

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

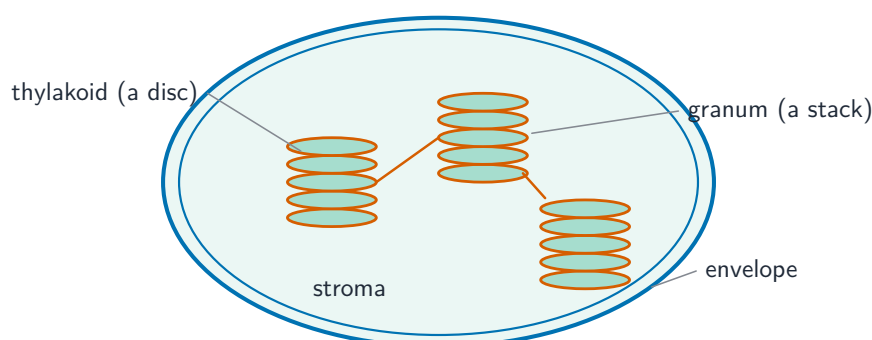
Build the skills to answer exam questions on **photosynthesis as an energy transfer process** — the **chloroplast** 叶绿体, the two stages, pigments, **photophosphorylation** 光合磷酸化 and the **Calvin cycle** 卡尔文循环.

You must be able to:

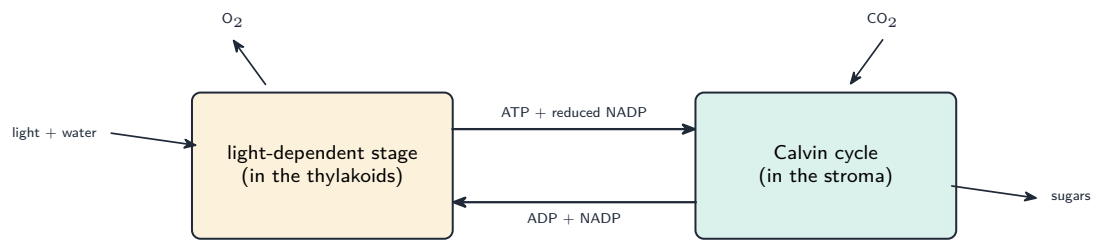
- relate chloroplast structure to function and explain the two linked stages
- describe the roles of pigments, interpret spectra, and use **Rf values** 比移值
- explain cyclic and non-cyclic photophosphorylation and the Calvin cycle

1 Worked examples

■ Chloroplast and the two stages

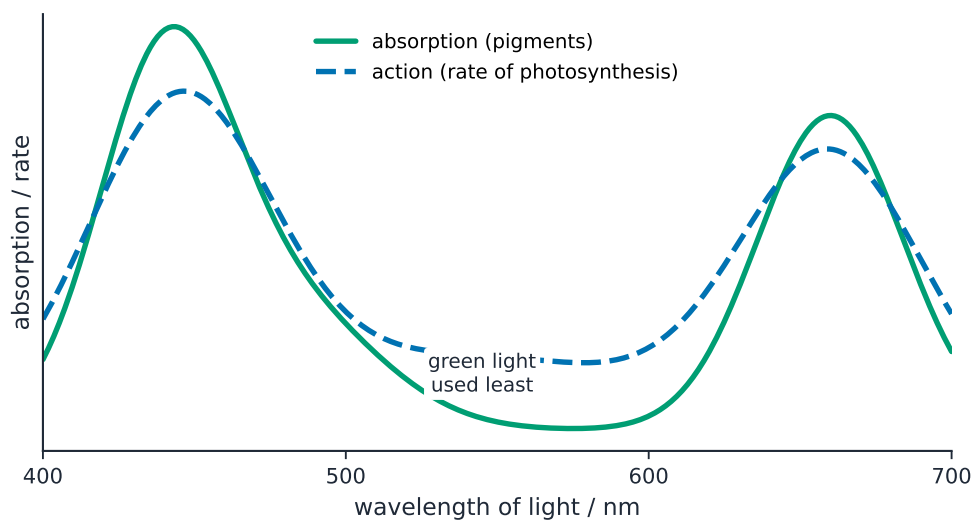


Thylakoids stack into grana (light-dependent stage); the stroma is where the Calvin cycle runs



