PHOTO: WALLY EBERHART/GETTY IMAGES

What is a fungus?

Fungi (singular: fungus) are a kingdom of usually multicellular eukaryotic organisms that are heterotrophs (cannot make their own food) and have important roles in nutrient cycling in an ecosystem. Fungi reproduce both sexually and asexually, and they also have symbiotic associations with plants and bacteria. However, they are also responsible for some diseases in plants and animals. The study of fungi is known as mycology.

General Characteristics of Fungi

✓Some fungi are single-celled, while others are multicellular.

✓The cell walls of fungi contain chitin, which is a hard substance also found in the exoskeletons of insects and arthropods such as crustaceans.

✓Multicellular fungi have many hyphae (singular: hypha), which are branching filaments.

✓A fungus's network of hyphae is called a mycelium.

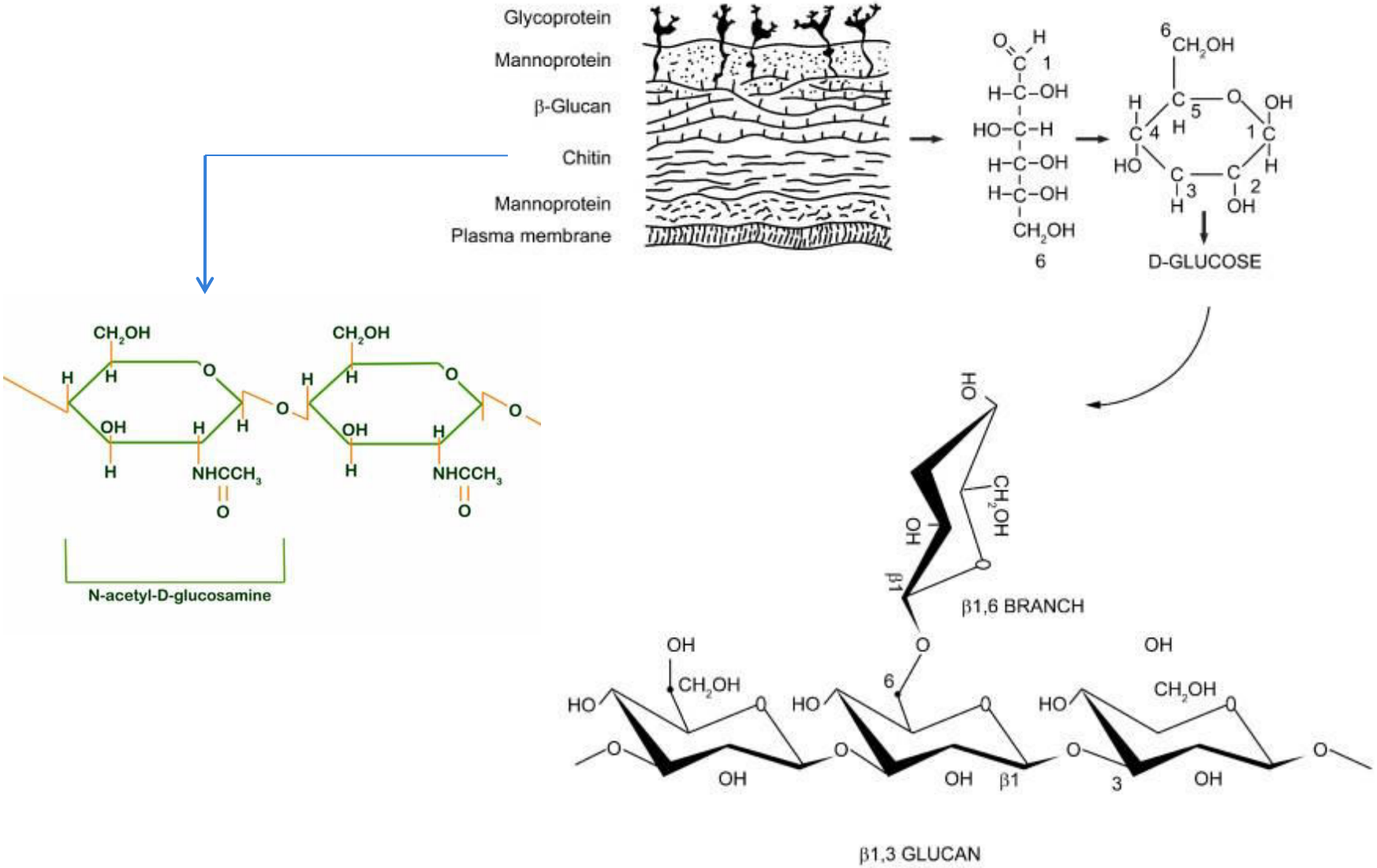
✓Fungi are heterotrophs; they cannot make their own food and must obtain nutrients from organic material.

