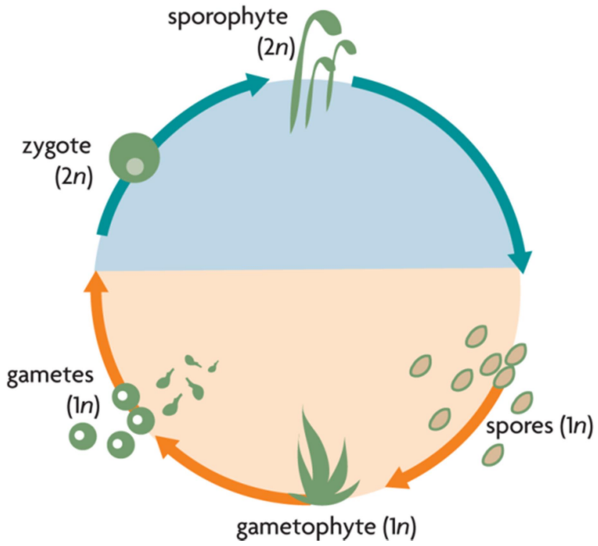
Lecture-3 Asexual Reproduction in flowering plants

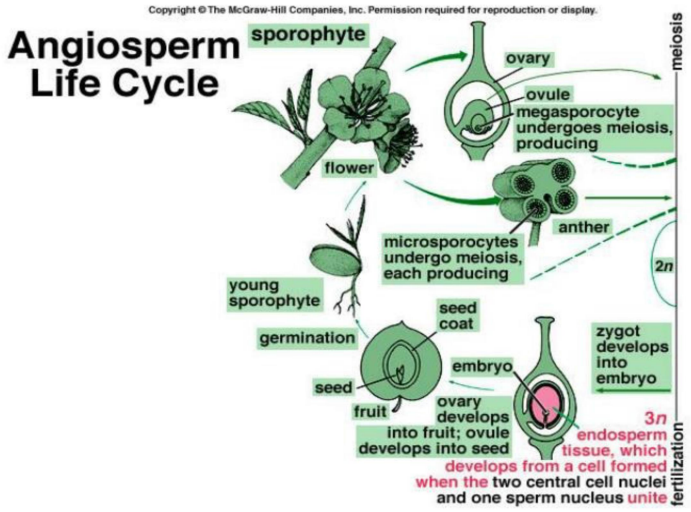
B. Asexual Propagation

Plant life cycles alternate between producing spores and gametes.

. A two-phase life cycle is called alternation of generations.

