

BOT3015L

Biology of Flowering Plants:

Reproduction

**Gametophytes, Fruits, Seeds,
and Embryos**

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PPES ACS College, Alibag**

Presentation created by Danielle Sherdan

All photos from Raven *et al.* *Biology of Plants* except when otherwise noted

Today

- Alternation of generations (sporic meiosis)
- Alternation of generations in angiosperms
- Angiosperm gametophytes
 - microgametophyte
 - megagametophyte
- Double fertilization** (endosperm and embryo)
- Seeds
- Fruits**

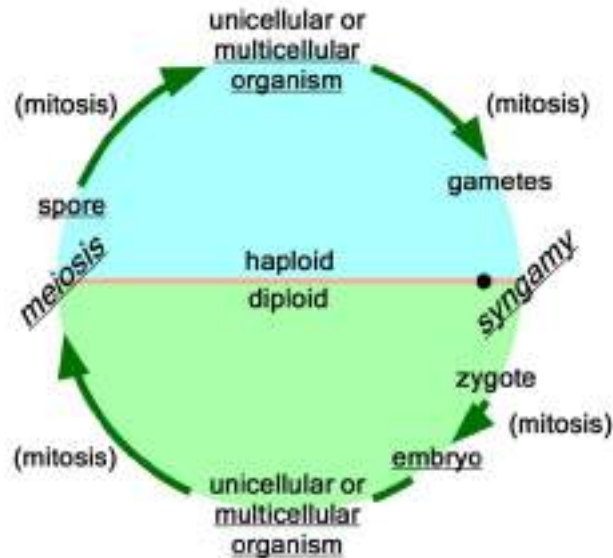
**Distinguishing characteristics of angiosperms

Generalized Overview of Three Sexual Life Cycles

Alternation of Generations

(aka *Sporic Meiosis*)

Gamete-forming Generation

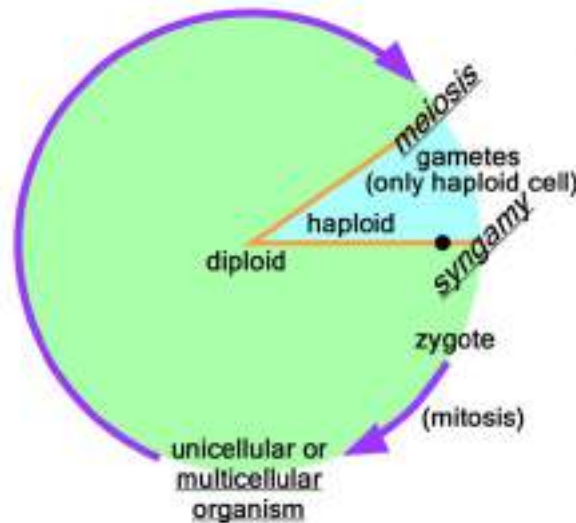


Spore-forming Generation

Example: All plants

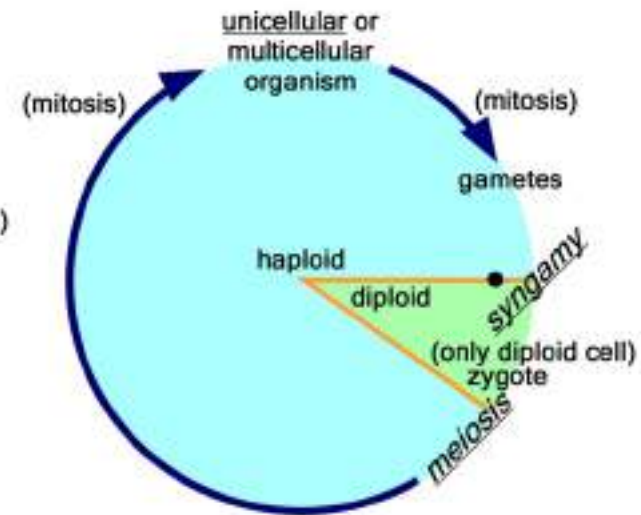
Meiotic Gametogenesis

(aka *Gametic Meiosis*)



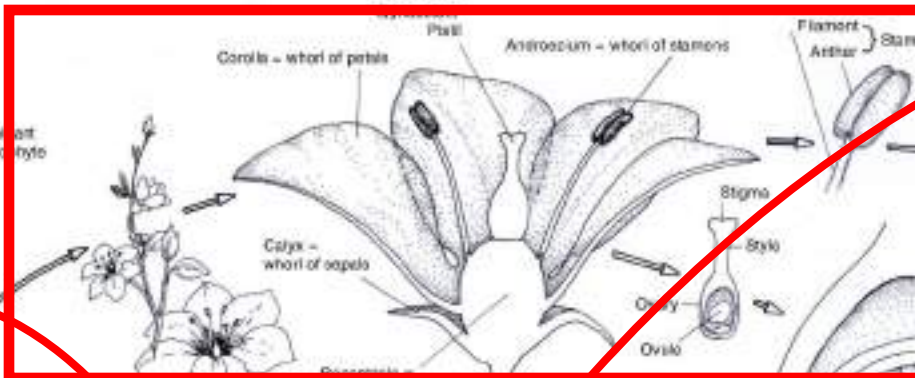
Example: Mammals

Zygotic Meiosis



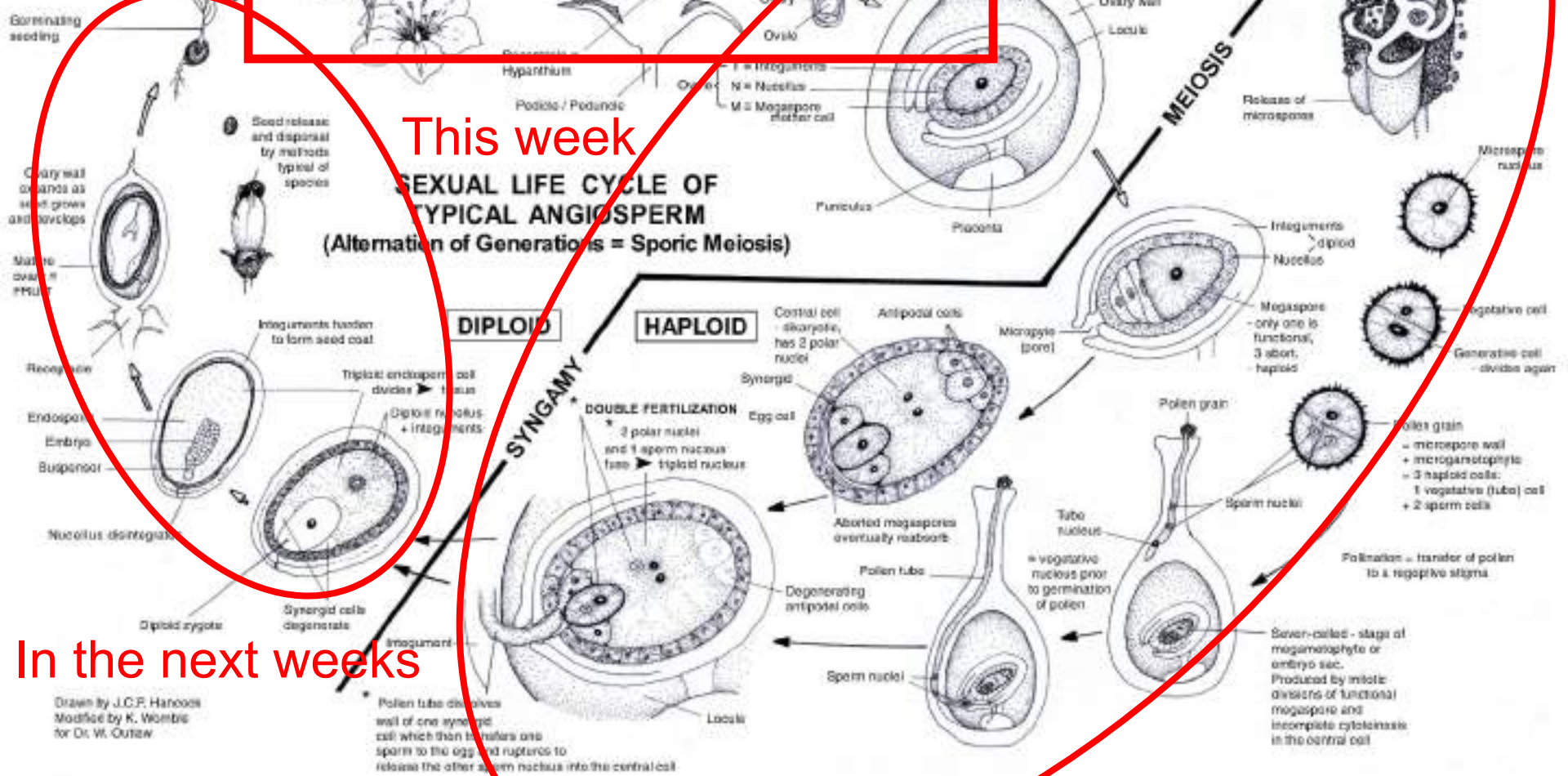
Example: *Chlamydomonas*

Last week



This week

SEXUAL LIFE CYCLE OF TYPICAL ANGIOSPERM
(Alternation of Generations = Sporic Meiosis)



