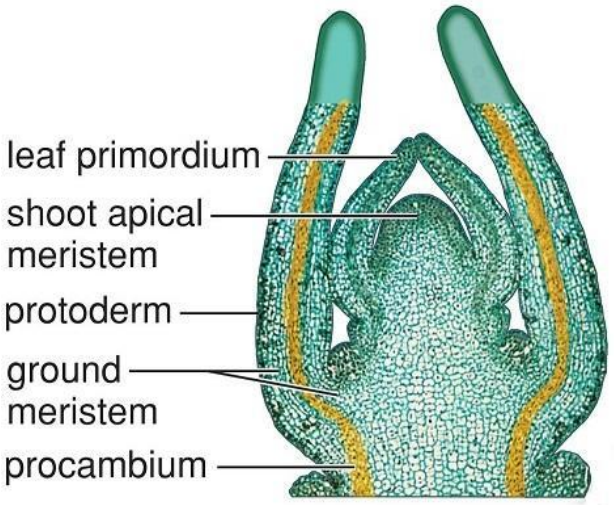
Year 13 HL

IB BIOLOGY

9.3 & 9.4 Growth & Reproduction in Plants



Name:

Teacher: Mr Trent

9.3 Growth in Plants

Essential idea:
Plants adapt their growth to environmental conditions.
Nature of science:
Developments in scientific research follow improvements in analysis and deduction—improvements in analytical techniques allowing the detection of trace amounts of substances has led to advances in the understanding of plant hormones and their effect on gene expression.

Understandings:
9.3.U1 Undifferentiated cells in the meristems of plants allow indeterminate growth.
9.3.U2 Mitosis & cell division in the shoot apex provide cells needed for extension of the stem & development of leaves.
9.3.U3Plant hormones control growth in the shoot apex.
9.3.U4 Plant shoots respond to the environment by tropisms.
9.3.U5Auxin efflux pumps can set up concentration gradients of auxin in plant tissue.
9.3.U6 Auxin influences cell growth rates by changing the pattern of gene expression.

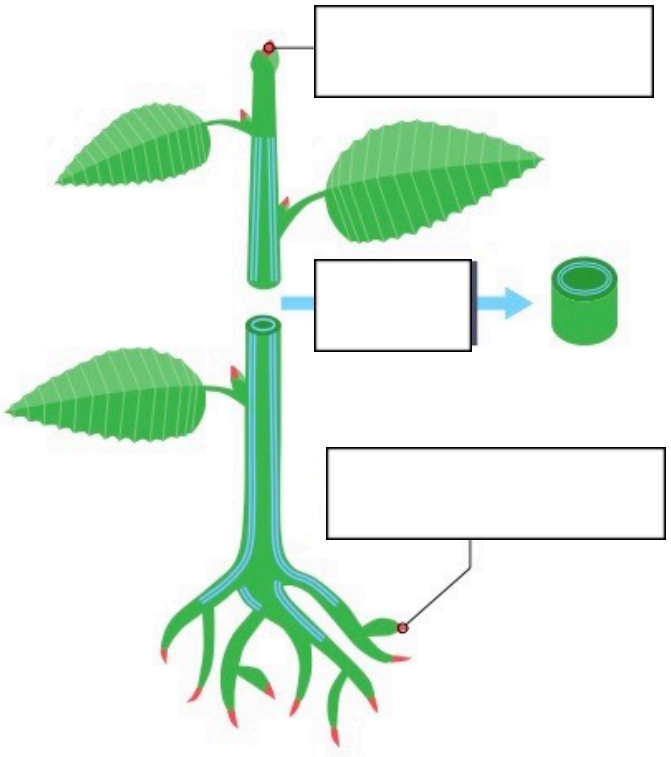
Guidance:
- Auxin is the only named hormone that is expected.

Applications and skills:
9.3.A1 Micropropagation of plants using tissue from the shoot apex, nutrient agar gels and growth hormones.
9.3.A2 Use of micropropagation for rapid bulking up of new varieties, production of virus-free strains of existing varieties and propagation of orchids and other rare species.
Utilization:
- Micropropagation is used for rapid bulking up of new varieties of plant.

Meristems

Define *meristem*.

Explain why meristem cells are more likely to be in mitosis than cells found in other parts of the plant.



Apical Meristems

Causes _____ growth

(i.e. lengthening of plant)

Occurs at tips of _____ and _____

Produces new leaves and flowers

Lateral Meristems

Causes _____ growth

(i.e. widening of plant)

