Sporogenesis & gametogenesis

Definitions

- **Mega** → Large, hence female
- **Micro** → Small, hence male
- **Spore** → Cells that result from meiosis in plants and fungi
- **Gamete** → Reproductive cells formed by mitosis
- **Genesis** → Creation, formation
- **Phyte** → Plant

Overview of floral organs

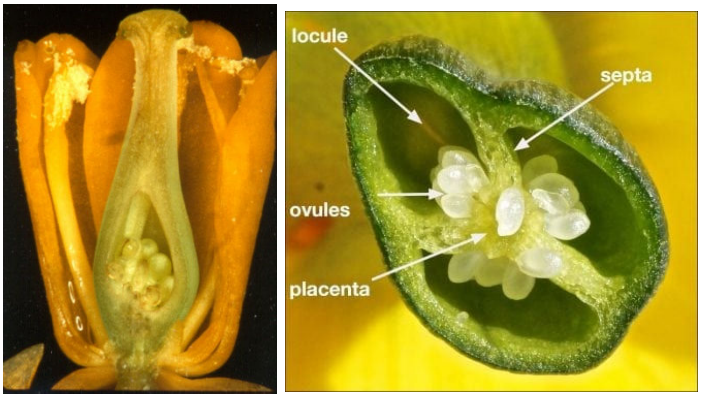
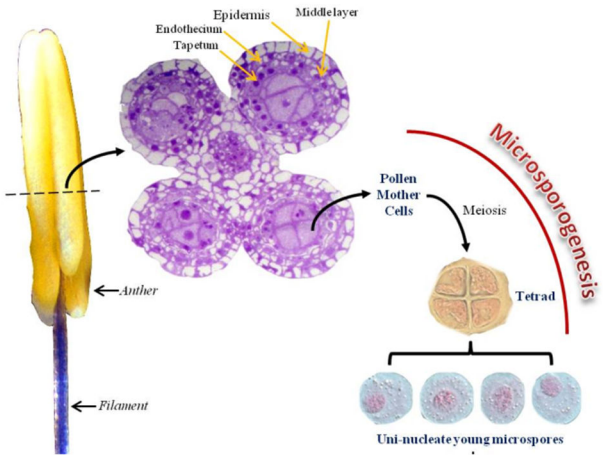


Figure 1.
http://courses.washington.edu/bot113/family_pages/Berberidaceae/berberidaceae.html
https://www.treeguideuk.co.uk/ovules-and-placentas/



Franchi, Pacini, Rottoli, 1984

Microsporogenesis

Meiosis that results in the formation of a male spore that will form the male gametophyte (Pollen)

- Starts with the microsporocyte or pollen mother cell
- Meiosis I is the same in both monocots and dicots

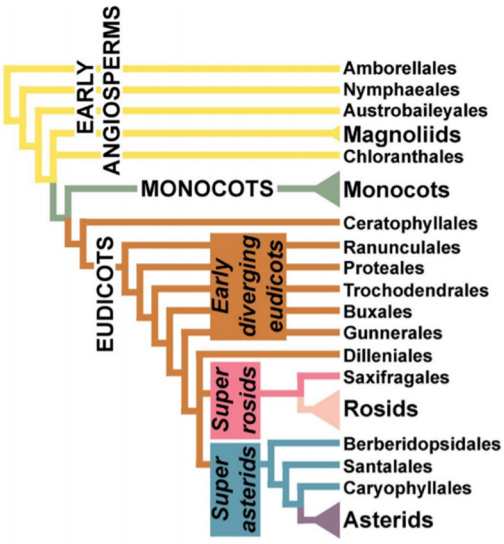


Figure 2. Byng et al 2018. The phylogeny of angiosperms poster: a visual summary of APG IV family relationships and floral diversity. http://www.plantgateway.com/globalflora/