- haploid phase
- diploid phase
- alternates between the two

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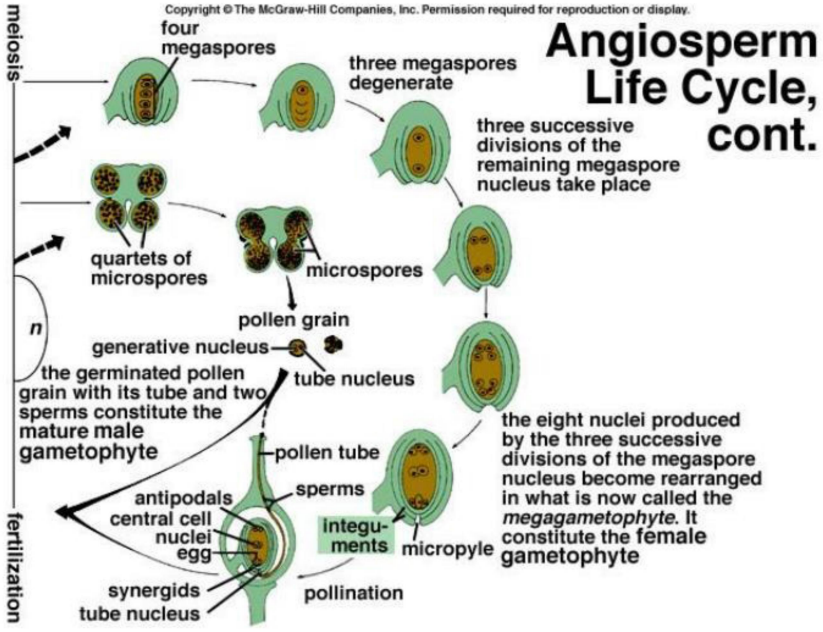
Angiosperm Life Cycle
sporophyte
ovary
ovule
megasporocyte undergoes meiosis, producing
meiosis
flower
anther
microsporocytes undergo meiosis, each producing
2n
young sporophyte
seed coat
germination
zygot develops into embryo
embryo
seed
fruit
ovary develops into fruit; ovule develops into seed
3n endosperm tissue, which develops from a cell formed when the two central cell nuclei and one sperm nucleus unite
fertilization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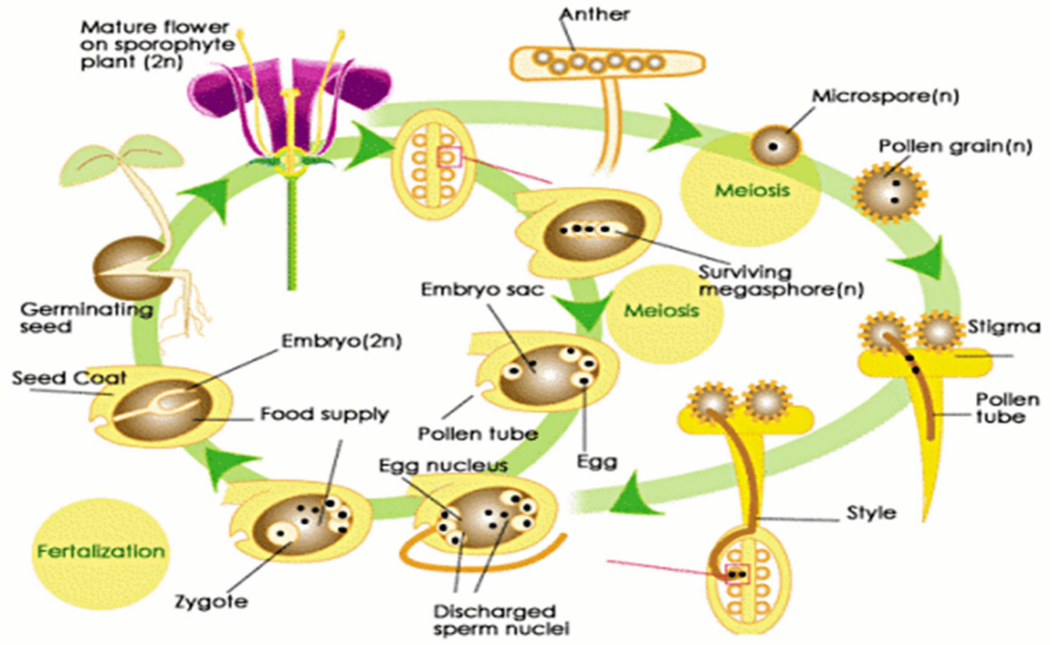
Angiosperm Life Cycle, cont.
meiosis
four megaspores
three megaspores degenerate
three successive divisions of the remaining megaspore nucleus take place
quartets of microspores
microspores
n
pollen grain
generative nucleus
tube nucleus
the germinated pollen grain with its tube and two sperms constitute the mature male gametophyte
the eight nuclei produced by the three successive divisions of the megaspore nucleus become rearranged in what is now called the megagametophyte. It constitute the female gametophyte
pollen tube
sperms
antipodals
central cell nuclei
egg
integu-ments
micropyle
synergids
tube nucleus
pollination
fertilization

Flowering Plant Life Cycle



Asexual reproduction is natural "cloning." Parts of the plant, such as leaves or stems, produce roots and become an independent plant

• It is independent of sexual propagation process as there is no involvement of sex organs.

• It takes place due to mitotic division. Mitotic division continues in shoot tip, root tip and cambium.

• When some portion of plant is wounded, mitotic division takes place.

• Under mitotic division, chromosomes divide longitudinally to form two daughter cells. This forms the basis of asexual propagation.

• The plants raised through asexual process are identical to mother plants. Cutting, division, layering, budding and grafting are main techniques of asexual propagation

Advantages

Propagation by asexual means has several advantages over sexual means, like

• Asexually propagated plants are true to type to their mother plants.

• Asexually propagated plants have short juvenile phase and bear flowers and fruits in the early age (3-4 years) than seedling plants.

• The vegetatively propagated plants are smaller in stature and hence management operations like spraying, pruning and harvesting etc. become easy.

• Plants in which seed setting does not take place, asexual propagation serves as a substitute for sexual propagation.

• Using asexual methods, desirable characters of a mother plant can be perpetuated/ multiplied easily.