✓Nutrition : Heterotrophic (Parasitic, Saprophytic & Symbiotic)

✓Reproduction : Vegetative, Asexual and Sexual

Fungus : Closer to Plants or Animals

FEATURES	PLANTS	ANIMALS	FUNGI
Unicellular or multicellular	Multicellular	Multicellular	Either
Cell wall	Present	Absent	Present
Cell membrane contains sterols	No	Yes	Yes
Organism uses chitin	No	Some	Yes
Displays locomotion	Never	Almost always	Never
Nutritional models	Autotrophs	Heterotrophs	Heterotrophs
Ability to cause infection to animals	No	Yes	Yes


Glycoprotein
Mannoprotein
β-Glucan
Chitin
Mannoprotein
Plasma membrane
D-GLUCOSE
N-acetyl-D-glucosamine
β1,6 BRANCH
β1,3 GLUCAN

Hyphal Modifications

- **Plectenchyma / *Claviceps purpurea***
- **Sclerotia / *Sclerotium rolfsii***
- **Rhizomorph / *Armillaria mellea***
- **Haustoria / *Perenospora pisi***
- **Appresoria / *Erysiphe graminis-tritici***
- **Traps / *Stylopage grandis***
- **Stroma / *Claviceps purpurea***

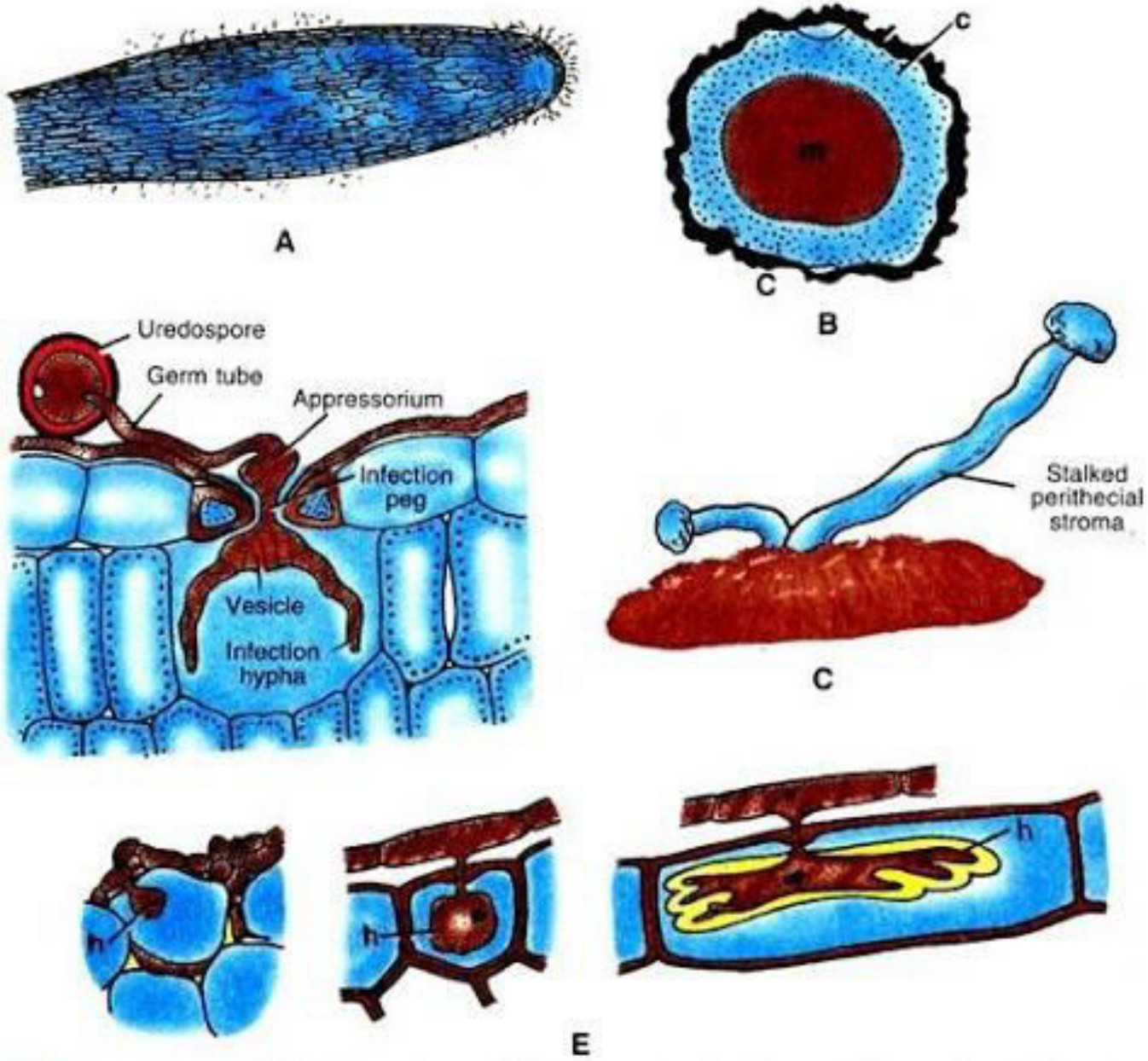


Fig. 1.14. Aggregation and Modifications of hyphae. A-B, Rhizomorph; C, Sclerotia; D, Appressorium; E, Haustorium.

