PUCCINIA: GENERAL CHARACTERS, CLASSIFICATION AND LIFE CYCLE

For B.Sc. Part I (Subs. and Hons.) Students

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Lecture No.14

Systematic Position of *Puccinia*

Kingdom	-	Mycota
Division	-	Eumycota
Sub-division	-	Basidiomycotina
Class	-	Teliomycetes
Order	-	Uredinales
Family	-	Pucciniaceae

- *Puccinia* is a very large genus with about 1800 species, distributed in all parts of the world
- The genus is represented by more than 147 species, which cause serious rust disease in cereal crops like wheat, barley, oats and maize.
- The species of Puccinia are internal obligate parasites; only spore are seen on the host surface.

➢ Species of *Puccinia* are either autoecious (complete life cycle on single host) or heteroecious (they complete life cycle on two different host).

➢ In India wheat crop is infected by the following three species of *Puccinia* which cause considerable damage to the crop.

1. *Puccinia graminis*	-	Black rust or stem rust
2. *Puccinia recondita*	-	Brown rust or leaf rust
3. *Puccinia striigormis*	-	Yellow rust or stripe rust

Puccinia graminis

➢ *Puccinia graminis* is the casual organism for black rust disease of wheat and other cereal crops

➢ This disease is also known as stem rust .

➢ *P . graminis* is an obligate parasite

- It is heteroecious fungus.
- There are two phases in its life cycle – dikaryophase and haplophase.
- Dikaryophase occurs in its primary host that is wheat plant (*Triticum aestivum*), whereas the haplophase in its alternate host that is *Berberis vulgaris.*

✓ Although *P. graminis* can survive in the absense of alternate host but its life cycle completed only when both hosts are avilable.

Physiological specialization:

- *P. graminis* has several physiological races , which show physiological specificity twoards their host.
- *P. graminis* cause rust disease in several cereal crops like wheat barley or oats but the strain which infects wheat plant does not infects barley or oats.

Vegetative structure

There are two types of mycelia

1. Dikaryotic mycelium: Occurs in primary host (wheat plant) .
2. Monokaryotic mycelium : occur in the alternate host (Barberry bushes).

- Both these mycelia are intercellular, septate and branched
- There is simple pore in each septum, which maintains protoplasmic connections between the adjecent cells.
- Each cell of the dikaryotic mycelium have two nucleus and monokaryotic mycelium have single nucleus.
- The mycelium takes nourishment from the host cells with the help of spherical haustoria.

Life cycle

Puccinia graminis is a macrocyclic heteroecious rust.

There are five types of spore in its life cycle

1. Uredospores
2. Teleutospores
3. Basidiospores
4. Pycnidiospores
5. Aeciospores

➢ These spores develop in two different hosts in a definite sequence. The sequence of various stages occurring in the primary and alternate hosts are as follows

Uredospores
Teleutospores
} On primary host (*Triticum aestivum*)

Basidiospores

Pycnidiospores
Aeciospores
} On alternate host (*Berberis vulgaris*)

Stages of *Puccinia graminis* on wheat plant

1. Uredospore stage

➢ The dikaryotic mycelium is produced by aeciospores on germination on wheat plants

➢ A binucleate uredospore develop at the tip of each erect hypha (Fig:…). These spores develop in groups and these groups are known as uredosori.

➢With the formation of uredospores disease symptom appears in form of reddish brown pustules or streaks on the stem, leaf and leaf base.

➢These symptom usually appears in late spring. The host epidermis burst due to pressure of developing uredosori and thus uredospores get exposed and are liberated.

➢The mature uredospore is oval stalked and binucleate structure (Fig. 1. B).