• The benefits of rootstocks and scion are usually exploited through asexual propagation.

• Repairing of damaged portion of plant is possible through asexual propagation as in case of bridge grafting.

• It is possible to convert a non-productive local variety into productive improved variety by using asexual methods.

• It is possible to grow several varieties on one plant or change variety of existing plan by top working

Disadvantages

• Asexual propagated plants have shorter life-span.

• Asexual propagation restricts diversity.

• Sometimes asexual propagation disseminates diseases e.g. Tristeza virus in citrus.

• Technical skill is required

Terms to know

•Haploid: having a single set of chromosomes in each cell.

•Diploid: having two sets of chromosomes in each cell, one set from each parent.

•Mitosis: cell division, which produces two genetically identical diploid cells.

•Meiosis: reduction division, which produces four haploid reproductive cells

•Spore: haploid reproductive cell that leads to a gametophyte in plant alternation of generations.

•Gamete: mature haploid male or female germ cell able to unite with another of the opposite sex in sexual reproduction to form a zygote.

•Zygote: diploid, eukaryotic cell formed during fertilization event between two gametes, combining DNA of each gamete, containing the genetic information to form a new individual

•Sporophyte: diploid, multicellular stage which develops from zygote, produced when a haploid female cell is fertilized by a haploid male cell, produces haploid spores by meiosis.

•Gametophyte: haploid, multicellular stage, develops from a spore by mitosis, produces haploid gametes by mitosis

Function of cells and nuclei of embryo sac

Secondary Nucleus : During fertilization, the secondary nucleus fuses with one sperm to form a triple fusion nucleus (2n+n = 3n). This is called primary endosperm nucleus. It gives rise to the food storing **endosperm** of the seed in many plants.

Egg Cell : Fuses with the second male gamete (sperm) to give rise to the **zygote,** which develops into the embryo. This is called double fertilization.

Synergid Cells : Considered to help in fertilization by directing the pollen tube to the egg cell.

Antipodal Cells : Degenerate just before fertilization and contribute nutrition for the young embryo.

3. Microsporogenesis
   a. Occurs in anther regions called pollen sacs (microsporangia)
   b. Microspore mother cells produce microspores (immature pollen grains) via meiosis

4. Microgametogenesis
   a. Microspores differentiate into pollen grains
      1) Generative cell of microspore divides forming 2 sperm cells
      2) Occurs during pollen germination
   b. Mature male gametophyte (germinating pollen grains) consists of 3 cells, 2 of which are nonflagellated sperm

5. Pollen grains
   a. Outer wall, exine, contains chemicals that interact with stigma of flower
   b. Aperture(s) in wall involved in pollen tube formation

POLLEN GRAIN:

 The pollen grains represent the male gametophytes.

 Each pollen grains has a two-layered wall. The outer hard layer called the exine is made up of sporopollenin which is one of the most resistant organic material that enables them to resist high temperature and strong acid and alkali. No enzyme is yet known to degrade sporopollenin.

 The region on exine where sporopollenin is absent are called the germ pores. It helps in the formation of pollen tube.

 The inner layer is thin called as intine. It is composed of cellulose and pectin.

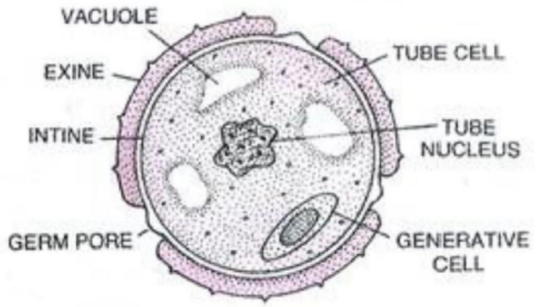
 A mature pollen grain contains two cells ,the vegetative cell and the generative cell.

 The vegetative cell is bigger, has abundant food reserve and a large irregular shaped nucleus.

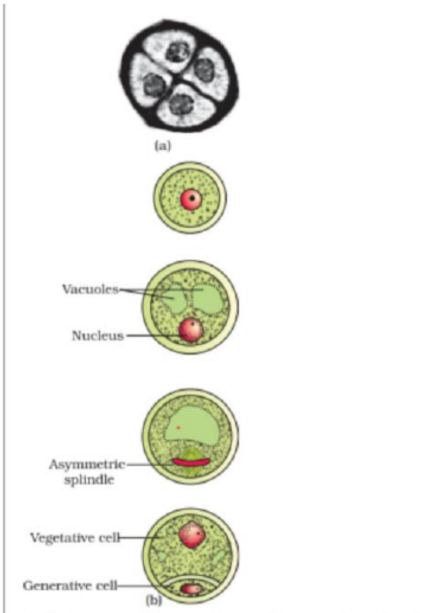
 The generative cell is small and floats in the cytoplasm of the vegetative cell.

