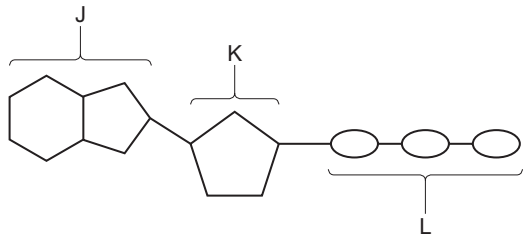


- 40 What describes a non-specific immune response?
- A activation of killer T-lymphocytes by infected cells
 - B cloning of B-lymphocytes to form plasma cells
 - C ingestion of a bacterial cell by a neutrophil
 - D recognition of antigens on the cell surface of macrophages

24 The diagram represents a molecule of ATP.



What are the components of ATP labelled J, K and L?

	J	K	L
A	adenine	deoxyribose	phosphates
B	adenosine	pentose	a phosphate group
C	adenosine	ribose	phosphorus
D	purine	pentose	phosphates

- 1 The wall of the small intestine is highly folded to form villi. Between the villi are infoldings known as crypts of Lieberkühn.

Fig. 1.1 is a diagram of a section through a single villus and a crypt of Lieberkühn.

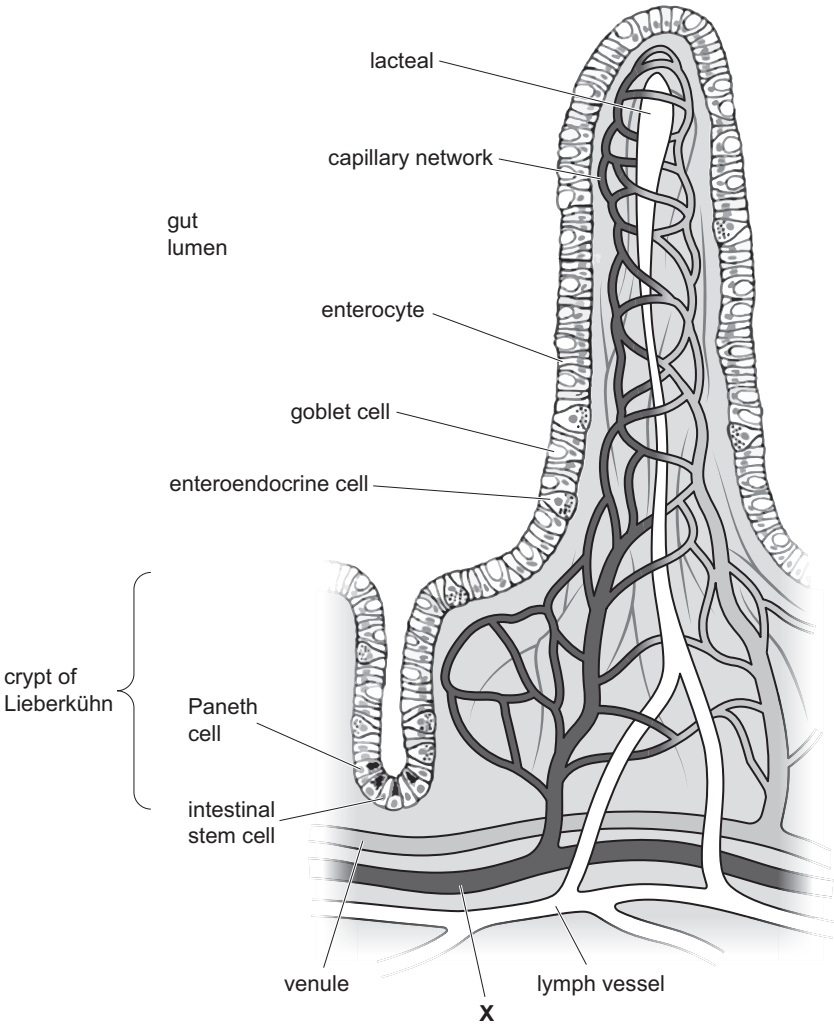


Fig. 1.1

Fig. 1.1 shows that the epithelium of the villus contains mainly goblet cells and cells known as enterocytes. Both cell types have microvilli on the apical surface (surface facing the gut lumen).

Goblet cells are involved in the production of mucus.

Enterocytes are adapted for the absorption of the soluble products of digestion. These products enter the circulatory system.

- (a) A student incorrectly stated that an enterocyte has many **cilia** on its apical surface.

Explain the difference between a cilium and a microvillus.

