

Week 37

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

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A-Level Biology

Name: _____ Score: _____

1. In a chloroplast, the stacks of thylakoids (grana) are where:
 - ☐ the light-dependent stage happens
 - ☐ the Calvin cycle happens
 - ☐ DNA is stored
 - ☐ respiration happens
2. Water is split in the light-dependent stage by _____.

3. In fixation, the enzyme rubisco:
 - ☐ joins CO_2 to RuBP (5C) to make two molecules of GP (3C)
 - ☐ splits water
 - ☐ makes ATP
 - ☐ breaks down glucose
4. A limiting factor is:
 - ☐ the factor in shortest supply that holds back the rate of photosynthesis
 - ☐ the factor that is always present in excess
 - ☐ the product of photosynthesis
 - ☐ the colour of the leaf
5. The light-dependent stage produces:
 - ☐ ATP and reduced NADP
 - ☐ glucose directly
 - ☐ carbon dioxide
 - ☐ only oxygen, nothing else
6. Cyclic photophosphorylation:
 - ☐ uses photosystem I only and makes only ATP
 - ☐ uses both photosystems and makes ATP and reduced NADP
 - ☐ splits water
 - ☐ happens in the stroma

7. The enzyme that joins CO₂ to RuBP in the fixation step is _____.

8. Adding carbon dioxide can raise the rate of photosynthesis when CO₂ is the limiting factor.

☐ True ☐ False

9. The light-dependent stage happens in the thylakoid membranes, and the Calvin cycle in the stroma.

☐ True ☐ False

10. The Calvin cycle is the light-independent stage; it uses the ATP and reduced NADP made by the light-dependent stage.

☐ True ☐ False

A-Level Biology

1. the light-dependent stage happens

The thylakoid membranes hold the pigments and carry out the light-dependent stage; the stroma runs the Calvin cycle.

2. photolysis

Photolysis releases electrons, H^+ and oxygen — the oxygen we breathe is a by-product.

3. joins CO_2 to RuBP (5C) to make two molecules of GP (3C)

Rubisco catalyses carbon fixation: $CO_2 + RuBP \rightarrow 2 GP$.

4. the factor in shortest supply that holds back the rate of photosynthesis

The limiting factor is whichever requirement is in shortest supply, capping the overall rate.

5. ATP and reduced NADP

It uses light to make ATP and reduced NADP, which power the Calvin cycle.

6. uses photosystem I only and makes only ATP

Cyclic photophosphorylation uses PSI alone and produces ATP only (no NADP reduced, no water split).

7. rubisco

Rubisco is the most abundant enzyme on Earth — it fixes nearly all the carbon in the living world.

8. True

Only the factor in shortest supply limits the rate, so increasing it speeds things up.

9. True

Light reactions need the membranes (pigments); the Calvin cycle uses the enzymes dissolved in the stroma.

10. True

It does not need light directly, but it cannot run without the ATP and reduced NADP from the light reactions.

13.1 Photosynthesis as an energy transfer process

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS chloroplast 叶绿体 • calvin cycle 卡尔文循环 • pigment 色素 • chromatography 色谱法
• light-dependent stage 光反应阶段

Objective

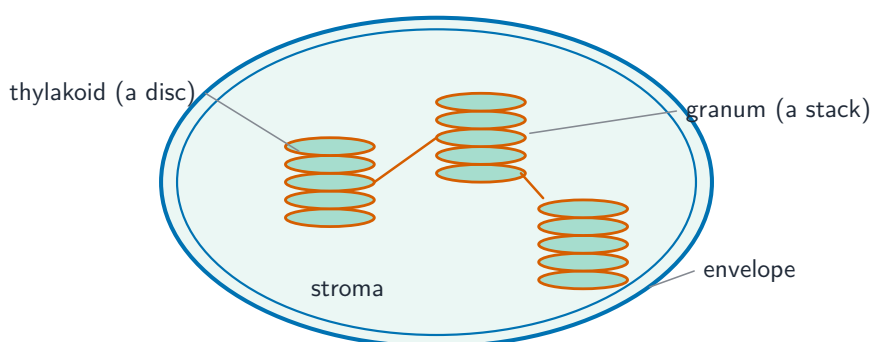
Build the skills to answer exam questions on **photosynthesis as an energy transfer process** — the **chloroplast** 叶绿体, the two stages, pigments, **photophosphorylation** 光合磷酸化 and the **Calvin cycle** 卡尔文循环.