In the next weeks

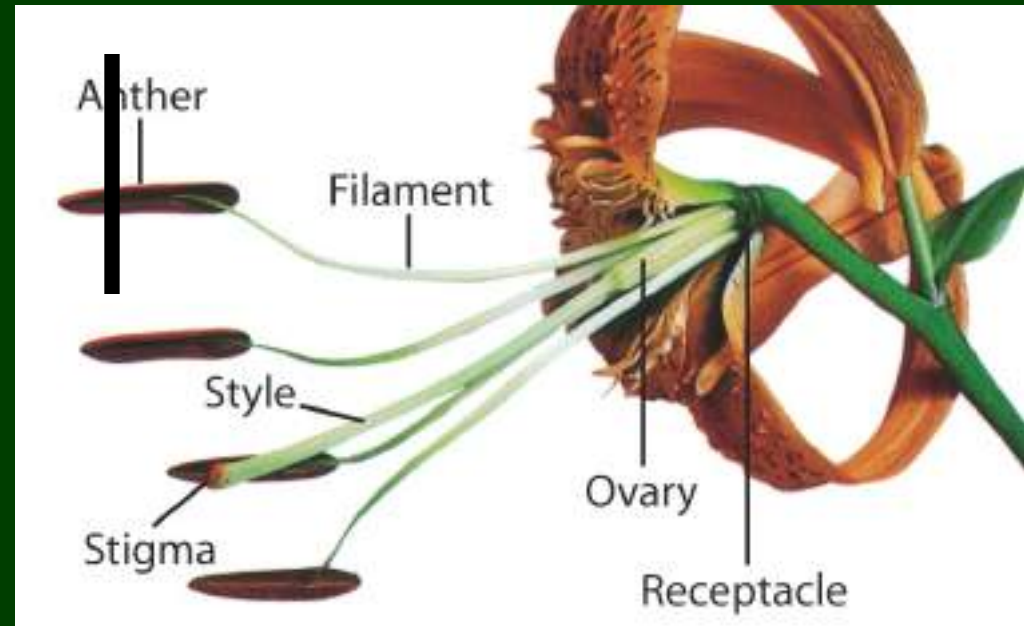
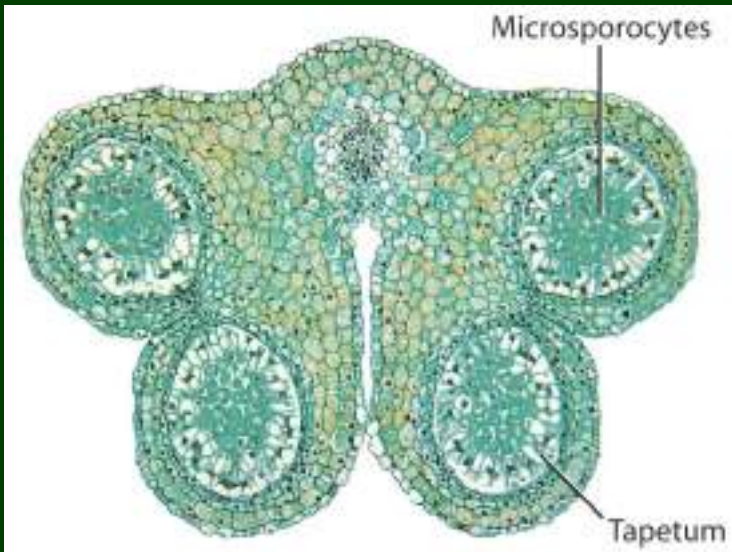
Drawn by J.C.P. Hancock
Modified by K. Wombie
for Dr. W. Outlaw

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**Distinguishing characteristics of angiosperms

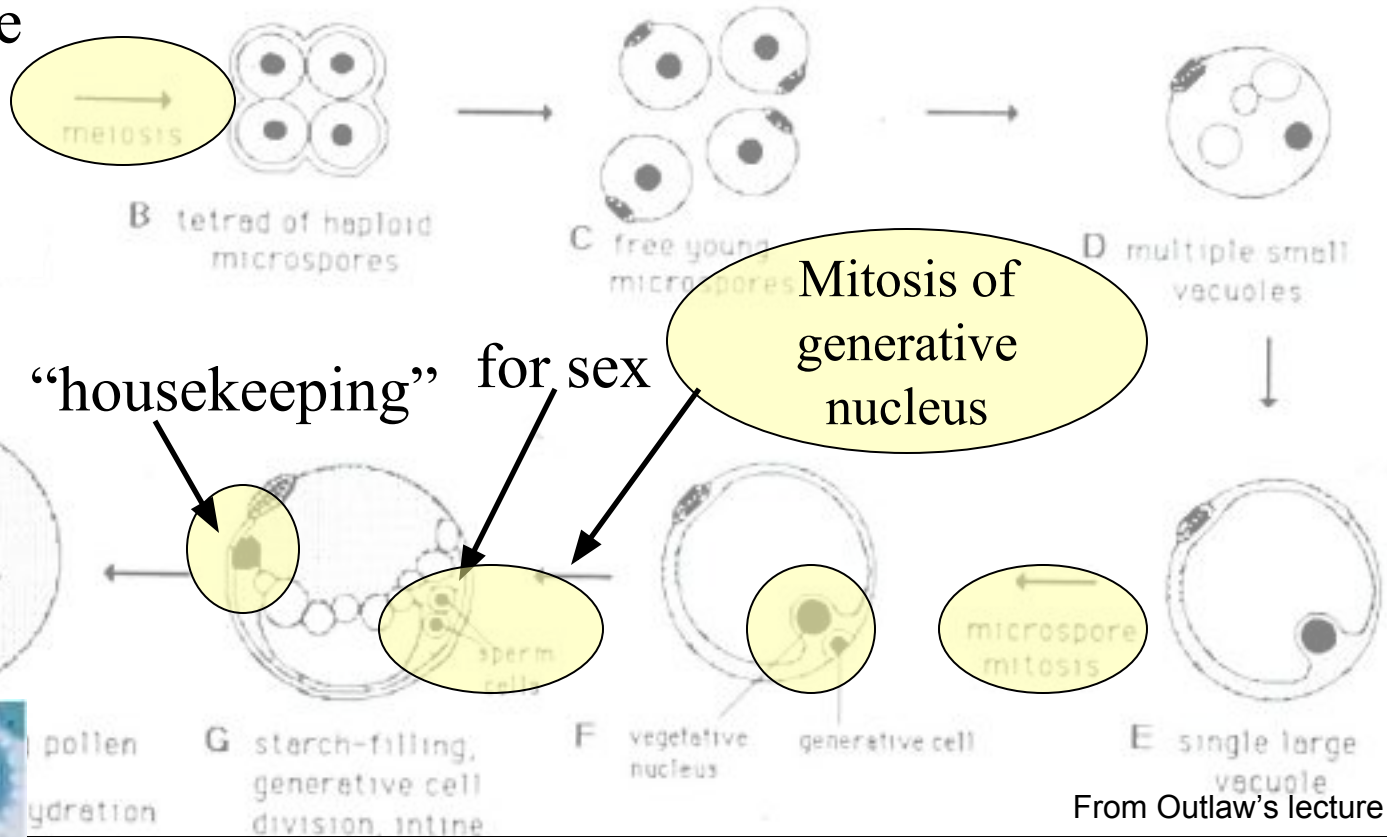
Microsporogenesis in the anther



Microsporocyte (a.k.a. microspore mother cells) undergo meiosis to produce four dissimilar microspores. Lily anther, immature, cross section

Formation of microspores & male gametes.

Microspore
mother
cell



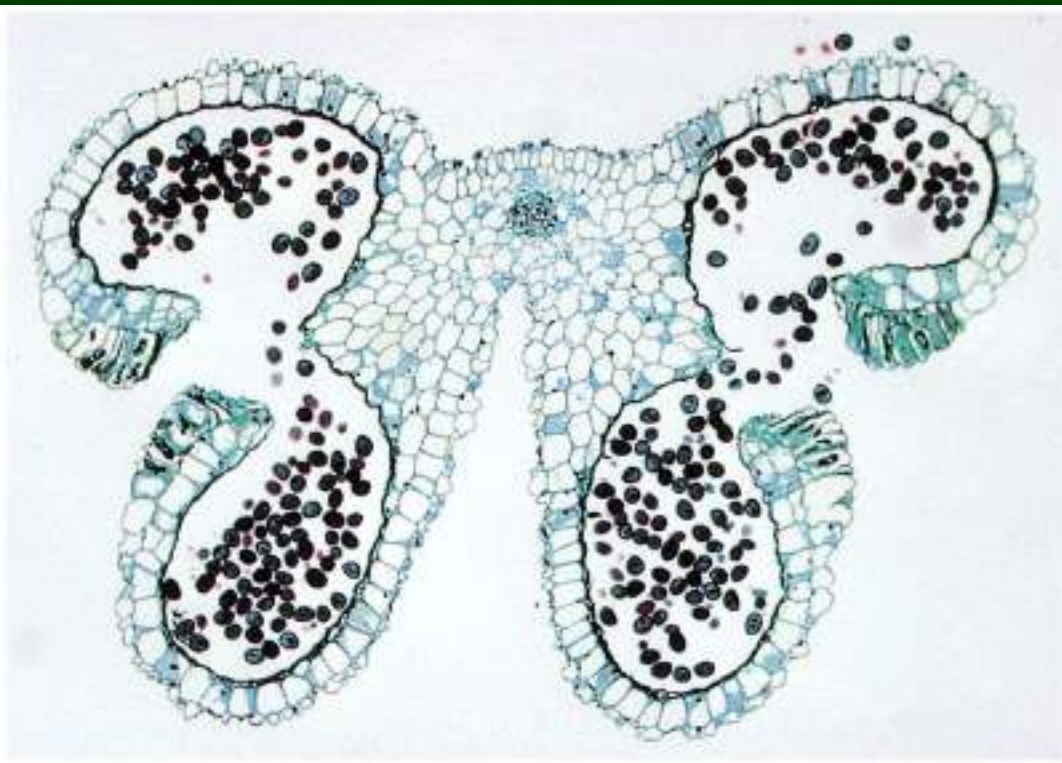
From Outlaw's lecture series

Entire Male Gametophyte (angiosperms):

