HL Paper 2

Angiospermophyta have vascular tissue (xylem and phloem) that bryophyta lack. Suggest advantages that vascular tissue confers.

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a. Outline the structure of a ribosome. [4]

b. Distinguish between fibrous and globular proteins with reference to **one** example of each protein type. [6]

c. Auxin is a protein. Explain its role in phototropism. [8]

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b. Explain how abiotic factors affect the rate of transpiration in terrestrial plants. [8]

c. Describe the importance of water to living organisms. [5]

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a. State the role of **four named** minerals needed by living organisms. [4]

b. Explain the processes by which minerals are absorbed from the soil into the roots. [8]

c. In anaerobic conditions, plants release energy by glycolysis. Outline the process of glycolysis. [6]

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a. Outline how **three** properties of water enhance its use by living organisms. [6]

b. Describe the role of ADH in osmoregulation. [4]

c. Explain how water is moved from roots to leaves in terrestrial plants. [8]

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a. Draw the absorption spectrum of chlorophyll. [4]

b. Explain the process of photophosphorylation in chloroplasts. [8]

c. Outline how the glucose produced as a result of photosynthesis is transported and stored in plants. [6]

Photosynthesis and transpiration occur in leaves. Explain how temperature affects these processes.

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a. Describe how plants carry out gas exchange in the leaves. [5]

b. Outline the causes and consequences of the enhanced greenhouse effect. [5]

c. Explain the role of limiting factors in photosynthesis. [8]

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a. Explain how minerals move into plants. [8]

b. Outline the conditions needed for the germination of a typical seed. [3]

c. Following germination of seeds, plants undergo a rapid increase in the number of cells. Describe stages in the cell cycle that result in this increase of cells. [7]

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a. Draw a labelled diagram of a eukaryotic plant cell as seen in an electron micrograph. [4]

b. Outline how the energy flow through food chains limits their length. [3]

c. In hot, dry conditions plants lose water rapidly due to transpiration. Explain how the structures and processes of the plant allow this water to be replaced. [8]

Angiospermophyta are vascular flowering plants.

a. Describe the transport of organic compounds in vascular plants. [4]

b. The flowers of angiospermophyta are used for sexual reproduction. Outline **three** processes required for successful reproduction of angiospermophyta. [3]

c. Growth in living organisms includes replication of DNA. Explain DNA replication. [8]

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a. Draw a labelled diagram of the structure of a chloroplast as seen with an electron microscope. [4]

b. Describe how water is carried by the transpiration stream. [7]

c. Explain how flowering is controlled in long-day and short-day plants. [7]

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b. Most of the surface of the Earth is covered with a wide diversity of ecosystems. Outline **two** general characteristics of all ecosystems. [2]

c.i. Vascular plants can be found in a wide variety of ecosystems. [2]

Outline active transport in phloem tissue.

c.ii. Vascular plants can be found in a wide variety of ecosystems. [3]

Explain how a plant replaces the water it loses in transpiration.

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a. Outline the various stages of the cell cycle. [4]

c. Define the term *transpiration* and explain the factors that can affect transpiration in a typical terrestrial plant. [9]

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a. Describe **four** properties of water that are due to hydrogen bonding and polarity. [4]

b. Describe how water is carried through a flowering plant. [6]

c. Some of the water carried to the leaves of a plant is used in photosynthesis. Explain the role of water in the light-dependent reactions of photosynthesis. [8]

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b. Outline the metabolic processes that occur in starchy seeds during germination. [6]

c. Explain the light-independent processes of photosynthesis in plants. [8]

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a. Outline how and where energy is stored in plants. [4]

b. Ecologists sometimes display data from an ecosystem using a diagram called a pyramid of energy. Describe what is shown in pyramids of energy. [6]

c. Explain the control of body temperature in humans. [8]

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a. Plants have widespread influences, from food chains to climate change. [3]

Draw a labelled diagram of the internal structure of a seed.

b. Plants have widespread influences, from food chains to climate change. [8]

Explain the process of water uptake and transport by plants.