You must be able to:

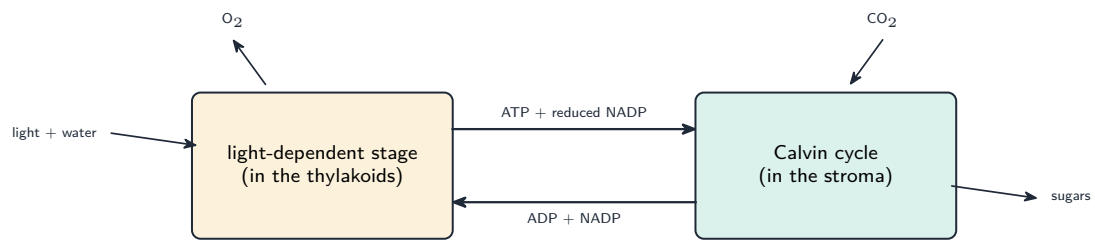
- relate chloroplast structure to function and explain the two linked stages
- describe the roles of pigments, interpret spectra, and use **Rf values** 比移值
- explain cyclic and non-cyclic photophosphorylation and the Calvin cycle

1 Worked examples

■ Chloroplast and the two stages

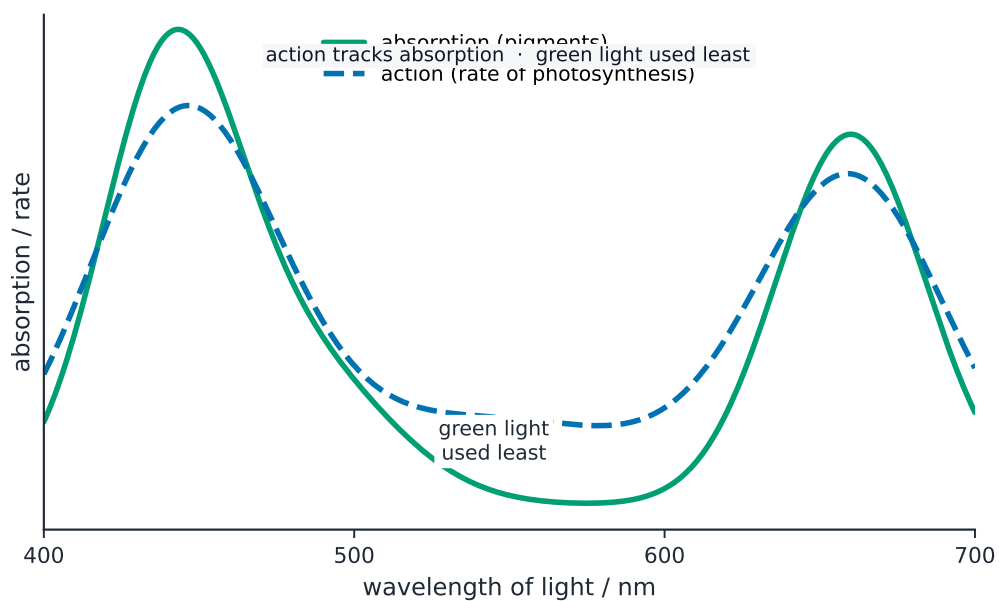


Thylakoids stack into grana (light-dependent stage); the stroma is where the Calvin cycle runs