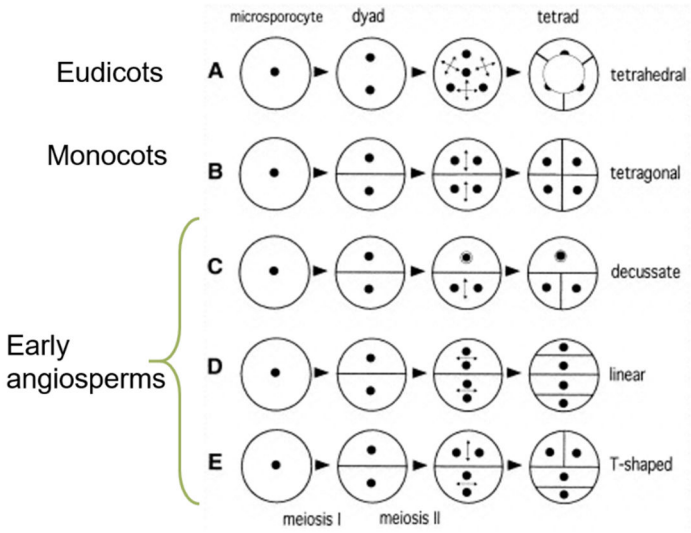


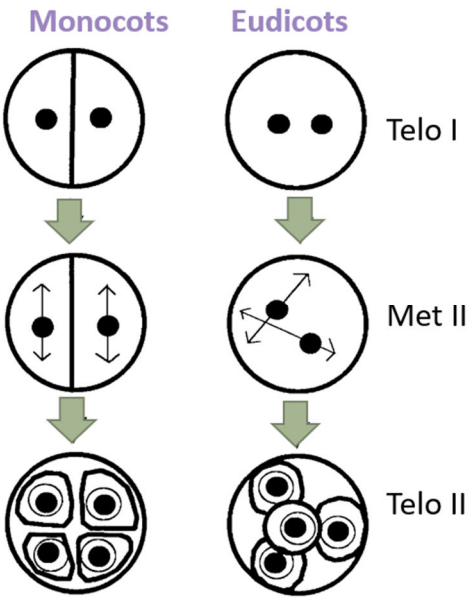
Figure 3. Furness et al., 2002

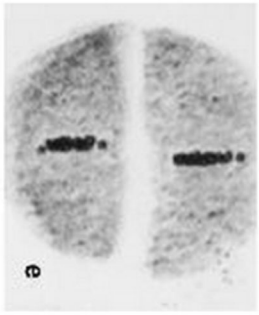
Monocots vs Eudicots

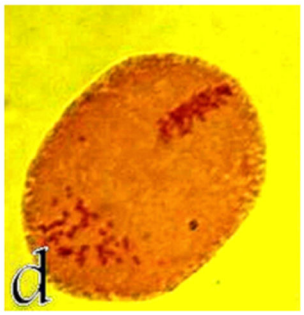
Cell wall formation occurs prior to Meiosis II in monocots, but not in eudicots

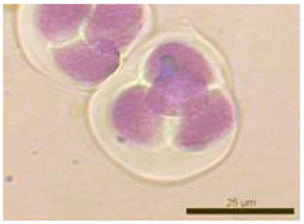
- In monocots, the Metaphase II spindles are parallel to each other. In eudicots, they are at angles, defining the poles of a tetrahedron (i.e., a pyramid)
- Simultaneous cell division occurs after telophase II

- The original cell wall of the pollen mother cell becomes a callose layer holding the microspores together
- Each telophase II cell becomes one microspore
- Monocots form a radial or tetragonal tetrad of microspores
- Eudicots form a tetrahedral tetrad
- Early dicots form decussate, linear or T-shaped tetrads