Occurs at the _____

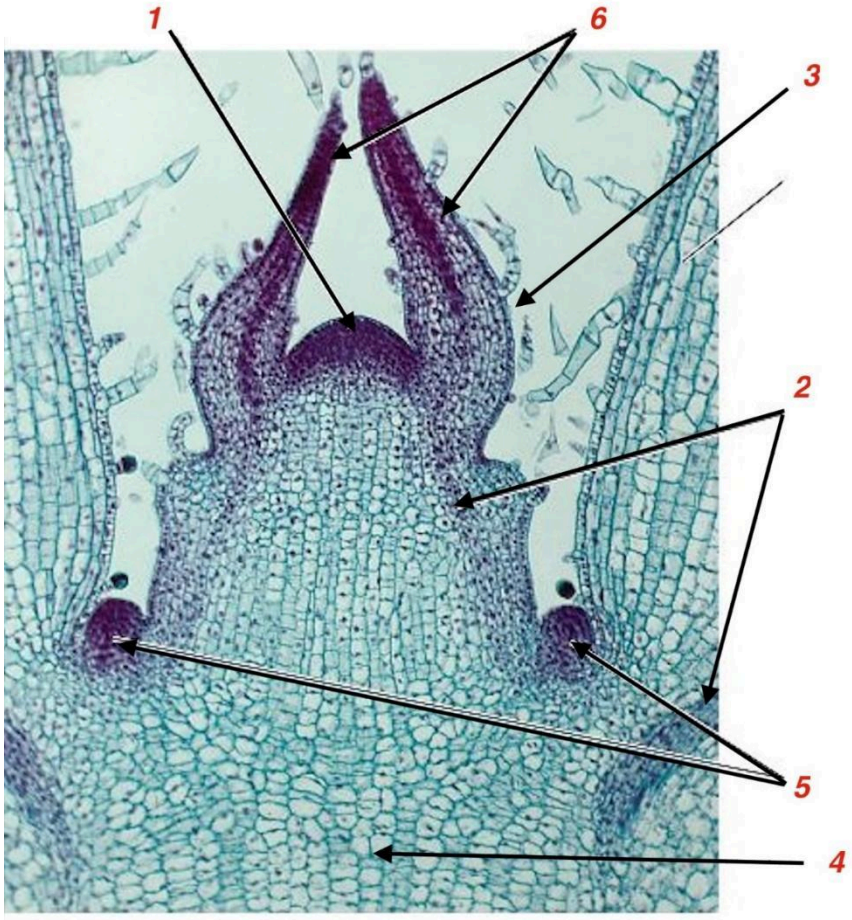
Produces bark on trees

Distinguish between *apical* and *lateral* meristems in terms of location and function in the stem.

	Apical	Lateral
Location		
Function		

Describe the function of the axillary bud.

What is the trigger to growth of a new shoot or branch?



Tropisms

https://www.youtube.com/watch?v=pCFstSMvAMI&feature=emb_logo

Compare these types of tropism:

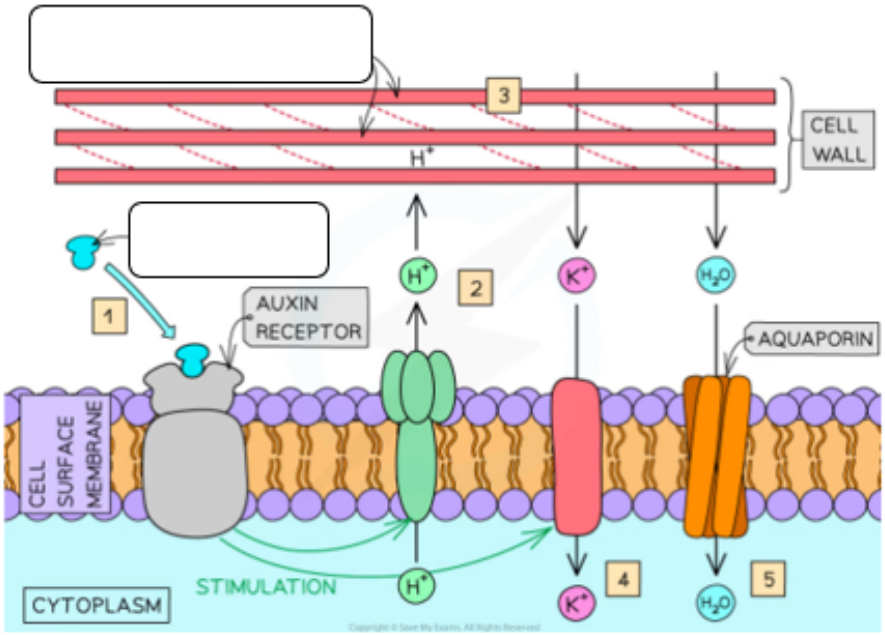
	Response to:	**Positive or negative?**
Phototropism		
Geotropism		
Hydrotropism		

Define *tropism*.

Define *auxin*.

State the difference of root and shoot auxins.

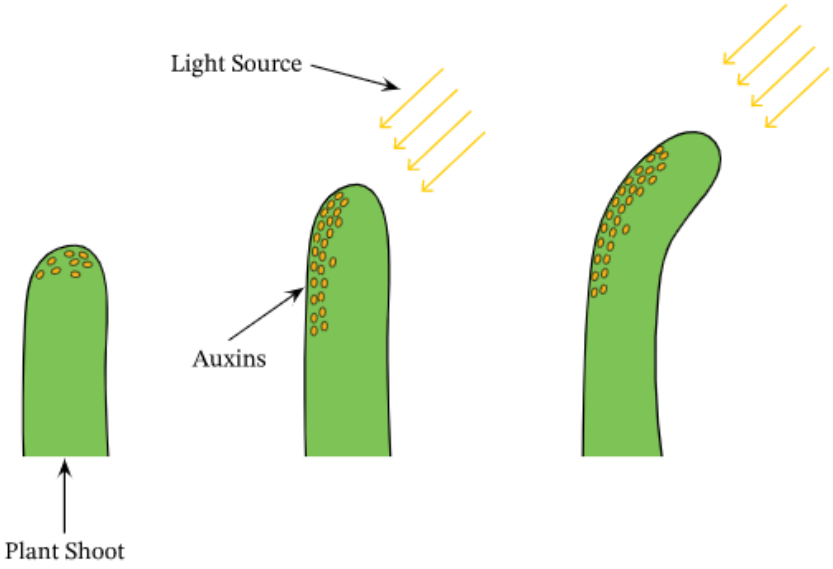
Explain, with the aid of the diagram, the role of auxins in phototropism. Describe auxin efflux pumps and the role of expansins.



