

Development of Seeds

- **First vascular plants on land had spores (ferns and mosses)**





open sori



covered sori

spores



sporangium

Development of Seeds

- **Next came seeds on cycads & gymnosperms**



Development of Seeds

- Unusual gymnosperms

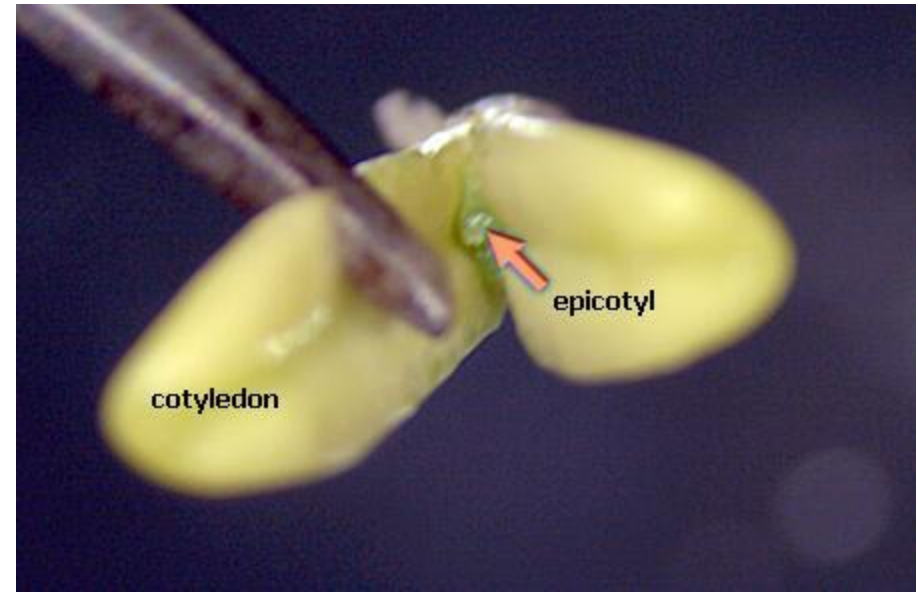
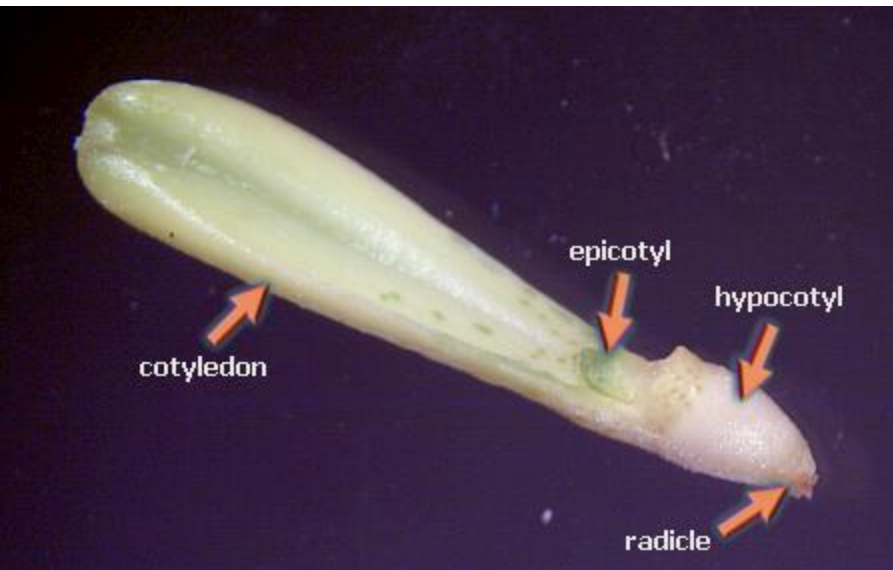
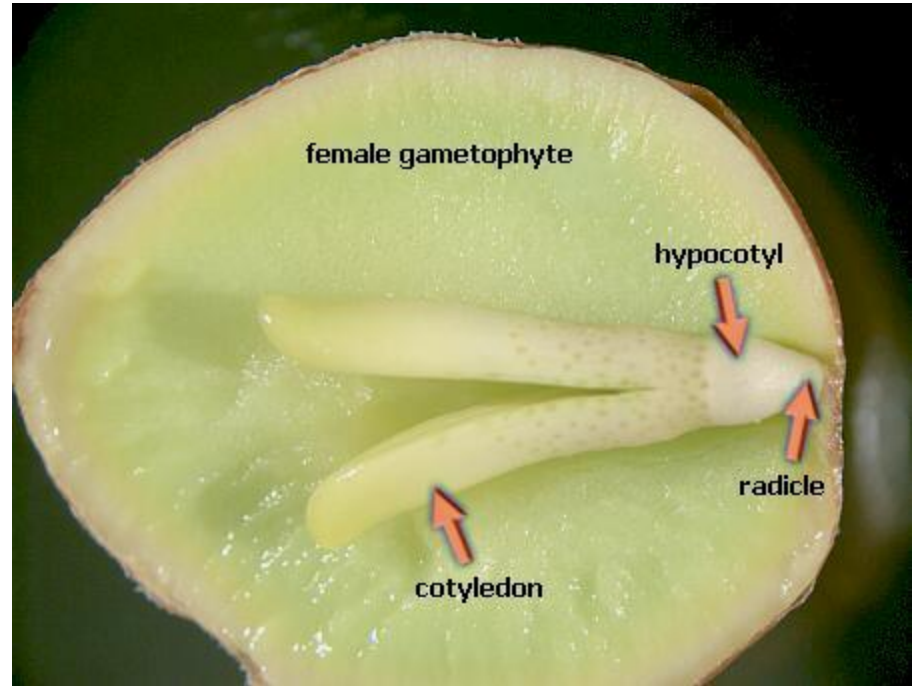


Taxus “yew” arils



Ginkgo “fruit” = fleshy seed

Ginkgo



Female



Male

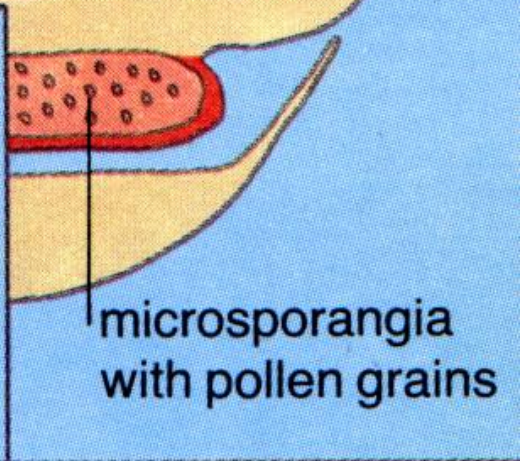
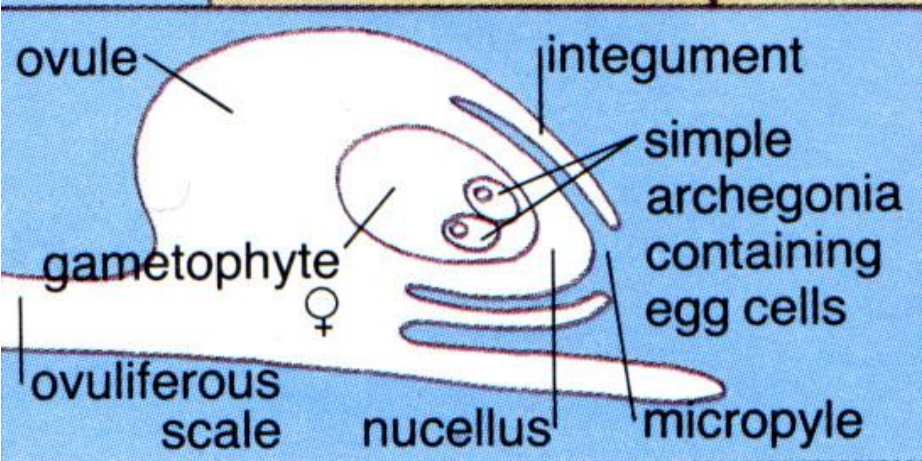
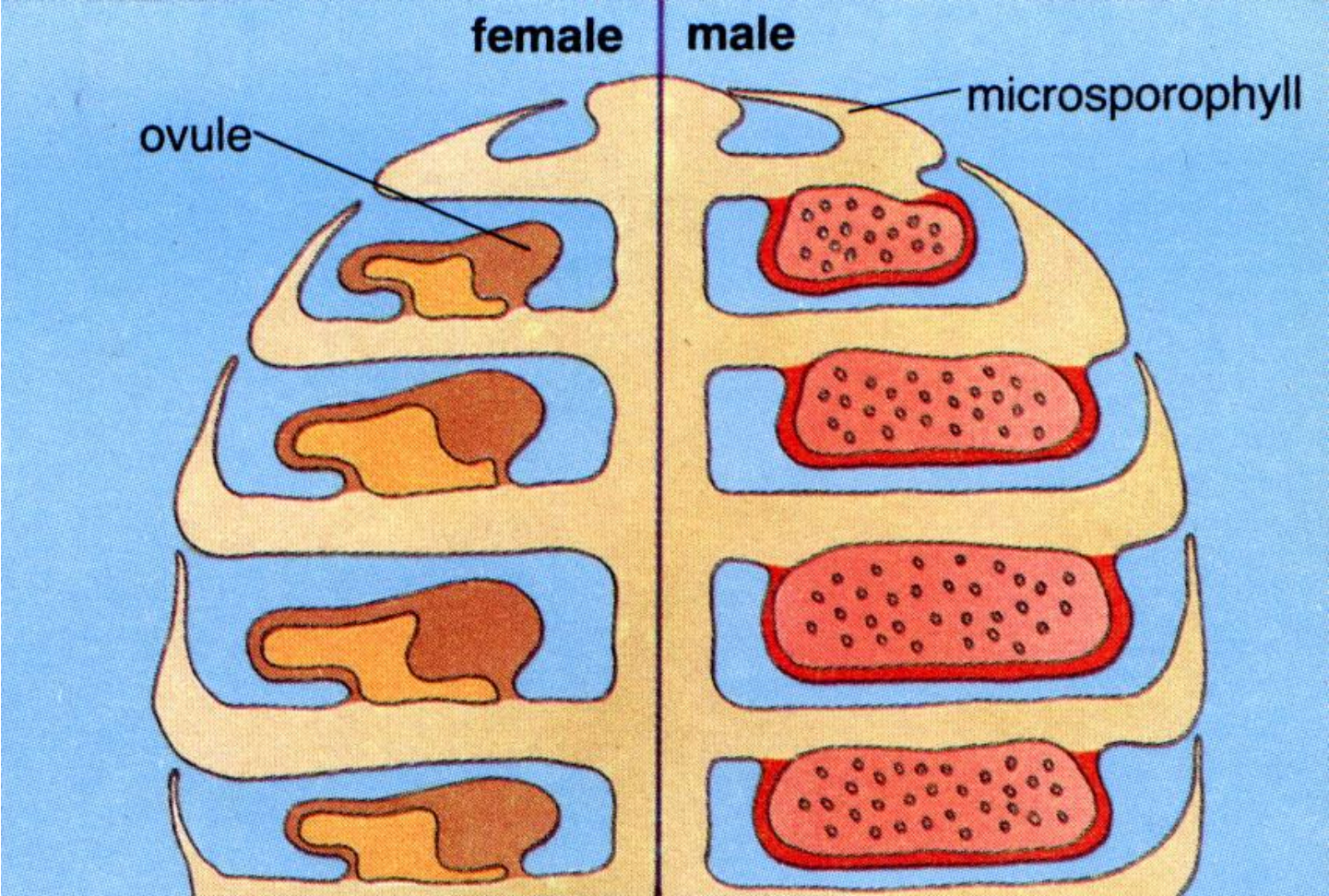


