

Main Problems

SAMPLE

"Plants have hormones"

Difficulty: Easy

This sample problem will give you a glimpse of how
Main Problems in the contest will be structured.

All the best for SBL 2024!



Last modified: 21 April 2024

Plants have hormones?

(100 points)

Figure 1 shows the terpenoid biosynthesis pathway of several plant hormones and plant pigments. Unlike hormones like epinephrine and testosterone that travel through the blood in humans, plant hormones travel through the plant via the xylem, phloem and cell-to-cell via plasmodesmata (do plants have feelings though?).

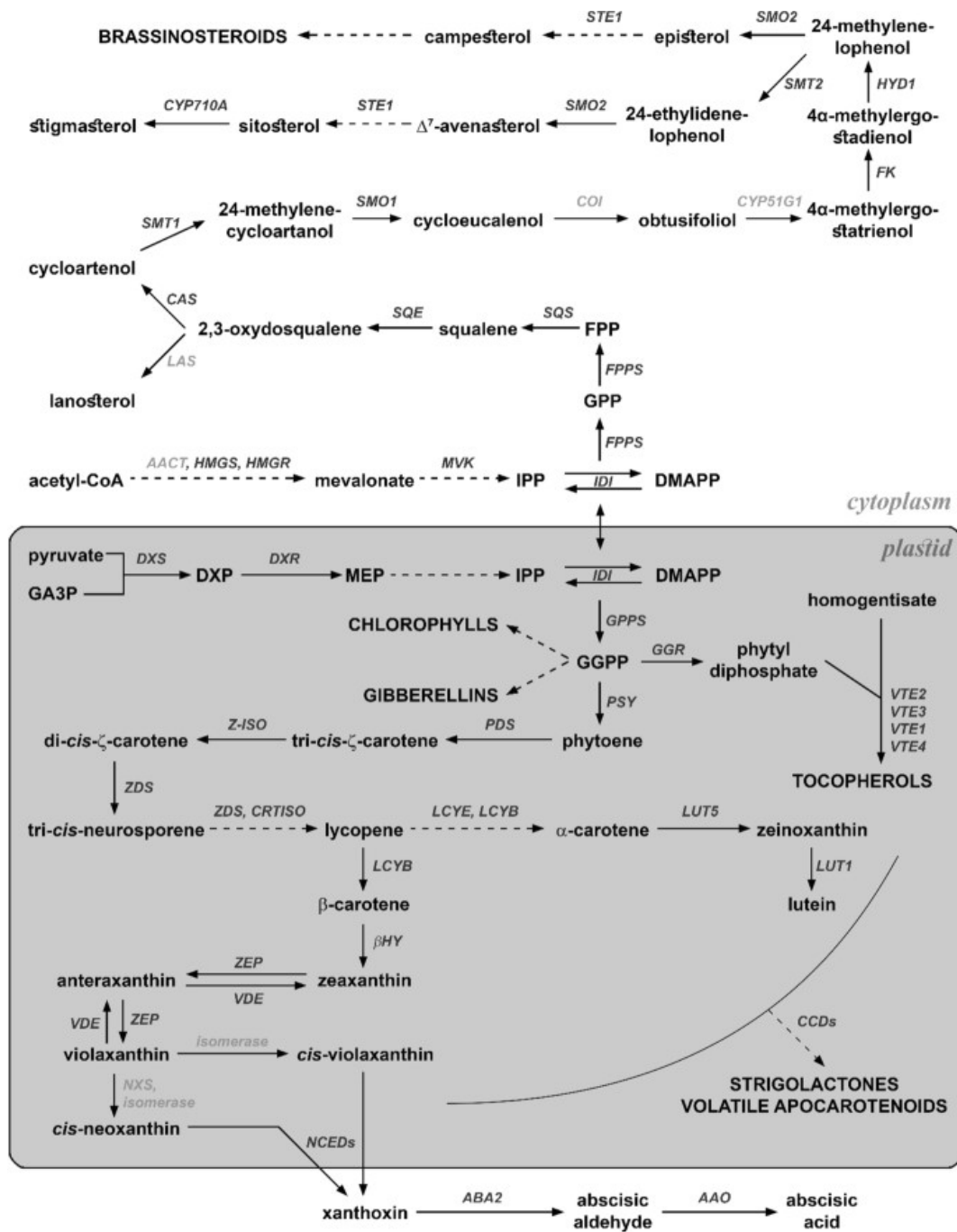


Figure 1: Plant Hormone and Pigment Biosynthesis Pathway. Note that “anteraxanthin” is a typo and should be “antheraxanthin” instead.