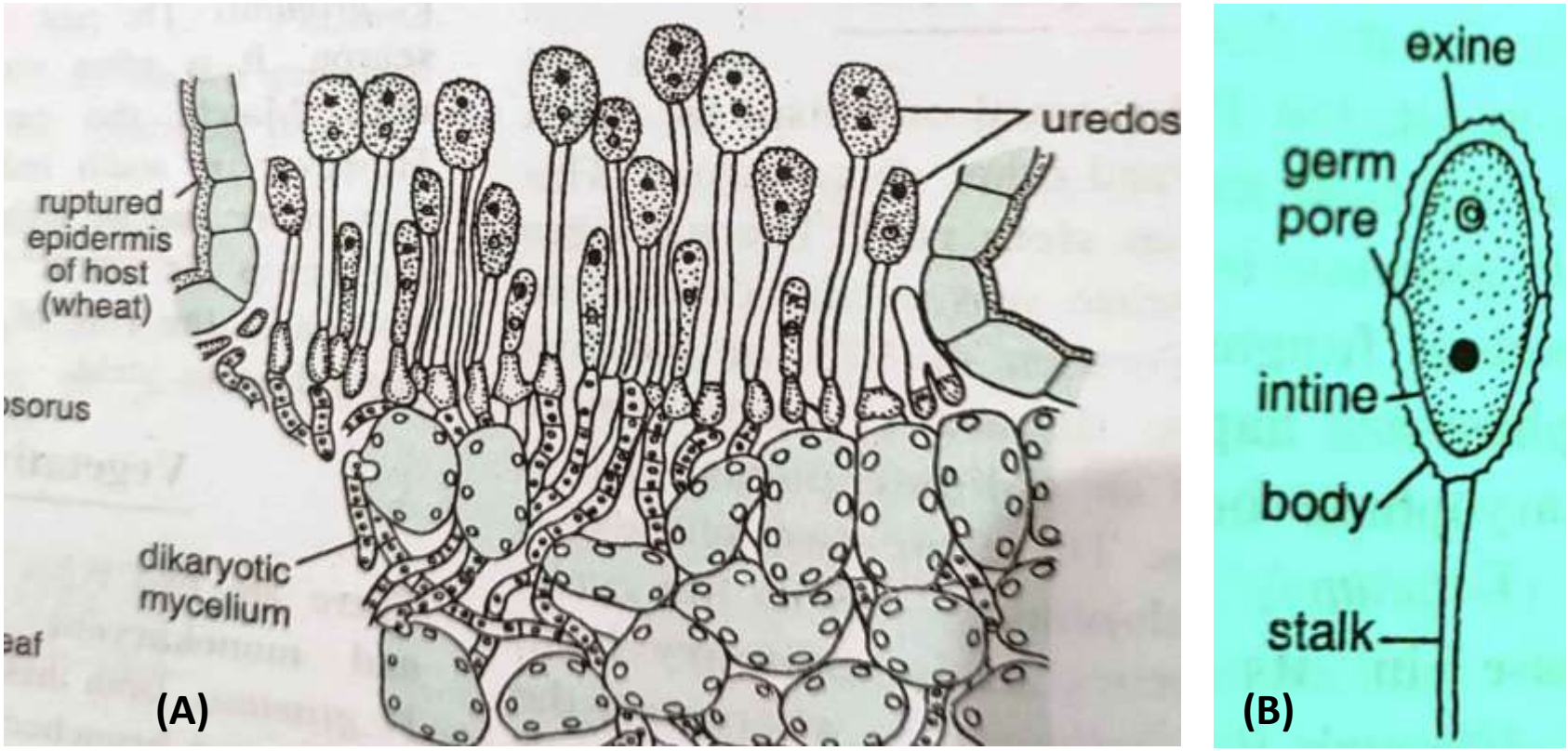


Fig 1: (A) Vertical section of wheat leaf passing through uredosorus , **(B)** A uredospore