Female



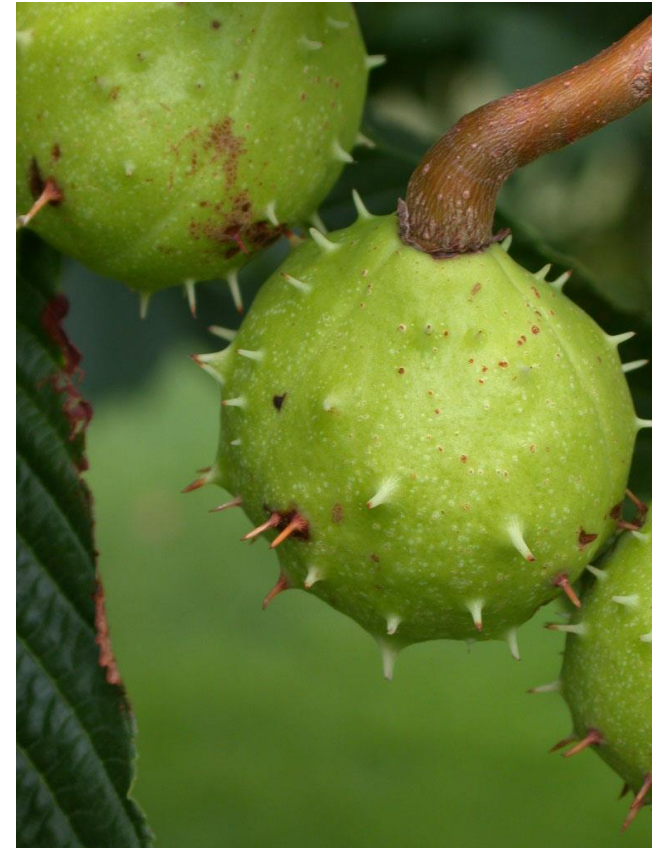
Male



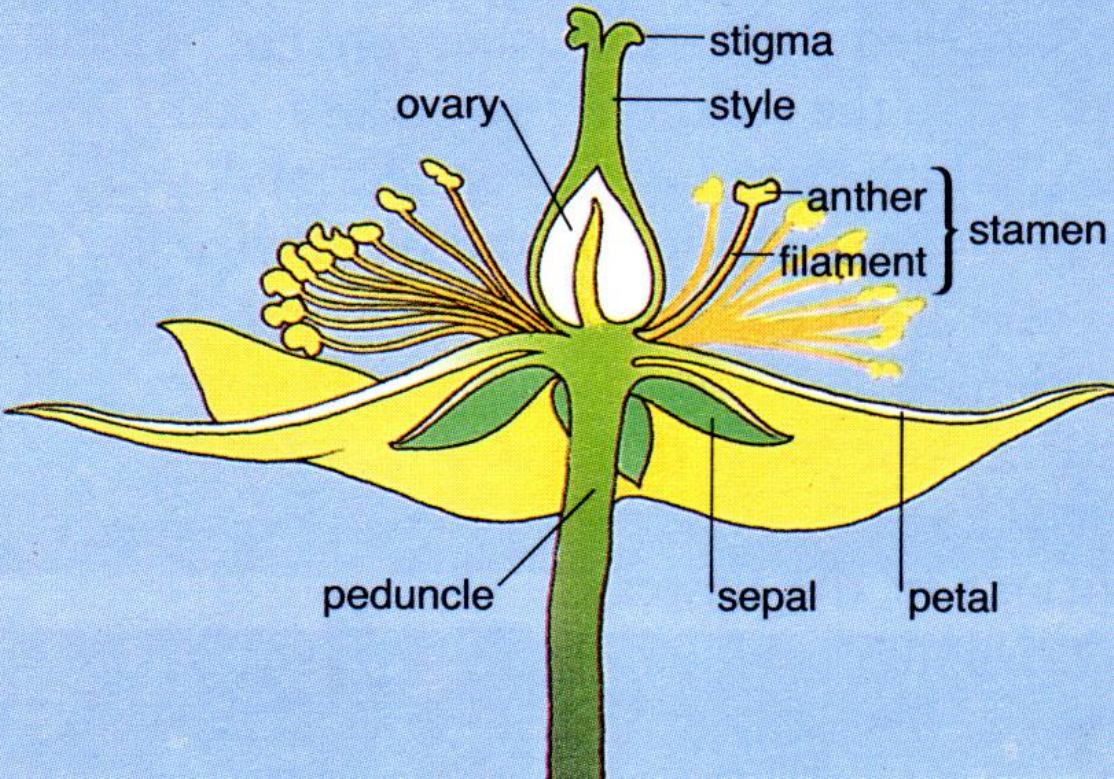


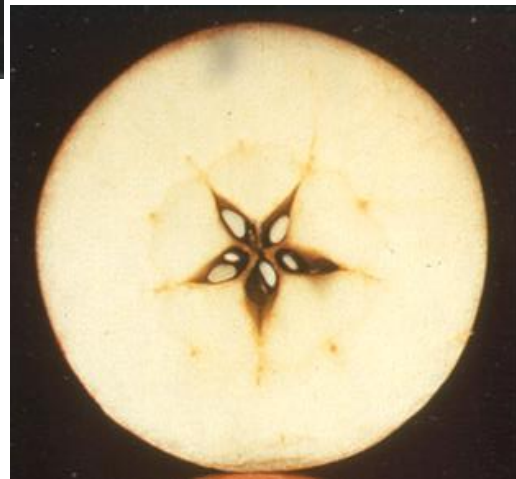
Development of Seeds

- Then seeds on angiosperms developed



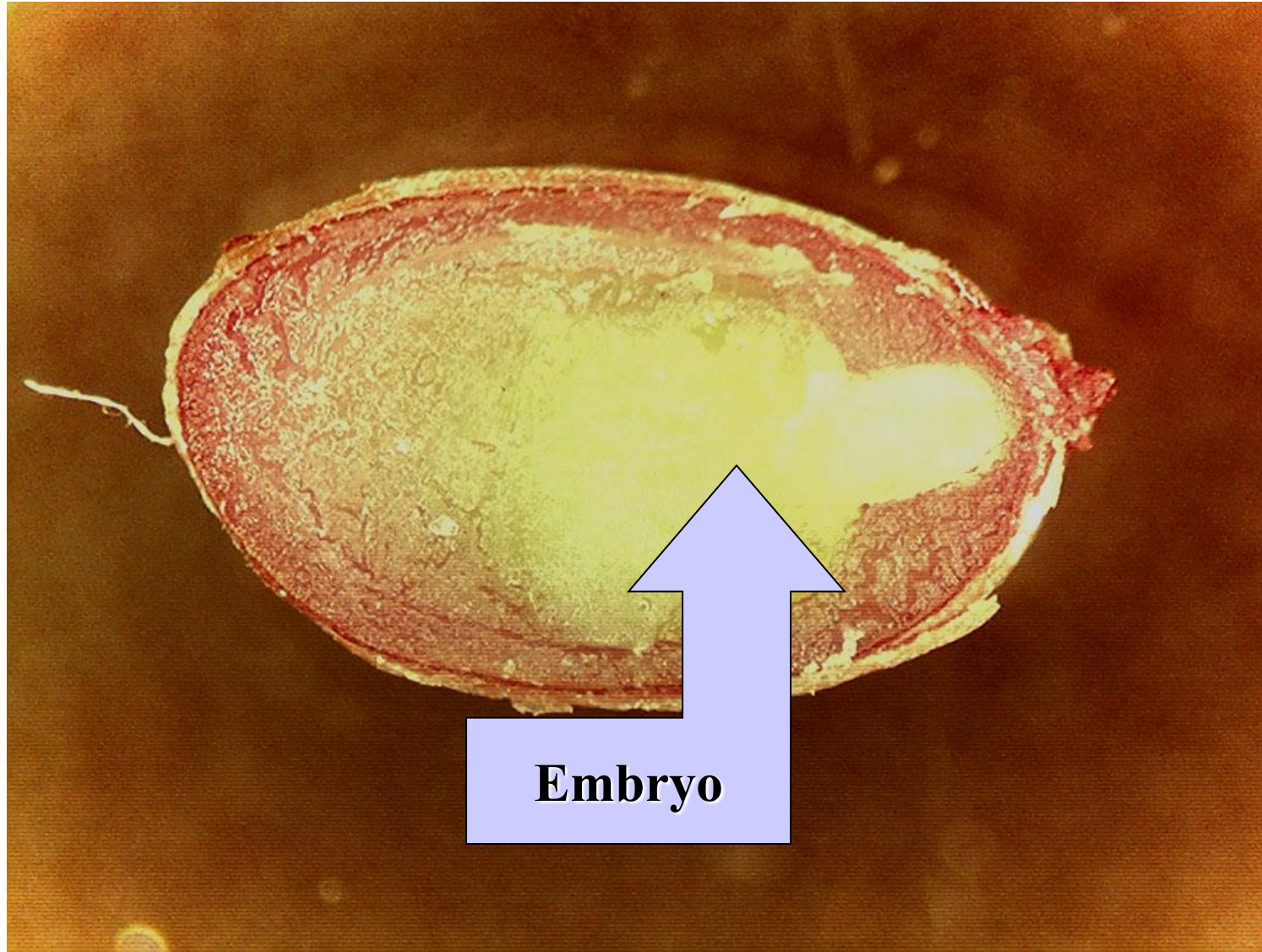
Typical angiosperm flower







Bittersweet miniature embryo

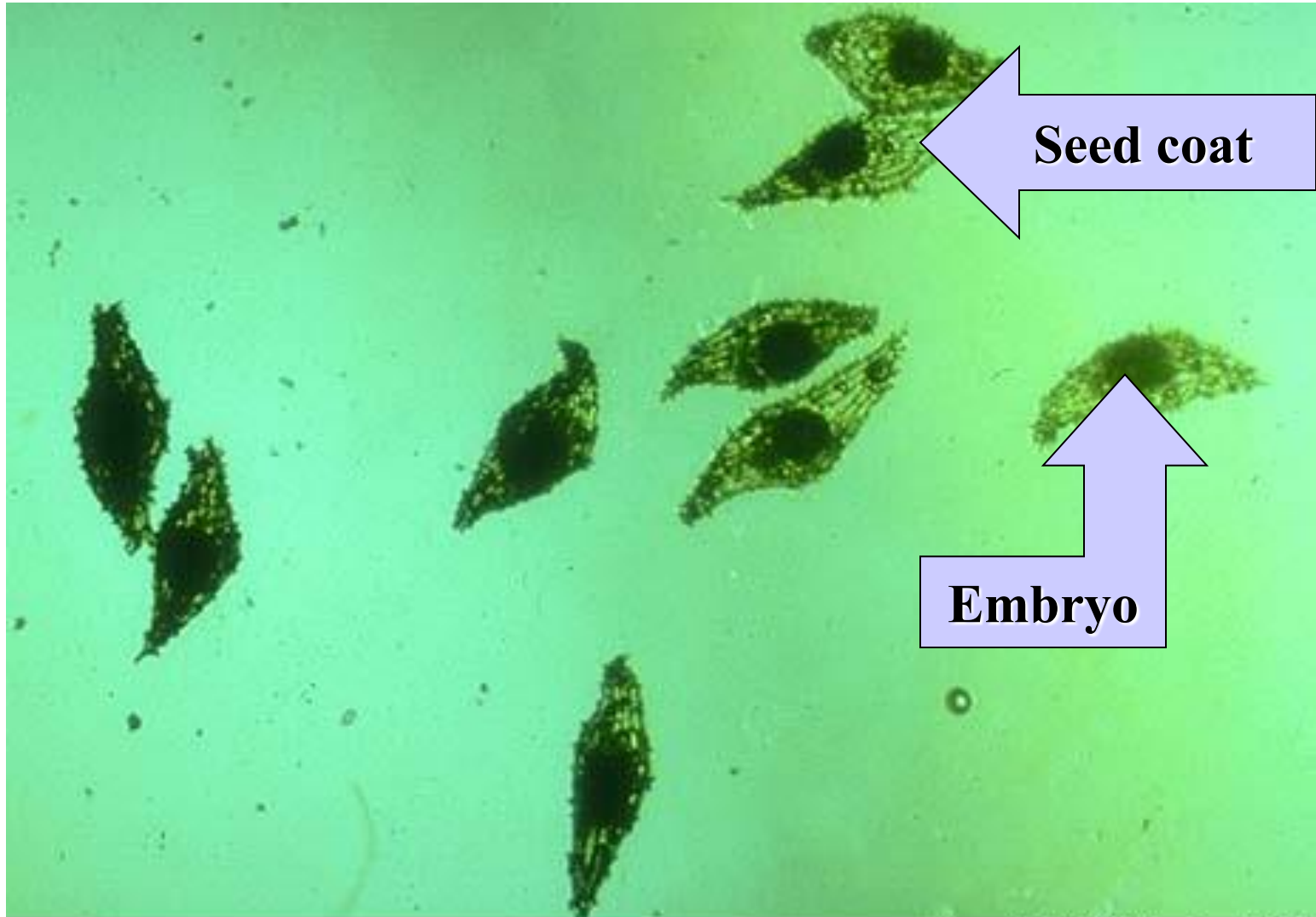


Marigold seed

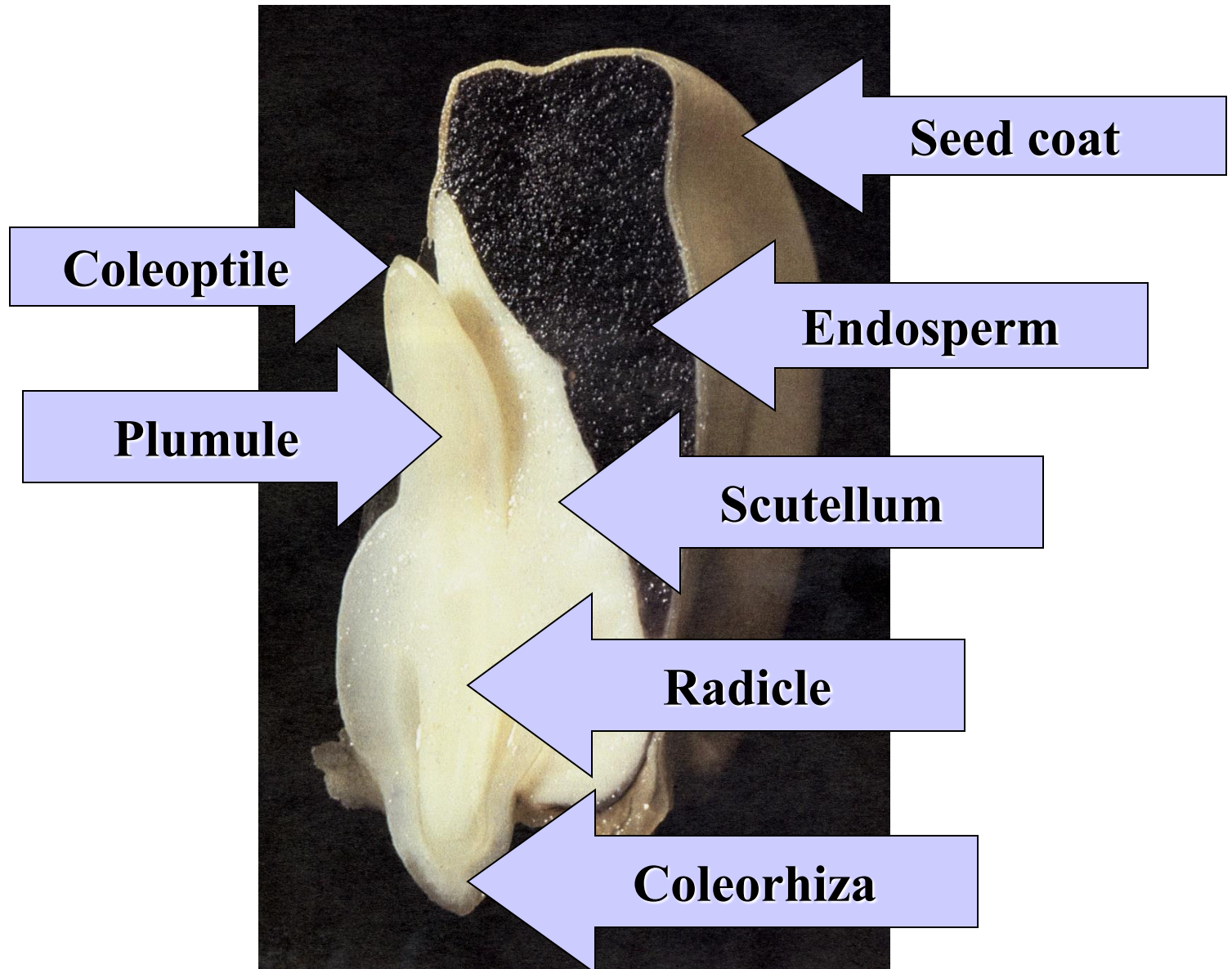




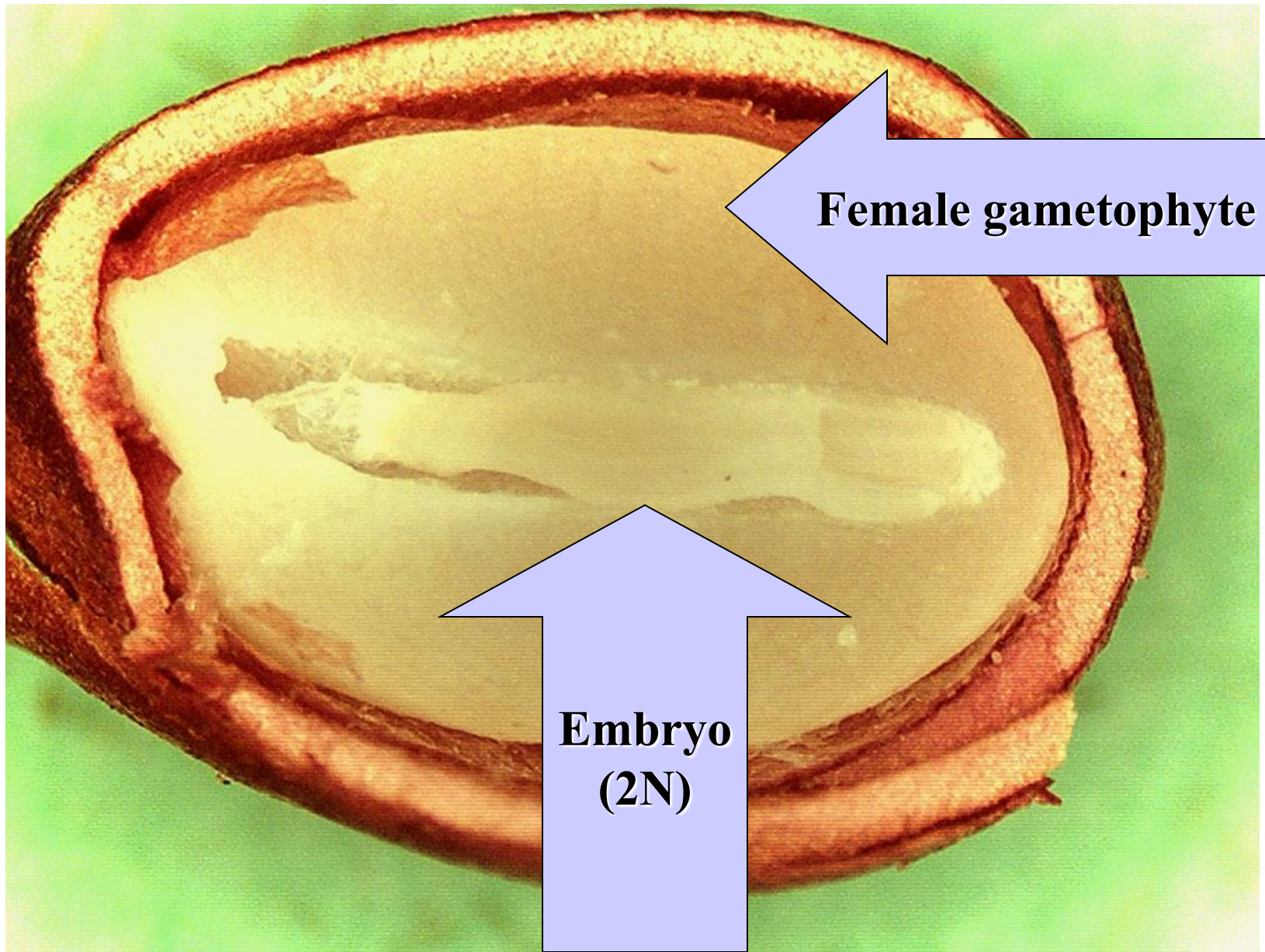
Orchid seed



Corn seed



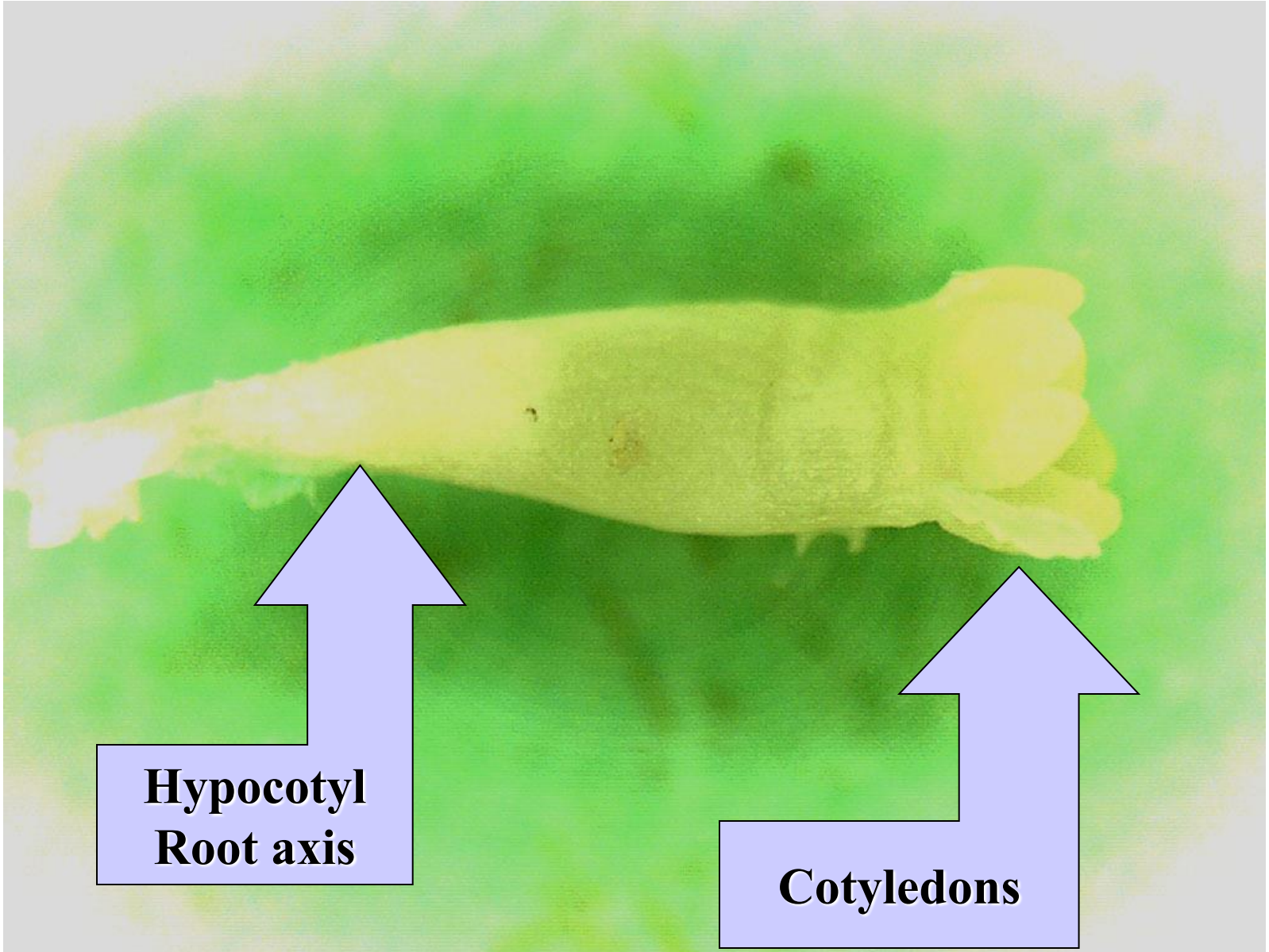
Pine seed



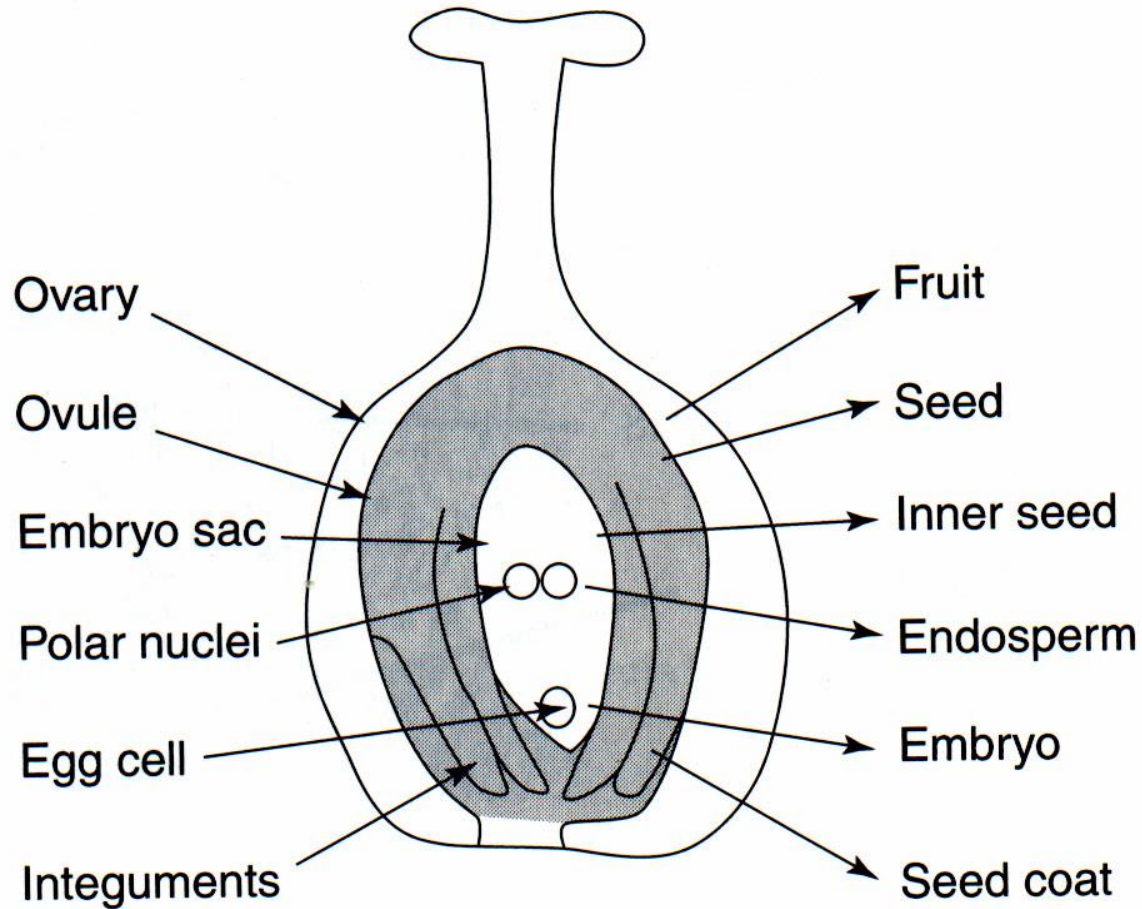
