Photosynthesis

Model Answers 2

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Communication, homeostasis and energy
Topic	Photosynthesis
Booklet	Model Answers 2

Time allowed: **39 minutes**

Score: **/29**

Percentage: **/100**

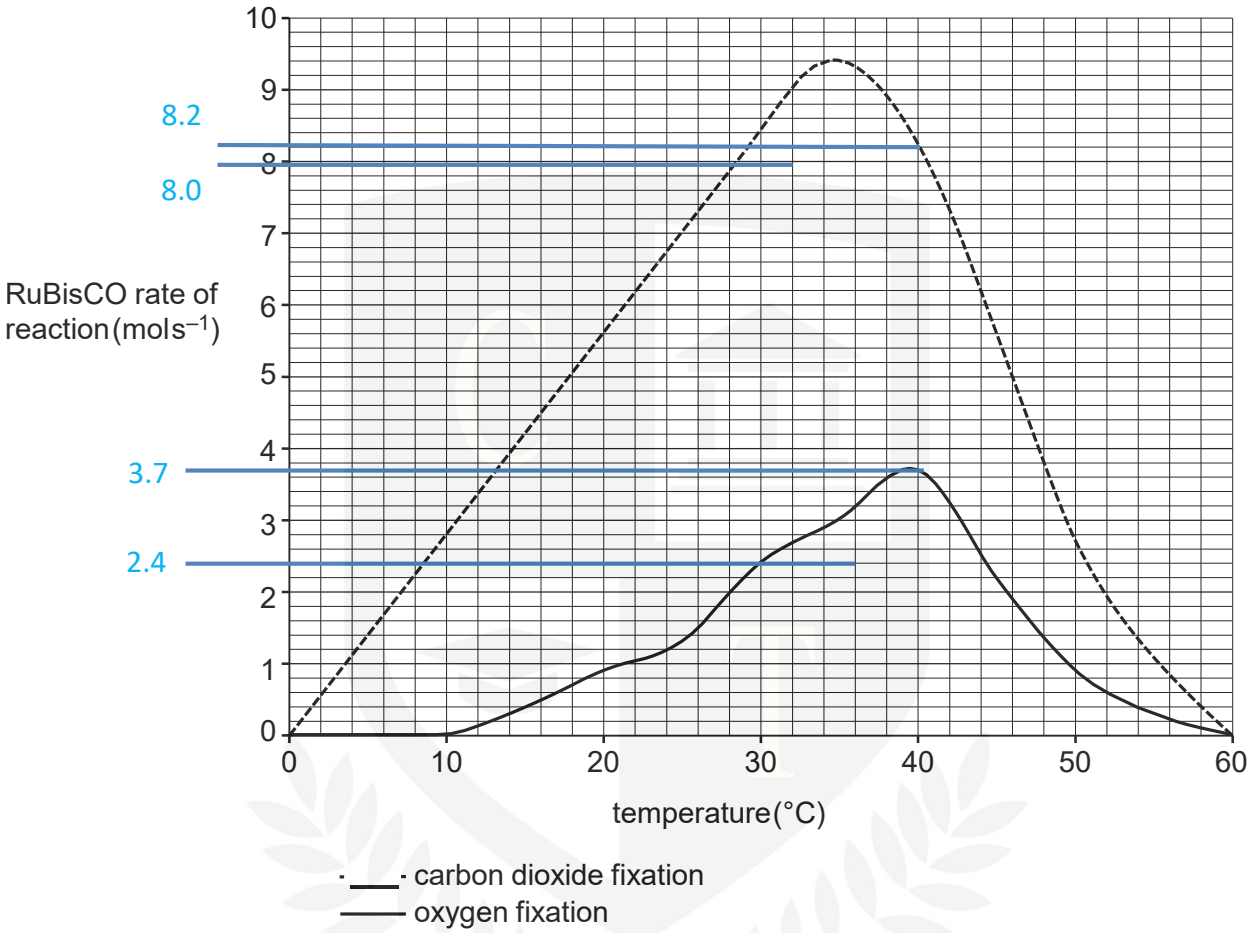
Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

RuBisCO is an enzyme that fixes carbon dioxide in photosynthesis. In some conditions, RuBisCO also carries out oxygen fixation.

