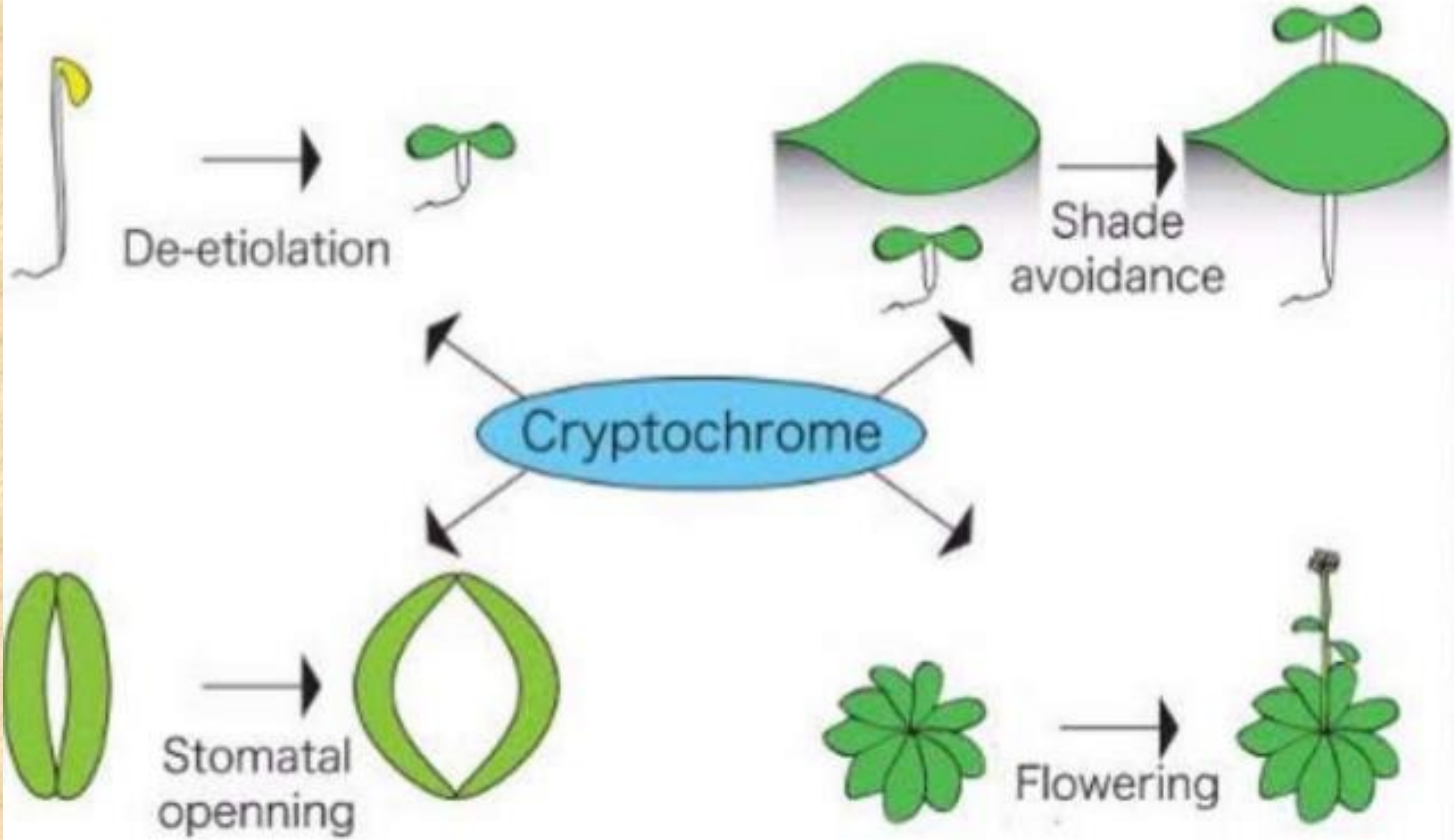