Female gametophyte (1N)

**Embryo
(2N)**

Pine seed

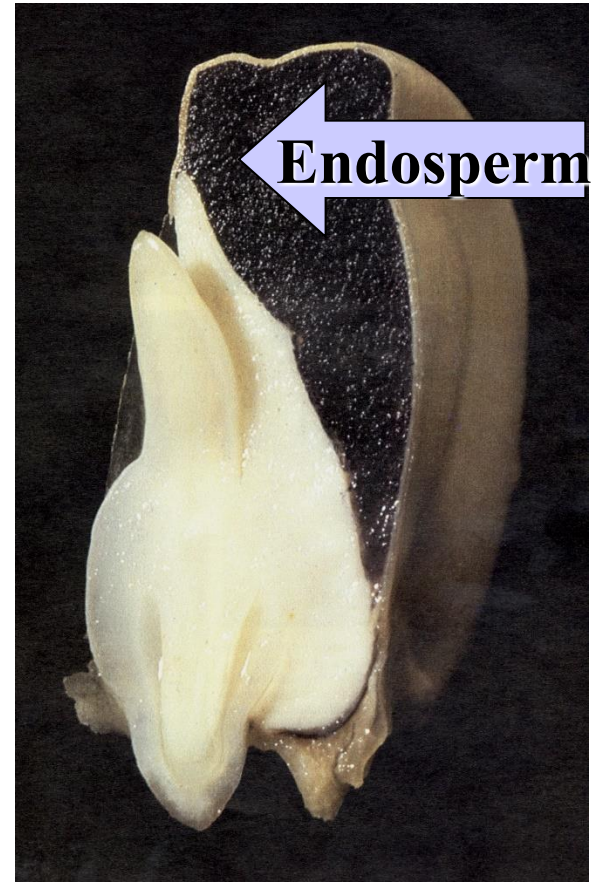


Development of Seeds



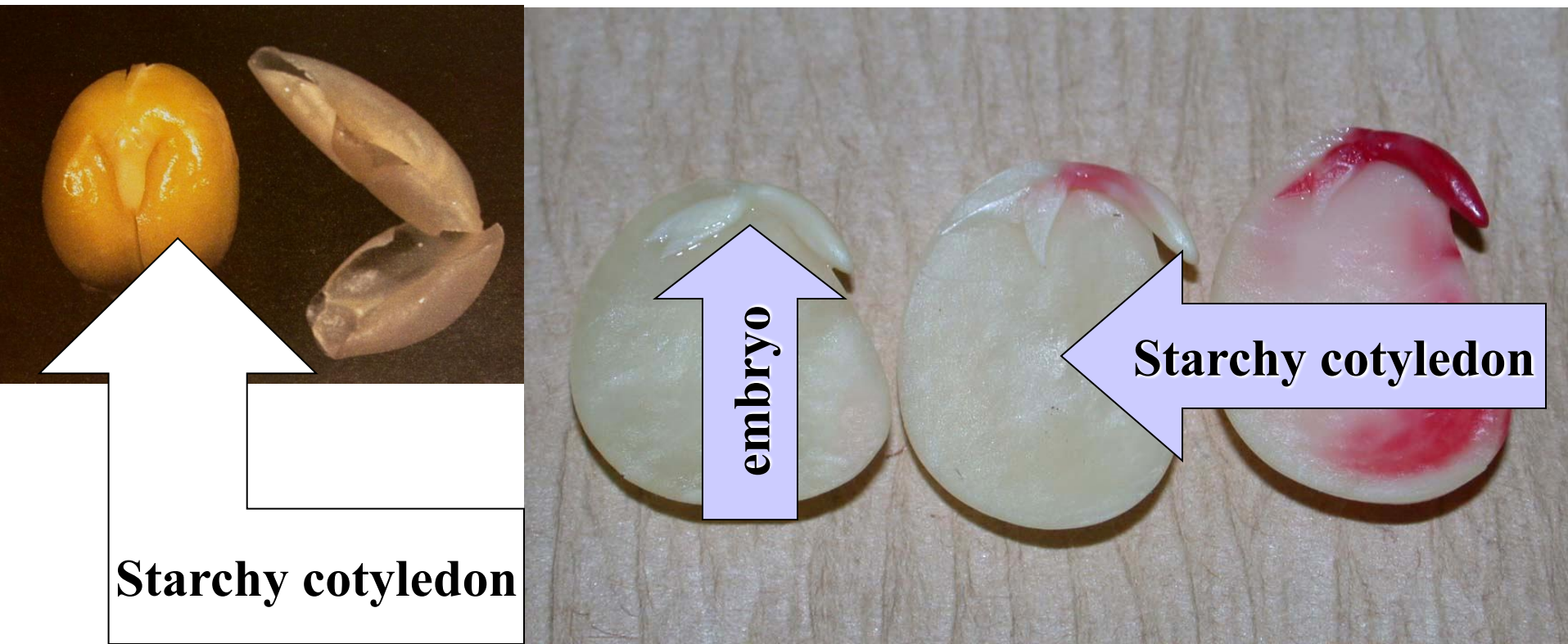
Development of Seeds

- **Storage tissues**
 - **Monocots = starchy endosperm**



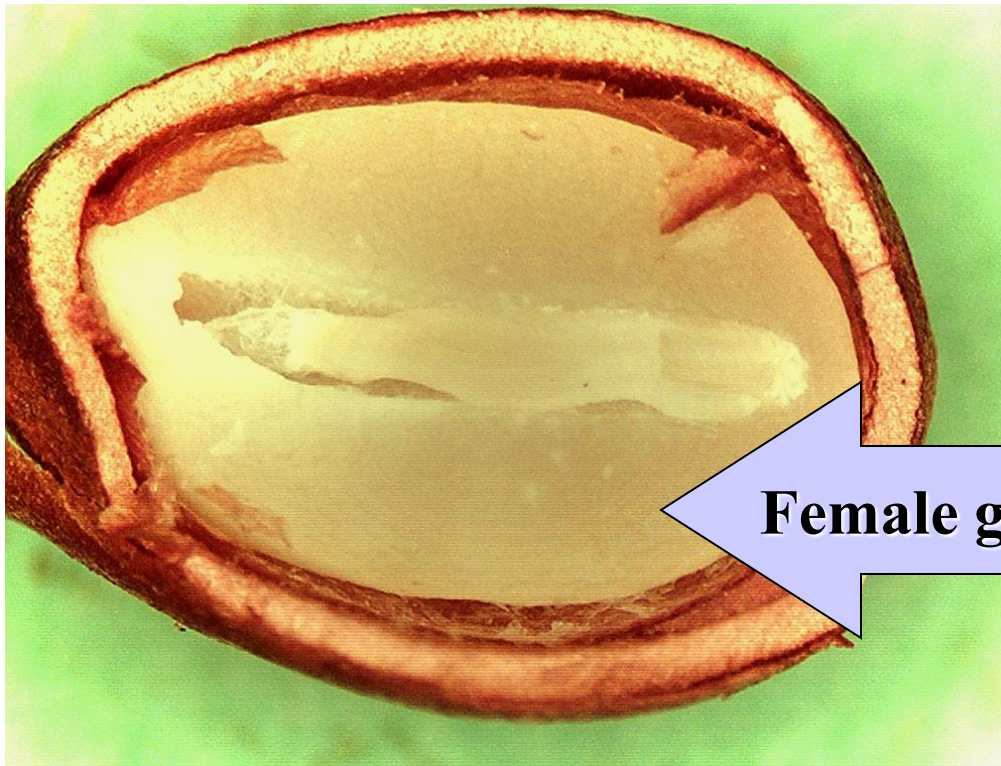
Development of Seeds

- **Storage tissues**
 - **Dicots = cotyledons and little or no endosperm**



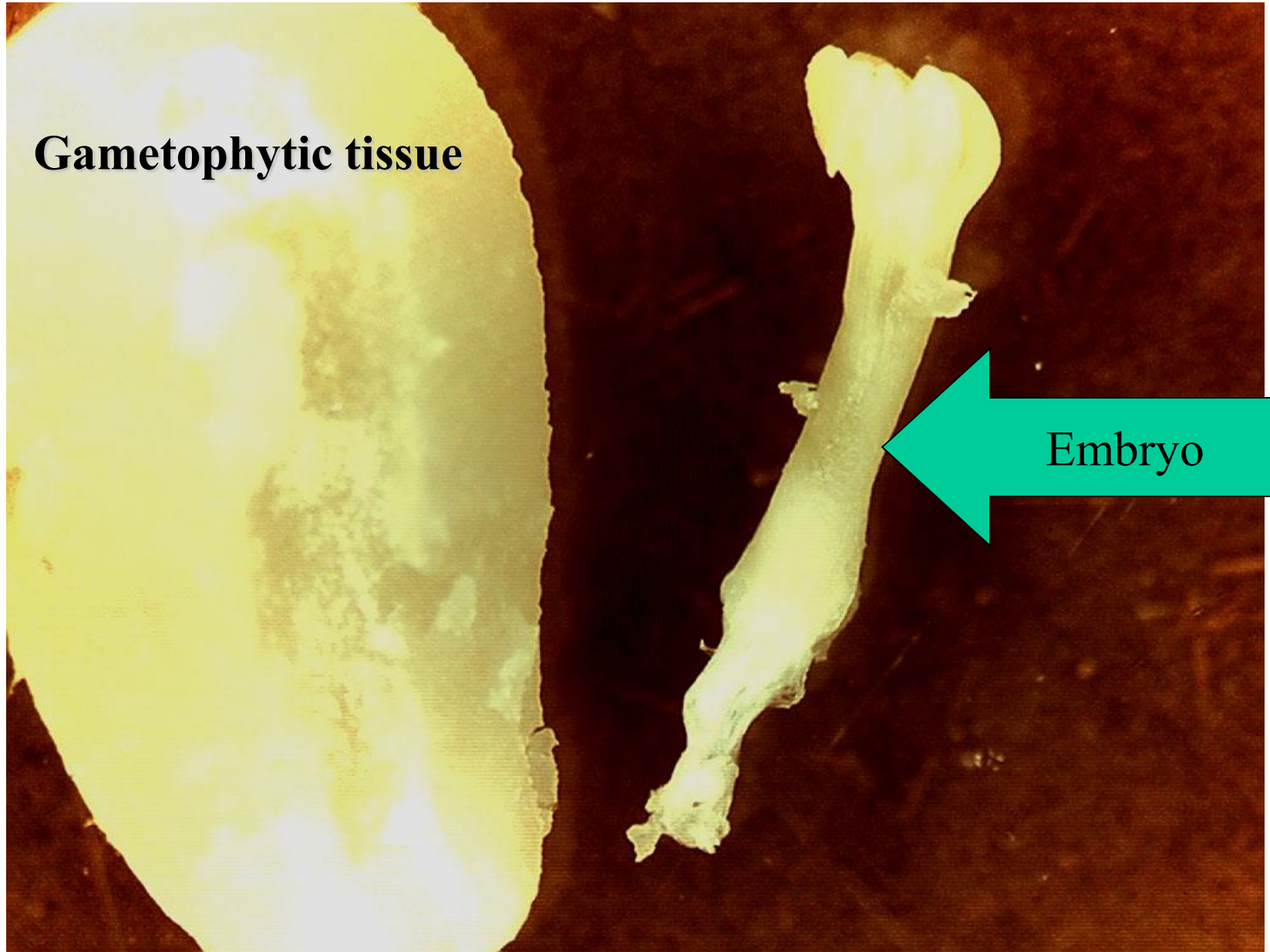
Development of Seeds

- **Storage tissues**
 - **Gymnosperms = haploid (1N) gametophytic tissue**



Female gametophyte (1N)

