Pteridophytes: General Characters

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1. Meaning of Pteridophytes:

Pteridophyta (Gr, Pteron = feather, phyton = plant), the name was originally given to those groups of plants which have well developed pinnate or frond like leaves. Pteridophytes are cryptogams (Gr. kruptos = hidden, and Gamos = wedded) which have well developed vascular tissue.

Therefore, these plants are also known as vascular cryptogams or snakes of plant kingdom. They are represented by about 400 living and fossil genera and some 10,500 species. Palaeobotanical studies reveal that these plants were dominant on the earth during the Devonian period and they were originated about 400 million years ago in the Silurian period of the Palaeozoic era. Earliest known Pteridophyte is *Cooksonia.*

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2. General Characters of Pteridophytes:

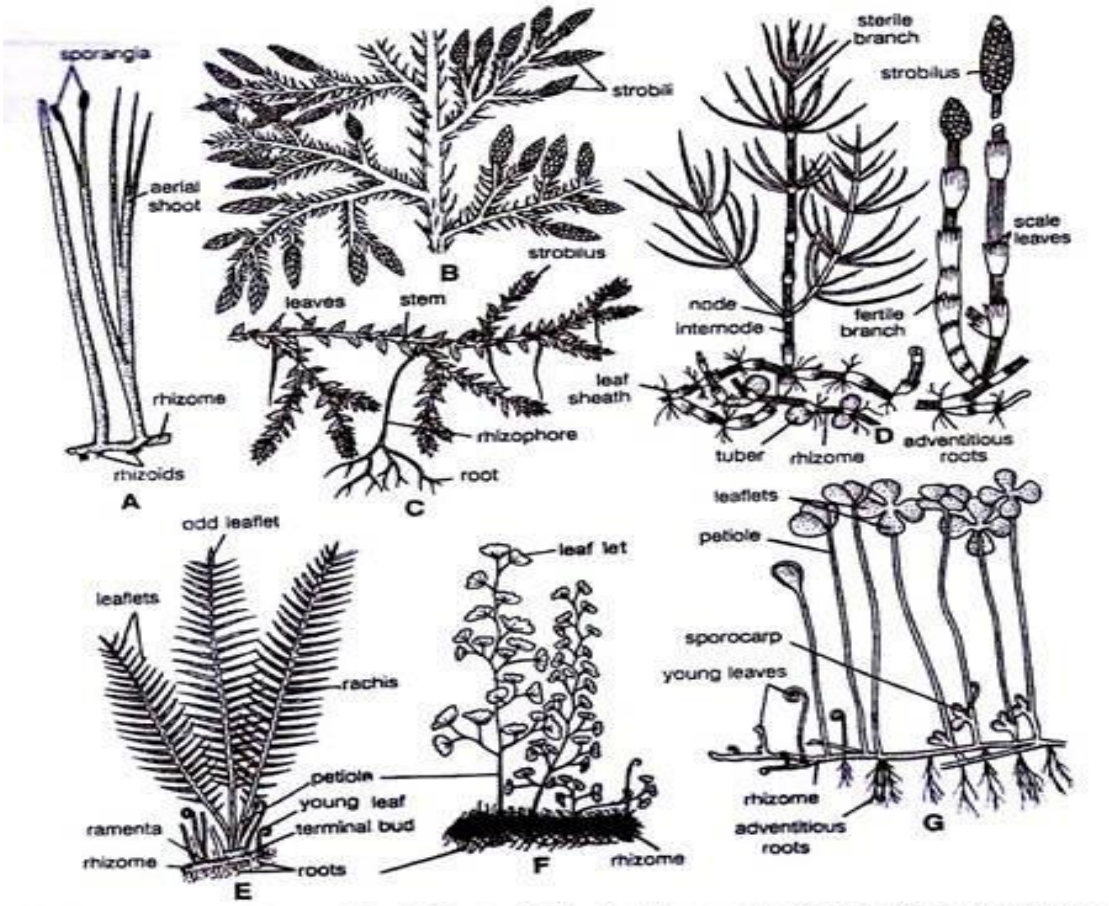

Fig 1 (A–G). Different forms of Pteridophytes A. *Rhynia*, B. *Lycopodium*,C. *Selaginella*, D. *Equisetum* E. *Pteris*, F. *Adiantum*, G. *Marsilea*