Le Xuan synthesised an *Arabidopsis* mutant *fk* which cannot produce brassinosteroids due to the lack of the *FK* enzyme.

Q1. Which compounds, when given to the *fk* mutant, will result in the synthesis of brassinosteroids? **(20 points)**

(Choose all correct options.)

- A. Obtusifoliol
- B. Episterol
- C. 24-ethylidene-lophenol
- D. 4 α -methylergo-statrienol
- E. Squalene
- F. Lanosterol

Q2. Indicate whether the following statements are true or false. **(40 points)**

(Choose whether the statements are true or false.)

- A. The plastid in Figure 1 likely refers to chloroplasts.
- B. Overproduction of CYP710A can lead to increased production of brassinosteroids.
- C. A plant with a mutation in SMT1 resulting in permanent binding to cycloartenol might result in an increase in lanosterol.
- D. Plants deficient in GGPP will have a slower rate of light-dependent reactions but the same rate of the Calvin Cycle as wild-type plants.

Q3. Indicate whether the following statements are true or false. **(40 points)**

(Choose whether the statements are true or false.)

- A. Deficiency in ZEP will lead to an overaccumulation of antheraxanthin.
- B. The reaction by IDI which is an isomerase is likely to produce water as a byproduct.
- C. An increase in the rate of enzymatic activity of MVK will cause the Krebs Cycle to slow down.
- D. The cell has a transmembrane transporter for IPP.

Answers and Explanations

Q1.

Answer: **B**

Explanation:

With the lack of FK enzyme, 4 α -methylergo-statrienol cannot be converted to 4 α -methylergo-stadienol, causing the former to accumulate and the latter to decrease in abundance as it is converted to 24-ethylidene-lophenol. Thus, only providing compounds downstream in the pathway from 4 α -methylergo-stadienol to brassinosteroids will allow them to be produced as the enzymes downstream are functional. 24-ethylidene-lophenol will not cause the production of brassinosteroids as it is in a different pathway.

Q2.

Answer: **TFTF**

Explanation:

- A. The plastid contains chlorophylls and thus it is likely the chloroplast.
- B. Overproduction of CYP710A will cause sitosterol to be used at a faster rate, causing more 24-ethylidene-lophenol to be used, thus there is less 24-ethylidene-lophenol available to produce brassinosteroids.
- C. SMT1 binding permanently to cycloartenol would cause a buildup of cycloartenol, shifting the position of equilibrium of the upstream reaction towards 2,3-oxidosqualene. Hence, less 2,3-oxidosqualene will be converted to cycloartenol and more will be available for conversion to lanosterol, thus the levels of lanosterol will rise.
- D. A lack of GGPP causes less chlorophyll and accessory pigments to be produced, so the plant has a poorer ability to capture light energy in the light-dependent reactions, causing the rate of the light-dependent reactions to fall. However, this will cause a fall in the production of NADPH and ATP, which causes the rate of the Calvin Cycle to fall too.

Q3.

Answer: **FFTT**

Explanation:

- A. A lack of ZEP with the presence of functional ZDE will cause violaxanthin to be converted to antheraxanthin and then zeaxanthin. Zeaxanthin will not be converted back to antheraxanthin as there is a lack of ZEP. Hence, antheraxanthin will not be accumulated but instead converted away.
- B. IDI is an isomerase. Isomerases catalyse changes within the molecule, allowing for the same molecular formula but a different physical structure so there should not be any loss of water.
- C. An increase in the activity of MVK will cause more mevalonate to be converted to IPP, causing more acetyl-CoA to be converted to mevalonate, thus there is less acetyl-CoA available for the Krebs Cycle.
- D. IPP is transported between the cytoplasm and the plastid. It has to pass through the plasma membranes of the plastid, implying that there is a transmembrane transporter to allow IPP to be transported through the membrane.

All the best for SBL 2024!



Credits

Figure 1: Boba, A., Kostyn, K., Kozak, B. et al. *Fusarium oxysporum* infection activates the plastidial branch of the terpenoid biosynthesis pathway in flax, leading to increased ABA synthesis. *Planta* 251, 50 (2020). <https://doi.org/10.1007/s00425-020-03339-9>