

Kingdom Fungi

- **General Characteristics of kingdom true fungi or fungi**
 - eukaryotic
 - mostly multicellular or (Yeasts – unicellular)
 - cell walls composed of chitin (arthropod exoskeletons) and glucan .
 - reproduce sexually or asexually mostly forming spore
 - heterotrophs – acquire nutrients via absorption;
 - “external digestion” – secretes enzymes to decompose complex molecules into simpler compounds
 - major role in ecosystems = decomposition = nutrient recycling

1-Phylum:Chytridiomycota

Cell walls are made of chitin and glucan , cellulose is not known to occur.

Chytridiomycota feed on both living and decaying organisms. They are heterotrophic and absorptive nutrition

They are mostly **aquatic**, and not terrestrial.

Sexual reproduction is variable and may be isogamous, anisogamous or oogamous.

Asexual reproduction by zoospores have a single, posterior **whiplash flagellum**.

Some individuals have alternation of generation in their life cycle

Somatic phase consists from unicellular with rhizoids or multicellular (mycelium with aseptated hyphae).

Synchytrium endobioticum

Scientific classification

Kingdom:Fungi

Phylum:Chytridiomycota

Class:Chytridiomycetes

Order:Chytridiales

Genus:*Synchytrium*

Species:***Synchytrium endobioticum***

It is obligate parasite-Holocarpic

Synchytrium endobioticum is a chytrid fungus that causes the potato wart disease or *black Scab*. It also infects some other plants of the Solanum genus, though potato is the only cultivated host.

Symptoms of Wart Disease

The major symptom of wart disease is a gall at the base of the potato stem. The gall, which is white when under ground, and black when decaying, may be as small as a pin or as large as a fist.

2-Zygomycota

General characteristics

The phylum Zygomycota is composed of a group of lower fungi whose thalli are generally aseptate (coenocytic) and that produce zygospores after fusion of isogamic sex organs (gametangia). Three orders contain clinically relevant species, namely, the small group Entomophthorales, members of which have forcibly discharged spores, and the Mucorales and Mortierellales, in which the spores arise by cleavage of the sporangial plasma and are passively liberated. Zygomycosis (mucormycosis) is caused by moulds belonging to the order Mucorales. The order Mucorales is divided into six families of significance in human or animal disease, but most cases of human infection are caused by members of the Mucoraceae. This includes the genera *Absidia*, *Mucor*, *Rhizomucor*, and *Rhizopus*. Two additional pathogenic families are the Cunninghamellaceae and the Saksenaceae. Many different organisms have been implicated in human illness, but the commonest cause of human infection is *Rhizopus oryzae* (arrhizus). Other less frequent aetiological agents include *Absidia corymbifera*, *Apophysomyces elegans*, *Cunninghamella bertholletiae*, *Rhizomucor pusillus*, and *Saksenaea vasiformis*. All of these moulds cause similar diseases in humans, and the diagnostic and therapeutic approaches are similar. Most members of the Entomophthorales are pathogens of insects and other invertebrates, but many species can also be found in the soil and on dung. The order is characterized by the presence of forcibly discharged propagules. The clinically important species are *Basidiobolus ranarum* and *Conidiobolus coronatus*.

Hyphae are coenocytic

Flagellated spores are absent

Most reproduce asexually by producing sporangiospores within a special sac called the sporangium.

Sexual spores are called zygo spores contained within a zygosporangium formed following gametangial fusion / copulation

Classification of Zygomycota

Two classes: 1- Zygomycetes 870 species in 124 genera, 32 families and 10 orders.

2- Trichomycetes 218 species in 55 genera, 6 families and 3 orders

Zygomycetes

Asexual reproduction

Reproduce asexually by sporangiospores in most orders of the Sporangium types (4 types)

