PTERIS

- Genus *Pteris* has **280** species distributed in tropical and sub-tropical regions.
- It is terrestrial genus growing in moist, shady forests and on hill sides.
- These species are found on the road sides and valleys of **Western** and **North western** Himalayas.
- *P. vittata* grows at less than **1200 m** altitudes. *P. cretica* grows between **1200 – 2400 m** altitudes.

External morphology of Sporophyte

- Sporophyte is the dominant stage in the life cycle of *Pteris*. It is differentiated into roots, stem and leaves.
- The primary root formed from embryo is short lived and soon replaced by adventitious roots. These roots are slender, black, wiry and arise from ventral side of Rhizome or all over the surface.
- Stem is rhizomatous, underground, branched, perennial and covered by brown scales.
- Some species have **persistent leaf bases** on the rhizome.
- Leaves are **macrophyllous**, **unipinnate imparipinnate** (*P. vittata*) and arise acropetally on the rhizome.
- Bipinnate leaves are seen in *P. biaurita*. Decompound and digitate leaves are also present.
- Developed leaves are known as **fronds**.
- Petiole base is covered with **brown scales** and some times with **ramenta**.
- Rachis has several **sessile**, **lanceolate**, **coriaceous** leaflets arranged in pairs except the terminal one.
- Leaflet is broader at the base and gradually tapers towards the apex.
- Middle leaflets are larger and the other leaflets show gradual decrease in size towards the basal and apical regions of the rachis.
- Leaflet is **rough**, has a mid rib from which the lateral veins with dichotomous branching arise. Venation is **open dichotomous venation**.
- Younger leaves show **circinate vernation**.
- Growth rate is very slow.

Anatomy of sporophyte

Anatomy of Rhizome

- In T.S., rhizome is oval in outline and differentiated into epidermis, cortex and stele.

Epidermis

- It is single layered with **quadrangular** cells.
- It is covered by **thick** cuticle.

Cortex

- It is multilayered and differentiated into **4–5 layered** sclerenchymatous hypodermis and inner multilayered broad parenchymatous region.
- Parenchymatous region has **root traces** and **leaf traces**.

Stele

- Stelar structure differs from species to species.
- In *P. vittata* it is **dictyostele** with a ring of vascular strands (**meristeles**).
- Meristeles are embedded in the parenchymatous ground tissue.
- Each meristele is **elliptical** with single layered endodermis having casparian strips in its radial walls.
- **1 – 2** layered thin walled pericycle is present below the epidermis and surrounding the phloem.
- Phloem has only **sieve cells** and phloem parenchyma. It completely surrounds the xylem.
- Xylem is present at the centre of meristele. It shows central protoxylem surrounded on either side by metaxylem.
- It consists of tracheids and xylem parenchyma.

Anatomy of Rachis or Petiole

- In T.S. the outline of rachis or petiole is **semicircular**.
- It is differentiated into epidermis, ground tissue and vascular bundle.

Epidermis

- It is single layered with narrow **quandragular** cells covered by thick cuticle.
- Some epidermal cells give rise uniseriate bicellular hairs called as **ramenta**.

Ground tissue

- It has multilayered sclerenchymatous hypodermis followed by parenchymatous tissue in which the vascular bundle is embedded.

Vascular bundle

- It is **'V'** or **'U'** shaped and embedded in the parenchymatous ground tissue.

- It resembles meristele and has single layered endodermis with casparian strips.
- Pericycle is **1** or **2** layered and parenchymatous.
- **Xylem** is at the centre with **mesarch** condition surrounded by phloem.

Anatomy of leaflet

- It has epidermis, mesophyll and vascular bundle.
- Epidermis is single layered present on both upper and lower surfaces. It has **stomata** only on the lower epidermis (**Hypostomatous** condition).
- Mesophyll is either homogenous or differentiated into upper palisade and lower spongy with broader intercellular spaces.
- Hypodermal region of midrib has **sclerenchymatous strips** in both abaxial and adaxial sides.
- Midrib has single **concentric, amphicribal** vascular bundle (xylem surrounded by phloem) surrounded by single layered pericycle and endodermis.
- Vascular strands are embedded in the mesophyll.

Root anatomy

- It is **circular** in outline and distinguished into epidermis, cortex and stele.
- Epidermis is single layered with thin walled cells. A few cells form root hairs.
- Cortex is multilayered and differentiated into **parenchymatous outer cortex, sclerenchy-matous inner cortex** and single layered endodermis with **casparian thickenings**.
- Stele has single layered thin walled pericycle, central **plate like exarch** and **diarch xylem** surrounded on either side by phloem.