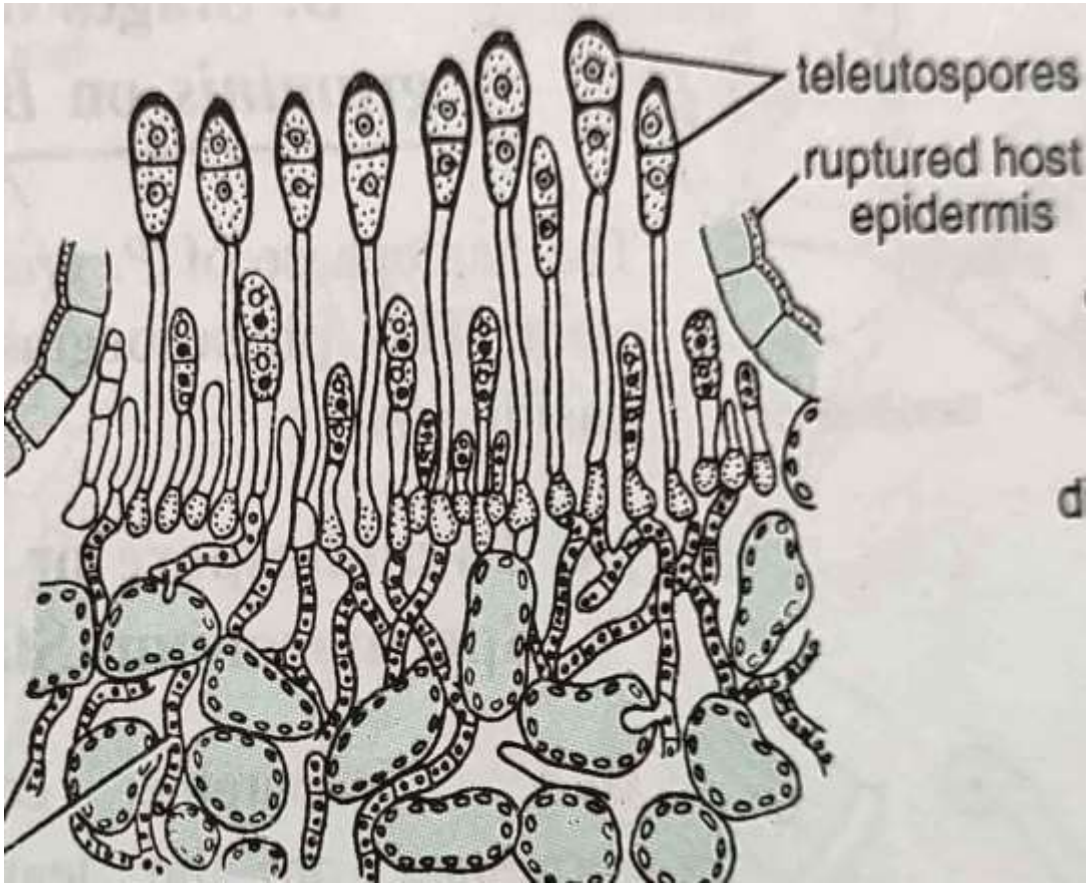
- The binucleate uredospore function as a conidium and it has capacity to germinate just after its formation.
- Uredosore can reinfect wheat plants and hence they are effective in the spread of the disease .
- Uredospore have not the capacity to infect the alternate host.

Germination of Uredospore:

- Under favorable conditions uredospores germinate as soon as they come in contact with fresh wheat leaves.
- The germ tube grows over the surface of host epidermis and on reaching a stoma the tip of the germ tube develop into the vesicle called appressorium.
- Hyphal branches develop from the appressorium into the intercellular spaces.
- This dikaryotic mycelium forms a new generation of uredospore which infect healthy plants.
- Once formed uredospore spread the disease rapidly under favorable condition

2. Telutospore stage

- At the end of the wheat season , uredosori also start to producing telutospore in addition to uredospore.
- The uredosori are ultimately converted into telutosori and produce telutospore exclusively.
- The telutospore is stalked, bi-celled, spindle shaped structure constricted slightly at the septum.
- The wall of the telutospore is thick and smooth and tip is usually pointed or round .
- Each cell of telutospore is binucleated and is provided with the germ pore.
- As the telutospore mature the two nuclei in a cell is fused to form a diploid nucleus.
- Telutospore act as resting spore and may survive most of the unfavorable conditions.
- Telutospore are not capable of reinfectining the wheat plant.
- Under favourable condition of high atmospheric humidity and low temprature they germinate in soil as no host is required for their germination.



