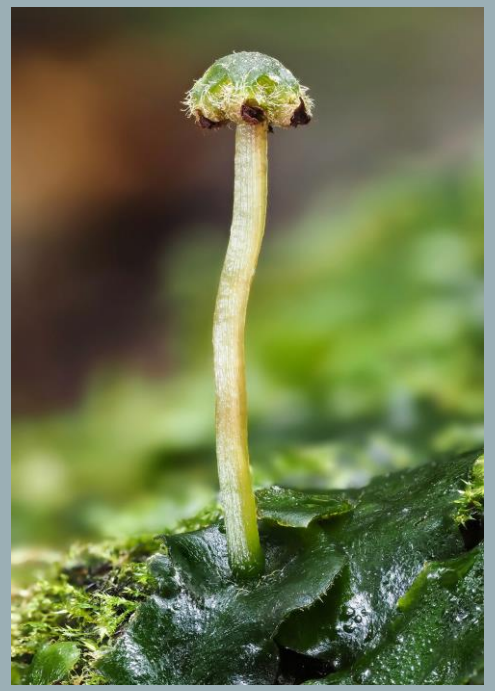
ARCHEGONIATE



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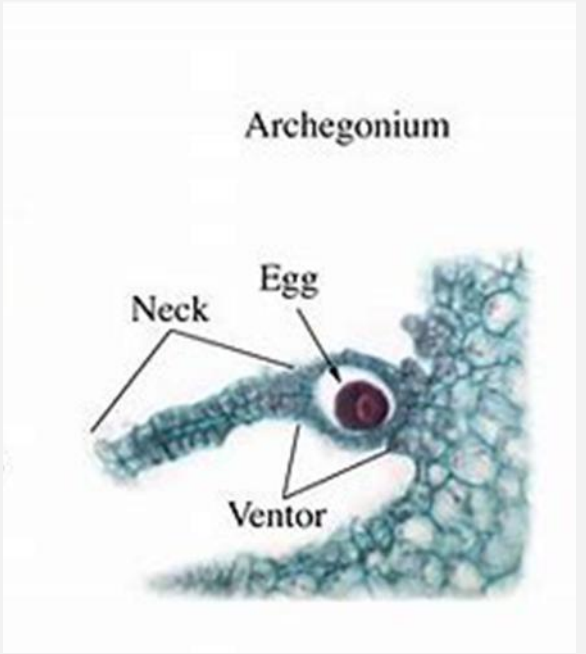
WHAT IS ARCHEGONIATE ?

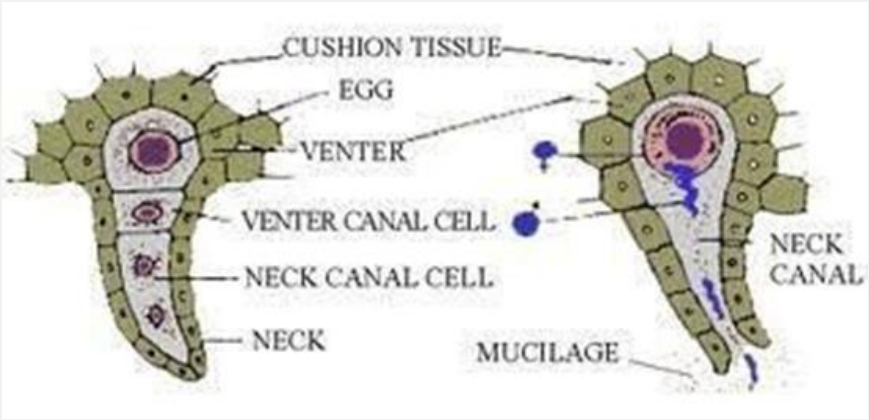
Archegoniate is a higher taxonomic term that indicates those embryophytes having a female sexual organ in the form of Archegonium.

The term ‘Archegonium’ was first introduced by a Russian botanist Ivan Nikolaevich Gorozhankin in 1876 to indicate a division including Bryophytes, Pteridophytes and Gymnosperm.

Archegonia is a multicellular, flask-shaped, egg-producing organ occurring in mosses, liverworts, ferns and most gymnosperms.

As the archegonium matures the neck-canal cells, located above the egg, disappear thus producing a passage for entry of the sperm.





STRUCTURE OF ARCHEGONIUM

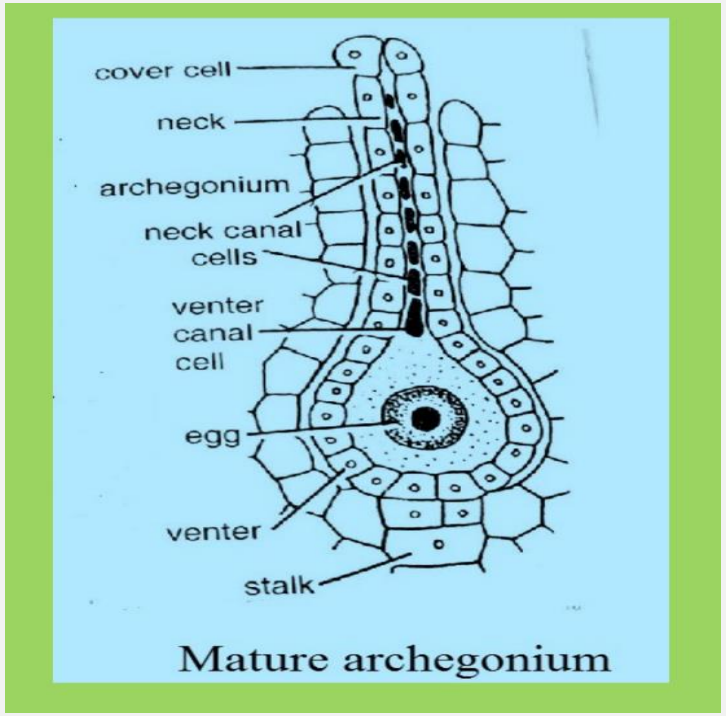
Archegonium consists of two main parts:

1. A basic swollen fertile part known as venter that includes two unequal cells;

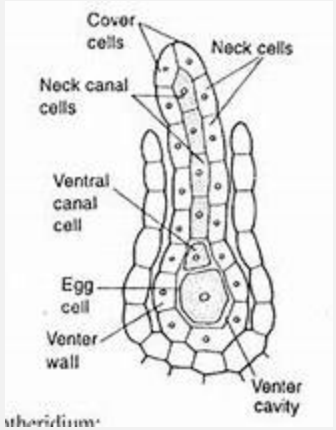
- **Larger fertile cell (egg) and**
- **a smaller elongated sterile cell (venter canal cell)**

2. An upper elongated slender part known as neck that usually contains a row of cells (4-6) known as neck canal cells.

- **A sterile wall formed of one or more layers of cells that extend to cover the neck and venter protects the whole structure.**
- **This archegonia may be stalked or sessile and its tip is usually cover by four special cells known as cover cells**

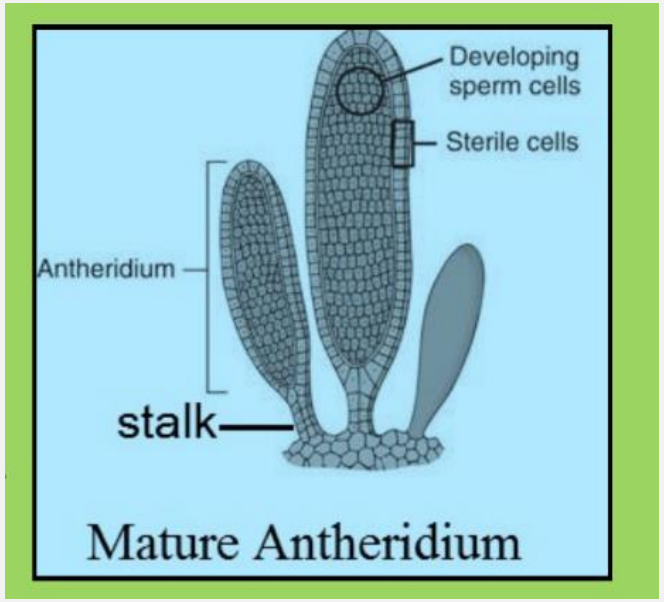


Mature archegonium



ANTHERIDIUM

- The male (♂) sexual organ of all archegoniate plants are called antheridium.
- Is a stalked club– shaped structure consists of spermatogenous tissue that develops into several cubic sperm–mother cells.
- These cells produce slightly twisted sperms that may be bi-flagellated or multi-flagellated.
- After being release from the antheridium, they swim in water and are attracted to the opened channel of archegonial neck (this phenomenon known as chemo taxis) for fertilization of the egg cell.



SPORES IN ARCHEGONIATE PLANTS

- The spores in archegoniate plants may be
- similar size
- different sizes.
- In the first case the plant is known as “homosporous”
- In the second case the plant is known as “heterosporous”
- In Heterosporous type:
- The larger spore (megaspore or macrospore) gives rise to female gametophyte.
- The smaller one (microspore) gives rise to male gametophyte.

Homosporous: found in all Bryophyta and a part of Pteridophyta.

Heterosporous: found in a part of Pteridophytes and all Gymnospermae.

UNIFYING CHARACTERISTICS OF ARCHEGONIATES

- The archegoniates seem to have originated from a monophyletic group of aquatic green algae.
- Presence of Female sexual organs are called archegonium and the male sexual organs are called antheridium.
- The presence of Chloroplasts containing chlorophyll a, b and carotene.
- The presence of multicellular gametophytic and sporophytic generation.
- Heteromorphic alternation of generation. (The heteromorphic alteration of generation occurs when the organisms have haploid gametophytic generation whereas diploid sporophytic generation)
- Provides protection to their embryo.
- Male gametes are flagellated and motile in bryophytes, pteridophytes, (Cycadales, Ginkgoales) while the female gamete (egg) is non-motile.

- Water is needed for fertilization in Bryophytes and Pteridophytes but not in Gymnosperms.
- In gymnosperms, pollen grains germinate to form a pollen tube (siphonogamy) which is not dependent on external fluid water to reach the archegonial neck.
- Differentiated tissues with thickened cell walls (collenchyma) and lignified walls (sclerenchyma) to support the erect habit.
- Efficient spore dispersal mechanism.
- The archegoniates evolved several adaptive strategies to survive on land.

A comparison between the three divisions of Archegoniate

Features	Bryophyta	Pteridophyta	Gymnosperms
Dominnant phase	Gametophyte	Sporophyte	Sporophyte
Ploidy of main plant body	Haploid	Diploid	Diploid
Differentiation of body	Thallus and rhizoids	Roots, stem and leaves	Roots , stem and leaves
Vascular bundles	Absent	Present	Present
Nature of spores	Homospores	Homospores or heterospores	Heterospores
Seed and its coverings	Seed absent	Seed absent	Seed naked without covering
Flower	Absent	Absent	Absent

TRANSITION TO LAND HABIT

- The first multicellular organisms that lived in the water are green algae which are considered to be the ancestors of land plants.
- Between 510-630 millions years ago, the land plant evolved from aquatic plants, specifically from green algae (Chlorophyceae).
- Molecular phylogenetic studies conclude that bryophytes are the earliest diverging lineages of the extant land plants.
- The first plants to colonize land were most likely closely related to modern day mosses.
- They were followed by liverworts and primitive vascular plants – pteridophytes.
- This transition from water to land habit was made possible due to different adaptations that occurred in those plants.

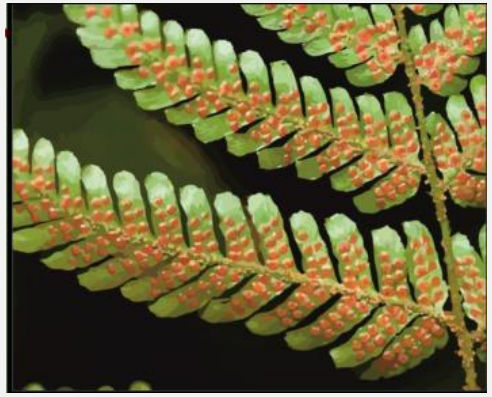
Adaptations of plants for transition from water to land habit

- Development of organs for attachment and absorption of water.
- Body support : Supportive structures developed to withstand the forces of gravity. Such as Rigid cell walls, different types of supportive tissues (e.g., woody tissues, branch cells, etc.).
- Organ develops for transport of materials.
- Absorption of CO_2 from the atmosphere for photosynthesis.
- Protection of reproductive cells from drying and mechanical injury.
- Mechanism of fertilization.
- Development and dispersal of the embryo.

ALTERNATION OF GENERATION IN ARCHEGONIATES

- First time demonstrated **by Hofmeister (1851).**
- Also called as **metagenesis** or **heterogenesis.**
- ***"Alternation of generations is a type of life cycle in which subsequent generations of plants alternate between diploid and haploid organisms."***
- Alternation of generations is common in plants, algae, and fungi. This can be compared to the sexual reproduction in animals where both haploid and diploid cells are found in every generation.
- The alternation of generations depends upon the type of the plant.

Stages of Alternation of Generations



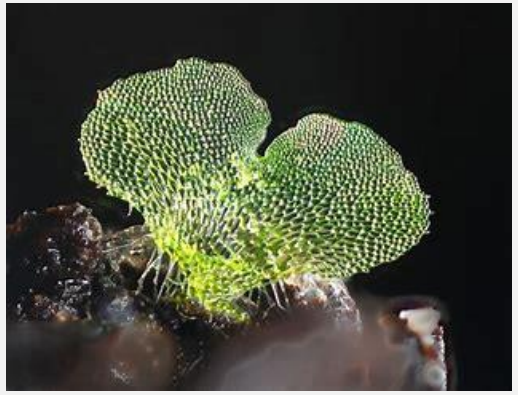
Following are the two stages of alternation of generations:

❖ **Sporophyte Generation**

- Two haploid gametes fuse together to form a diploid zygote. This results in a sporophyte.
- The sporophyte is formed by multiple rounds of mitosis and is a multicellular organism.
- On reaching maturity, the sporophyte develops reproductive organs known as sporangia.
- These sporangia are used to create haploid spores. These spores are released and carried away by air and water and when the conditions are favorable they develop into a gametophyte.

❖ Gametophyte Generation

- The gametophyte generation creates gametes.
- These gametes are produced by gametangia.
- These gametes are then transferred between plants or spread into the environment.
- When a gamete encounters a gamete of the opposite sex, it fuses with it to form a zygote which eventually becomes a sporophyte.



Alternation of generations in different plants

Depends on type of plant

- Bryophytes(mosses and ferns)
  - dominant generation-haploid phase
  - main plant body is composed of gametophyte
- Pteridophytes and gymnosperms
  - dominant generation- diploid phase
  - main plant body is composed of sporophyte.

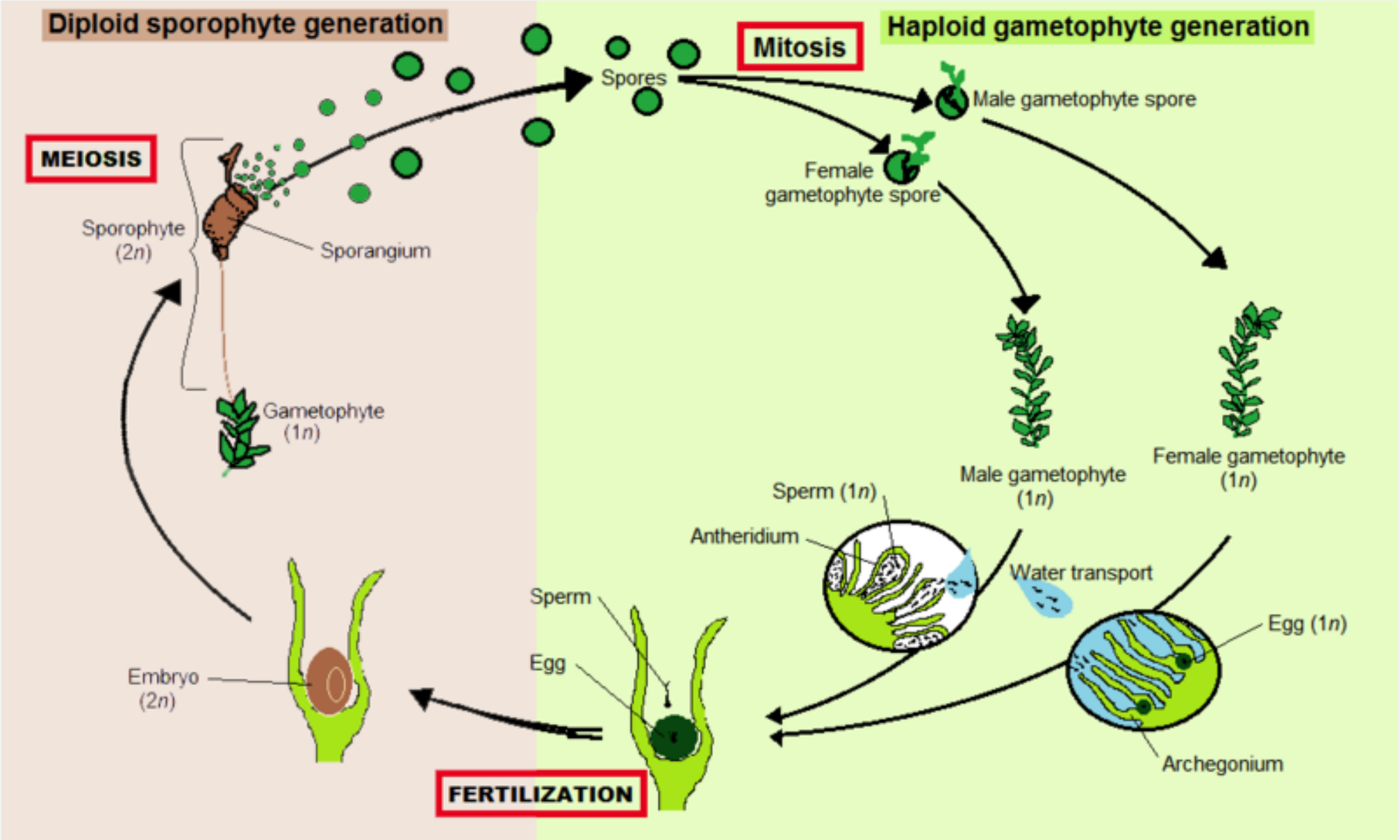
Significance of alternation of generation:

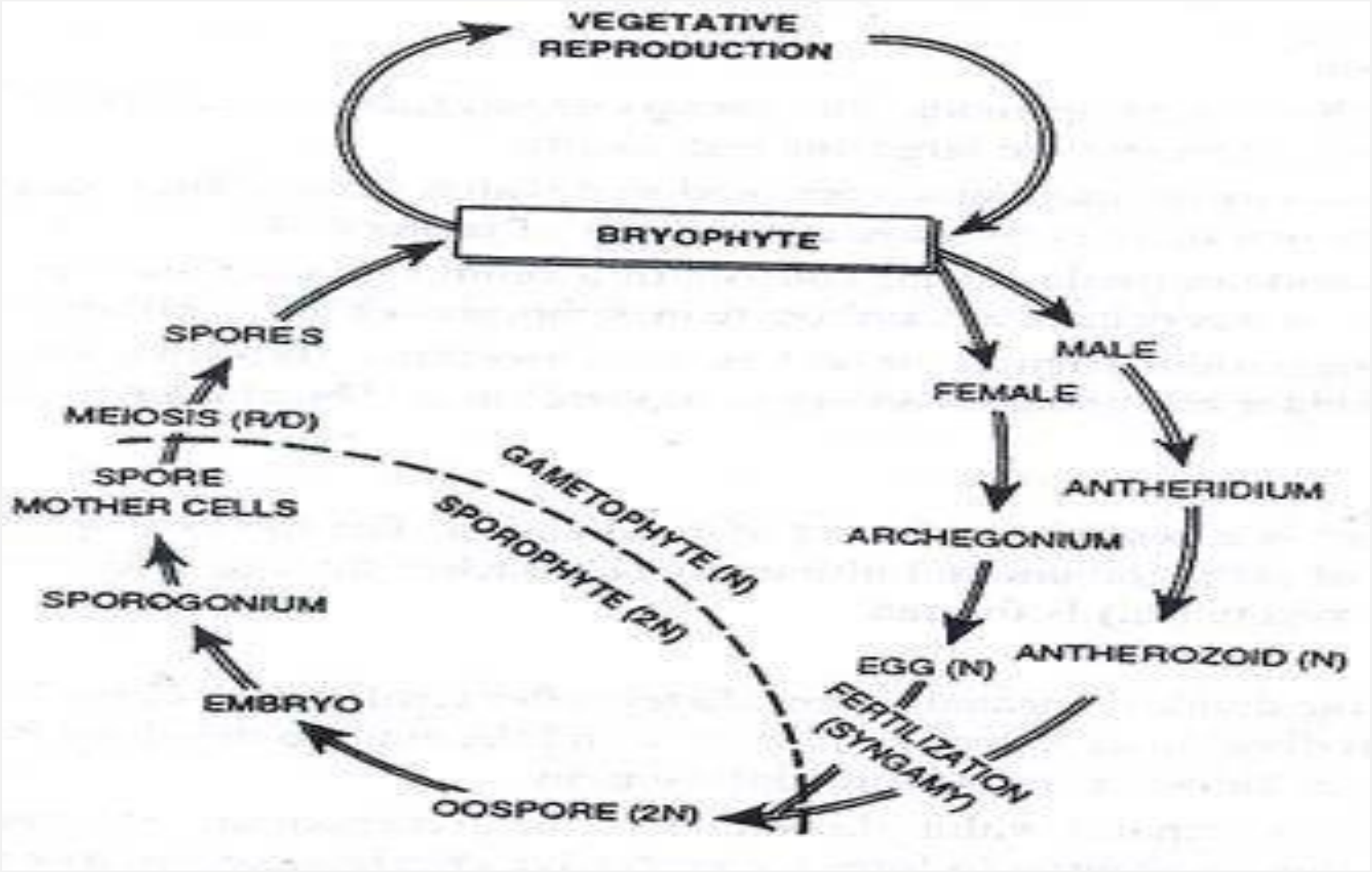
- Better chance for survival
- Better adapted to environment
- Newer varieties develop
- Variations are produced during meiosis

Alternation of generation in Bryophytes

- **Haploid phase (n)** is **gametophytic generation or sexual phase.**
- Bears reproductive organs
  - produce **antherozoids** and **eggs**
- **Gametophytic stage** - longer lived ,conspicuous as compared to sporophyte.
- Gametophytic stage is dominant in life cycle.
- **Diploid phase (2n) or the sporophytic stage**
  - gametic union results into the formation of zygote which develops into sporophyte.
  - Meiosis in SMC(spore mother cell)
  - spore formed
  - germinate to form gametophyte again.
  - cycle continues with alternation b/w gametophye and sporophyte.
- **Sporophyte dependent on gametophyte**
- **Heteromorphic alternation of generation.**

Alternation of generation in Bryophytes




VEGETATIVE REPRODUCTION
BRYOPHYTE
SPORES
MALE
FEMALE
MEIOSIS (R/D)
SPORE MOTHER CELLS
GAMETOPHYTE (N)
SPOROPHYTE (2N)
ANTHERIDIUM
ARCHEGONIUM
SPOROGONIUM
EGG (N)
ANTHEROZOID (N)
EMBRYO
FERTILIZATION (SYNGAMY)
OOSPORE (2N)

Alternation of generation in Pteridophytes

❖ **Haploid phase (n) is gametophytic generation or sexual phase**.

• Bears reproductive organs

-anthredia and archegonia

• Anthredia and archegonia produced - flagellate antherozoids and egg respectively.

• Gametophyte may be **monoecious as in homosporous sp. / dioecious in heterosporous sp**.

• Gametophyte is independent in Pteris and dependent in Selaginella.

❖ **Diploid phase (2n) or sporophytic stage**

➢ Formed from zygote after fertilization.

➢ Meiosis in SMC(spore mother cell)

➢ non motile haploid spore formed

➢ germinate to form gametophyte again.

➢ cycle continues with alternation b/w gametophye and sporophyte.

• All spore formed may be of one type ie.homosporous species (Lycopodium,Dryopteris)

• Spores formed may be of two types ie. Heterosporous species (Selaginella,Marsilea)

• Microspores/male spores developed in male sporangia

-germinate to form male gametophyte

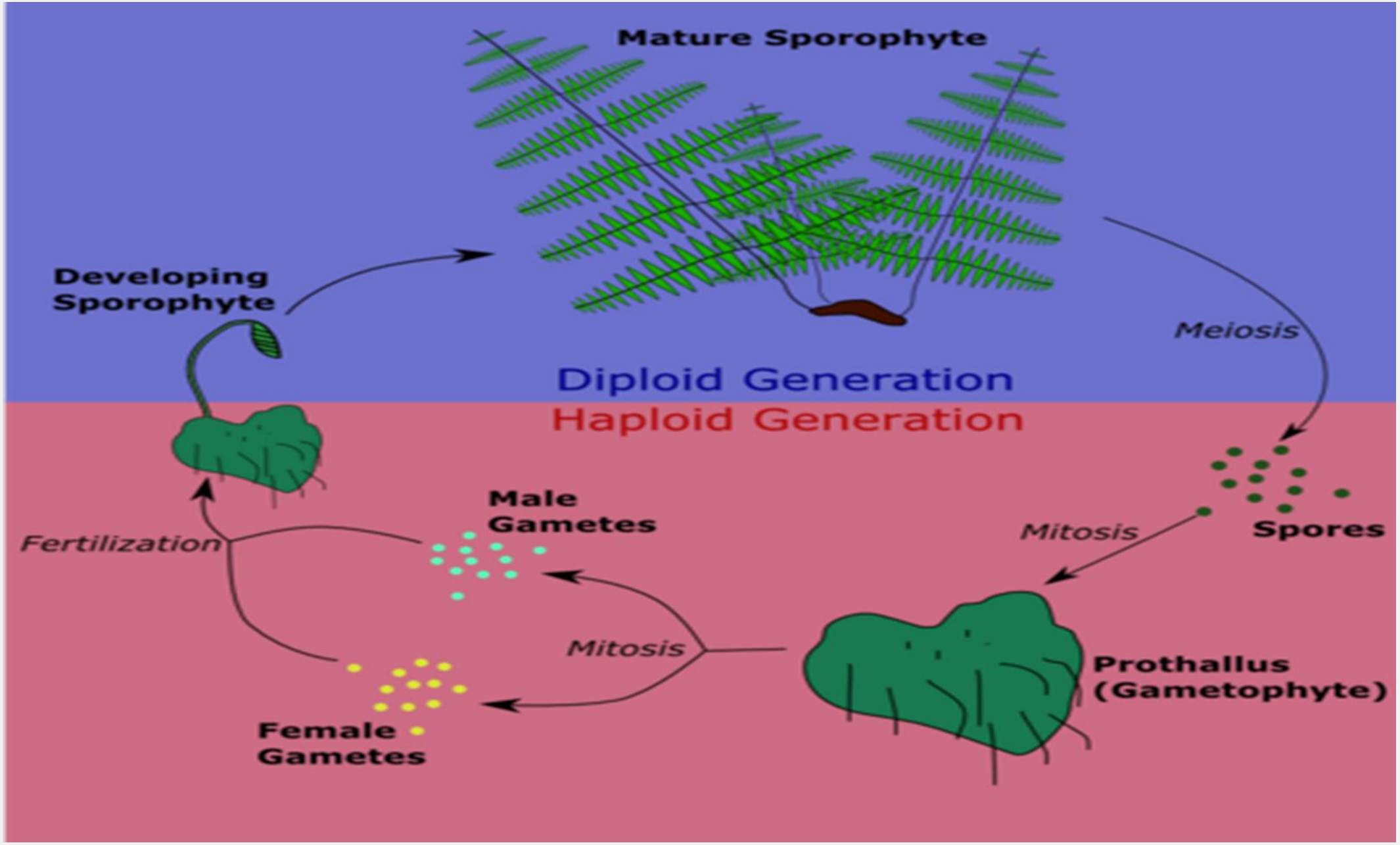
• Megaspores/female spore developed in megasporangia.

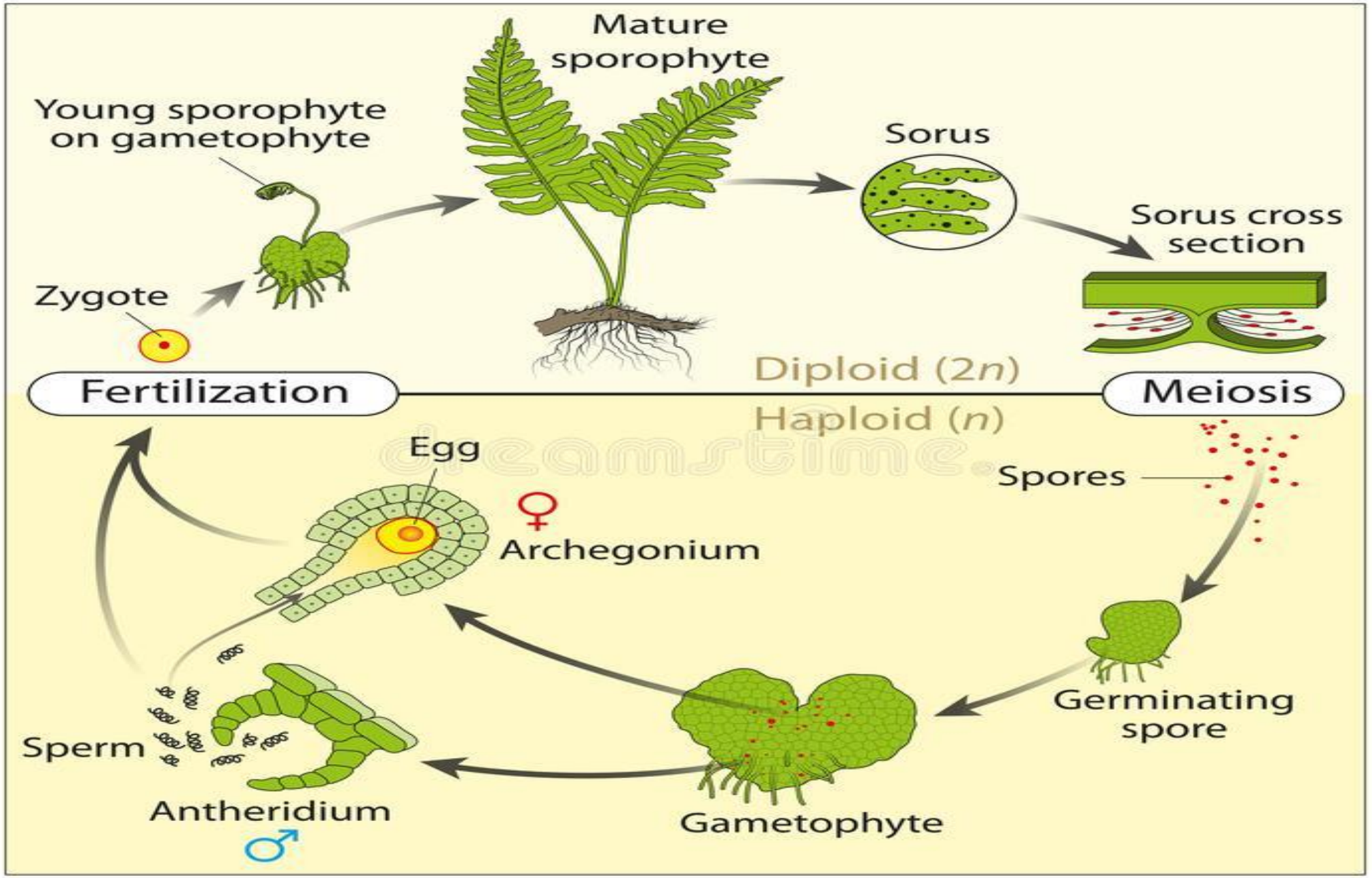
-germinate to form female gametophyte

• **Sporophyte is dominant phase in life cycle**

• independent of the gametophyte (prothallus) and grows to a much greater size.

• sporophytes are differentiated into stems, leaves and roots and shows well developed conducting tissues


Mature Sporophyte
Developing Sporophyte
Meiosis
Diploid Generation
Haploid Generation
Male Gametes
Fertilization
Mitosis
Spores
Mitosis
Prothallus (Gametophyte)
Female Gametes


Mature sporophyte
Young sporophyte on gametophyte
Sorus
Sorus cross section
Zygote
Diploid (2n)
Haploid (n)
Fertilization
Meiosis
Egg
Archegonium
Spores
Germinating spore
Sperm
Antheridium
Gametophyte

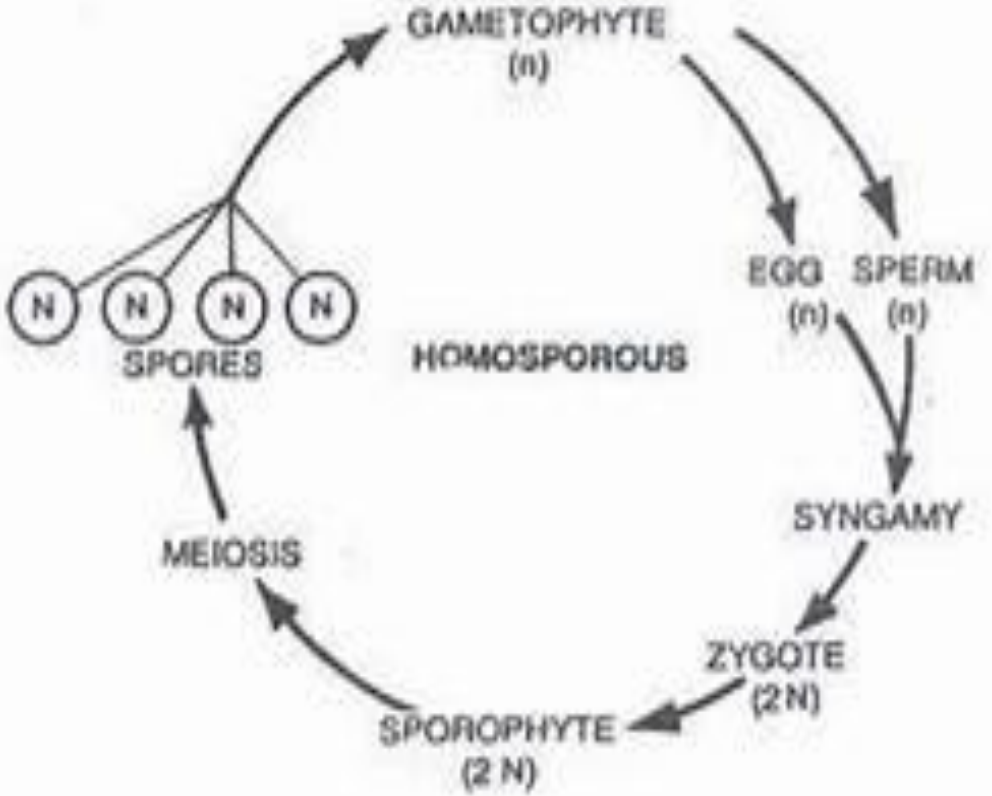


Fig. 25.3. Alternation of generations in Pteridophytes. Life-cycle pattern in homosporous pteridophytes.

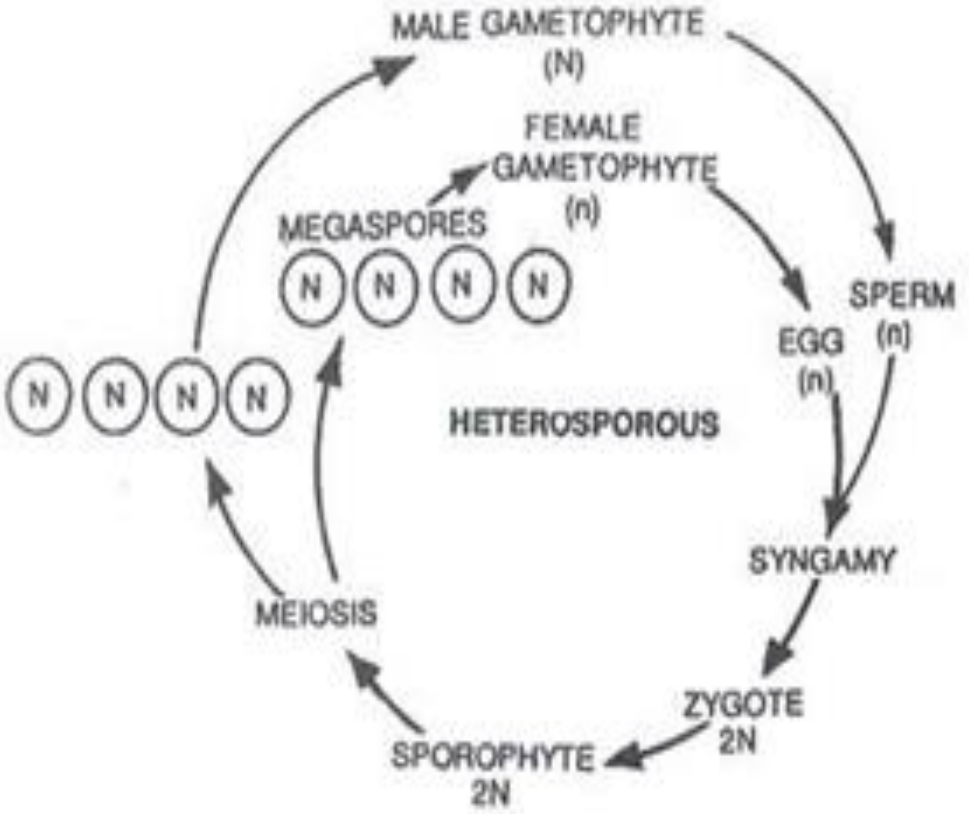


Fig. 25.4. Alternation of generations in Pteridophytes. Life cycle pattern in heterosporous pteridophytes.

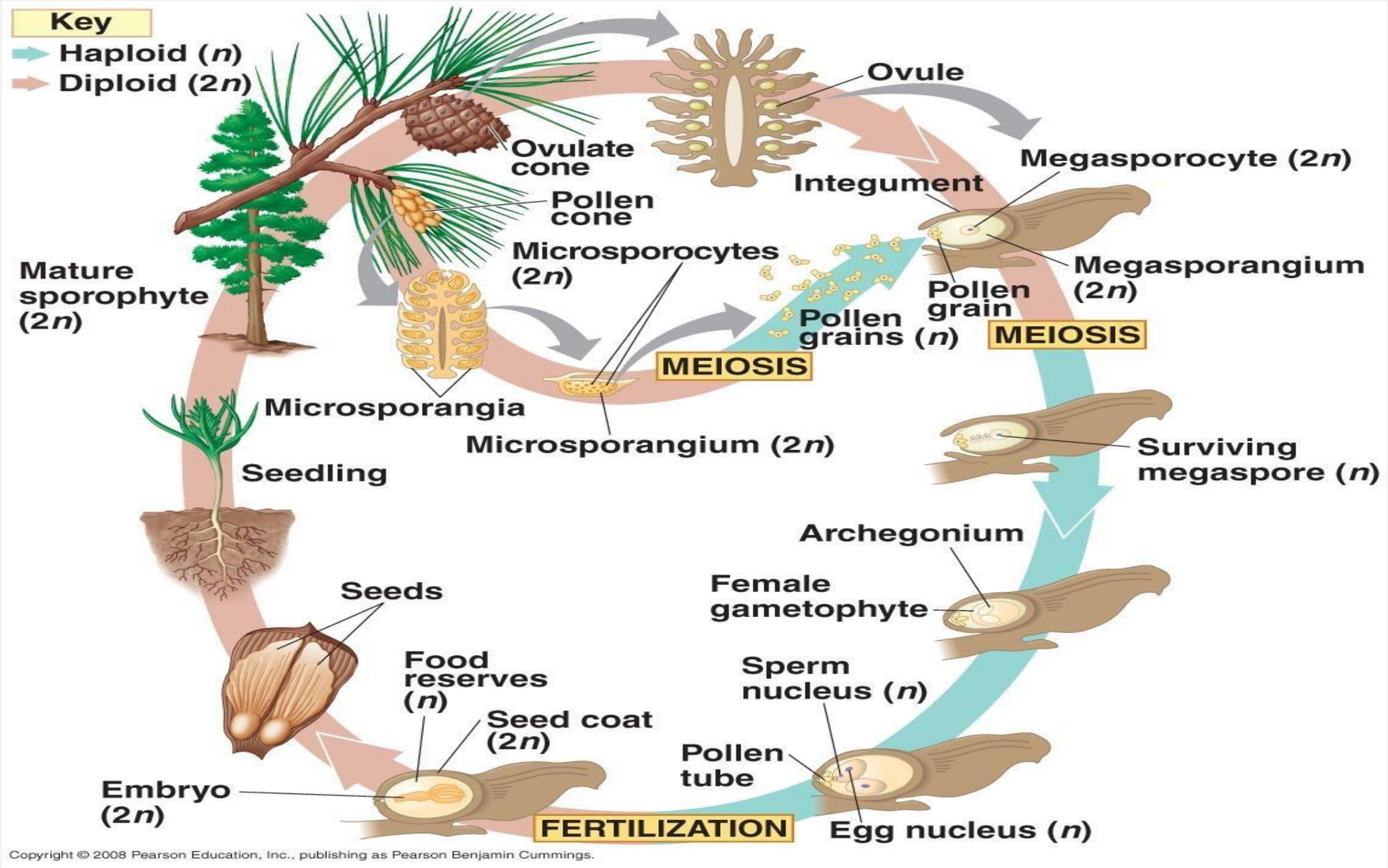
Alternation of generation in gymnosperms

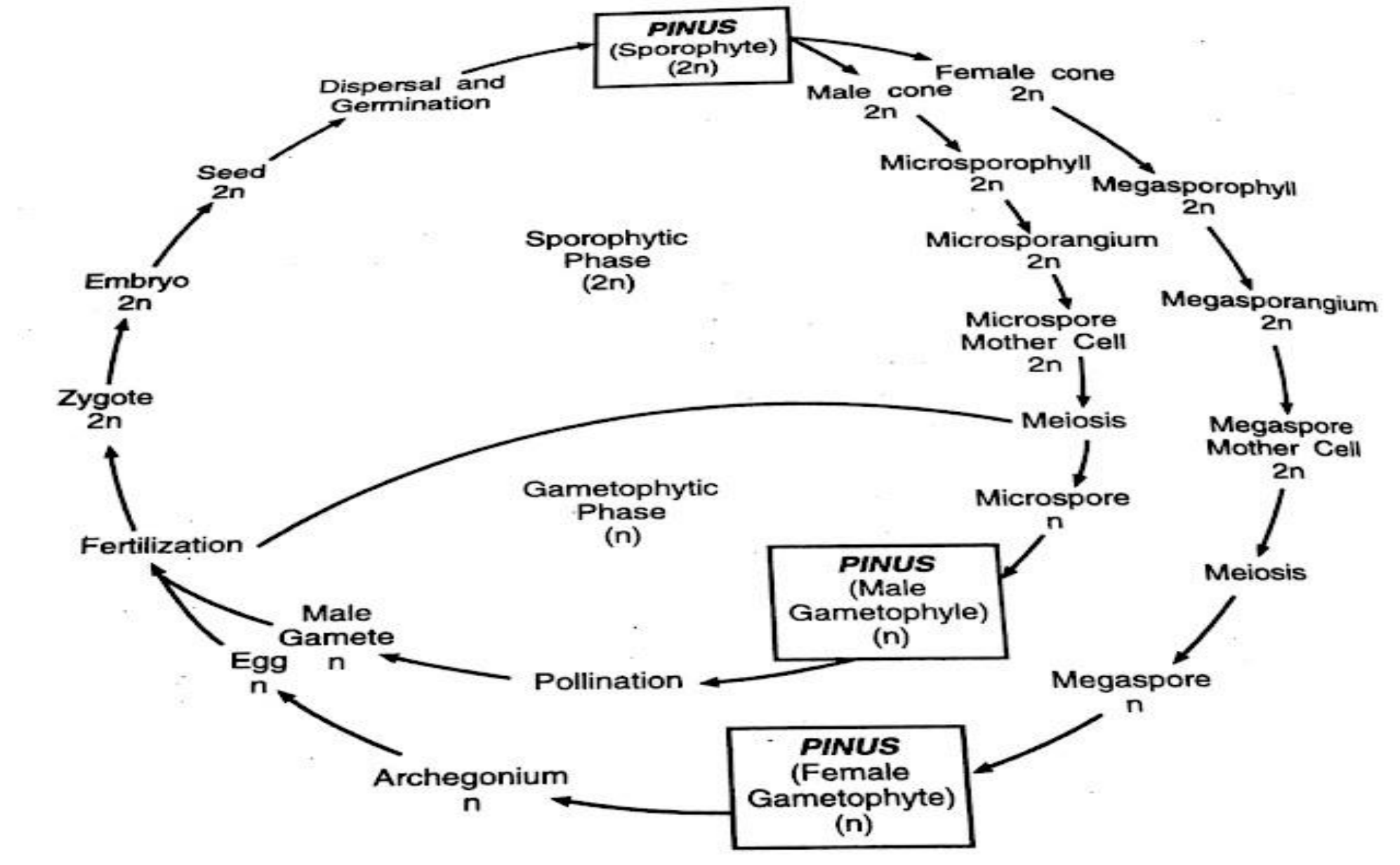
Gametophytic stage

- Dependent on sporophyte for protection and nutrition
- Haploid gametophyte found within mature sporophyte.
- Two type of spores produced:
  - **Microspore ie. Male spore**, undergoes mitosis to form multicellular male gametophyte ie. Pollens grain which are contained within the **male cone/pollen cones**.
  - **Megaspore ie.large**, female spore, undergo mitosis in order to produce the multicellular female gametophyte. The female gametophyte is housed in the **female cone/ovulate cones** which are larger and generally easier to see than the male pollen cones.
- The haploid stage will continue as long as the male and female gametophytes are kept separate.
- In spring, the tree release large amounts of pollen
  - pollen grains that contain the male gametophyte travel by air and hopefully land on an ovulate cone.
- pollen tube develops in order for the newly produced male gamete to reach and fertilize the female gamete.

Seed

- Following fertilization, the zygote develops into a sporophyte embryo, and the whole ovule transforms into the seed.
- The seed contains the embryo’s food supply and has a tough seed coat
- In a typical pine, seeds are shed from the cones about 2 years after pollination
- When conditions are favorable, it germinates
- Eventually, it grows into a sporophyte.




PINUS
(Sporophyte)
(2n)
Dispersal and
Germination
Seed
2n
Embryo
2n
Zygote
2n
Fertilization
Male
Gamete
n
Egg
n
Archegonium
n
Pollination
PINUS
(Female
Gametophyte)
(n)
Megaspore
n
Meiosis
Megaspore
Mother Cell
2n
Megasporangium
2n
Megasporophyll
2n
Female cone
2n
Male cone
2n
Microsporophyll
2n
Microsporangium
2n
Microspore
Mother Cell
2n
Meiosis
Microspore
n
PINUS
(Male
Gametophyle)
(n)
Sporophytic
Phase
(2n)
Gametophytic
Phase
(n)