SL Paper 3

a. State the names of the **three** domains, giving a microbial example of each. [3]

b. Traditional classification separates organisms into two groups: prokaryotes and eukaryotes. Explain the reasons for reclassification of life into three domains. [2]

c. Distinguish between the **two** domains of prokaryotes. [2]

Using the mammalian pentadactyl limb as an example, outline the process of adaptive radiation.

Outline the process of adaptive radiation.

Outline **two** processes needed for the spontaneous origin of life on Earth.

Explain the reasons for the reclassification of Prokaryotes and Eukaryotes into Eubacteria, Archaea and Eukaryota.

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a. Outline the process of adaptive radiation. [3]

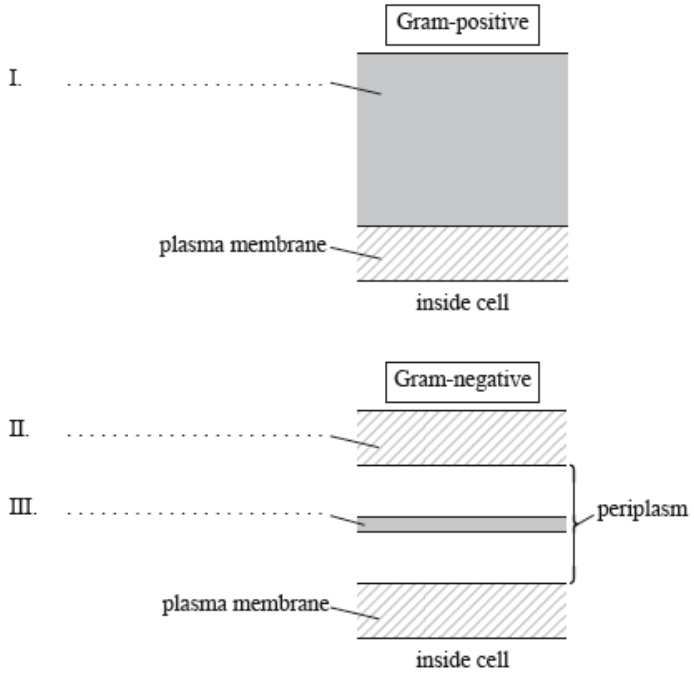
b. There has been a change of thinking; moving from gradualism to punctuated equilibrium demonstrates the changing nature of science. Discuss these two ideas about the pace of evolution. [4]

Discuss the definition of the term **species**.

Outline the process of adaptive radiation.

a. Distinguish between Archaea and Eukarya. [2]

b. Label the parts of the cell walls in Gram-positive Eubacteria and Gram-negative Eubacteria shown below. [3]



Antibiotics are sometimes given orally to poultry to prevent disease that may lead to reduced growth. Antibiotic resistance of bacteria from turkeys and chickens bred for meat and from egg laying hens was measured.

Excrement was collected and *Escherichia coli* bacteria were isolated. These bacteria were tested for resistance to a range of antibiotics and the results are shown below.

Number of antibiotics to which *E. coli* are resistant	Turkeys $n = 43$	Chickens $n = 45$	Egg laying hens $n = 20$
0	7	9	13
1	8	5	3
2	7	7	0
3	2	7	3
4	5	7	1
≥5	14	10	0

[Source:Antibiotic resistance of faecal _Escherichia coli_ in poultry, poultry farmers and poultry slaughterers. A. E. van den Bogaard, N. London, C. Driessen, E. E. Stobberingh. _Journal of Antimicrobial Chemotherapy_, 47, June 1, 763--771. 2001, Oxford University Press.]

a. Calculate the percentage risk of bacteria becoming resistant to more than five kinds of antibiotics in turkeys and egg laying hens. [1]

Turkeys:

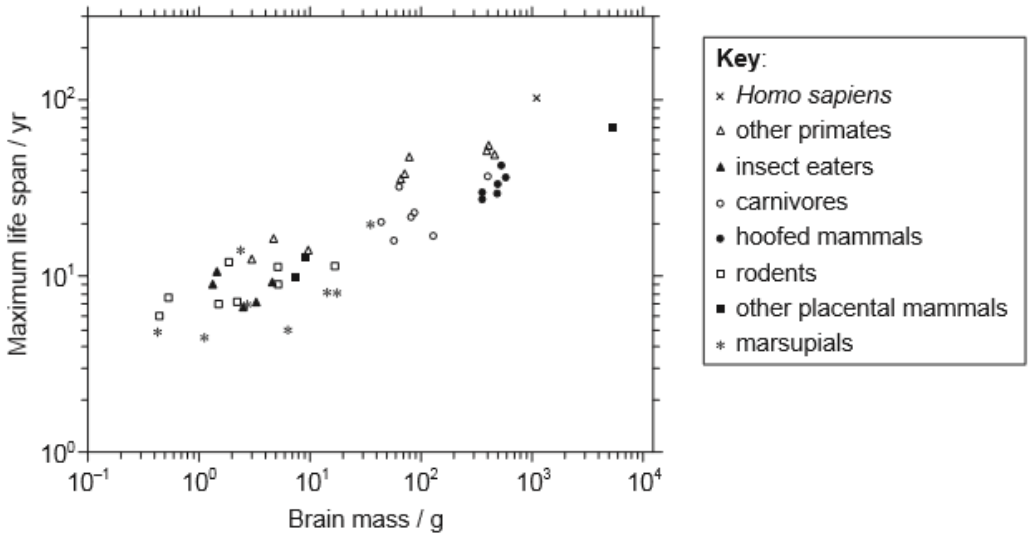
Egg laying hens:

b. Compare the incidence of drug resistance in bacteria from chickens and egg laying hens. [2]

c. Discuss the hypothesis that giving antibiotics increases antibiotic resistance in poultry bacteria. [2]

d. Suggest how antibiotic-resistant bacteria are passed from animals to humans. [1]

The evolution of increased body size in mammals has been accompanied by an increase in life span. Another variable that could affect life span is brain size. Data was analysed from 47 mammalian species.



