9.3 Growth in plants

Undifferentiated cells in the meristem of plants allow **indeterminate** growth. Cells continue to divide indefinitely.

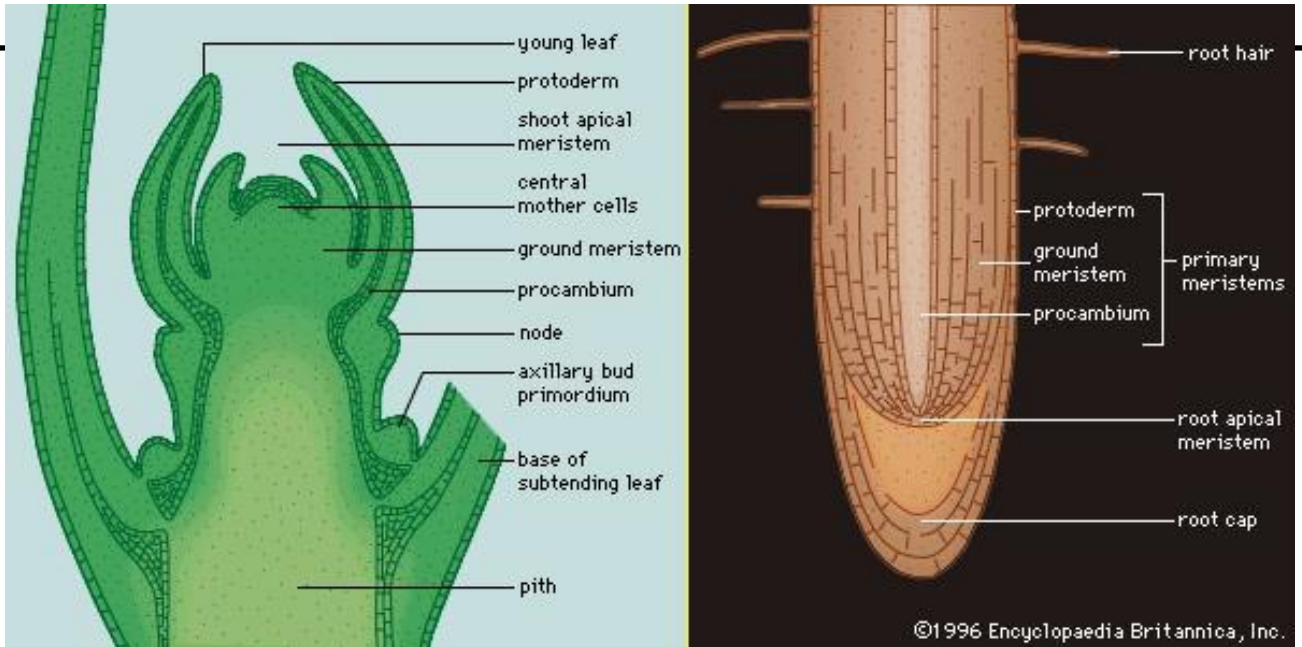
After mitosis one cell remains undifferentiated and one specializes

9.3.U1

Meristems are composed of undifferentiated cells.

Primary meristems: tips of stems and roots (**apical meristems**).- length

Many dicotyledenous plants develop **lateral meristems**. - width

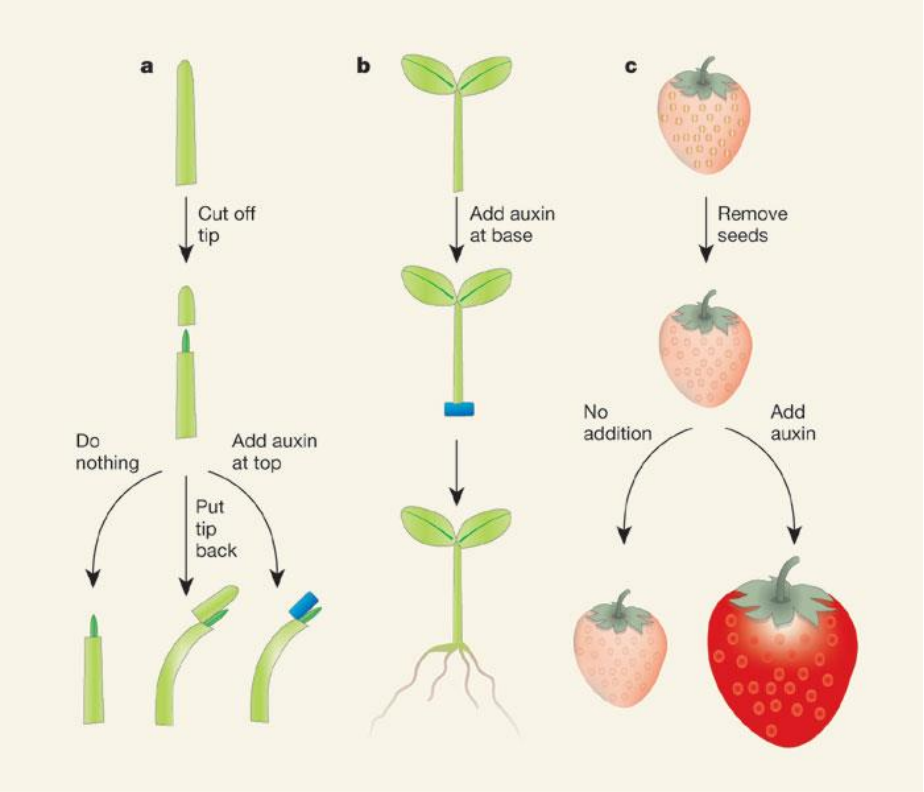


9.3.U2 Mitosis and cell division in the shoot apex provide cells needed for extension of the stem and development of leaves.

Shoot apical meristem: growth of the stem, cells grow and develop into leaves and flowers.

9.3.U3 Plant hormones control growth in the shoot apex.

Auxin is synthesized in the apical meristem of the shoot and is transported down the stem. It promotes the elongation of cells in stem.



9.3.U4 Plant shoots respond to the environment by **tropism**.