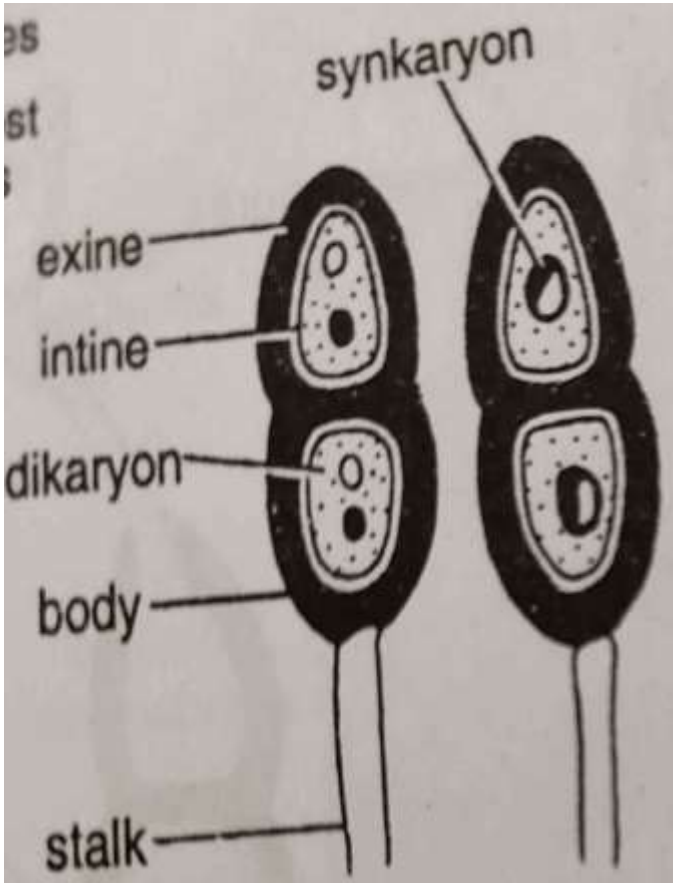


Fig 2: (A) Vertical section of wheat leaf passing through telutosorus , **(B)** A telutospore

3. Basidiospore stage

- On return of favorable conditions in spring the telutospore germinates. It produces one germ tube from each cell.
- The germ tube has limited growth and I known as promycelium or epibasidium.
- The diploid nucleus move into promycelium and divides meiotically to form four haploid nuclei (2 + and 2 -).
- The promycelium divides into four cells by the formation of transverse septa.
- Each cell produces a single basidiospore which is borne asymmetrically on a fine sterigmata.
- Basidiospores are small thin walled, unicellular structure with haploid nucleus.
- Basidiospores are discharged by explosive mechanism and are disseminated by wind.
- Basidiospores germinate only on the leaves of alternate host , the barberry bushes.
- Basidiospores can survive only for few days.