..... [2]

- (b) Suggest **one** role of the mucus produced by the goblet cells of the villus.

..... [1]

- (c) In Fig. 1.1, blood vessel **X** delivers blood to the capillary network of the villus, where tissue fluid is formed. Some of the fluid passes back into the capillaries and then into the venule.

- (i) Blood vessel **X** receives blood from an artery.

Name the type of blood vessel represented by X.

..... [1]

- (ii) Describe the formation of tissue fluid in the capillary network of the villus.

..... [2]

- (d) In response to the presence of compounds in the gut lumen, enteroendocrine cells synthesise and release peptides (short chains of amino acids) that are cell-signalling molecules. One of these cell-signalling molecules is known as GLP-1.

GLP-1 initiates a number of responses in different body cells. Some of these responses include:

- the increase in release of the hormone insulin from cells in the pancreas
- the decrease in release of acid from cells in the stomach.

Outline, **in sequence**, the main stages involved in the process of cell signalling by GLP-1.

[3]

- (e) Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.

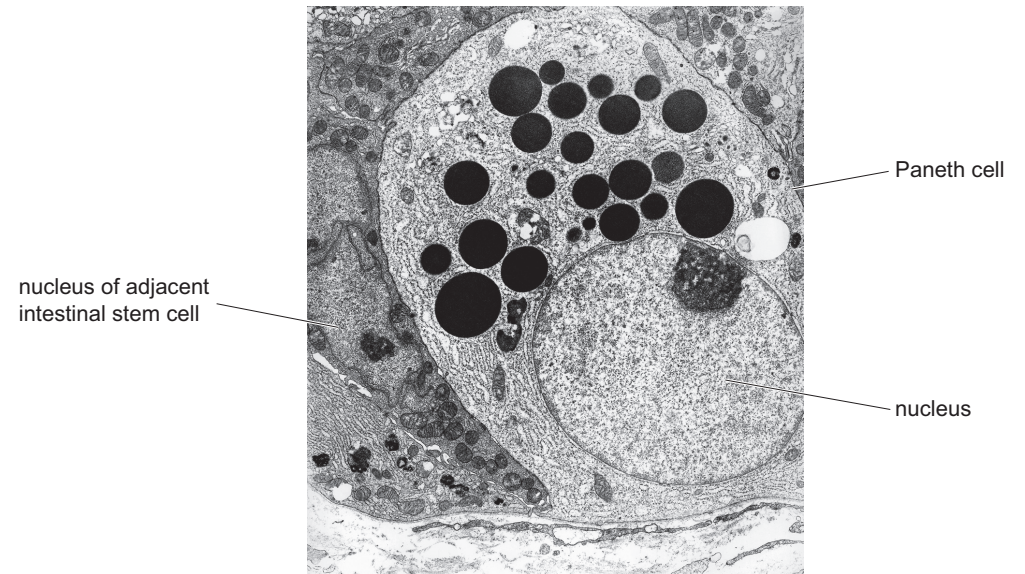


Fig. 1.2

- (i) In **step 2** in Fig. 3.1, the single-stranded primary transcript loops and forms a section where dsRNA is present.

Explain how it is possible for the double-stranded section of RNA to be held together in **step 2** and maintained this way in **steps 3, 4** and **5**.

.....

 [2]

- (ii) After **step 3**, the shorter dsRNA produced by the action of Drosha is transported to the cytoplasm, where it is cleaved further by Dicer to produce ds siRNA.

Suggest why two different enzymes, Drosha and Dicer, are needed to cut dsRNA into shorter lengths.

.....

 [2]

- (b) From 2018, siRNA has been used as a therapeutic drug to treat a number of diseases.

The presence of molecules of siRNA in the cytoplasm can result in the cleavage of messenger RNA (mRNA) molecules coding for a protein involved in the disease. This prevents the synthesis of the protein.

Describe the differences between a molecule of mRNA and a molecule of siRNA, such as the siRNA shown in **step 5** in Fig. 3.1.

.....

 [2]

- (c) Fig. 3.2 summarises how mRNA coding for a protein involved in disease can be targeted and cleaved by siRNA.