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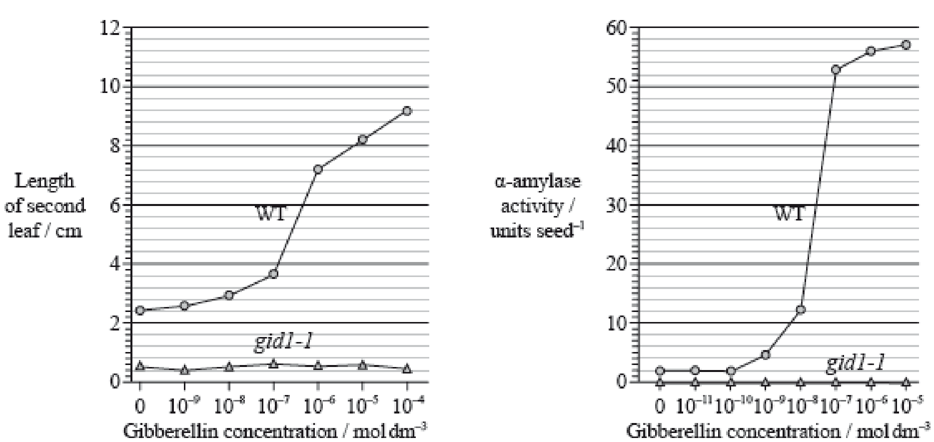
a. Outline pollination, fertilization and seed dispersal. [4]

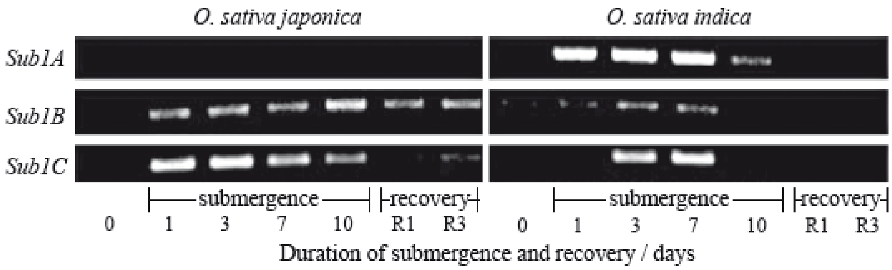
b. Compare the processes of spermatogenesis and oogenesis. [8]

Gibberellin promotes both seed germination and plant growth. Researchers hypothesize that the gene *GID1* in rice (*Oryza sativa*) codes for the production of a cell receptor for gibberellin. The mutant variety *gid1-1* for that gene leads to rice plants with a severe dwarf phenotype and infertile flowers when homozygous recessive. It is suspected that homozygous recessive *gid1-1* plants fail to degrade the protein SLR1 which, when present, inhibits the action of gibberellin. The graphs show the action of gibberellin on the leaves and α-amylase activity of wild-type rice plants (WT) and their *gid1-1* mutants.



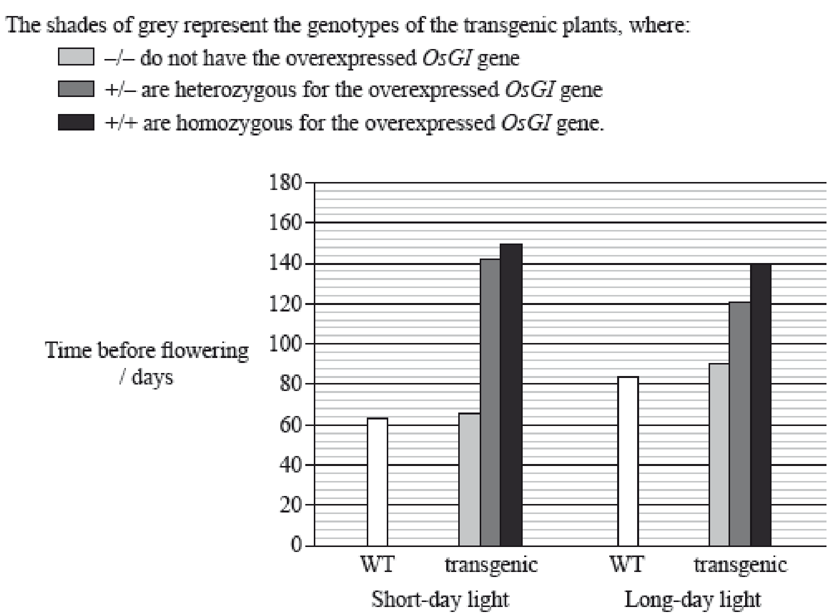
[Source: adapted from M. Ueguchi-Tanaka et al. (2005) 'Gibberellin-insensitive dwarf1 encodes a soluble receptor for gibberellin'. Nature, 437, pp. 693—698. Adapted by permission from Macmillan Publishers Ltd (c) 2005.]