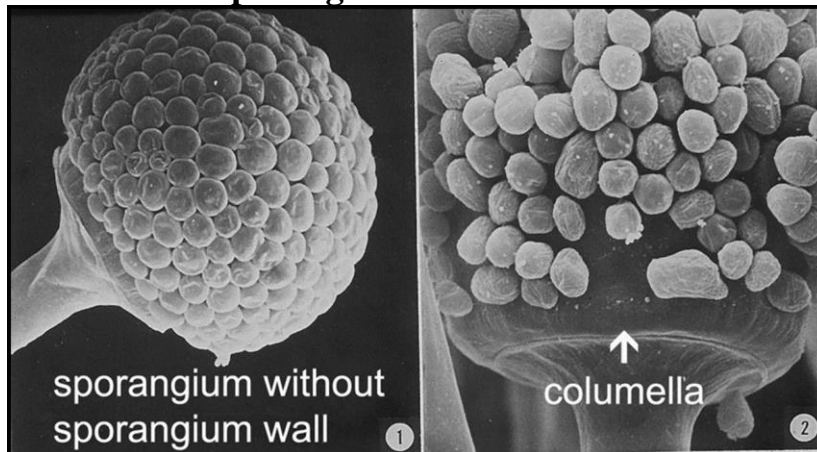
1-True sporangium

2-Sporangioles - much smaller than true sporangia. No columella produced and few spores (1-50)

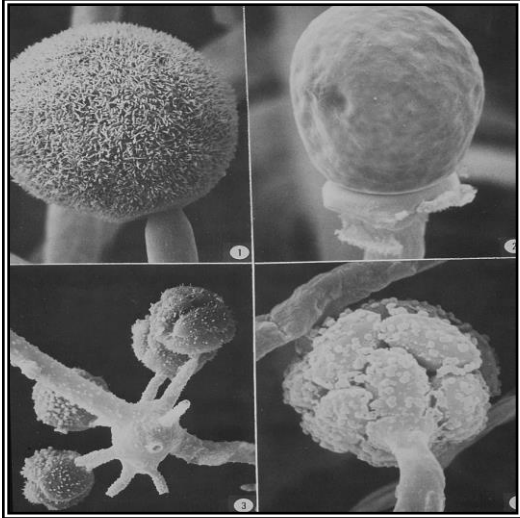
3-Monosporous sporangium (one-spored sporangium)

4-Merosporangium - sac containing 10 -15 sporangiospores that occur in a linear sequence

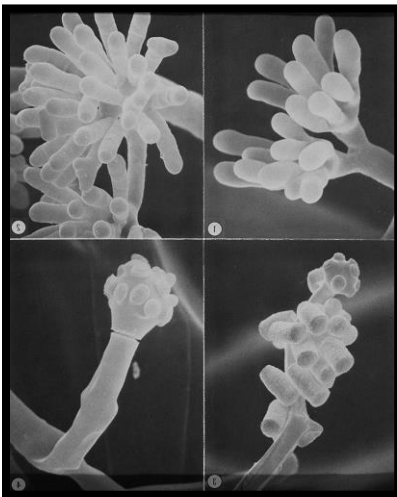
Columellate Sporangium



SPORANGIA & SPORANGIOLA



MEROSPORANGIA

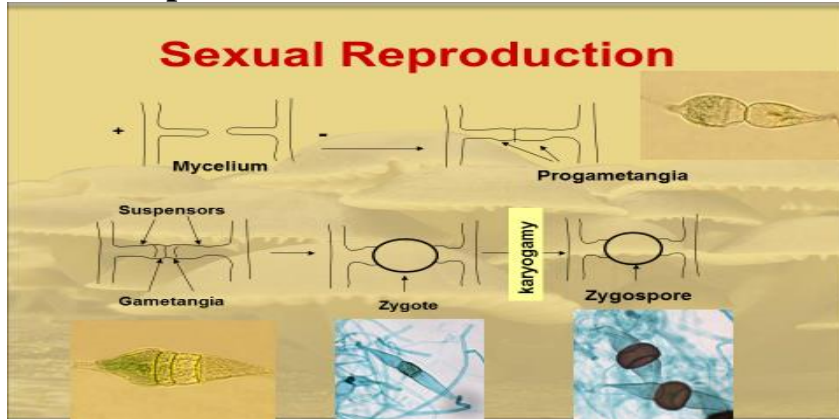


Dispersal Mechanisms in the Zygomycetes

In the Zygomycetes, the unit of dispersal is normally a sporangiospore from within a sporangium. Typically, a sporangium may contain up to 100 000 spores. Smaller sporangia may contain only a few hundred spores. Some mucorales exhibit xerophytism. Generally, mucoraceous moulds can produce aerial growth only when the surrounding air is extremely damp. However, some mucorales can form sporangiospores in dry air. In most mucorales, the wall of the sporangium eventually dissolves. Not only does the wall, except for a small collar around the base of the columella, break down, but water passes into the

spore-mass through the columella. The result is that a ‘sporangial drop’ is formed; this is considerably larger than the original sporangium, and its spores are dispersed by splash dispersal. Other species form dry, powdery spores. The sporangiospores dehisce, and the released sporangiospores can be dispersed by low-speed winds. The most familiar example of a mucoraceous fungus producing dry sporangiospores is the common ‘bread mould’ *Rhizopus*.