Pine seed

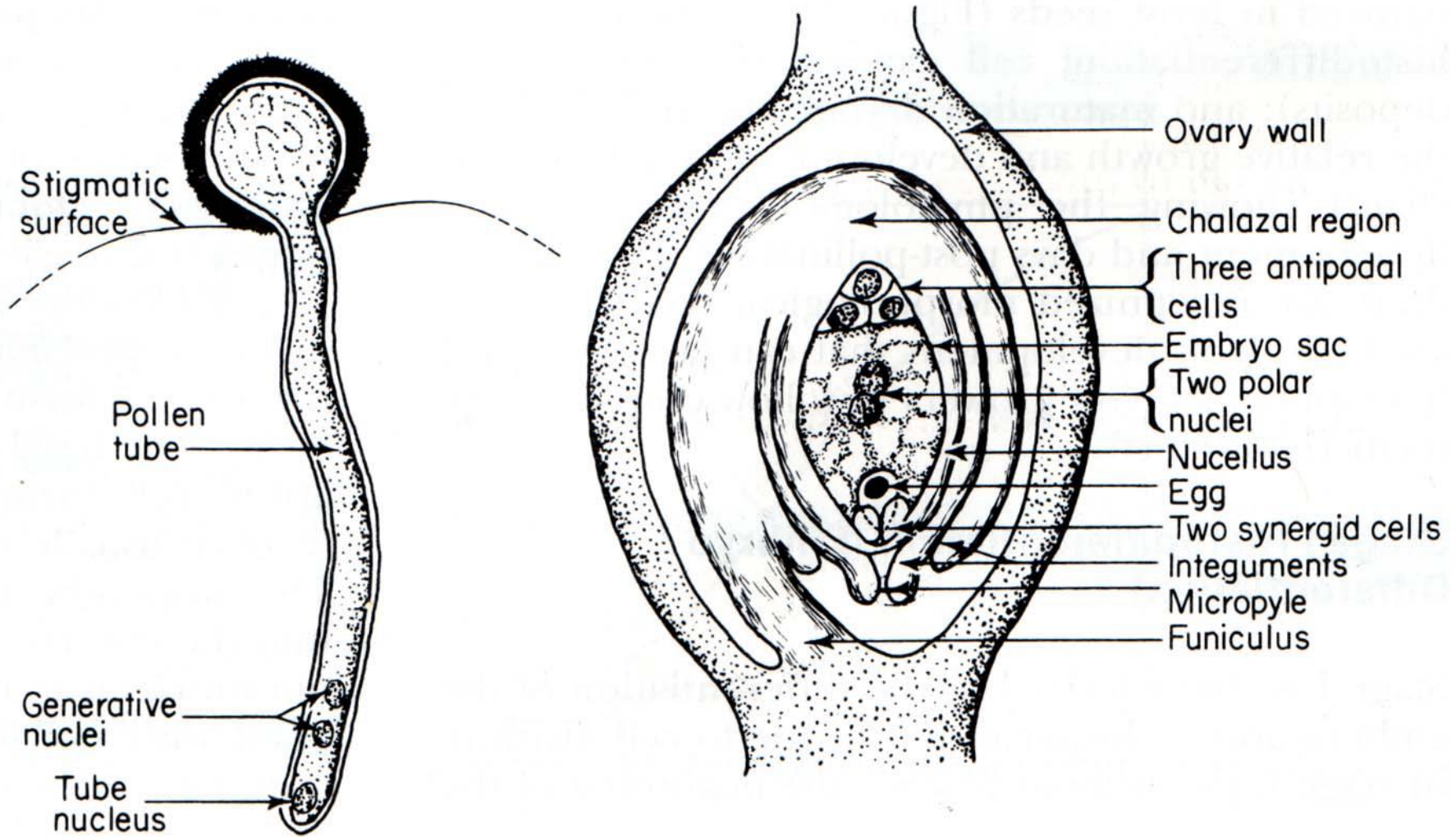


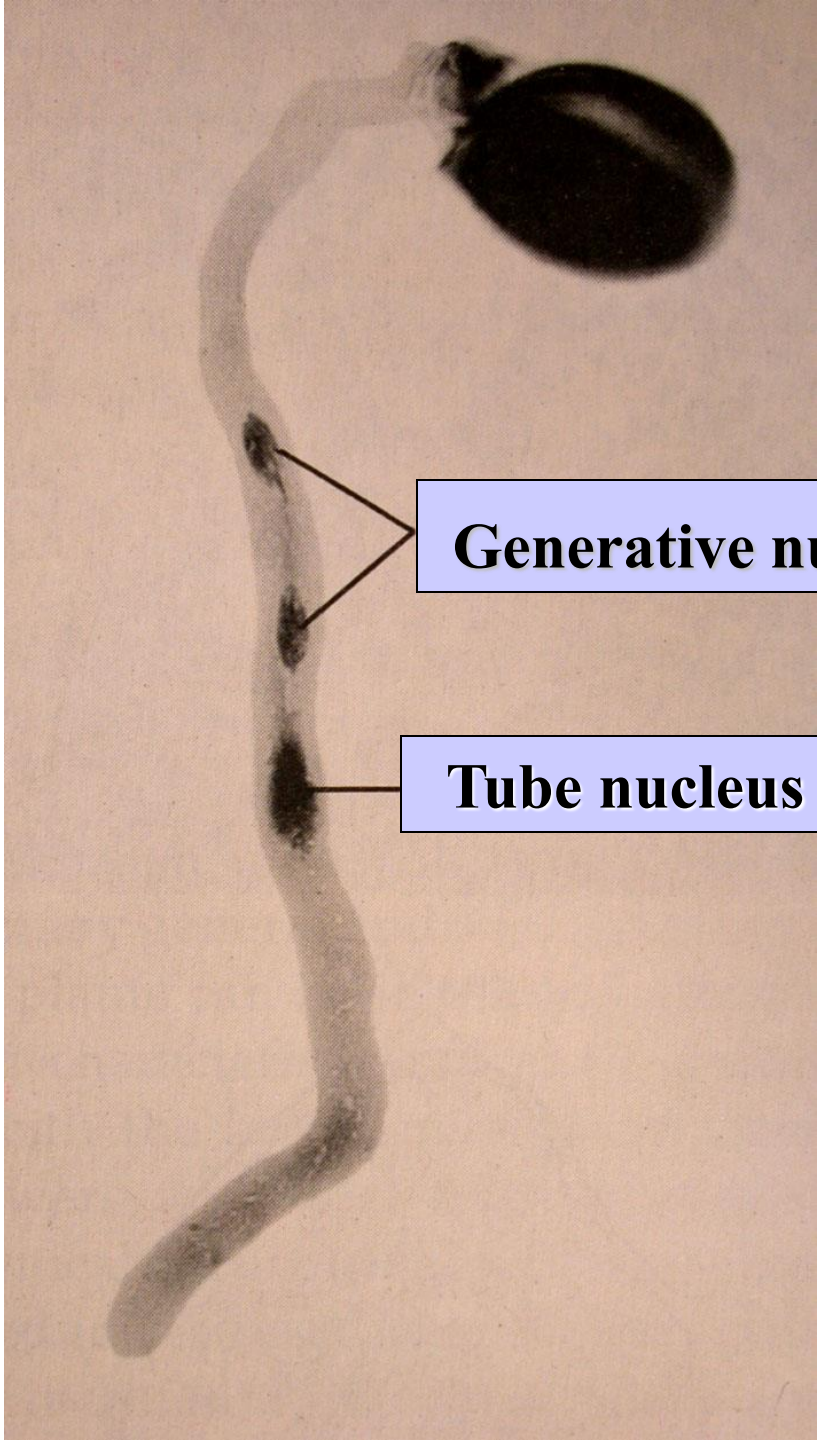
Gametophytic tissue

Embryo



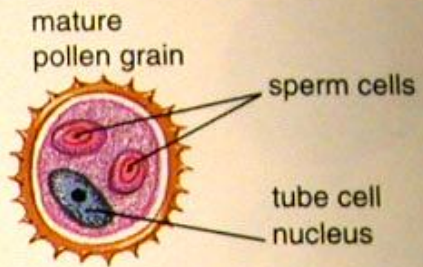
Development of Seeds





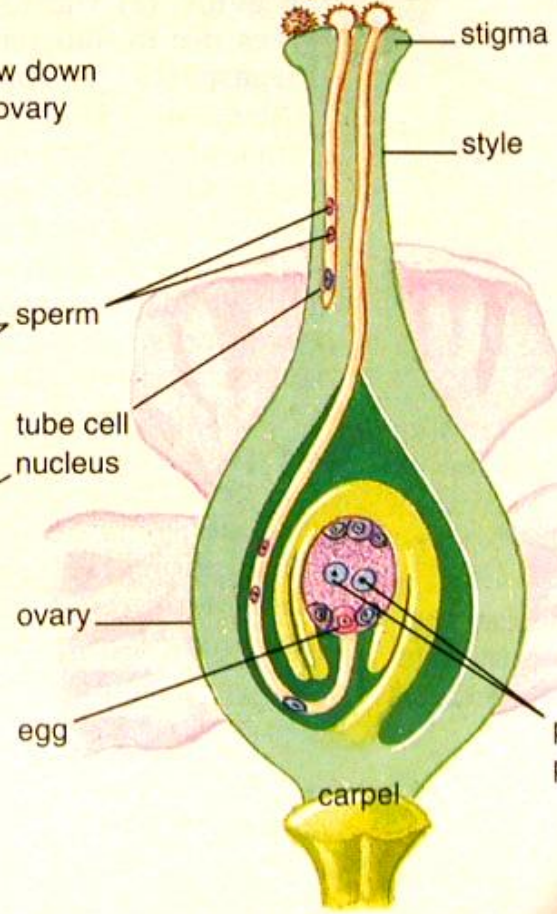
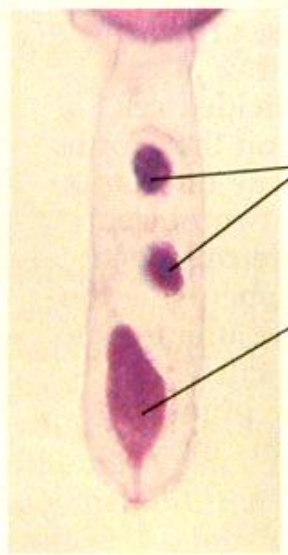
Generative nuclei = "sperm"

Tube nucleus

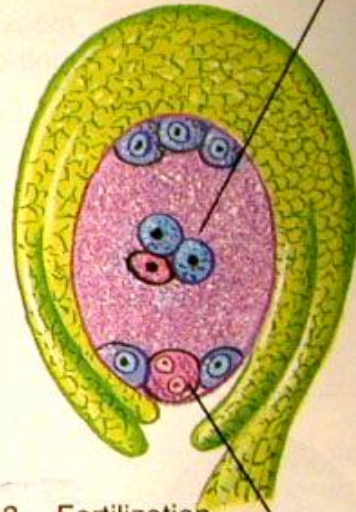


1 Pollen grains land on stigma

2 Pollen tubes grow down through style to ovary



fusion of sperm nucleus with two polar nuclei



3 Fertilization within ovule

fusion of sperm with egg

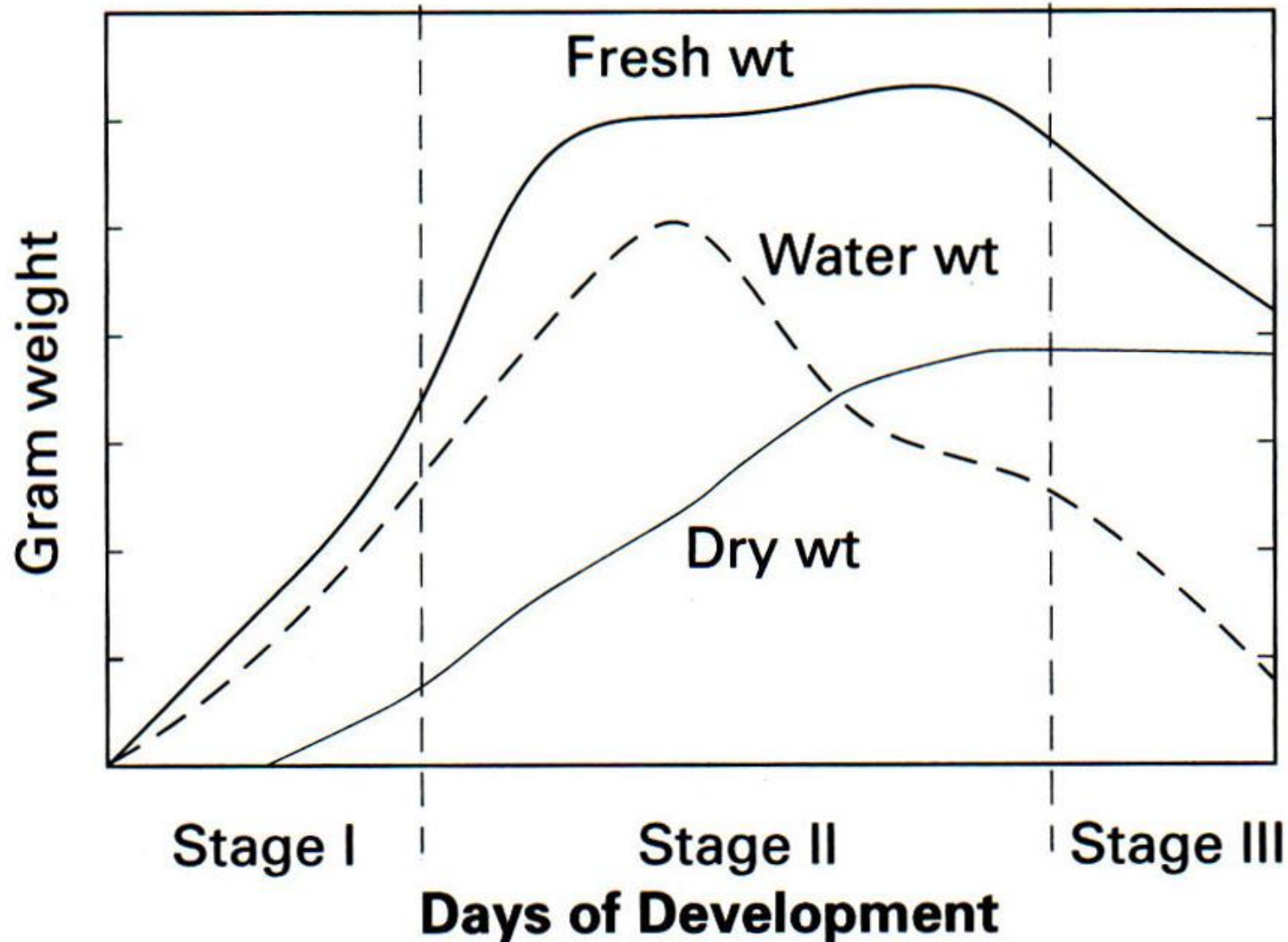
polar nuclei within primary endosperm cell

