

BASIDIOMYCOTINA

**(THE CLUB FUNGI, JELLY FUNGI,
GILL FUNGI, BIRDS NEST FUNGI)**

GENERAL FEATURES

- Well developed filaments, septate branched hyphae
- Motile cell completely absent
- Primary mycelium **homokaryotic** constitute **haplophase** (**monokaryophase**)
- Secondary mycelium **heterokaryotic** constitute **dikaryophase**
- Special structures called **clamp connections** are formed during nuclear division of **dikaryotic cells**
- The cross wall of the septum has pore with swollen rim called **dolipore septum** which look like paranthesis (round bracket) thus given the name **parenthosome**
- The secondary mycelium becomes organized into special tissue called **tertiary mycelium**

Mycelium

Mycelium is branched, well developed and perennial

- Spreading in a fan shaped manner – forming fairy rings in mushrooms
- Mycelium spread on the substratum and absorb food
- In few genera mycelium form rhizomorphs
- Hyphae are septate, septal pore is surrounded by a swollen rim or crescent shaped cap – paraphyses – such septa are called dolipore septum ; Not seen in rusts and smuts
- Cell wall is made up of chitin

Mycelium occur in three stages:

- Primary mycelium: Monokaryotic, short lived, formed by germination of basidiospores, represent haplophase, does not bear any sex organs
- Secondary mycelium: Dikaryotic, perennial, formed by the fusion (dikaryotisation) of two dissimilar primary mycelium. Represent dikaryotic phase, produce fruiting bodies and show clamp connections
- Tertiary mycelium: In higher members, secondary mycelium get organised into specialized tissues forming fruiting bodies. Dikaryotic in nature

Clamp Connections

Dikaryotic secondary mycelium grow by producing clamp connections, unique feature of basidiomycotina

- Cell divisions are confined to apical cell
- Dividing cell forms a pouch or clamp during nuclear division
- The two nuclei of the cell undergo conjugate division
- One of the four daughter nuclei moves into the pouch/clamp
- A septum is formed at the base of pouch, separating it
- Another septum is formed below the clamp connection on parent cell dividing it into two daughter cells, upper cell with two nuclei and lower with one nucleus
- Clamp cell grows and fuse with sub apical cell
- The nucleus within the clamp migrate to sub apical cell making it dikaryotic
 - Clamps degenerate later

Fairy rings

Due to centrifugal growth of dikaryotic mycelium, fruit bodies are formed in a circular ring around the spot where fruit bodies formed in the last year.

- These fruit bodies are arranged in a ring
- Imagined that these rings mark the path of dancing fairies

Reproduction

☐ Asexual

- Blastic Conidia
- Oidia
- Budding
- Fragmentation
- Chlamyospores
- Bulbils

Usually insignificant in life cycle

☐ Sexual

- Absence of sex organs
- Plasmogamy followed by Karyogamy
- Immediate meiosis
- Formation of fruit body called basidiocarp

Three morphological types of dikaryotic hyphae may be present in basidiocarps

- Generative hyphae: Present in all basidiocarps, thin walled, produce basidia and constitute hymenium, give rise to other kinds of hyphae
- Skeletal hyphae: Un branched or sparsely branched, thick walled with narrow lumen, form a rigid frame work
- Binding hyphae/ligative hyphae: Much branched, narrow, thick walled and limited growth. Weave between other hyphae and bind them together

Different combinations of hyphal types may occur in basidiocarps

- Monomitic basidiocarps: Basidiocarps made up of only generative hyphae
- Dimitic: Fruit bodies made of generative hyphae along with any other type of hyphae
- Trimitic: Fruit bodies consist of all three types of hyphae

Development of Basidiocarp (General)

- Basidiocarps arise as hyphal knots from sub-terrestrial mycelial strands – rhizomorphs
- Hyphal knots enlarge into round or ovoid structures which break through the surface
- Development of basidiocarps show variations
- In many hymenomycetes species, young fruit bodies may be enveloped by a universal veil, which is broken as the pileus expands
- This leaves a cup like volva at the base of stipe and broken scales on cap (Eg. Amanita)