Cell Biology International 32: 1459-1463. Class alum Doug Heckart

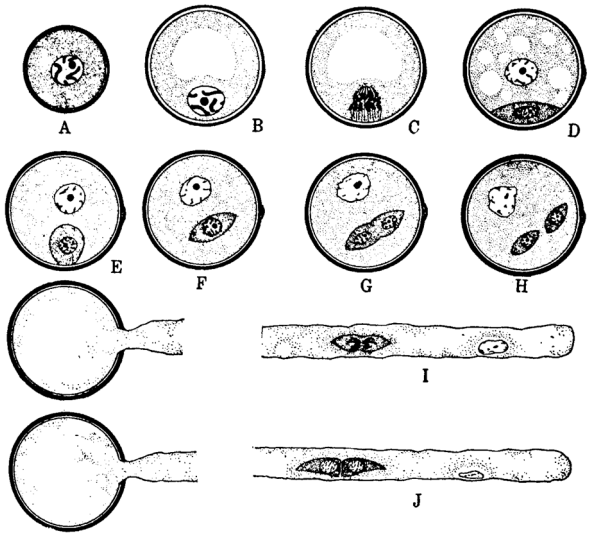
Caryologia 65:258-262. Class alumna Rebecca Tashiro

Microgametogenesis

Maheshwari, 1950

The formation of the male gametophyte (pollen) via mitosis from a microspore

Figure 4. Panchanan Maheshwari, 1904 – 1966. https://royalsocietypublishing.



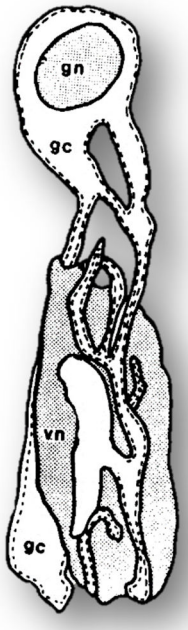
Stages of microgametogenesis. From Maheshwari, 1950

- The first mitotic division is asymmetric and gives a 2-cell pollen grain (D in the diagram)
- The nucleus in the center is called the vegetative or tube nucleus
- The generative cell (formerly called generative nucleus, but now know that it is a complete cell) divides to form two sperm cells
    - When this happens in the pollen tube, as in the example at right, the pollen is said to be binucleate
- In some plants, the division of the generative cell to form the two sperm cells occurs in the pollen grain itself
    - Such pollen is called trinucleate pollen

The male germ unit

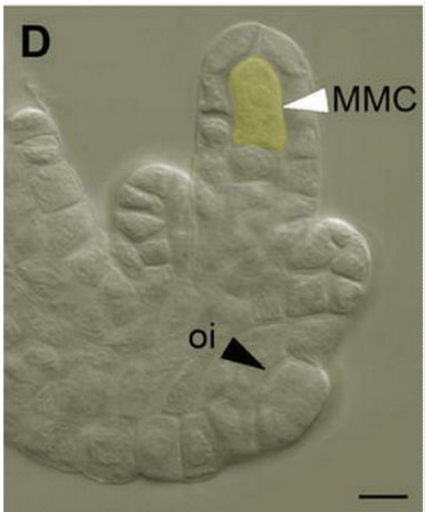
Morgensen, 1992

The nucleus of the vegetative cell and the generative cell [or sperm cell(s)] become associated in a complex known as the male germ unit



- In the diagram, gn = generative cell nucleus; gc = generative cell; and vt = vegetative cell nucleus.
- This association can be transient, as in barley, or long-lasting, as in rhododendron.
- Function of this association remains unknown