**1 round of mitosis to yield 2 nuclei (generative + vegetative).

**The generative nucleus divides again mitotically to yield 2 sperm.

Mature microgametophyte



Mature anther
lily

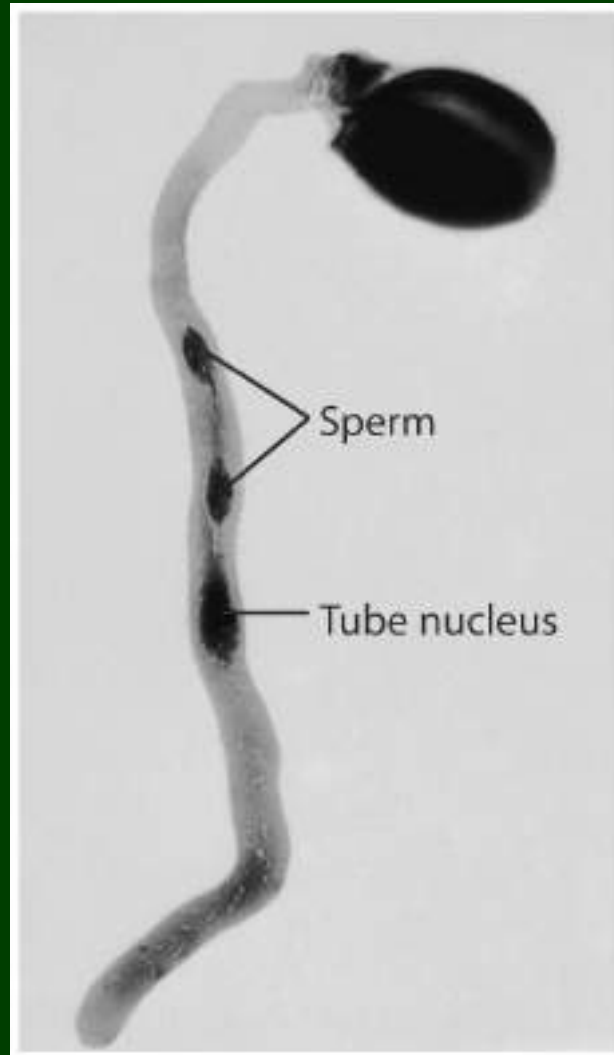


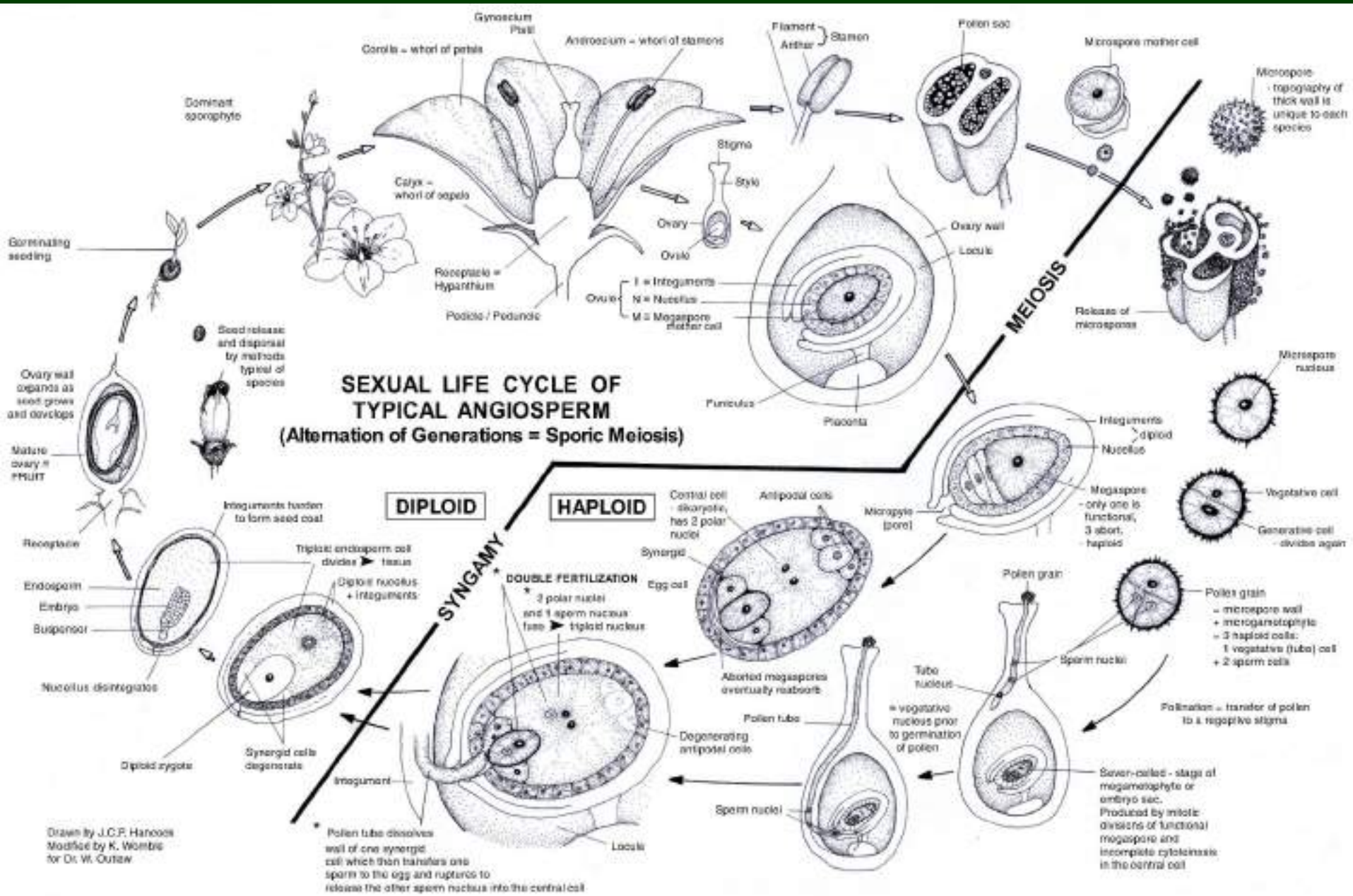
Mature pollen
telegraph plant

The protective wall and efficient dispersal of microgametophytes are two adaptations to terrestrial life (compare to flagellated gametes being released)

Note: Some pollen are shed before the generative cell divides mitotically to produce the two sperm cells, some pollen are shed after (as shown above)

Pollination to fertilization pollen tube growth





Drawn by J.C.P. Hancock
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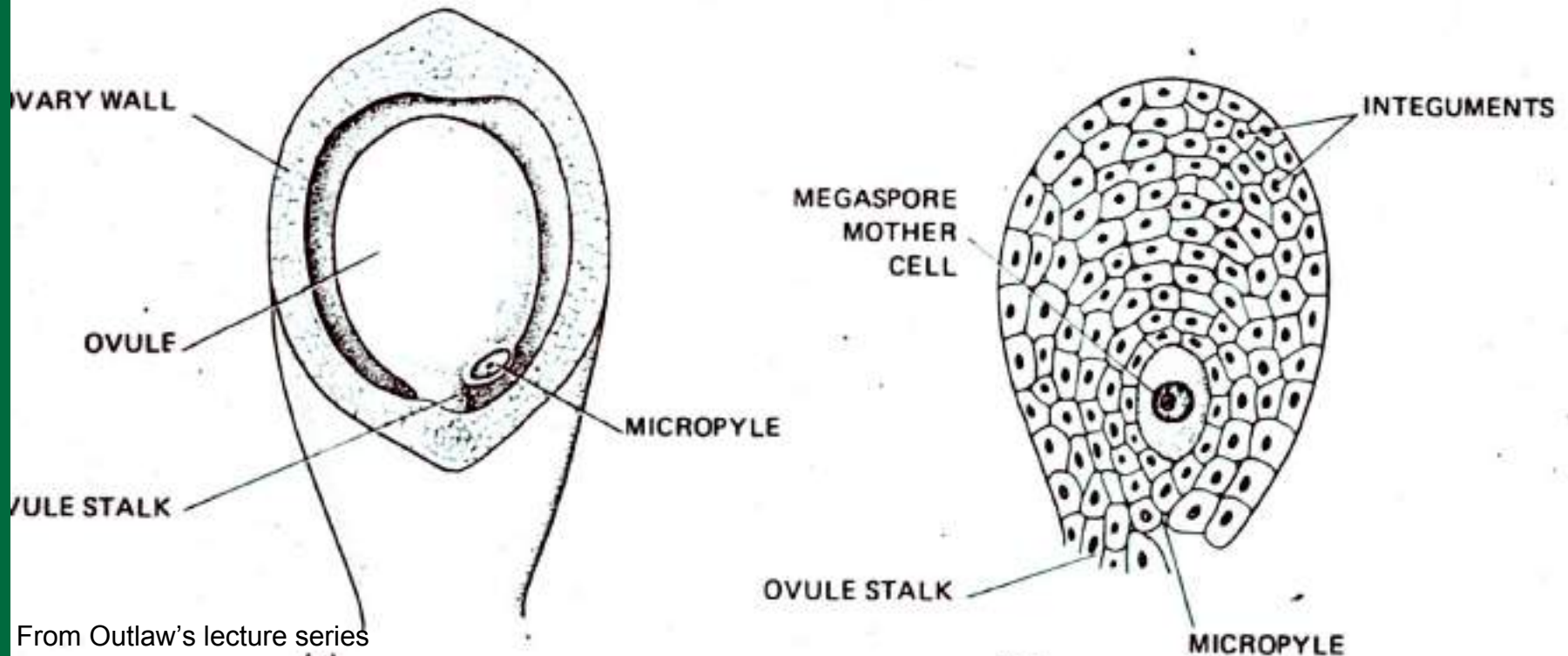
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**Distinguishing characteristics of angiosperms

Megasporogenesis within the ovule within the ovary

The swollen base of the carpel (megasporophyll) is the ovary. Ovules form on the inside and remain attached for nutrition. The megaspore mother cell ($2n$) is inside the ovule; it gives rise (through meiosis) to the megagametophyte, which completes its entire life within the ovule wall (later, seed coat).



Formation of megaspores & female gametes.

3 degenerate

Megaspore
mother cell

Meio
sis



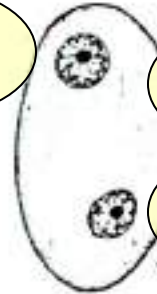
(d)

Mito
sis



(e)

Mito
sis

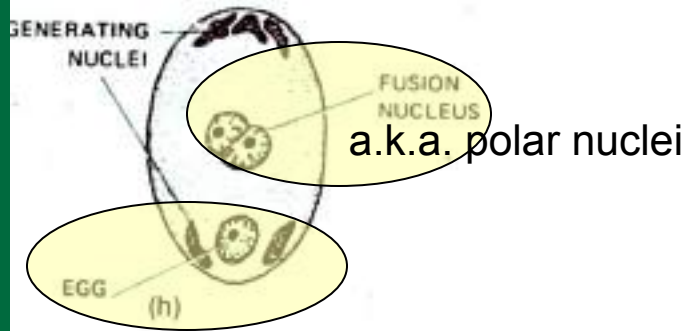


(f)

Mito
sis



(g)



From Outlaw's lecture series

Entire Female Gametophyte (angiosperms):

