1 **(a)** Fig. 1.1 is a diagram representing a three-dimensional view of a chloroplast.

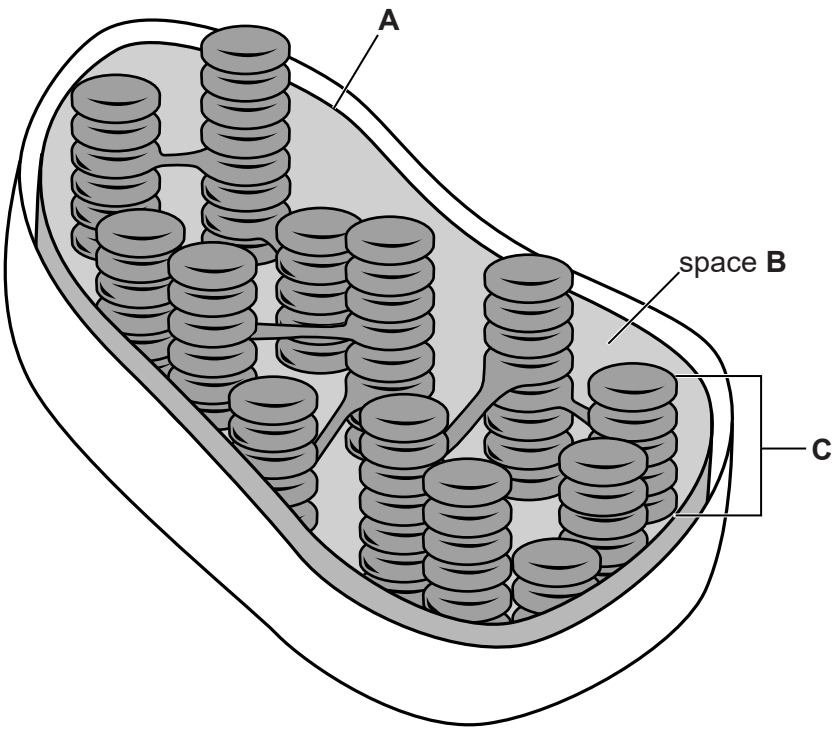

Fig. 1.1

(i) Name parts **A** to **C** in Fig. 1.1.

A .....

B .....

C ..... **[3]**

(ii) Describe **two** ways in which the structure of part **C** is adapted to its function.

.....

.....

.....

.....

.....

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

(iii) A key aspect of photosynthesis is the metabolic pathway involving carbon dioxide.

Place a tick (✓) in the appropriate box to indicate the part of the chloroplast (**A**, **B** or **C**) in which the metabolic pathway involving carbon dioxide is located.

A	
B	
C	

[1]

(b) Fig. 1.2 shows the theoretical and actual relationship between light intensity and the rate of photosynthesis.