- In some other species, the hymenium is protected during the development by a partial veil (inner veil/velum), extending from the edge of cap to stipe
- Remnants of inner veil persists as a ring on stipe called Annulus (Eg. Agaricus)
- In many hymenomycetes, basidiocarp has a stipe and pileus
- Lower surface of pileus has radially arranged gills

Arrangement of hymenium show variations

- Agaricoid: hymenium consists of gills/lamellate
- Poroid: Hymenium has pores instead of gills
- Hydroid: toothed or spiny hymenium
- Clavate: Club shaped or coralloid fruit body, out side of which is covered by hymenium
- Resupinate: Flattened hymenium, appressed to underside of solid surfaces
- Gasteroid: Hymenium is enclosed

Subdivision: Basidiomycotina

- Heterobasidiomycetidae – basidium partitioned
- Classes –
 - **Teliomycetes** – basidiocarp absent, spores grouped in sori within host tissue, saprophytic or parasitic
 - **Smut and Rust fungi**
- Homobasidiomycetidae – basidium not septate
 - **Hymenomyces** – basidiocarp gymnocarpous (hymenia exposed)
 - **Mushroom and Toad stool fungi**
 - **Gastromycetes** – basidiocarp angiocarpous (hymenia enclosed)
 - **Puffball and earth star fungi**

- Basidiocarps are characteristic of the hymenomycetes; rusts and smuts do not produce such structures.
- As with other sporocarps, epigeous (above-ground) basidiocarps that are visible to the naked eye (especially those with a more or less agaricoid morphology) are commonly referred to as mushrooms, while hypogeous (underground) basidiocarps are usually called false truffles
- All basidiocarps serve as the structure on which the hymenium is produced. Basidia are found on the surface of the hymenium, and the basidia ultimately produce spores.
- In its simplest form, a basidiocarp consists of an undifferentiated fruiting structure with a hymenium on the surface.
- Basidiocarps are classified into various types of growth forms based on the degree of differentiation into a stipe, pileus, and hymenophore, and also the type of hymenophores as,
 - **Jelly fungus**
 - **Club fungus and Coral fungus**
 - **Polypore**
 - **Cantharelloid fungus**
 - **Tooth fungus or hydroid fungus**
 - **Gasteromycetes or gastroid fungus**
 - **False truffle**
 - **Secotioid fungus**
 - *Agaricus or agaricoid fungus*

Class Teliomycetes

Rusts, Smuts, Jelly Fungi (Club Fungi)

- Sexual reproduction results in usually 4 basidiospores produced on the outside of a microscopic club-shaped sporangium called a **basidium**
- Basidium partitioned transversely or longitudinally into two, three or four cells – **Phragmobasidium**

Rusts (Uredinales)

- Fungi in this order are **obligate parasites** (require living hosts) on plants.
- No fruiting bodies are produced. Classification is based on the presence of teleutospores, representing the overwintering, resting stage
- Many rusts attack only specific plants. Some require two hosts to complete their life cycles

Wheat rust alternates between wheat (*Triticum*) and barberry (*Berberis*)—unrelated hosts. This is called **heteroecism** (different homes)

EXAMPLES

- White pine blister rust *Cronarium ribicola* (with currants and gooseberries as the alternate hosts)
- Rusts of juniper, apple, hawthorn, and pear (*Gymnosporangium* spp)
- Rusts of wheat, barley, oats, rye, and hollyhock (*Puccinia* spp)

Smuts (Ustilaginales)

Smuts form masses of black, sooty-looking teleutospores. Smuts are similar to rusts but do not need living host material and can be grown in the laboratory.

Tilletia foetia (bunt or stinking smut of wheat), *Ustilago* spp. (smut of corn, oats), *Urocystis cepulae* (onion smut). *Ustilago maydis* (corn smut) is sold as a gourmet food called “cornmushroom.” Economically, smuts cause extensive damage to crops and consequent reductions in yields.

***Urocystis cepulae* Onion Smut**

- Black teleutospores (f) form an infestation on bulbs of onions (g). This is commonly seen on commercially sold onions.

