

# 13.1 Photosynthesis as an energy transfer process

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 12 marks

## Objective

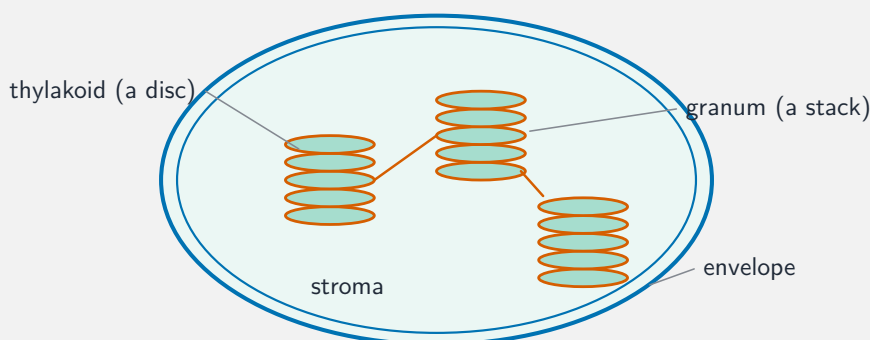
Build the skills to answer exam questions on **photosynthesis as an energy transfer process** —the **chloroplast** 叶绿体, the two stages, pigments, **photophosphorylation** 光合磷酸化 and the **Calvin cycle** 卡尔文循环.

You must be able to:

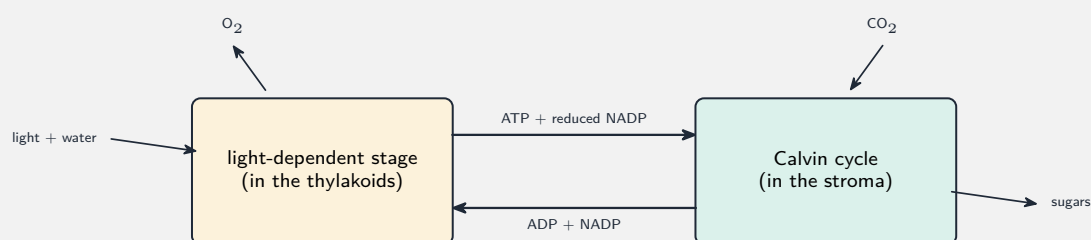
- relate chloroplast structure to function and explain the two linked stages
- describe the roles of pigments, interpret spectra, and use **Rf values** 比移值
- explain cyclic and non-cyclic photophosphorylation and the Calvin cycle

## 1 Worked examples

### ■ Chloroplast and the two stages

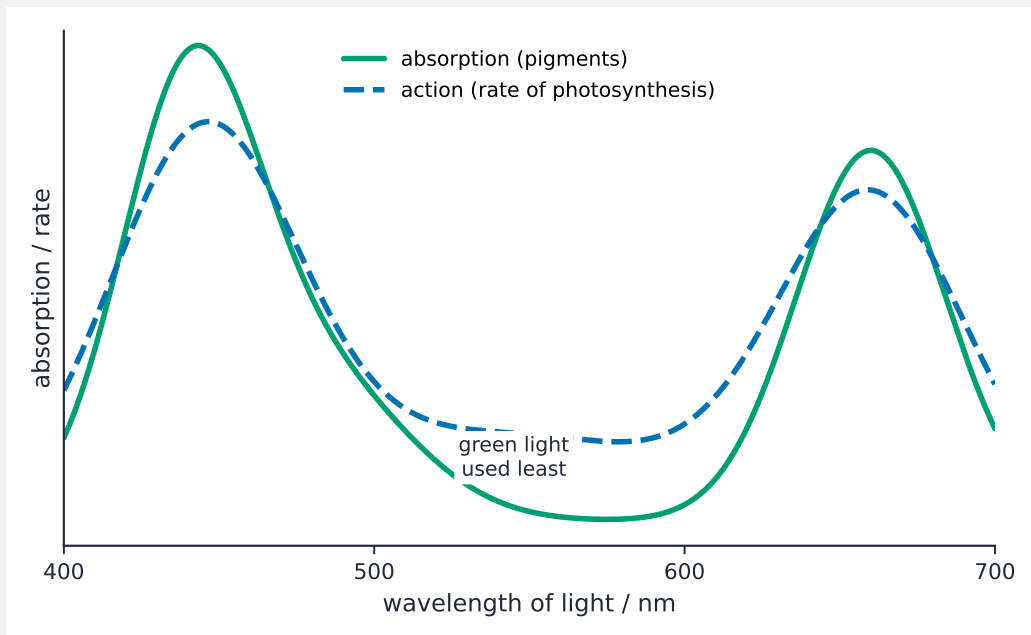


*Thylakoids stack into grana (light-dependent stage); the stroma is where the Calvin cycle runs*