Vegetative reproduction in Fungi

Fragmentation

- hyphae break up into pieces to develop into new fungus (e.g. *Rhizopus, Mucor*)

Budding

- buds from vegetative body cut off and mature to new fungus (e.g. yeast, *Ustilago*)

Fission

- splitting of the cell into 2 daughter cells by constriction (e.g. yeast)

Oidium formation

- hyphae break up into oidia to give rise to new fungus (e.g. *Rhizopus*, *Coprinus*)

Sclerotia

- serve as a organ of perennation (e.g. *Claviceps*, *Botrytis*)

Chlamydospores

- thick walled resting resistant spores germinate to give new individuals (e.g. *Fusarium*)

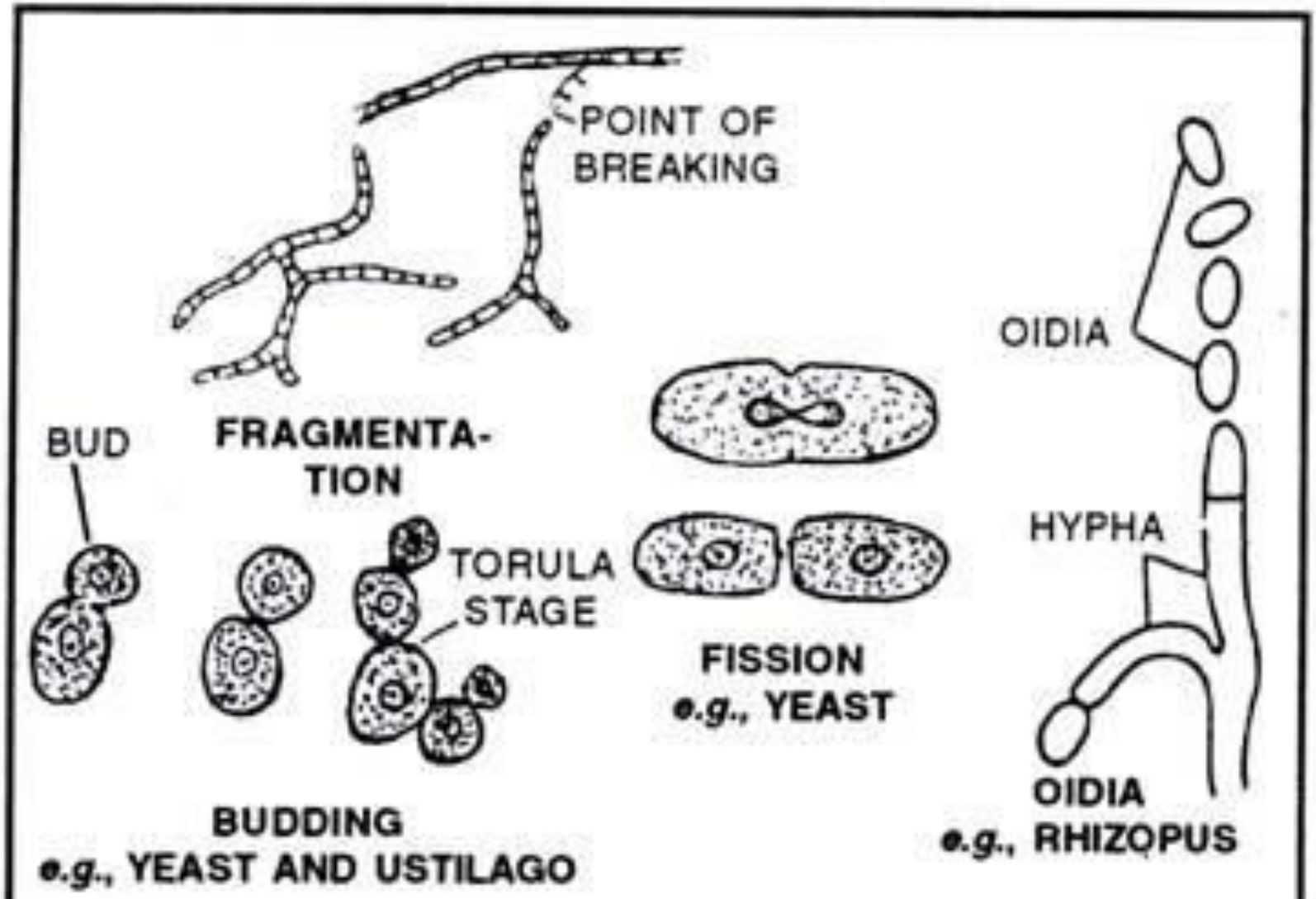
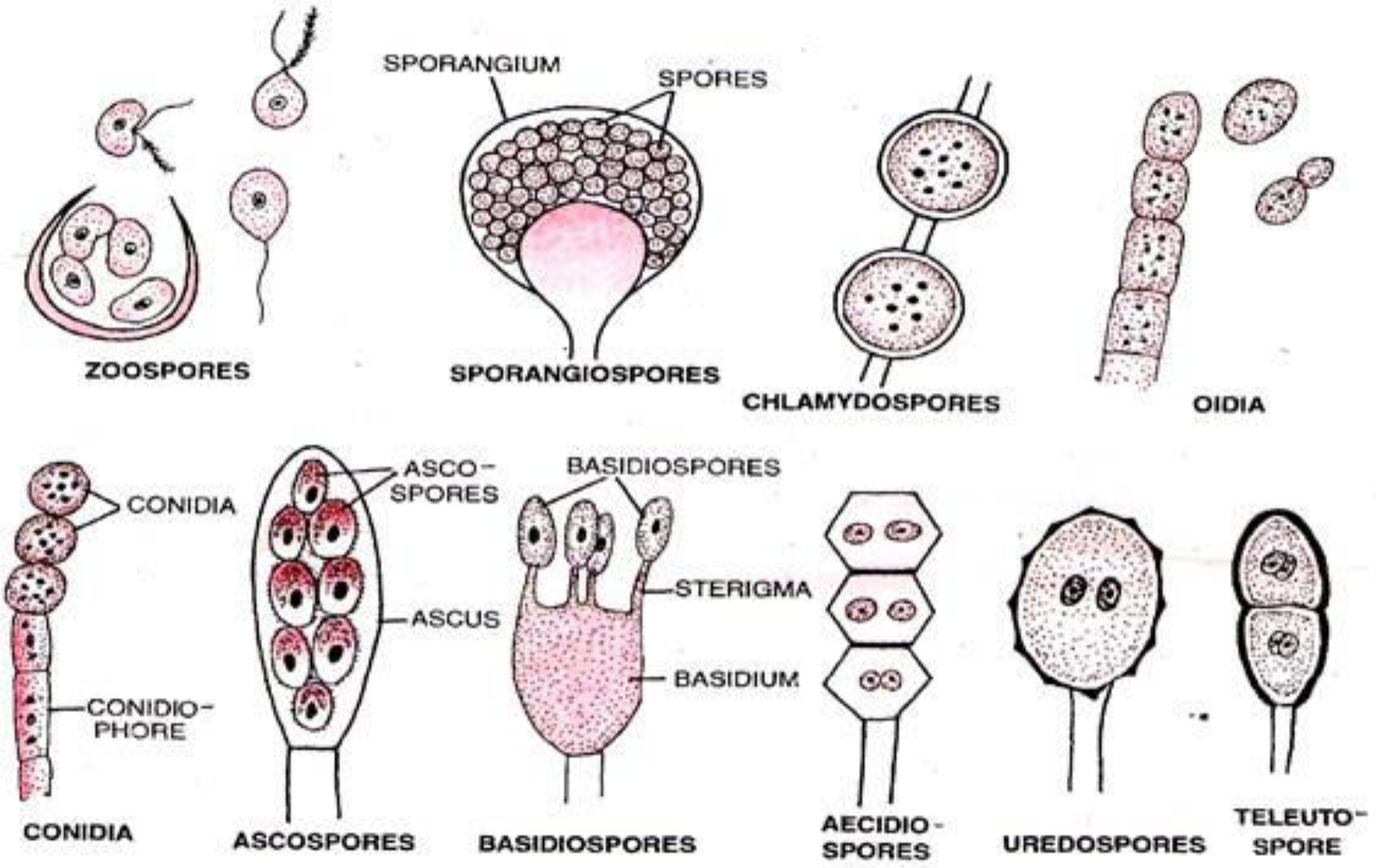


Figure 6.4 Different types of vegetative reproduction in



Types of fungal spores.

Sexual reproduction in fungi
[Phases : Plasmogamy, Karyogamy & Meiosis]

Gametic copulation

- fusion of motile gametes of opposite strains (isogamy, anisogamy & oogamy)
- e.g. *Olpidium*

Gametangial contact

- two gametangia come in contact either through a passage or a fertilization tube
- e.g. *Albugo, Aspergillus*

Gametangial copulation

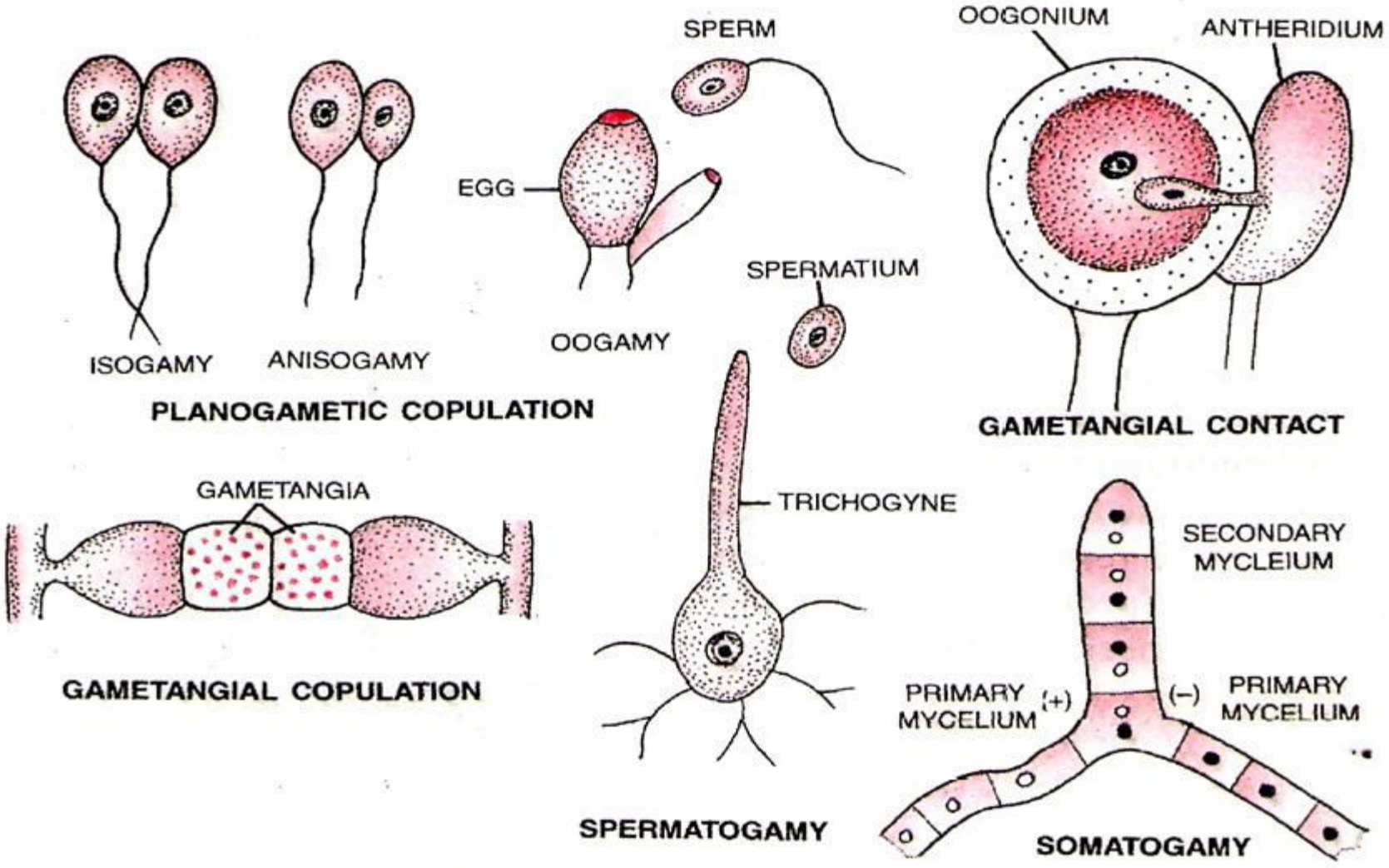
- fusion of entire contents of two gametangia
- e.g. *Mucor, Rhizopus ,* Yeast

Spermatization

- production of spermatia
- e.g. *Puccinia*

Somatogamy

- hyphal anastomosis
- e.g. *Peziza, Agaricus*



Types of sexual reproduction in fungi.

GENERALIZED IDEA : CLASSIFICATION OF KINGDOM FUNGI

FUNGI

DIVISION

Myxomycota
Plant body in the form of
Amoeboid naked protoplast

Eumycota
Plant body unicellular or multicellular
and filamentous

CLASSES

Phycomycetes

Ascomycetes
Mycelium septate,
Characteristic spore ascospore
Produced endogenously
e.g. Yeast, *Peziiza, Ascobolus*

Basidiomycetes
Mycelium septate,
Characteristic spore basidiospore
Produced exogenously
e.g. *Puccinia, Agaricus*

Deuteromycetes
Mycelium septate,
Propagation only by
Asexual spores
e.g. *Penicillium*

Archimycetes
Mycelium absent or
rudimentary
e.g. *Synchitrium*

Oomycetes
Mycelium well developed,
Sexual reproduction by
dissimilar gametes,
Result is oospore
e.g. *Phytophthora*

Zygomycetes
Mycelium well developed,
Sexual reproduction by
similar gametes,
Result is zygospore
e.g. *Rhizopus*

Class - Zygomycetes

The Bread Molds (*Rhizopus*)

Class – Oomycetes

The Water Molds
(potato blight)

Class – Ascomycetes

The Sac Fungi
(Yeast, morels, truffles)

Class – Basidiomycetes

The Club Fungi
(Mushrooms, puffballs, bracket fungi, rusts, smuts, toadstools)

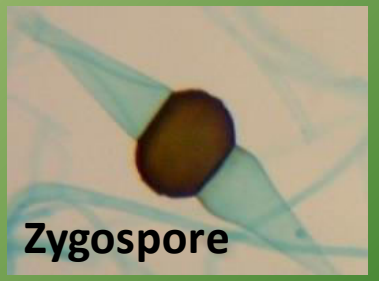
Class – Deuteromycetes

The Fungi Imperfecti

Zygomycetes / zygote fungi

- Commonly Saprophytes (Decomposers)
- Hyphae have no cross walls
- Vegetative Reproduction - Fragmentation
- Asexual Reproduction (Common) – Sporangium & Sporangiospores
- Sexual Reproduction (Unusual) – Zygosporangium & Zygospores
- Only the zygote is diploid; all hyphae and asexual spores are haploid

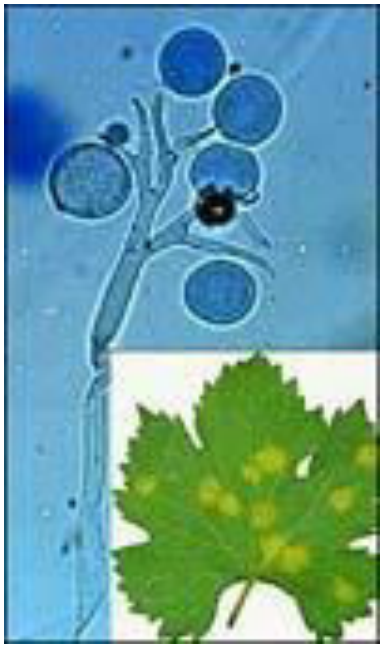

Rhizopus grown in bread



Oomycetes - Water Molds / MILDEWS

- Mostly aquatic
- Unicellular, holocarpic to coenocytic, branched mycelium
- Plant body Diploid
- Cell wall contains cellulose
- Asexual Reproduction – Zoospores
- Sexual Reproduction – Oogamous

Oospores/
Saprolegnia sp.