****3 round of mitosis to yield 8 nuclei .**

****Egg near micropylar end of female gametophyte.**

****Polar nuclei in the center of female gametophyte.**

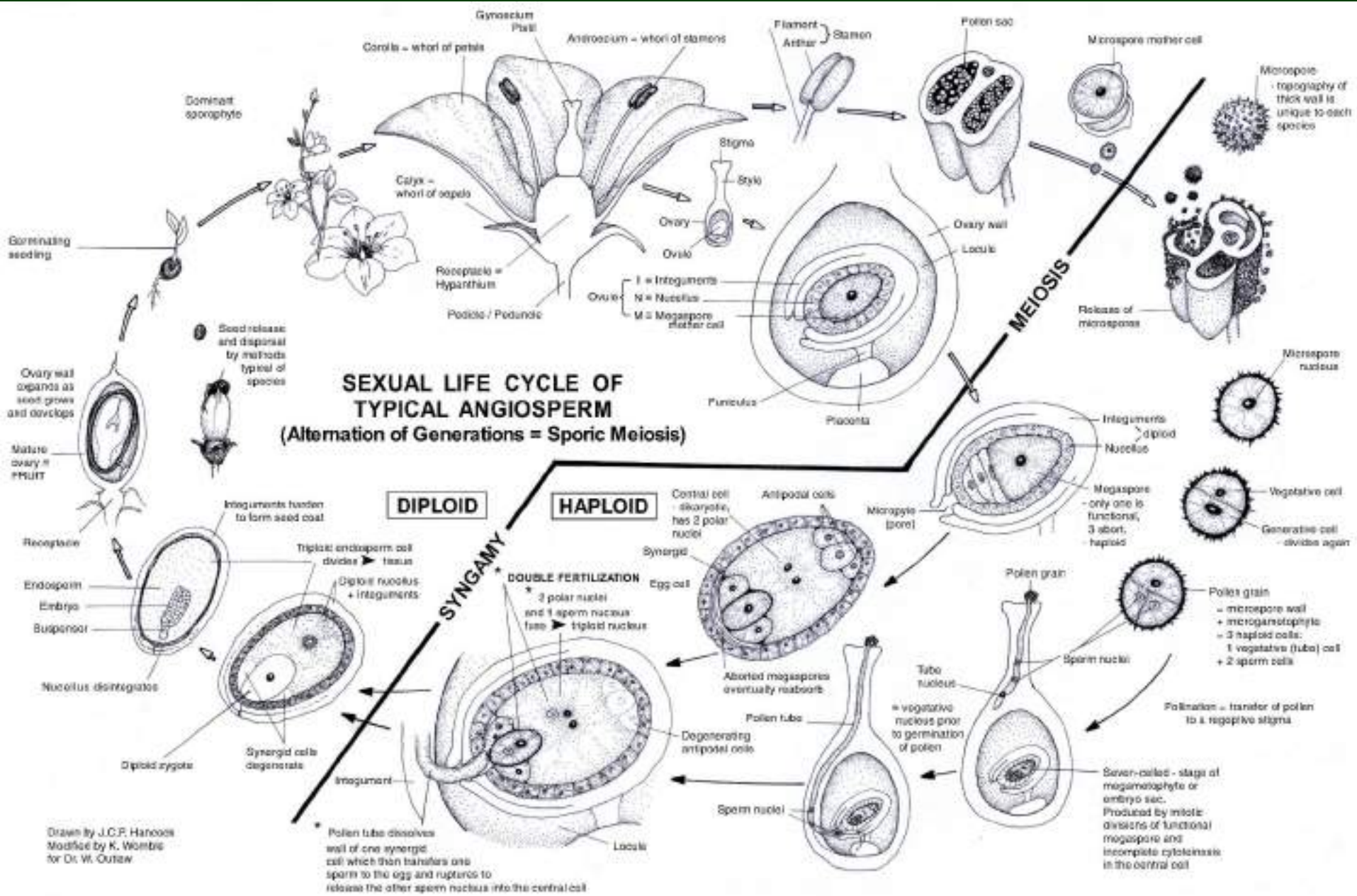
Megagametophyte

(Before migration of polar nuclei to center)



Megagametophyte

8-nucleate megagametophyte
within ovule of lily (only 6 nuclei are
visible in this section)



Today

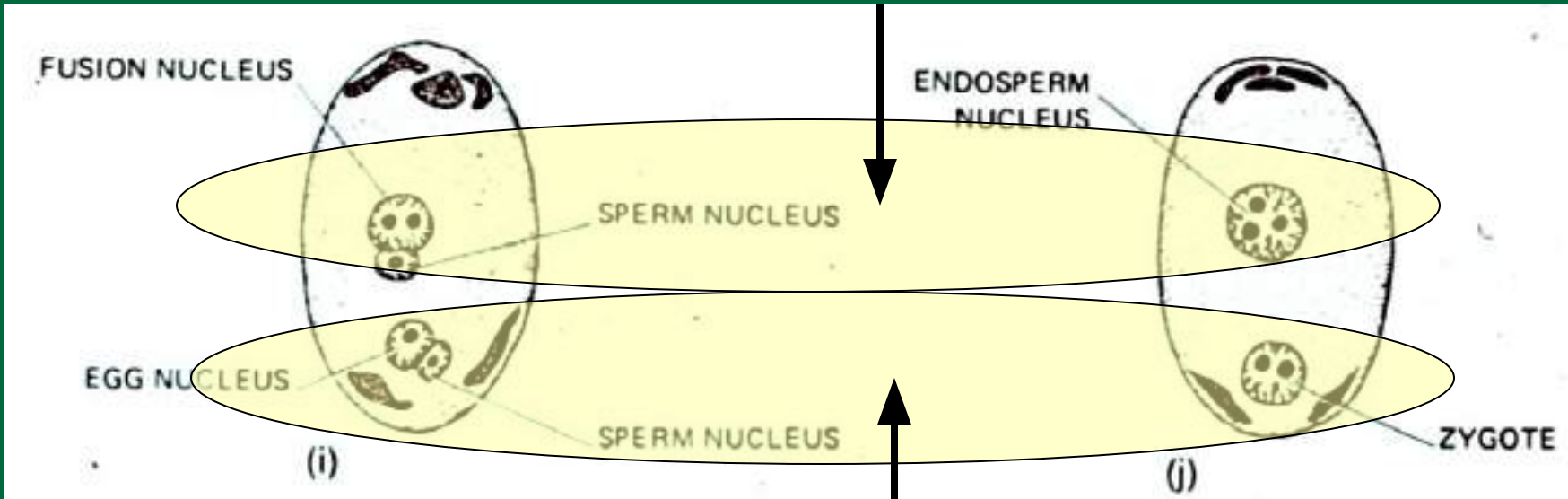
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**Distinguishing characteristics of angiosperms

Double

Fertilization

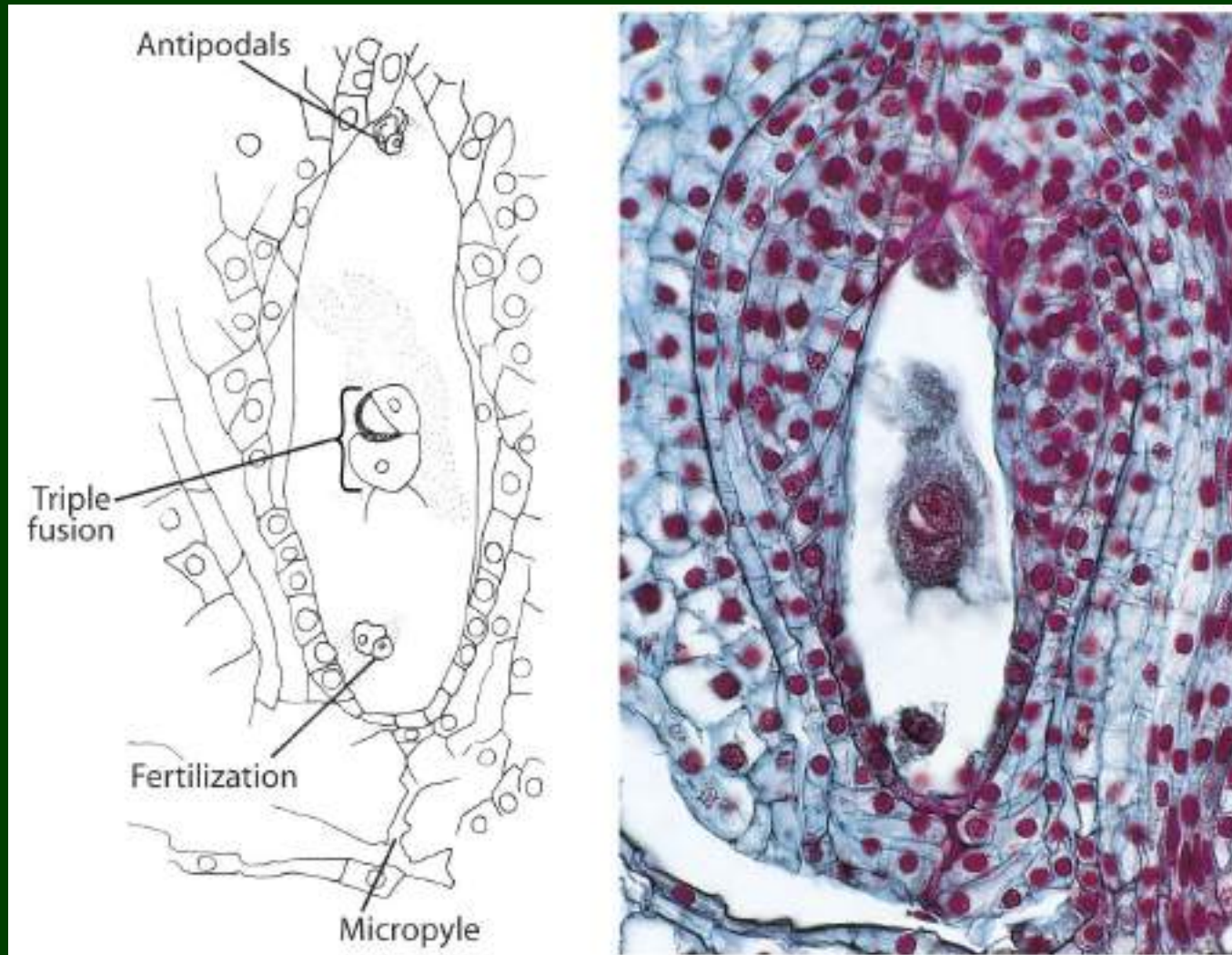
Second fertilization event: 1 male gamete (n) + 2 female gametes (n + n) = endosperm (3n)



From Outlaw's lecture series

Ordinary fertilization event: 1 male gamete (n) + 1 female gamete (n) = zygote (2n)

