Basidiomycotina – Agaricus

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General Features

- ***Agaricus*** is a large and important genus of mushrooms containing both edible and poisonous species, with possibly over 300 members worldwide.
- The genus includes the common ("button") mushroom (*Agaricus bisporus*), and the Field mushroom (*Agaricus campestris*) the dominant cultivated mushrooms of the West.
- Members of *Agaricus* are characterized by having a fleshy cap or *pileus*, from the underside of which grow a number of radiating plates or gills on which are produced the naked spores.
- They are distinguished from other members of their family, Agaricaceae, by their chocolate-brown spores. Members of *Agaricus* also have a stem or *stipe*, which elevates the pileus above the object on which the mushroom grows, and a partial veil, which protects the developing gills and later forms a ring or annulus on the stalk.

Kingdom:	Fungi
Phylum:	Basidiomycota
Class:	Agaricomycetes
Order:	Agaricales
Family:	Agaricaceae
Genus:	*Agaricus*

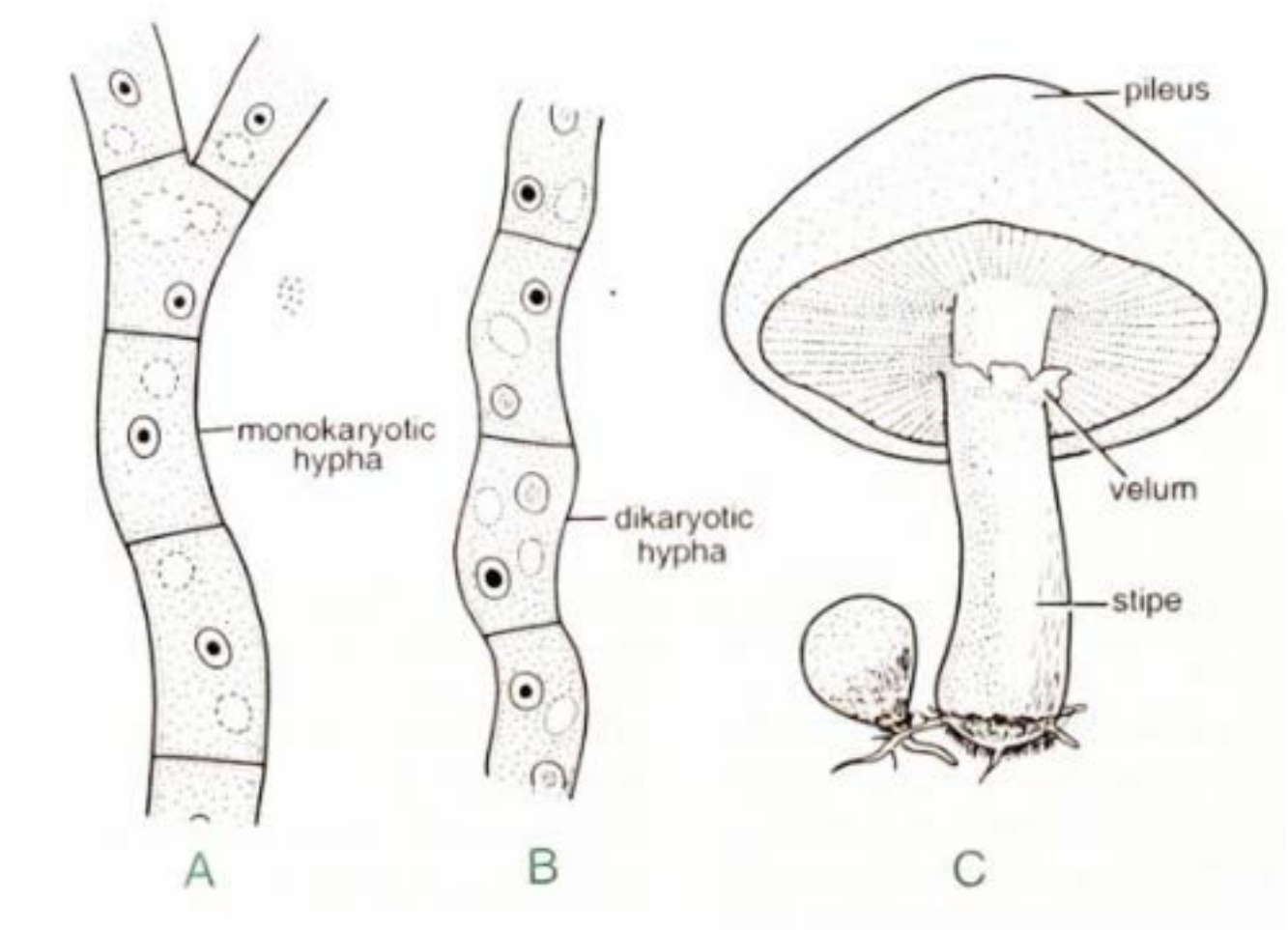


Fig 1. *Agaricus thallus structure.* ***(A)*** *Monokaryotic hyphae* ***(B)*** *Dikaryotic hyphae* ***(C)*** *Fruiting body (basidiocarp)*

Thallus Structure

- The structure of *Agaricus* can be studied under the following two heads:
  - Vegetative mycelium
  - Fruiting body (basidiocarp)

Vegetative Structure of *Agaricus campestris*

- The vegetative mycelium remains underground and is of two types.
  - The primary mycelium formed by the germination of basidiospore, is **hyaline**, **septate** and **monokaryotic**.
  - Depending on the strain of the basidiospore, it may of (+) or (-) strain.
- The primary mycelium is short-lived and soon gets transformed into the secondary mycelium. The secondary mycelium, formed by the fusion of two primary mycelia of opposite strains, is perennial, branched and septate. It contains **dolipore septa** and its cells are binucleate. The hyphae of the secondary mycelium twist together to form white hyphal cords, called **rhizomorphs**.
- The dikaryotic mycelium shows **centrifugal growth**, i.e., hyphae grow outward from a centre in a circle. A circular colony of hyphae is thus formed in the soil. At maturity, hyphae develop fruiting bodies at their tips in a more or less circular ring.
- As the outer edge of the colony grows, older parts in the centre degenerate. When fruiting bodies are formed next time, the ring is larger in diameter. Thus successive crops of fruiting bodies are produced in larger and larger rings. Based on the ancient belief that they marked the path of dancing fairies, these rings are called **fairy rings**.