(i) Majority of the living Pteridophytes are terrestrial and prefer to grow in cool, moist and shady places e.g., ferns. Some members are aquatic (e.g., *Marsilea, Azolla*), xerophytic (e.g., *Selaginella rupestris, Equisetum*) or epiphytic (e.g., *Lycopodium squarrosum*) (Fig. 1).

(ii) Majority of the Pteridophytes are herbaceous but a few are perennial and tree like (e.g., Angiopteris). Smallest Pteridophyte is *Azolla* (an aquatic fern) and largest is *Cyathea* (tree fern).

(iii) Plant body is sporophytic and can be differentiated into root, stem and leaves.

(iv) Roots are adventitious in nature with monopodial or dichotomous branching. Internally usually they are diarch.

(v) Stem is usually branched. Branching is monopodial or dichotomous. Branches do not arise in the axil of the leaves. In many Pteridophytes stem is represented by rhizome.

(vi) Leaves may be small, thin, scaly (microphyllous e.g., *Equisetum*), simple and sessile (e.g., Selaginella) or large and pinnately compound (megaphyllous e.g., *Dryopteris, Adiantum*).

(vii) Vascular tissue is present in stem and root. It consists of xylem and phloem. Xylem consists of tracheids only and phloem has only sieve tubes.

(viii) The steel is protostele (e.g., *Rhynia, Lycopodium*), siphonostele (e.g., *Equisetum*), dictyostele *Adiantum*) or polycyclic (e.g., *Angiopteris*).

(ix) Cambium is absent; hence, they do not show secondary growth.

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3. Reproduction in Pteridophytes:

(i) Reproduction takes place by means of spores which are produced inside sporangia.

(ii) The development of the sporangium may be leptosporangiate (sporangium originates from a single cell) or eusporangiate (sporangium develops from a group of cells).

(iii) Sporangia may be borne either on stem or leaves. On the stem they may be terminal (e.g., *Rhynia*) or lateral (e.g., *Lycopodium*). On the leaves (sporophylls) they may be ventral, marginal (*Pteris, Adiantum*) or dorsal (e.g., Polypodiceae). In *Equisetum* the sporangia are borne on special structures called sporangiophores which constitute a cone. In *Marsilea, Azolla, Salvinia* sporangia are produced in sporocarps.

(iv) Spores on germination give rise to multicellular gametophytic bodies called prothalli (sing. prothallus).

(v) In homosporous Pteridophytes prothalli are monoecious (antheridia and archegonia develop on the same prothallus). In heterosporous species prothalli are always dioecious. Microspores on germination give rise to male prothalli and megaspores to the female prothalli.

(vi) Antheridia and archegonia are developed on prothalli.

(vii) Antheridium is surrounded by a single layered sterile jacket.

(viii) Archegonium consists of four vertical rows of neck cells, 1-2 neck canal cells, ventral canal cell and egg.

(ix) Antherozoids are unicellular, biflagellate (e.g., *Selaginella*) or multiflagellate (e.g., *Equisetum* and ferns) and motile.

(x) Antherozoids are attracted towards the neck of the archegonium chemotactically by certain substances like malic acid) present in the mucilaginous substance formed by the degeneration of neck canal cells and venter canal cell.

(xi) Water is essential for fertilization (zooidogamous). Therefore, Pteridophytes are also known as amphibians of the plant kingdom.

(xii) Fertilization results in the formation of zygote or oospore, which ultimately develops into well-developed sporophyte.

(xiii) The fertilized egg divides transversely or vertically. Another cross wall forms a quadrant stage producing stem, leaf, foot and root.