Megagametophyte after double fertilization



Today

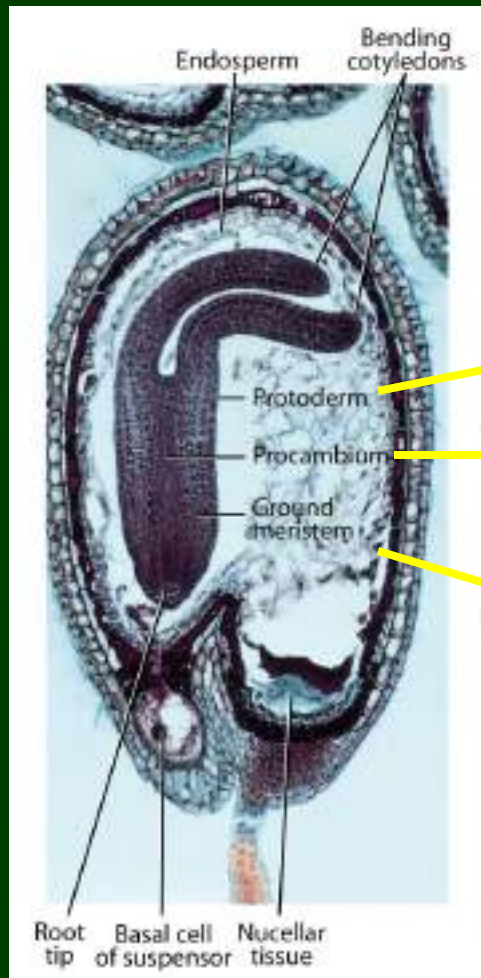
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- **Distinguishing characteristics of angiosperms

Seed development

immature

dicot - two cotyledons

mature



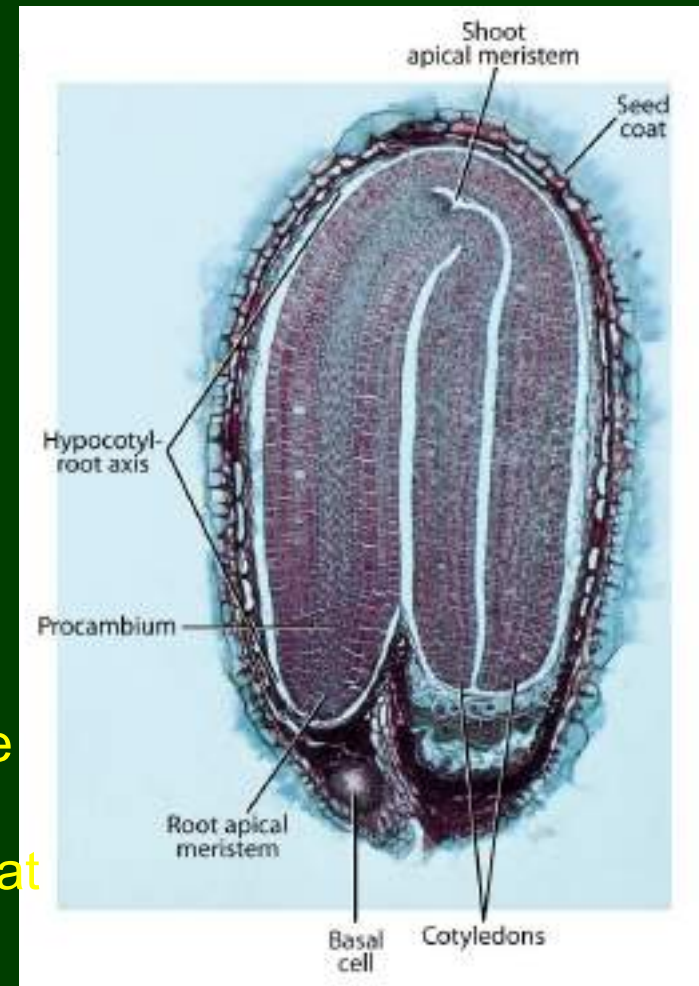
Three tissue systems:

Dermal

Vascular

Cortex or Ground

All cells of the plant are part of these three systems and originate at meristems



... A reminder that endosperm is formed in all angiosperms, but does not persist in dicots. In dicots, cotyledons are the primary source of nutrients for germination.

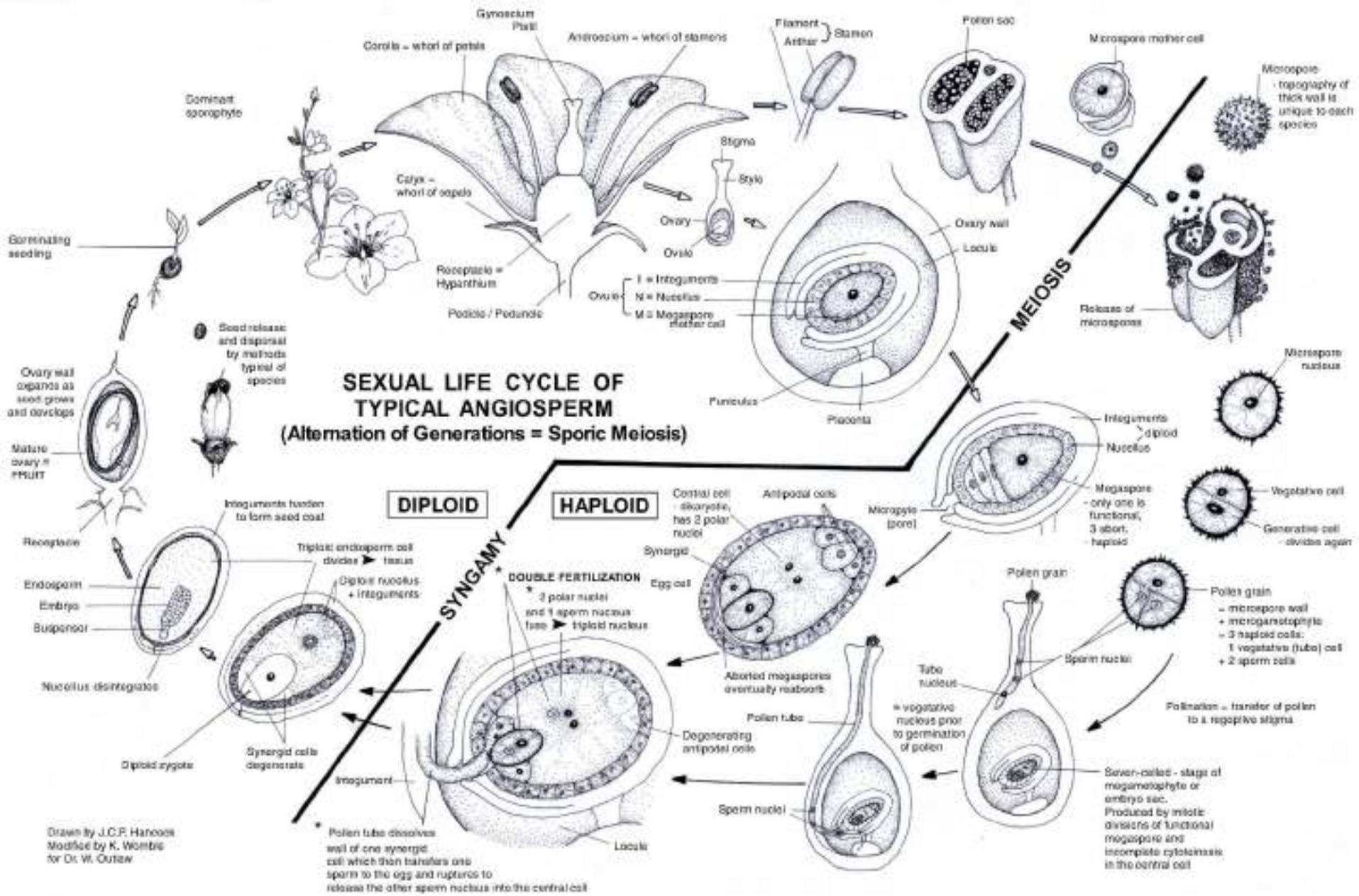
Seed development

typical monocot (wheat)
seed with ovary wall (pericarp)

Monocots have one cotyledon
that matures during germination

Source of nutrition for seed
germination: endosperm
(compare to dicot)





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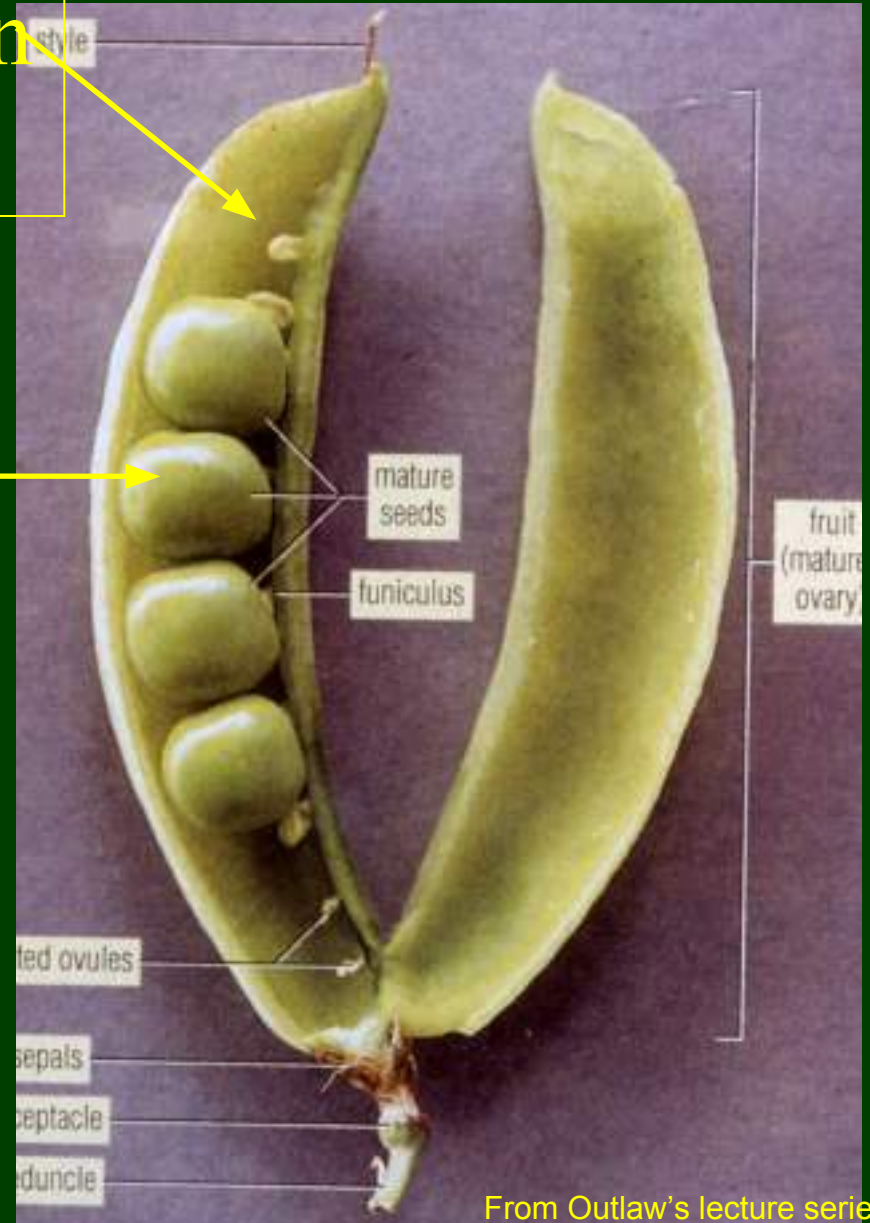
**Distinguishing characteristics of angiosperms

Angiosperm seeds are in
a vessel

All seeds have a seed coat
(plus embryo & nutritive
supply)

This simple fruit is derived from
one carpel with several ovules
and has marginal/parietal
placentation.