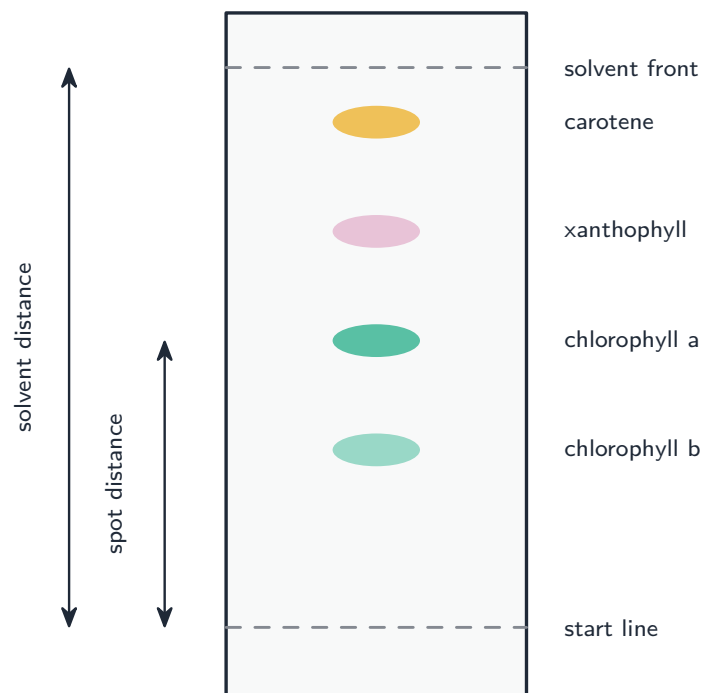
The first stage makes the ATP and reduced NADP that the second spends to turn CO_2 into sugars

■ Pigments, spectra and chromatography



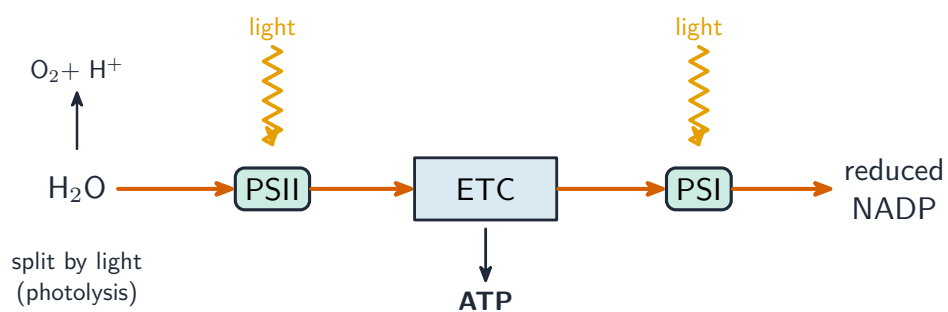
action tracks absorption · green light used least

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



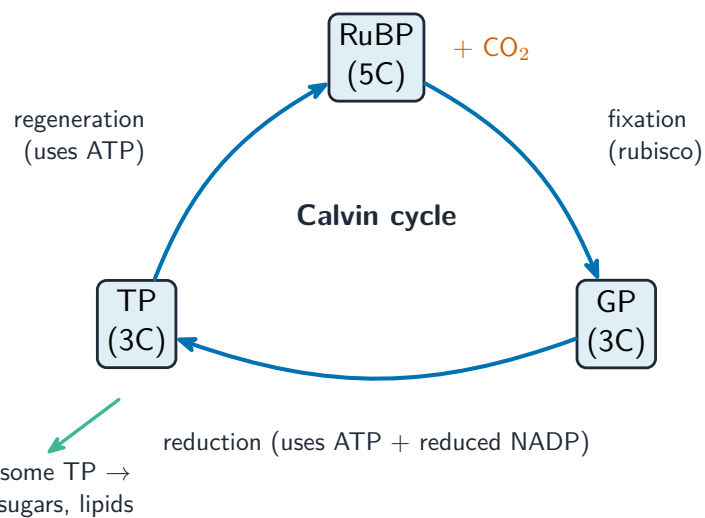
$$R_f = \text{distance moved by the pigment} \div \text{distance moved by the solvent}$$

■ 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.