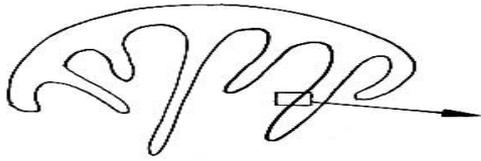
Jelly Fungi

Jelly Fungi (Auriculariales). Fruiting bodies of gelatinous material are produced. When wet, basidia are formed. Most genera are saprobic, living on dead organic matter. A few genera are parasitic on mosses and flowering plants. *Herpobasidium deformans* (blight of honeysuckle).

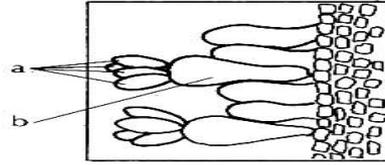
***Auricularia auricula* Ear Fungus**

- The gelatinous fruiting body resembles a human ear.

Club Fungi

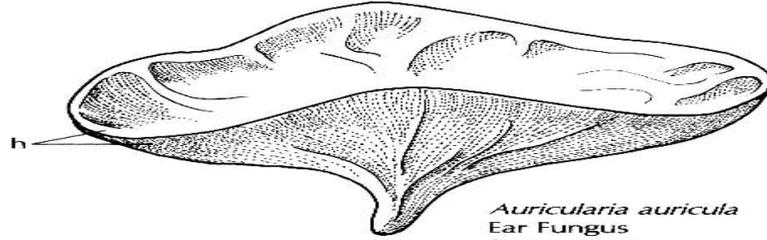


Basidiocarp
gill section



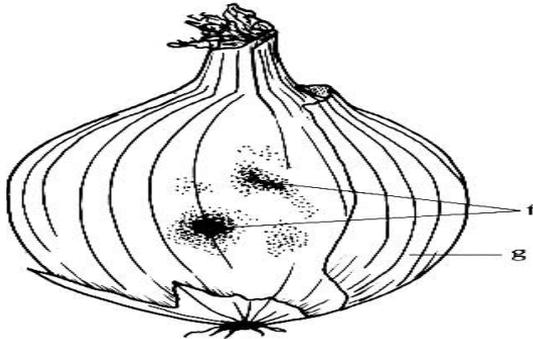
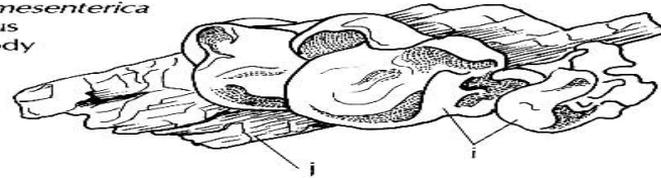
Basidia
with basidiospores
× 450

Gymnosporangium
gall on cedar
× 1



Auricularia auricula
Ear Fungus
fruiting body
× 1½

Tremella mesenterica
Jelly Fungus
fruiting body
× 1



Urocystis cepulae
Onion Smut
on onion
× 1



Dacryopinax spathularia
Jelly Fungus
fruiting body
× 1

Class Hymenomycetes

Gill fungi and Pore fungi

Hymenium Gymnocarpus

- A basidium usually produces 4 basidiospores, which are forcibly discharged from the fruiting body
- Fruiting bodies may occur in forms commonly known as mushrooms, toadstools, shelves, corals, and toothed fungi
- A “spore print” (basidiospore collection) can be made by placing a fruiting body cap with gills or pores half on white paper or black paper. Spore color is useful for identification. It can be white, pink, yellow, brown, purple, or black