The graph below shows how the carbon dioxide and oxygen fixing activities of RuBisCO are affected by temperature.



What are the correct percentage changes in RuBisCO carbon dioxide and oxygen fixing activities between 30 °C and 40 °C?

A carbon dioxide fixation –12.7%, oxygen fixation 23.3%

B carbon dioxide fixation –14.6%, oxygen fixation 18.9%

C carbon dioxide fixation –2.4%, oxygen fixation 54.2%

D carbon dioxide fixation –3.6%, oxygen fixation 35.1%

[1]

Carbon dioxide fixation is 0.2 ÷ 8.0 x 100 = 2.4%

Oxygen fixation is 1.3 ÷ 2.4 = 54.2%

Read the values off accurately and use a ruler

Question 2

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

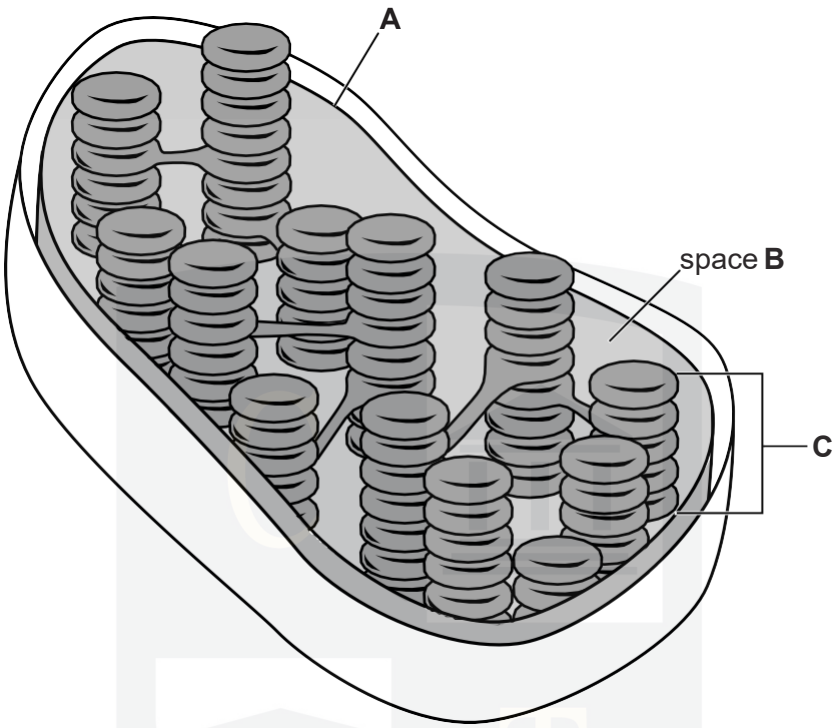


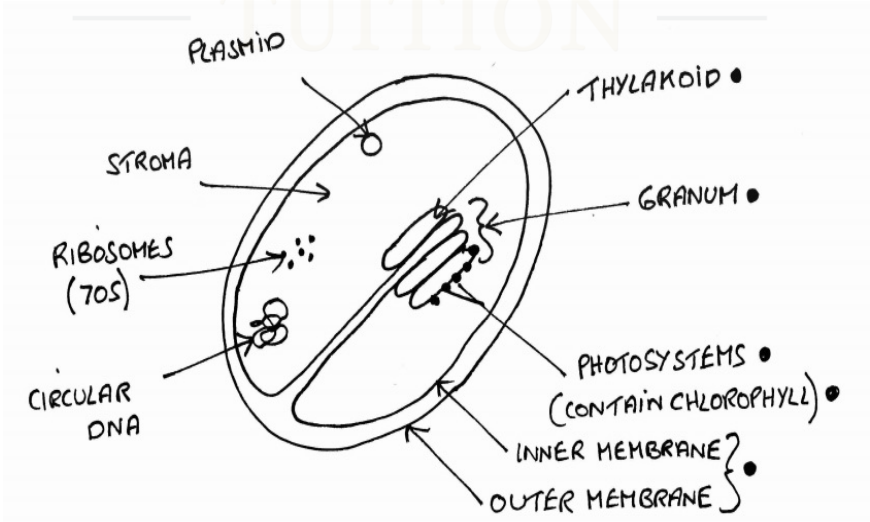
Fig. 1.1

(i) Name parts **A** to **C** in Fig. 1.1. **[3]**

A inner membrane (of chloroplast)