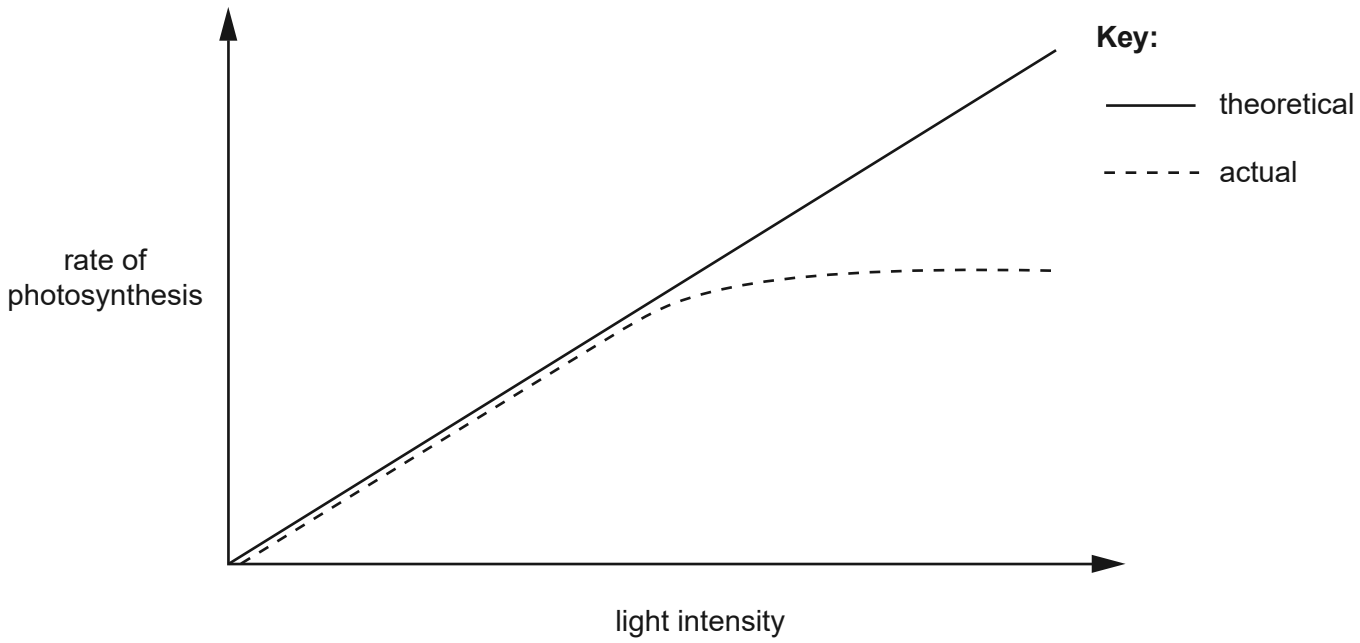

Fig. 1.2

With reference to the biochemistry of photosynthesis, explain why the theoretical rate of photosynthesis is **not** achieved at higher light intensities.

.....

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

(c) Plants are usually adapted to living in conditions of different light intensities.

The rate of photosynthesis at different light intensities for two different species of plant was investigated. The results are shown in Fig. 1.3.

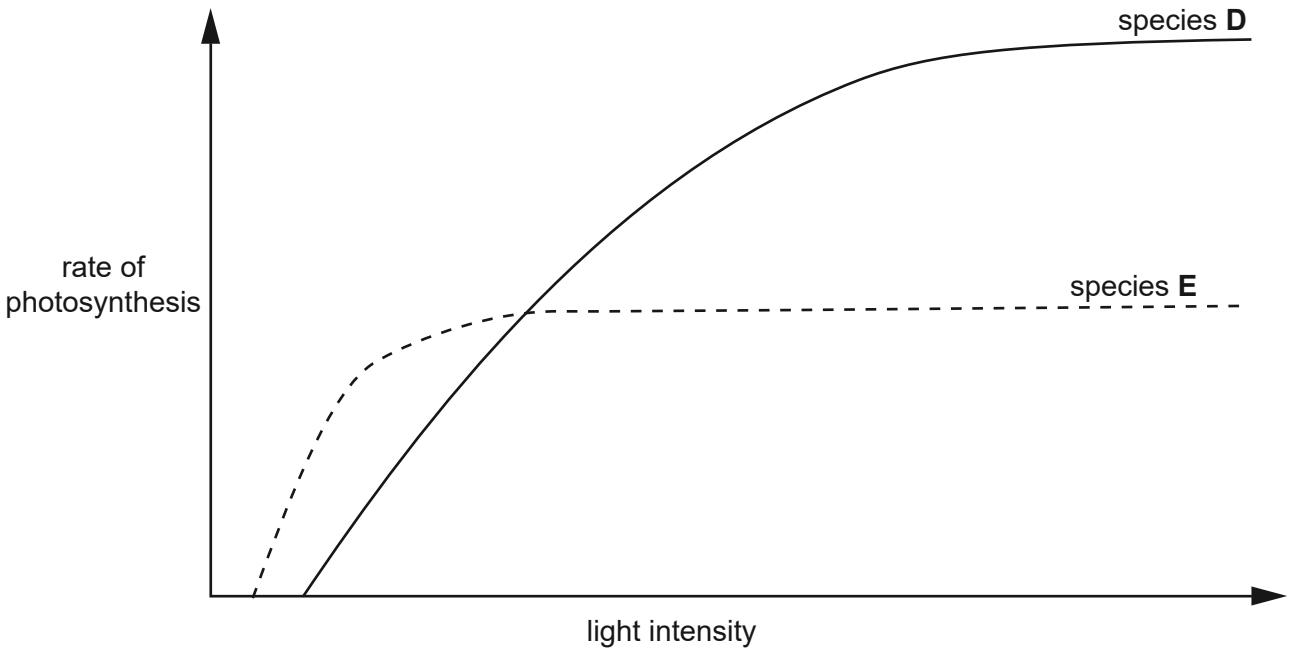

Fig. 1.3

(i) Using the information in Fig. 1.3, explain which of the two species, **D** or **E**, is better adapted to living in **shady** conditions.