- Auxin activates a proton pump in the plasma membrane which causes the secretion of H^+ ions into the cell wall
- The resultant decrease in pH causes cellulose fibres within the cell wall to loosen (by breaking the bonds between them)
- Additionally, auxin upregulates expression of expansins, which similarly increases the elasticity of the cell wall
- With the cell wall now more flexible, an influx of water (to be stored in the vacuole) causes the cell to increase in size

Draw a summary of the 4 points

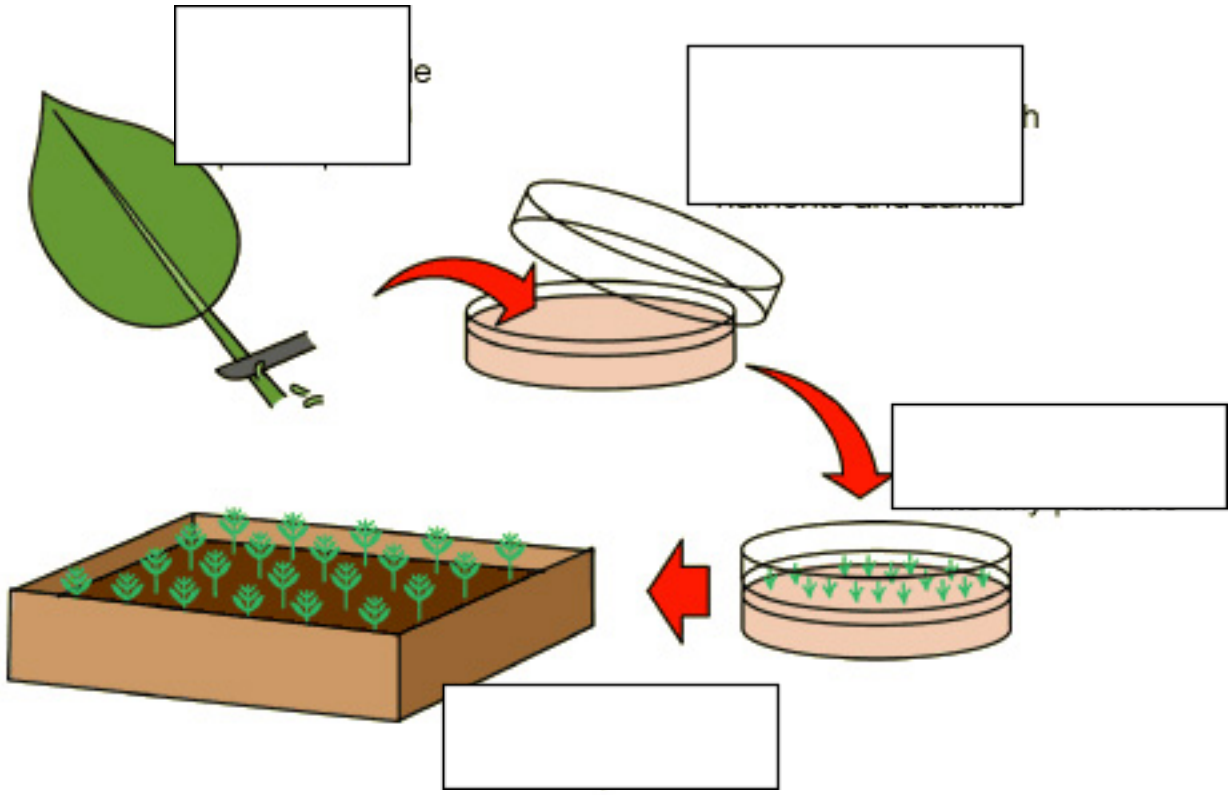
In **shoots**, auxin increases the flexibility of the cell wall to promote plant growth via cell elongation



Micropropagation

- Application: Micropropagation of plants using tissue from the shoot apex, nutrient agar gels and growth hormones.
- Application: Use of micropropagation for rapid bulking up of new varieties, production of virus-free strains of existing varieties and propagation of orchids and other rare species.
- Utilization: Micropropagation is used for rapid bulking up of new varieties of plant.

Micropropagation:



Why use micropropagation?

- Plant _____ are transported within the plant through the vascular tissue.
- The _____ does not contain vascular tissue
- Propagating plants from sterilised vascular tissue produces _____-free plants
- _____and use of _____ space

- _____ are prized for their beautiful long-lasting flowers exhibiting an incredible range of diversity in size, shape and colour.
- It is very _____to get orchids to breed sexually and to maintain the _____ traits

- Seeds are diificult to _____
- Micropropagation has been so successful that orchids occupy a position as one of the top ten cut flowers