[Source: Hofman, M. A. (1993), Encephalization and the evolution of longevity in mammals. *Journal of Evolutionary Biology*, **6**: 209–227. doi: 10.1046/j.1420-9101.1993.6020209.x]

a. State the relationship between brain mass and maximum life span. [1]

b. Identify the group with the widest range of brain mass. [1]

c. Compare the brain mass and life span of primates and marsupials. [3]

d. Discuss how a larger brain size and longer life span might have contributed to the evolution of these species. [2]

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	Tyr	Ala	Lys	Asp	Ala	Leu	Ala
E. coli (Mn)	Ser	Tyr	Thr	Leu	Pro	Ser	Leu	Pro	Tyr	Ala	Tyr	Asp	Ala	Leu	Glu
Mitochondrial (Mn)	Lys	His	Thr	Leu	Pro	Asp	Leu	Pro	Tyr	Asp	Tyr	Gly	Ala	Leu	Glu
Cytoplasmic (Cu-Zn)	AcAla	Thr	Lys	Ala	Val	Cys	Val	Leu	Lys	Gly	Asp	Gly	Pro	Val	Gln

	⑮				⑳					㉕					
E. coli (Fe)	Pro	His	Ile	Ser	Ala	Glu	Thr	Ile	Glu	Tyr	His	Tyr	Gly	Lys	
E. coli (Mn)	Pro	His	Phe	Asp	Lys	Gln	Thr	Met	Glu	Leu	His	His	Thr	Lys	
Mitochondrial (Mn)	Pro	His	Ile	Ser	Ala	Glu	Ile	Met	Gln	Leu	His	His	Ser	Lys	
Cytoplasmic (Cu-Zn)	Gly	Thr	Ile	His	Phe	Glu	Ala	Lys	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.]

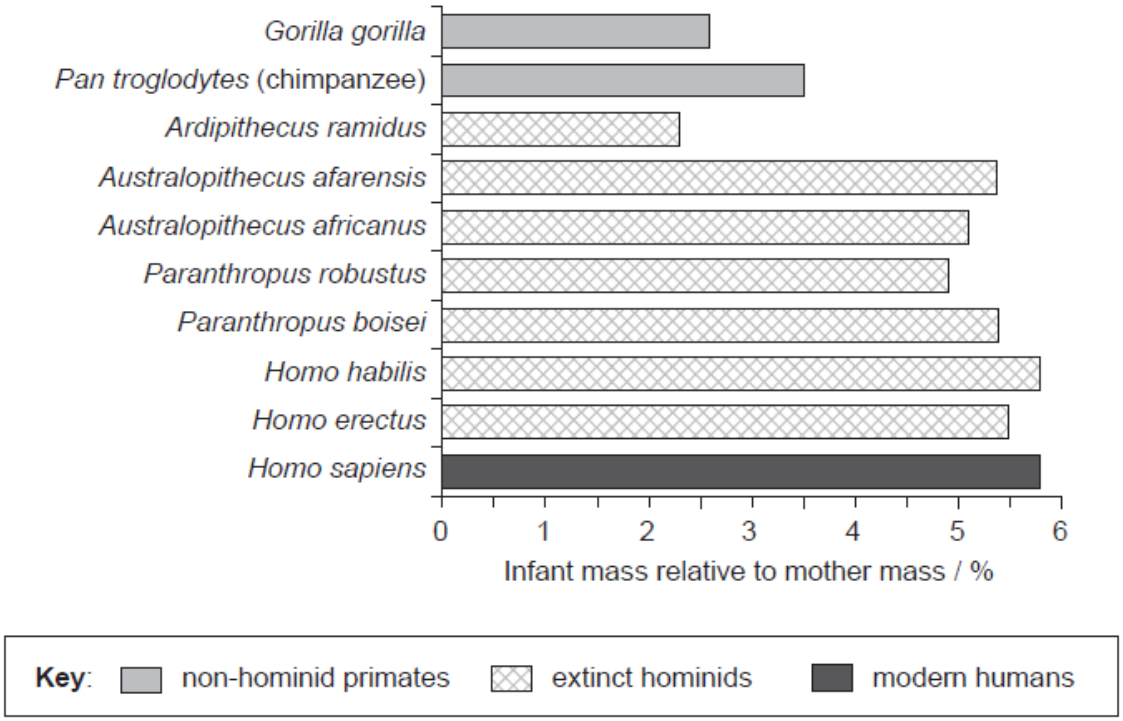
a. State how many amino acids are in the same position in the *E. coli* (Fe), *E. coli* (Mn) and the mitochondrial dismutase sequences shown. [1]

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]

Modern human mothers give birth to proportionately larger infants than apes do, but it is not clear when this change occurred over the course of human evolution. The graph shows the infant mass relative to mother mass in primates, extinct hominids and modern humans.



[Source: adapted from J DeSilva, (2011), *Proceedings of the National Academy of Science*, **108** (3), pages 1022–1027]

a. State the infant mass relative to mother mass of *Homo sapiens*. [1]

b. Outline the difference in infant mass relative to mother mass in extinct hominids and modern humans. [1]

c. Suggest a hypothesis, based on evidence in the data, for when the shift to giving birth to larger infants occurred in the evolution of humans. [2]

d. Suggest **one** disadvantage of infants being born with a relatively large size in humans. [1]