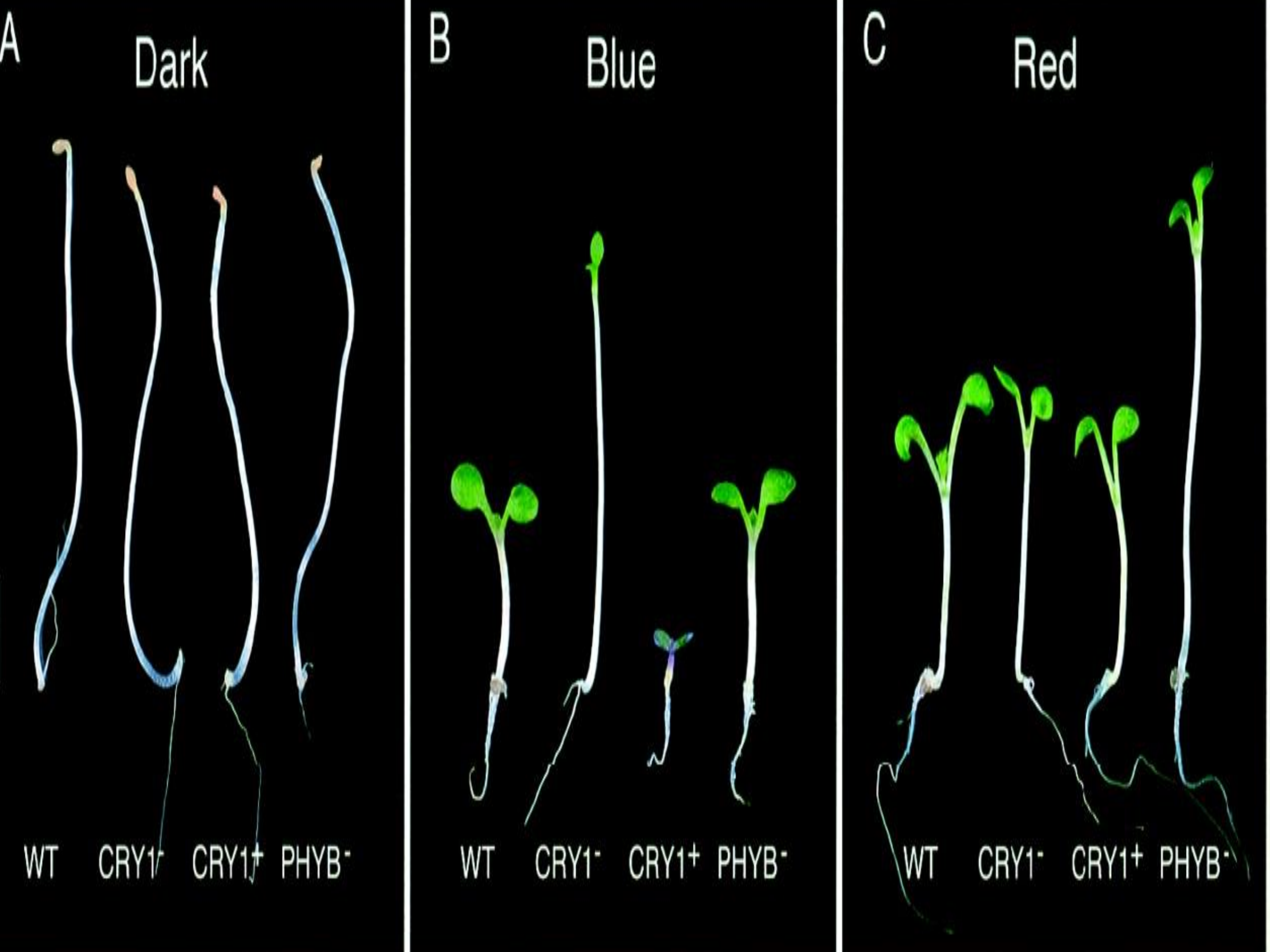
Plant Developmental Biology