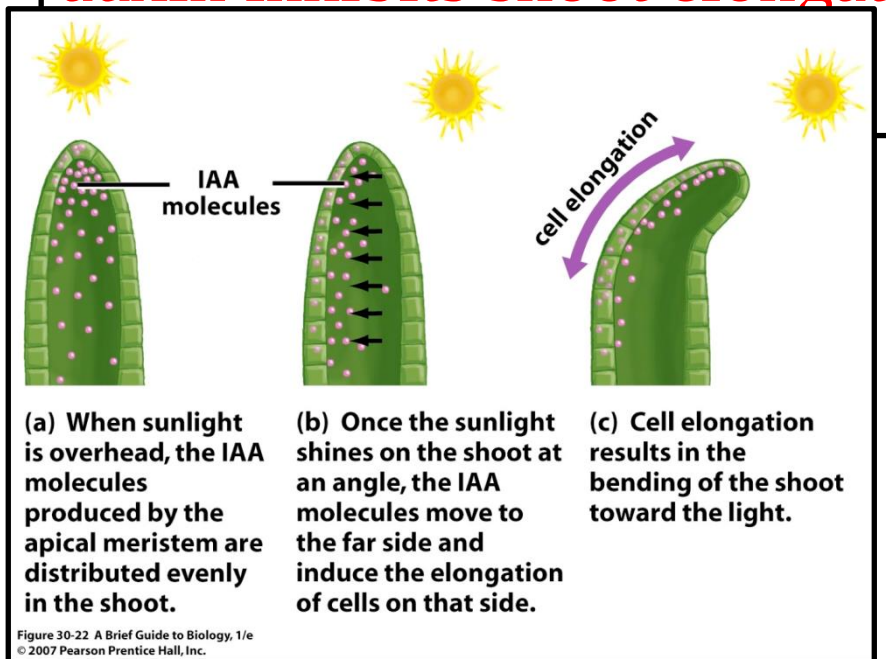
Directional growth responses to directional external stimuli are called tropism.

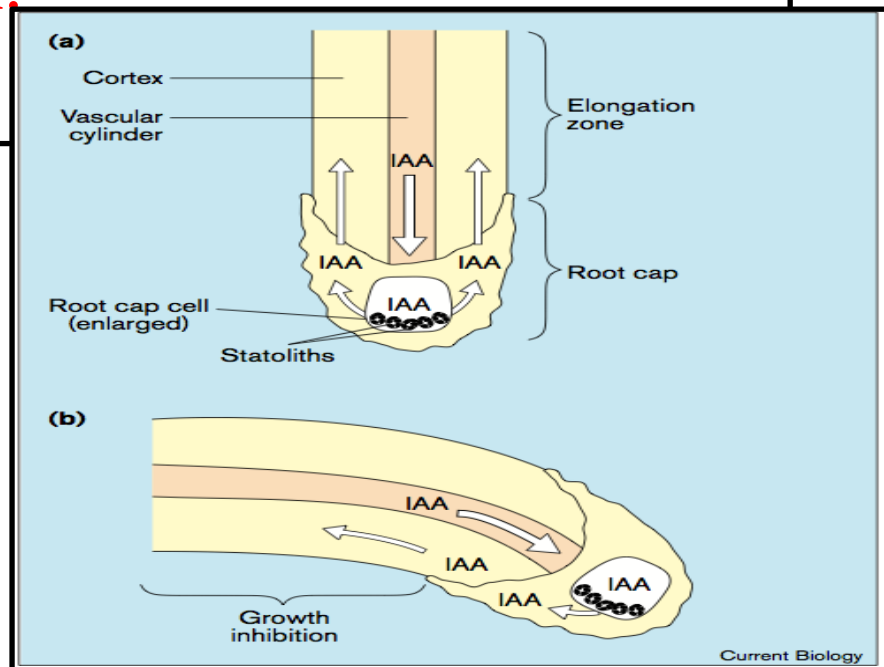
Phototropism.

Gravitropism.

9.3.U5 Auxin efflux pumps can set up concentration gradients of auxin in plant tissue.

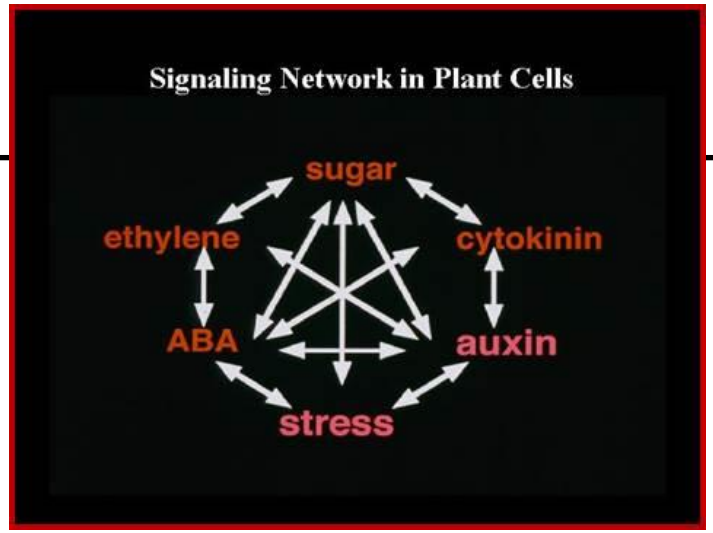
In the shoot, auxin promotes elongation but in the root auxin inhibits shoot elongation.

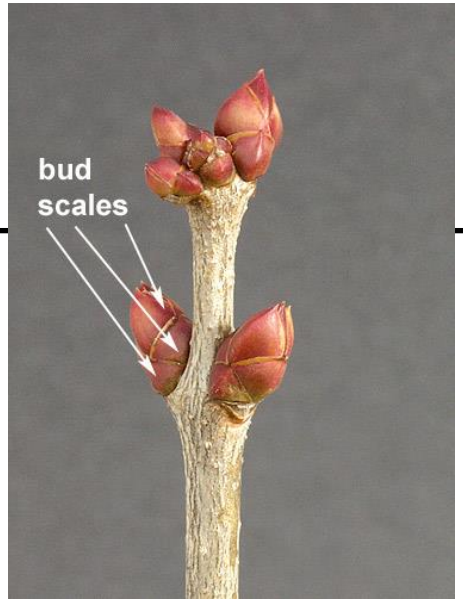




9.3.U6 Auxin influences cell growth rates by changing the pattern of gene expression.

Phototropism is an adaptation response, through which plants grow towards the light. It involves light perception and asymmetric distribution of the plant hormone auxin.





