

Cheat Sheet 1 – General Characteristics of Fungi

Definition & Basics

- **Achlorophyllous, eukaryotic, heterotrophic thallophytes.**
 - Body = **Thallus** → unicellular (*yeast*) or multicellular (*moulds*).
 - Science of fungi = **Mycology** (term from “mykes” = mushroom).
 - First described by Micheli (1729).
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Key Features

- No chlorophyll → **cannot photosynthesize**.
 - Nutrition: **absorptive** (saprophytic, parasitic, symbiotic).
 - Reserve food: **Glycogen + lipids** (never starch).
 - Cell wall: **Chitin + glucans** (except lower fungi).
 - Reproduction:
 - Vegetative → fragmentation, budding, fission.
 - Asexual → sporangiospores, conidia.
 - Sexual → planogametic, gametangial, somatogamy.
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Habitats

- **Terrestrial** → soil, humus, litter.
 - **Aquatic** → primitive fungi (Chytrids).
 - **Parasitic** → plants (*Puccinia*, *Ustilago*), animals (*Candida*).
 - **Symbiotic** → Lichens (fungus+alga), Mycorrhiza (fungus+roots).
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Mnemonics

- **Fungi = FAT** → Filamentous hyphae • Absorptive nutrition • Thallus body.
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Exam Capsule

- Reserve food = **Glycogen**, not starch.
- Found in **all habitats** – terrestrial, aquatic, parasitic, symbiotic.
- Fungi reproduce **vegetatively, asexually, and sexually**.

Cheat Sheet 2 – Fungal Thallus & Mycelium

◆ Types of Thalli

- **Unicellular** → *Yeasts* (budding), *Synchytrium* (holocarpic).
 - **Plasmodial** → *Plasmodiophora* (naked multinucleate mass).
 - **Filamentous** → Hyphae forming **mycelium**.
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◆ Hyphal Types

- **Aseptate (coenocytic)** → multinucleate, no cross walls (*Mucor*).
 - **Septate** → cross walls with pores (*Ascomycetes*, *Basidiomycetes*).
 - *Dolipore septum* + *Parenthesome* = diagnostic for Basidiomycota.
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◆ Hyphal Modifications

- **Rhizomorphs** – root-like aggregations (*Armillaria*).
 - **Sclerotia** – resting bodies (*Claviceps*).
 - **Appressorium** – penetration peg (*Puccinia*).
 - **Hauatoria** – absorptive structures (parasites).
 - **Hyphal traps** – loops to capture nematodes (*Arthrobotrys*).
 - **Stroma** – compact cushion of hyphae for reproduction.
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◆ Mnemonics 💡

- **Hyphal Modifications** → “**Really Strong AHHHS**”
 - Rhizomorphs • Sclerotia • Appressorium • Hauatoria • Hyphal traps • Stroma
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◆ Exam Capsule 🧠

- **Mycelium** = network of hyphae.
 - **Septate vs Aseptate** = important classification feature.
 - Specialized structures = **infection + survival + predation**.
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📄 Cheat Sheet 3 – Fungal Cell Structure □

◆ Cell Wall Composition

- **Oomycetes** → Cellulose + glucans.

- **True fungi** → Chitin (N-acetyl glucosamine) + β -glucans.
 - **Yeasts** → Chitin + mannans + proteins.
 - **Diatom-like fungi (rare)** → silica deposition.
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◆ Protoplasm

- **Nucleus** → small, Feulgen-negative; multiple in coenocytes.
 - **Mitochondria** → tubular cristae.
 - **Ribosomes** → 80S (eukaryotic).
 - **Storage** → glycogen, lipid droplets, carotenoids.
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◆ Organelles

- **Golgi** → secretion.
 - **ER** → protein synthesis.
 - **Vacuoles** → storage + turgor.
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◆ Flagella (motile spores only) ➤

- Types:
 - **Whiplash** – smooth, posterior.
 - **Tinsel** – hairy, anterior (mastigonemes).
 - Structure = **9+2 microtubules**.
 - Present in **Chytrids, Oomycetes** only.
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◆ Mnemonics 💡

- **Wall chemicals** → “**COY**”
 - Cellulose (Oomycetes)
 - Other true fungi → Chitin
 - Yeasts → Mannans
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◆ Exam Capsule 🌀

- **Chitin** = hallmark of true fungi.
- **Flagella** absent in higher fungi (Ascomycota, Basidiomycota).
- **Reserve food** = glycogen + oils.