.....

.....

.....

.....

.....

.....

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

(ii) The leaf of a plant that is adapted to living in shade will differ from the leaf of a plant that is adapted to living in sunlight.

Suggest **one** way in which the **structure** of these leaves will differ.

.....

.....

..... **[1]**

(d) Plants are autotrophs. Most other organisms are heterotrophs.

Outline the ways in which heterotrophic organisms are dependent on plants.

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..... **[3]**

[Total : 14]

2 Photosynthesis involves two main stages:

- the light-dependent stage, which involves photosystems
- the light-independent stage, which involves the Calvin cycle.

(a) Photosynthetic pigments are arranged in groups known as photosystems I and II.

(i) Name the primary photosynthetic pigment in these photosystems.

..... **[1]**

(ii) Name an accessory pigment.

..... **[1]**

(iii) State the advantage to the plant of having a range of accessory pigments in photosystems.

.....

.....

..... **[1]**

(iv) Name the compound that is synthesised in the light-dependent stage as a result of the generation of an electrical and pH gradient across the thylakoid membrane.

..... **[1]**

(b) The Calvin cycle takes place in the stroma of the chloroplast.

(i) Identify the enzyme that catalyses the fixation of carbon dioxide.

..... **[1]**

(ii) Identify the first stable product of carbon dioxide fixation.

..... **[1]**

(iii) Identify the compound that is regenerated in the Calvin cycle so that more carbon dioxide can be fixed.

..... **[1]**

(iv) Name **two different polysaccharides** that can be synthesised from the end products of the light-independent stage of photosynthesis.

.... **[1]**

[Total: 8]

3 The molecules listed below are all associated with photosynthesis.

amino acid	**reduced NADP**
ATP	**ribulose bisphosphate (RuBP)**
carbon dioxide	**rubisco**
glycerate-3-phosphate (GP)	**triose phosphate (TP)**
oxygen	**water**

From these molecules, identify:

(a) the enzyme.

..... **[1]**

(b) a product of the light-dependent reaction that is **used** in the light-independent reaction.

..... **[1]**

(c) a 3-carbon compound.

..... **[1]**

(d) a compound that can be made from TP but is **not** part of the Calvin cycle.

..... **[1]**

(e) a 5-carbon compound.

..... **[1]**

(f) a product of the light-dependent reaction that **is not** used in the light-independent reaction.

..... **[1]**

[Total: 6]

4 **(a)** Explain what is meant by the terms *autotroph* and *heterotroph*.

autotroph .....

.....

.....

heterotroph .....

.....

.....

[2]

(b) Fig. 3.1 is a transmission electron micrograph showing part of a chloroplast, including some of the internal membranes.