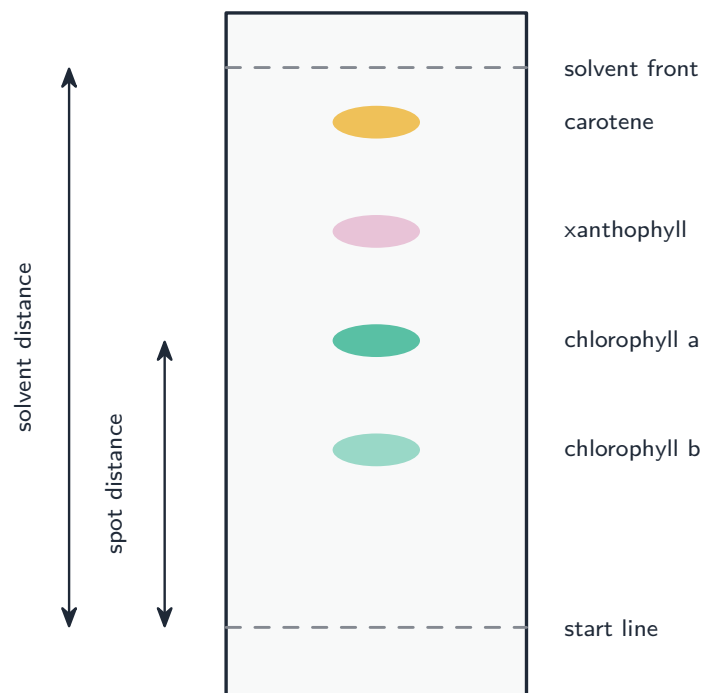


The first stage makes the ATP and reduced NADP that the second spends to turn CO₂ into sugars

■ Pigments, spectra and chromatography

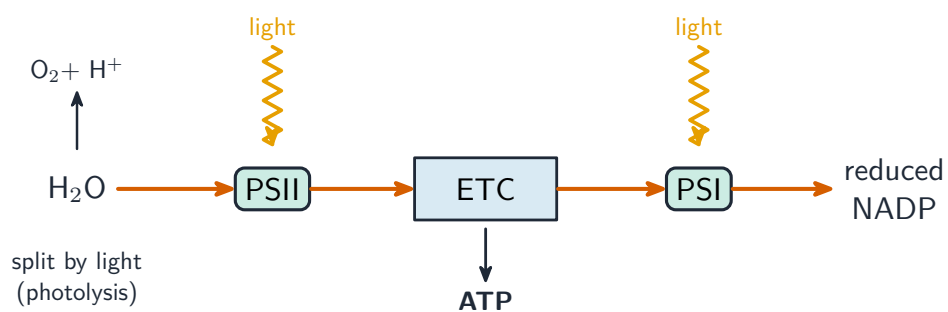


The absorption and action spectra match — blue and red light are used most



$$R_f = \text{distance moved by the pigment} \div \text{distance moved by the solvent}$$

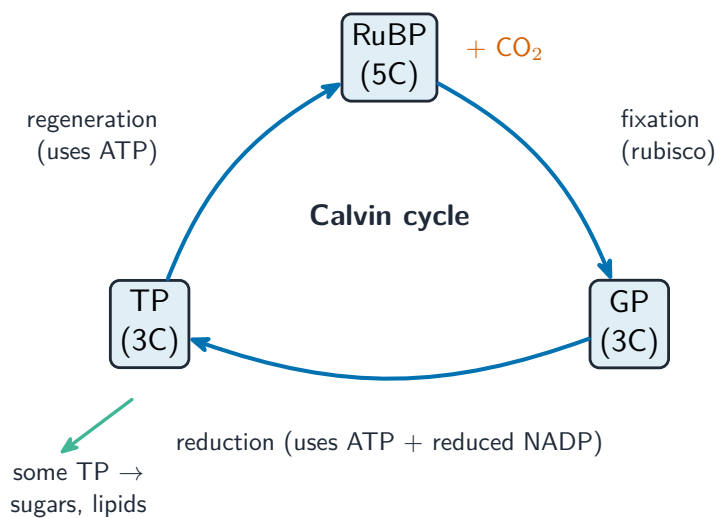
■ Photophosphorylation



Non-cyclic: both photosystems, photolysis of water, makes ATP and reduced NADP.