Fruiting Body (Basidiocarp)

- The basidiocarp is the aerial part of *Agaricus* and it develops from rhizomorph.
- This part is commonly known as mushroom.
- It is differentiated into a **stipe** and a **pileus**.
- The stipe is about 6-9 cm in height and the pileus is 5-10 cm in diameter.
- There are about 300-600 gills in the under-surface of the pileus arranged in radial fashion.

Reproduction in *Agaricus campestris*

- *Agaricus* reproduces by vegetative, asexual and sexual means.

Vegetative Reproduction in *Agaricus campestris*

- The edible mushrooms are propagated by vegetative means.
- Small pieces of dikaryotic mycelium are used as **inoculum**.
- The pieces are grown in soil rich in organic manure to obtain basidiocarps.

Asexual Reproduction in *Agaricus campestris*

- It is not a common method of propagation in *Agaricus*. It takes place by **chlamydospore** formation.
- The chlamydospores develop in terminal or intercalary positions on the secondary mycelium.
- They germinate to produce dikaryotic mycelium.
- In some species oidia are also formed, but these are involved mainly in **dikaryotization** rather than developing directly into new mycelia.

Sexual Reproduction in *Agaricus campestris*

- Primary mycelia formed by the germination of basidiospores of two different strains act as male and female sex organs.
- There is somatogamy between the somatic hyphae of opposite strains and this results in diplotization and formation of the secondary mycelium.
- The secondary mycelium later develops fruiting bodies, known as basidiocarps.
- Somatogamy between two primary hypha of opposite strains takes place through **plasmogamy**, **karyogamy** and **meiosis**.

1. Plasmogamy

- In this step, two primary monokaryotic hyphae of opposite strains come in contact with each other. At the point or their contact, the cell walls are dissolved and a **dikaryon** is formed.
- A dikaryolic mycelium develops by successive divisions of the dikaryotic cell. At the time of the division of dikaryotic cell, both nuclei of the dikaryon divide synchronously and form four haploid daughter nuclei, two of (-) and two of (+) strain.
- Out of these, two nuclei (one of (+) and one of (-) strain) are transferred to the daughter cell by the formation of **clamp connection**. The dikaryotic mycelium is perennial and subterranean. It produces basidiocarps under favourable conditions.