Most rice varieties are intolerant to sustained submergence under water and will usually die within a week. Researchers have hypothesized that the capacity to survive when submerged is related to the presence of three genes very close to each other on rice chromosome number 9; these genes were named *Sub1A*, *Sub1B* and *Sub1C*. The photograph below of part of a gel shows relative amounts of messenger RNA produced from these three genes by the submergence-intolerant variety, *O. sativa japonica*, and by the submergence-tolerant variety, *O. sativa indica*, at different times of a submergence period, followed by a recovery period out of water.



[Source: Adapted from "Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice" (2006) Kenong Xu, Xia Xu, Takeshi Fukao, Patrick Canlas, Reycel Maghirang-Rodriguez et al. Nature, 442, pp. 705—708. Adapted by permission from Macmillan Publishers Ltd (c) 2006.]

The *OsGI* gene causes long-day flowering and the effect of its overexpression has been observed in a transgenic variety of rice. Some wild-type rice (WT) and transgenic plants were exposed to long days (14 hours of light per day) and others to short days (9 hours of light per day).



[Source: adapted from R. Hayama, S. Yokoi, S. Tamaki, M. Yano and K. Shimamoto (2003) 'Adaptation of photoperiodic control pathways produces short-day flowering in rice.' Nature, 422, pp. 719—722. Adapted by permission from Macmillan Publishers Ltd (c) 2003.]

a(i). State which variety of rice fails to respond to gibberellin treatment. [1]

a(ii). The activity of α-amylase was tested at successive concentrations of gibberellin. Determine the increment in gibberellin concentration that produces the greatest change in α-amylase activity in wild-type rice plants (WT). [1]

b. Discuss the consequence of crossing *gid1-1* heterozygous rice plants amongst themselves for food production. [3]

c(i). Determine which gene produced the most mRNA on the first day of the submergence period for variety *O. sativa japonica*. [1]

c(ii). Outline the difference in mRNA production for the three genes during the submergence period for variety *O. sativa indica*. [2]

d. Using only this data, deduce which gene confers submersion resistance to rice plants. [2]

e(i). State the overall effect of overexpression of the *OsGI* gene in plants treated with short-day light. [1]

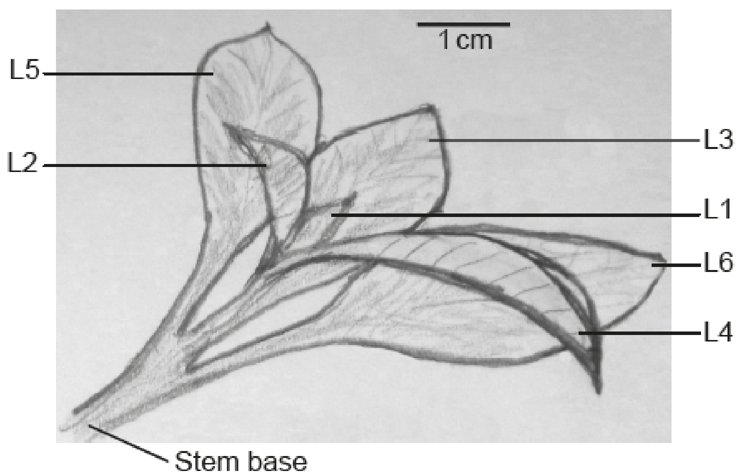
e(ii). Compare the results between the plants treated with short-day light and the plants treated with long-day light. [2]

e(iii). State, giving **one** reason taken from the data opposite, if unmodified rice is a short-day plant **or** a long-day plant. [1]

g. Evaluate, using all the data, how modified varieties of rice could be used to overcome food shortages in some countries. [2]