B stroma

C granum of thylakoid stack



(ii) Describe **two** ways in which the structure of part **C** is adapted to its function. **[2]**

- The granum contains pigment molecules and photosystems
- It contains carriers of the electron transport chain and ATP synthase molecules
- It provides a large surface area to attach pigment molecules and proteins of the electron transport chain

(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 or the stroma is where carbon dioxide is involved

In the stroma CO_2 is fixed when it joins to RuBP, a reaction catalysed by rubisco

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

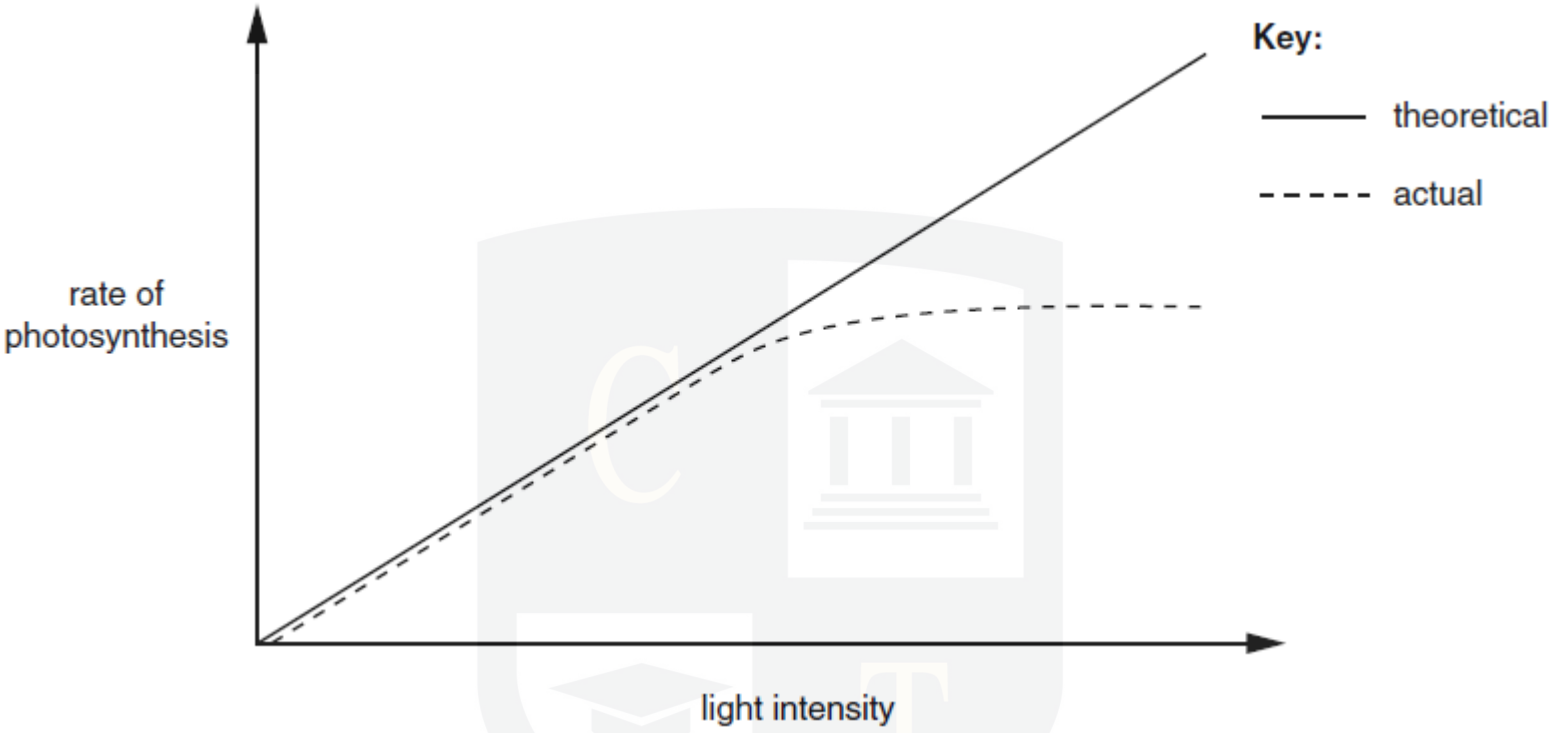


Fig. 1.2

With reference to the biochemistry of photosynthesis, explain why the theoretical rate of photosynthesis is **not** achieved at higher light intensities. **[2]**

- At high light intensity is other factors become limiting
- Temperature can become a limiting factor as various stages such as the light independent reaction involves the use of enzymes such as Rubisco
- Carbon dioxide concentration becomes limiting as it is needed for Calvin cycle, where it is fixed by joining to the 5 carbon sugar RuBP

Note for this 2 mark question you must refer to the biochemistry of photosynthesis, that is, the molecules and reactions involved in the light dependent and independent reactions

(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.