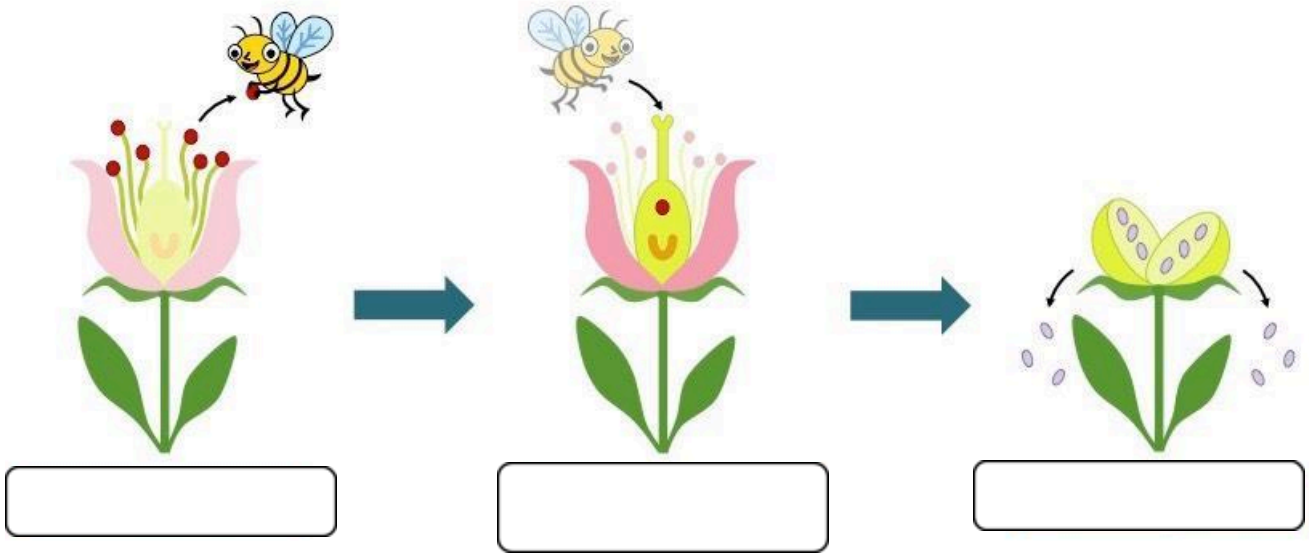
9.4 Reproduction in Plants

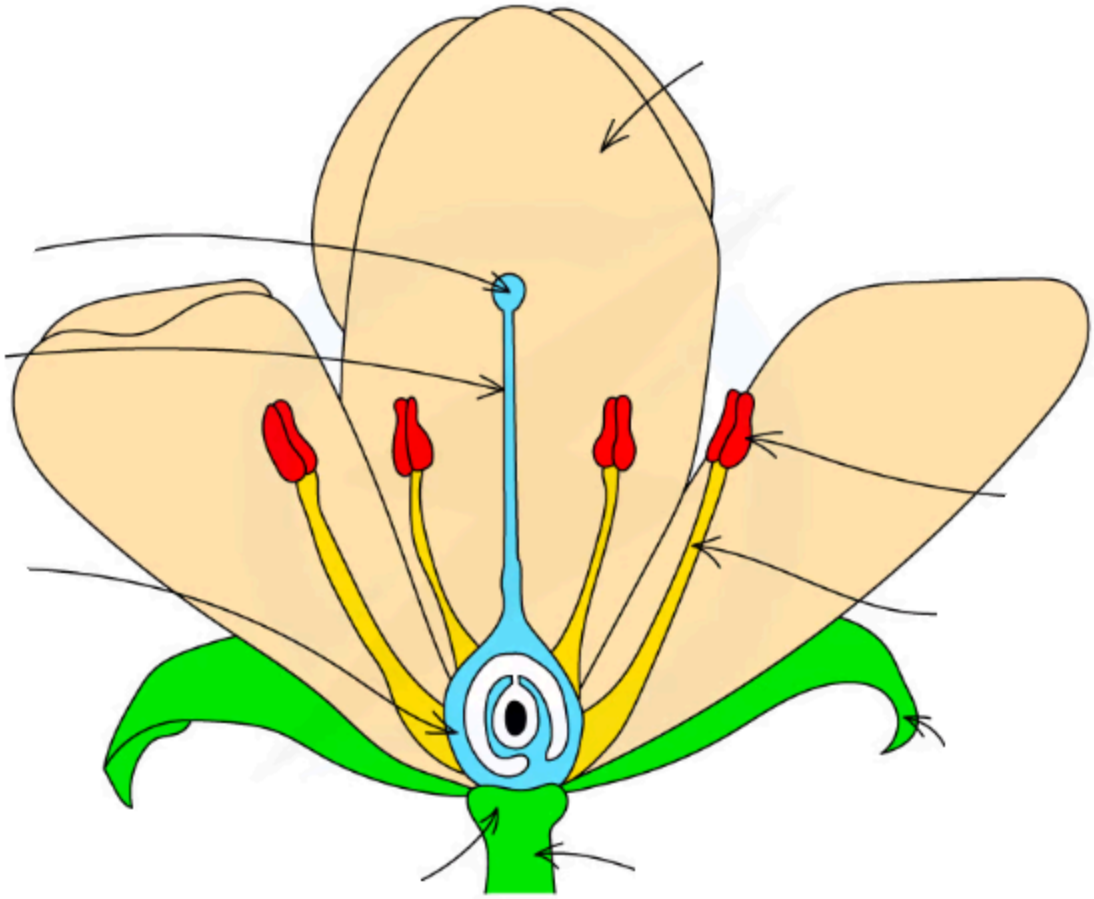
Essential idea:
Reproduction in flowering plants is influenced by the biotic and abiotic environment
Nature of science:
Paradigm shift—more than 85% of the world's 250,000 species of flowering plant depend on pollinators for reproduction. This knowledge has led to protecting entire ecosystems rather than individual species.