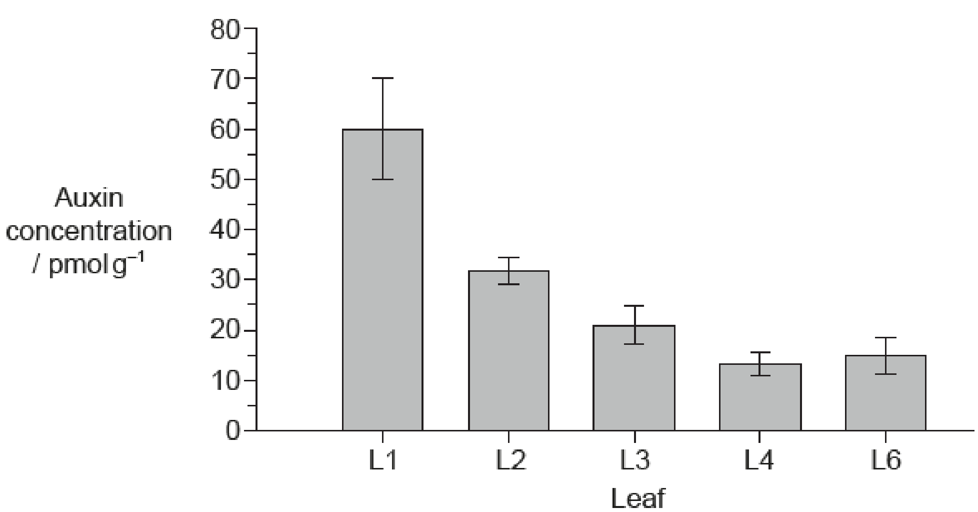
Auxin can be used to promote the development of roots from stem and leafy cuttings in some plants. In a study into the distribution of auxin in the development of these roots, scientists measured the amount of auxin in different leaves of a shoot tip of *Petunia hybrida*.

The figure indicates the numbering of leaves on the shoot, from L1 as the youngest and smallest to L6 as the largest and oldest leaf. The developmental stage of L5 and L6 was very similar, so L5 was not analysed. The stem base is the lowest part of the cutting where roots may form.



[Source: A. Ahkami *et al.* (2013) *Planta*, 238, pages 499–517]

The graph shows the auxin concentration in the different leaves.



[Source: A. Ahkami *et al.* (2013) *Planta*, 238, pages 499–517]

N-1-naphthylphthalamic acid (NPA) is an inhibitor used to block auxin transport. NPA was sprayed onto the leaves of a set of cuttings for 14 days.

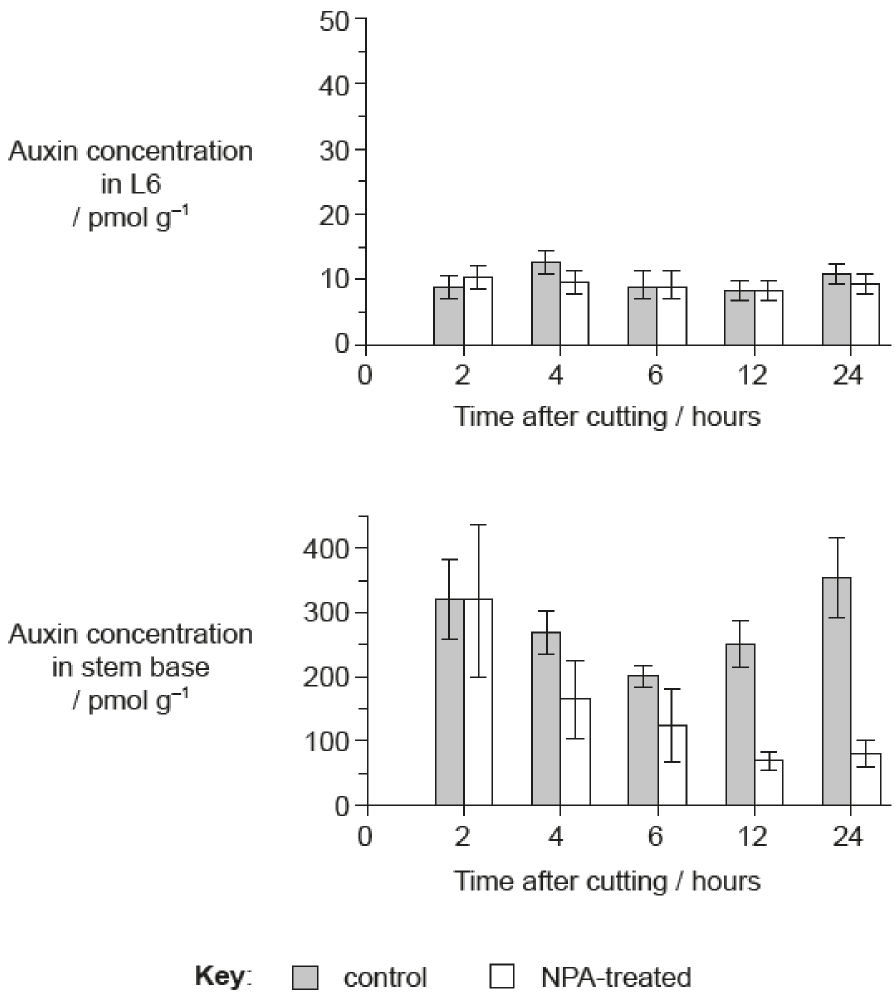
Development of the roots in control (non-treated) and NPA-treated cuttings was measured 14 days after taking the cuttings.