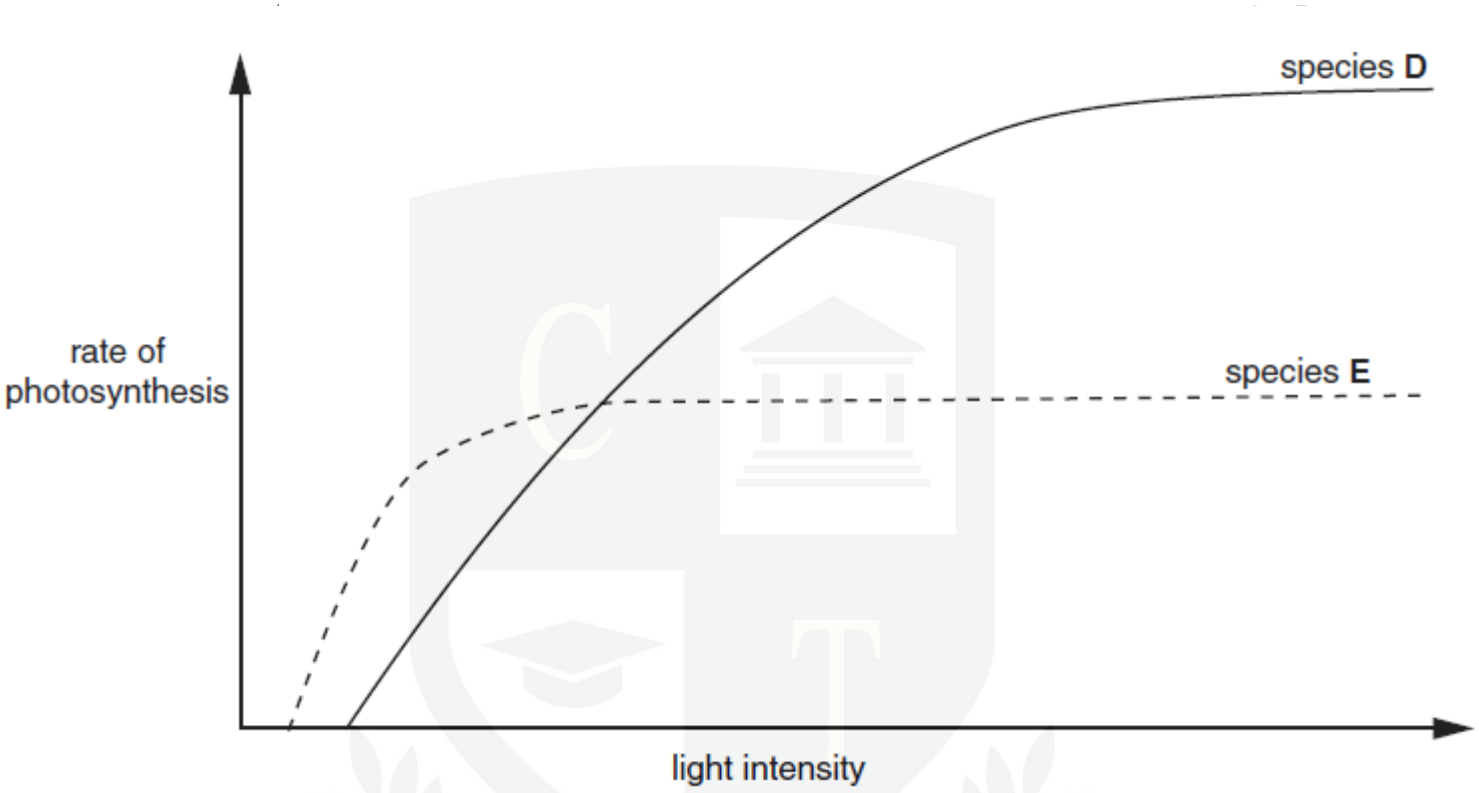


Fig. 1.3

(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]**

- Species E is better adapted to living in shady conditions because it begins to photosynthesise at lower light intensity
- Species E reaches its maximum rate of photosynthesis at lower intensities
- Species E shows a faster increase in the rate with only a small increase in light intensity
- It has a faster rate of photosynthesis than D at lower light intensities

For a plant to survive the rate of photosynthesis must exceed of respiration for long enough so it can accumulate the sugars and other assimilates that it needs to grow. When the rate of photosynthesis is equal to the rate of respiration it is known as the compensation point and it is this that must be exceeded. Species E will have a much lower compensation point so it does not need as much light to exceed this.