Cheat Sheet 4 – Fungal Nutrition

Modes of Nutrition

1. Saprophytic

- Feed on dead organic matter.
- Secrete enzymes → extracellular digestion → absorb nutrients.
- Examples: *Rhizopus*, *Aspergillus*.

2. Parasitic

- Live on living hosts (plants/animals).
- **Biotrophs** → take nutrients without killing host (*Puccinia*).
- **Necrotrophs** → kill host cells, then feed (*Botrytis*).
- Structures: **Appressoria** (penetration), **Haustoria** (absorption).

3. Symbiotic

- **Lichens** = fungus + alga/cyanobacterium.
- **Mycorrhiza** = fungus + higher plant roots (*Glomus* → arbuscular mycorrhiza).
- Benefits: Nutrient exchange (fungus gets sugar, host gets minerals).

4. Predacious Fungi

- Capture nematodes using hyphal loops/nets.
- Example: *Arthrobotrys*.

Reserve Food

- **Glycogen + lipids** (not starch – unlike plants).
- Carotenoids often present (pigments).

Special Nutritional Traits

- **Obligate parasites**: must live on host (e.g., *Albugo*).
- **Facultative saprophytes/parasites**: can live freely or on host (*Fusarium*).
- **Endophytes**: fungi living inside plants without causing harm.

Mnemonics

- **Types of Nutrition in Fungi** → “SPaSP”

- Saprophytic
- Parasitic
- Symbiotic
- Predacious

◆ Exam Capsule 🧠

- Fungi = absorptive heterotrophs.
- Parasites → form **haustoria & appressoria**.
- Symbiotic forms → **Lichens & Mycorrhiza**.
- **Glycogen**, not starch = fungal reserve food.

📖 Cheat Sheet 4 – Fungal Nutrition 🧫🧠

◆ Modes of Nutrition

1. Saprophytic 🍄

- Feed on dead organic matter.
- Secrete enzymes → extracellular digestion → absorb nutrients.
- Examples: *Rhizopus*, *Aspergillus*.

2. Parasitic ☐

- Live on living hosts (plants/animals).
- **Biotrophs** → take nutrients without killing host (*Puccinia*).
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- Structures: **Appressoria** (penetration), **Hhaustoria** (absorption).

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4. Predacious Fungi 🕸️

- Capture nematodes using hyphal loops/nets.
- Example: *Arthrobotrys*.

◆ Reserve Food

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- Carotenoids often present (pigments).
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- **Obligate parasites:** must live on host (e.g., *Albugo*).
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◆ Mnemonics 💡

- **Types of Nutrition in Fungi → “SPaSP”**
 - **S**aprophytic
 - **P**arasitic
 - **S**ymbiotic
 - **P**redacious
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◆ Exam Capsule 🧠

- Fungi = absorptive heterotrophs.
- Parasites → form **haustoria & appressoria**.
- Symbiotic forms → **Lichens & Mycorrhiza**.
- **Glycogen**, not starch = fungal reserve food.

📄 Cheat Sheet 5 – Fungal Tissues 🍄

◆ Concept

- Fungi are **thallophytes** → body not differentiated into true tissues.
 - But hyphae often organize into **pseudotissues (plectenchyma)**.
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◆ Types of Fungal Tissues

1. Prosenchyma

- Hyphae loosely arranged, parallel.
- Retain individuality.
- Found in fruiting bodies of many fungi.

2. Pseudoparenchyma

- Hyphae tightly packed, appear like true parenchyma.
- Cells look isodiametric.
- Seen in sclerotia, stromata.