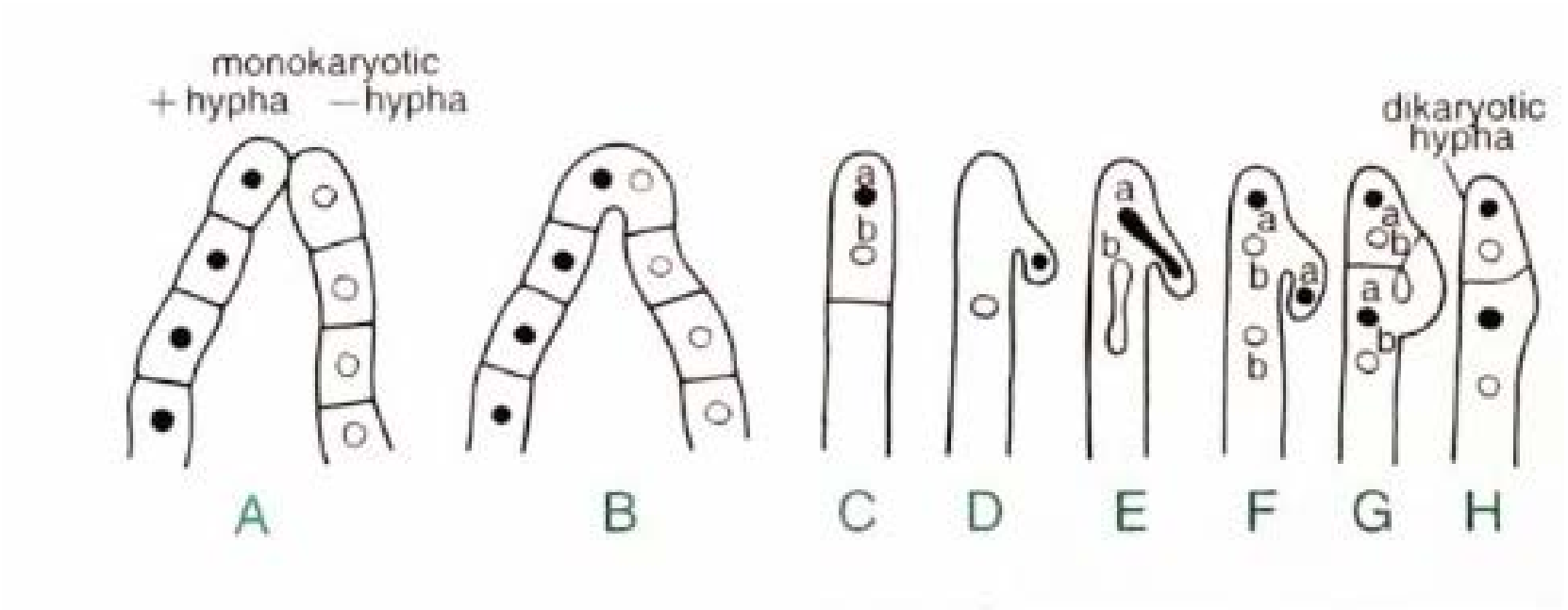


Fig 2. *Formation of dikaryotic hyphae using clamp connections.*

2. Karyogamy

- In this step, both nuclei of a dikaryon fuse to form a diploid nucleus.
- Karyogamy takes place in young basidium.

3. Meiosis

- Soon after karyogamy, meiosis takes place in the basidium.
- The basidiospores, thus formed in the basidium, are haploid.

