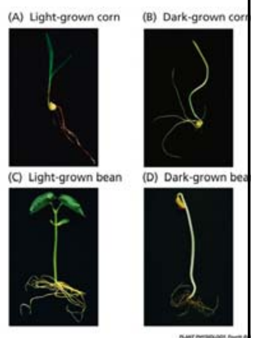
Photomorphogenesis

1. Most significant environmental factor affecting plant development:

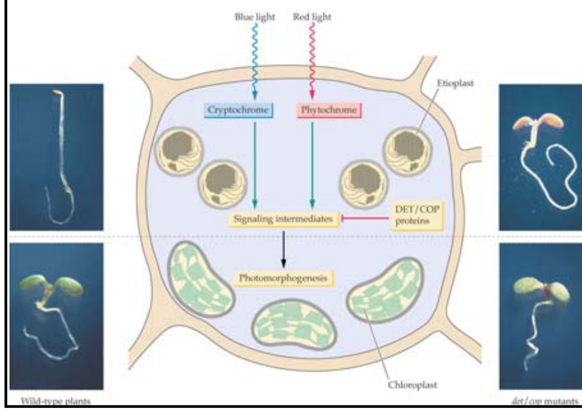
Light quality

Light quantity

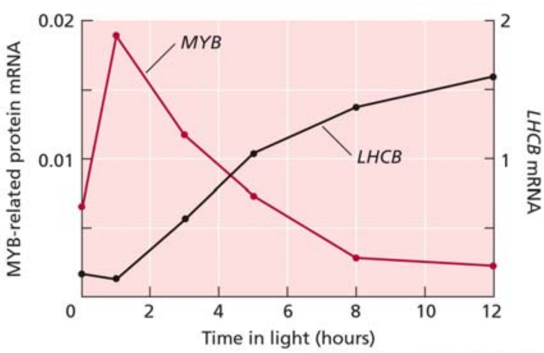
2. Low-level light-triggered responses are called photomorphogenic responses



18-4 Buchanan ***Light regulates plant development***



17-17. Taiz. Induction of mRNA for **Light-harvesting complex (LHC)** after transfer of seedling to light



Photomorphogenesis: OUTLINE

Effect of light on Growth and Development

-Light quality and quantity are the most significant environmental factors affecting plant development.

-Light induces dramatic changes in morphology and biochemical (protein) composition. How does light induce such changes? e.g. increase in rubisco, LHC

A Simple Model of Signal-induced Responses

1. Signal perception by a receptor
2. Signal transduction
   a) Communicate signal to other cell parts
   b) Amplify the signal
   c) Network and cross talk
3. Primary response
   e.g. Increase or decrease in gene expression
   e.g . Change from inactive protein ---> active protein
4. Cellular and Physiological responses

Plants have 3 types of Photoreceptors

1. Phytochrome 660 nm
2. Blue light receptor ~400-500 nm
3. UV-B Receptors ~300 nm

1. Phytochrome: a red light receptor
   acts as a light-activated switch

Two types of phytochrome: Phy A & PhyB-PhyE

Mode of action

2. Blue-light induced responses

Multiple receptors

Mode of action

Signal transduction

1. Each cell is programmed to respond to specific combination of signals.
2. Different cells respond differently to the same signal.
   a. response depends on receptors in the cell
   b. response depends on the intracellular machinery coupled to the receptor

Model of signal perception and transduction

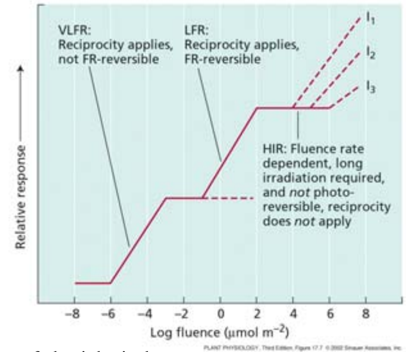
1. Signal perception by a receptor
2. Signal transduction
   a) Communicate signal to other cell parts
   b) Amplify the signal
   c) Network and cross talk
3. Primary response
   e.g. Increase or decrease in gene expression
   e.g . Change from inactive protein ---> active protein
   or an Ion channel opens
4. Cellular and Physiological responses

e.g. light stimulated guard cell movement,

Light stimulated greening of etiolated seedling

17-7 Taiz: How do plants respond to **light?**

Different intensities of light induce different responses.



Examples of physiological responses

Light quantity matters.