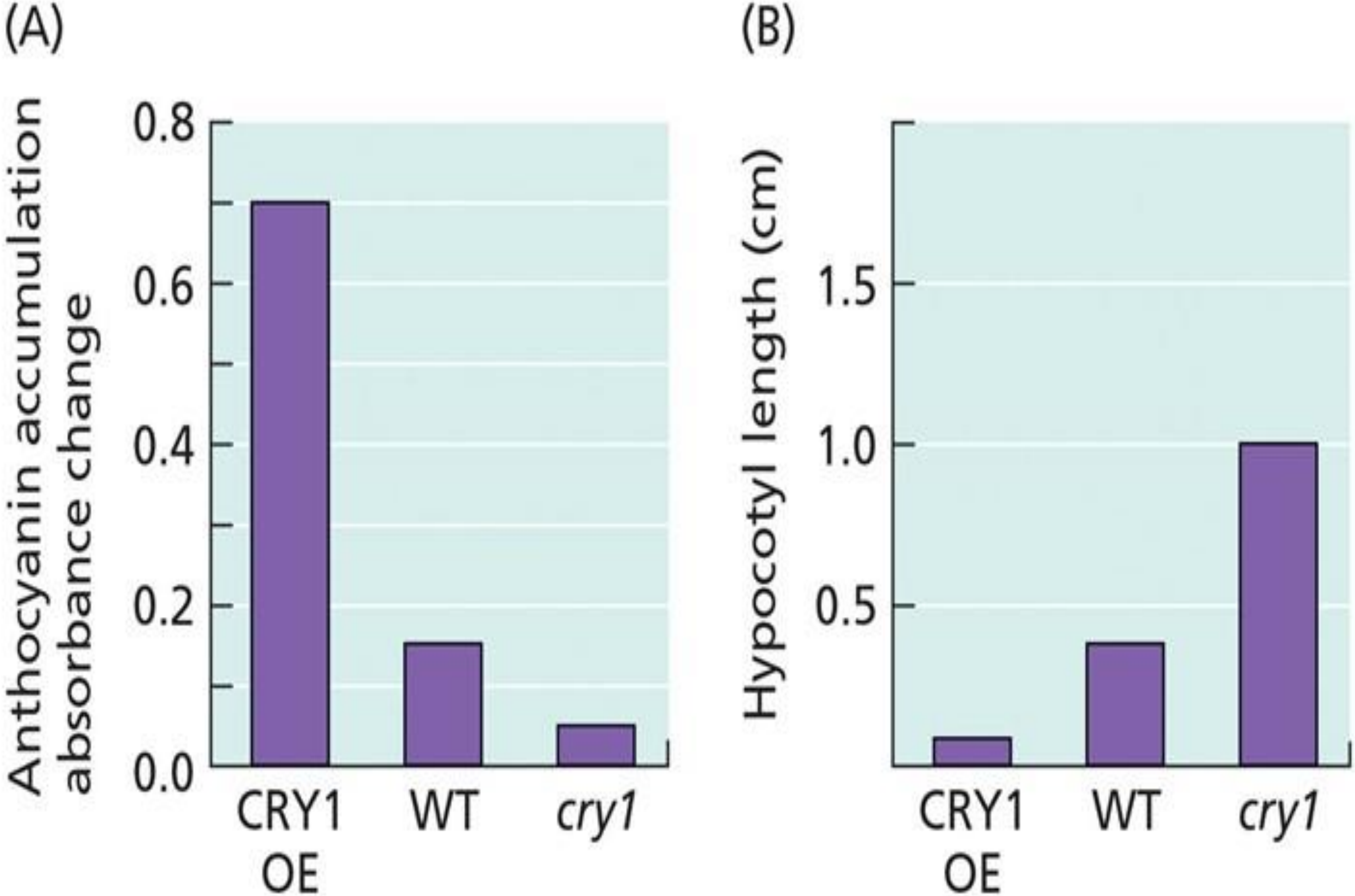
FUNCTION



De-etiolation
Shade
avoidance
Cryptochrome
Stomatal
openning
Flowering

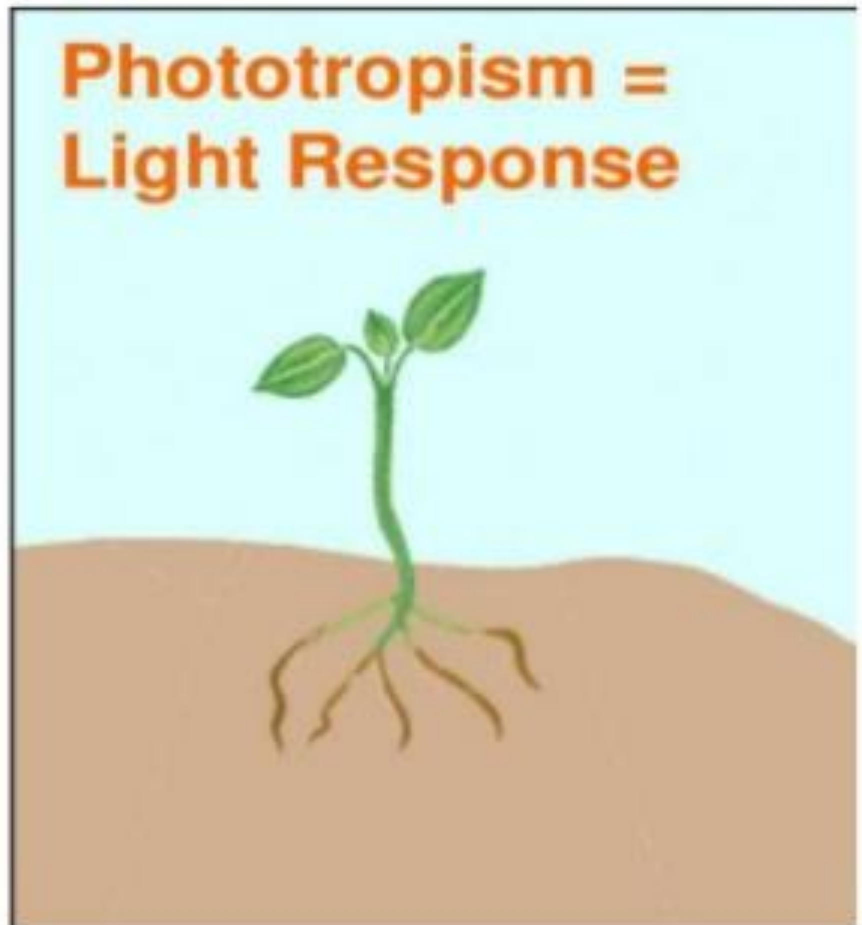

A
Dark
WT
CRY1⁻
CRY1⁺
PHYB⁻
B
Blue
WT
CRY1⁻
CRY1⁺
PHYB⁻
C
Red
WT
CRY1⁻
CRY1⁺
PHYB⁻

Color-blind mutant *Arabidopsis* seedlings. Six-day-old *Arabidopsis* seedlings are shown after growth under darkness (**A**), blue light (**B**) (25 μmol m^{-2} s^{-1}), or red light (**C**) (75 μmol m^{-2} s^{-1}). The *cry1*mutant ($CRY1^{-}$) shows a long hypocotyl under blue light (similar to growth of the wild-type in darkness) but is like wild-type under red light. Conversely, the *phyB* mutant ($PHYB^{-}$) shows an elongated hypocotyl under red light but not under blue light. The CRY1-overexpressing seedling ($CRY1^{+}$) is hypersensitive to blue light (but not to red light), exhibiting an unusually short hypocotyl and enhanced anthocyanin production.


(A)
(B)
Anthocyanin accumulation absorbance change
0.8
0.6
0.4
0.2
0.0
CRY1 OE
WT
cry1
Hypocotyl length (cm)
1.5
1.0
0.5
CRY1 OE
WT
cry1

- Growth towards a light source is called **positive** phototropism, while growth away from light is called **negative** phototropism.

