1 The flowers of pea plants, *Pisum sativum*, are produced for sexual reproduction. The flowers are naturally self-pollinating, but they can be cross-pollinated by insects.

(a) Explain the difference between self-pollination and cross-pollination.

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..... [2]

(b) Explain the **disadvantages** for plants, such as *P. sativum*, of reproducing sexually.

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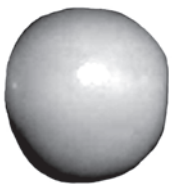
..... [4]

Pea seeds develop inside pea pods after fertilisation. They contain starch. A gene controls the production of an enzyme involved in the synthesis of starch grains.

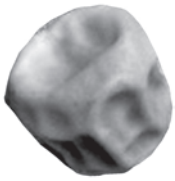
The allele, **R**, codes for an enzyme that produces normal starch grains.
This results in seeds that are round.

The allele, **r**, does not code for the enzyme. The starch grains are not formed normally. This results in seeds that are wrinkled.

Fig. 6.1 shows round and wrinkled pea seeds.



round pea seed



wrinkled pea seed

Fig. 6.1

Pure bred plants are homozygous for the gene concerned. A plant breeder had some pure bred pea plants that had grown from round seeds and some pure bred plants that had grown from wrinkled seeds.

(c) State the genotypes of the pure bred plants that had grown from round and from wrinkled seeds.

round .....

wrinkled ..... [1]

These pure bred plants were cross-pollinated (cross **1**) and the seeds collected.
All the seeds were round. These round seeds were germinated, grown into adult plants (offspring 1) and self-pollinated (cross **2**).

The pods on the offspring 1 plants contained both round and wrinkled seeds.

Further crosses (**3** and **4**) were carried out as shown in Table 6.1.

Table 6.1

cross		phenotype of seeds in the seed pods		ratio of round to wrinkled seeds
		round seeds	wrinkled seeds	
1	pure bred for round seeds x pure bred for wrinkled seeds	✓	✗	1:0
2	offspring 1 self-pollinated	✓	✓	
3	offspring 1 x pure bred for round seeds			
4	offspring 1 x pure bred for wrinkled seeds			

(d) Complete Table 6.1 by indicating

- the type of seeds present in the pods with a tick (✓) or a cross (✗)
- the ratio of round to wrinkled seeds.

You may use the space below and the next page for any rough working. [3]

(e) Seed shape in peas is an example of discontinuous variation.
Suggest **one** reason why seed shape is an example of discontinuous variation.

.....

..... [1]

Plants have methods to disperse their seeds over a wide area.

(f) Explain the **advantages** of having seeds that are dispersed over a wide area,

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

2 **(a** Explain the meaning of the term *transpiration*.

.....

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.....

..... [2]

(b) Root hair cells provide a large surface area for the absorption of water from the soil.

Explain, using the term **water potential**, how water is absorbed from the soil into root hair cells.

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.....

..... [3]

Some plants are adapted for life in dry habitats where it can be very hot during the day and very cold at night.

Fig. 3.1 shows some saguaro cacti from the Sonoran desert in Arizona and Mexico.

Fig. 3.2 shows the surface of the stem of a saguaro cactus.

Fig. 3.1

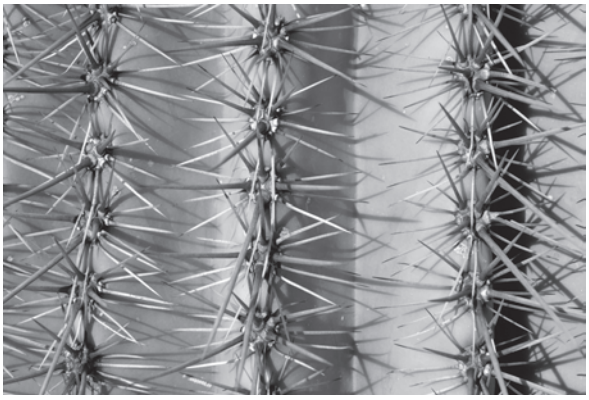

Fig. 3.2

(c) Explain how two features, **visible in Fig. 3.1 or Fig. 3.2**, are adaptations to the conditions in the Sonoran desert.

feature 1 .....

.....

.....

.....

feature 2 .....

.....

.....

..... [4]

(d) The stomata of some desert plants, such as the saguaro cactus, open at night and close during the day.