Development of Basidiocarp

- The subterranean secondary mycelium takes nutrients from the soil and then forms the fruiting body or the basidiocarp.
- Basidiocarps develop as small ‘white-knot’ like structures at the tips of hyphae.
- These hyphal knots enlarge gradually and give rise to **button stage**.
- At button stage, the developing basidiocarp is differentiated into a basal bulbous part and an apical hemispherical region. The basal part forms the stipe, and the apical hemispherical part, the pileus.
- Some hyphae at the junction of the stipe and pileus are drawn apart and form a ring-like chamber, called **pre-lamellar chamber**. The inner surface of the roof of the pre-lamellar chamber becomes deeply concave and it is lined with alternating radial bands of slow and rapidly dividing cells. The latter form **gill primordia**, which develop into gill lamellae that hang downward into the prelamellar chamber.
- As pileus expands, there is an increase in radial interspaces between the gills. A membrane, called **velum** or **inner veil**, connects the margin of the pileus with the stipe. Due to the elongation of stalk, the buttons are raised on the soil surface.
- The upper hemispherical region of the button grows more rapidly than the stalk. This causes rupture of the velum and the upper hemispherical region finally expands out as an open umbrella-like structure with numerous gills attached to its lower surface. The gills are exposed by the rupture of the velum.

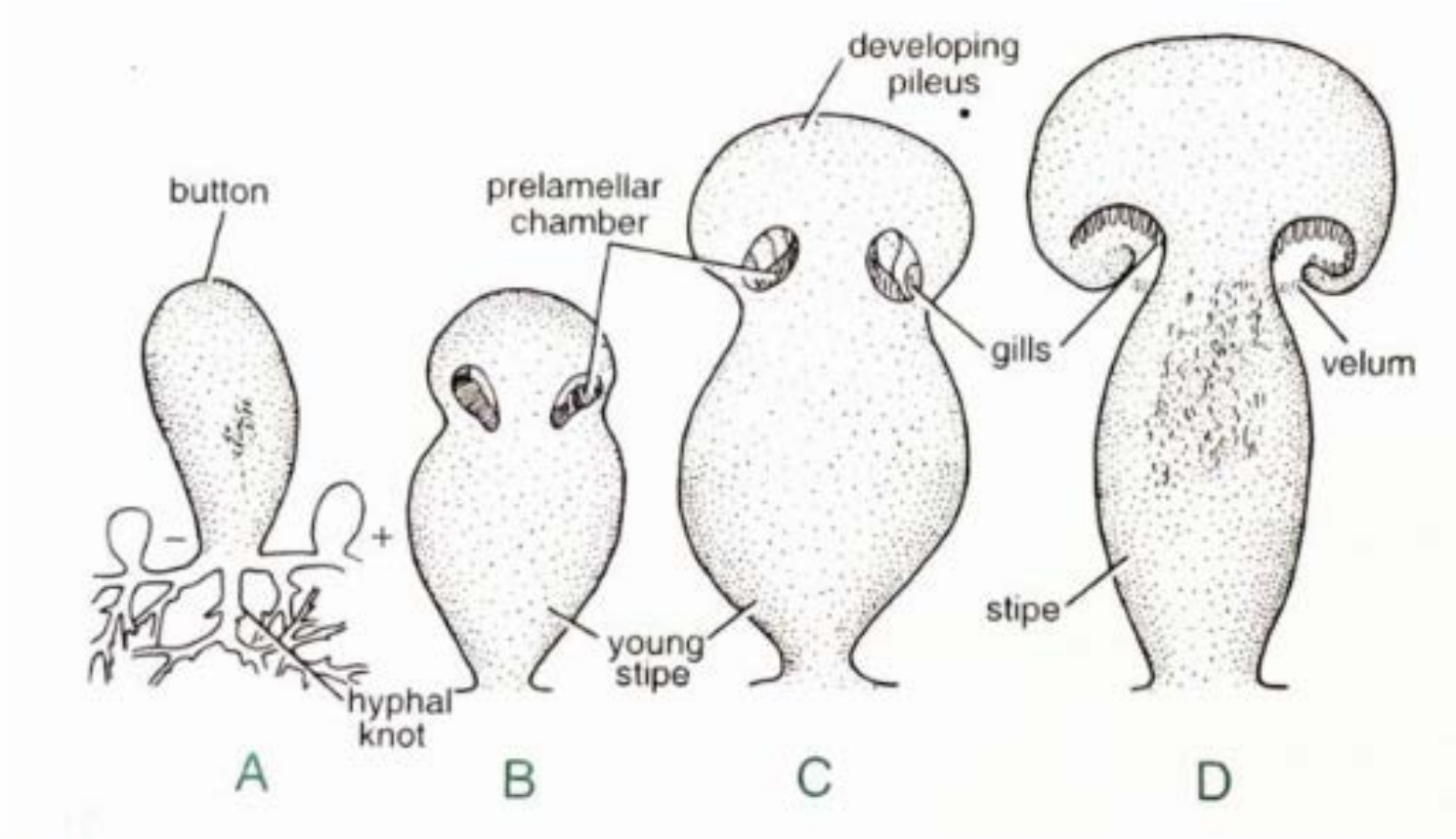


Fig 3. *Formation of basidiocarp in Agaricus campestris*

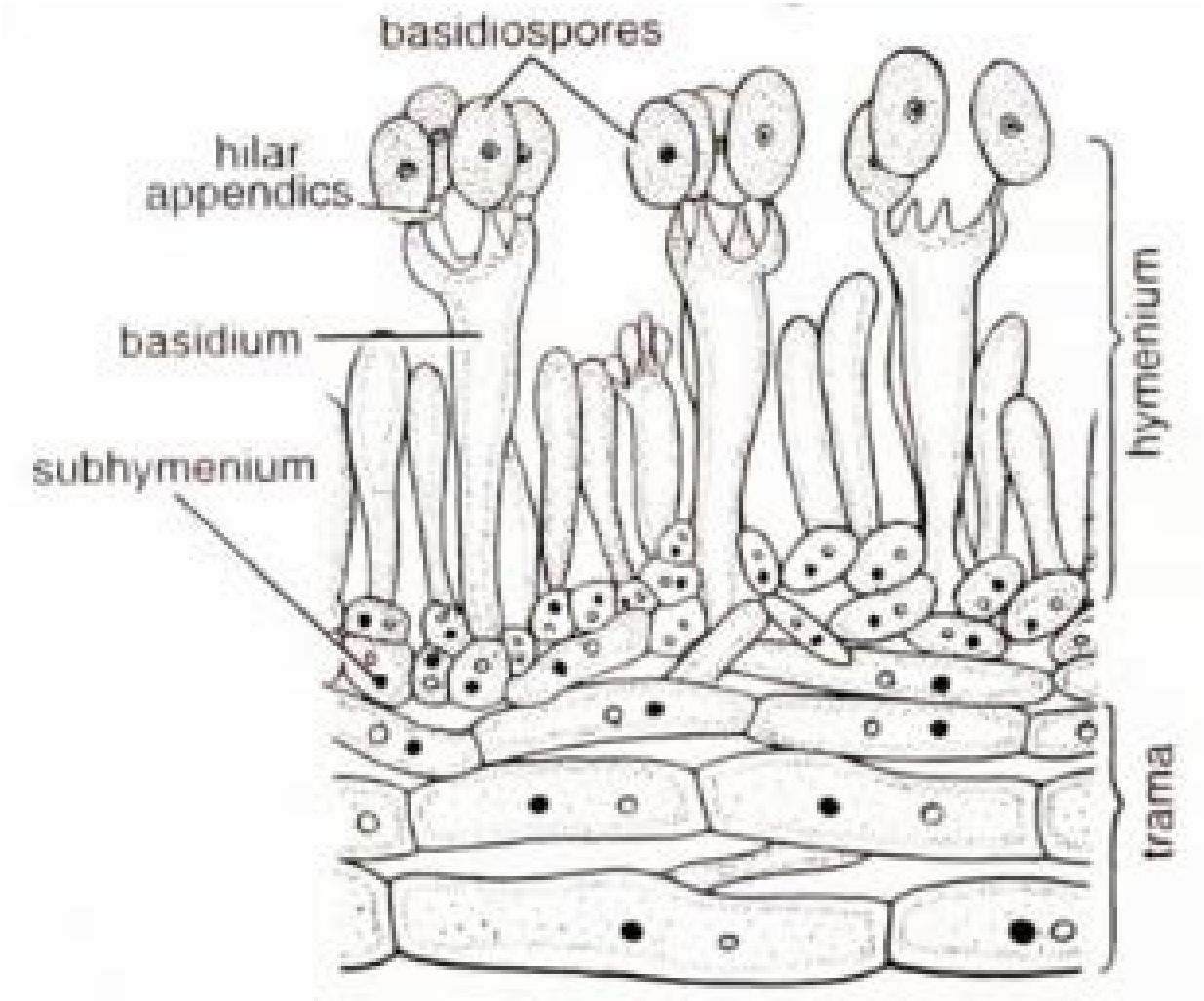
Mature Basidiocarp

- An umbrella-like pileus, 5-12 cm in diameter, is present at the distal end of the stipe. The upper convex surface of the pileus is white, light brown or yellow in colour. About 300-600 radially arranged gills hang down from the inner surface of the pileus.
- The surface of the gill is enveloped by a fertile layer, the hymenium. The gills are of light pink colour when young, but they turn brown or purplish black at maturity.

Internal Structure of Gills

- In the internal structure of gill following three regions can be distinguished.
- **Trama.** This is the central sterile region of the gill. It consists of many loosely arranged interwoven hyphae.