 In about 60% of angiosperms, pollen grains are shed at this (2- celled stage).

 In the remaining species, the generative cell divides mitotically to give rise to .two male gametes before pollen grains are shed (3 celled stage)



. Section of a mature 2 celled pollen grain of an angiosperm.



(a) Enlarged view of a pollen grain tetrad (b) stages of a microspore maturing into a pollen grain

THE MEGASPORANGIUM (OVULE)

 The main parts of megesporangium (ovule) are –

i. Funicle—stalk that attached ovule to placenta

ii. Hilum—Junction between ovule and funicle.

iii. Integuments—one or two protective envelops around the ovules.

iv. Micropyle—a small opening at the tip of integuments.

v. Chalaza—basal part of ovule.

vi. Nucellus—mass of cells enclosed within the integuments having abundant reserve food material

vii. Embryo sac or femal gametophyte—it is located inside the nucellus

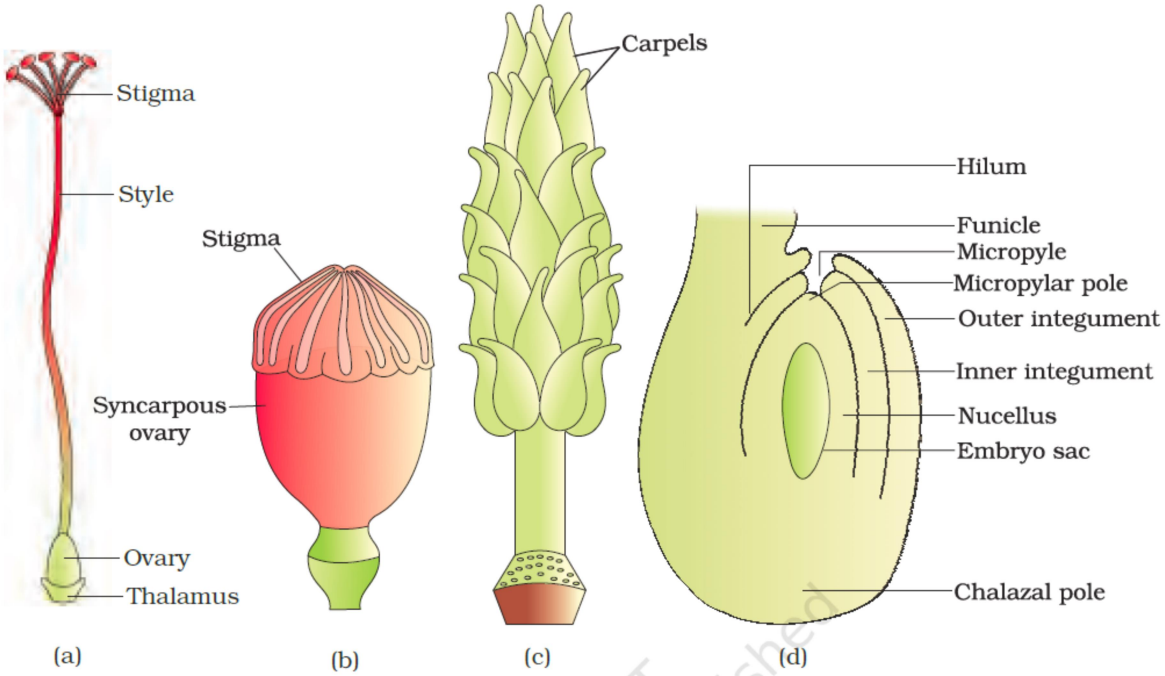


Figure 2.7 (a) A dissected flower of *Hibiscus* showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*; (d) A diagrammatic view of a typical anatropous ovule

MEGASPOROGENESIS – The process of formation of haploid megaspores from megaspore mother cell (MMC) through meiosis is called megasporogenesis.

 The megaspore mother cell divides meiotically to form four haploid megaspores.

 One of the megaspore is functional while the other three degenerate in majority of the angiosperms.