EXAMPLES

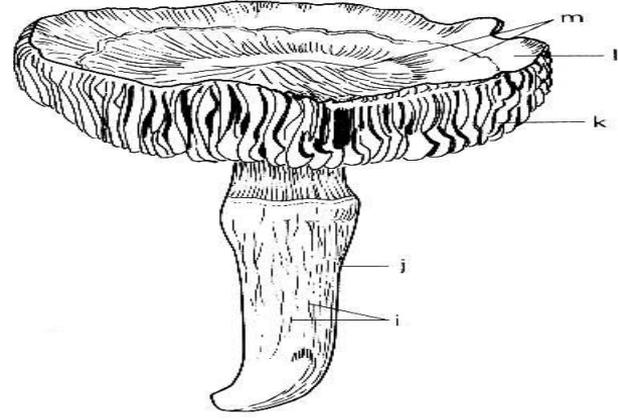
- **Food Production:** *Agaricus campestris* (commercial mushroom), *Lentinus edodes* (shiitake, high in vitamin B12, cobalamin; grown commercially on white oak logs to produce fruiting bodies *Pleurotus ostreatus* (oyster mushroom, this mushroom is grown commercially on vertically stacked sections, *Ulmus americana*, trunks covered with black plastic film.) *Termitomyces* sp. (phutoo), *Calocybe indica* (Inky caps mushrooms), *Volvariella* sp. (Paady straw mushroom)

- **wild:** *Amanita verna* (destroying angel, contains a deadly poison that destroys liver and kidney cells), *Armillaria mellea* (honey mushroom, causes root rot of trees, exhibits bioluminescence or “fox-fire” in mycelia penetrated organic matter), *Boletus edulis* (porous mushroom), *Ganoderma applanatum* (shelf or bracket fungus, a type of artist’s fungus, so called because marks made on the smooth white underside will remain when the mushroom dries)

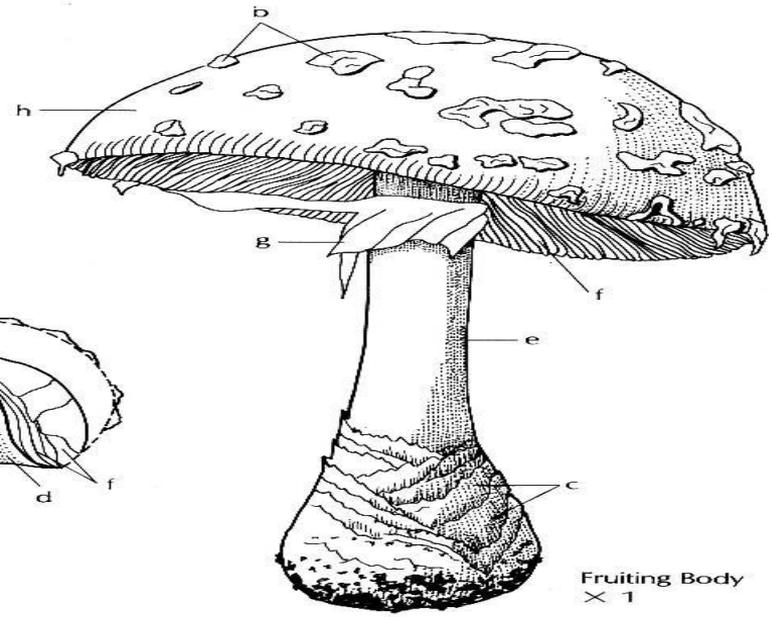
Polyporus sulphureus (sulfur mushroom, causes wood rot of trees), *P. squamosus* (heart rot of trees), *Coprinus comatus* (Inky cap) As the white fruiting body matures, the gills undergo self-digestion with black basidiospores released in an inky black fluid. This mushroom is found in lawns, golf courses and fields

Polyporus trametes (Turkey-tail Fungus)

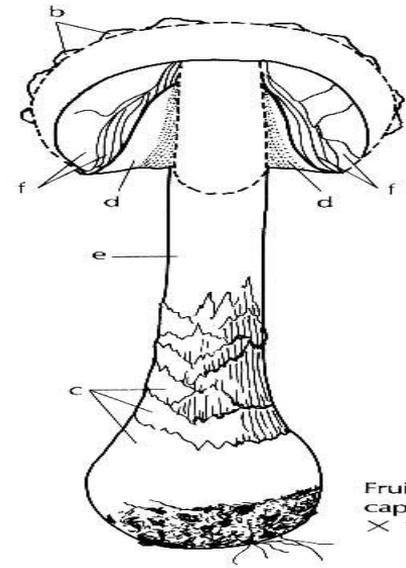
polypore (=many pores) fungi, basidia are formed on the inner surface of leathery pores on the lower portion of the fruiting body. This fan-shaped bracket fungus is found on rotting wood. The bands of tan, brown, white are like the colors of a turkey's tail feathers, and thus account for the common name