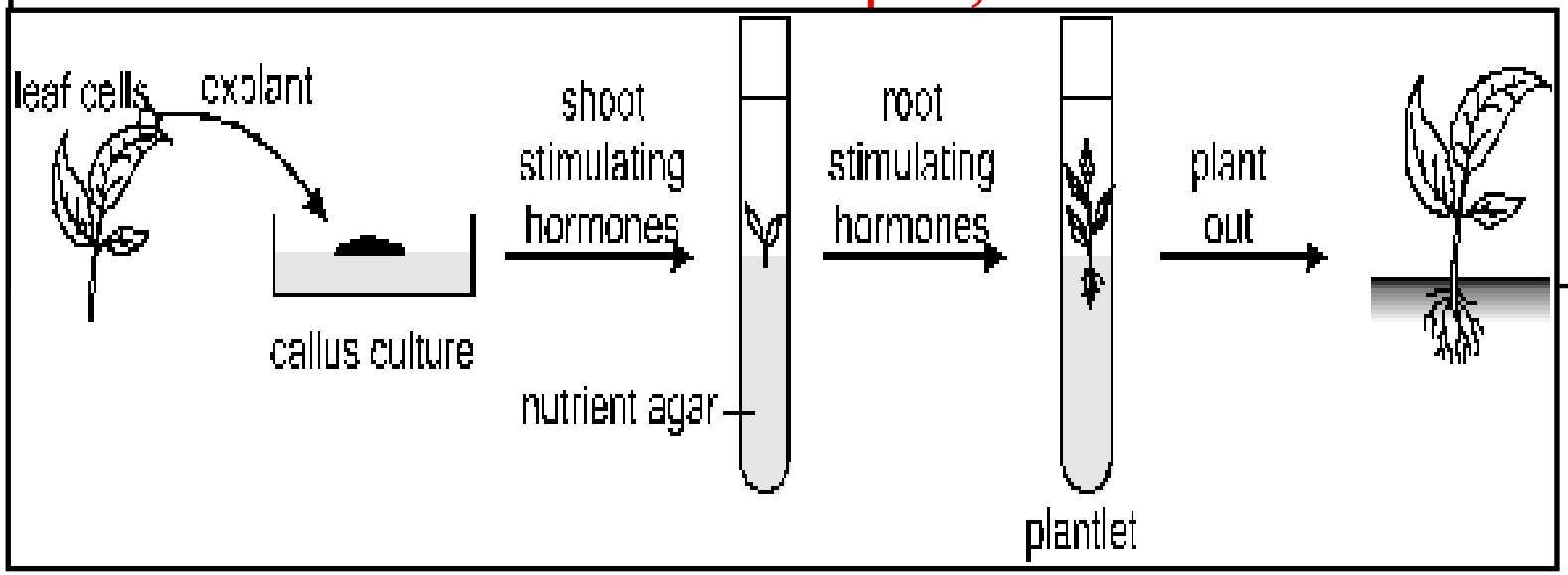
9.3.A1 Micropropagation produces large numbers of identical plants.

Sterilization, cut into pieces (**explants**).

Growth media with plant hormones. Auxin, cytokinin.

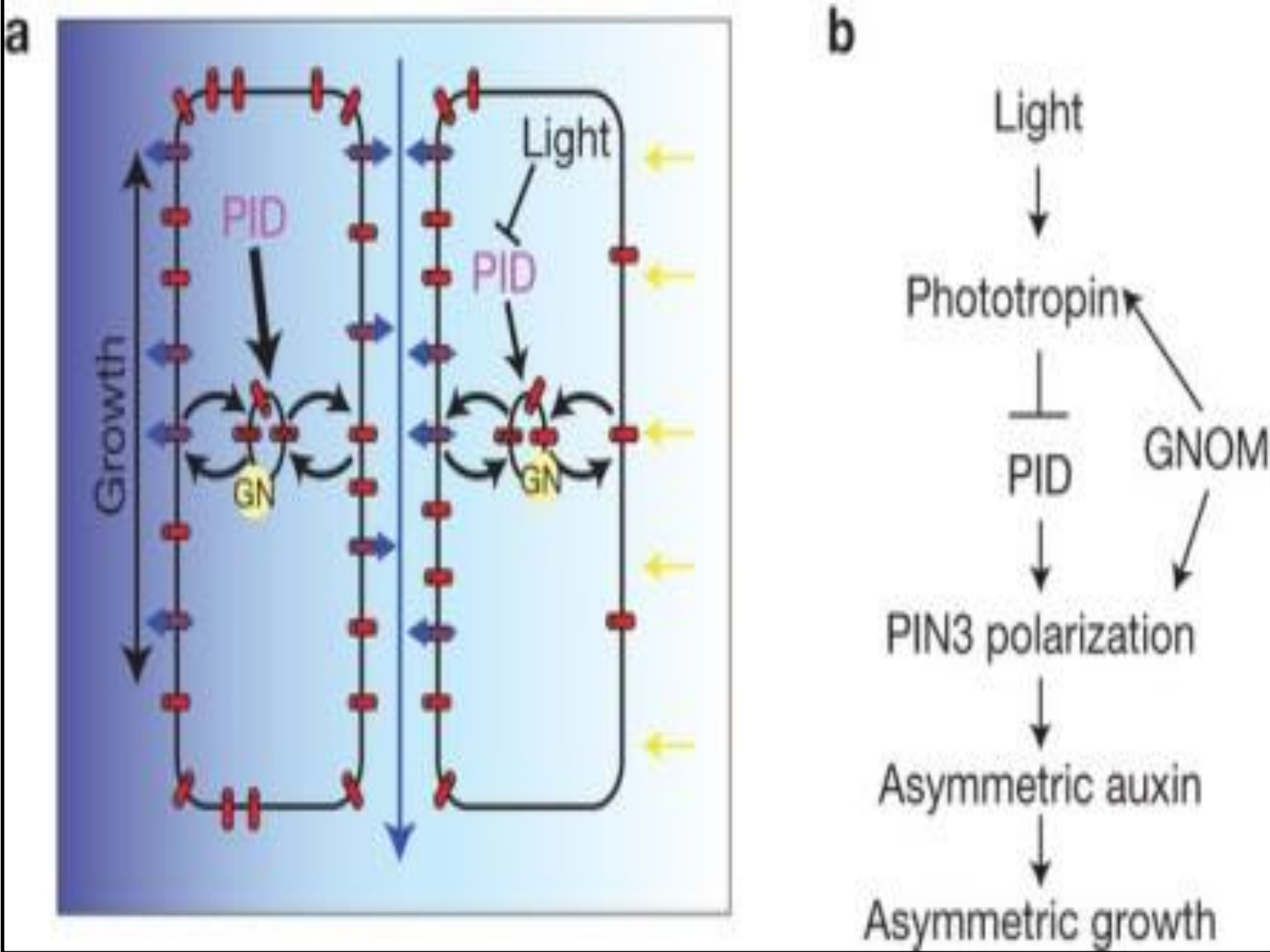
Cytokinin: promotes cell division in roots, shoots.

Roots and shoots are developed, transferred to soil.



9.3.A2 Use of micropropagation for rapid bulking up of new varieties, production of virus-free strains of existing varieties and propagation of orchids and other rare species.

Light perception initiates auxin redistribution that leads to directional growth. Light polarizes the cellular localization of the auxin efflux carrier PIN3 proteins, resulting in changes in auxin distribution and differential growth.


a
Light
PID
PID
Growth
GN
GN
b
Light
Phototropin
PID
GNOM
PIN3 polarization
Asymmetric auxin
Asymmetric growth

9.4 Reproduction in plants

9.4.U1 Flowering involves a change in gene expression in shoot apex.