Understandings:
9.4U1 Flowering involves a change in gene expression in the shoot apex.
9.4U2 The switch to flowering is a response to the length of light and dark periods in many plants.
9.4U3 Success in plant reproduction depends on pollination, fertilization and seed dispersal.
9.4U4 Most flowering plants use mutualistic relationships with pollinators in sexual reproduction.
Guidance:
- Students should understand the differences between pollination, fertilization and seed dispersal but are not required to know the details of each process.
- Flowering in so-called short-day plants such as chrysanthemums, is stimulated by long nights rather than short days.

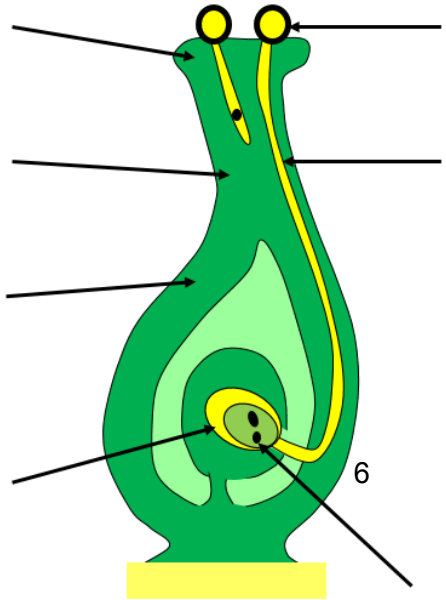
Applications and skills:
9.4A1 Methods used to induce short-day plants to flower out of season.
9.4S1 Drawing internal structure of seeds
9.4S2 Drawing of half-views of animal-pollinated flowers.
9.4S3 Design of experiments to test hypotheses about factors affecting germination.
Utilization:
- The University of Gottingen, in Germany, conducted an extensive review of scientific studies from 200 countries for 115 of the leading global crops in 2005. They found that 87 of the crop plants depend to some degree upon animal pollination, including bees. This accounts for one-third of crop production globally.

9.4.U1 Flowering involves a change in gene expression in the shoot apex.
9.4.U4 Most flowering plants use mutualistic relationships with pollinators in sexual reproduction.





9.4S2 Drawing of half-views of animal-pollinated flowers.



Which terms are defined below?

Term	**Definition**
	Coloured, flag-like structures which attract insects
	The male sex organ – made of the filament and the anther
	Part of the male sex organ – makes pollen
	A thin stalk that supports the anther
	The female sex organs – made of the stigma, the style and the ovary
	Collects pollen
	Connects the stigma to the ovary
	Found inside the ovary; contains the egg cell
	Grows out of the pollen grain and into the stigma: carries the pollen nucleus down to the egg cell
	Stalk of the flower

Order these in the correct order of pollintation and fertilisaiton.

Fertilisation is when the two nuclei fuse together to make a zygote. This divides by mitosis to form an embryo

A pollen tube grows out of the pollen grain and down through the style to the ovary

The transfer of pollen grains from the anther to the

Wind-pollinated plants

The features of wind-pollinated plants include:

- small petals, often brown or dull green
- no nectar
- pollen produced in large quantities to increase the chances of it reaching another plant
- pollen has a very low mass so it is very light; it can be blown easily by the wind
- anthers are loosely attached and dangle out of the flower, to make it easier to release pollen into the wind
- stigma hangs outside the flower, to make it easier to catch pollen blown by the wind.

The pollen from the flower of one plant is blown by the wind and might land on the stigma of another plant's flower.

Insect-pollinated plants

Features of insect-pollinated plants include:

- brightly coloured and sweet-smelling petals to attract insects
- often contain nectar, a sweet, sugary fluid; bees use nectar to make honey
- smaller quantities of pollen produced
- pollen is often sticky or spiky, to stick to insects
- anthers and stigma are held firmly inside the flower, so insects can brush against them
- stigma has a sticky coating, so pollen sticks to it.

When insects visit the flower, pollen gets stuck to them. When they move to the flowers of another plant, the pollen from the first flower rubs off on to the stigma of the next flower.

Insect pollination is very important in food production. Foods such as fruit, vegetables, and nuts are pollinated by insects.

	Wind	Insect

Scent and Nectar		
Number of Pollen Grains		
Pollen grains		
Anthers		
Stigma		

Match the following term with its function

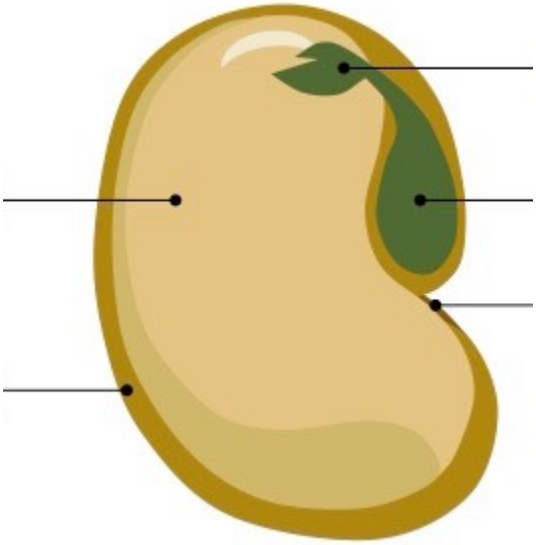
anther	holds up the anther
filament	brightly coloured to attract insects
stigma	produces pollen
style	contains ovules
ovary	this is sticky to 'catch' pollen grains
petal	holds up the stigma

9.4.U3 Success in plant reproduction depends on pollination, fertilization and seed dispersal.