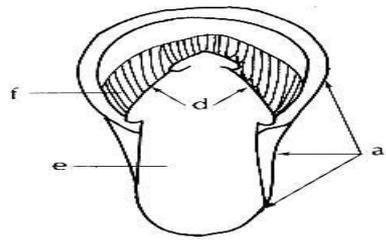
Cortinarius
fruiting body
× 1



Fruiting Body
× 1



Fruiting Body
cap, vertical section
× 1

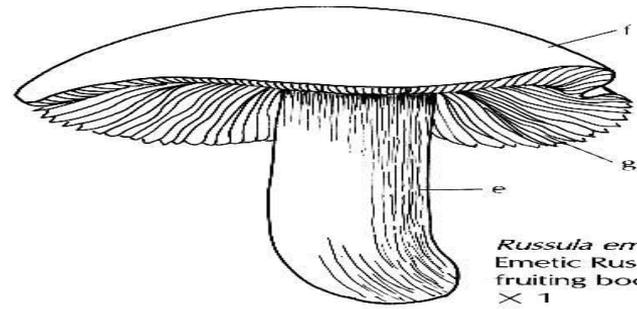
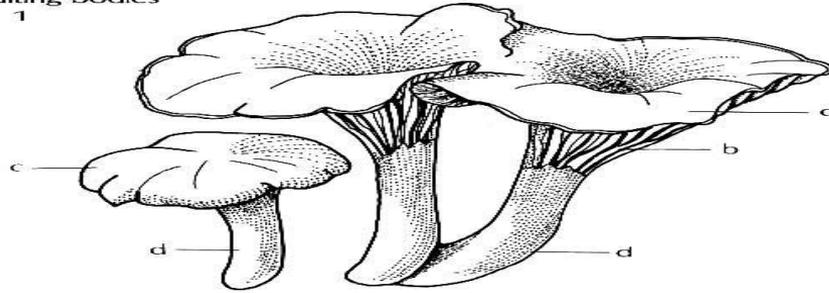


Fruiting Body
button stage
vertical section
× 1

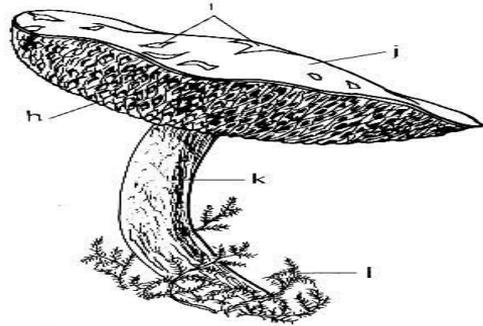
Amanita muscaria
Fly Amanita

Club Fungi

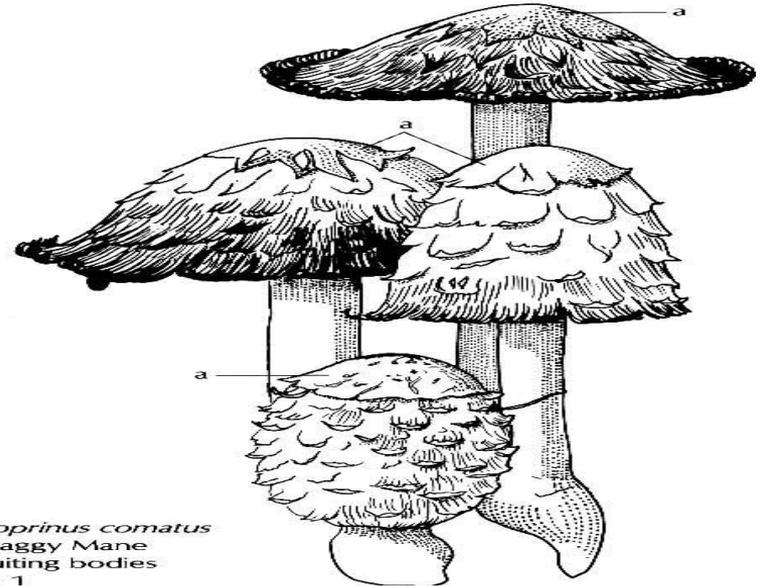
Chantharellus cinnabarinus
Cinnabar Chanterelle
fruiting bodies
× 1