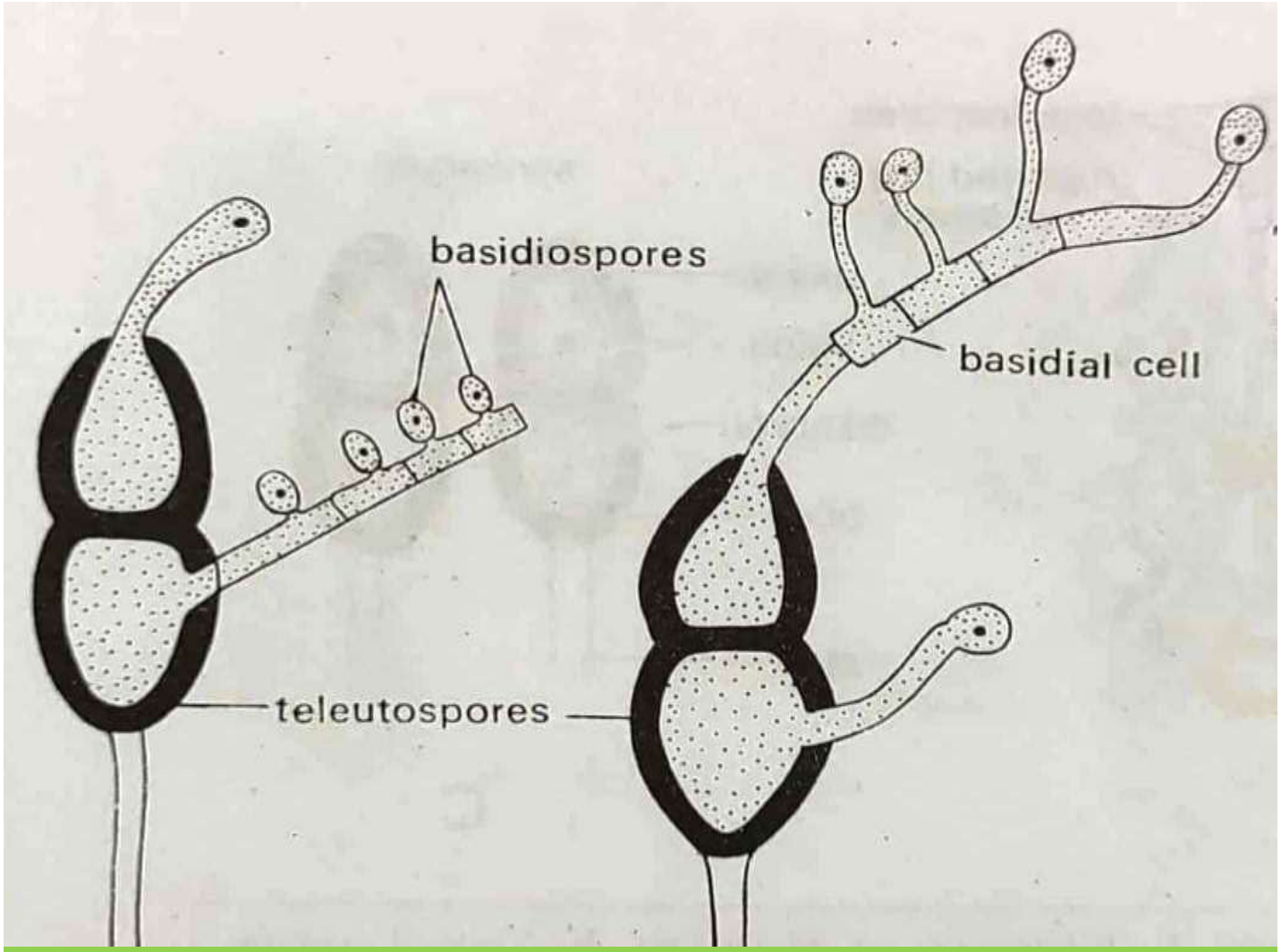


Fig. 3: Germination of telutospore and formation of basidia

Stages of *Puccinia graminis* on *Berberis* plant

The haplophase of *Puccinia gramins* occurs on Berberis plant . This phase begins with the formation of basidiospores.

4. Pycnidiospore or spermogonium stage

- The basidiospores germinate on leaves of alternate host and thus form monokaryotic mycelium (+ and – strain).
- The mycelium forms flask shaped spermogonia or pycnidia on upper surface of leaves.
- The wall of pycnidium is lined internally by spermatiophores or pycniophores each of which produces many small uninucleate spermatia or pycniospores or pycnidiospores.
- These may be + or – strain.
- The pycniospores neither infect primary host nor the alternate host.
- Inside the pycnidium there are also present flexous hyphae (receptive hyphae) and periphyses which came out through ostiole or pore of pycnidium.
- Now the pycniospores of one strain are transferred to flexous hyphae of opposite strain (spermatization) and a result of which dikaryotic mycelim is formed.