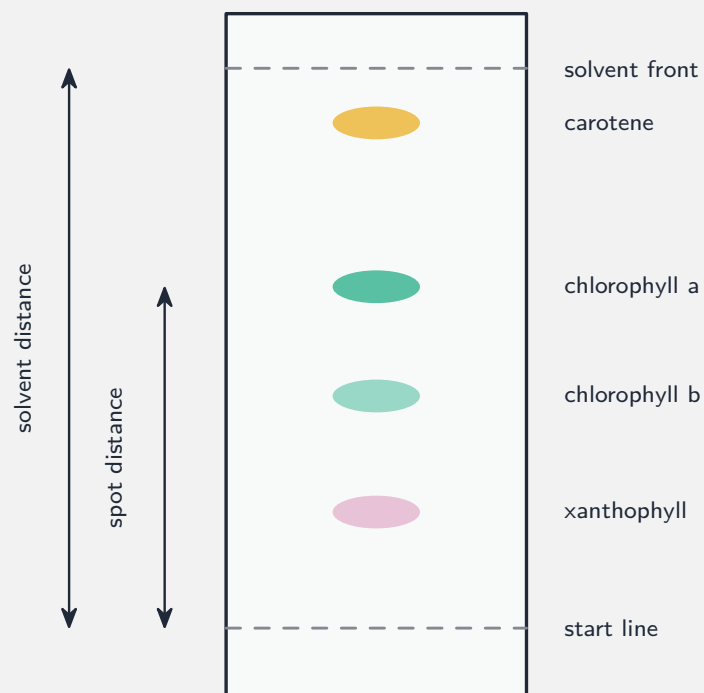


*The first stage makes the ATP and reduced NADP that the second spends to turn CO<sub>2</sub> into sugars*

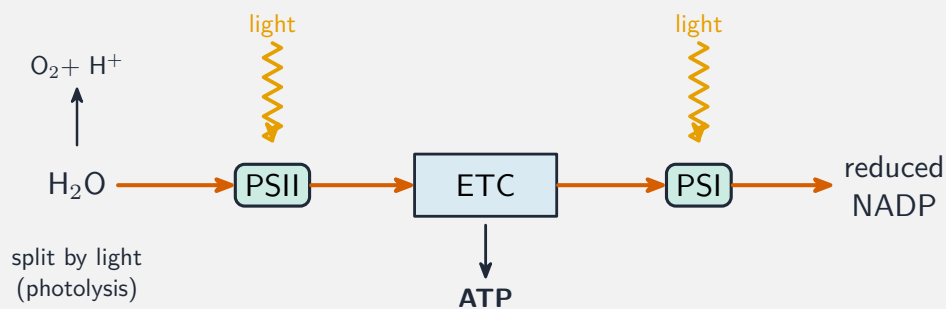
## ■ Pigments, spectra and chromatography



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

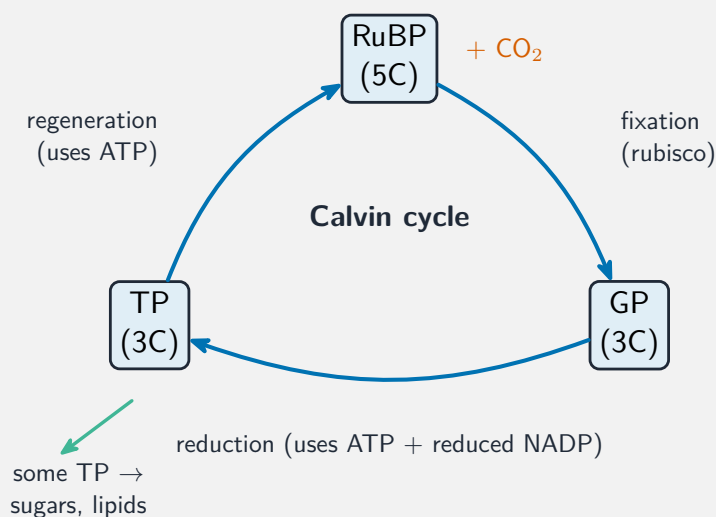


$$Rf = \text{distance moved by the pigment} \div \text{distance moved by the solvent}$$



*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]

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

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### 3 Exam-style questions

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

(a) Calculate the R<sub>f</sub> value of the pigment. [2]

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

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

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### 4 Go further

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You are now ready for the real exam questions on this subtopic. Open the **13.1 Photosynthesis as an energy transfer process** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/41 N25 —Q3 (photosynthesis, calculation)
- 9700/44 N25 —Q10 (light-dependent stage)
- 9700/41 J25 —Q4 (Calvin cycle, calculation)

## Solutions

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**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<sub>2</sub> 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.