Sexual Reproduction



Gametangial copulation

Homo- & heterothallic species **Heterothallism** the condition of being self-sterile, requiring a partner for sexual reproduction **Homothallism** the condition of being self fertile; able to reproduce sexually without a partner exhibited among species in this phylum

Refers to the fusion of gametangia to form a unique structure called the **zygosporangium**

Order Mucorales

Mucorales

MUCORALES

- 30% of known zygomycetes (~300 spp.)
- Well developed, typically **coenocytic mycelium**
- Wall composition of **chitosan**, **chitin** and **polyglucuronic acid**

- Asexual reproduction by formation of **sporangiospores** cleaved out from the cytoplasm of **sporangia**
- **Chlamydospores** may be formed
- Called **mucoralean** or **mucoraceous** fungi

Members of this group are the "weeds" of the fungal world

Common genera include Mucor, Absidia, Rhizopus, and Pilobolus.

Grow and invade quickly on easily digestible substrates, such as those containing starches, sugars, and hemicelluloses

Can act as parasites and/or cause diseases in plants, animals and some insects and humans. In humans, such diseases are opportunistic and occur in an immunocompromised person (e.g., uncontrolled diabetes, AIDS)

Contains commercially important species - synthesize certain organic acids (citric, succinic, oxalic, fumaric, lactic), unusual alcohols, carotene, transform steroids from one form to another (*R. arrhizus*/progesterone), etc.

Some species (eg. *Rhizopus stolonifera*) attack fruits and vegetables in transit or storage (strawberry leak, soft rot of sweet potatoes).

Cause mucormycoses in humans (*Rhizopus arrhizus*, *R. oryzae*, species of *Mucor*, *Rhizomucor*, *Absidia*, *Cunninghamella*) - four kinds of systemic infection: rhinocerebral, thoracic, gastro-intestinal, and cutaneous. Some species also cause abortion in cattle and swine.

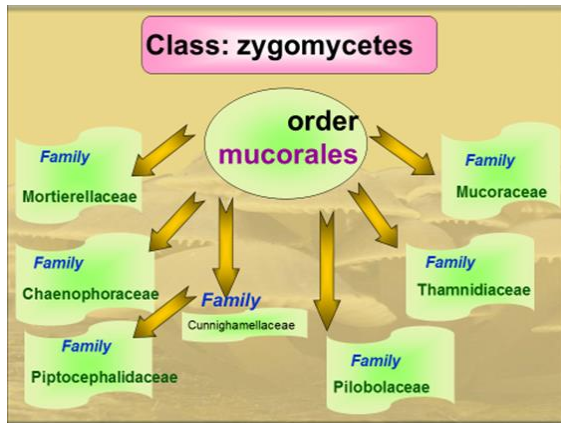
Tempeh, a kind of soybean cheese which is an important food in Indonesia, is made by inoculating cooked soybeans with *Rhizopus oligosporus*. The fungus helps digest the protein and imparts flavor. The same type of food is made in China but it is called **sufu** and the fungus is *Actinomucor elegans*.



Tempe



rhinocerebral



Family Mucoraceae

All have large multi-spored sporangia

Sporangia contain well-defined columellae

3-Sporangial wall is thick and persistent

4-Zygospores are common.