◆ Special Structures from Plectenchyma

- **Sclerotium** → compact resting mass (e.g., *Claviceps*).
- **Stroma** → dense cushion bearing fruiting bodies.
- **Rhizomorphs** → root-like cords of hyphae (*Armillaria*).
- **Plectenchymatous basidiocarps** → mushrooms, brackets, puffballs.

◆ Reproductive Tissues

- **Hymenium** → fertile layer with asci/basidia.
- **Trama** → sterile tissue below hymenium.
- **Paraphyses** → sterile filaments among asci/basidia.
- **Conceptacles** → cavities with reproductive structures (in some Ascomycota).

◆ Mnemonics 💡

- **Fungal Tissues = PPRS**
 - Prosenchyma
 - Pseudoparenchyma
 - Rhizomorphs
 - Sclerotia/Stroma

◆ Exam Capsule 🧠

- True tissues absent → only **plectenchyma**.
- **Prosenchyma** → parallel, loose hyphae.
- **Pseudoparenchyma** → tightly packed, parenchyma-like.

- Reproductive tissues: **hymenium + trama + paraphyses**.

Cheat Sheet 6 – Classification of Fungi

Basis of Classification

- **Older systems:** morphology of mycelium, spores, fruiting bodies.
 - **Modern systems:** ultrastructure, mode of reproduction, molecular phylogeny (DNA, rRNA).
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Major Groups of Fungi

1. Chytridiomycota (Chytrids)

- Simplest, mostly aquatic.
- **Motile zoospores** with single posterior whiplash flagellum.
- Cell wall: **chitin + glucans**.
- Example: *Synchytrium*, *Batrachomyces*.

2. Zygomycota (Zygomycetes)

- Coenocytic (aseptate) hyphae.
- Asexual → **sporangiospores**.
- Sexual → **zygospores** (thick-walled).
- Example: *Mucor*, *Rhizopus* (bread mould).

3. Glomeromycota

- Obligate symbionts → **arbuscular mycorrhiza (AM fungi)**.
- Asexual reproduction only.
- Example: *Glomus*.

4. Ascomycota (Sac Fungi)

- Septate hyphae.
- Sexual → **ascospores** inside **ascus**.
- Asexual → **conidia**.
- Examples: *Saccharomyces* (yeast), *Aspergillus*, *Neurospora*, *Claviceps*.

5. Basidiomycota (Club Fungi) 🍄

- Septate hyphae with **dolipore septa**.
- Sexual → **basidiospores** borne on **basidium**.
- Fruiting bodies: mushrooms, puffballs, bracket fungi.
- Examples: *Agaricus*, *Puccinia* (rusts), *Ustilago* (smuts).

6. Deuteromycota (Fungi Imperfecti) ?

- “Imperfect fungi” → only **asexual stage** known.
 - Many later placed into Ascomycota/Basidiomycota after sexual stage discovered.
 - Examples: *Candida*, *Trichoderma*, *Colletotrichum*.
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◆ Old Classifications 🏛️

- **Eichler (1883)** → Fungi under Thallophyta.
 - **Ainsworth (1973)** → classified fungi as separate kingdom.
 - **Whittaker (1969)** → Kingdom Fungi (Eukaryota, absorptive nutrition).
 - **Carl Woese (1990)** → molecular phylogeny confirmed fungi as unique lineage.
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◆ Mnemonics 💡

- **Fungal Divisions** → “**Crazy Zebras Go And Break Doors**”
 - Chytridiomycota
 - Zygomycota
 - **G**lomeromycota
 - **A**scomycota
 - **B**asidiomycota
 - **D**euteromycota
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◆ Exam Capsule 🧠

- **Chytrids** → only motile fungi (flagellated zoospores).
- **Zygomycetes** → zygospores = hallmark.
- **Ascomycota** → ascus + ascospores (8 spores typical).
- **Basidiomycota** → basidium + basidiospores, dolipore septa.
- **Deuteromycota** → artificial group, no sexual stage.