Reminder: carpels are modified leaves



From Outlaw's lecture series

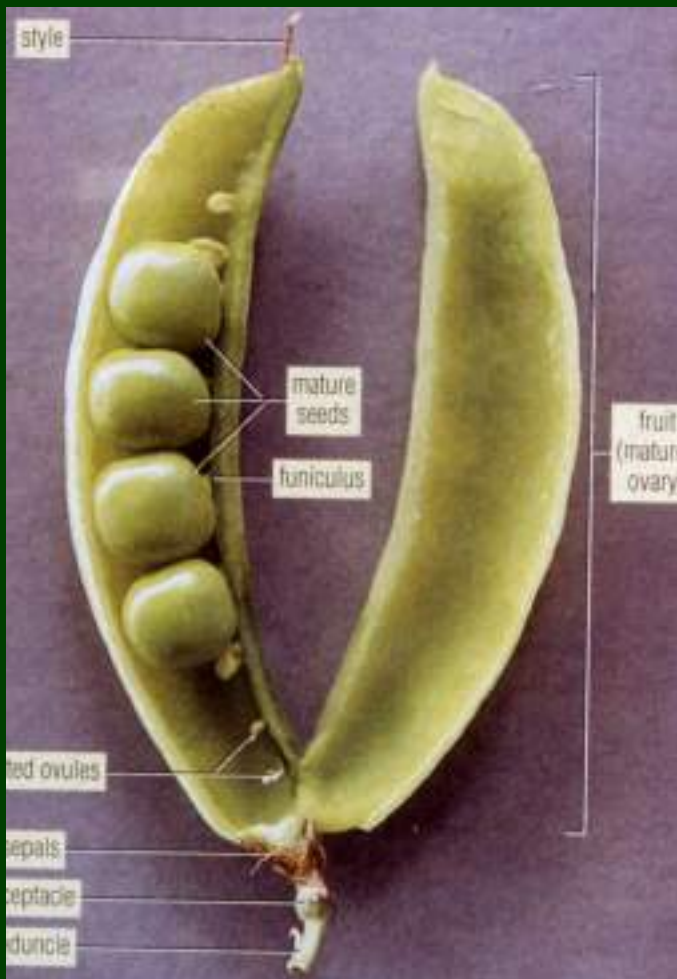
Pisum (Leguminosae family)

Fruit types

- Simple - one carpel or fused carpels
 - Fleshy
 - Berry - each carpel contains many seeds, inner layer of carpel fleshy
 - Drupe
 - Pome
 - Dry
 - Dehiscent
 - Indehiscent
- Aggregate
- Multiple

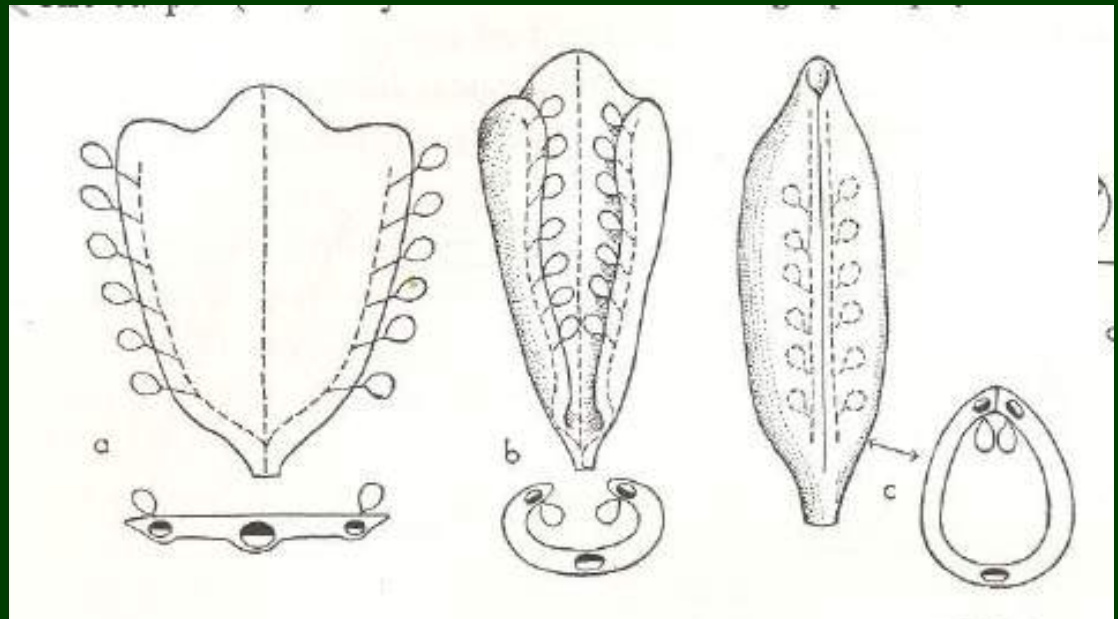
Simple

Each carpel contains many seeds, inner layer of carpel fleshy
Legumes are examples of simple, dry (for dispersal) fruits



Pisum (Leguminosae family)

Marginal placentation

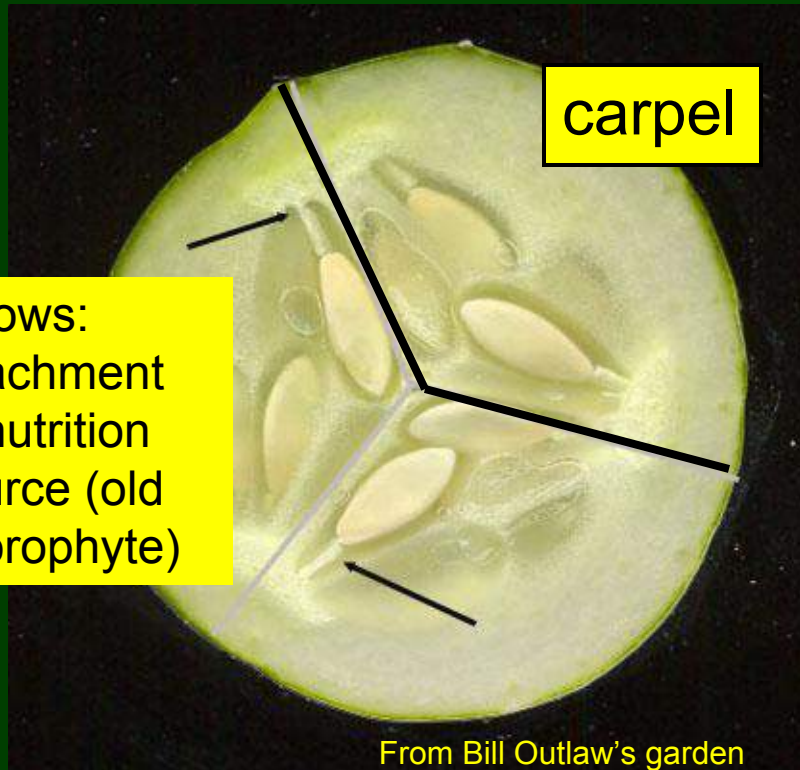


Recall that the carpel is a modified leaf (megasporophyll)

Pepo - a type of berry

a simple (not multiple or aggregate), fleshy fruit

Each carpel contains many seeds, inner layer of carpel fleshy

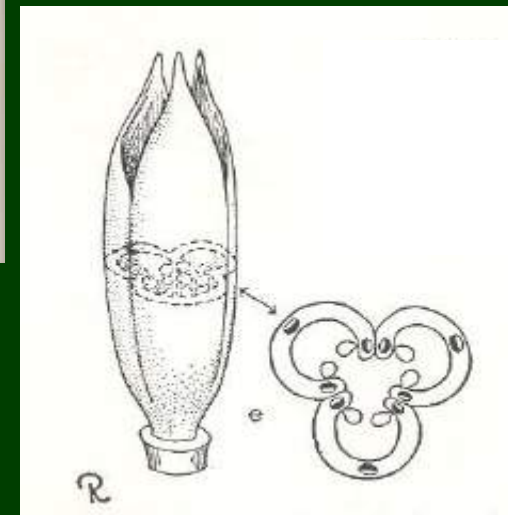
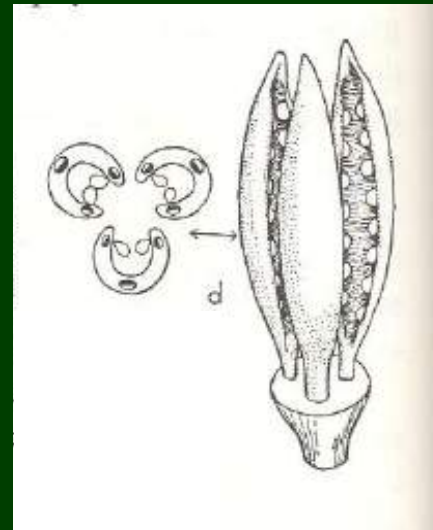


Arrows:
attachment
to nutrition
source (old
sporophyte)