The table shows the influence of NPA on rooting.

	Mean number of roots per cutting	**Mean root length / cm**	**Mean total root length per cutting / cm**
Control	53.2	1.4	47.7
NPA-treated	8.0	0.6	1.0

[Source: adapted from A Ahkami, *et al*., (2013), *Planta*, **238**, pages 499–517]

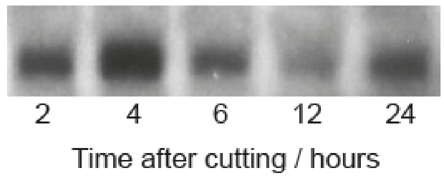
The scientists also measured the changes in auxin concentration in L6 and the stem base during the early period of root formation. They recorded the concentration in the control and NPA-treated cuttings for 24 hours after taking the cuttings.



[Source: adapted from A Ahkami, *et al*., (2013), *Planta*, **238**, pages 499–517]

The scientists wanted to know whether the accumulation of auxin over time in the stem base of the controls affected expression of the *GH3* gene, known to have a role in growth regulation in different plants. The technique that was used to quantify the level of transcription of the *GH3* gene was Northern blotting. In this procedure the darkness

and thickness of the band is an indicator of the level of transcription of a particular gene. The image shows the result of the Northern blot from 2 hours to 24 hours after cutting.



[Source: adapted from A Ahkami, *et al*., (2013), *Planta*, **238**, pages 499–517]

a. Calculate the difference in the concentration of auxin found in L1 and L6. [1]

. . . . pmol g^{-1}

b. Identify the relationship between the concentration of auxin and the age of the different leaves. [2]

c. Analyse the effect of NPA on the formation of roots. [2]

d.i. Compare and contrast the changes in auxin concentration in the stem base over time for the control and NPA-treated cuttings. [2]

d.ii. Deduce the effect of NPA on auxin transport between L6 and the stem base. [2]

e. Based on all the data presented and your knowledge of auxin, discuss the pattern of auxin production and distribution in the leaves and the possible relationship to root formation in leafy cuttings of *Petunia hybrida*. [3]

f.i. State the name of the molecule which is produced by transcription. [1]

f.ii. Compare the pattern of *GH3* transcription with the pattern of auxin concentration in the stem base control cuttings. You may use the table provided to help you to record the patterns before you compare them. (Please note: a simple

comparison in the table will not gain marks) [2]

	2–4 hours	4–6 hours	6–12 hours	12–24 hours
Auxin concentration				
***GH3* bands**				

f.iii. The scientists concluded that auxin activates the transcription of the *GH3* gene. Using the information on the auxin concentration in the stem base in the graph and the Northern blot, evaluate whether this conclusion is supported. [2]