Cyclic: PSI only, makes ATP only

■ The Calvin cycle



Fixation (rubisco) → reduction (uses ATP + reduced NADP) → regeneration of RuBP; some TP becomes sugars

2 Practice

2.1 State what is made in the light-dependent stage and passed to the Calvin cycle. [2]

2.2 Name the enzyme that fixes carbon dioxide onto RuBP in the Calvin cycle. [1]

3 Exam-style questions

3.1 In which part of the chloroplast does the Calvin cycle take place? [1]

- **A** the thylakoid membrane
- **B** the stroma
- **C** the grana
- **D** the outer envelope

3.2 Which is produced **only** in non-cyclic (not cyclic) photophosphorylation? [1]

- **A** ATP
- **B** reduced NADP and oxygen

- **C** carbon dioxide
 - **D** RuBP
-

3.3 In a chromatography experiment a pigment moved 4.8 cm while the solvent moved 12.0 cm.

(a) Calculate the R_f value of the pigment. [2]

(b) State **one** reason the chloroplast contains several different pigments. [1]

3.4 Describe the three main steps of the Calvin cycle. [4]

Solutions

2.1 ATP and reduced NADP.

2.2 rubisco.

3.1 B. The Calvin cycle takes place in the stroma.

3.2 B. Only non-cyclic photophosphorylation makes reduced NADP and releases oxygen (from photolysis).

3.3 (a) $R_f = \frac{4.8}{12.0} = 0.40$.

(b) different pigments absorb different wavelengths, so more of the light energy is trapped.

3.4 fixation — rubisco joins CO_2 to RuBP (5C) to make two GP (3C); reduction — GP is reduced to TP using ATP and reduced NADP; regeneration — most TP is used (with ATP) to remake RuBP.

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**.

