HL Paper 2

a. Distinguish between autotrophs and heterotrophs. [2]

b. Define *saprotroph*. [1]

c (i) State an external feature that is different in: [1]

Cnidaria and Mollusca.

c (ii) State an external feature that is different in: [1]

Mollusca and Annelida.

---

a. Outline the structure and functions of nucleosomes. [4]

b. Explain how DNA is used to pass on genetic information to offspring accurately but also produce variation in species. [8]

c. Accurate transmission of base sequences to offspring depends on successful gamete production. Describe how spermatogenesis occurs in humans. [6]

---

a. Draw a labelled diagram of a mature human egg. [5]

b. Outline a technique used for gene transfer. [5]

c. Explain how evolution may happen in response to environmental change with evidence from examples. [8]

---

a. Describe the relationship between the rise in the concentration of atmospheric carbon dioxide and the enhanced greenhouse effect. [5]

b. Outline the precautionary principle. [5]

c. Antibiotic resistance in bacteria is an example of evolution in response to environmental change. Using another example, explain how an environmental change can lead to evolution. [8]

---

a. Outline the types of evidence that can be used to support the theory of evolution. [4]

c. Explain **two** examples of evolution in response to an environmental change. [8]

The biological insights of Mendel and Darwin in the 19th century remain important to this day.

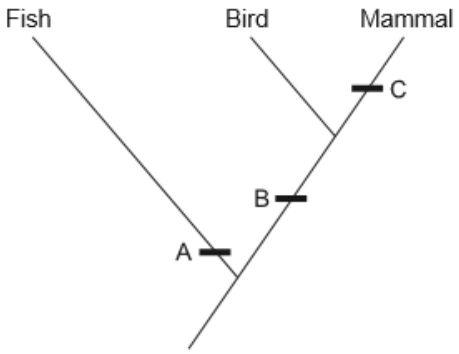
a. Discuss the role of genes and chromosomes in determining individual and shared character features of the members of a species. [7]

b. Outline the process of speciation. [4]

c. Describe, using **one** example, how homologous structures provide evidence for evolution. [4]

---

a. The image shows part of a cladogram. [3]



Using the cladogram, identify one diagnostic feature that characterizes the given groups of vertebrates at A, B and C.

A: .....
B: .....
C: .....

b. Starting from the concept of gene pool, explain briefly how populations of early vertebrates could have evolved into different groups. [3]

c. Mitochondria are thought to have evolved from prokaryotic cells. Describe **two** adaptations of the mitochondria, each related to its function. [2]

---

a. List **two** causes of variation within a gene pool. [2]

b. Describe how variation contributes to evolution by natural selection. [3]

c. Outline what is required for speciation to occur. [3]