(xiv) Plants show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle.

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4. Affinities of Pteridophytes:

Similarities with Gymnosperms:

(i) Plant body is sporophytic, dominant and can be differentiated into root, stem and leaves in both the groups.

(ii) Gametophytic phase is of short duration.

(iii) Young leaves show circinate vernation.

(iv) Vascular tissue is well developed. Xylem lacks vessels (except in order Gnetales of Gymnosperms) and companion cells are absent in phloem).

(v) Like Gymnosperms many Pteridophytes are heterosporous (e.g., *Marsilea, Selaginella*).

(vi) Like Pteridophytes many Gymnosperms show ciliate antherozoids (e.g., *Cycas, Ginkgo*).

(vii) Like Gymnosperms, in some Pteridophytes megaspore is retained within the megasporangium (e.g., *Selaginella*).

(viii) Regular alternation of sporophytic and gametophytic phase is present.

Differences Between Pteridophytes and Gymnosperms

S. No.	Character	Pteridophytes	Gymnosperms
(i)	**Habitat**	Hygrophytes (*i.e.*, grow in moist and shady places)	Xerophytes (grow where the water supply is scanty)
(ii)	**Root**	Adventitious roots	Tap root
(iii)	**Vascular cambium**	Absent	Present
(iv)	**Archegonium**	Neck canal cells, venter canal cell present	Absent
(v)	**Water**	Essential for fertilization	Not necessary.
(vi)	**Microspores and megaspores**	Develop independently after being shed from their sporangia	Microspores are shed for a short time from microsporangia and the megaspores are permanently retained within megasporangia.
(vii)	**Pollen tube**	Absent	Present
(viii)	**Ovule**	Absent	Present
(ix)	**Seed**	Absent	Present
(x)	**Gametophyte**	Independent of the sporophyte	Dependent on the sporophyte.

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5. Development of Sporangia in Pteridophytes:

On the basis of development, the sporangia in Pteridophytes are divided into two types:

(i) Eusporangiate type

(ii) Leptosporangiate type

(i) Eusporangiate Type:

Sporangium develops from group of superficial cells. These cells divide periclinally into primary wall layers and inner primary sporogenous cells (Fig. 2A, B). The outer wall layers form the wall of the sporangium while inner sporogenous cells divide meiotically and form spores (Fig. 2 A-F).

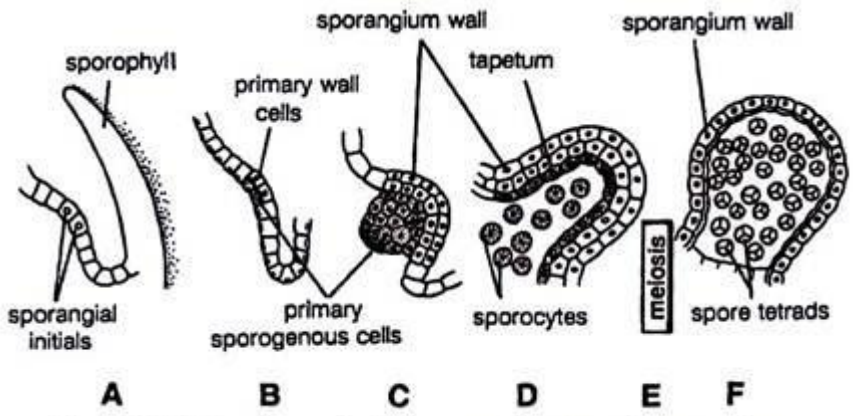

Fig. 2. (A-F) Development of Eusporangiate type of Sporangium

(ii) Leptosporangiate Type:

This type of sporangium arises from a single superficial cell. It divides transversely to form an outer and an inner cell (Fig. 3A, B). While the inner cell forms the stalk, the entire sporangium develops from the outer cell. The outer cell divides by three successive periclinal divisions and in this way a tetrahedral apical cell is formed (Fig. 3C). It divides by periclinal division to form the outer jacket cell and inner primary sporogenous cell (Fig. 3D). Jacket cell forms the single layered sporangial wall while primary sporogenous cell divides into tapetal initial and sporogenous tissue (Fig. 3E). Sporogenous tissue divides meiotically to give rise to haploid spores while tapetal initial forms two layered tapetum (Fig. 3 F, G).