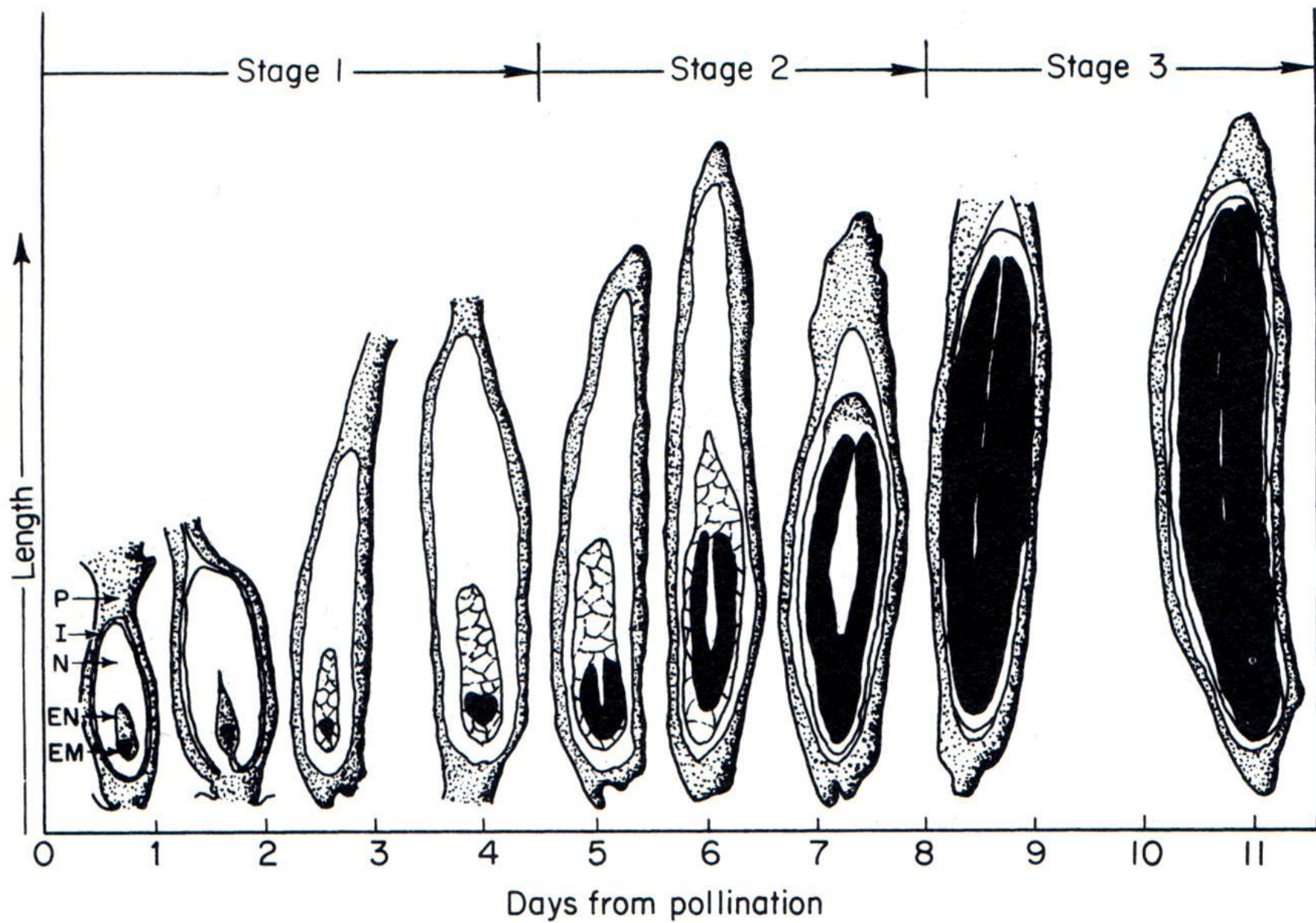
Stages of Seed Development

Histo-
differentiation

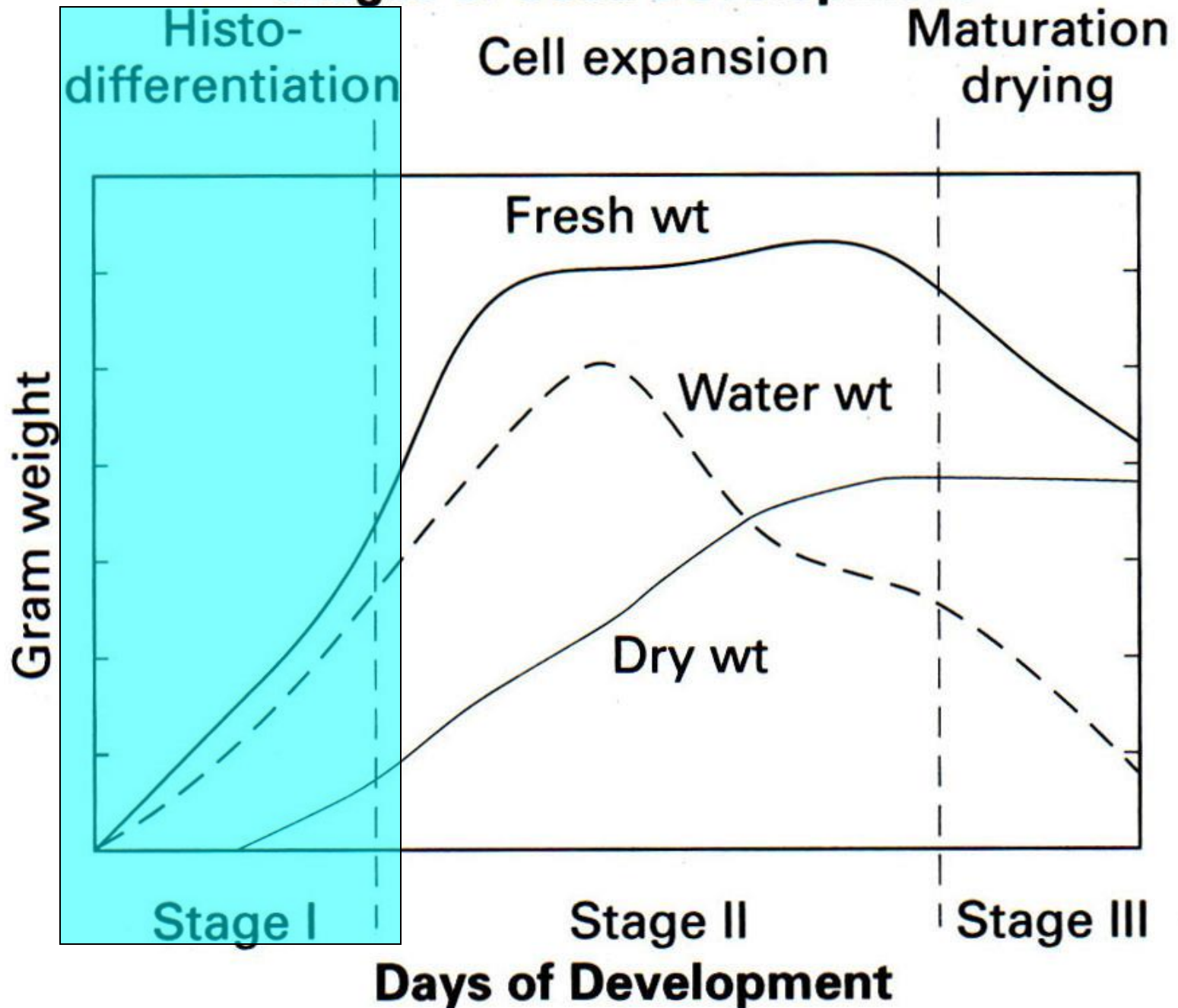
Cell expansion

Maturation
drying



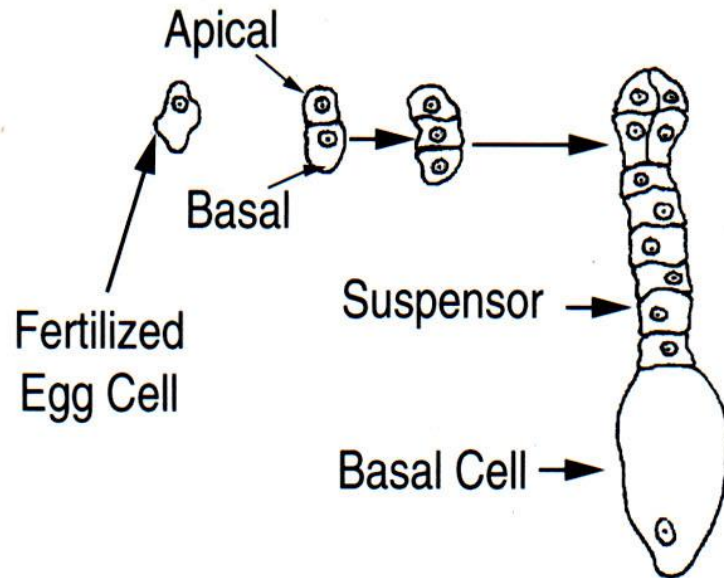


Stages of Seed Development



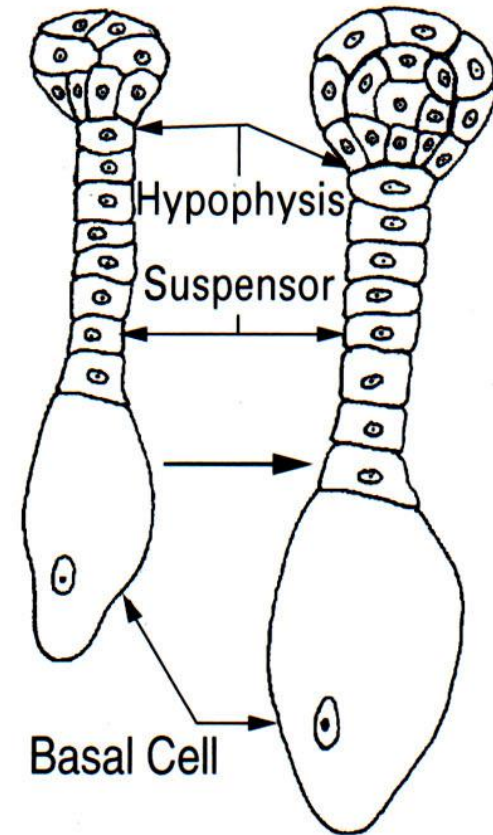
Proembryo Stage

(a)



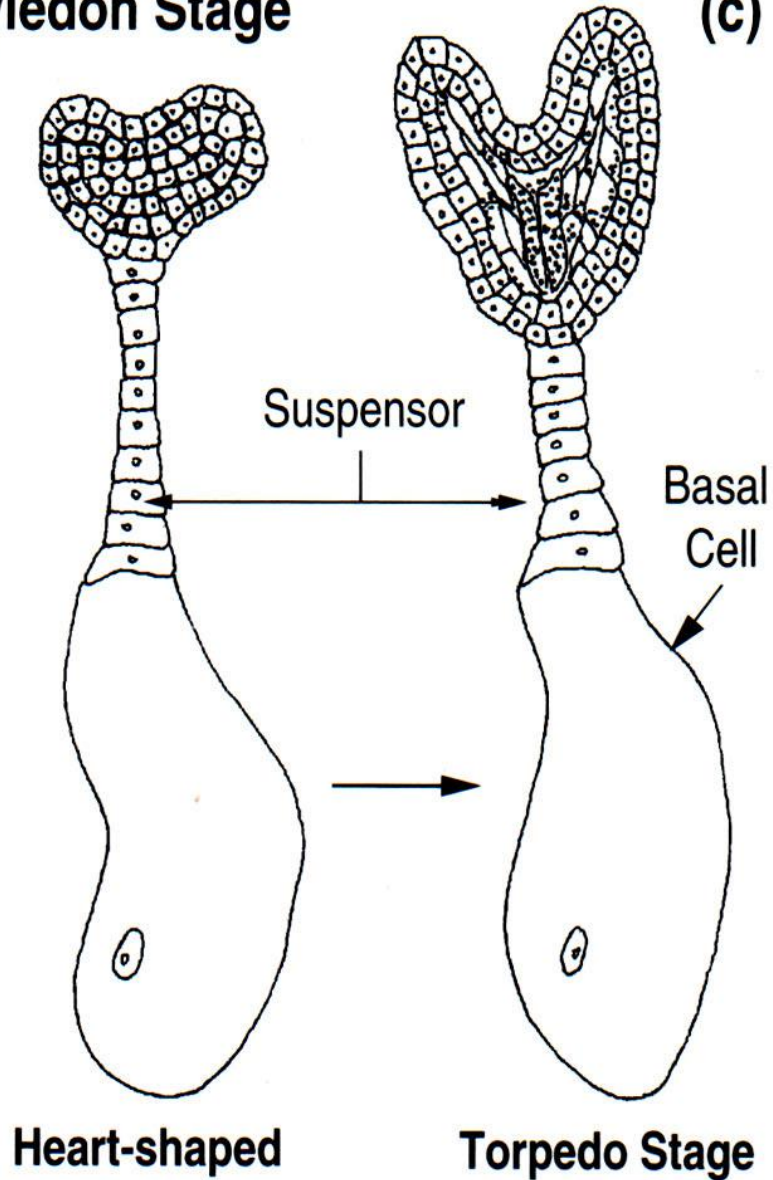
Globular Stage

(b)



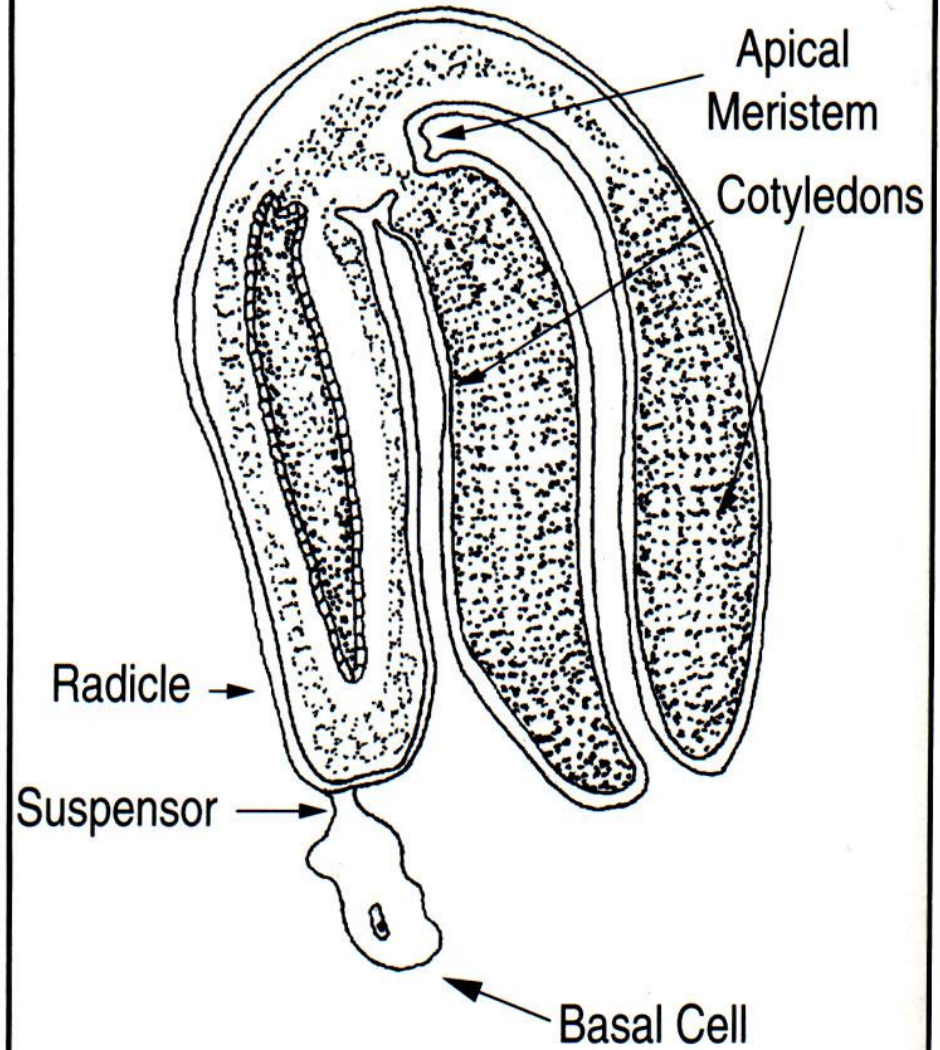
Cotyledon Stage

(c)

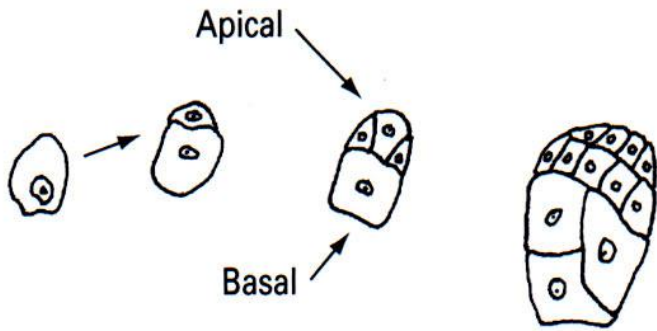


Mature Stage

(d)

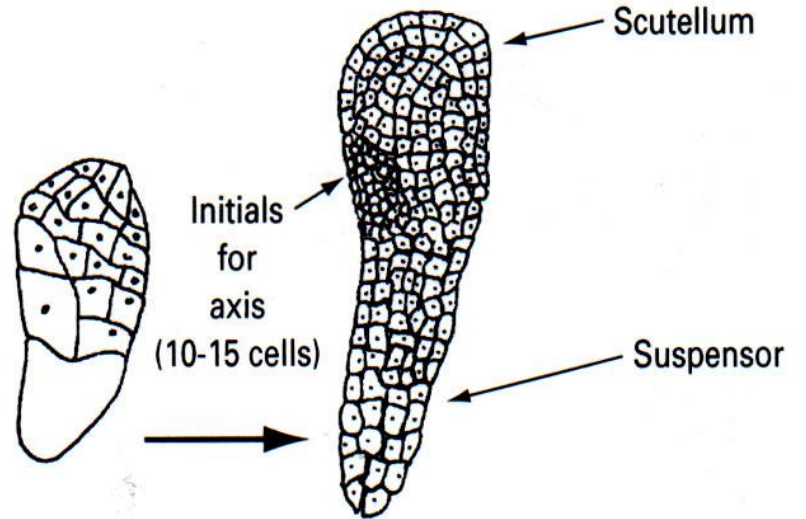


Proembryo Stage



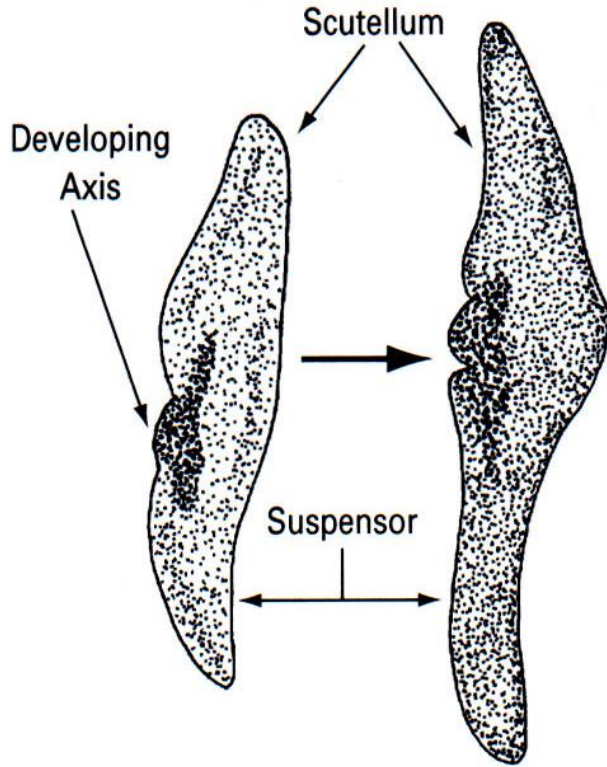
(a)