Reproduction

- It reproduces vegetatively and asexually.

Vegetative reproduction

- It takes place by progressive death and decay of older portions of the rhizome.
- When the decay reaches the point of branching, the main axis and branch are separated and grow as individual plants.

Asexual reproduction

- It takes place by spore formation.
- It is homosporous because it produces only one type of spores.

Sorus structure

- The fertile frond with sporangia is called as **sporophyll**.
- Sporangia are formed in groups known as **sori**.
- A sorus is developed from a pad of tissue known as **receptacle** or **placenta** on the lower surface nearer to the margin of leaflet of sporophyll.
- Every leaflet has two sori one on each side.
- Since the sorus is extended as a narrow line along the margin except at some length at the apical and basal regions, it is called as linear sorus.
- It is called as **mixed sorus** because both young and old sporangia are intermingled.
- As the sorus has several sporangia, it is called as **Coenosorus**.
- Besides sporangia, there are multicellular uniseriate sterile structures known as **paraphyses** developing from placenta.
- The sorus is protected by reflexed margin of leaflet known as **False indusium**.

Structure of Sporangium

- Sporangium shows **leptosporagiate** development because it is developed from single initial.
- It has a multicelluar, long slender stalk called **pedicel** or **seta** and globose or oval body known as **capsule** or **spore sac**.
- Spore sac has **single** layered jacket.
- Some cells of the jacket are modified to form **annulus** and **stomium**.
- Annulus is ring like structure with vertically elongated cells. It begins from the stalk on one side, encircles the top and extends upto half way on the other side where it joins with the **epistomium** of stomium.
- Annulus cells have **thin outer tangential** and **lateral walls** and **thickened inner tangential** and **radial walls**. It helps in the **dehiscence** and **dispersal** of spores.
- **Stomium** is present in between the end of annulus and stalk that forms the remaining portion of the ring.
- Stomium cells are long, flat and thin walled and permit easy **cleavage** of the sporangium and **dehiscence**.
- The middle two cells of the stomium are narrow, **radiallly elongated** and called as **lip cells**.
- **Two or three** cells present above the lip cells form the **epistomium** and **2 or 3** cells below the lip cells form the **hypostomium**.
- The other cells of jacket are thin walled and polygonal or hexagonal.

- Interior to jacket 1 or 2 layered nutritive tissue, tapetum is present. It encircles the sporogenous tissue.
- Sporogenous tissue usually forms **12 spore** mother cells that divide meiotically and form **48** haploid, morphologically similar spores (Homosporous).
- Young sporangium is green and mature sporangium is **dark brown**.

Sporangial dehiscence

- At maturity the capsule is dry.
- In dry conditions, the annulus contracts and the sporangial wall is broken transversely at stomium between the lip cells.
- The stomium bends backwards carrying the upper half of the broken capsule containing the spores that are exposed for wind dispersal.
- When the annulus absorbs moisture, it flips forward hurling the spores with some force and snaps back to its original position like **spring**. This mechanism of spore dispersal is known as **sting** or **catapult** mechanism.
- The spores are carried away by **wind** and remain viable for longer period.

Apospory

- It is formation of diploid prothallus from diploid cells of sporophyte without the involvement of spores.
- It can be induced in some species of ***Pteris***.
- In *Pteris vittata*, aposporous formation of prothalli can be induced from **petiole**, **laminar surface** or from **juvenile leaves**.

Spores

- These are **reddish brown** and triangular and have clear triradiate mark known as **trilete** on its surface.
- Spore wall has outer thick **sculptured exine** (exospore) and inner thin **smooth intine** or (endospore).
- It is uninucleate and unicellular.

Sexual reproduction

- **Prothallus** or gametophyte developed from spore is involved in sexual reproduction.