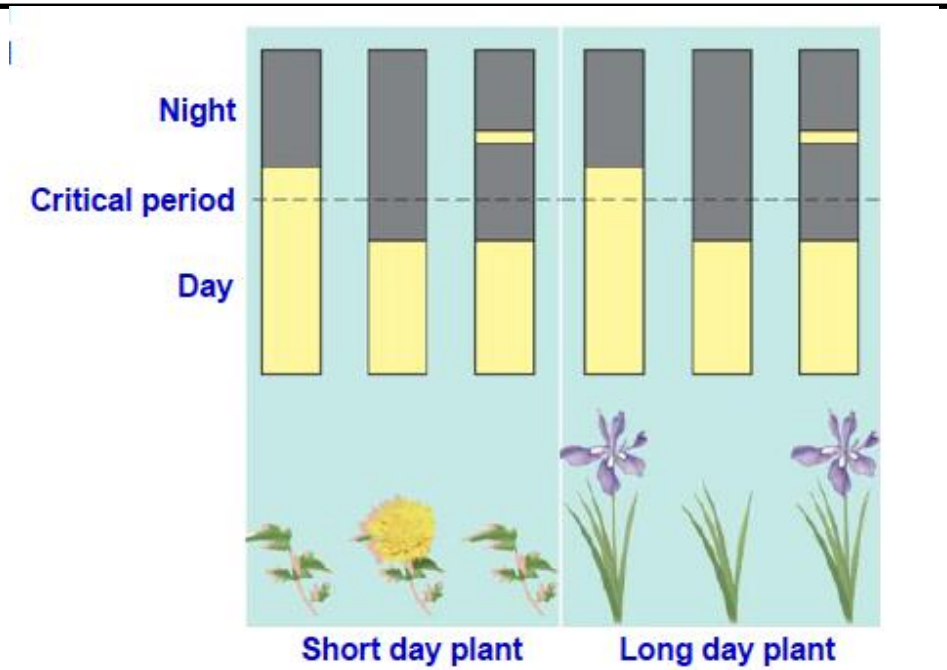
Vegetative phase, reproductive phase.

9.4.U2 Flowers are produced by the shoot apical meristem.

The length of the dark period is the main trigger.

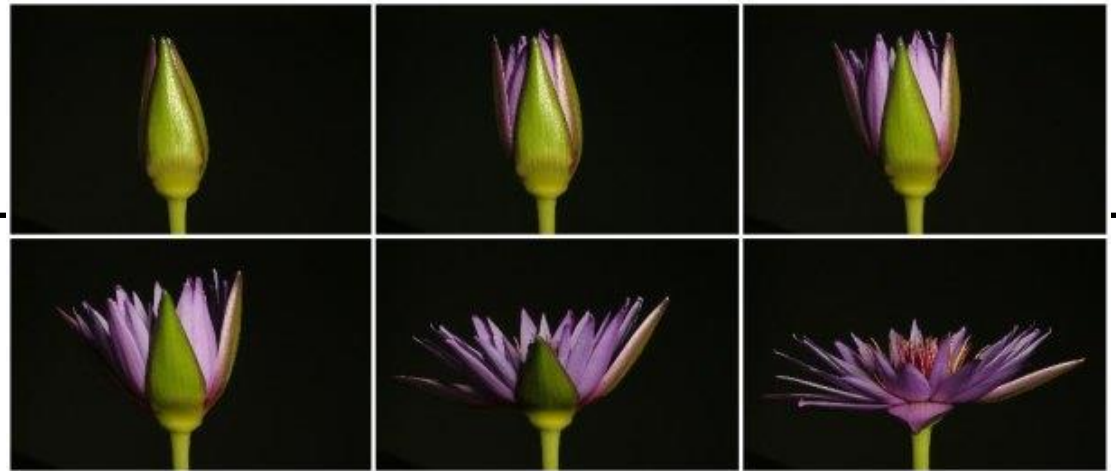
Long-day plants, flower after short dark period. (midsummer)

Short-day plants, flower after long dark period. (Spring, fall)



Flowering Cues

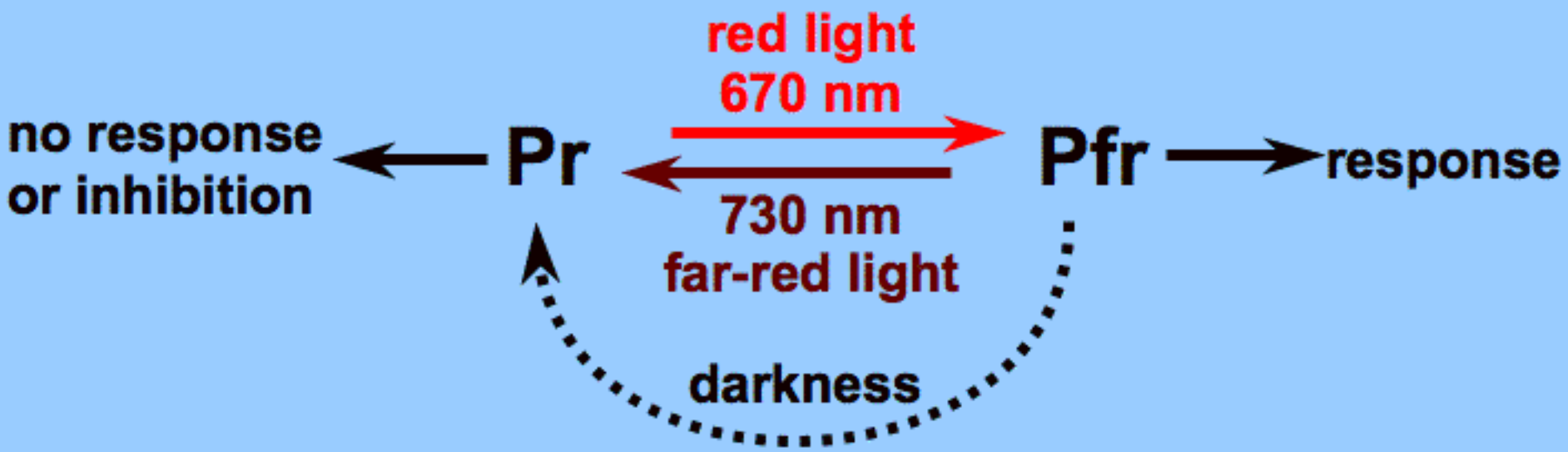
Plants have to coordinate the production of flowers to coincide with the best reproductive opportunities. The photoperiod, the period of day light in relation to dark (night), is the most reliable indicator on 'time' of year.



Phytochrome System

The receptor of photoperiod is located within the leaf. The chemical nature of the receptor is the molecule **phytochrome**. Phytochrome can be converted from one form to another by different types of light.