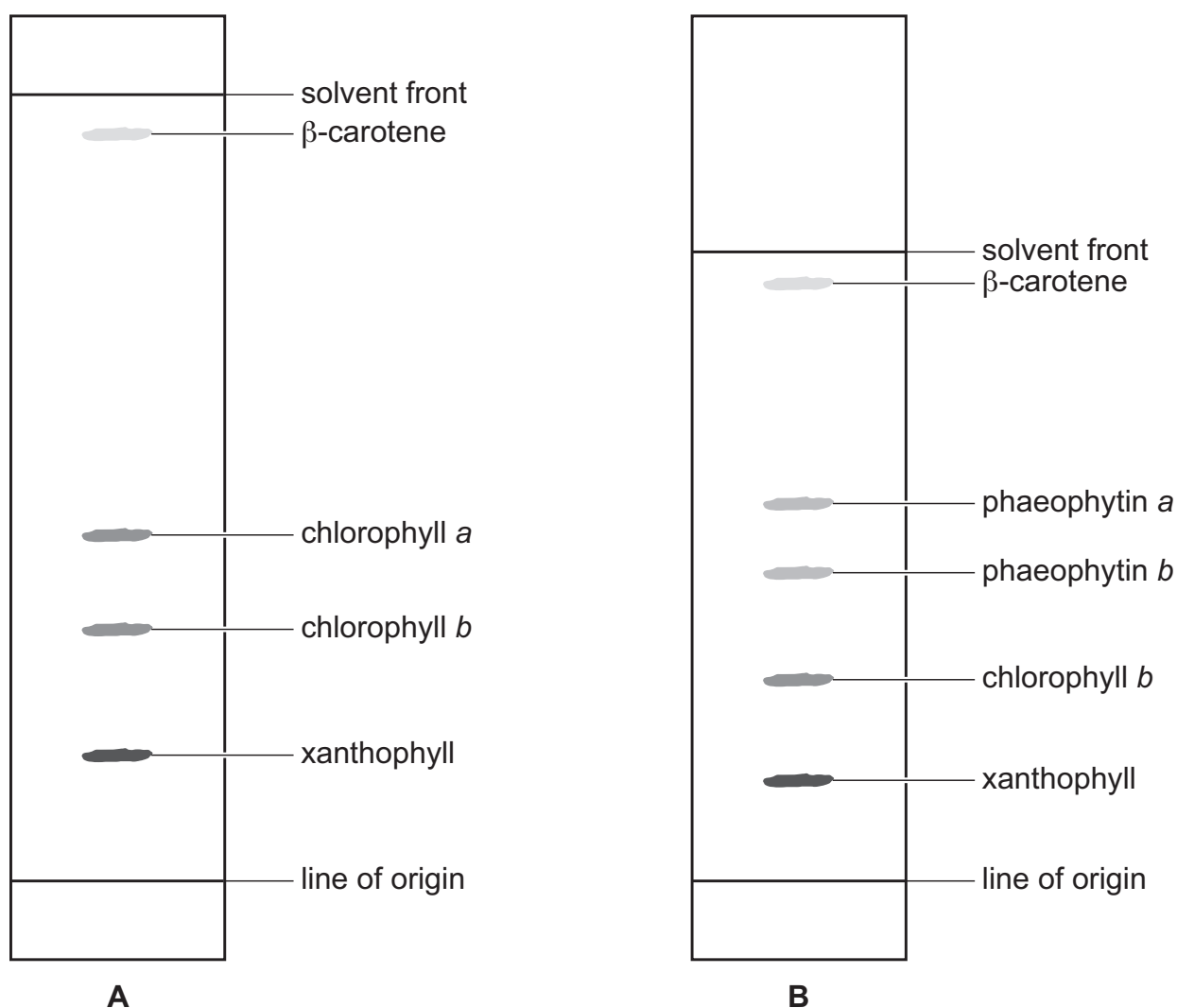


Fig. 3.1

(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.