Peronospora sp./
Powdery mildew (inset)

Phytophthora infestans

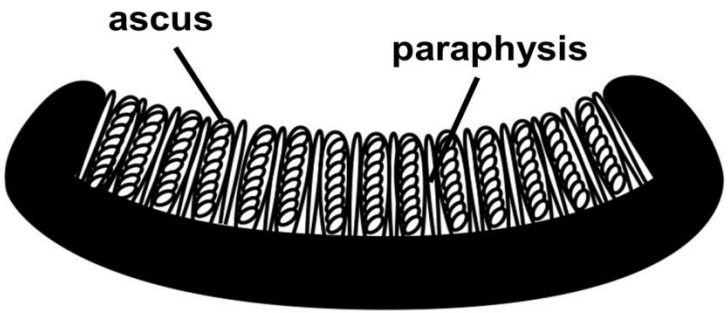
Plasmopara viticola

Ascomycetes – "sac fungi"

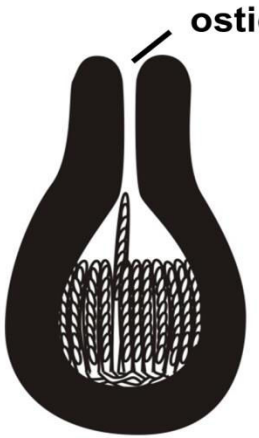
- Important plant parasites & saprobes
- Fungal member of most lichens
- Unicellular(Yeast) & Filamentous
- Vegetative Reproduction – Fission/Budding
- Asexual Reproduction – Conidium, Conidiospores, Oidia, Papulospores
- Sexual Reproduction – Ascus & Ascospores
- Largest group among all