Globular Stage



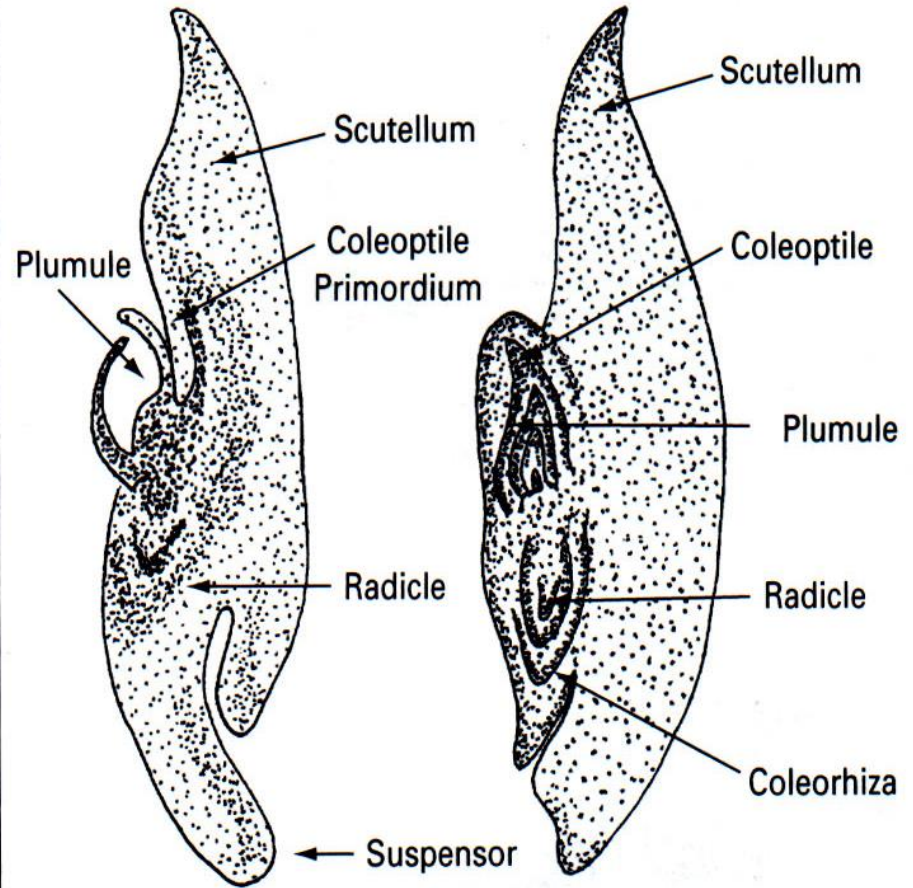
(b)

Scutellar Stage



(c)

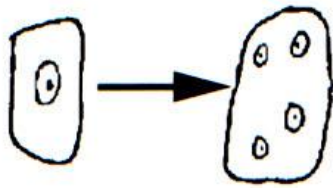
Coleoptilar Stage



(d)

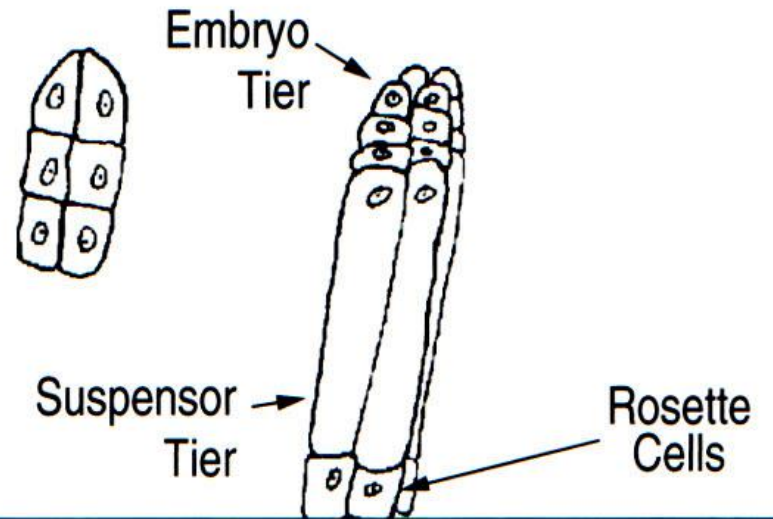
Free Nuclear Stage

(a)

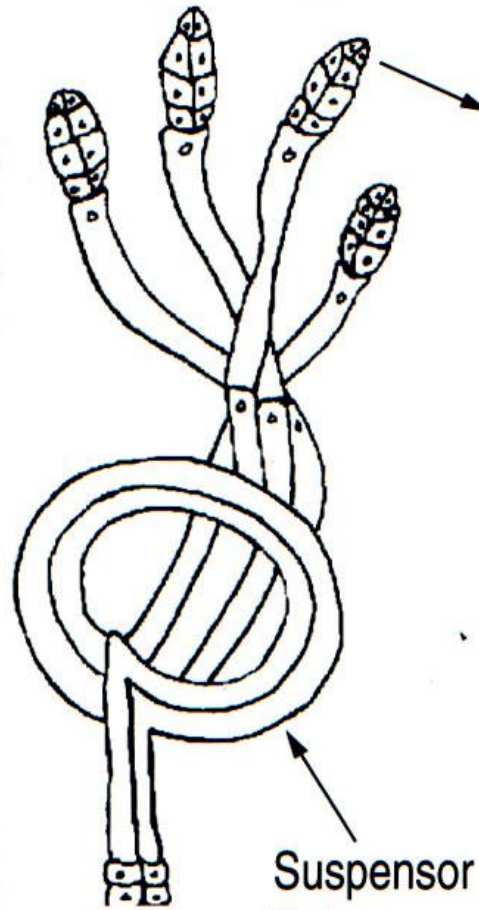


Suspensor Tier

(b)

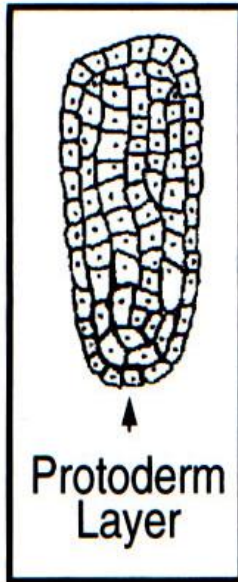
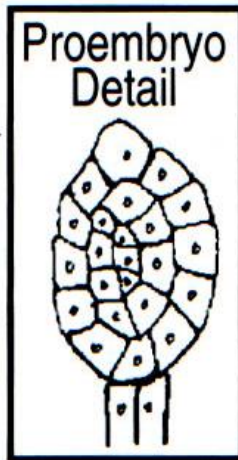


Proembryo Stage



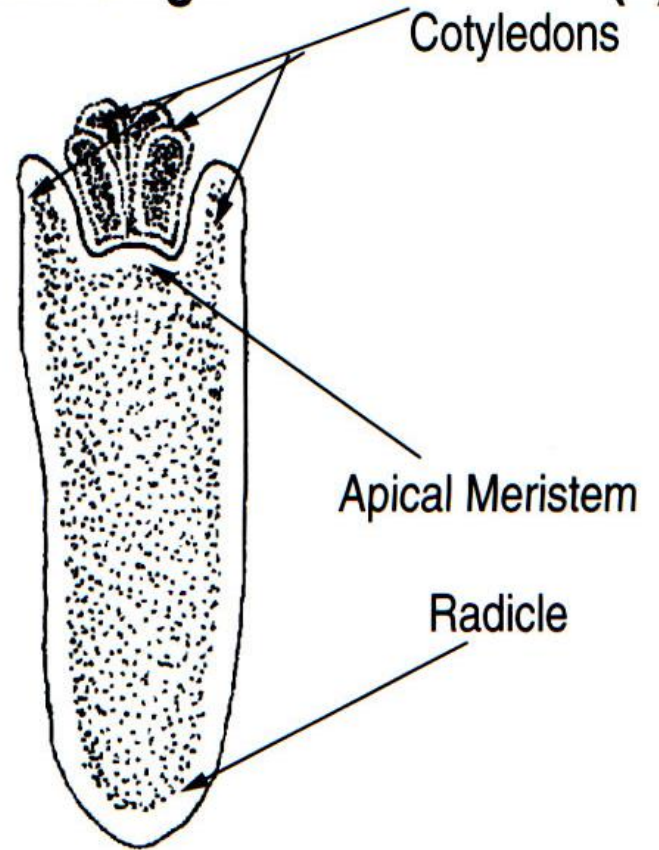
Suspensor
Tubes

(c)



Protoderm
Layer

Cotyledon Stage



Cotyledons

Apical Meristem

Radicle

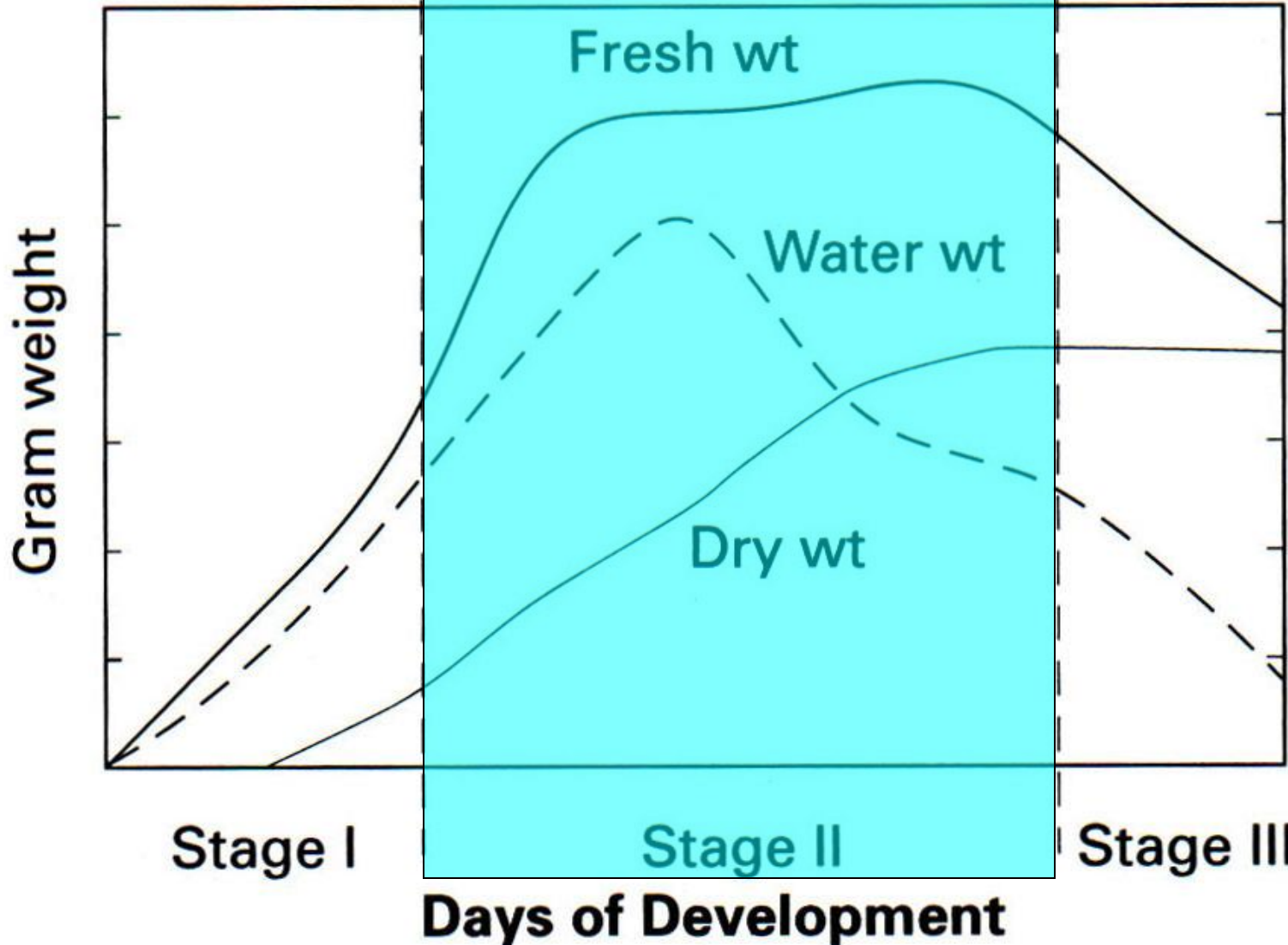
(d)

Stages of Seed Development

Histo-differentiation

Cell expansion

Maturation drying



Developing peas in pod

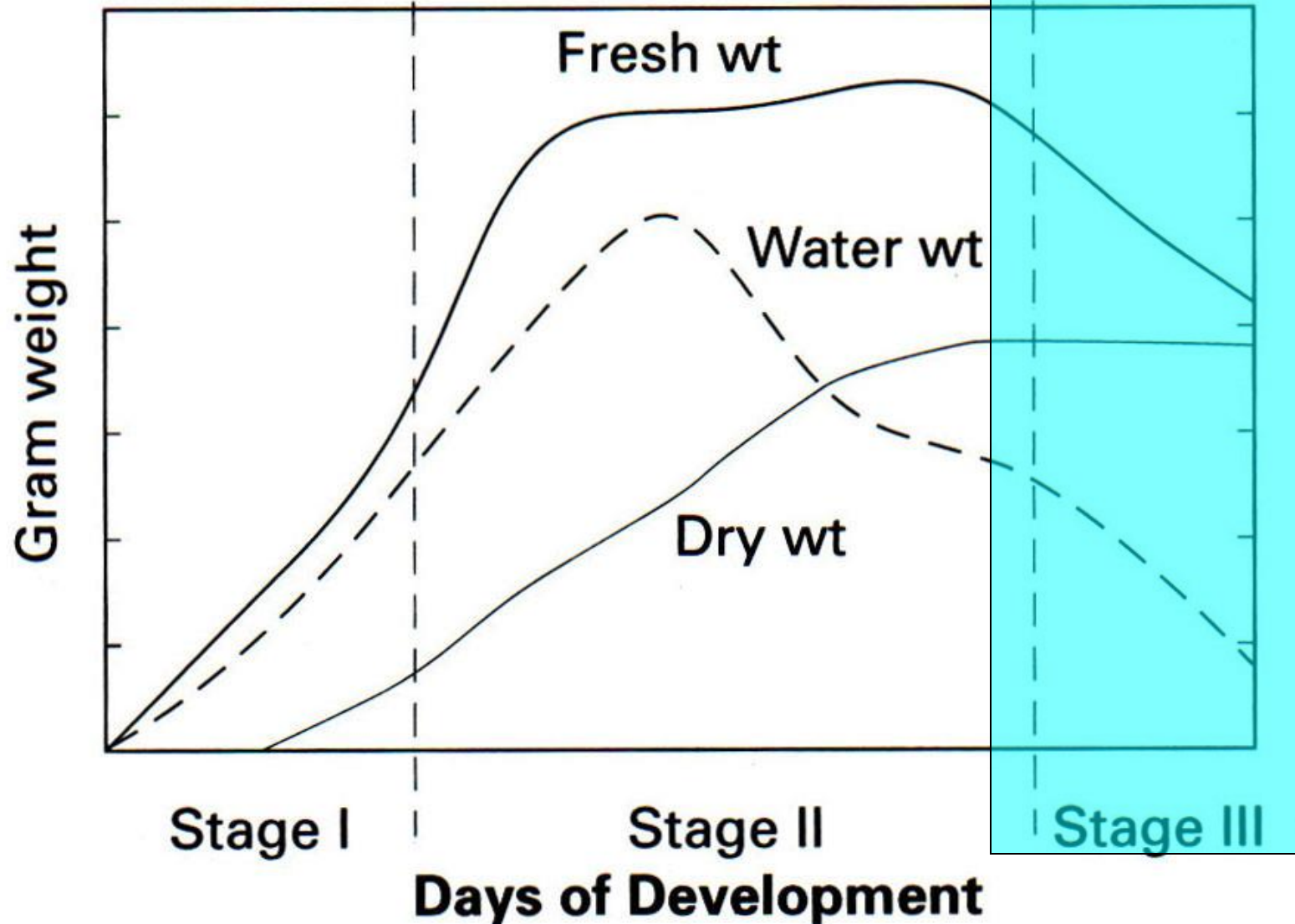


Stages of Seed Development

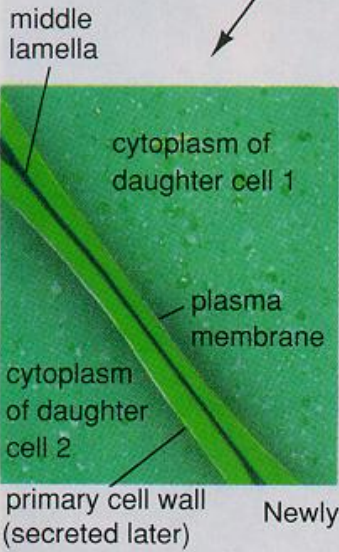
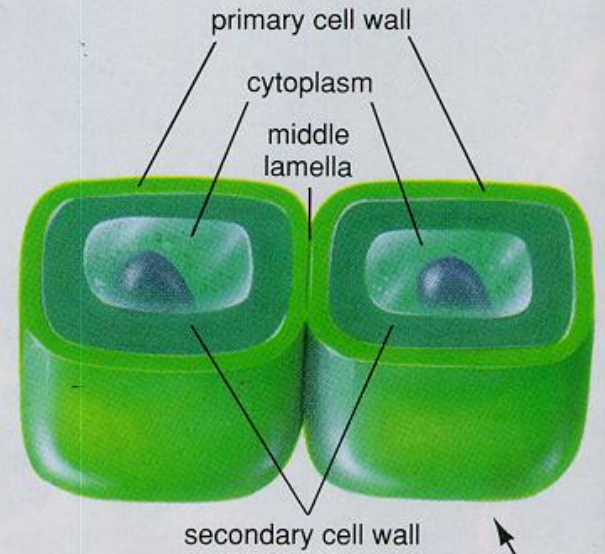
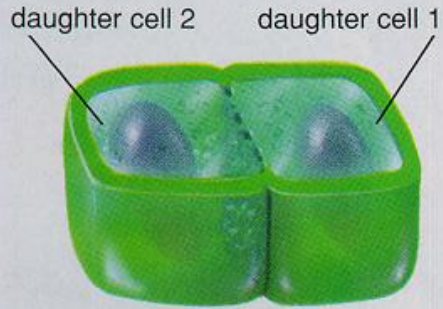
Histo-
differentiation