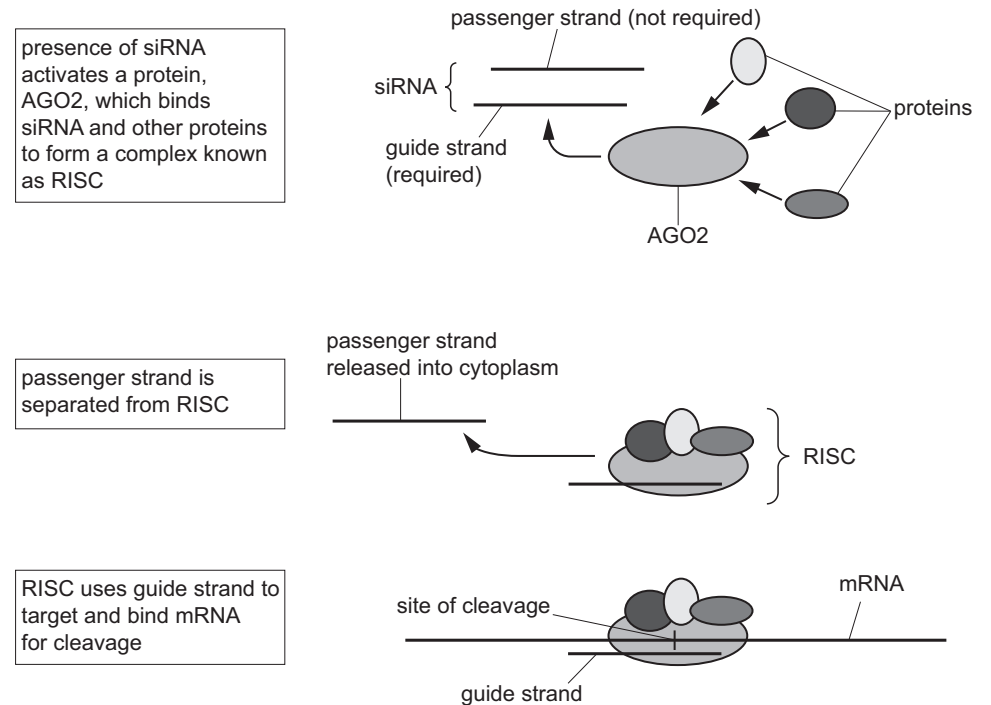


Fig. 3.2

(i) With reference to Fig. 3.2, state why the passenger strand needs to be separated and released from the RISC.

[1]

(ii) The aim of siRNA therapy is to prevent or decrease the synthesis of a protein involved in the disease being treated.

A target mRNA molecule can be cleaved in a different location by a RISC with a different siRNA.

Suggest how cleaving mRNA in different locations will have different effects on protein synthesis **and** explain how these different effects can result in a lack of functioning protein.

[3]

[Total: 10]

2 *Exserohilum turcicum* is a fungal pathogen. The growth of the mycelium of the fungus damages the leaves of maize plants, *Zea mays*. Leaf damage reduces crop yield.

(a) (i) Complete Table 2.1 to show **one** structural difference and **one** functional difference between *E. turcicum* and *Z. mays*.

Table 2.1

	<i>E. turcicum</i>	<i>Z. mays</i>
structural difference		
functional difference		

[2]

(ii) Describe the principles by which organisms such as *E. turcicum* and *Z. mays* are classified in the taxonomic hierarchy.

[4]

- (b) Two inbred varieties of maize, SKV50 and CML153, were crossed. The resulting F1 hybrids were self-crossed to produce F2 offspring. The F2 plants were grown, and the percentage area of leaf damage caused by *E. turcicum* was measured.

Fig. 2.1 shows the results for the F2 generation. The arrows show the mean percentage area of leaf damage for the two parent varieties.

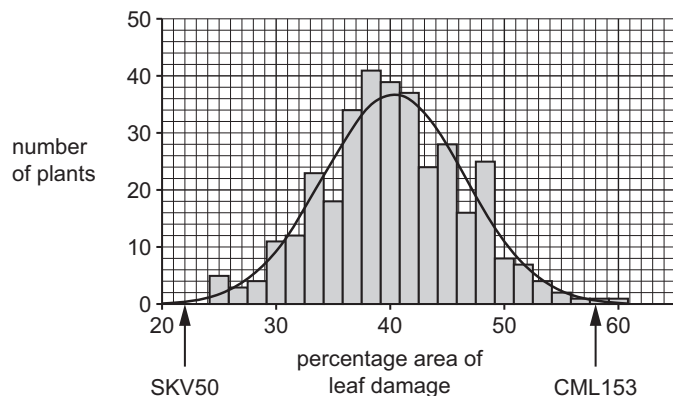


Fig. 2.1

- (i) Explain how Fig. 2.1 can be used to determine which parent maize variety shows the greatest resistance to infection by *E. turcicum*.