DIFFERENT TYPES OF FRUIT BODY

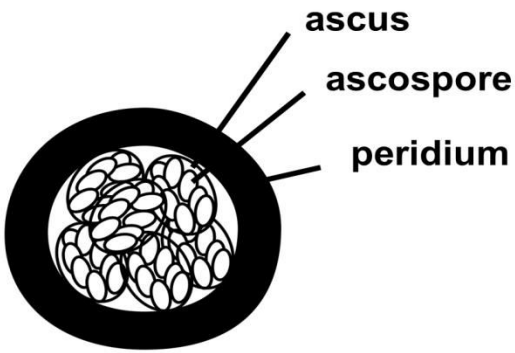
apothecium



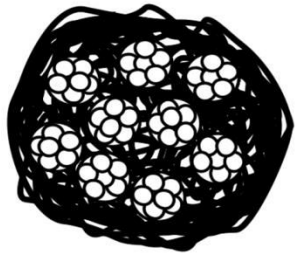
perithecium



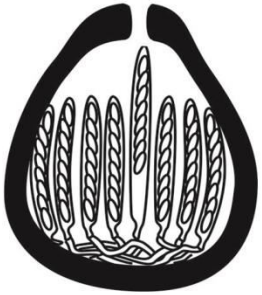
cleistothecium



gymnothecium

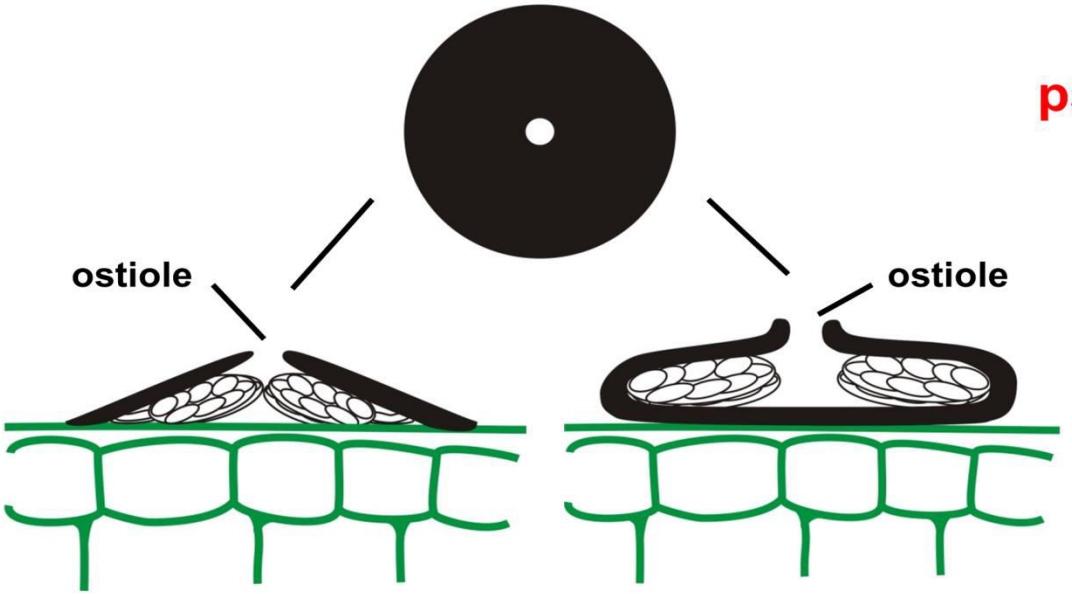


pseudothecium



chasmothecium

superficial view



thyriothecium

catathecium

LIFE CYCLE PATTERN IN YEASTS

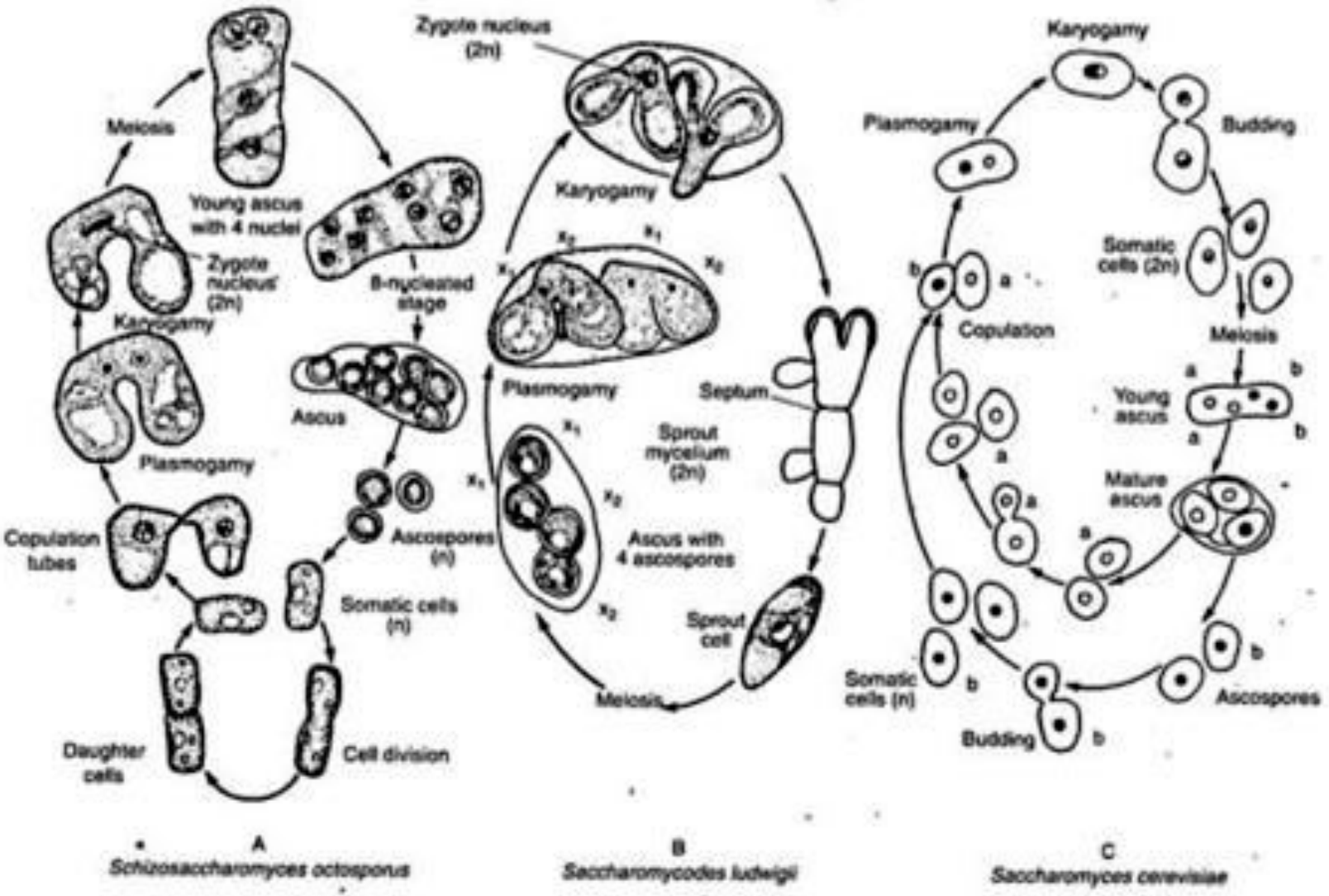


Fig. 4.41: Life cycles of three types of yeasts : A. Haplobiontic (*Schizosaccharomyces octosporus*). B. Diplobiontic (*Saccharomycodes ludwigii*), C. Haplo-diplobiontic (*Saccharomyces cerevisiae*).

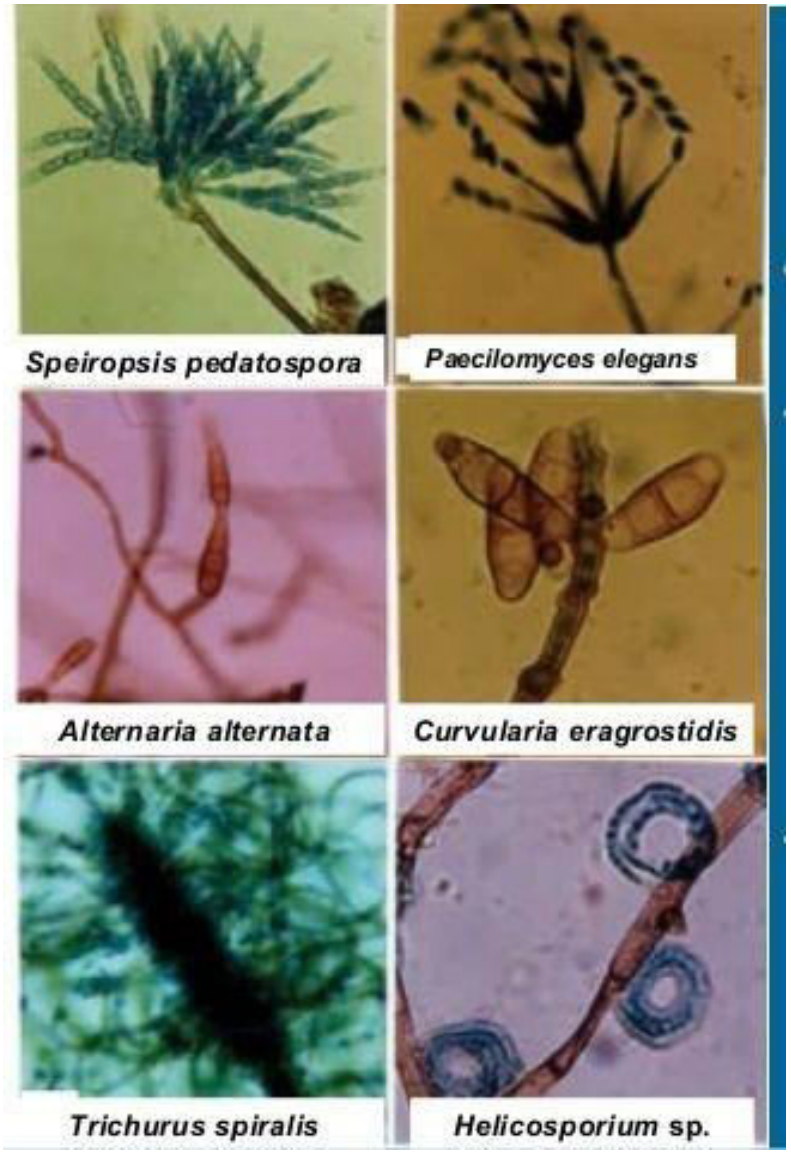
Basidiomycetes – "club fungi"

