Lecture 15: Light signal transduction

- gravity
- light
- temperature
- wind
- CO2
- photoperiod
- humidity
- ethylene
- pathogen
- nutrient
- water
- mineral
Fig. 18.2
Skotomorphogenesis (dark development)
Seedlings are bleached, lanky, said to be *etiolated*
(elongated hypocotyl, pronounced apical hook and
unexpanded cotyledons)

Photomorphogenesis (light development)
Seedlings begin to de-etiolate (elongation of hypocotyl
stops, cotyledons green and enlarge)
Two types of mutants in light response

1. Light insensitive: *hy* (*long hypocotyl*)

2. Undergo photomorphogenesis in the dark: *cop, det, fus*
Most *hy* mutants define photoreceptors

*hy*3 (*insensitive to red light*): PHYB (phytochrome B apoprotein)
*hy*8 (*insensitive to far-red light*): PHYA (phytochrome B apoprotein)
*hy*1, 2, 6 (*insensitive to red and far-red*): chromophore production
*hy*4 (*insensitive to blue light*): CRY (apoprotein for blue light receptor)
*hy*5 (*insensitive to full spectrum white light*): Tx factor
Phytochromes are photoreceptors that sense both photoperiod and light quality.

TKD: transmitter kinase domain

Fig. 18.23 A-C
**Cryptochrome**

*CRY1* and *CRY2* encodes homologues of DNA photolyases which are flavin proteins that carry blue-light dependent electron transfer

http://www.sciencemag.org/cgi/content/full/284/5415/760
wt cry1− cry1+ phb

dark  blue  red
**COP, DET, FUS mutants**

*cop*: constitutive photomorphogenic
*det*: de-etiolated
*fus*: fusca (dark purple)

Cop1: encodes a WD protein

Cop9 complex (signalosome)
COP1-GUS localization

COP9 complex is required for the nuclear localization of COP1

In dark conditions, COP1-GUS localizes to the cytoplasm, repressing photomorphogenesis.

In light conditions, COP9 complex relieves the repression, allowing photomorphogenesis to occur.
How does COP1 represses photomorphogenesis?

Cop1: ubiquitin ligase (E3)
Cop10: ubiquitin-conjugating enzyme (E2)
Cop9 signalosome: essential E3 modulator

Degradation of Hy5: the Transcription factor in the activation of photomorphogenesis
Figure 9.43 (A) The three dimensional structure of Ubiquitin which consists of a compact globular domain with a flexible protruding C-terminal segment. (B) A ribbon diagram of Ubiquitin.
Fig. 9.44

[Diagram of protein ubiquitination process]

1. AMP + E1
2. E1
3. Target protein
4. E2 + Ubiquitin
5. Ubiquitinating enzyme complex
6. E2
7. E2
8. E2
9. Ubiquitin-protein complex
10. Delivery to proteasome
How does COP1 receive the light signal from photoreceptors?

Direct physical interactions between

PHYB and COP1
CRY1 and COP1 (both blue light and dark)
CRY2 and COP1

[http://www.sciencemag.org/cgi/content/full/294/5540/154/F1](http://www.sciencemag.org/cgi/content/full/294/5540/154/F1)

CRY1 undergoes an intramolecular, light-dependent redox reaction, which results in a change in CRY1 C-terminus and modulate COP1 activity.
Light-activated gene expression
Development of chloroplasts

LIGHT

far-red
red
blue
UV-A
UV-B

RECEPTORS

PHYA
PHYB
HY4/CRY1, 2
CRY1, 2

COP
DET
FUS

HY5

Development of chloroplasts