.....
.....
.....
..... [2]

- (ii) State the name of the type of variation shown by the maize F2 generation in Fig. 2.1.

..... [1]

- (iii) Explain the **genetic** basis of the type of variation shown by the maize F2 generation.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [4]

- 3 Plants have several different photosynthetic pigments in their chloroplasts.

- (a) A student separated and identified the chloroplast pigments present in a leaf extract from a spinach plant using two slightly different methods.

Method A

- A type of chromatography known as thin layer chromatography (TLC) was used to separate the pigments.
- A mixture of ether and cyclohexane was used as a solvent in TLC.

Method B

- The student repeated TLC but treated the spinach leaf extract with a chemical. The chemical causes a magnesium ion in a pigment to be replaced by two hydrogen ions.
- The student used a leaf from the same spinach plant, and used the same solvent as in method A.

The student calculated R_f values and compared these to reference values to identify the pigments.

Fig. 3.1 shows the results for method A and method B.

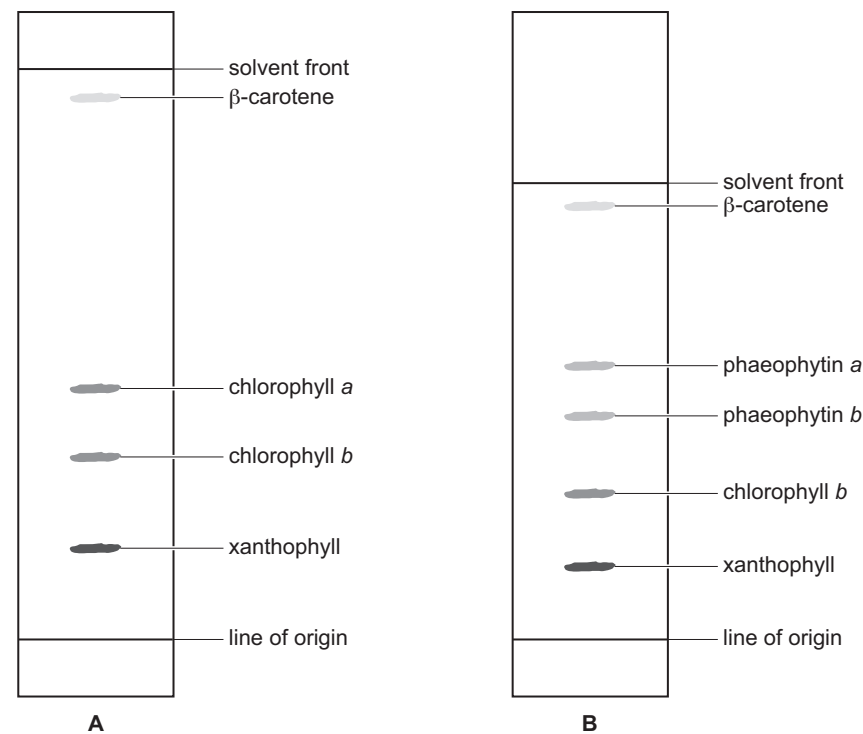


Fig. 3.1

(i) Calculate the R_f value of β -carotene in Fig. 3.1.

$R_f =$ [2]

(ii) Suggest **two** explanations for the differences in appearance of chromatograms **A** and **B** in Fig. 3.1.

1

2

[2]

(iii) The student found some different R_f values for the chloroplast pigments of spinach in a scientific paper.

The values in the scientific paper were different from the reference values that the student originally used to identify the pigments on chromatograms **A** and **B** in Fig. 3.1.

Suggest **one** reason, other than measurement error, for the different R_f values.

[1]

(b) Fig. 3.2 shows the absorption spectra of some chloroplast pigments.