Explain how this allows the cacti to survive in the desert, but limits their growth rate.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 13]

3 The field mustard plant, *Brassica rapa*, is cross-pollinated by insects.

(a) Describe the advantages of cross-pollination to plants.

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.....

..... [3]

Fig. 6.1 shows the events that follow pollination in *B. rapa*.

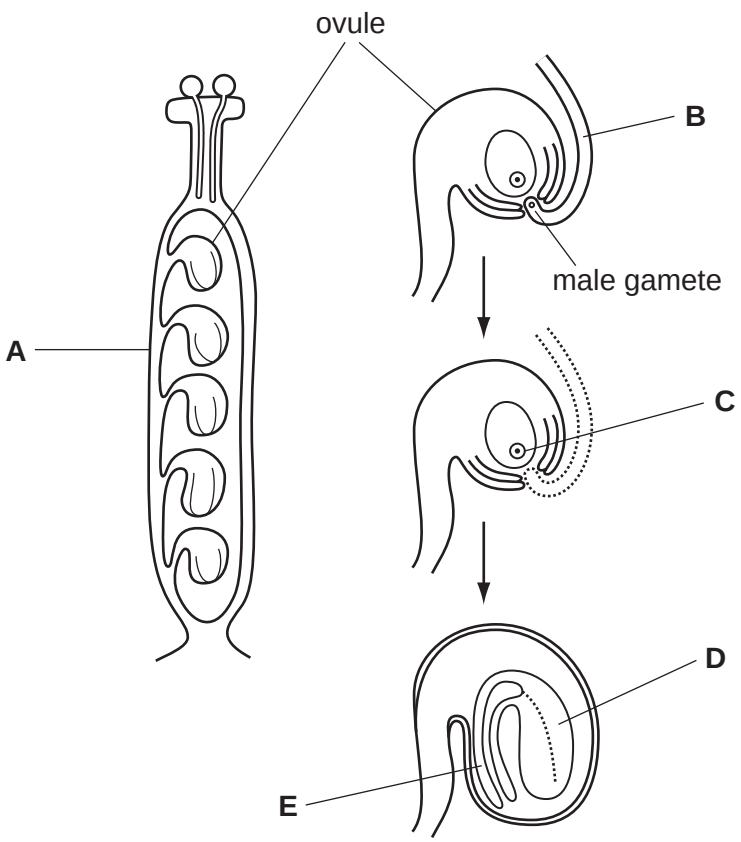

Fig. 6.1

(b) Name

(i) structures **A** to **E**.

A .....

B .....

C .....

D .....

E ..... [5]

(ii) the type of nuclear division that occurs to produce the new cells as the seed grows.

..... [1]

(c) Explain why the genotypes of the seeds are not all the same.

.....

.....

.....

.....

..... [2]

When ripe, the seed pod breaks open and the seeds are scattered. Some of the seeds germinate and grow into adult plants, but many do not.

(d) Explain why many seeds released by *B. rapa* do **not** germinate and grow into adult plants.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

4 Haemoglobin is a protein that is made inside developing red blood cells in the bone marrow.

(a) (i) State the function of haemoglobin.

.....

[1]

(ii) Name the small molecules that are combined to make haemoglobin.

.....

[1]

(iii) Name the mineral ion provided in the diet that is needed to make haemoglobin.

.....

[1]

There are many different varieties of haemoglobin. The gene for haemoglobin exists as two alleles, $\mathbf{Hb^A}$ and $\mathbf{Hb^S}$.

People with the genotype $\mathbf{Hb^SHb^S}$ have a condition called sickle cell anaemia.

(b) Describe the features of sickle cell anaemia.

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.....

.....

[3]

(c) The allele for $\mathbf{Hb^S}$ is rare in many parts of the world, but it is more common in parts of tropical Africa.

Explain why $\mathbf{Hb^S}$ is more common in parts of tropical Africa.

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.....

[3]

(d) The parents of people with sickle cell anaemia rarely have this condition.

Explain, using a genetic diagram, how two parents who do not have sickle cell anaemia may have a child with the condition.

.....

.....

.....

parental genotypes ..... × .....

gametes .... + ...

genotype of child with sickle cell anaemia .....

[3]

(e) Sickle cell anaemia is an example of variation in humans. There are many causes of variation, including nuclear fall-out.

Suggest how nuclear fall-out could cause variation in humans.

.....

.....

.....

.....

..... [2]

[Total: 14]