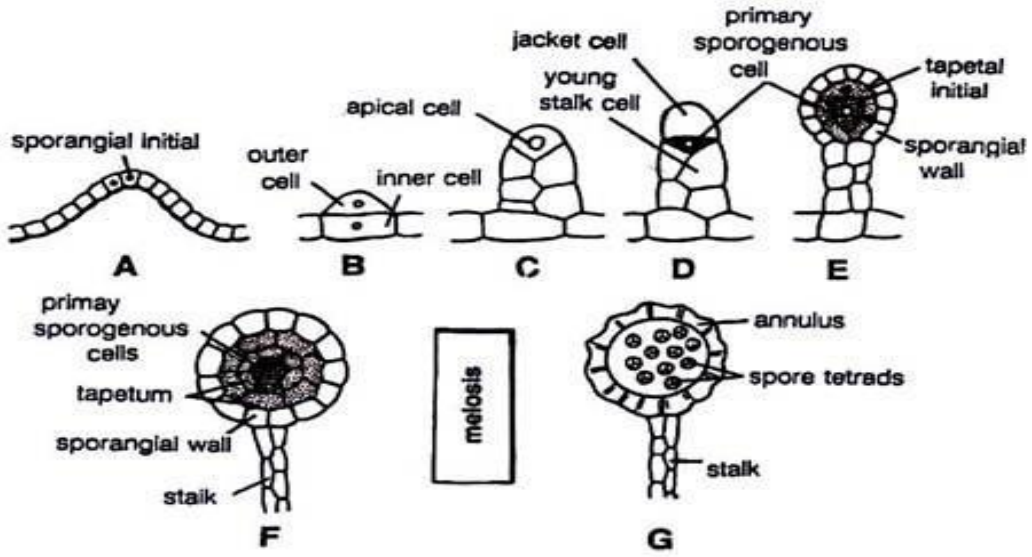

Fig. 3. (A-G) Development of Leptosporangiate type of Sporangium

Differences Between Eusporangiate and Leptosporangiate Type of Sporangium

S. No.	Eusporangiate Type	Leptosporangiate Type
1.	Sporangium is massive	Sporangium is small
2.	Sporangium is formed from many initials	Sporangium is formed from single initial
3.	Sporogenous tissue is derived from the inner daughter cell	Sporogenous tissue is derived from the outer daughter cell.
4.	Wall is several cells thick	Wall is only one cell thick.
5.	Examples : *Lycopodium, Selaginella, Equisetum*	Examples : *Pteris, Polypodium, Marsilea.*

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6. Life Cycle Patterns in Pteridophytes:

Pteridophytes show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle. Sporophytic plant body develops sporangia in which sporogenous tissue is formed. Sporogenous tissue divides meiotically to form haploid spores.

Majority of the Pteridophytes are homosporous e.g., *Lycopodium*, *Pteris* etc. Spores on germination produce monoecious gametophyte. Some Pteridophytes are heterosporous and produce two types of spores: microspores and megaspores.

Microspores on germination produce male gametophyte (prothallus) while megaspores on germination produce female gametophyte (prothallus). So, the prothalli are dioecious.

Antheridia and archegonia develop on the same prothallus (monoecious) or on different prothalli (dioecious). The male and female gametes fuse to form zygote which develops into sporophyte. Thus, the life cycle of a Pteridophyte consists of an alternate succession of sporophytic and gametophytic generations.