Seed Dispersal

- Fertilisation of gametes results in the formation of a _____, which moves away from the parental plant
- This seed dispersal reduces competition_____ for resources between the germinating seed and the parental plant
- There are a variety of seed dispersal mechanisms, including wind, water, fruits and _____

Seed Structure and Function

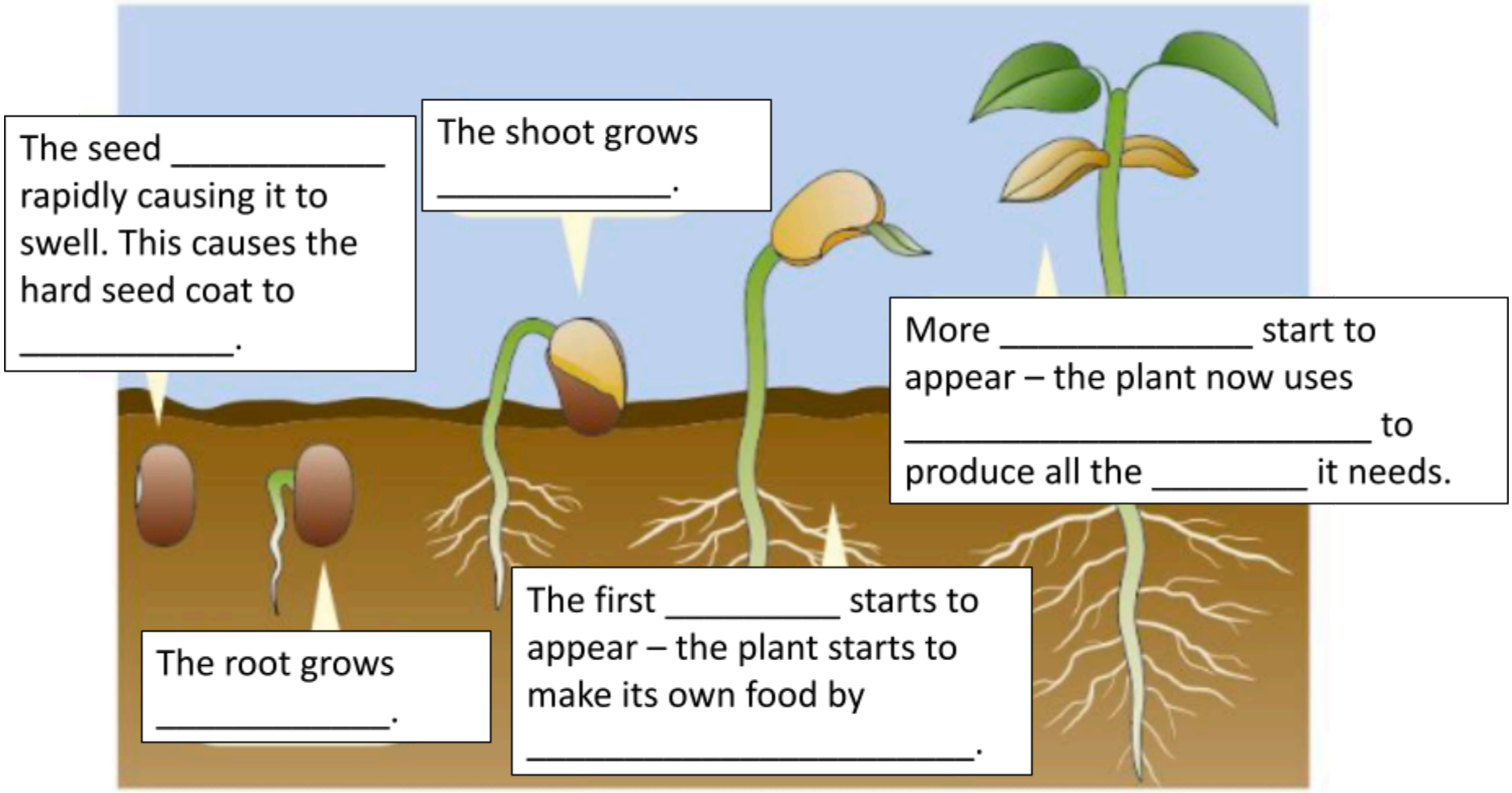


Structure		Function
Testa		the embryonic root
Micropyle		contains the food stores for the seed and forms the embryonic leaves
Cotyledon		an outer seed coat that protects the embryonic plant
Plumule		the embryonic shoot (also called the epicotyl)

Radicle		a small pore in the outer covering of the seed, that allows for the passage of water

9.4S1 Drawing internal structure of seeds

Germination



- Water is _____, gibberellin (plant hormone) is _____, protein _____ occurs, _____are produced and with these enzymes, _____ of starch can occur.