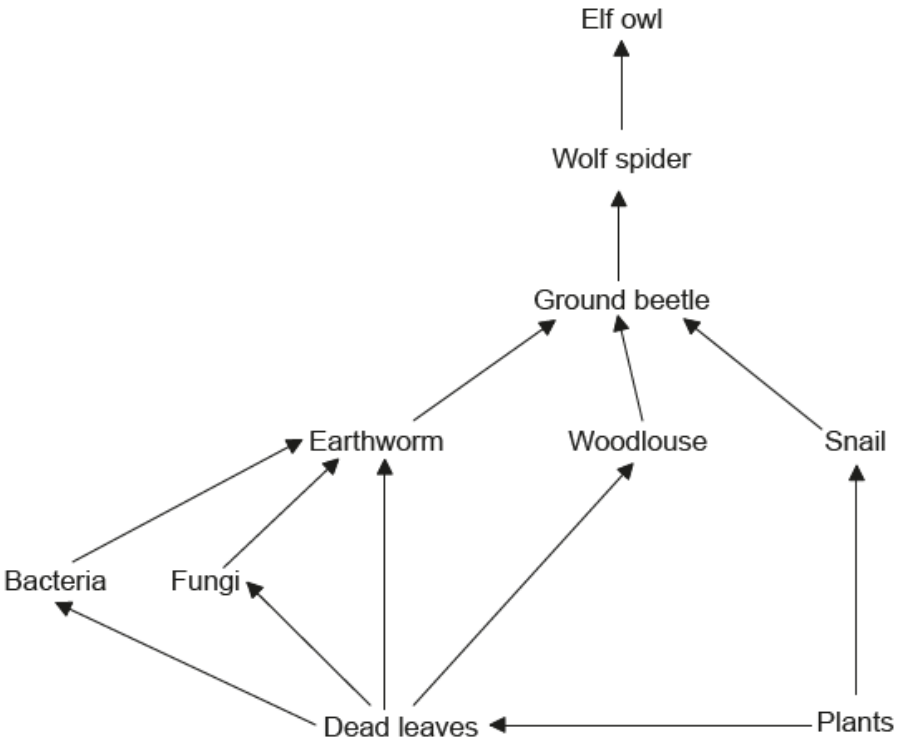
---

a. Outline how antibiotic resistance in bacteria can arise in response to environmental change. [5]

b. Outline the principle of immunity. [6]

c. Discuss the benefits and dangers of vaccination. [7]

The image shows a food web.



[Source: © International Baccalaureate Organization, 2017]

a.i. Using the food web, identify a detritivore. [1]

a.ii. Using the food web, identify a saprotroph. [1]

b. State the name of the domain to which birds, such as the Elf owl, belong. [1]

c. Outline the energy flow through this food web. [3]

In some maize plants the seed is enclosed in a green sheath called a tunica. The allele (T) for this is dominant to the allele (t) for normal, unenclosed seeds. The endosperm of the seed can be starchy (allele E) or sugary (allele e). The genes for these two characteristics are linked. The table below shows the outcome of crosses between a plant heterozygous for both characteristics and one that is homozygous recessive for both characteristics.

Phenotype	Number
Tunica present, starchy	326
Unenclosed seeds, starchy	111
Tunica present, sugary	118
Unenclosed seeds, sugary	295

a (i) State the genotype of the heterozygous parent using the correct notation. [1]

a (ii) Identify which individuals are recombinants in this cross. [1]

a (iii) Explain what has occurred to cause these results. [2]

b. Maize belongs to the group of plants known as angiospermophyta. Distinguish between angiospermophytes and bryophytes. [2]

---

a. Draw a labelled diagram of the human adult male reproductive system. [5]

b. Compare the processes of spermatogenesis and oogenesis [8]

c. Describe the consequences of the potential overproduction of offspring. [5]

---

a. Cell biologists play an important role in research into disease, fertility, evolution and many other areas of science. [4]

Describe the origin of eukaryotic cells according to the endosymbiotic theory.

b. Cell biologists play an important role in research into disease, fertility, evolution and many [8]

other areas of science.

Compare and contrast the processes of spermatogenesis and oogenesis.

c. Cell biologists play an important role in research into disease, fertility, evolution and many [3]

other areas of science.

Outline the evidence for evolution provided by selective breeding.

The Chinese soft-shelled turtle, *Pelodiscus sinensis*, lives in salt water marshes. The turtle can live under water and out of water.