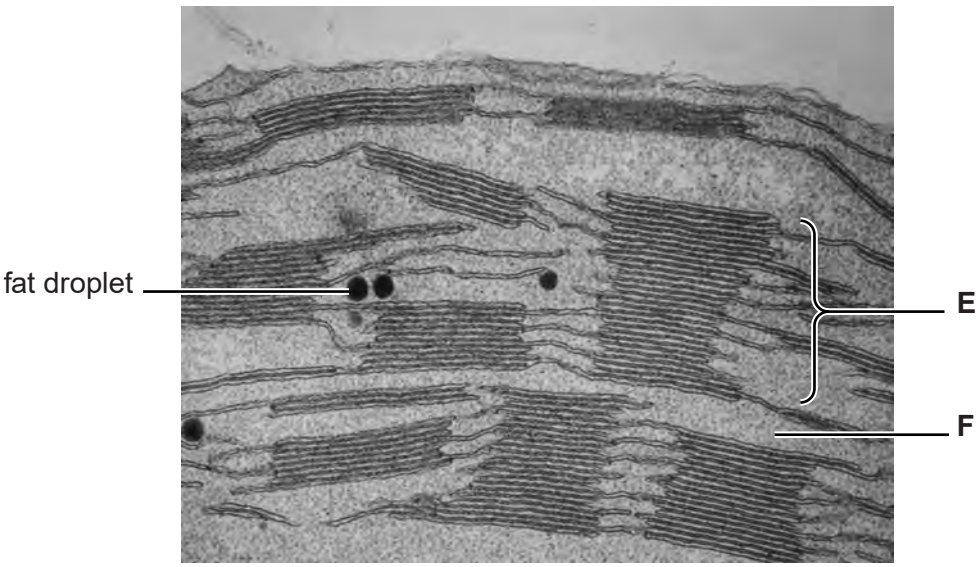

Fig. 3.1

(i) Identify **E** and **F** in Fig. 3.1.

E .....

F .....

[2]

(ii) The chloroplast contains fat droplets, as shown in Fig. 3.1. These act as a reserve of raw material **for the chloroplast**.

Suggest what this raw material might be used for in the chloroplast.

.....

.....

..... **[1]**

(c) Fig. 3.2 represents the light harvesting system found on the surface of the internal membranes of the chloroplast.

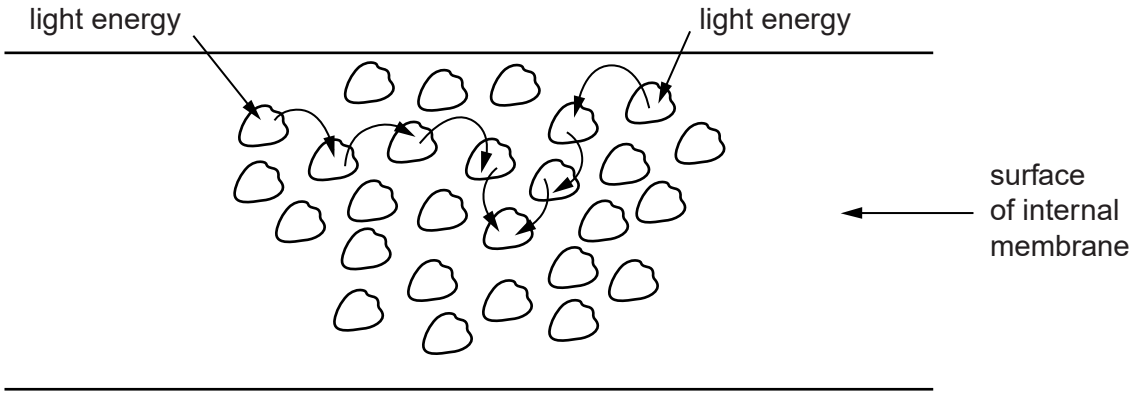

Fig. 3.2

Use the information in Fig. 3.2 to describe how light is harvested in the chloroplast membranes.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[5]**

(d) Many herbicides act by inhibiting photosynthesis in weeds. A series of research studies were carried out to evaluate the effectiveness of a triazine herbicide on the yield of a crop of corn, *Zea mays*. Some of the data obtained is shown in Table 3.1.

Study	Plots not treated with herbicide		Plots treated with herbicide		Yield difference with herbicide	
	Number of plots	Mean yield ($kg\,ha^{-1}$)	Number of plots	Mean yield ($kg\,ha^{-1}$)	($kg\,ha^{-1}$)	(%)
A	90	8321.4	51	8756.9	+435.5	+5.2
B	21	10344.8	3	11457.0	+1112.2	+10.8
C	30	10411.8	14	10954.5	+542.7	+5.2
D	20	13982.9	7	13607.7	−375.2	−2.7
E	2	6532.5	8	11041.6	+4509.1	+69.0
F	66	8750.2	63	8971.3	+221.1	+2.5
G	17	11671.4	7	10807.1		

Table 3.1

(i) Calculate the yield difference caused by the application of herbicide in study **G**.

Show your working.