Cell expansion

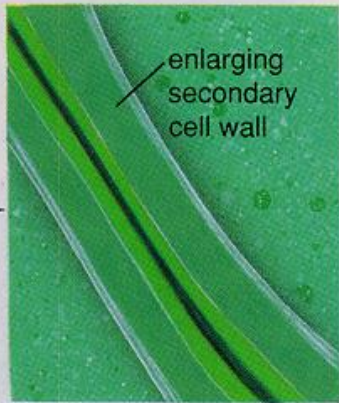
Maturation
drying



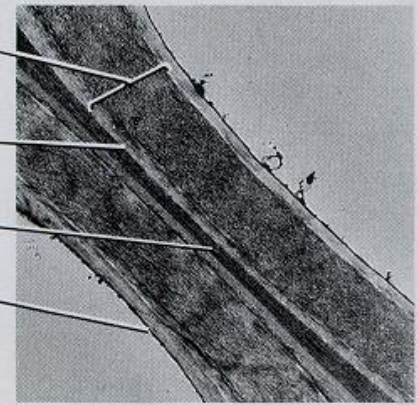
fusion of pectin-filled vesicles separates daughter cells and forms middle lamella



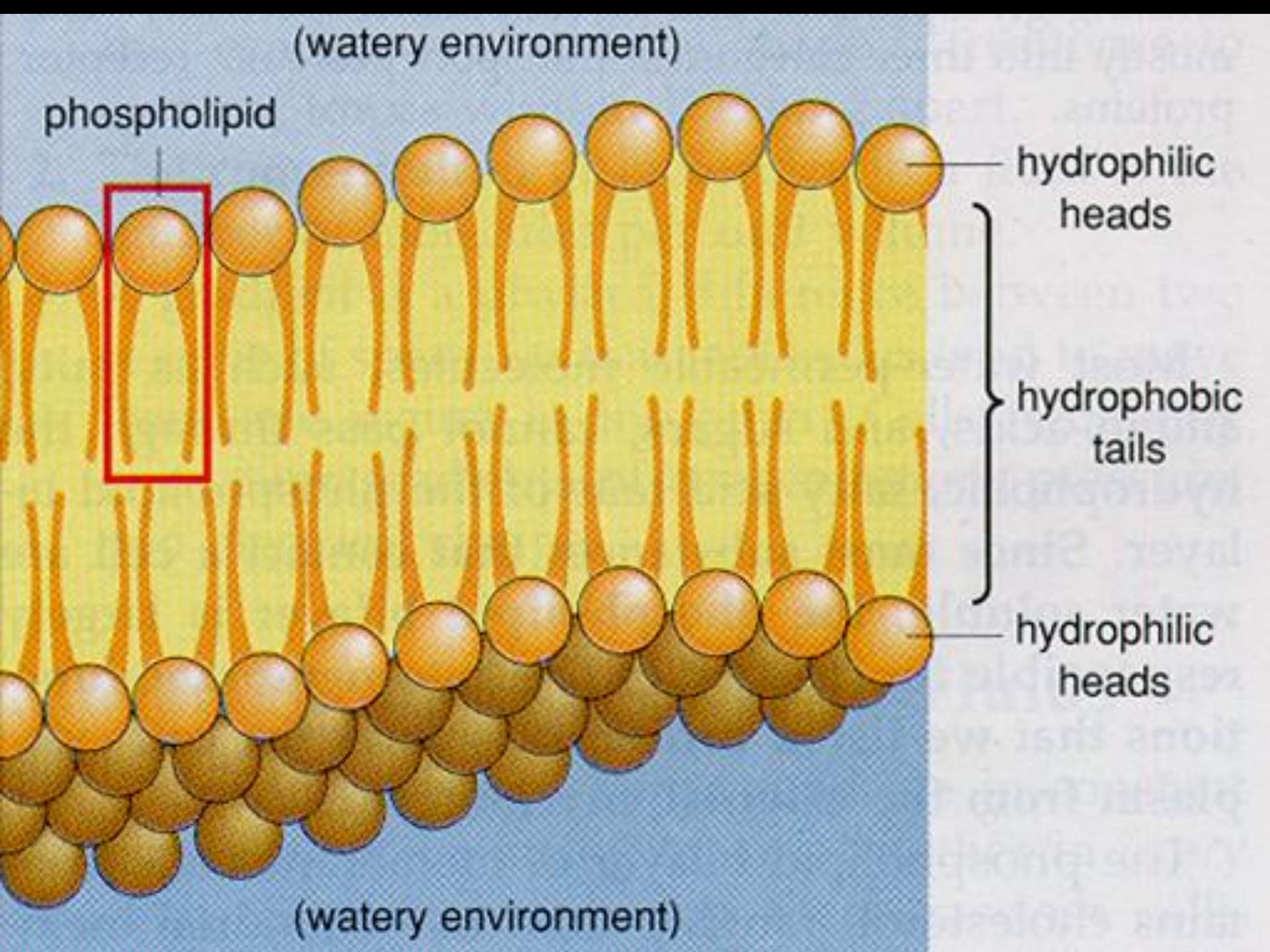
Newly formed cells



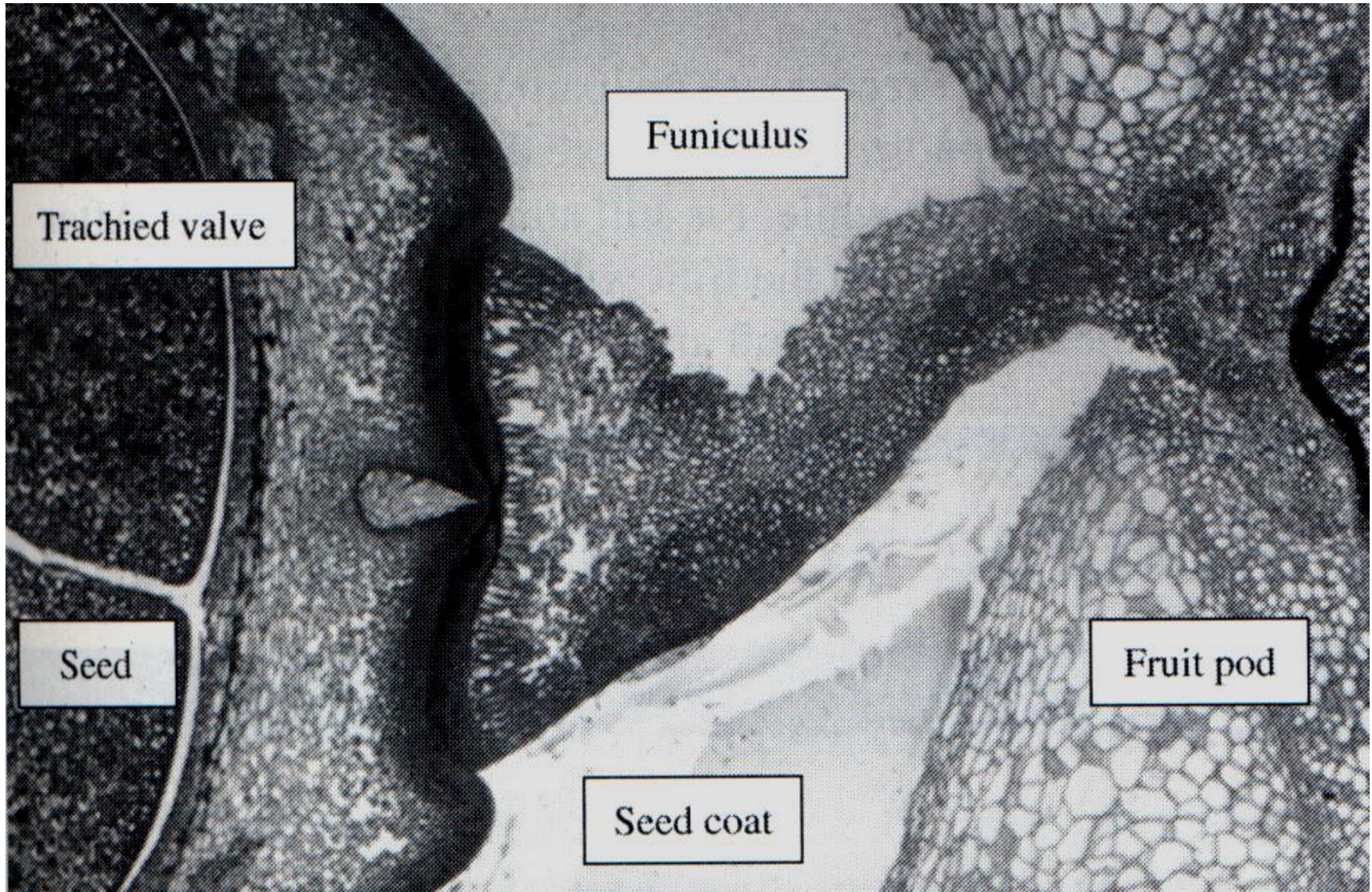
Mature cells



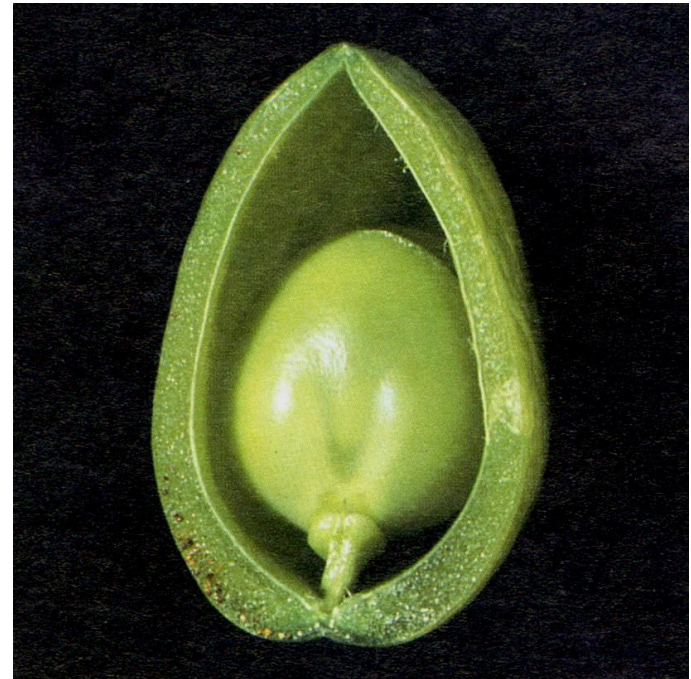
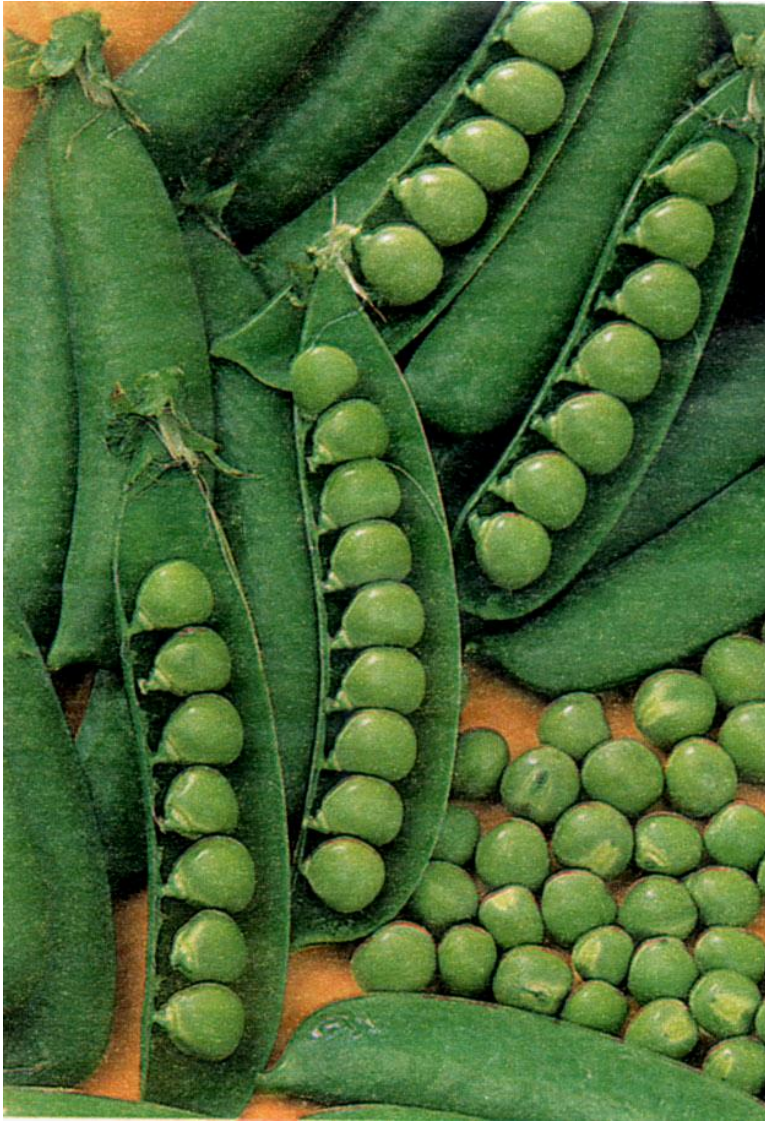
1 micrometer



Hilum/funiculus connection



Hilum/funiculus connection



Precocious seed germination in corn



Precocious germination in mangrove



Fruit development in blackberry

Good pollination /fertilization

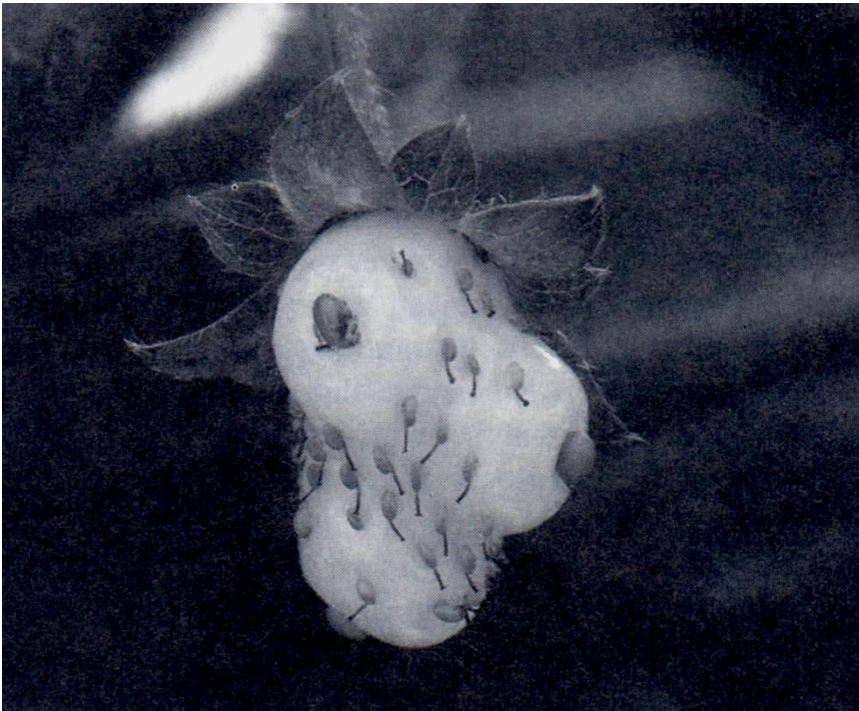


Poor pollination/fertilization



Fruit development in strawberry

Poor pollination/fertilization



Good pollination/fertilization



Vegetative parthenocarpy



© W.P. Armstrong 2004

Fruit = a hollow receptacle with hundreds of small fleshy flowers facing each other