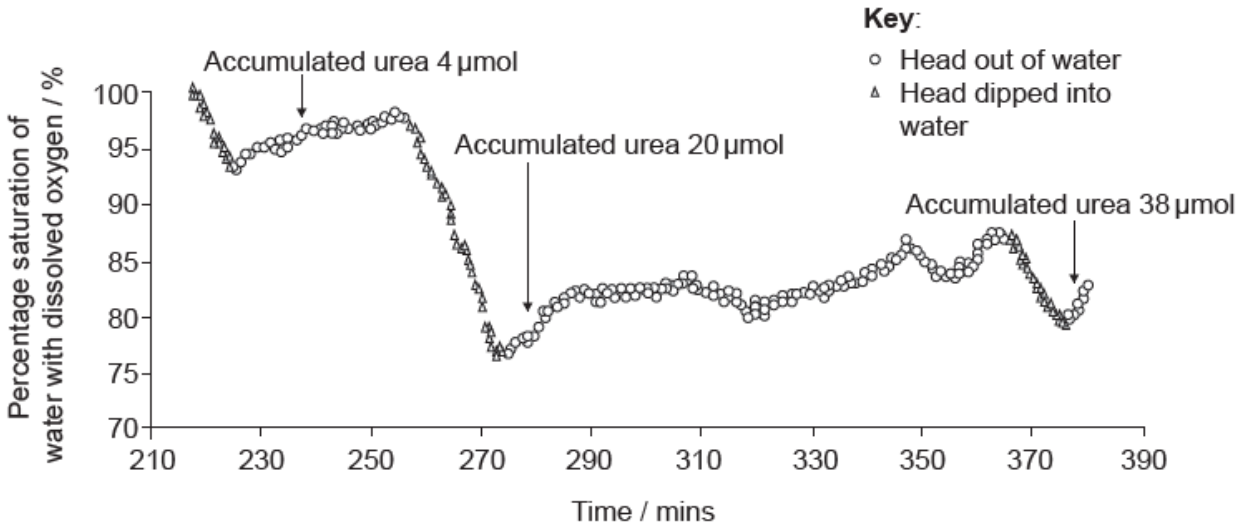
These turtles have fully developed lungs and kidneys, however, many microvilli have been discovered in the mouth of *P. sinensis*. A study was undertaken to test the hypothesis that oxygen uptake and urea excretion can simultaneously occur in the mouth.

Initial experiments involved collecting nitrogen excretion data from *P. sinensis*. The turtle urinates both in water and out of water. When in water it allows waste products to be washed out of its mouth. When out of water it regularly dips its head into shallow water to wash its mouth. The table shows the mean rates of ammonia and urea excretion from the mouth and kidney over six days.

	Excretion of nitrogen by the mouth / μmol day^{-1} g^{-1} turtle		Excretion of nitrogen by the kidney / μmol day^{-1} g^{-1} turtle	
	Turtle submerged in water	Turtle out of water	Turtle submerged in water	Turtle out of water
Ammonia	0.29	0.30	0.63	0.54
Urea	0.90	1.56	0.07	0.73

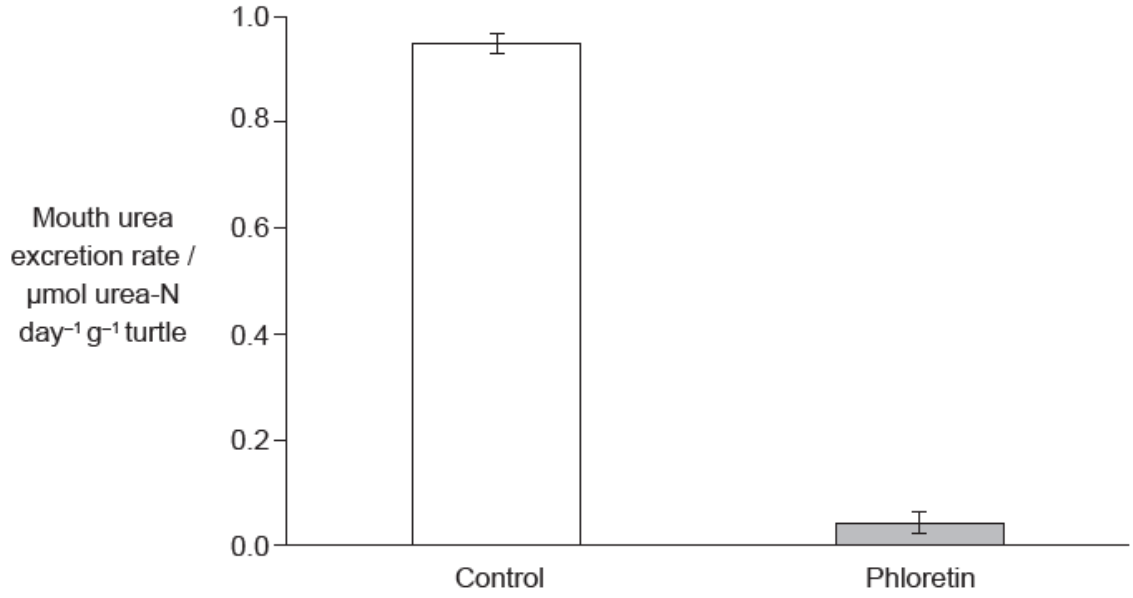
[Source: Reproduced with permission, Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723—3733. jeb.biologists.org. doi: 10.1242/jeb.068916]