 Only the functional megaspore develops into female gametophyte or embryo sac.

 This method of embryo sac formation from a single megaspore is termed as monosporic development

Structure of an Embryo sac: Embryo sac consist of—

i. Egg apparatus – present at the micropylar end. It consists of two synergids and one egg cell.

ii. Antipodals – Three cells present at the chalazal end.

iii. Central cell—It has two polar nuclie.

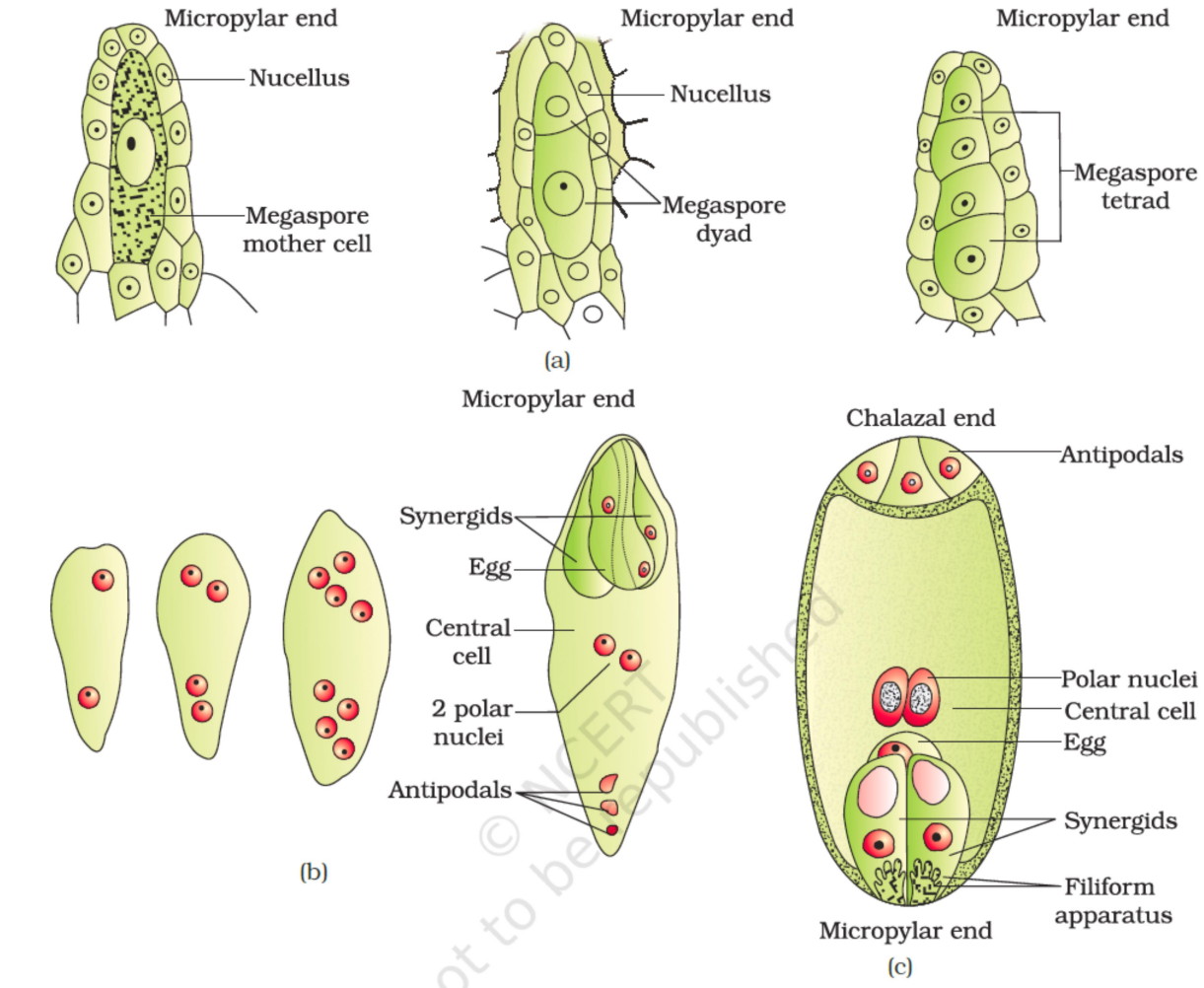


Figure 2.8 (a) Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores; (b) 2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac.