Reproduction

Life cycle

Alternation of generation

in

Pteridophytes

Reproduction:

Pteridophytes reproduce by spores. Spores are produced in sporangia. The leaf bearing sporangia is called sporophyll. The sporophyll with microspore is called microsporophyll and sporophyll with megaspore is called megasporophyll.

The sporangia develops either on the ventral surface or in the axil of leaves. However in Psilophytales (e.g. *Rhynia*, *Horneophyton* etc.)the sporangia were cauline.

The Pteridophytes includes both homosporous (i.e. all the spores of one type e.g. *Equisetum*) and heterosporous (having two different types of spores i.e. microspores and megaspores/macrospores e.g. *Selaginella*).

In homosporous members, the gametophyte grows upon the soil and form independent plant i.e. exosporic gametophytes are present. In such gametophytes, spore germination and gametophyte development are controlled by external conditions.

In heterosporous members, gametophyte for most of its part is retained within sporangium i.e. endosporic gametophytes are present. In such gametophytes, spore germination and gametophyte development are not controlled by external conditions. These processes takes place in darkness in such gametophytes.

In different genera the sporangia are either present in a restricted area or throughout the vegetative portion.

In *Equisetum* and *Selaginella* they are present in the form of compact structure called strobili or cones.

In genera such as *Azolla*, *Marsilea*, Salvinia etc. sporangia are present in specialised bodies called sporopcarps.

The sporangia in higher ferns are present in the form of well-organised groups called sori (sin. Sorus).

A sorus in which all the sporangia appear, grow and mature at the same time is called as simple sorus.

A sorus in which the centre is occupied by the oldest sporangium and the successive younger sporangia are present towards the base is called a gradate sorus.

But sometimes, sporangia of different ages are present in a sorus, without any definite arrangement. Such a sorus is called a mixed sorus.


Sporangiophores
Annulus
Strobilus
Leaves

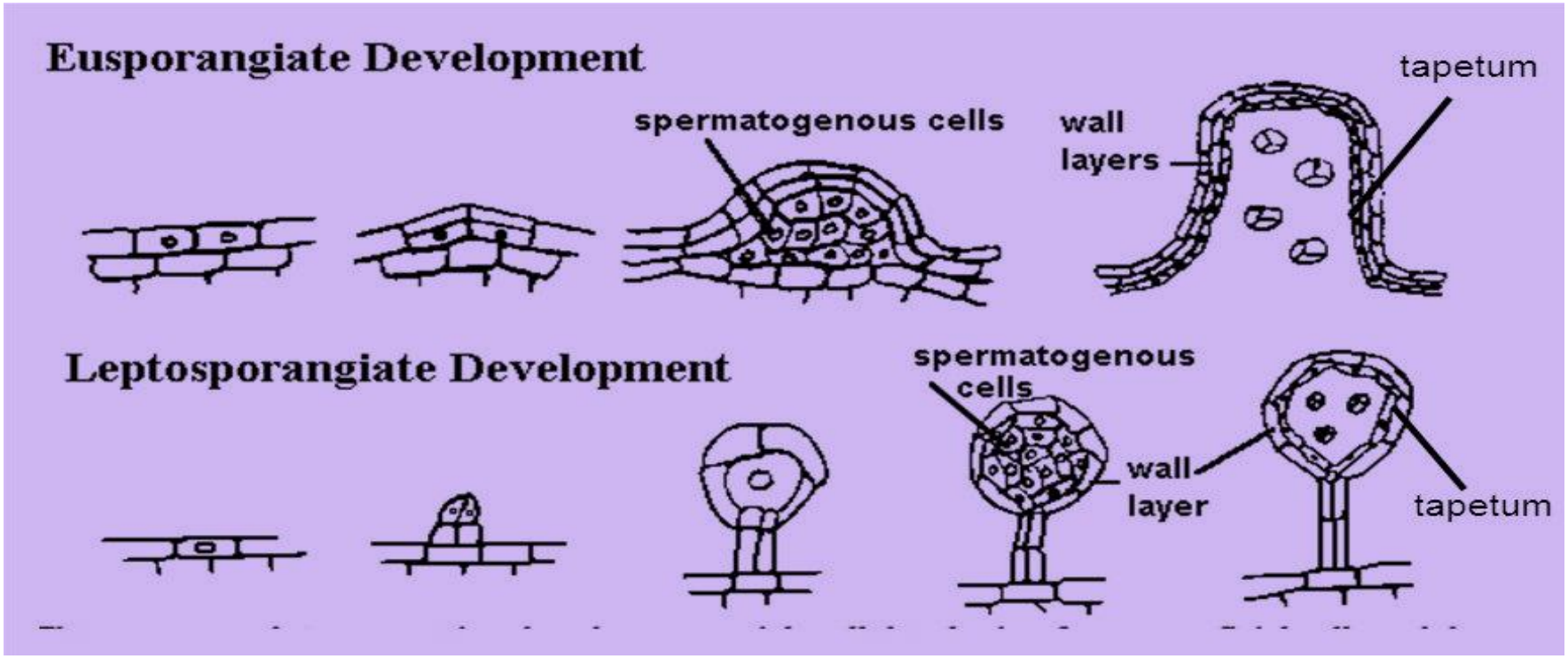

sporocarps

Development of sporangia:

Sporangia development is of two types: eusporangiate and leptosporangiate.

In eusporangiate sporangia develop from a group of superficial cells. E.g. *Lycopodium*, *Selaginella*, *Equisetum*.

In leptosporangiate the sporangia develop from single superficial cell. E.g. *Marselia*, *Pteris*, *Adiantum*.



Spore and its germination:

Spores are haploid and are formed after the reduction division in the sporogenous cells of the sporangium. The form of spore is variable. The spore germinate into a multicellular gametophytic body called the prothallus.

Germination of spore is a two phase process i.e. Spore distension and spore extension. In the former process spore swelling takes place while in the later process, the formation of germ tube and germ rhizoid take place.

Prothallus:

The spore germinate into a prothallus. Generally the prothalli are green simple, somewhat branched and aerial structure. But in some genera such as *Lycopodium* they are subterranean, well branched, tuberous, colourless and saprophytic structure. They obtained their food by symbiosis through mycorrhiza which occur within the tissues of prothallus.

Two sex organs i.e. Antheridia and Archegonia develop on the prothallus. Generally the prothalli of homosporous Pteridophytes are monoecious and protandrous. The prothalli develop from heterosporous Pteridophytes are generally dioecious.

Prothallus with a Young Sporophytic Plant

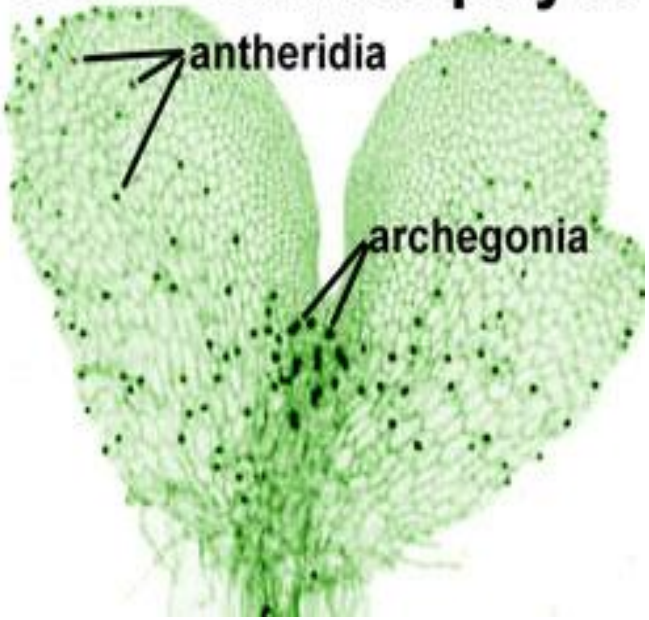
(a) *Lycopodium obscurum* sporophyte showing strobili. (b) *Lycopodium clavatum* mycoheterotrophic gametophytes with shoots (arrowheads).

In both homosporous and heterosporous Pteridophytes, generally the archegonium remains embedded in the prothallus. On the other hand the antheridium does not have a consistent structure. In some members antheridium is embedded e.g. *Lycopodium*, *Selaginella*, *Isoetes* etc. while in other they are emergent or projected e.g. *Psilotum* etc.

The antheridium is always surrounded by a well defined jacket. In projected antheridia the jacket is always on cell thicked. Only one opercular cell is present. The antherozoids are unicellular, uninucleate and biciliate structure in *Lycopodium*, *Selaginella* etc. but they are multiciliate in Psilotales, *Isoetes* and ferns. The number of antherozoids varied from four (*Isoetes*) to few thousands (*Ophioglossum*).

The archegonium consist of a projecting neck and a lower embedded portion, the venter. The neck region encloses neck canal cells and venter region encloses venter canal cell and egg cell. Many neck canal cells are present in *Lycopodium* while in leptosporangiate ferns only one binucleate neck canal cell is present.

Fern Gametophyte



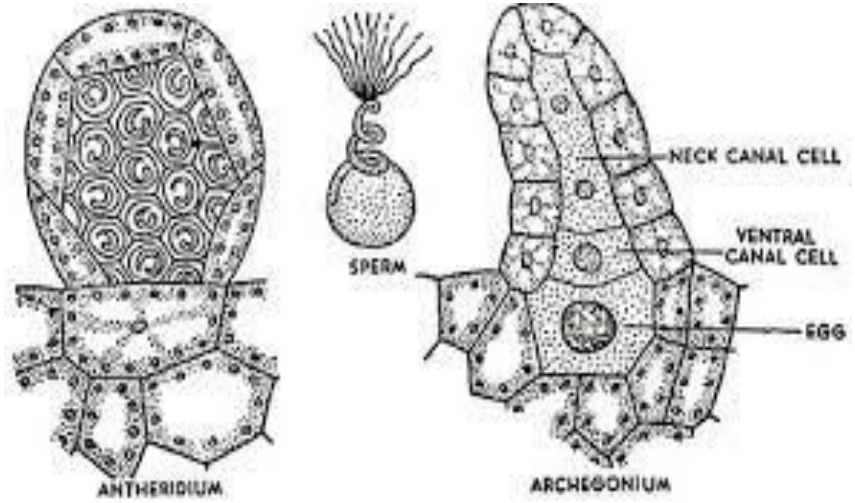
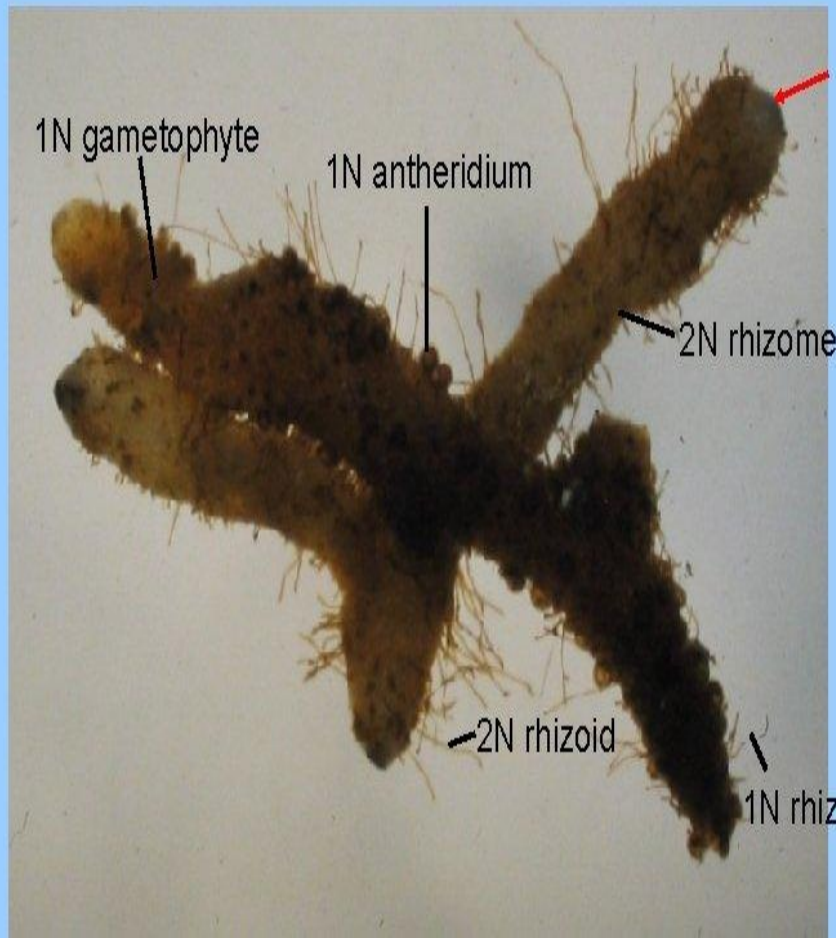


Fig. 213. Antheridium and archegonium of fern.

Psilotum gametophyte (SE to NW) and sporophyte (Y-shape)

The photo is flipped and cropped. Some versions of Powerpoint may fail to retain this making the labels erroneous!

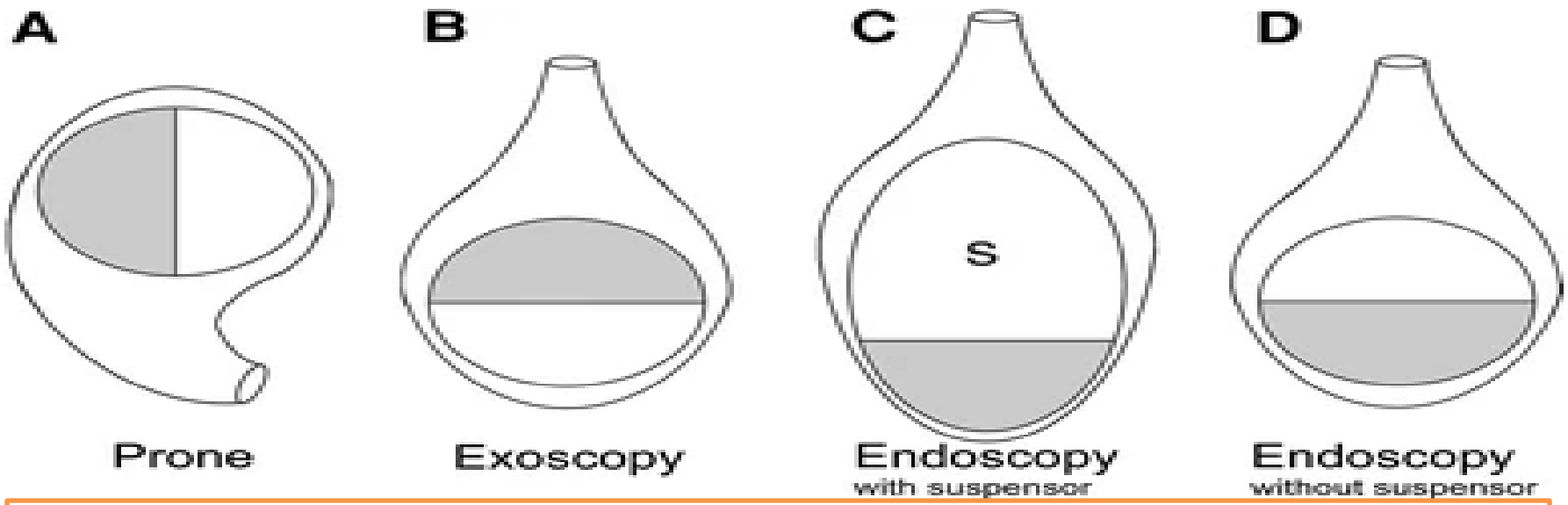


Fertilization and zygote formation:

Fertilization takes place with the help of water and results in the formation of a diploid zygote. The antherozoids are attracted chemotactically towards the archegonium. A chemical substance comes out from the open archegonium, most likely from the egg. This substance which function as a sperm attracter, contains a large number of organic and inorganic compounds especially malic acid and fumaric acid.

The zygote is the first cell of sporophyte and it is diploid. It develop into a well developed sporophyte bearing root, stem and leaves. The sporophyte is dependent on gametophyte only during its early stages.

The embryo has endoscopic development e.g. *Lycopodium*, *Selaginella* etc. and exoscopic development e.g. *Marsilea*, *Pteris*.



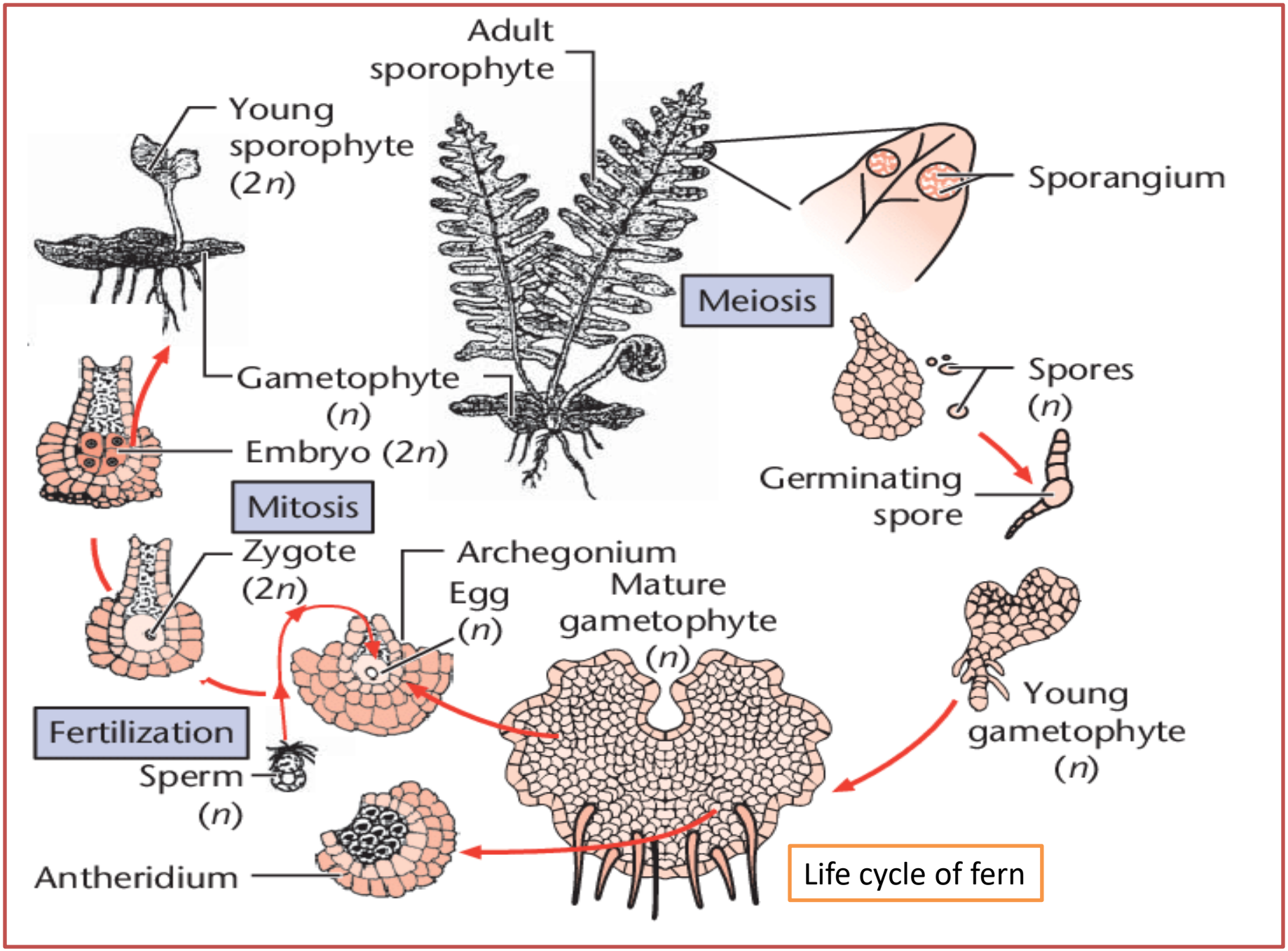
Pteridophyte embryology can be divided into four types (Gifford and Foster 1989; reproduced with permission of W.H. Freeman, New York). **a** In prone embryology, the zygote division parallels the direction of gravity; this positions the precursor of the green organs (*grey*) toward the apical notch of the gametophyte, opposite the direction of the archegonial neck. The foot and root (*white*) arise from the embryo region away from the apical notch. This is characteristic of only leptosporangiate ferns. **b** In exoscopy, the zygote divides at right angles to the gravitational vector which positions the green organ precursor (*grey*) toward the archegonial neck. Exoscopy is typified by *Psilotum*, *Equisetum*, and some Ophioglossaceae and leptosporangiate ferns with subterranean gametophytes. **c** In endoscopy with suspensor (*s*) formation, the zygotic division is perpendicular to the gravitational vector. This produces the suspensor cell which pushes the precursor to the embryo proper (*grey*) into the gametophyte. This occurs in some Marattiaceae, Ophioglossaceae and all lycophytes except *Isoëtes*. **d** The zygote also divides perpendicular to gravity in endoscopy without a suspensor. The initial division delineates the foot and sometimes the root precursors from the cell closer to the base of the archegonium which will form the green organs (*grey*). This embryology occurs in some Marattiaceae and *Isoëtes*; although in the latter, the zygote divides parallel with gravity. *s*, suspensor

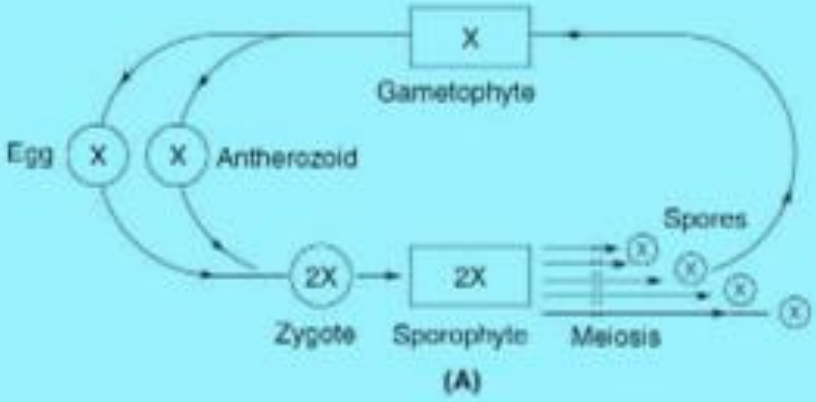
The life cycle of a typical Pteridophytes can be summarised as under:

A diploid sporophytic phase produces haploid spores by meiosis. The haploid spores grow by mitosis into a gametophyte which is typically a photosynthetic prothallus. The gametophyte produces gametes (sperm and egg) by mitosis. A mobile flagellate sperm fertilises an egg that remain attached to the prothallus. The fertilized egg is now a diploid zygote and grows by mitosis into a sporophyte.

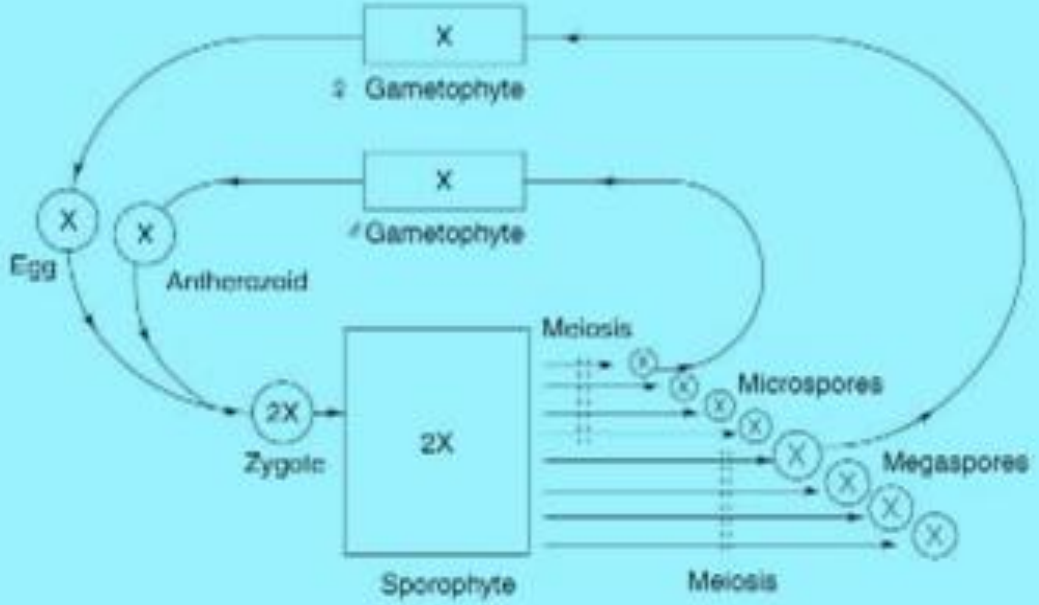
Pteridophytes show heteromorphic alternation of generation. In homosporous Pteridophytes the flagellated antherozoids are liberated from the antheridia. The antherozoid remain swimming in water. The egg in the archegonium is non-motile. The fusion between antherozoid and egg results into the formation of diploid zygote. The zygote develop into sporophyte plant body, which is also diploid. At the time of spore formation in the sporophyte , the reduction of nuclear content takes place by meiosis and thus haploid spores are formed. The spore germinates into a gametophyte that again bears sex organs.

On the other hand the life cycle of a heterosporous Pteridophyte shows the formation of two types of spores i.e. microspores and megaspores. These spores are formed after meiosis in the sporogenous cells present in the sporangia of the diploid sporophytic plant body. The microspore and megaspore are haploid structure. The microspore develops into male gametophyte that bears antheridia containing antherozoids. The megaspore develops into female gametophyte bearing archegonia contain egg. During the process of fertilization fusion takes place between male and female gametes and the result is the diploid zygote that directly germinates into a sporophytic plant body.


Adult sporophyte
Young sporophyte (2n)
Sporangium
Meiosis
Gametophyte (n)
Embryo (2n)
Spores (n)
Germinating spore
Mitosis
Zygote (2n)
Archegonium
Egg (n)
Mature gametophyte (n)
Young gametophyte (n)
Fertilization
Sperm (n)
Antheridium
Life cycle of fern



(A)



(B)

g. 1.9 Diagrammatic representation of life cycles in pteridophytes: A, homosporous pteridophyte; B, heterosporous pteridophyte.

THANKS.....