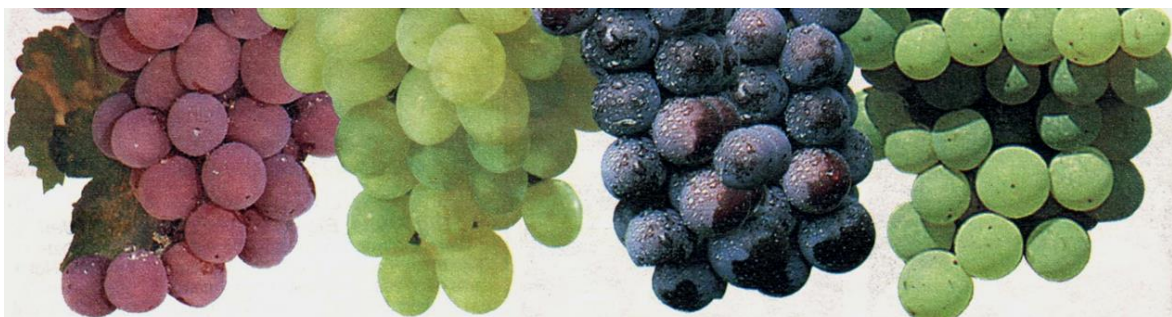




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Stimulative parthenocarpy





SEEDLESS PINK RELIANCE
Extreme Cold Can't Stop It

Patent #5174. Sugar-sweet flavor, appetizing good looks. Rosy fruit is big and plump, perfect for snacking. Ripens in late August, 40-50 clusters per vine. Displays a strong resistance to black rot, anthracnose and mildew. No. 1, 1-year vines. ZONES 4-8.

1 Offer 2 Offers 3 & Up
08499 9.25 8.69 Ea. 7.79 Ea.

SEEDLESS THOMPSON
Super for Snacking

The one you see in the grocery store—a snacktime favorite. Unbeatable for fresh use! Pale green fruit is sweet and delicious, with no bitter aftertaste. Dependably productive vines average 20-30 clusters apiece. No. 1, 1-year vines. ZONES 4-8.

1 Offer 2 Offers 3 & Up
13126 8.45 7.89 Ea. 7.15 Ea.

SEEDLESS CONCORD
Just Right for Jelly Making

Famed Concord flavor—without the seeds! Slightly smaller fruit clusters than seeded Concord—an ideal size for processing. Plump grapes have deep purple color, plenty of juice. A single vine yields 30-40 fruit clusters. No. 1, 1-year vines. ZONES 4-9.

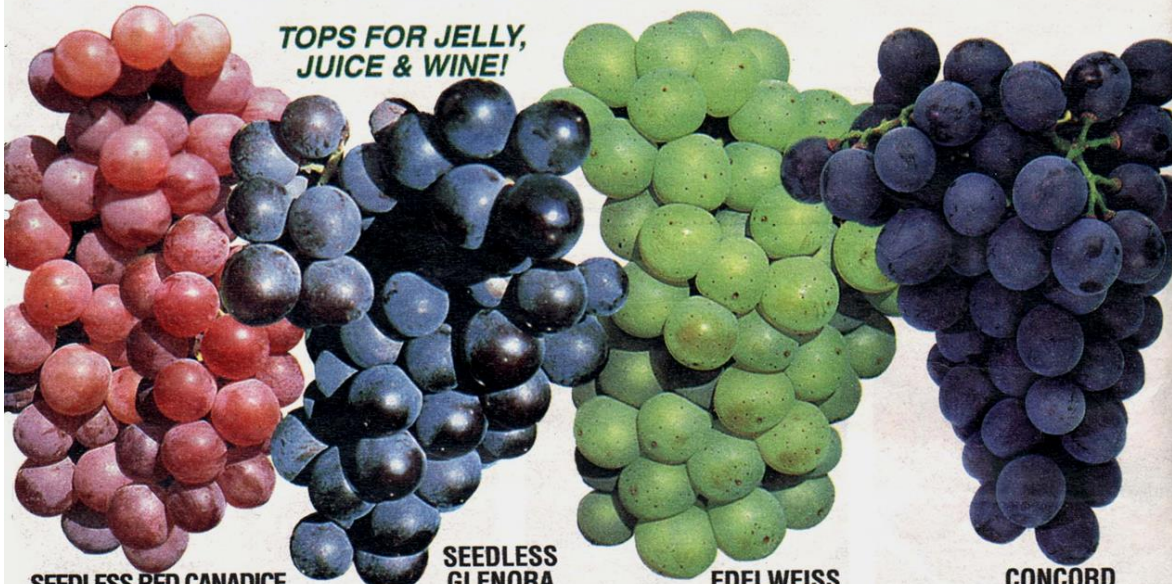
1 Offer 2 Offers 3 & Up
08498 7.99 7.49 Ea. 6.79 Ea.

SEEDLESS HIMROD
Cold - Hardy White

Cool green table grapes ripen in August—a month before Concord—and store for months. So much tastier than supermarket varieties! Crisp and fruity as wine delicious dried as golden raisins. Yields 35-40 fruit clusters. No. 1 1-year vines. ZONES 5-8.

1 Offer 2 Offers 3 & Up
08500 8.45 7.89 Ea. 7.15 Ea.

**TOPS FOR JELLY,
JUICE & WINE!**



SEEDLESS RED CANADICE
Hardest Red Available

Firm, fully ripe red grapes have a pleasant tang, no tough skins. Flavor is excellent—this variety is hard to beat for fresh use. Produces 35-40 clusters of fruit per vine in late August, early September. Tolerates subzero temperatures, resists insects and disease. No. 1, 1-year vines. ZONES 4-8.

1 Offer 2 Offers 3 & Up
08497 8.45 7.89 Ea. 7.15 Ea.

SEEDLESS GLENORA
Fine for Winemaking

A mouthwatering medium-sized grape with full-bodied flavor and rich aroma. Fine for wine and superb for snacking. Blue-black fruit makes a luscious jelly that tempts the eye in addition to treating the taste buds. Produces 25-35 clusters of fruit per vine. No. 1, 1-year vines. ZONES 4-8.

1 Offer 2 Offers 3 & Up
13130 8.45 7.89 Ea. 7.15 Ea.

EDELWEISS
Stands Subzero Cold

Pale green grapes, so sweet they're prized for desserts and for making mellow white wine. And you get reliably large crops every year—even subzero winter temperatures don't slow the vines. Ripens in late August—40 clusters per vine. No. 1, 1-year vines. ZONES 4-8.

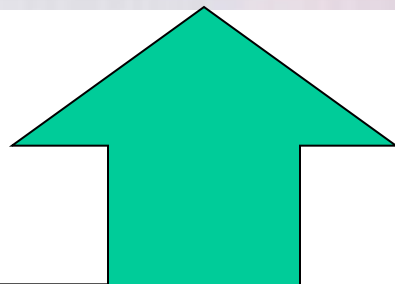
1 Offer 2 Offers 3 & Up
08496 7.59 7.09 Ea. 6.39 Ea.

CONCORD
America's Favorite

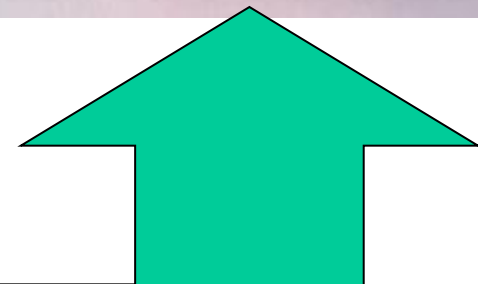
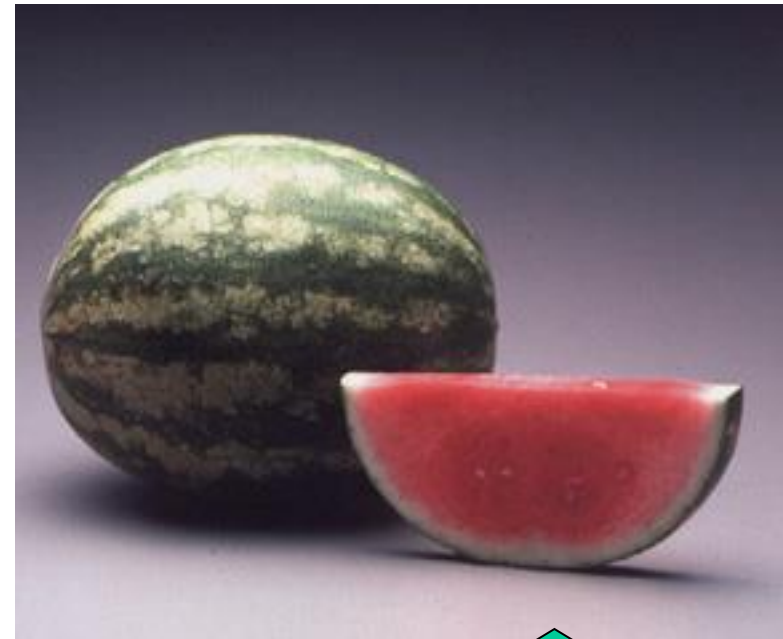
The one folks think of when jelly and jam comes to mind. Skins slip from the dark purple fruits, so it's a snap to make sweet Concord wine—just let the juice ferment. Bears in late September. Pick bit earlier for preserves, when the pectin content runs higher. No. 1-year vines. ZONES 4-8.

1 Offer 2 Offers 3 & Up
08493 4.69 4.39 Ea. 3.99 Ea.

Stimulative parthenocarpy

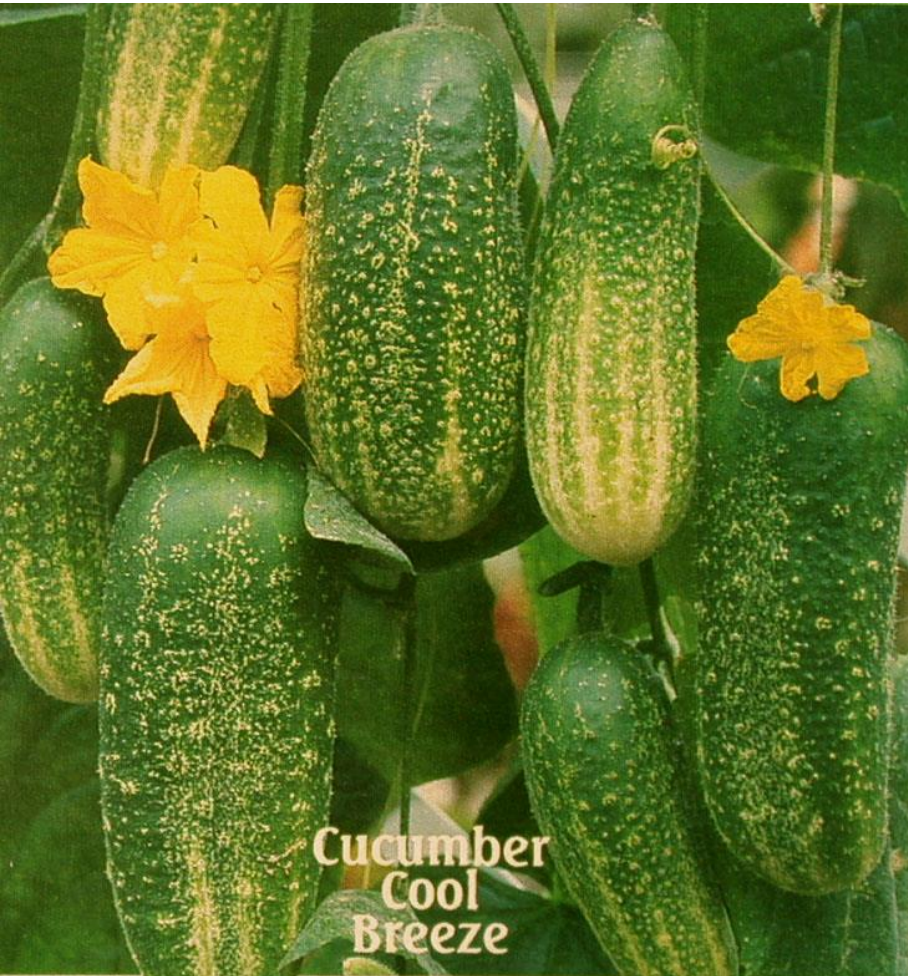


Seeded watermelon



Seedless watermelon

Stimulative parthenocarpy





Acer saccharinum
“silver maple”

Quercus macrocarpa
“bur oak”



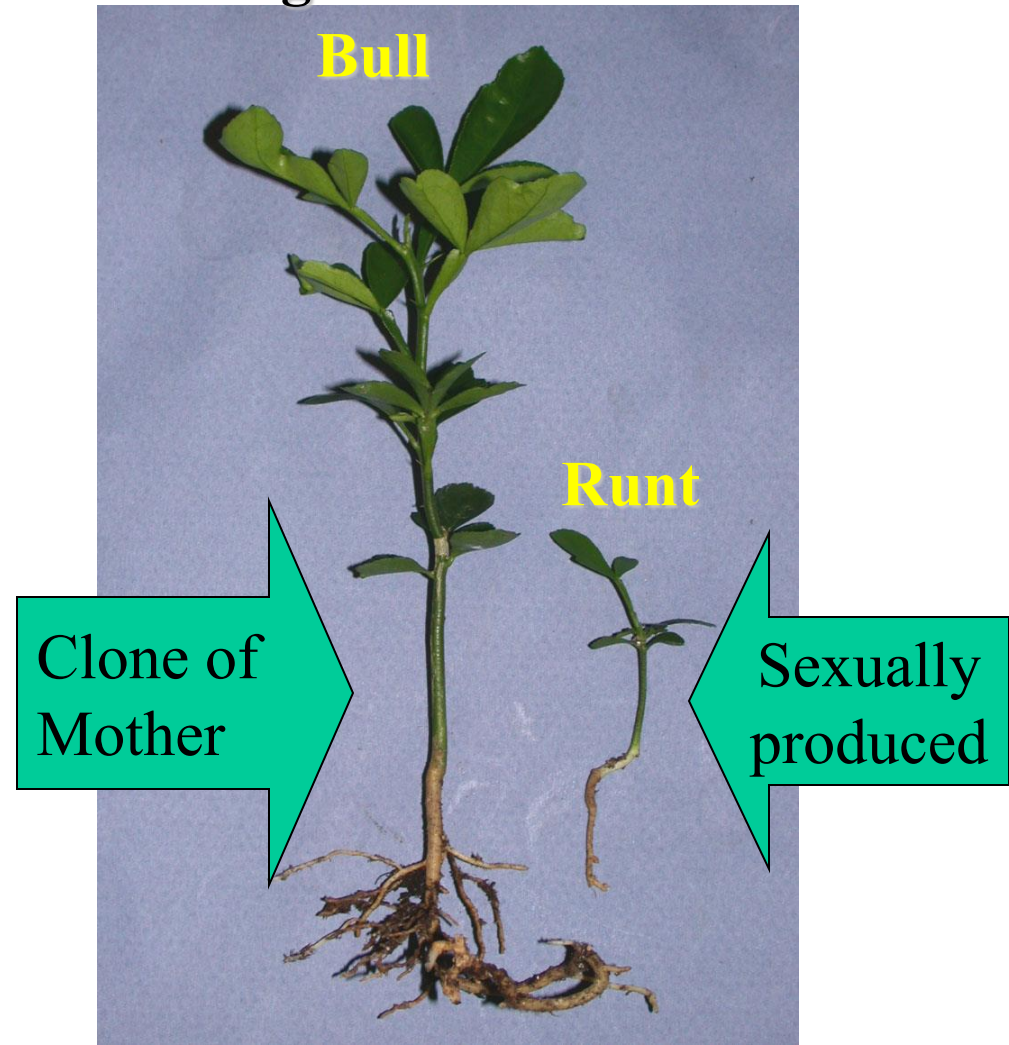
Unusual types of seed development

- **Polyembryony**
 - The development of multiple embryos within the same seed



Polyembryony

Both grew from 1 seed!



Polyembryony