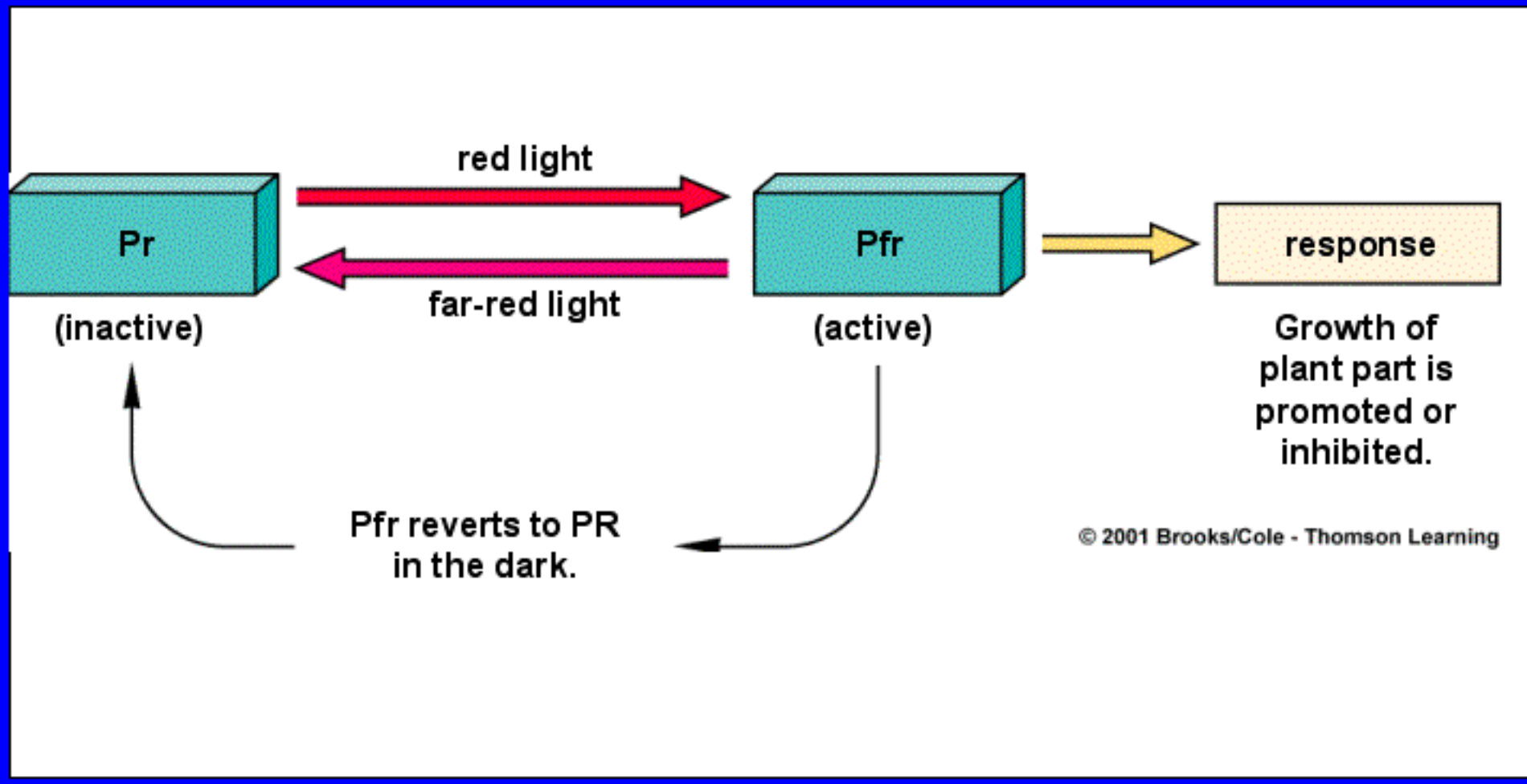
Phytochrome is a Pigment with Two interconvertible forms
The two forms elicit different responses



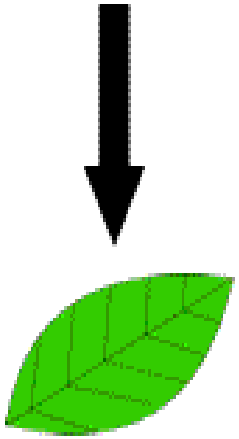
Be sure you understand the difference between red and far-red light and the two different forms of phytochrome!

Be sure you understand which form of phytochrome is present when red or far-red light is on!

Interconversion of Phytochrome



Light

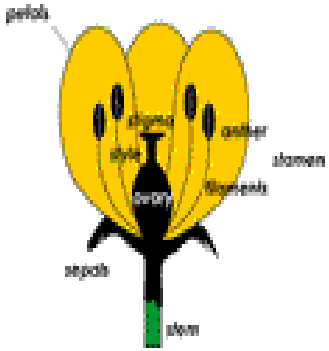


Phytochromes

Pr $\underset{\text{far red}}{\overset{\text{white/ red}}{\rightleftarrows}}$ Pfr

Dark

Flowering



SDP

Long night critical/ Low conc Pfr

LDP

Short night critical/ High Pfr

Link to genes

Hormone / Florigen

2005 FTmRNA

In LDP there remains a higher concentration of P_{FR}, high P_{FR} concentration is the trigger for flowering.

A long night means that there is a long time for the conversion. Under short day conditions at the end of the night period the concentration of P_{FR} is low. In SDP, low P_{FR} concentration is the trigger for flowering.

Flowering in LDP

Long day plants flower when the night period is short. In day light the P_r is converted to P_{FR}. During periods when the day light period is long but critically the dark period is short, P_{FR} does not have long to breakdown in the dark.

9.4.U3 Success in plant reproduction depends on pollination, fertilization and seed dispersal.

Pollination: is the transfer of pollen from an anther to a stigma.

Fertilization: a zygote is formed by the fusion of a male gamete (in the pollen grain) with a female gamete inside the ovule.

Seed dispersal: the seeds provide the plants with a way to spread out and grow in new places. This is important because if the seeds are not dispersed, many germinating seedlings will grow very close to the parent plant. This results in competition between the seedlings as well as with the parent plant.

9.4.U4 Most flowering plants use mutualistic relationships with pollinators in sexual reproduction.

Pollinators including: birds, bats and insects.

Mutualism: both organisms benefit from the relationship.

Pollinators: gain food (nectar).