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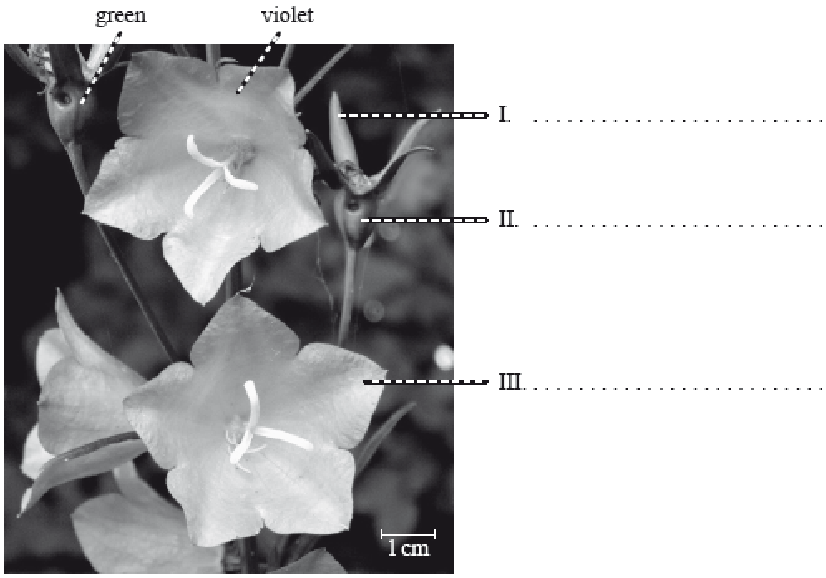
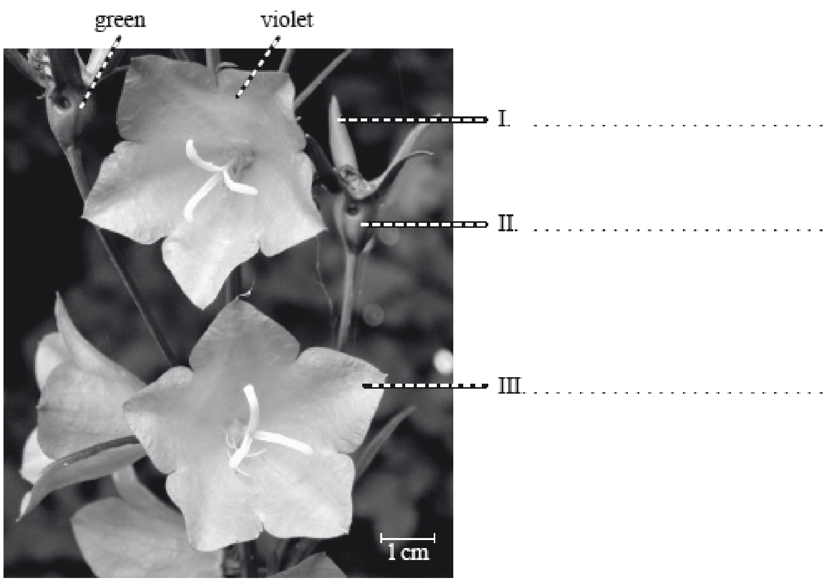
a. The photograph below shows the flowers of *Campanula persicifolia*. Label structures I, II and III. [3]



[Source: photograph provided by IB examiner]

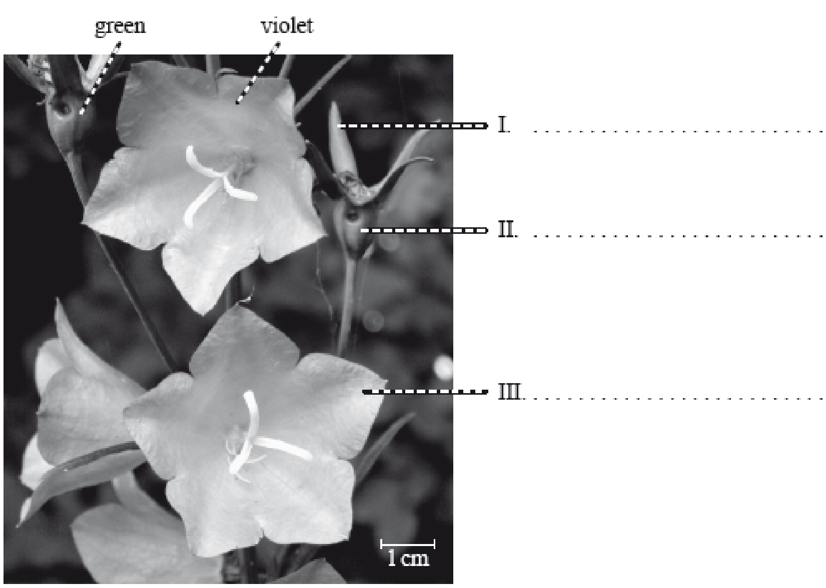
b(i). [1]



[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]