  - **Stems** are **positive**ly phototropic.
  - **Roots** are **negative**ly



- Most plant shoots exhibit positive phototropism, and rearrange their chloroplasts in the leaves to maximize photosynthetic energy and promote growth.
- Roots usually exhibit negative phototropism, although gravitropism may play a larger role in root behavior and growth.
- Some vine shoot tips exhibit negative phototropism which allows them to grow towards dark, solid objects and climb them.

Blue Light and Plant Development

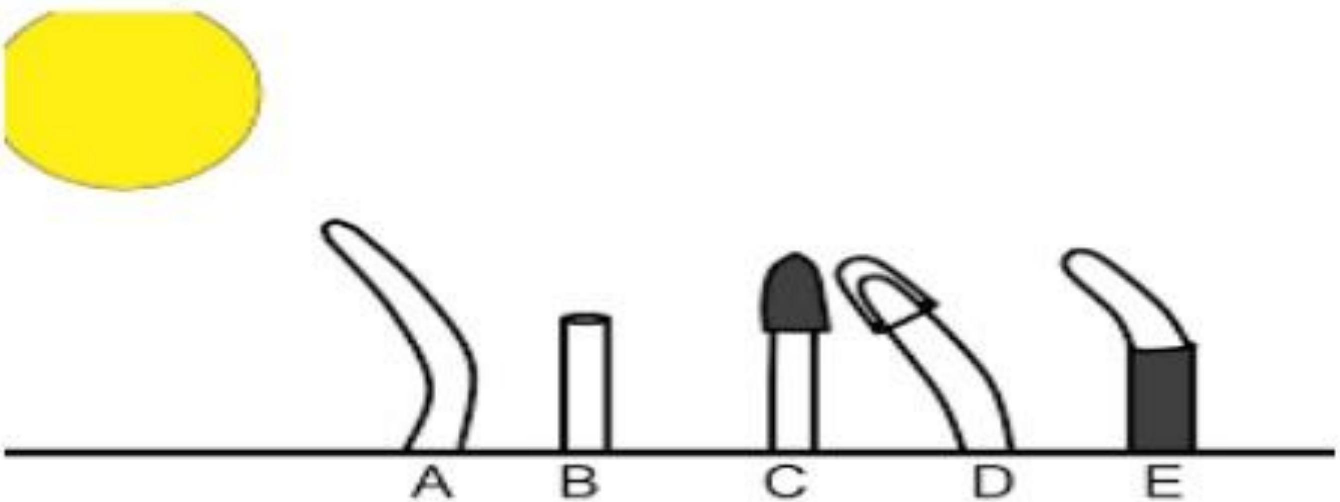
- To maximize photosynthesis

Phototropins promote:

1) Phototropism
2) Chloroplast movement
3) Stomatal opening

HISTORY OF PHOTOPERIODISM

- The best known early research on phototropism was by Charles Darwin, who reported his experiments in a book published in 1880, *The Power of Movement in Plants*.
- Darwin studied phototropism in **canary grass and oat coleoptiles.**