- **Sub-hymenium (hypothecium).** This region is situated on both sides of the trama. It is formed by the lateral branches of hyphae of trama region. The cells of these hyphal branches are isodiametric and 2-3 nucleate. This is also a sterile zone like trama.
- **Hymenium.** This is the outermost layer of the gill. It is fertile and composed of hyphae of the sub-hymenium region. In this region the cells are arranged in palisade-like layer. These aseptate fertile cells are known as **basidium**. Club-shaped sterile paraphysis occur in between the fertile cells.

A Part of Gill Region Magnified



- The young basidium is a dikaryon and as the basidium matures the two nuclei fuse to form a diploid nucleus.
- This diplophase is ephemeral and after karyogamy the diploid nucleus divides meiotically to form four haploid nuclei.
- Of these four nuclei, two are of (+) strain and two of (-) strain.
- At the distal end of the basidium, four peg-like outgrowths are formed.
- These outgrowths are known as **sterigmata**.
- The sterigmagata swells up at their tips and forms a single basidiospore.
- Thus, four monokaryotic basidiospores are formed in a basidium.

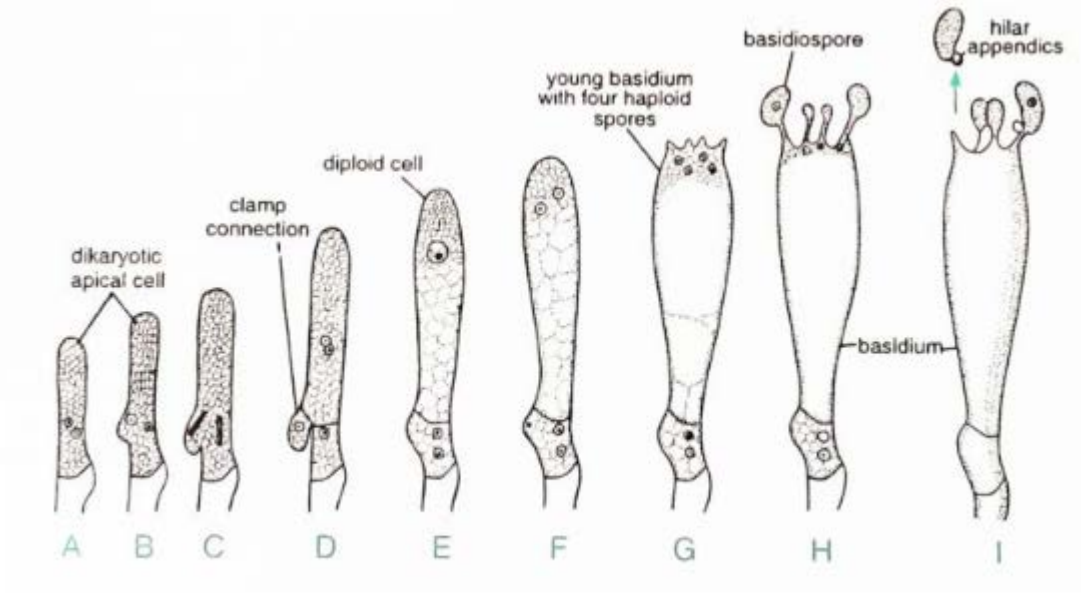


Fig 5. Development of basidium and basidiospores in Agaricus campestris.

Life cycle of Agaricus