Prothallus

- It is **cordate** or **heart shaped**, dorsiventral, short lived, anterio-posterior, independent gametophyte.
- It grows in moist, shady habitats with growing point located in the notch. Its survival depends on the availability of moisture.
- It is less adapted to land when compared to the sporophyte.
- The developed prothallus is **green, small, flat, thin, thallus** like autotrophic structure.
- It has a deep **'U' shaped** apical notch inside which a few meristematic cells are present.
- It is thick cushion like with many celled thick at the centre and gradually becomes thin towards the margins. It is single celled in thickness at the margin.
- It is parenchymatous with elongated **polygonal** or **hexagonal** cells without intercellular spaces.
- Each cell has central large vacuole that pushes the cytoplasm as thin layer towards the periphery (**Primordial utricle**).
- The peripheral cytoplasm has a haploid nucleus and **discoid** chlorplasts.
- Some of the posterior cells of ventral surface give rise **brown, delicate**, hair like, thin walled unicellular rhizoids. These help in fixation and absorbing mineral water.
- It is usually **monoecious**. The sex organs are developed on the ventral surface and exposed directly to moisture which is needed for the **development** and **dehiscence**.
- Male sex organs are called as **antheridia**. These are developed earlier than the female sex organs archegonia. Hence prothallus is **protandrous**.
- These are developed among the rhizoids from antheridial initials that ensures proper availability of **moisture** for the movement of antherozoids.
- **Archegonia** are developed from the cushion like region behind the apical notch. These sex organs slightly protrude out from the prothallus.
- In some cases the prothallus is **dioecious** and in still others it produces **functionless** sex organs and reproduce by apogamy.

Sex organs

Antheridia

- These are male sex organs developed and mature earlier than archegonia.
- These are small, sessile and **globular** structures.
- Its wall consists of three **tabular celled jacket**.
- These cells are **1st** ring cell that covers the basal portion of antheridial body, **2nd** ring cell that covers the middle portion of antheridial body and **cap cell** that covers the apical portion of the antheridium. The cap cell forms the lid.
- Apart from these cells, there is a **4th** cell at the base that can be considered as single celled stalk.

- The wall encloses **32** spermatocytes.
- Each one is metamorphosed into long, spirally coiled, multiciliate, motile antherozoid.
- Each spermatozoid has prominent posterior vesicle of homogenous substance, coiled nuclear part covered **cytoplasmic sheath** and motor apparatus from which the **cilia** arise.
- Dehiscence of mature antheridium takes place in the presence of water.
- Jacket cells and androcytes absorb water, swell and exert pressure due to which the cap cell is either tilted upwards or thrown off.
- The antherozoids covered by androcyte membrane extrude out *en masse*. This extrusion is further assisted by the inward **swelling** and **shortening** of the wall cells.
- The membrane around the spermatozoids is dissolved and the male gamets become free to swim.

Archegonia

- These are developed later than antheridia nearer to apical notch of prothallus.
- It is flask shaped with swollen embedded venter in the prothallus and projected short, slender, slightly curved neck.
- It has no venter **wall** or **jacket**. It consists of basal naked egg cell and above it a small ventral canal cell.
- Neck consists of a single layered jacket with **4 vertical rows** of cells with each row having **4 cells**. So the total number of jacket cells is **16**. Opercular cells or lid cells are absent.
- Interior to jacket of neck, a single **dikaryotic neck canal cell** is present.
- At maturity, the ventral canal cell and neck canal cell degenerate and form a sugary mucilaginous substance rich in **malic acid**.
- This substance exerts pressure at the distal end of archegonium due to which the distal tier of neck cells are ruptured and the neck cells are far separated to establish a passage and the substance comes out in the form of **droplet**.

Fertilisation

- It takes place in the presence of water between the lower surface of prothallus and soil.
- Malic acid of archegonial secretion helps in attracting the male gametes by **chemotaxy**.
- The male gamets enter into the archegonium and one of the male gametes fuses with the egg to form the diploid zygote with its own wall.
- Fertilisation is **oogamous**.
- Out of several archegonia of the prothallus, usually **only one** is fertilised. In some cases even 2 or more archegonia may be fertilised.
- With the act of fertilisation, the **growth of prothallus is arrested**. The archegonial venter forms a cap like **calyptra** around the fertilised egg.

Embryo

- Zygote develops into **8 celled** embryo that later develops into adult sporophyte.
- The first division in the zygote is **vertical** and forms two cells.
- The second division is also **vertical but perpendicular to the first division** to form 4 cells.
- The third division is **transverse** to form 8 cells.
- At this 8 celled stage the embryo gives out the **primary root from its lower tier region**, that pierces the calyptra and establishes contact with the soil.
- Later the **first** leaf emerges through the apical notch of the prothallus. It turns green and performs photosynthesis.
- The shoot grows slowly to become an underground rhizome. At this stage the primary root perishes and in its place many adventitious roots arise from the rhizome.

Apogamy

- It is development of haploid sporophyte from haploid cells of prothallus without the involvement of gametic union and sex organs.
- It is common is *Pteris*.

Life cycle

- The dominant stage is diploid independent sporophyte that produces spores in its **coenosorus**. The haploid gametophyte is highly reduced, short lived and independent. Hence the life cycle is **diplohaplontic**.
- Since both gametophyte and sporophyte are morphologically different, its alternation of generations are described as **heteromorphic**.