Russula emetica
Emetic Russula
fruiting body
× 1



Suillus americanus
Bolete Fungus
fruiting body
× 1



Coprinus comatus
Shaggy Mane
fruiting bodies
× 1

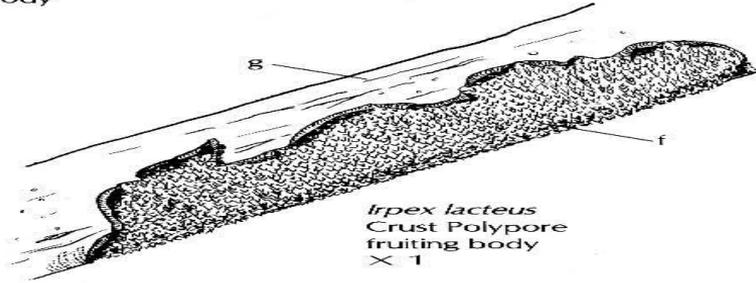
Club Fungi



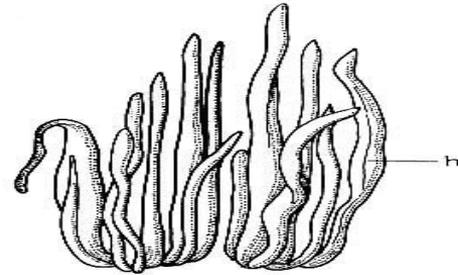
Coriolus versicolor
Turkey-tail Fungus
fruiting body
× 1



Fomes fomentarius
Rusty-hoof Fungus
fruiting body
× ½

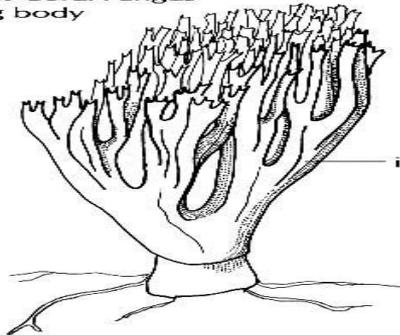


Irpex lacteus
Crust Polypore
fruiting body
× 1

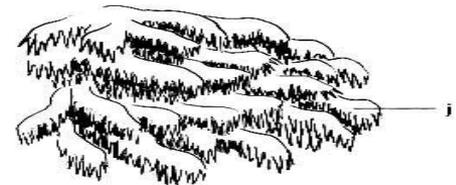


Clavulinopsis fusiformis
Coral Fungus
fruiting body
× 1

Ramaria stricta
Straight Coral Fungus
fruiting body
× 1



Hericium
Toothed Fungus
fruiting body
× 1



Class Gastromycetes

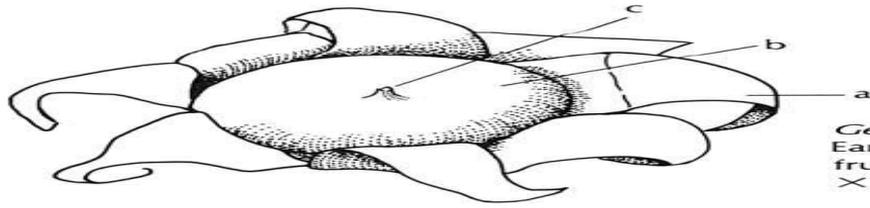
Puff balls, Earthstars, Birds nests fungi

- Fruiting body called enclosed Hymenium (angiocarpus)
- All are saprophytes found growing in soil, dead wood or dung, rarely mycorrhizal
- Spores are dispersed by wind from puffball fruiting bodies. An inner fertile portion, called the **gleba**, is composed of basidiospores and sterile thread-like structures (**capillitia**). Powdery masses of spores are exposed when the puffball wall (**peridium**) disintegrates, or emerge in a cloud from an opening (**ostiole**) when the flexible peridium is disturbed.