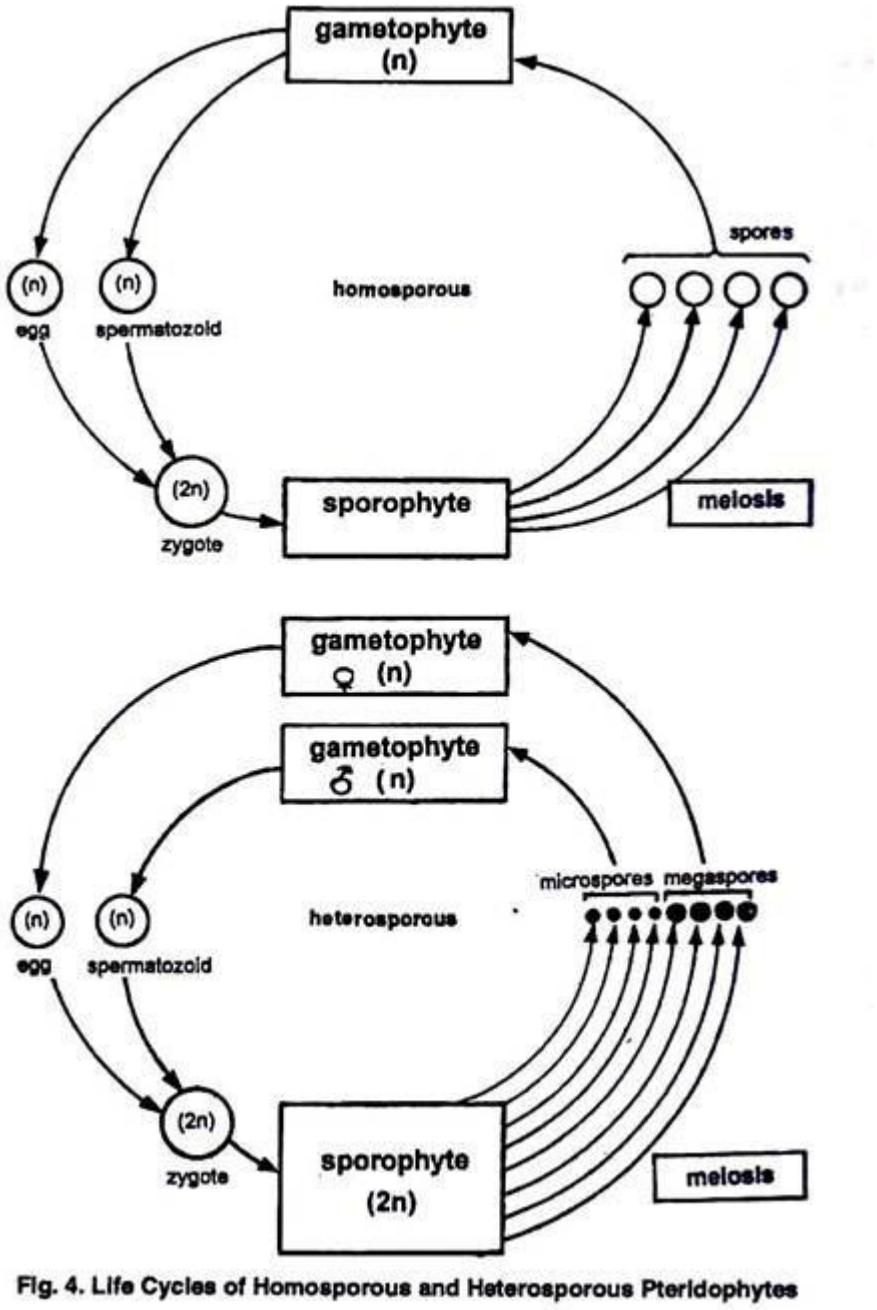

Fig. 4. Life Cycles of Homosporous and Heterosporous Pteridophytes

Apogamy, Apospory and Parthenogenesis:

Pteridophytes show heteromorphic alternation of generation. However, there are certain other modifications where the essential stages of life cycle are eliminated. These modifications are called apogamy, apospory and parthenogenesis.