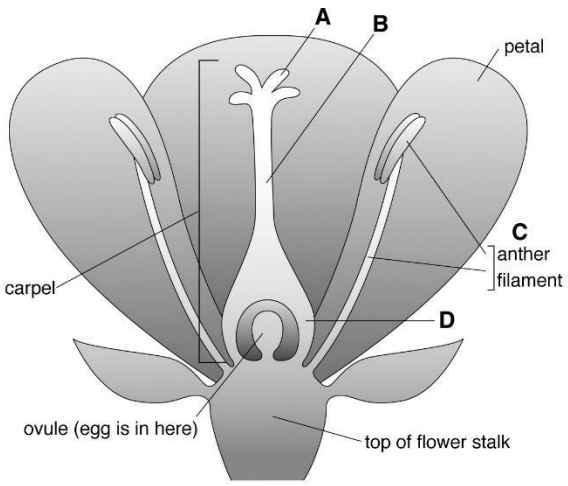
Need	Why?
Warmth	
Oxygen	
Water	
pH	
Light	
Minerals	

- *Fire* – some seeds will only sprout after exposure to intense heat (e.g. after bushfires remove established flora)
- *Freezing* – some seeds will only sprout after periods of intense cold (e.g. in spring, following the winter snows)
- *Digestion* – some seeds require prior animal digestion to erode the seed coat before the seed will sprout
- *Washing* – some seeds may be covered with inhibitors and will only sprout after being washed to remove the inhibitors
- *Scarification* – seeds are more likely to germinate if the seed coat is weakened from physical damage

9.4S3 Design of experiments to test hypotheses about factors affecting germination.

Plan an investigation to about germination below.

Complete the puzzle on flowers and pollination.



Across

2. Contains the egg (the female gamete)

3. Where the pollen lands (part A on the diagram)

4. The part of the flower which holds up the anther

7. Where the ovule is found (part D on the diagram)

9. The transfer of pollen from anther to stigma

Down

1. An insect with brightly coloured wings that pollinates flowers

5. Contains the male sex cells (gametes)

6. The female part of the flower

8. A method that some flowering plants use for pollination

10. Part of the carpel in between the ovary and the stigma (part B on the diagram)

10. Male parts of the plant (part C on the diagram)

11. The part of the stamen where pollen is found

9.4.U2 The switch to flowering is a response to the length of light and dark periods in many plants.

Photoperiodism

Map the sunlight hours per month in London for the year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Map the sunlight hours per month in Vietnam for the year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Distinguish between *long-day* and *short-day plants* in terms of conditions needed for flowering.

Define *phytochrome*.

The response of the plant to the relative lengths of light and darkness is called

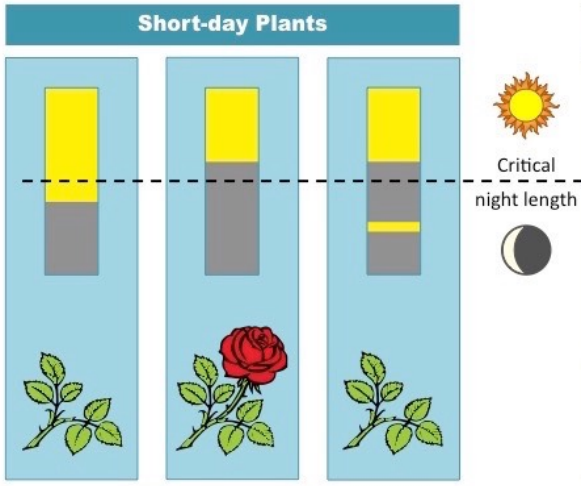
Distinguish between *red light* and *far-red light (length and EM spectrum).*

Use the diagram below to help explain the interconversion of phytochromes during daylight and darkness.

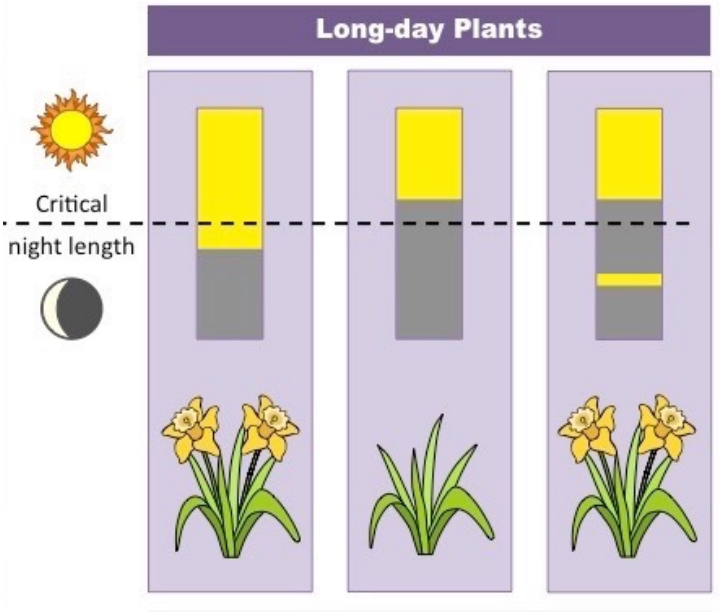
Explain how phytochrome levels control flowering:

a. In short-day plants.

- **Short-day plants:** otherwise known as **_____**: flowering is induced by exposure to **_____ periods <u>longer</u> than a critical length** e.g. chrysanthemum, tobacco, poinsettia.



b. In long-day plants.



Long-day plants: otherwise known as **_____**: flowering is induced by exposure to **dark periods (number of hours) _____than a critical length** e.g. cabbage, petunia.