(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.

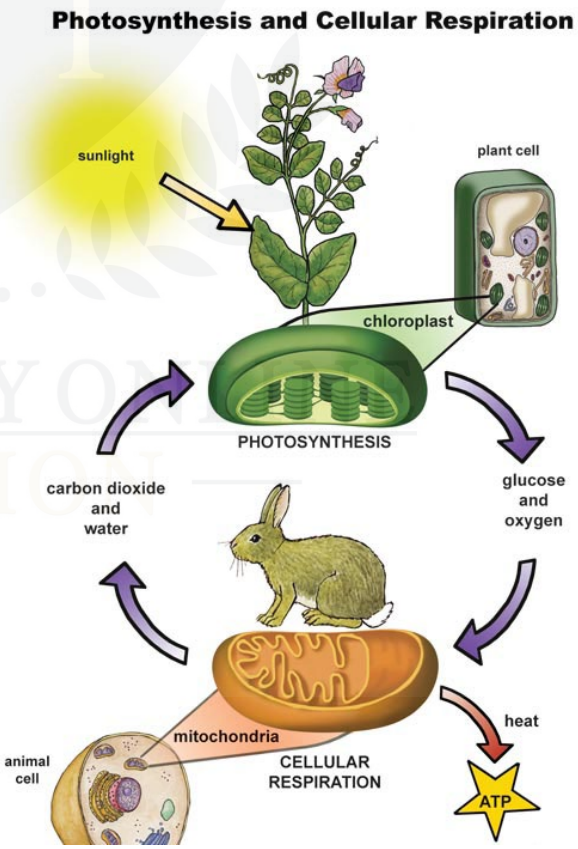
Suggest **one** way in which the **structure** of these leaves will differ. **[1]**

- The leaf living in the shade could be larger and have more chloroplasts
- The membrane of the chloroplast in the shade leaf maybe more folded with more granum and thylakoids
- The leaves may have a larger surface area

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

Outline the ways in which heterotrophic organisms are dependent on plants. **[3]**

- Heterotrophs or animals need to obtain the organic material from plants or autotrophs
- Autotrophs produce organic molecules during photosynthesis or Calvin cycle
- Autotrophs also produce oxygen as a result of the light dependent stage
- Glucose and oxygen are both used in respiration by animals are heterotrophs



[Total : 14]