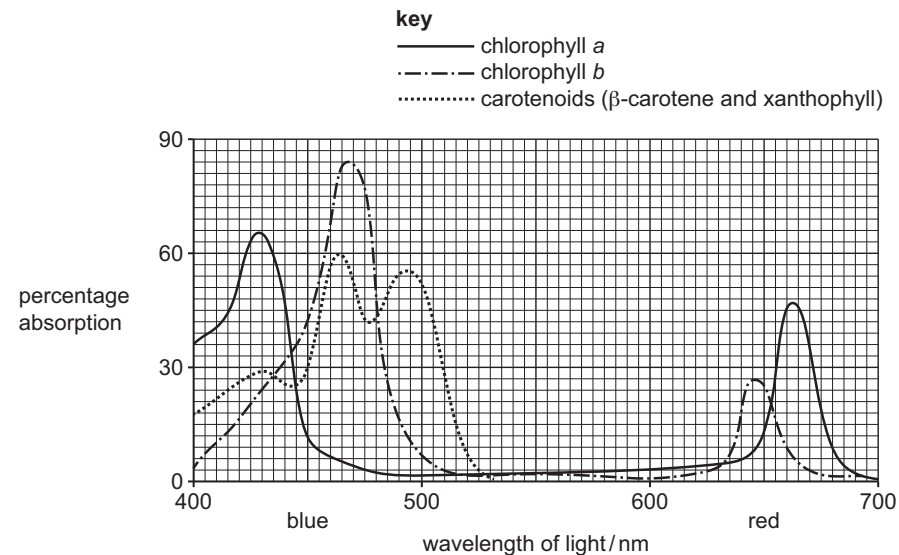


Fig. 3.2

Use Fig. 3.2 to compare the similarities and differences between the absorption spectra of chlorophyll *a* and carotenoids.

[4]

- Describe the role of gibberellin in the germination of a seed.

[Total: 13]

- Put a tick (✓) or a cross (✗) in every box.

Table 5.1

feature	ADH	glucagon	insulin
binds to receptors on cell surface membranes			
results in molecules moving from cells into the blood			
is secreted as a result of detection by osmoreceptors			

[3]

- Describe **other** ways in which the endocrine system and the nervous system differ.

..... [4]

- (c) The endocrine system and the nervous system can affect muscle function.

Fig. 5.1 shows a transmission electron micrograph of a longitudinal section of striated muscle tissue that is in a relaxed state.

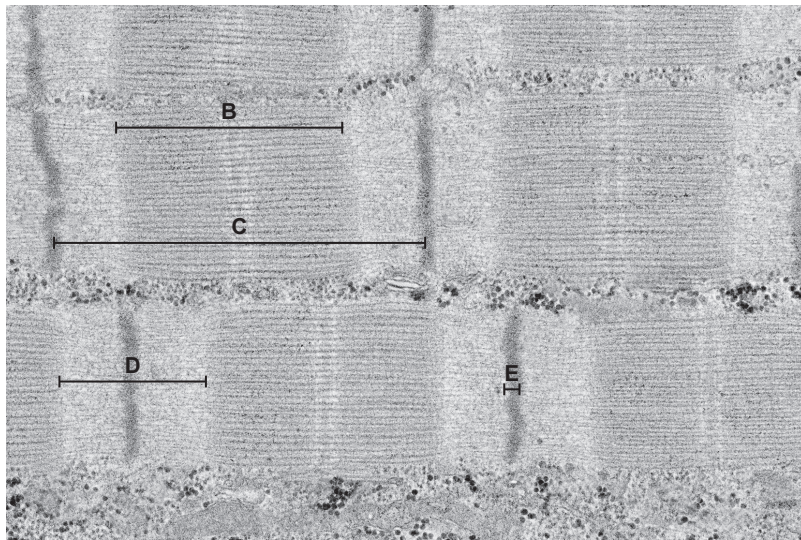


Fig. 5.1

- (i) State the letter on Fig. 5.1 that indicates the length of a sarcomere.
 [1]
- (ii) State the letter on Fig. 5.1 that indicates a region where actin and myosin overlap.
 [1]
- (iii) Describe **and** explain how the region labelled **D** on Fig. 5.1 changes during muscle contraction.

 [4]

- 8 LibertyLink® soybean is a genetically modified crop. It was first grown in 1996 and used in food products from 1998. It has been grown in 6 countries and used in food products in 21 countries.

Table 8.1 summarises the modifications made to the soybean plant to produce LibertyLink® soybean.

Table 8.1

name of introduced gene	gene donor organism	gene product	function of gene product
<i>pat</i>	<i>Streptomyces viridochromogenes</i>	phosphinothricin <i>N</i> -acetyltransferase	stops action of glufosinate, a herbicide

- (a) Explain how the modification made to produce LibertyLink® soybean may help to solve the global demand for food.

 [4]
- (b) (i) Name the type of enzyme that could be used to cut out the *pat* gene from *S. viridochromogenes*.
 [1]
- (ii) Name the enzyme that could be used to join the *pat* gene to a plasmid by forming phosphodiester bonds.
 [1]
- (c) Suggest reasons why LibertyLink® soybean is used in food products in 21 countries but only grown in 6 countries.

 [3]