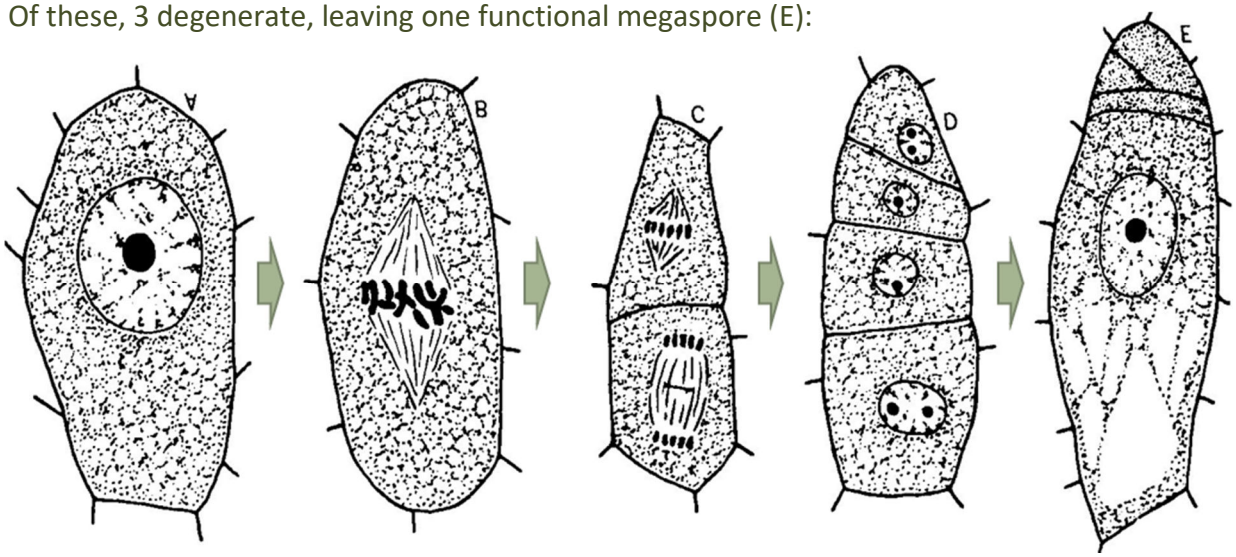
Megasporogenesis



Megaspore mother cell. Sexual Plant Reproduction 24:47-61

Megasporogenesis = the formation of the female spore (megaspore) via meiosis

In megasporogenesis, the megaspore mother cell (A) undergoes meiosis I (B) to form 2 daughter cells, each of which undergo meiosis II (C), forming a linear tetrad of megaspores (D). Of these, 3 degenerate, leaving one functional megaspore (E):



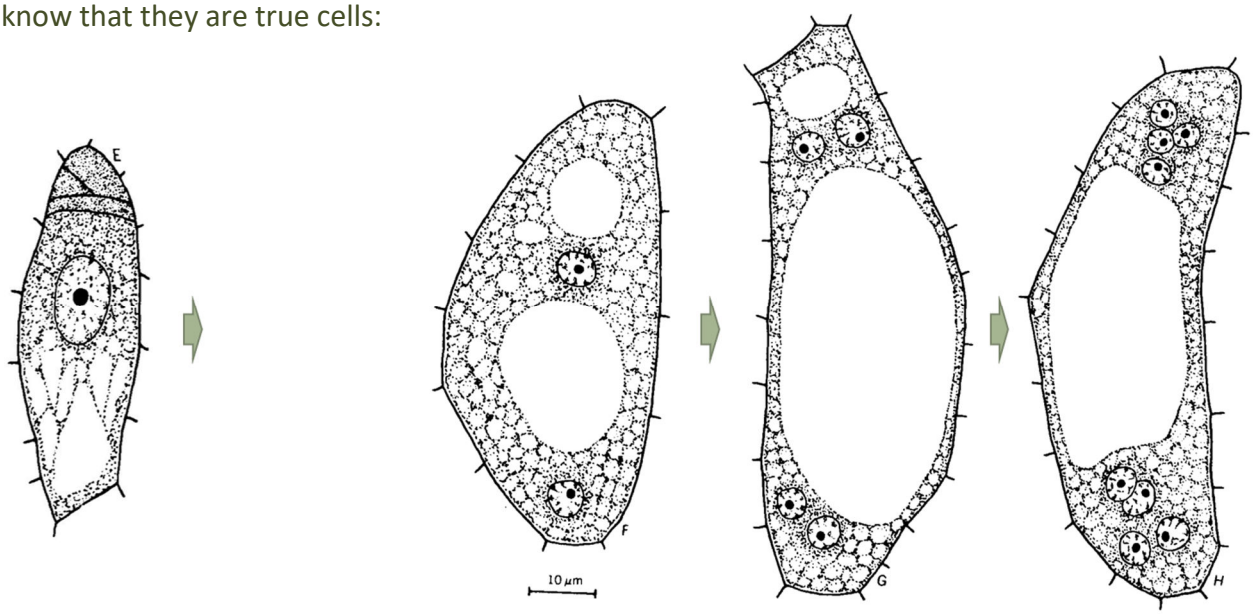
Mega sporo- and gametogenesis drawings by Walker, 1955