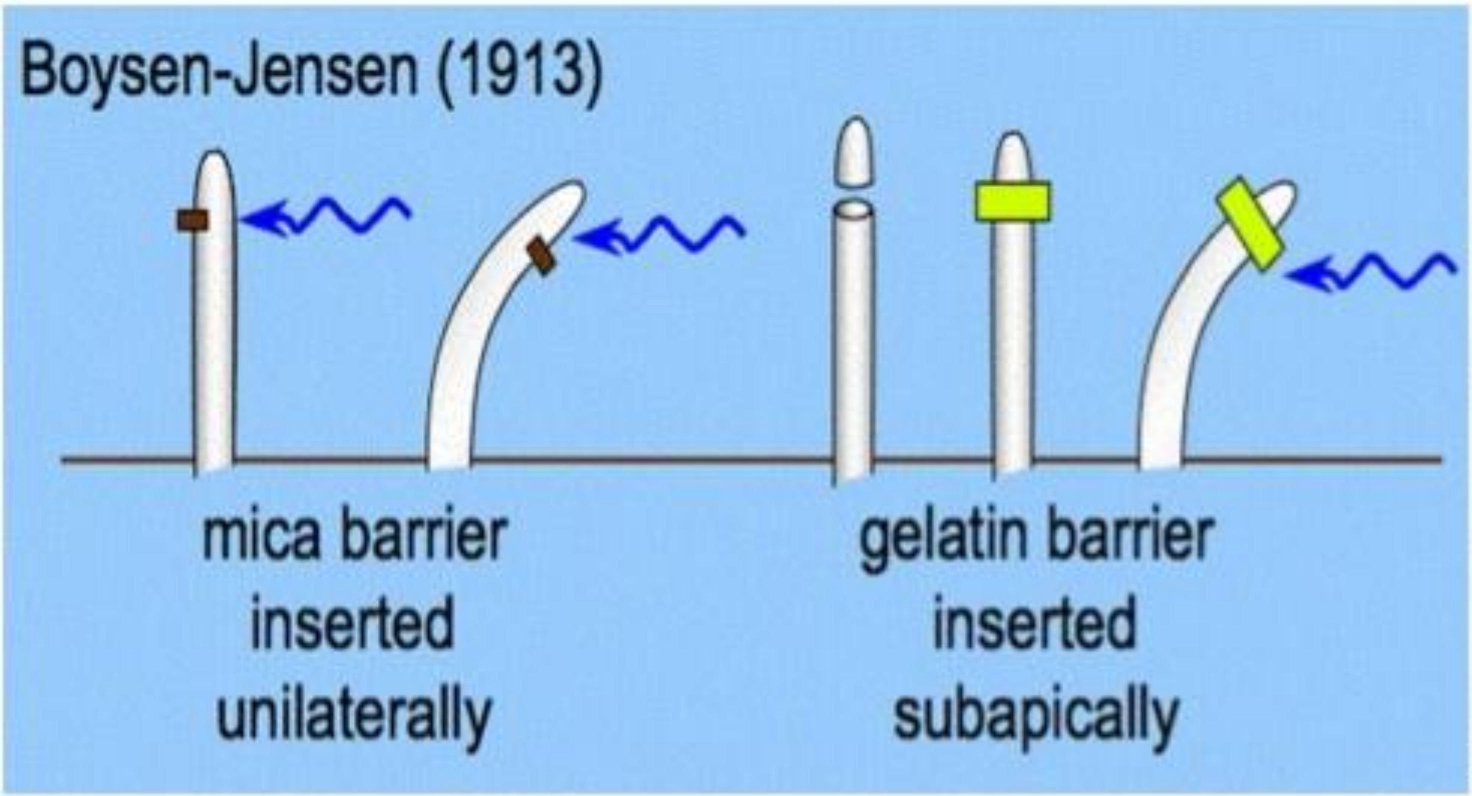


Darwin conclusions

- The tip of the coleoptile is the most photosensitive region.
- The middle of the coleoptile is responsible for most of the bending.
- An influence which causes bending is transmitted from the top to the middle of the coleoptile.

Boysen-Jensen's experiment (1913)

- He cut the tips off coleoptiles and placed a thin piece of mica between the coleoptile and the lower shoot.
- The result was that the shoot did not grow or curve toward the light.