It was noted that during long periods out of water, turtles rhythmically moved their mouths to take in water from a shallow source and then discharge it. Changes in the dissolved oxygen and the quantity of accumulated urea in the rinse water discharged by the turtles were monitored over time as shown in this graph.



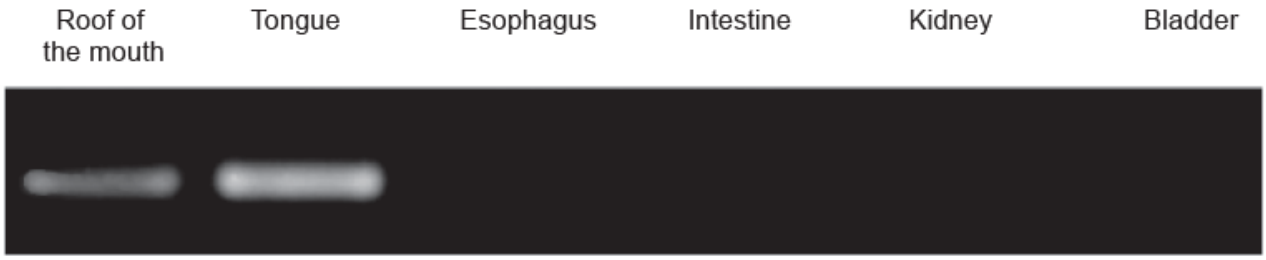
[Source: adapted with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733.]

In order to test whether a urea transporter was present in the mouth tissues of the turtles, phloretin (a known inhibitor of membrane proteins that transport urea) was added to the water in which a further set of turtles submerged their heads. The results of that treatment are shown.



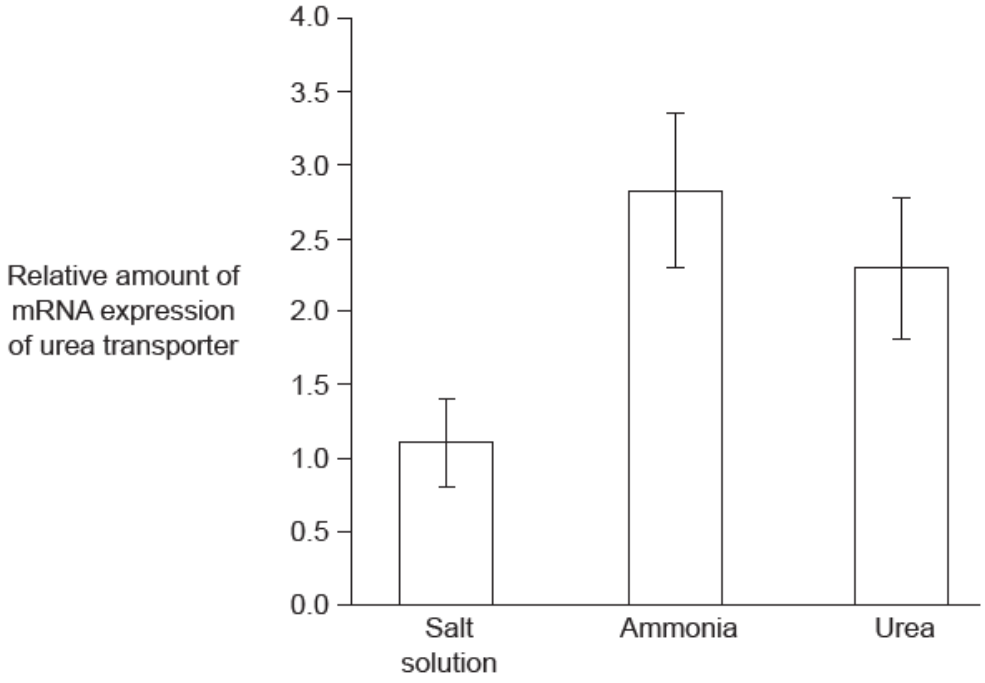
[Source: Reproduced with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. jeb.biologists.org.]