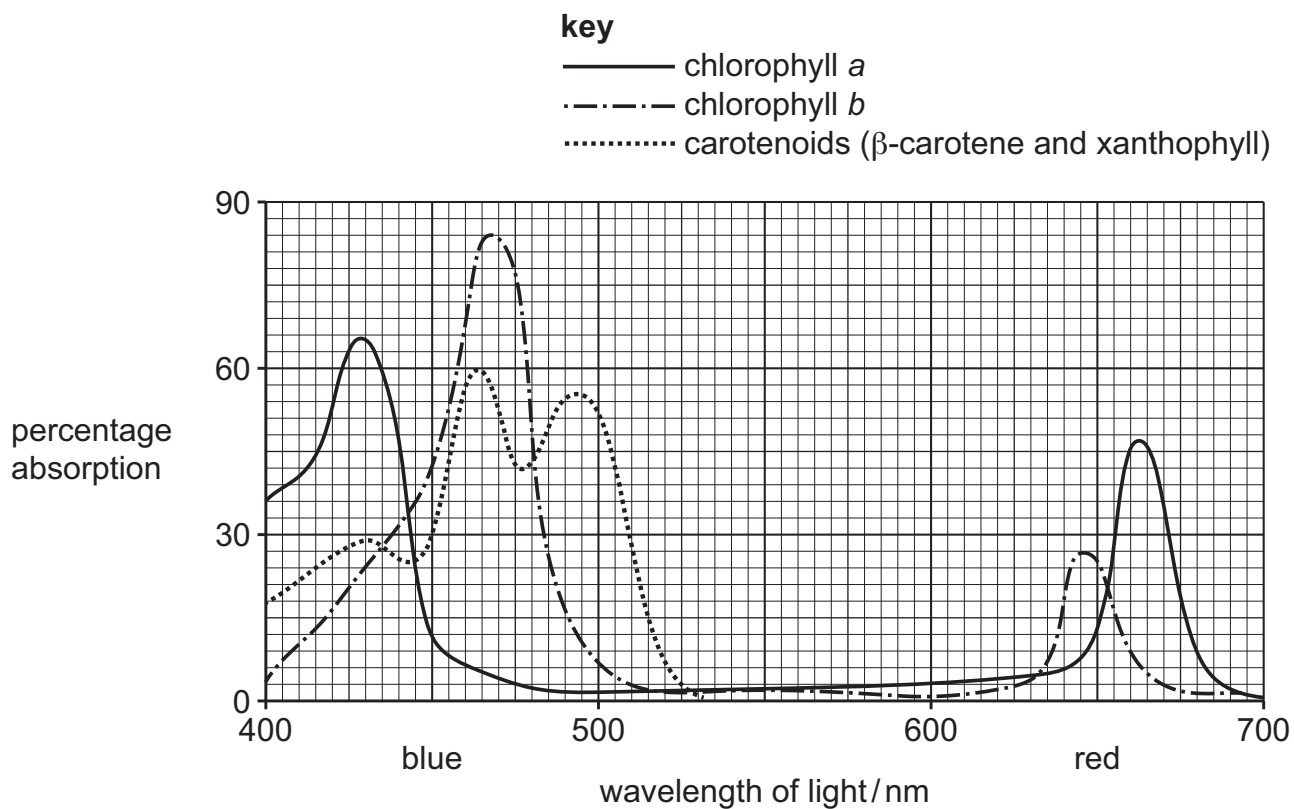


Fig. 3.2

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

[4]

(c) In some species of plant, the absorption of light stimulates seed germination.

The absorption of light increases the production of gibberellin in the embryo of a seed.

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

[4]

[Total: 13]

- 10 (a)** Cyclic photophosphorylation and non-cyclic photophosphorylation occur during the light-dependent stage of photosynthesis.

Outline the **differences** between cyclic photophosphorylation and non-cyclic photophosphorylation.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (b)** Complete the passage about the Calvin cycle using the most appropriate word or words.

A molecule of combines with a five-carbon molecule, ribulose biphosphate (RuBP), catalysed by the enzyme

This reaction produces a six-carbon compound that splits into two molecules of a three-carbon compound, glycerate 3-phosphate (GP).

ATP and are used to convert GP molecules into molecules of a three-carbon sugar, triose phosphate (TP).

Some TP molecules are used to make, while others are recycled to regenerate RuBP using ATP.

[4]

[Total: 7]

4 Scientists have invented a way of producing food by artificial photosynthesis.

- Solar panels convert sunlight energy into electricity.
- The electricity powers an electrolysis reaction between carbon dioxide gas and water to form the organic product acetate.
- The single-celled alga *Chlamydomonas*, a protocist, can use acetate to grow and reproduce in the dark, instead of photosynthesising in the light.
- The algae can be processed to make a food product.

Fig. 4.1 shows an outline of the artificial photosynthesis process.