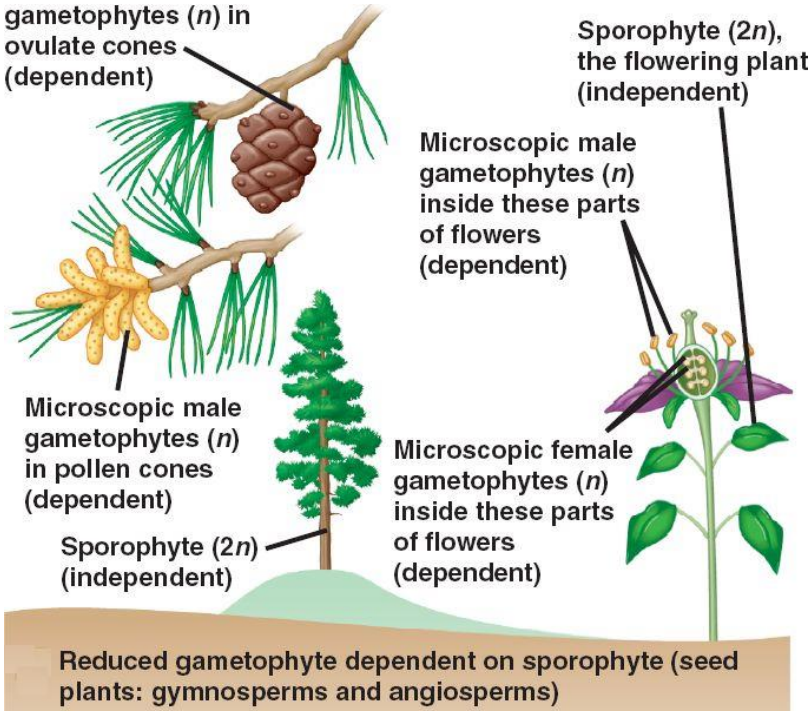
Plant: gains a means to transfer pollen

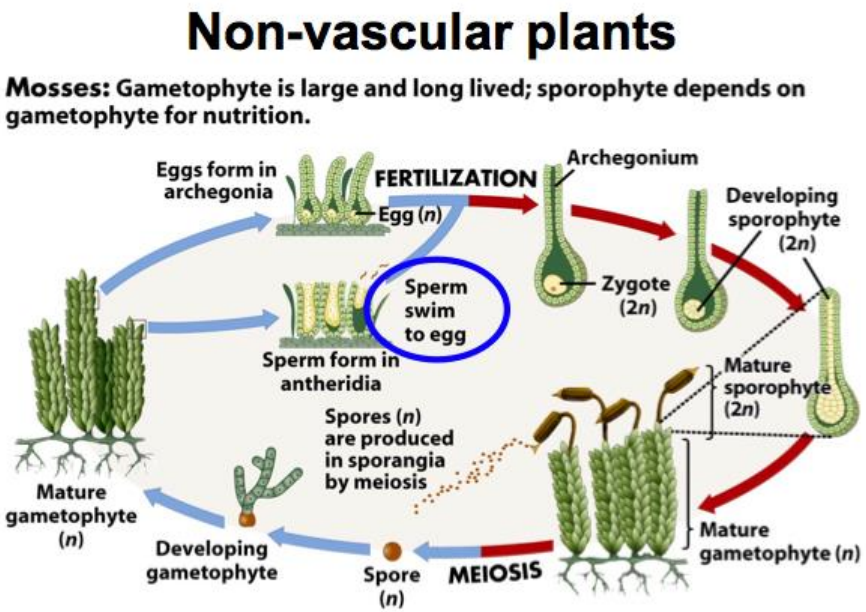
Application

9.4.A1 Methods used to induce short-day plants to flower out of season.

Growers can manipulate the length of the days and nights to force flowering.

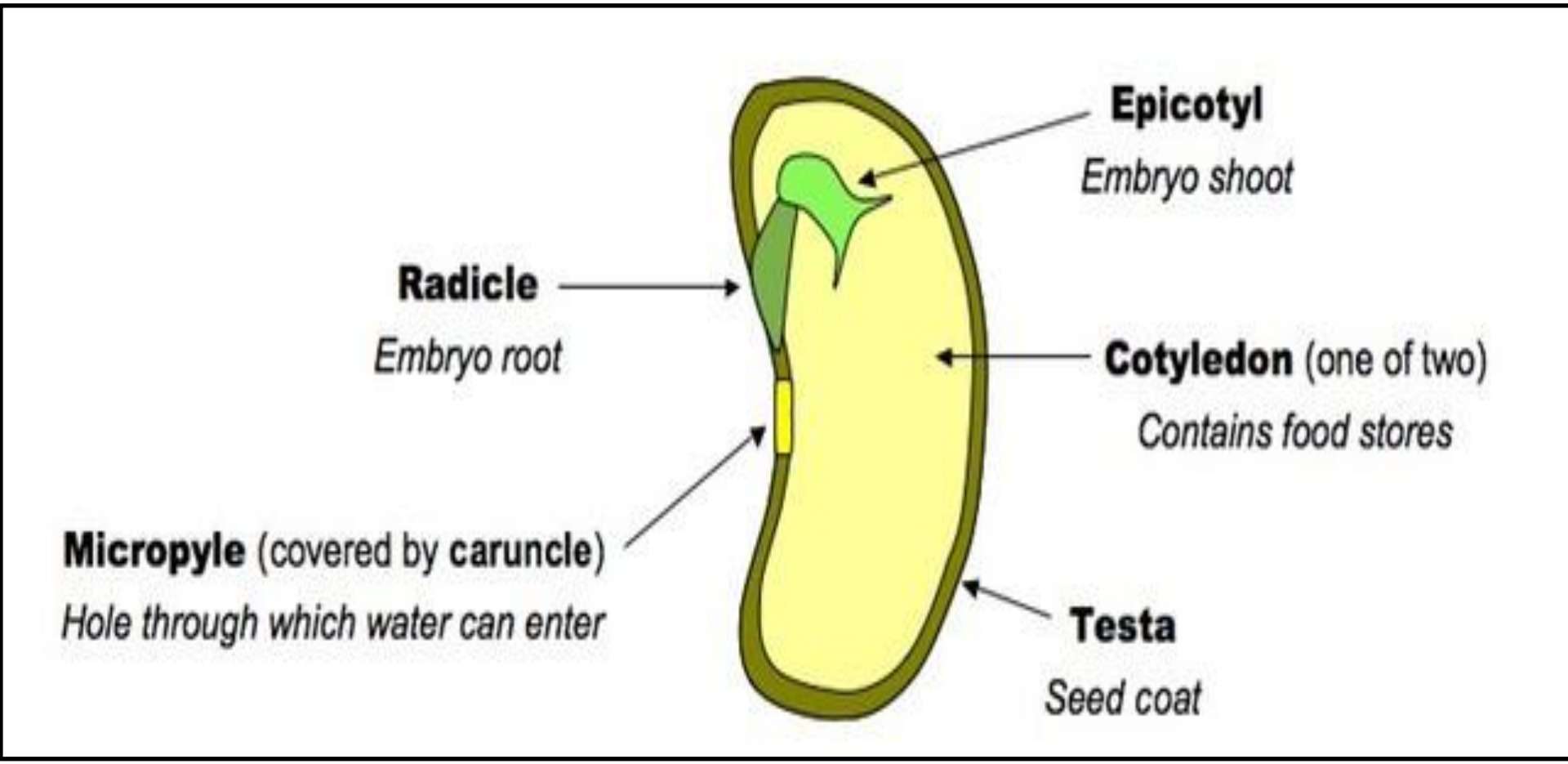
Sporophytes (2n) vs gametophytes (n)

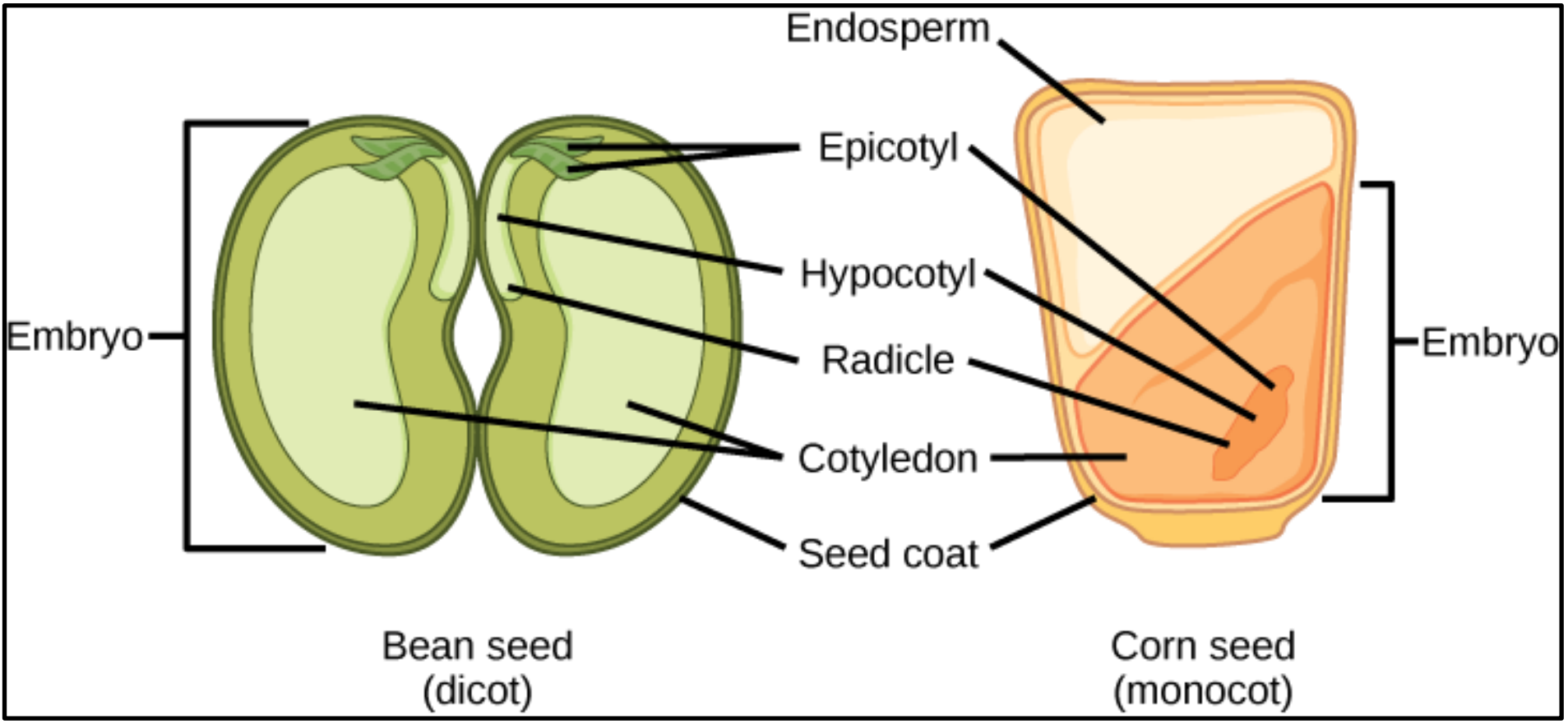




Skills

Drawing internal structure of seeds.


Epicotyl
Embryo shoot
Radicle
Embryo root
Cotyledon (one of two)
Contains food stores
Micropyle (covered by caruncle)
Hole through which water can enter
Testa
Seed coat


Endosperm
Epicotyl
Hypocotyl
Radicle
Cotyledon
Seed coat
Embryo
Embryo
Bean seed
(dicot)
Corn seed
(monocot)

a) **Testa** protects the plant embryo and the cotyledon food stores.

b) **Radicle** is the embryonic root.

c) **Plumule** is the embryonic stem.

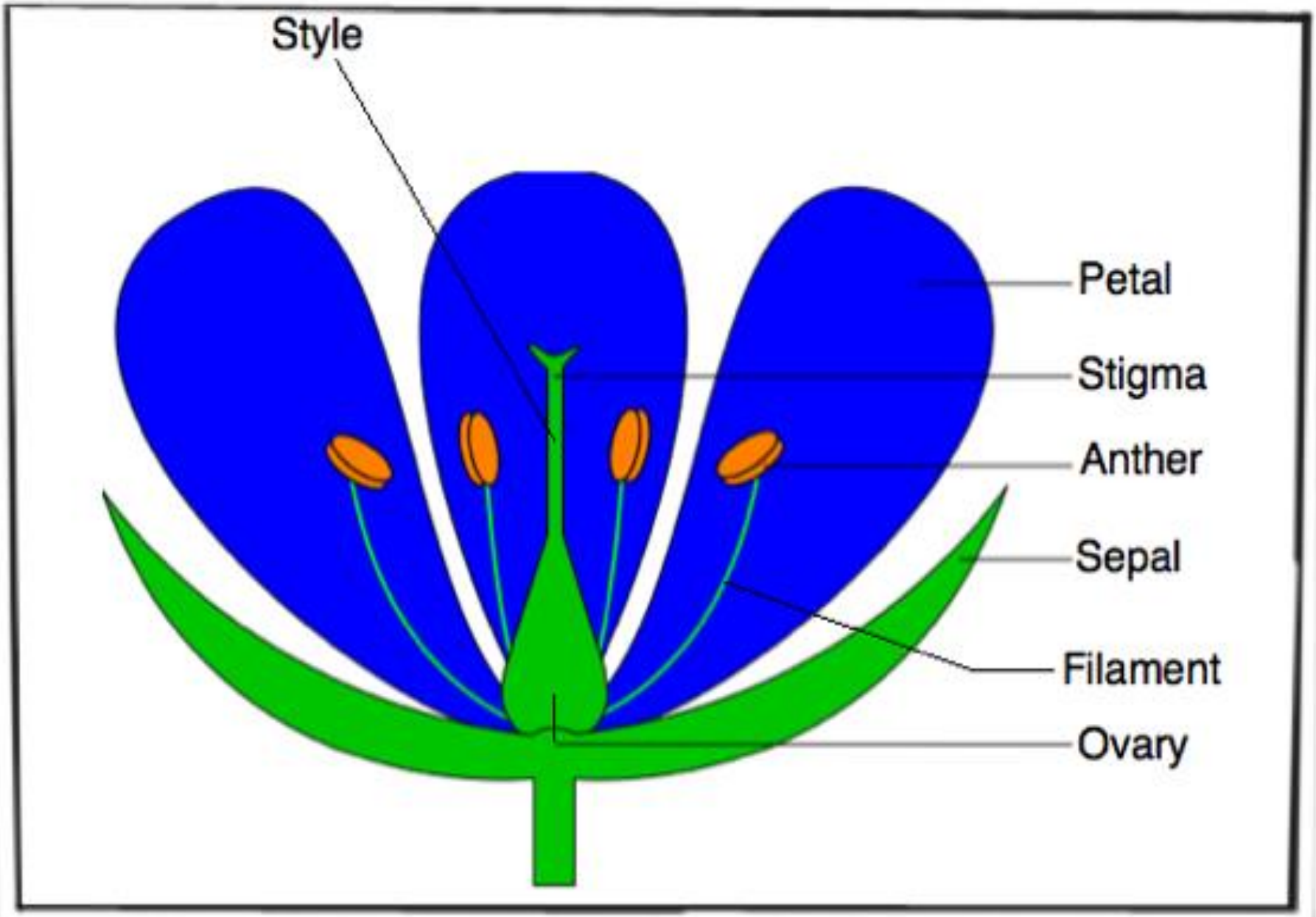
c) **Plumule** is the embryonic stem.

d) **Cotyledon**s contain food store for the seed.

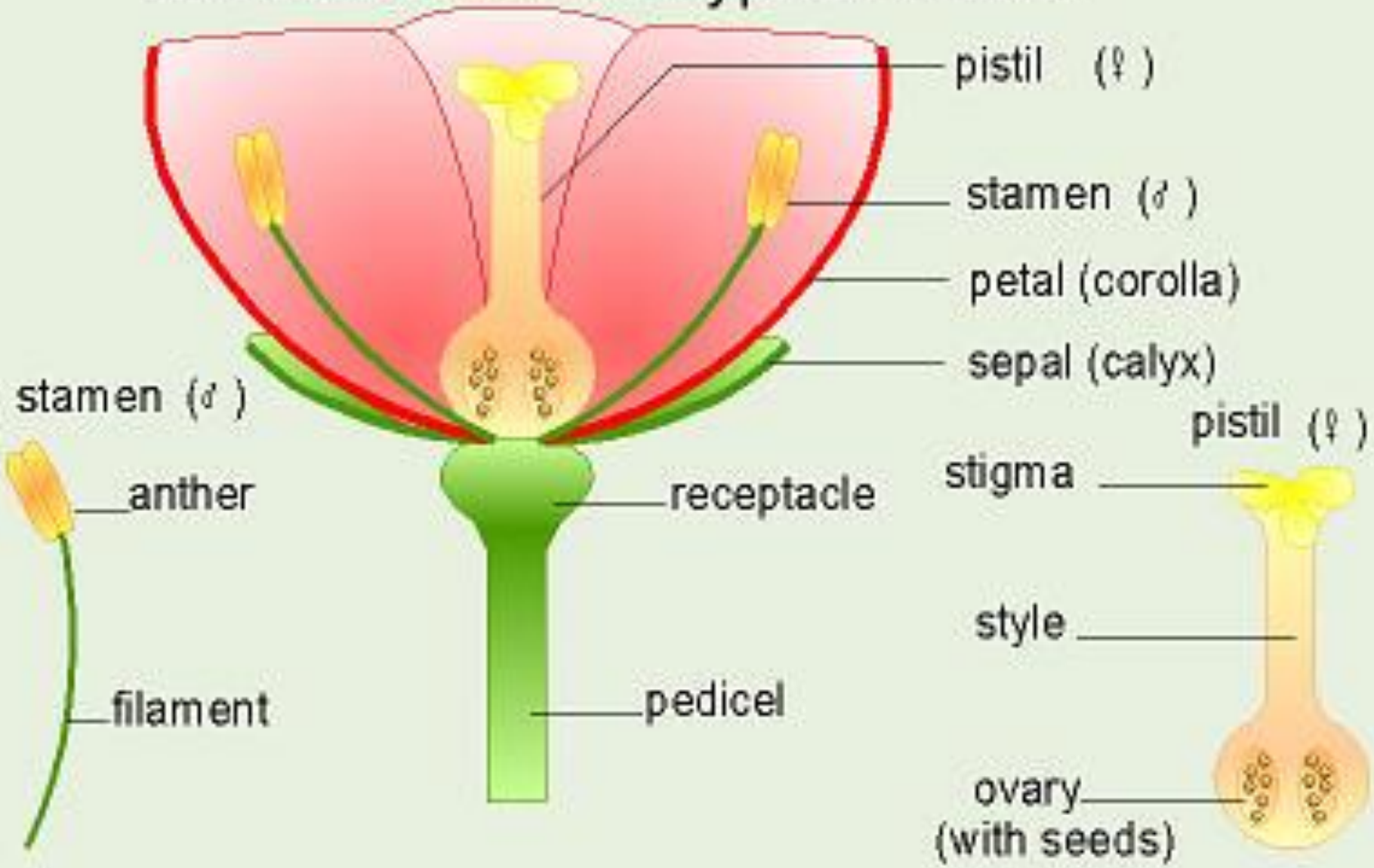
e) **Micropyle** is a hole in the testa through which water can enter the seed prior to germination.

Skills

Drawing of half-views of animal-pollinated flowers.


Style
Petal
Stigma
Anther
Sepal
Filament
Ovary

ANGIOSPERM FLOWERS
Cross Section of Typical Flower



Skills

Design of experiments to test hypotheses about factors affecting germination.

Every seed needs a combination of **oxygen** for aerobic respiration, **water** to metabolically activate the cells, **temperature** for optimal function of enzymes.

Long-day plants

Active phytochrome P_{FR} → binds to receptor protein → transcription of FT gene → FT mRNA to shoot apical meristem → FT protein → binds to transcription factor → activation of many flowering genes → leaf-producing apical meristem turns to a reproductive meristem

Flowering in SDP

Short day plants flower when the night period is long. In day light, Phytochrome Red (P_R) is converted to Phytochrome Far Red (P_{FR}). The conversion requires a brief exposure to white or red light. In the dark, P_{FR} is slowly converted back to P_R.

Short-day plants

Active phytochrome P_{FR} bound to receptor protein → inhibition of transcription of FT gene

After a long night → little P_{FR} remains → inhibition fails → activation of many flowering genes → leaf-producing apical meristem turns to a reproductive meristem