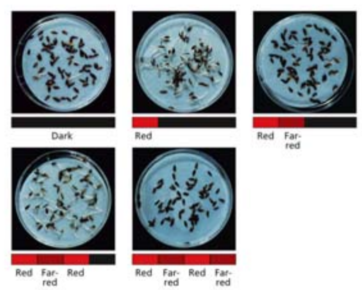
VLFR very low fluence	1-100 nmol /m2	Induce gene expression LHCB Arabidopsis germination [not photoreversible]
LFR Low fluence	1-1000 umole/m2	Promote lettuce seed germination [Photoreversible]
HIR High irradiance	>10,000 umole/m2 10 mmole/m2	Inhibit stem elongation synthesis of anthocyanin [not photoreversible]

How can plants respond to light quality & quantity?

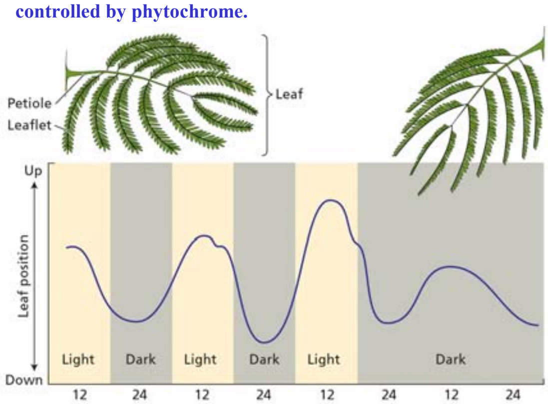
Ans. Plant has several different photoreceptors.

Examples of responses mediated by phytochrome light receptor

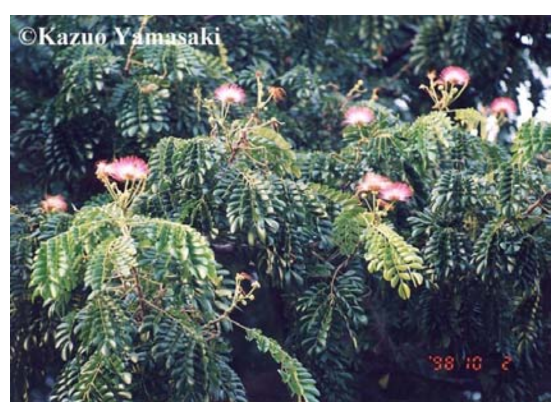
a. Lettuce seed germination (VLFR)



17-13. Taiz. **Circadian rhythm of Albizzia leaf movement is controlled by phytochrome.**



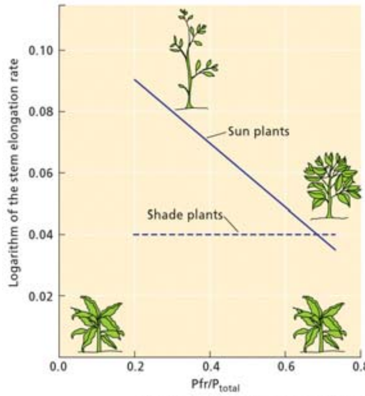
Samanea



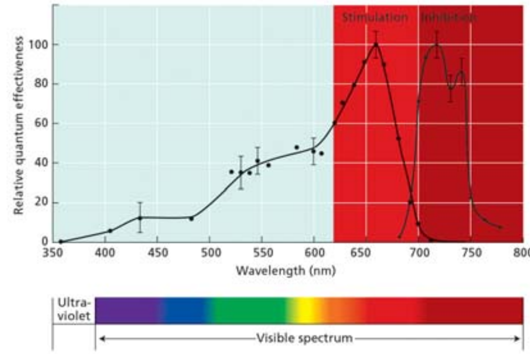
17-13 Taiz. Inhibition of stem elongation by light. **High IR**

PhyB

Ratio of Pfr/Pr is important.



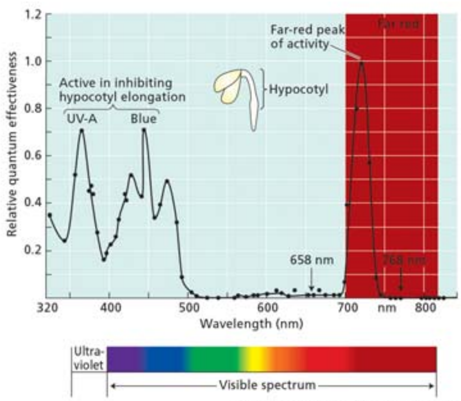
17-8 Taiz. LFR action spectra for Arabidopsis seed germination
What wavelength is important?
Evidence for a role of phytochrome (Phy A)

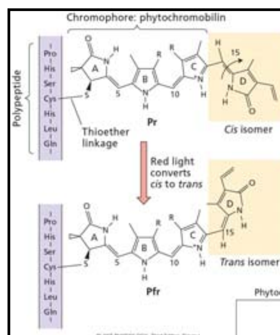


17-9. Taiz. Inhibition of hypocotyl elongation in dark grown lettuce seedlings

HIR

PhyB & UV-A, Blue

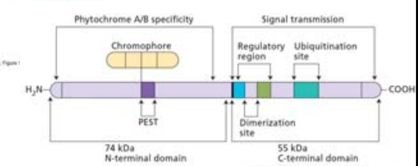




What is phytochrome?