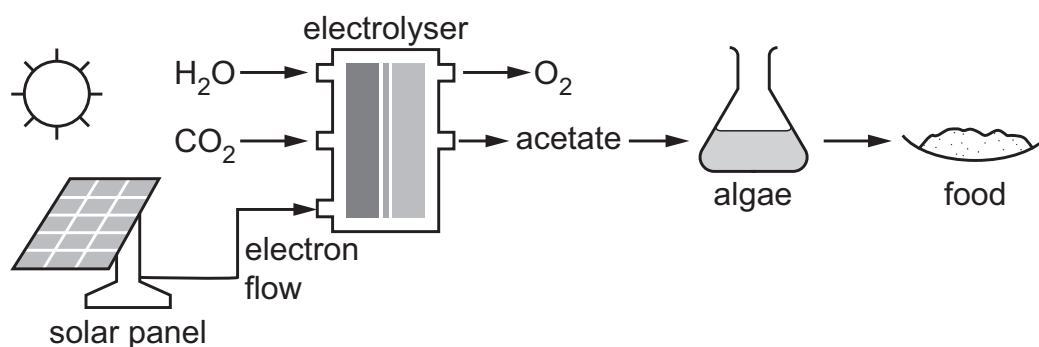


Fig. 4.1

- (a) Identify **three** similarities between the artificial photosynthesis process shown in Fig. 4.1 and the normal process of photosynthesis.

.....

.....

.....

.....

.....

..... [3]

- (b) Fig. 4.2 shows the single-celled alga *Chlamydomonas*. It contains a large, cup-shaped chloroplast for photosynthesis.



Fig. 4.2

Structures **A** and **B** in Fig. 4.2 are found within the chloroplast.

Name structures **A** and **B**.

A

B

[2]

- (c) Thylakoid membranes are the site of the light-dependent stage of photosynthesis.

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

..... [1]

(ii) Some of the protein components of the thylakoid membrane have a role in the light-dependent stage of photosynthesis.

Explain the roles of the different proteins that function in the light-dependent stage of photosynthesis.

[4]

(d) The products of the light-dependent stage of photosynthesis are used in the Calvin cycle. Calvin cycle intermediates are used to produce amino acids, carbohydrates and lipids.

Name the Calvin cycle intermediate that can be used to produce starch.

[1]

(e) Scientists claim that the artificial photosynthesis process shown in Fig. 4.1 is more efficient at converting light energy into food than normal photosynthesis by crop plants.

Give reasons why this claim may or may not be true.

true

not true

[3]

[Total: 14]

13.2 Investigation of limiting factors

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS temperature 温度 • light intensity 光照强度 • concentration 浓度 • limiting factor 限制因素
• indicator 指示剂

Objective

Build the skills to answer exam questions on the **investigation of limiting factors** of photosynthesis — **light intensity** 光照强度, **carbon dioxide concentration** 浓度 and **temperature** 温度.

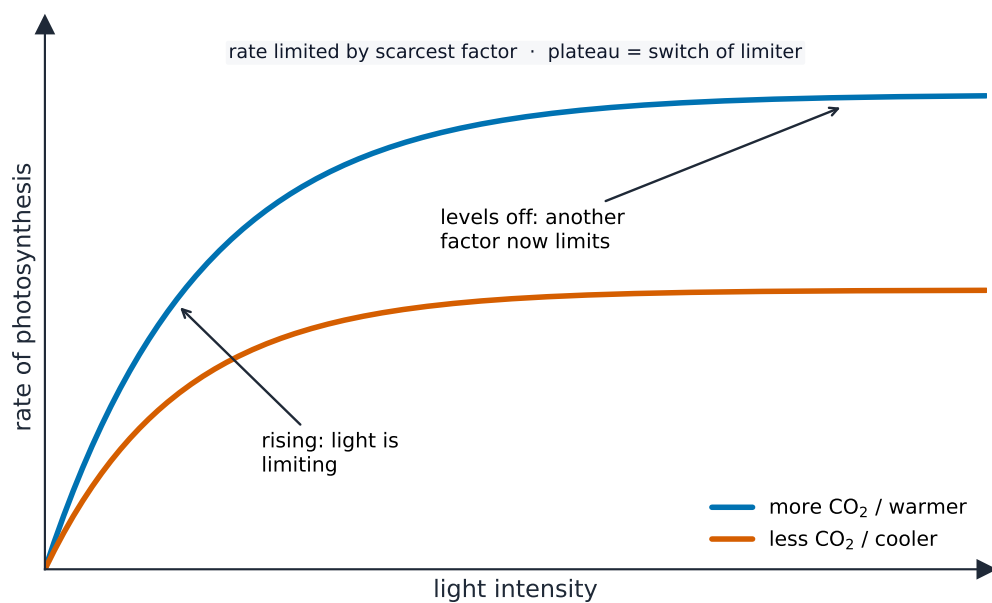
You must be able to:

- explain the effects of light intensity, carbon dioxide concentration and temperature on rate
- read a rate graph to identify which factor is limiting
- describe investigations using redox indicators and whole aquatic plants

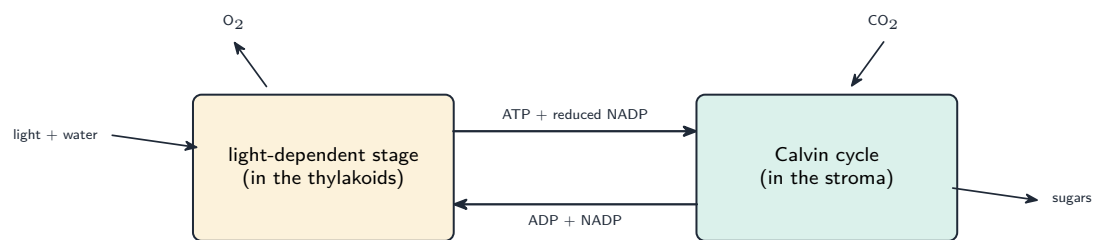
1 Worked examples

■ Limiting factors

A **limiting factor** 限制因素 is the one in shortest supply that holds back the rate.



While the rate rises, light is limiting; where it levels off, another factor (CO_2 or temperature) is limiting



Limiting factors act on the two stages of photosynthesis

- raising **light intensity** speeds the rate until another factor becomes limiting.
- raising **CO_2 concentration** speeds the rate until another factor becomes limiting.
- raising **temperature** speeds the rate to an optimum; too high and the enzymes denature.

■ Investigations

- a redox **indicator** 指示剂 (DCPIP or methylene blue) with a chloroplast suspension loses colour as the light-dependent stage works — time the colour loss at different light intensities or wavelengths.
- with a whole **aquatic plant** 水生植物 (e.g. *Elodea*), count the oxygen bubbles per minute, or collect the gas, under different conditions. Use a control and repeat for reliability.

2 Practice

2.1 Name **three** factors that can limit the rate of photosynthesis. [3]

2.2 State how you could measure the rate of photosynthesis of pondweed. [1]

3 Exam-style questions

3.1 On a rate-against-light-intensity graph, the curve rises then levels off. At the levelled-off part, the limiting factor is: [1]

- **A** light intensity
- **B** something other than light (e.g. CO₂ or temperature)
- **C** the amount of chlorophyll only
- **D** oxygen concentration

3.2 Why does the rate of photosynthesis fall at very high temperatures? [1]

- **A** too much CO₂ dissolves
- **B** the enzymes denature
- **C** light cannot reach the leaf
- **D** water freezes

3.3 A student counts oxygen bubbles from pondweed at different distances from a lamp.

(a) Explain why moving the lamp closer increases the bubble rate (up to a point). [2]

(b) State **two** variables the student must control to make this a fair test. [2]

3.4 Explain how a redox indicator such as DCPIP can be used to measure the rate of

the light-dependent stage.

[3]

Solutions

2.1 light intensity; carbon dioxide concentration; temperature.

2.2 count the oxygen bubbles given off per minute (or collect/measure the volume of oxygen).

3.1 B. When the curve levels off, light is no longer limiting — another factor is.

3.2 B. Above the optimum the enzymes denature, so the rate falls.

3.3 (a) moving the lamp closer raises the light intensity, so more light energy is available for the light-dependent stage, increasing the rate.

(b) any two: temperature; CO₂ concentration; same piece of pondweed; same time counted.

3.4 add DCPIP to an illuminated chloroplast suspension; the dye is reduced by the light-dependent stage and loses its blue colour; time how long the colour takes to disappear at each condition — faster loss means a faster rate.