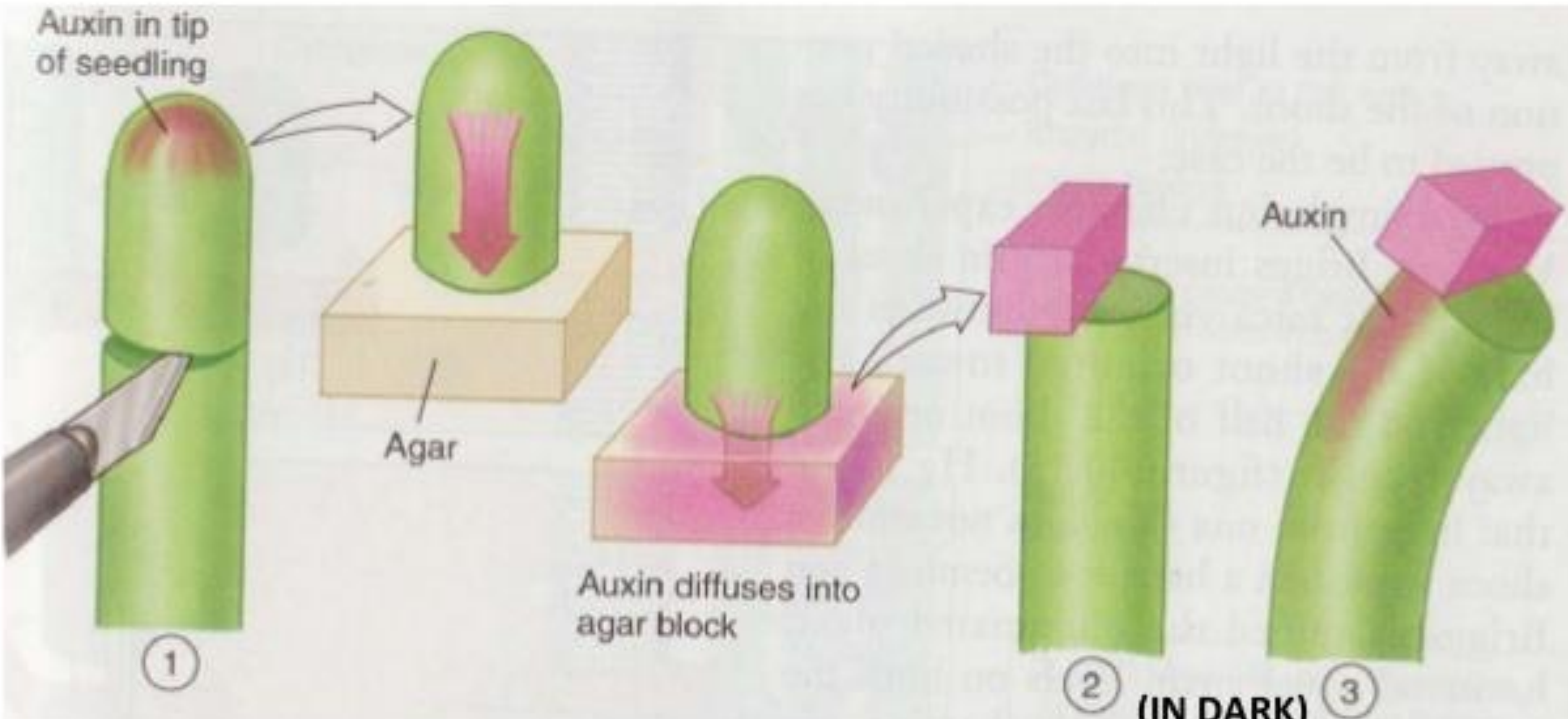
- When he repeated the experiment using a block of agar instead, the result was that the shoot grew and curved towards the light.

Conclusion,

- The chemical signal was a growth stimulant as the phototropic response involves faster cell elongation on the shady side than on the illuminated side.