From Bill Outlaw's garden

Cucumis (Cucurbitaceae family)

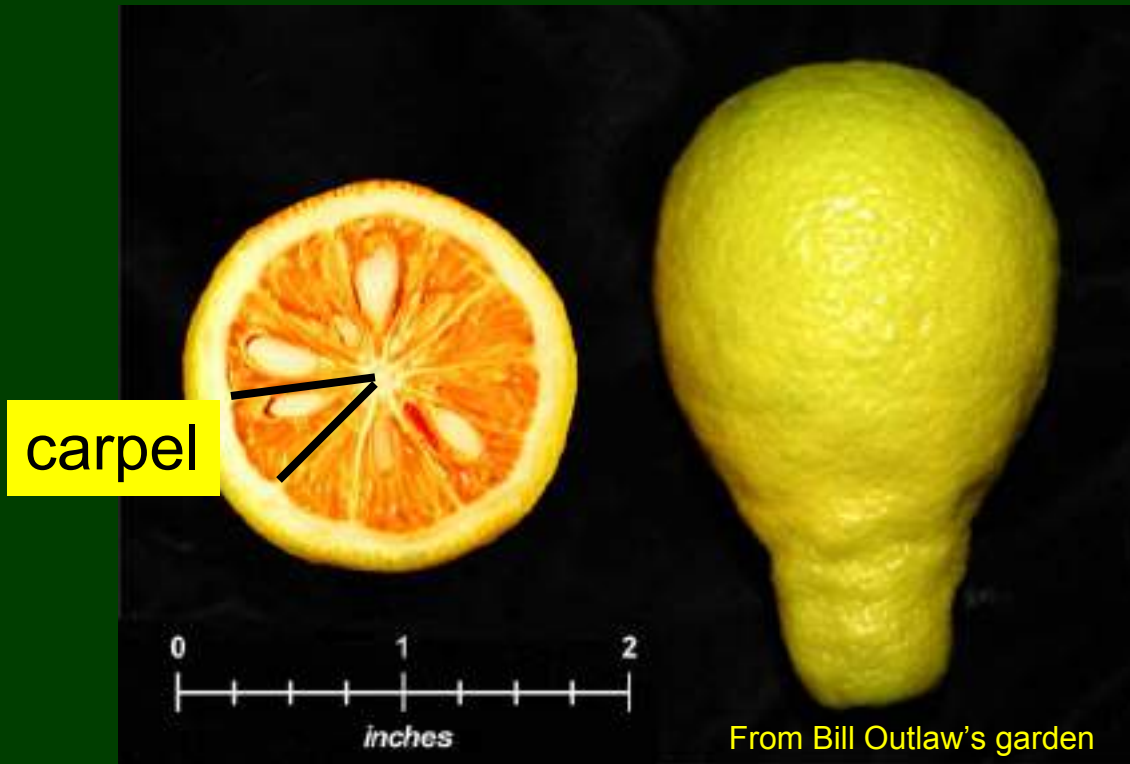
Parietal placentation



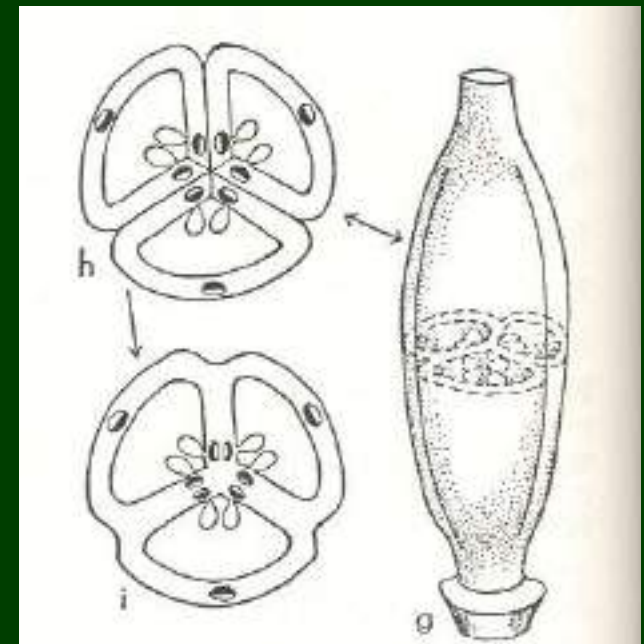
Berry

Each carpel contains many seeds, inner layer of carpel fleshy

Examples: citrus, tomato, grape



Axile placentation



Fruit types

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 - Indehiscent
- Aggregate
- Multiple

Drupe

Outer fleshy layer; stone-like inner layer from ovary wall

Examples: Peach, olive



Ovary

Seed within pit (ovary wall)

Photo by Bill Outlaw

Prunus (Rosaceae family)

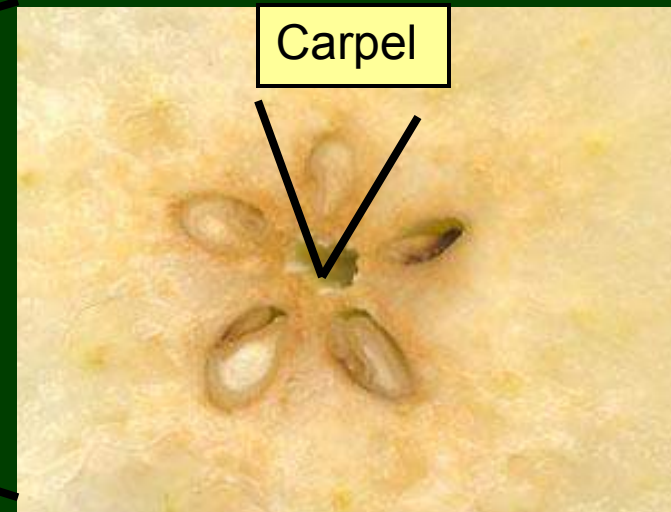
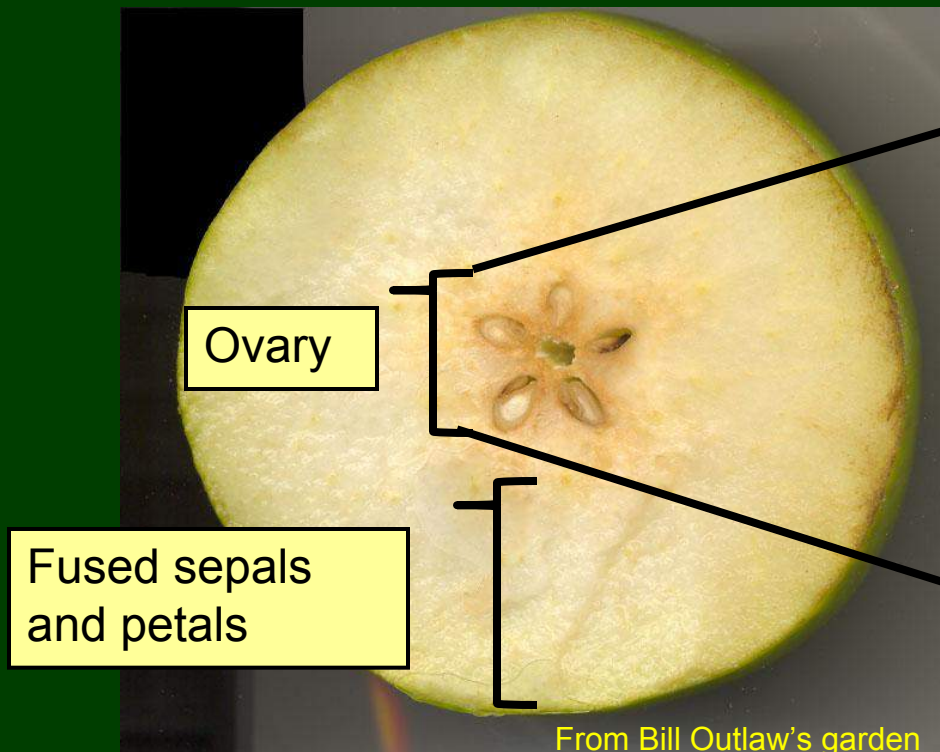
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 - Indehiscent
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- Multiple

Pome

Outer fleshy layer from fused sepals and petals. Core derived from ovary

Example: pear



Placentation type?

Axile

Pyrus (Rosaceae family)

Fruit types

- Simple - one carpel or fused carpels
 - Fleshy
 - Berry - each carpel contains many seeds, inner layer of carpel fleshy
 - Drupe
 - Pome
 - Dry
 - Dehiscent
 - Indehiscent
- Aggregate - separate carpels of one flower
- Multiple

Aggregate

Separate carpels of one gynoecium (gyno=woman, ecium=house)

Examples: strawberry, raspberry

Mock strawberry
aggregate of
achenes (small,
single-seeded fruits)

One flower with large
receptacle (base of flower)
and many carpels, each
produces a fruit; thus, we
eat the receptacle and the
fruits are often mistaken for
seeds



Rosaceae family

Photo by Bill Outlaw

Fruit types

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 - Fleshy
 - Berry - each carpel contains many seeds, inner layer of carpel fleshy
 - Drupe
 - Pome
 - Dry
 - Dehiscent
 - Indehiscent
- Aggregate
- Multiple - gynoecia of more than one flower; inflorescence