- Long-lived dikaryotic mycelia
- Rusts & smuts – primitive plant parasites
- Asexual Reproduction – not so common
- Sexual Reproduction – Basidium & Basidiospores
- Mushrooms, puffballs (edible fungi)
- Enzymes decompose wood (wood decay)
- Important member of mycorrhizal association

Deuteromycetes – Fungi Imperfecti

- Resemble Ascomycetes, but their reproductive cycle has never been observed

- Different from Ascomycetes because there is a definite lack of sexual reproduction, which is why they are called Fungi Imperfecti

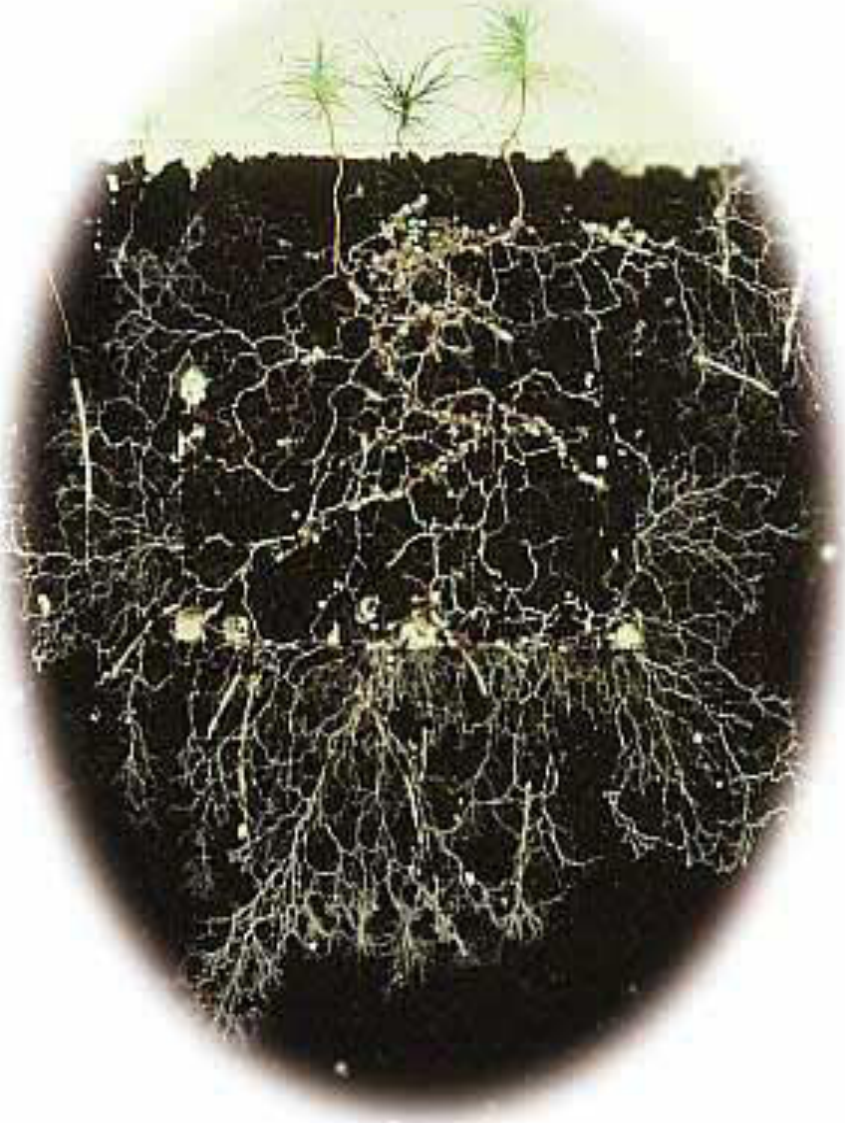


FUNGAL SYMBIOSIS I : MYCORRHIZA

- Fungus roots
- Mutualism between:
  - Fungus (nutrient & water uptake for plant)
  - Plant (carbohydrate for fungus)
- Several kinds:
  - Zygomycota – hyphae invade root cells
  - Ascomycota & Basidiomycota – hyphae invade root but don't penetrate cells

Plant benefits include:

- Improved nutrient/water uptake
- Improved root growth
- Improved plant growth and yield
- Improved disease resistance
- Reduced transplant shock
- Reduced drought stress



FUNGAL SYMBIOSIS II : LICHENS

Lichens are mutualistic symbiotic organisms. They have a fungus and an algal portion