Apogamy:

The formation of a sporophyte directly from the vegetative cells of the gametophyte without the act of syngamy or gametic union is called apogamy (Winkler, 1908). The term apogamy was first used by De Bary (1878). It was first reported in *Pteris cretica* by Farlow (1874).

Later, apogamy has been described in many Pteridophytes e.g., *Selaginella* (Hieronymus, 1911, 1913), *Marsilea* (Strasburger, 1907) etc. The apogamous embryo may develop from one or more cells of the gametophyte. The sporophytes, produced as a result of apogamy, possess the same number of chromosomes as the gametophyte.

Apospory:

The formation of gametophyte from a sporophytic cell without meiosis is known as apospory. It was first discovered by Druery (1884) as a natural phenomenon in *Athyrium filix-femina var. clarissima*. Since then it has been reported in many Pteridophytes e.g., *Tricohmanes* (Bower, 1888*), Pteris aquilina* (Farlow, 889) *Asplenium dimorphum* (Goebel, 1905), *Osmunda javanica* (Sarbadhikari, 1936), *Tectaria trifoliata* Steil. 1944) etc.

In apospory, a filamentous or heart shaped gametophyte may be formed from one or more cells of any vegetative portion of a young or mature sporophyte. Due to apospory polyploidy is common in ferns. It has been observed that there is no change in the chromosome number (from the parent plant) when the aposporous gametophytes originate.

Parthenogenesis:

Formation of sporophyte from egg without fertilization is called parthenogenesis. In homosporous leptosporangiate ferns, it was observed that apospory was followed by neither apogamy nor fertilization but by parthenogenesis (Farmer and Digby, 1907). Strasburger (1907) reported parthenogenesis in Marsilea drummondii.

In many species of Selaginella (e.g., S. spinulosa, S. rubricaulis etc.), archegonia failed to open and the egg developed into sporophyte parthenogenetically. Parthenogenesis in S. intermedia and S. langere was first reported by Hieronymus in 1911.

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7. Economic Importance of Pteridophytes:

The Pteridophytes are of little economic value.

Some of the major uses of Pteridophytes are:

(i) As ornamentals:

Many species of Pteridophytes are grown as ornamental plants e.g., *Selaginella*, (species of *Selaginella* for e.g., *S. willedenovii, S. caesi*a have metallic tints and therefore used as ornamentals, me other species of *Selaginella* e.g., *S. lepidophylla* and *S. pilifera* are sold as curiosities under the name of resurrection plants. Plant is a ball like structure under dry conditions and on availability of water, it becomes green and flat on soil.

Others species like *Lycopodium, Osmunda, Polypodium, Pteridium, Nephrolepis* etc are also grown in gardens.

(ii) In Soil conservation:
Many species of Pteridophytes are used in soil conservation e.g., *Lycopodium, Selaginella* etc.

(iii) As medicines:
(a) Extracts of *Lycopodium* plants are used as kidney stimulant.

(b*) Lycopodium clavatum* is used in skin diseases.

(c) *Equisetum arvense* is used as diuretic (promoting urine discharge).

(d) Rhizome and frond bases of *Dryopteris filix-max* are used as taenifuge.

(iv) Some other uses:
(a) Several species of *Lycopodium* e.g., *L. obscurum* are used in Christmas wreaths and other decorations. It is commonly called as 'Christmas green'.

(b) *Equisetum arvense* is biological indicator (for the presence of gold in the soil).

(c) *Equisetum* deposit large amount of silica in their cell walls. So formerly, it was used in cleaning and polishing the metal pots. Therefore, the plant has been given the name 'scouring rushes'.

(d) Young shoots of *Dryopteris filix-max* are used as vegetables.

(e) Starchy paste of sporocarps of *Marsilea drummondii* is used in making cakes and is called 'nardoo'

(f) *Azolla* is grown in the rice fields to maintain its fertility because it has the symbiotic association with the cyanobacteria (blue green algae) *Anabaena*, *Nostoc*.

(Source: Based mainly on biologydiscussion)