Multiple fruit

Gynoecia of more than one flower, inflorescence

Examples: mulberry, pineapple



Notice the remnants of the carpel of each flower of the inflorescence



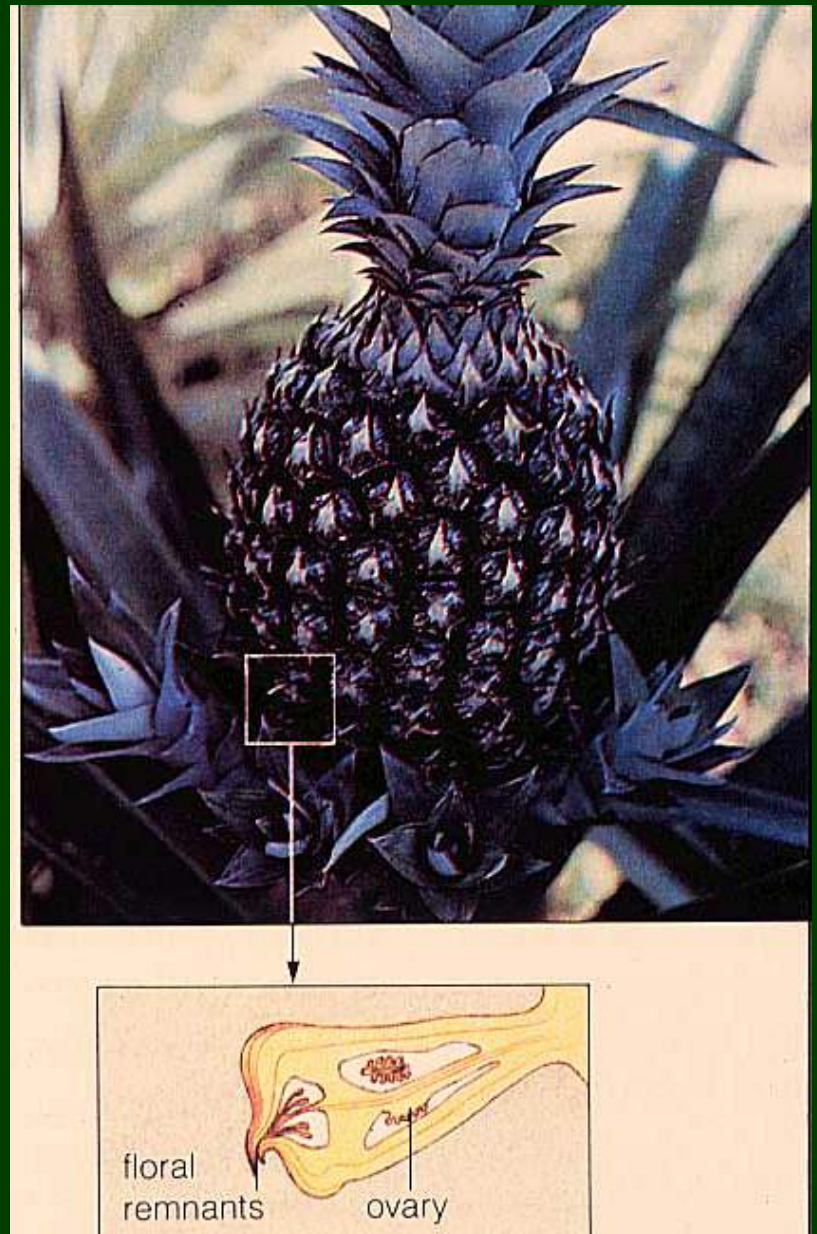
Morus (Moraceae family)

From Bill Outlaw's garden

Multiple fruit

Gynoecia of more than one flower, inflorescence

Examples: mulberry, pineapple



Ananas (Bromeliaceae family)

??

Type of fruit?

Type of placentation?

Single carpel or fused carpels?

One or many ovules per carpel?

Bonus: If this flower has a superior ovary, where would you find remnants of the petals?
Of the style?



Capsicum (Solanaceae family)

From Bill Outlaw's garden

??

Type of fruit?

Type of placentation?

Number of carpels?

Number of flowers that
produced this fruit?

One or many ovules per
carpel?



Photo by Outlaw

Malus (Rosaceae family)

Pawpaw for fun



From Bill Outlaw's garden

Pawpaw (Annonaceae family)

Largest edible fruit native to North America

A berry with marginal placentation

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Fruits and seed dispersal

dehiscence



Albizzia
(Leguminosae family)



Pisum
(Leguminosae family)

Used by Mendel for his studies of genetics

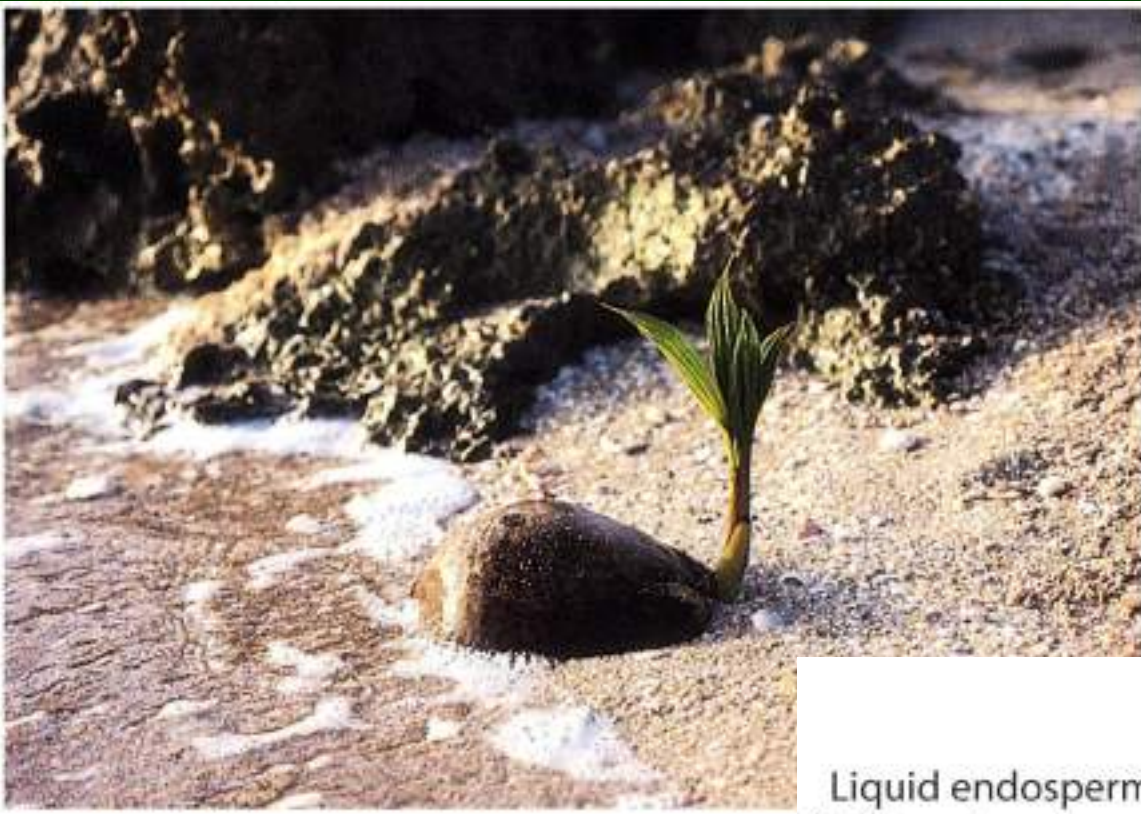


Griffonia
(Leguminosae family)

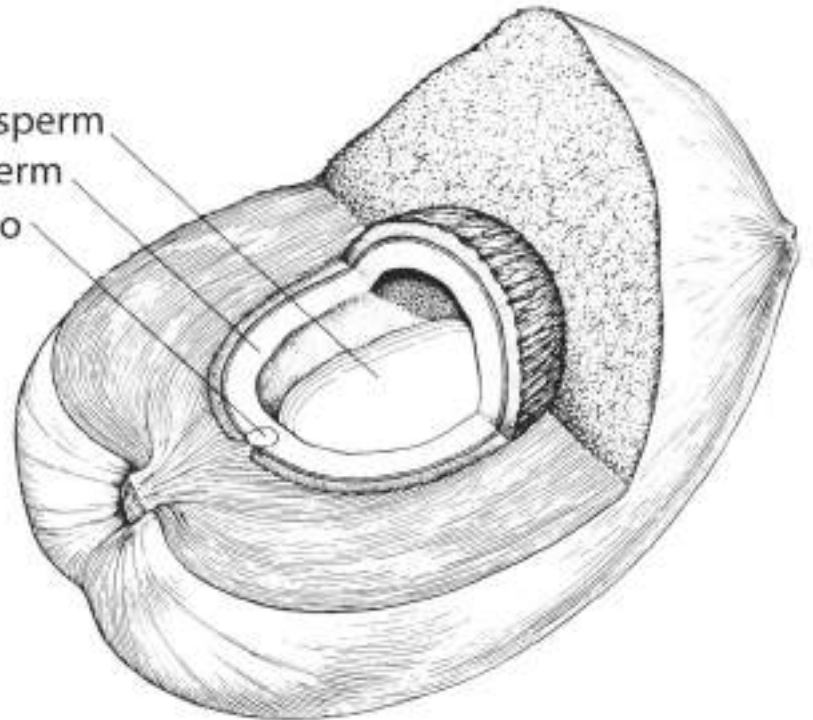
Type of fruit?

Type of placentation?

Fruits and seed dispersal water



Liquid endosperm
Solid endosperm
Embryo



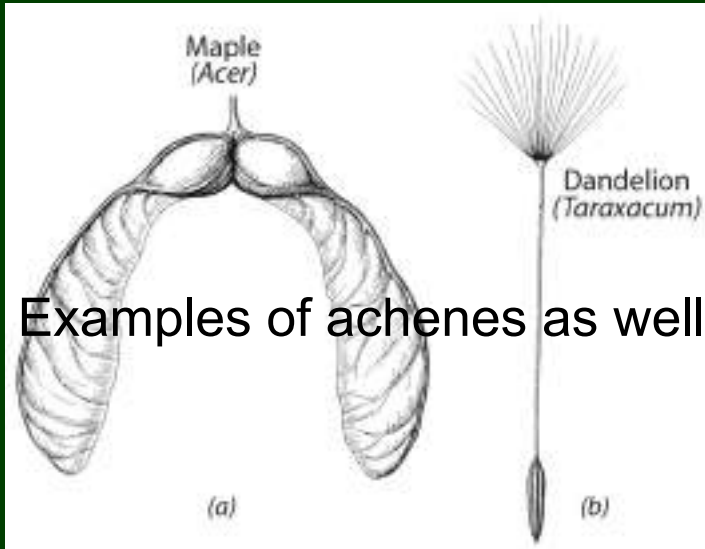
Cocos (Arecaceae family)

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Fruits and seed dispersal

wind



Agoseris (Asteraceae family)

Tumbleweed. The plant breaks off from its roots and blows across open terrain, scattering seeds as it rolls

Salsola (Chenopodiaceae family)



Fruits and seed dispersal

animals by attachment

All the various seeds that stick on your socks and pants stick to animal fur



Harpagophytum (Pedaliaceae family)



Xanthium (Asteraceae family)

Independent Germination Experiment

1. Be sure to design an experiment with repetition and control.
2. Turn in a design with the experimental question, hypothesis, and design details including measurements you will take.
3. You are required to bring your germinated seedlings when the report is due, so better not to delay beginning your experiment.