Further research was conducted to determine where mRNA expression of a urea transporter gene might be occurring in *P. sinensis*. Gel electrophoresis was used to analyse different tissue samples for mRNA activity.



[Source: Reproduced with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. jeb.biologists.org.]

Expression of the urea transporter gene by cells in the turtle's mouth was assessed by measuring mRNA activity. Turtles were kept out of water for 24 hours and then injected with either a salt solution that matched the salt concentration of the turtle, dissolved ammonia or urea, followed by another 24 hours out of water.



[Source: © International Baccalaureate Organization 2017]

a. Deduce whether the excretion of ammonia or urea changes more when a turtle emerges from water. [2]

b. Compare and contrast the changes in urea excretion in the mouth with the changes in urea excretion in the kidney when a turtle emerges from the water. [3]

c.i. Describe the trends shown by the graph for dissolved oxygen in water discharged from the mouth. [1]

c.ii. Suggest reasons for these trends in dissolved oxygen. [2]

d. Deduce with a reason whether a urea transporter is present in the mouth of *P. sinensis*. [2]

e. Outline the additional evidence provided by the gel electrophoresis results shown above. [2]

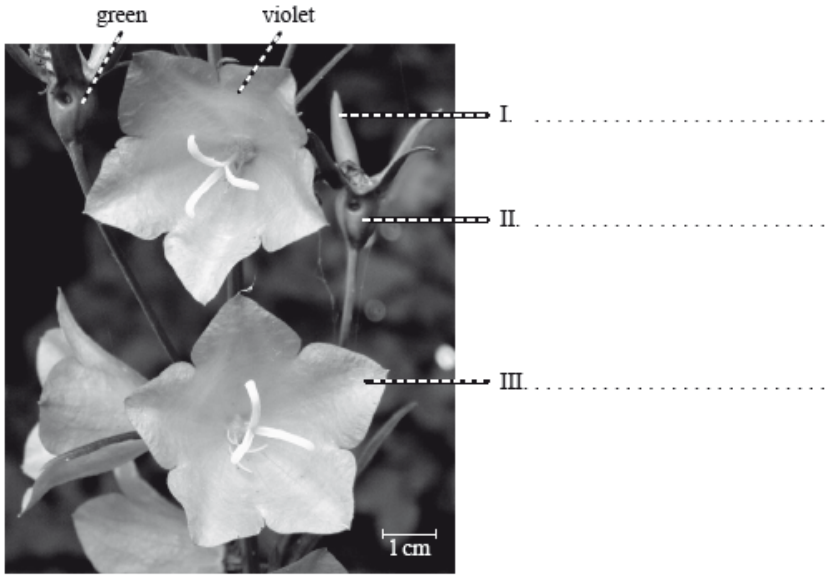
f.i. Identify which of these turtle groups represent the control, giving a reason for your answer. [1]

f.ii. Suggest a reason for the greater expression of the gene for the urea transporter after an injection with dissolved ammonia than an injection of urea. [2]

g. The salt marshes where these turtles live periodically dry up to small pools. Discuss the problems that this will cause for nitrogen excretion in the turtles and how their behaviour might overcome the problems. [3]

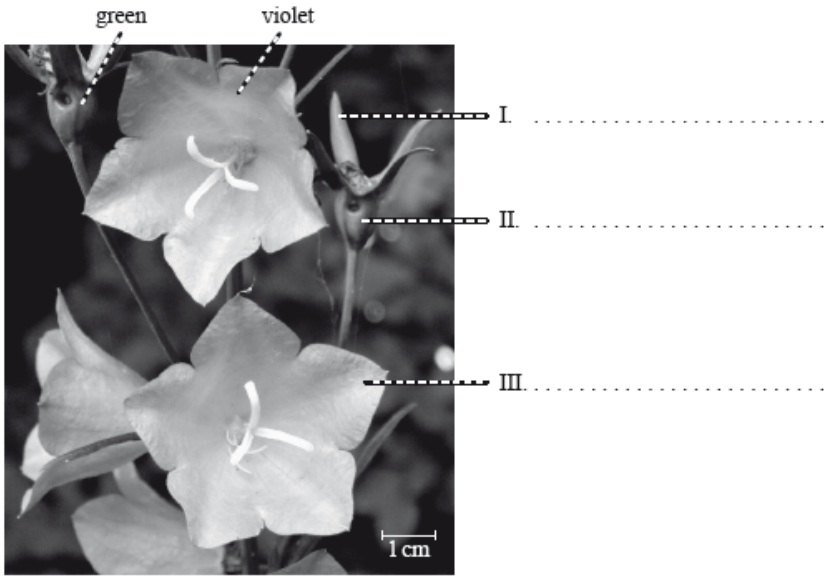
---

a. The photograph below shows the flowers of *Campanula persicifolia*. Label structures I, II and III. [3]



[Source: photograph provided by IB examiner]

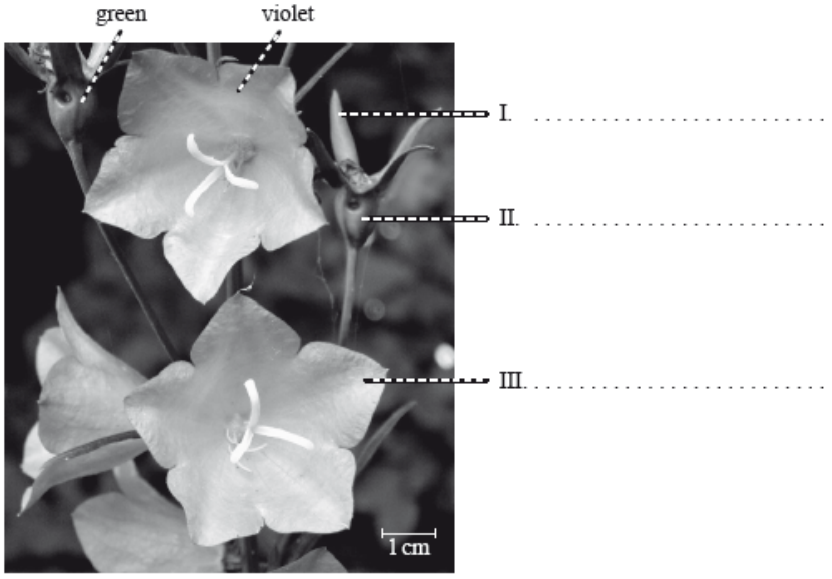
b(i). [1]



[Source: photograph provided by IB examiner]

Using the external features shown in the photograph, state the phylum to which this plant belongs.

b(ii). [2]



[Source: photograph provided by IB examiner]

Comment on the hypothesis that the plant shown in the photograph could be pollinated by an animal.

c. Outline the use of the binomial system of nomenclature in *Campanula persicifolia*. [2]