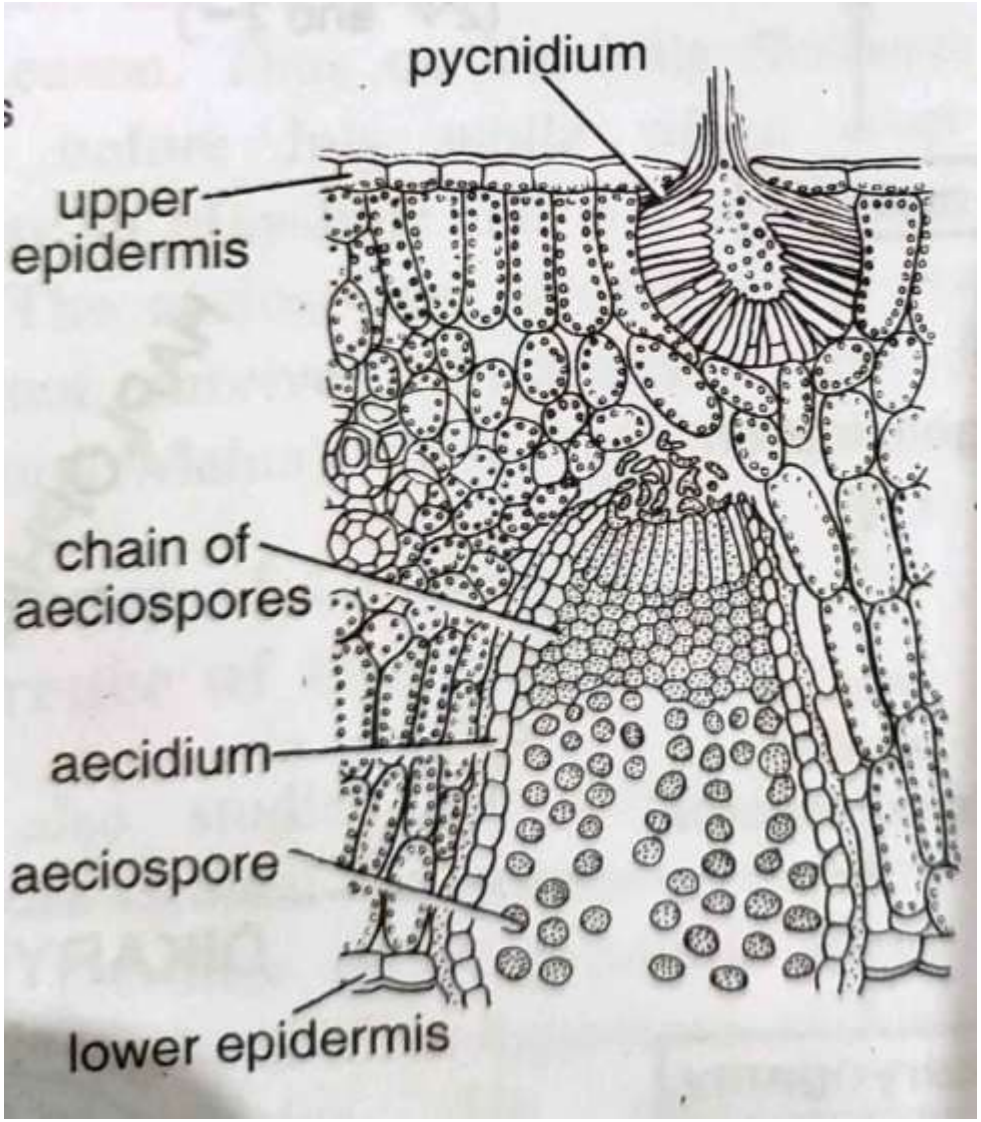


Fig 4: Vertical section of leaf to show a young pycnidium (upper surface) and mature aecidium (lower surface)

5. Aeciospore stage

- Aecidia are cup shaped structure formed on the lower surface of Barberry leaf.
- They develop from the same mycelium which forms pycnidia on the upper surface.
- Dikaryotic mycelium forms the roof of the protoaecidium.
- The cells of the protoaecidium are known as aecidiophores .
- Each aecidiophores cut off numerous binucleate cells which are arranged in chain.
- The chains are made up of long and short cells arranged alternately .
- The long cells mature into aeciospores, whereas short cells are known as disjunctor, remains sterile and soon disintigrate.
- Simultaneously with the formation of aeciospores , the peripheral cells of aecidium divide to form a thick protective covering known as peridium.
- Aeciospores are unicellular , thin walled binucleate structure.
- The aeciospores are incapable of infecting Barberry plants but they can infect wheat plant.
- They are dispersed by wind and germinate on the surface of primary host by producing germ tubes.