Answer = ... $kg\,ha^{-1}$

..... % **[2]**

(ii) Suggest why the researchers concluded that the data obtained from Study **E** was not useful in evaluating the effectiveness of the herbicide.

.....

..... **[1]**

(iii) Triazine herbicide acts on the weeds by binding to a specific protein associated with photosystem II, blocking the movement of electrons between electron carriers.

Explain the effect that the herbicide binding to this protein will have on photosynthesis.

.....

.....

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

(iv) Plants treated with triazine herbicide can, when illuminated under experimental conditions, be seen to fluoresce (emit light) and give off small quantities of heat.

Suggest how this experimental finding could be explained.

.....

.....

..... **[1]**

[Total: 16]

5 One way to determine the rate of photosynthesis is to measure the uptake of carbon dioxide.

(a) Discuss why measuring carbon dioxide uptake may or may not give a better indication of photosynthetic activity than measuring oxygen production.

.....

.....

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.....

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

(b) Fig. 4.1 shows the relationship between light intensity and the relative carbon dioxide uptake and production in a plant.

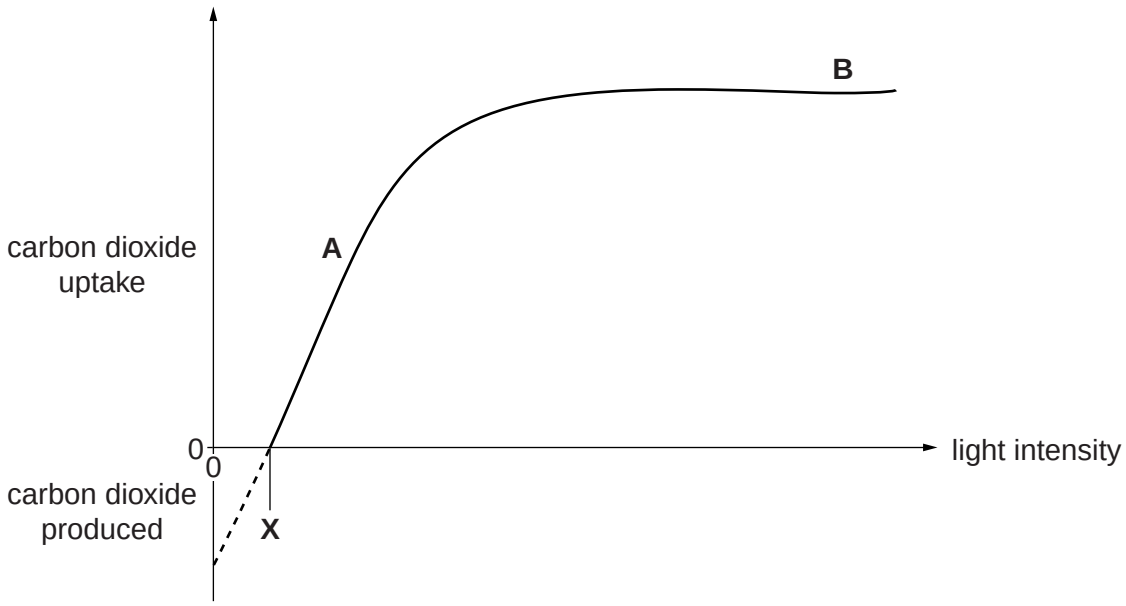

Fig. 4.1

(i) State the factor that is limiting the rate of photosynthesis at **A** on the graph.

..... **[1]**

(ii) Suggest **one** factor that may limit the rate of photosynthesis at **B**.

..... **[1]**

(iii) Carbon dioxide is given off by the plant when the light intensity is lower than **X**.

Name the process that **produces** carbon dioxide in the plant.

..... **[1]**

(iv) With reference to Fig. 4.1, explain the biochemical processes that are occurring in the plant:

- as light intensity increases from 0 (zero) to **X**.
- at light intensity **X**.
- at light intensities greater than **X**.

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..... **[3]**

(c) **(i)** Name the products of the light-dependent stage of photosynthesis.

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..... **[3]**

(ii) Paraquat is a weedkiller. It binds with electrons in photosystem I.

Suggest how paraquat results in the death of a plant.

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

[Total: 13]