Cholodny-Went model

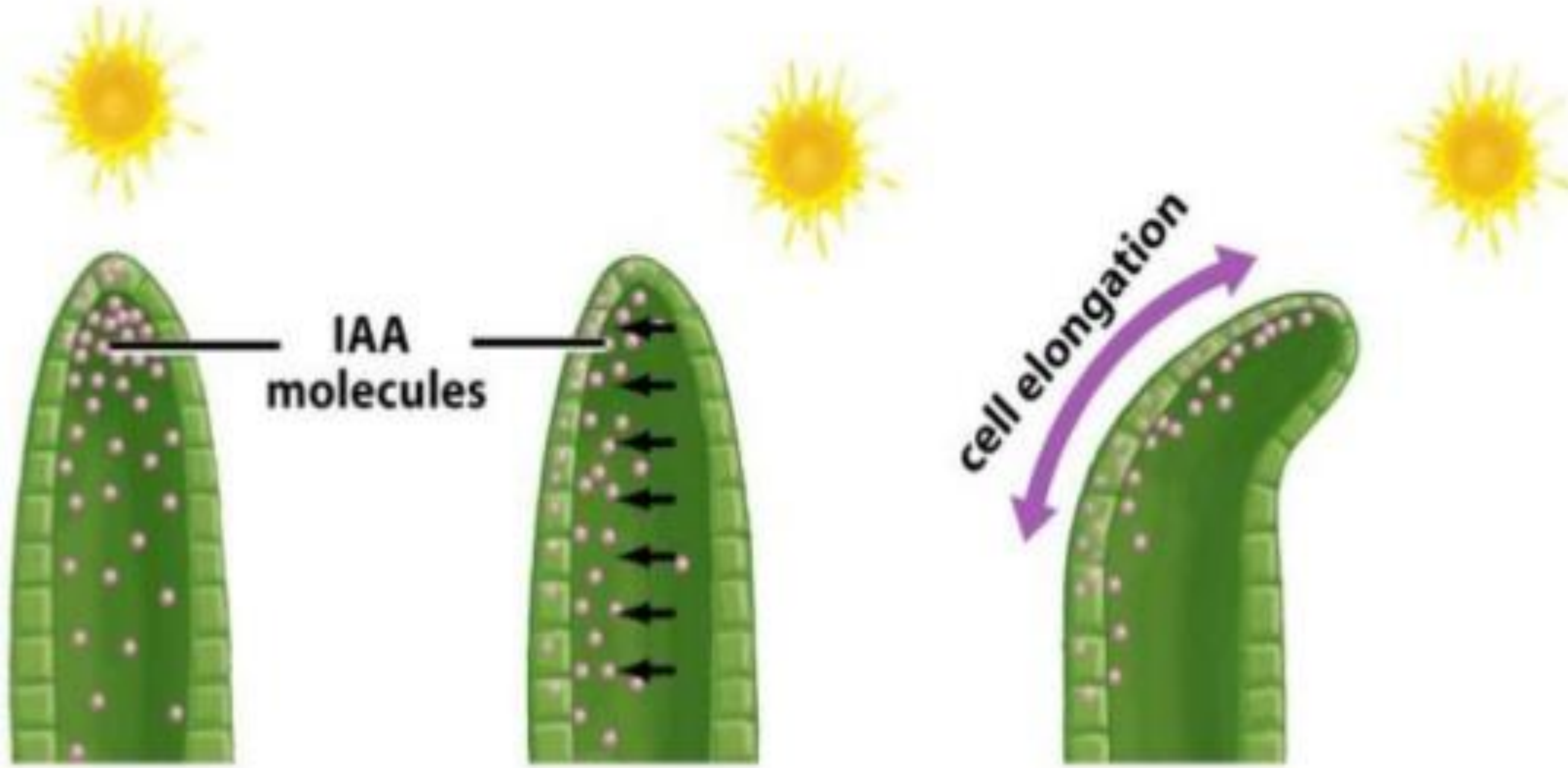
- The theory that the plant hormone auxin could play a role in phototropism was first proposed in 1937 by the Dutch researcher Frits Warmolt Went.



- When the agar block was centred on top the coleoptile grew straight.
- If the agar block was offset, resulting in an uneven distribution of the chemical on one side, the shoot would curve as though it was growing towards a light source.

Conclusions,

- This proved that the response was due to a water soluble chemical that diffused from the tip of the plant down the dark / shaded side of the coleoptile causing it to curve towards the light.
- Went repeated the experiment with agar that had not been treated, which produced no growth.



(a) When sunlight is overhead, the IAA molecules produced by the apical meristem are distributed evenly in the shoot.

(b) Once the sunlight shines on the shoot at an angle, the IAA molecules move to the far side and induce the elongation of cells on that side.

(c) Cell elongation results in the bending of the shoot toward the light.