Genera are Rhizopus, Mucor, Circinella, Absidia, Zygorhynchus

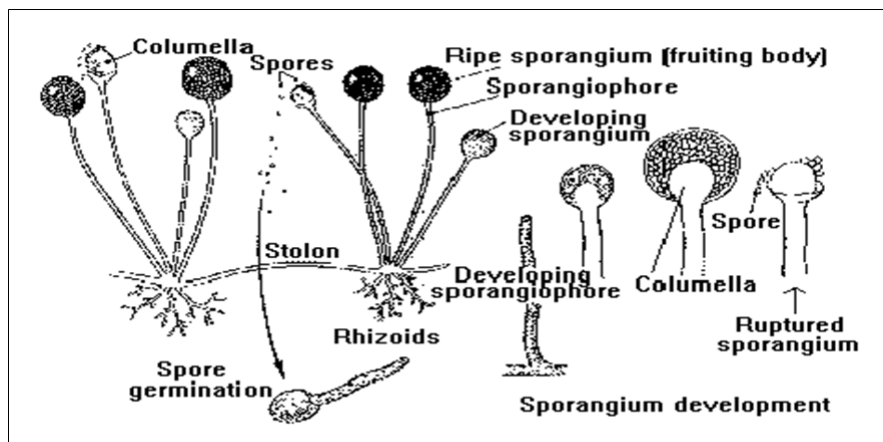
30% of known zygomycetes (~300 spp.)

Well developed, typically coenocytic mycelium

Wall composition of chitosan, chitin and polyglucuronic acid

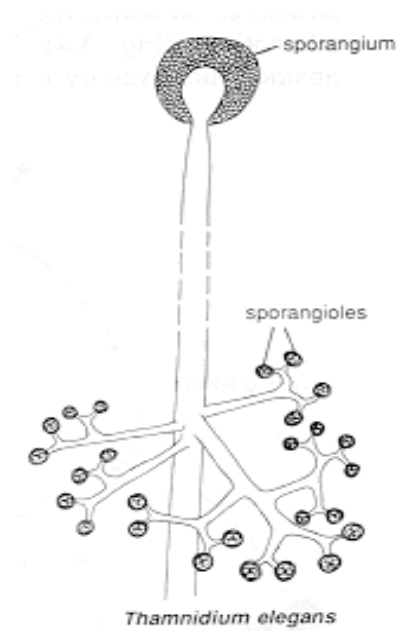
Asexual reproduction by formation of sporangiospores cleaved out from the cytoplasm of sporangia. Chlamydospores may be formed. They are called

Called mucoralean or mucoraceous fungi



2-Family Thamniaceae

Thamnidium: large, terminal columellate sporangia produced with dichotomous lateral branches bearing fewer-spored, non-columellate sporangia.



3- **Pilobolaceae**: wall cuticularized and persistent above, thin and diffuent below. E.g. *pilobolus* sp.



The life cycle of *Pilobolus* begins with a black sporangium that has been discharged onto a plant substrate such as grass. A herbivorous animal such as a horse then eats the substrate, unknowingly consuming the sporangium as well.

The *Pilobolus* sporangium survives the passage through the digestive tract without germinating, and emerges with the excrement. Once outside its host, spores within the sporangium germinate and grow as a mycelium within the excrement, where it is a primary colonizer. Later, the fungus fruits to produce more spores.

Growth

The mycelium is coenocytic and grows beneath the surface of the medium. The mycelium then begins to form trophocysts, which are swollen regions along certain hyphae.

Trophocysts enlarge as the protoplasm flows into them, and are finally completed by forming crosswalls to separate them from the parent hyphae.

Scientists followed the development of *Pilobolus* after growing it in transparent synthetic agar medium, and they found out that :
From each trophocyst grows a stout sporangiophore and emerges from the medium to the air. After a time when the sporangiophore stops elongating, its tip swells to form the sporangium.

- The part below the sporangium then swells to form a conspicuous subsporangial vesicle.
- The contents of the sporangium cleave to form a large number of spores.
- Finally, the wall of the subsporangial vesicle ruptures suddenly just below the sporangium.
- The sporangium is discharged, propelled by the liquid in the sporangiophore, and the empty sporangiophore is thrown flat on the medium.