1st receptor discovered in plants.
Purified from dark-grown seedling.
A protein with a chromophore.

Absorbs R and FR light

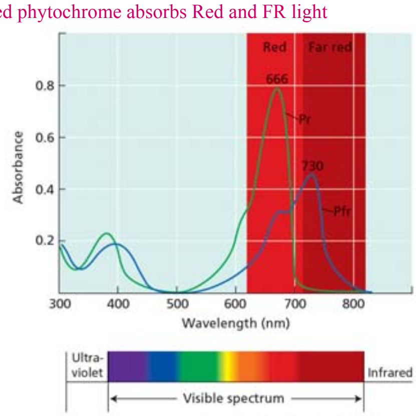


17-4. Structures of Pr and Pfr

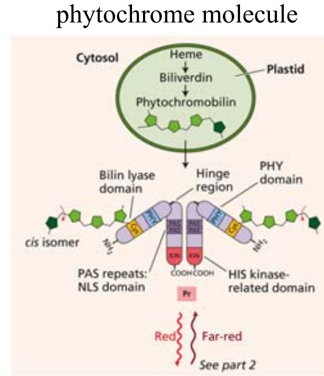
17-3 Taiz Purified phytochrome absorbs Red and FR light

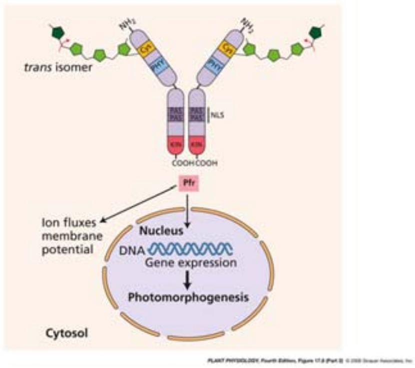
Photoreversible

Pr Pfr

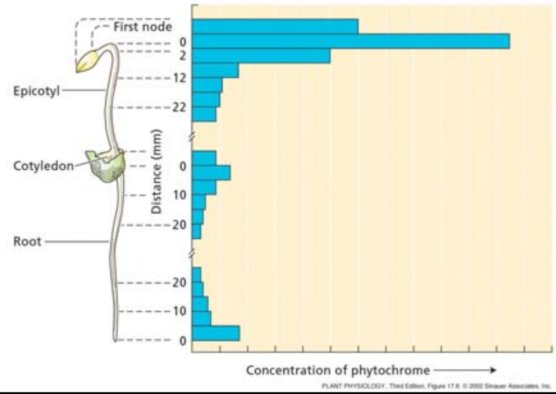


Light induces conformational changes in the phytochrome molecule





17-8 Taiz Phytochrome level is high in apical meristems



Multiple types of Phytochrome: Two types:

I. *PhyA, and II. Phy B-PhyE*

Multiple phytochrome genes

I. Phy A, Abundant, active in dark grown seedling
Unstable in light, degraded

Pr ----RED---> Pfr
<---FR----
<---dark--

II. Phy B: stable form in green seedlings

Phy C

Phy D

Phy E

How can plants sense light of different quantity and quality & respond ?

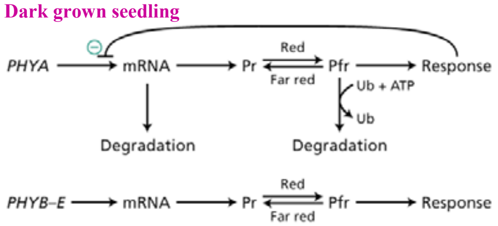
How do you know if phytochrome is acting in a light-induced response?

1. *The wavelength needed for the response (action spectrum)*
2. *Photoreversibility (Low fluence response)*
3. *Response is affected by ratio of Pfr/Pr*

17-7. PhyA is labile. PhyB-E are more stable.

Arabidopsis has 5 genes encoding phytochrome. phyA, B, C, D, E

Dark grown seedling



Green seedling/plant

[continued in Lec18b]