Megagametogenesis

Review by Yadegari & Drews, 2004

Megagametogenesis = the formation of the female gametophyte from the megaspore via mitosis

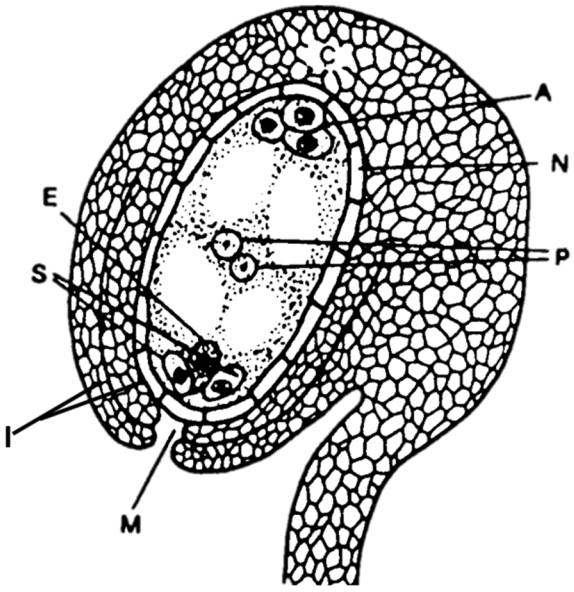
Megagametogenesis usually consists of 3 mitotic divisions to form an 8-celled megagametophyte. As with microgametogenesis, used to think these were nuclei, but now know that they are true cells:



Megagametophyte

Ovule- the female gametophyte and the integuments (tissues) around it. This becomes the seed.

Ovary- The basal part of the pistil, which contains the ovules inside of it. This becomes the fruit.



The mature megagametophyte is shown at the right

- This structure is called an embryo sac, but this is a misnomer
- Egg sac would be a better term.

- N = nucellus, often limited to a single row of cells, and surrounded by 1 or 2 integuments (I)
- M = micropyle;
- C = the chalazal region
- A = antipodals
- P = polar cells, which fuse to form the central cell
- S = synergids; E = egg

This type of egg sac is the most common type of all, and is called monosporic 8-celled, or simply, Polygonum type.

Maheshwari, 1950

- Monosporic - All cells in the Polygonum-type egg sac are derived from one telophase II nucleus. Consequently, all the cells in the egg sac have the same genotype.

- Bisporic - Cells in the egg sac are derived from two different telophase II nuclei. Consequently, cells of 2 different genotypes are present.

- Tetrasporic - All 4 products of meiosis contribute to the cells in the egg sac. Cells of four different genotypes can be present in the egg sac.

Type:	Megasporogenesis			Megagametogenesis			
	MMC	Meiosis I	Meiosis II	Mitosis 1	Mitosis 2	Mitosis 3	Egg sac
Monosporic 8-celled Polygonum type							
Monosporic 4-celled Oenothera type							
Bisporic 8-celled Allium type							
Tetrasporic 16-celled Peperomia type							
Tetrasporic 16-celled Penea type							
Tetrasporic 16-celled Drusa type							
Tetrasporic 8-celled Fritillaria type							
Tetrasporic 8-celled Plumbagella type							
Tetrasporic 8-celled Plumbago type							
Tetrasporic 8-celled Adoxa type							