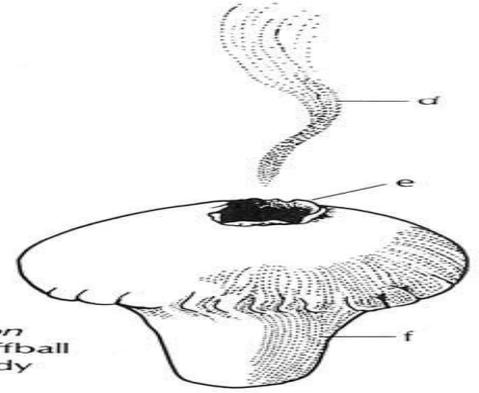
EXAMPLES

Calvatia gigantea (giant puffball) found in mostly open or sometimes wooded areas and after rains in late summer or early autumn and is edible when pure white inside, *Lycoperdon* (Stalked Puffball) At maturity, a powdery gleba of spores puffs out of an ostiole in the peridium due to rain drops or other physical disturbances, *Geastrum* (Earthstar type of puffball) has a star shape when the rigid outer wall or peridium becomes wet and splits open. An inner flexible peridium is exposed. A single pore (ostiole) for spore dispersal occurs at the center

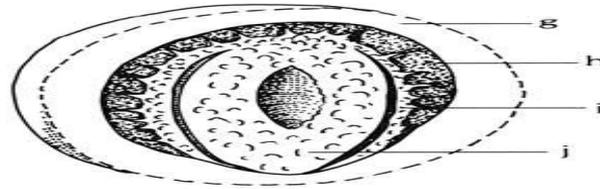
Club Fungi



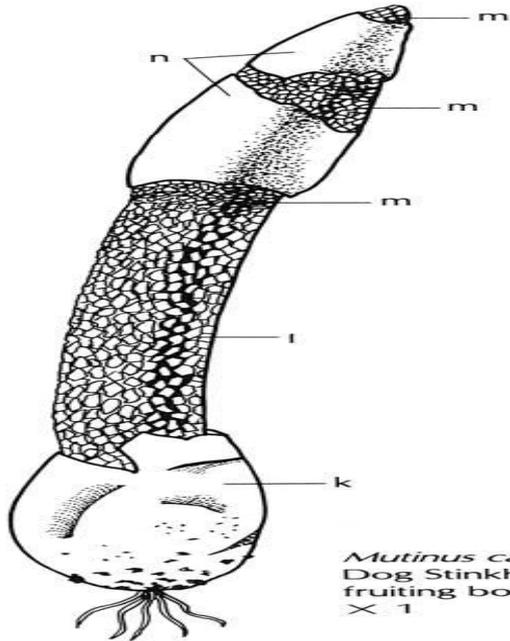
Geastrum
Earthstar
fruiting body
× 1



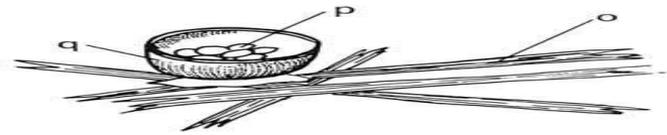
Lycoperdon
Stalked Puffball
fruiting body
× 1



Dictyophora duplicata
Collared Stinkhorn
fruiting body, egg stage
vertical section
× 1



Mutinus caninus
Dog Stinkhorn
fruiting body
× 1



Crucibulum vulgare
Common Bird's-nest
fruiting body
× 1

Jelly fungus Tremella sp



Coral fungus *Artomyces*
sp.



Polypores fungus *Ganoderma* sp.



Cantharellus fungi
Cantharellus sp.



Gastroid fungi *Lycoperdon* sp.



Birds nest fungi



Secotioid fungi



Agaricoid fungi *Agaricus* sp.