9.4.A1 Methods used to induce short-day plants to flower out of season.

Explain how chrysanthemum gardeners can use this to increase their crops yield

1. (a) State **two** types of meristem found in plants.

(1)

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(b) Explain the role of auxin in phototropism.

(3)

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2. Outline the techniques used in cloning plants by micropropagation.

(4)

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1. Fertilization, pollination and seed dispersal all occur during the reproduction of a flowering plant. In what sequence do these processes occur?

A. Seed dispersal → pollination → fertilization

B. Fertilization → pollination → seed dispersal

C. Pollination → fertilization → seed dispersal

D. Seed dispersal → fertilization → pollination

(Total 1 mark)

2. What is the correct sequence of events in the germination of a starch seed?

A. gibberellin produced → water absorbed → hydrolysis of food reserves → protein synthesis → enzymes produced

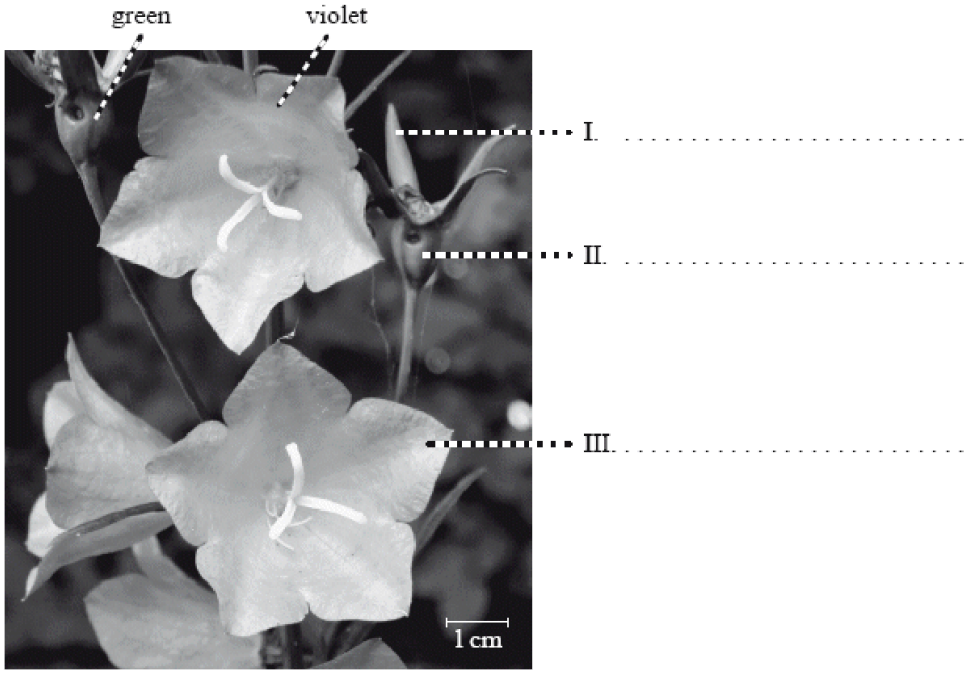
B. water absorbed → hydrolysis of food reserves → protein synthesis → gibberellin produced → enzymes produced

C. water absorbed → gibberellin produced → protein synthesis → enzymes produced → hydrolysis of food reserves

D. gibberellin produced → water absorbed → protein synthesis → enzymes produced → hydrolysis of food reserves

(Total 1 mark)

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



[Source: photograph provided by IB examiner]

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

(2)

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3. Explain how flowering is controlled in long-day and short-day plants.

(7)

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1. (a) apical and lateral 1

(c) auxin produced at apical meristem / tip;
transported to growing area / zone of cell growth;
lateral transport to cells on shade side;
results in cell expansion / elongation;
shoot "grows" towards light source;
3 max

2. small piece of plant removed;
tissue is placed on sterile nutrient agar gel containing high auxin concentration;
callus growth / tissue cut into smaller pieces with same treatment;
callus growth / tissue is transferred to agar gel containing cytokinin;
gibberellin is sometimes added;
plantlets are separated and transferred to soil;
4 max

1. C

[1]

2. C

[1]

3. (a) I. sepal;
II. ovary / receptacle;
III. petal; 3

(b) confirms the hypothesis; *must be qualified*
stigma/anther inside the flower/ring of petals so as visiting animal enters it brushes past them;
colourful petals (provide contrast) so that flowers can be seen by animals;
(slightly) cone-shaped flowers so animals come in; 2 max

4. flowering affected by light;
phytochrome;
exists in two (interconvertible) forms/P_{fr} and P_r;
P_r (red absorbing/660 nm) converted to P_{fr} (far-red/730 nm absorbing) in red or day light;
sunlight contains more red than far red-light so P_{fr} predominates during the day;
gradual reversion of P_{fr} to P_r occurs in darkness;
P_{fr} is active form / P_r is inactive form;
in long-day plants, flowering induced by dark periods shorter than a critical length / occurs when day is longer than a critical length;
enough P_{fr} remains in long-day plants at end of short nights to stimulate flowering;
P_{fr} acts as promoter of flowering in long-day plants;
short-day plants induced to flower by dark periods longer than a critical length/days shorter than a critical value;
at end of long nights enough P_{fr} has been converted to P_r to allow flowering to occur;
P_{fr} acts as inhibitor of flowering in short-day plants; 7 max