Discharge of sporangium

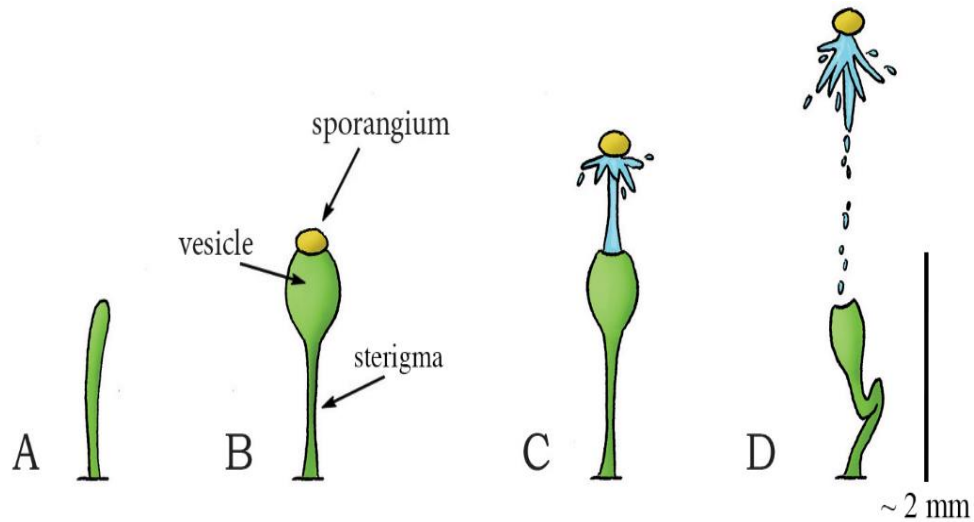
The sporangiophore has the remarkable ability of orienting itself to point directly towards a light source. The subsporangial vesicle acts as a lens, focusing light via carotenoid pigments deposited near the base of the vesicle.

When turgor pressure within the subsporangial vesicle builds to a sufficient level (often 7 ATM or greater), the sporangium is launched, and can travel anywhere from a couple of centimeters to a distance of 2 meters.

The sporangium is covered in calcium oxalate crystals. Besides serving as a protective mechanism, their hydrophobic nature also leads the sporangium to flip over onto its sticky bottom after landing in a drop of dew, thus allowing it to cling to a plant substrate.

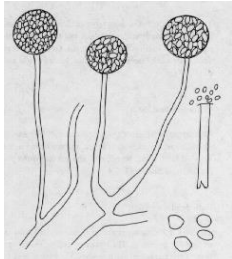
A commensal relationship ?

The discharge mechanism of *Pilobolus* is exploited by parasitic nematodes including lungworms in the genus *Dictyocaulus*. Larval lungworm nematodes excreted by infected deer, elk, cattle, horses, and other hosts climb up *Pilobolus sporangiophores* and are discharged with the sporangium.

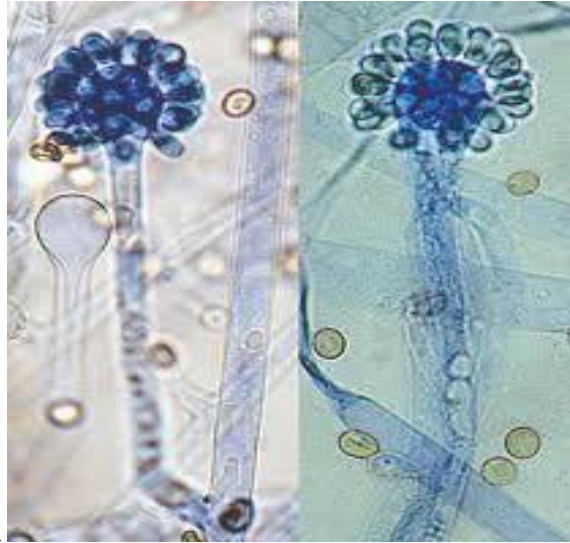


*They complete their life cycle when they and their *Pilobolus* vector are eaten by a new host. The larvae move from the digestive system to infect the respiratory tract of the animal, where they mature, reproduce, and perpetuate their parasitic life cycle.*

4- **Mortierellaceae**: columella absent; zygospore enveloped in a dense hyphal covering. E.g. *mortierelle* sp.



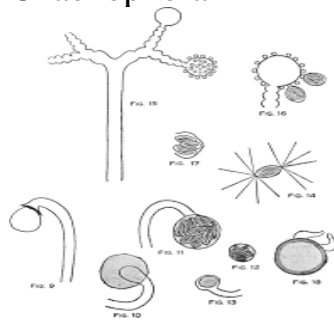
5-Cunninghamellaceae



Cunninghamella

6-Chaenophoraceae

Sporangioles or conidia never borne on same sporangiophores as columettated Chaenophora



7- Piptocephalidaceae

Synccephalastrum

Merosporangia borne on tips of sporangiophores at first cylindrical dividing into a single row of sporangiospores Simulating a chain of conidia.