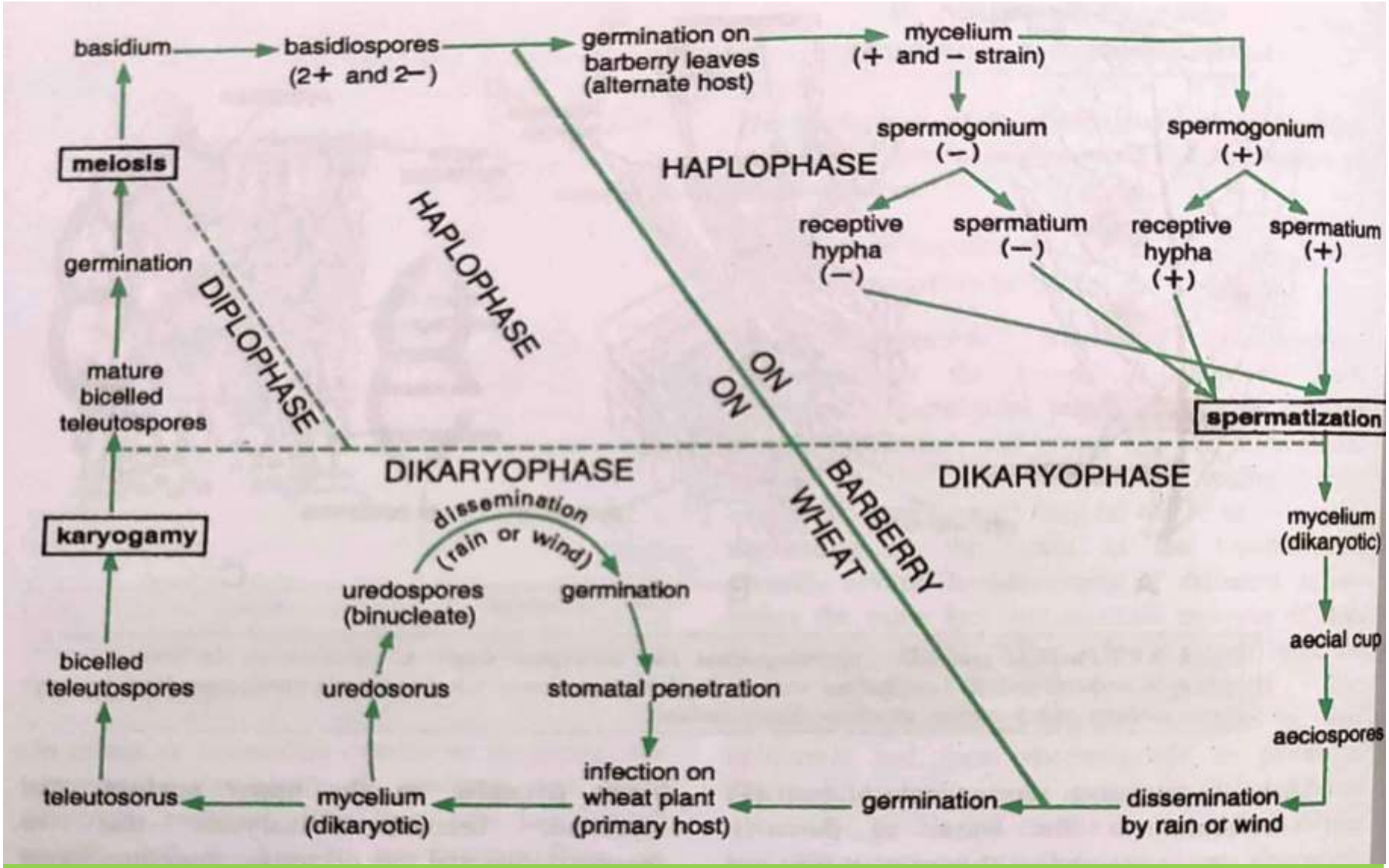


Fig. 5: Schematic representation of the life cycle of *Puccinia graminis*

Thank You !!