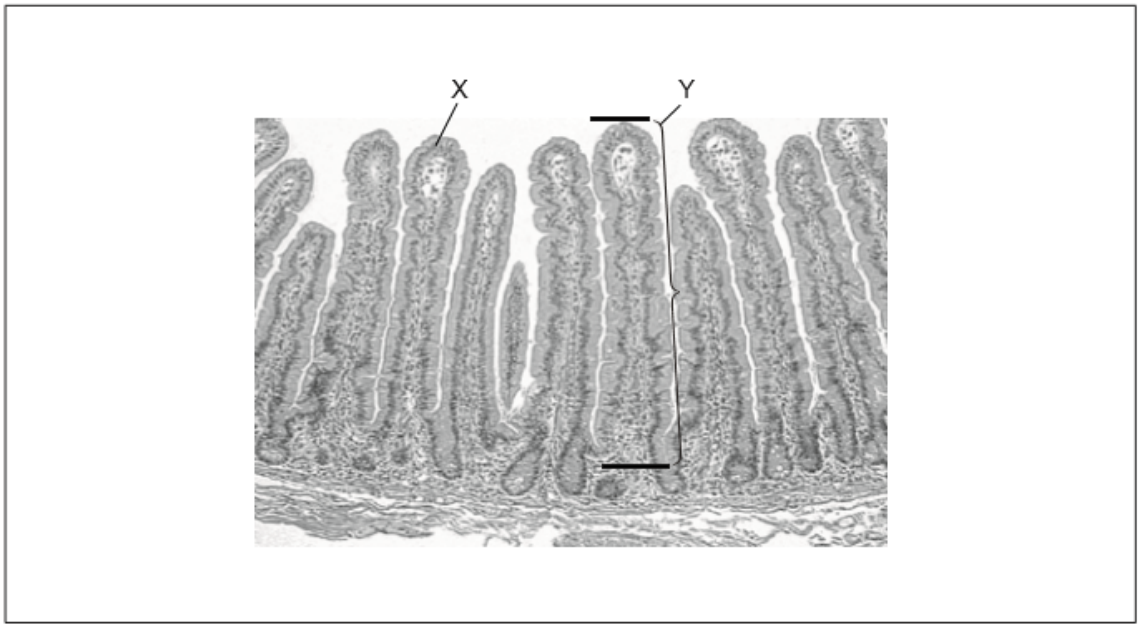


[Source: adapted from A. J. Karley, A. E. Douglas, W. E. Parker, Amino acid composition and nutritional quality of potato leaf phloem sap for aphids. *Journal of Experimental Biology* 2002 205: 3009-3018.© The Company of Biologists Limited 2002.]

a. Describe briefly how scientists obtained leaf phloem sap from the potato plants. [2]

b. Suggest reasons for different amounts of sucrose in the leaf phloem sap of the potato plants. [3]

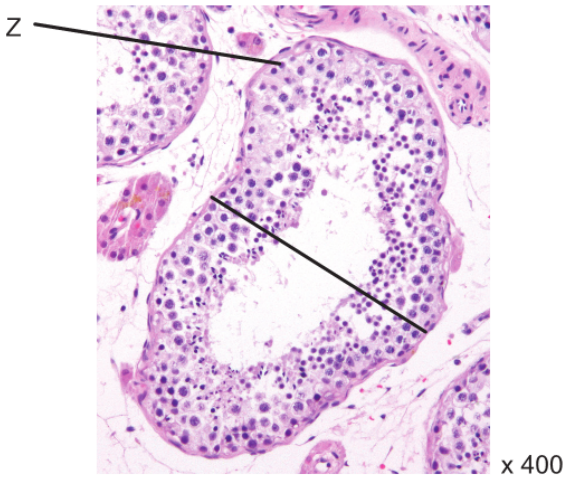
The micrograph shows a section of an organ in the human body.



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

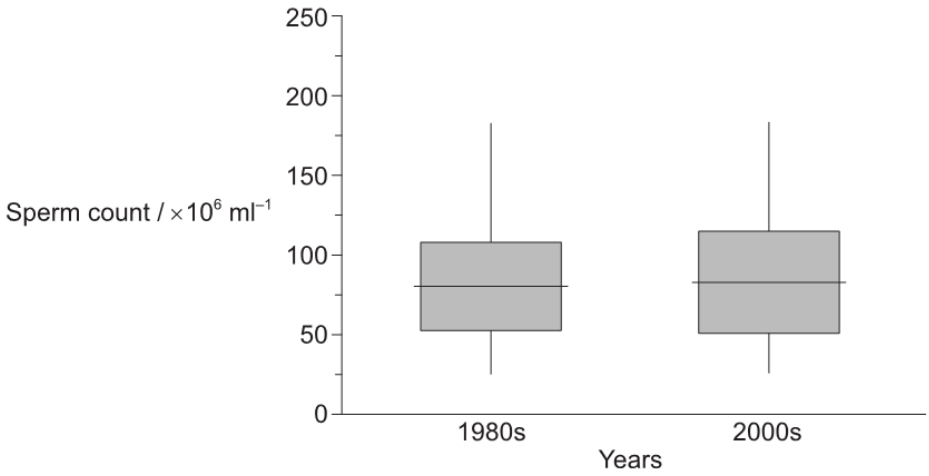
One of the functions of this organ is absorption. On the micrograph, draw an arrow showing the direction of absorption.

The light micrograph shows a cross section of seminiferous tubules.



[Source: Micrograph of a seminiferous tubule with sperm by Nephron (https://commons.wikimedia.org/wiki/File:Seminiferous_tubule_and_sperm_low_mag.jpg)]

a. Concerns have been raised about the effect of rising pollution levels on sperm production in men. To investigate the possible effects of pollution on spermatogenesis, sperm samples from men of similar ages were collected in Kolkata in the 1980s and 2000s. The box plot represents the mean and range of sperm counts in the 1980s and 2000s. [3]



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Semen quality and age-specific changes: A study between two decades on 3729 male partners of couples with normal sperm count and attending an andrology laboratory for infertility-related problems in an Indian city', Dyutiman Mukhopadhyay, Alex C. Varghese, Manisha Pal, Sudip K. Banerjee, Asok K. Bhattacharyya, Rakesh K. Sharma, and Ashok Agarwal, Fertility and Sterility, 93 (7), 2009; permission conveyed through Copyright Clearance Center, Inc]

A hypothesis has been suggested that pollution may have a negative effect on spermatogenesis. Evaluate whether the data support this hypothesis.

b.i. Calculate the actual size of the seminiferous tubule in the area indicated by the line across it, giving the units. [1]

b.ii. Identify the type of cell labelled Z. [1]