Question 3

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]**

chlorophyll a

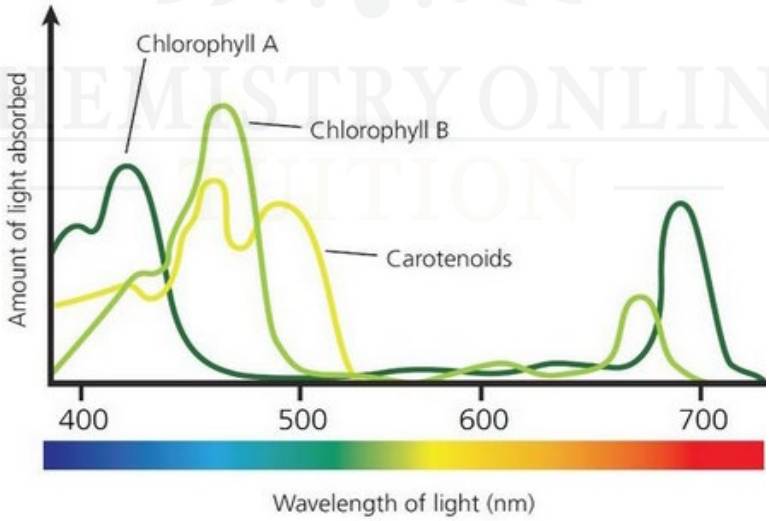
(ii) Name an accessory pigment. **[1]**

Examples of accessory pigments include chlorophyll b, xanthophyll, carotenoids and carotene

(iii) State the advantage to the plant of having a range of accessory pigments in photosystems. **[1]**

The advantage of having a range of accessory pigments is to be able to absorb a wider range of wavelengths of light

The absorption of light by different chlorophyll pigments leads to an absorption spectrum



(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]**

ATP is made by chemiosmosis in the light dependent reaction of photosynthesis

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

(i) Identify the enzyme that catalyses the fixation of carbon dioxide. **[1]**

RuBisCO or ribulose biphosphate carboxylase

(ii) Identify the first stable product of carbon dioxide fixation. **[1]**

GP or glycerate phosphate

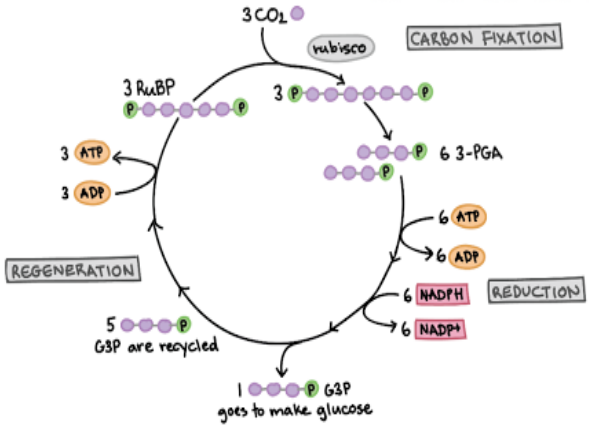
(iii) Identify the compound that is regenerated in the Calvin cycle so that more carbon dioxide can be fixed. **[1]**

RuBP or ribulose biphosphate

(iv) Name **two different polysaccharides** that can be synthesised from the end products of the light-independent stage of photosynthesis. **[1]**

starch and cellulose

Other molecules that can be made from the end product of the light independent stage include amino acids and lipids. Collectively these are known as assimilates.



By multiplying each stage of Calvin cycle by x3 you can see that 3 x CO_2 are fixed by 3 x RuBP. The net gain is 1 x 3 carbon sugar TP. So the 3 CO_2 become the net gain of 1 x 3 carbon sugar.

[Total: 8]

Question 4

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]**

rubisco

(b) a product of the light-dependent reaction that is **used** in the light-independent reaction. **[1]**

ATP or reduced NADP

(c) a 3-carbon compound. **[1]**

GP and TP

(d) a compound that can be made from TP but is **not** part of the Calvin cycle. **[1]**

amino acids

(e) a 5-carbon compound. **[1]**

RuBP

(f) a product of the light-dependent reaction that **is not** used in the light-independent reaction **[1]**

oxygen

Oxygen is not a useful product of photosynthesis, it is to us, but to the plant it is a waste product

[Total: 6]