Cheat Sheet 7 – Indian Mycologists & Their Contributions IN

Early Pioneers

- **E.J. Butler (1874–1943)**
 - Known as the “**Father of Modern Plant Pathology in India.**”
 - Worked extensively on plant pathogenic fungi.
 - Author of *Fungi and Disease in Plants* (1918).
 - **Birbal Sahni (1891–1949)**
 - Famous palaeobotanist.
 - Studied fossil fungi associated with plant remains.
 - Founded **Birbal Sahni Institute of Palaeosciences** (Lucknow).
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Key Indian Mycologists

- **M.J. Narasimhan**
 - Mycology & plant pathology research.
 - Known for studies on **smuts and rusts**.
- **C.V. Subramanian (1924–2016)**
 - Specialized in **Deuteromycetes (Fungi Imperfecti)**.
 - Established advanced fungal taxonomy labs in India.
 - President of International Mycological Association.
- **K.C. Mehta**
 - Studied **life cycles of rust fungi (Puccinia)**.
 - Contributed to epidemiology of cereal rusts in India.
- **B.B. Mundkur**
 - Established Indian Phytopathological Society.
 - Contributions to taxonomy of plant pathogenic fungi.
- **T.S. Sadasivan**

- Worked on **host–parasite interactions**.
 - Studied physiological aspects of fungal diseases.
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◆ Modern Contributors

- **M.J. Thirumalachar**
 - Discovered many **antibiotic-producing fungi**.
 - Known for “Thirumalacharomyces.”
 - **C.V. Subramanian & K. Ramakrishnan**
 - Greatly advanced fungal taxonomy and biodiversity research.
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◆ Mnemonics 💡

- **Indian Fungal Legends → “Big Myco Men Create Serious Trends”**
 - **B**utler – Father of Plant Pathology in India
 - **M**ehta – Rust fungi
 - **M**undkur – Phytopathology society
 - **C.V.** Subramanian – Deuteromycetes
 - **S**adasivan – Host–parasite physiology
 - **T**hirumalachar – Antibiotics
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◆ Exam Capsule 🧠

- **E.J. Butler** → Father of Modern Plant Pathology in India.
- **K.C. Mehta** → studied rust life cycles.
- **C.V. Subramanian** → world authority on **Deuteromycetes**.
- **B.B. Mundkur** → founder, Indian Phytopathological Society.

📖 Cheat Sheet 8 – Economic Importance of Fungi 💰🍄

◆ Beneficial Roles ✅

1. Food & Fermentation 📖🍷

- Yeast (*Saccharomyces cerevisiae*) → Bread, beer, wine, ethanol.
- *Aspergillus oryzae* → Sake (rice wine), soy sauce.

- Edible fungi → *Agaricus* (button mushroom), *Morchella* (morels), *Tuber* (truffles).
- Single Cell Protein (SCP) → *Candida*, *Fusarium*, *Saccharomyces*.

2. Medicine

- Antibiotics → *Penicillium notatum* (penicillin), *Cephalosporium* (cephalosporins).
- Immunosuppressants → *Tolypocladium inflatum* (cyclosporin).
- Statins (cholesterol-lowering) → *Monascus purpureus*.
- Ergot alkaloids (*Claviceps purpurea*) → control bleeding, induce labour.

3. Industry

- Organic acids → *Aspergillus niger* (citric acid), *Rhizopus* (fumaric acid).
- Enzymes → Amylase, cellulase, protease from *Aspergillus* & *Trichoderma*.
- Cheese ripening → *Penicillium roqueforti*, *Penicillium camemberti*.

4. Agriculture

- Mycorrhiza (*Glomus*) → improve P uptake, drought tolerance.
- Biocontrol → *Trichoderma* against soil pathogens.
- Nitrogen fixation → *Nostoc* in lichens (indirect fungal role).
- Organic matter recycling → decomposers maintain soil fertility.

5. Research Models

- *Neurospora crassa* → Beadle & Tatum's "One gene—one enzyme" theory.
- Yeast (*Saccharomyces cerevisiae*) → eukaryotic model for genetics, cell cycle.

◆ Harmful Roles ✕

1. Plant Diseases

- *Puccinia graminis* → Wheat rust.
- *Ustilago* → Smuts in cereals.
- *Albugo candida* → White rust of crucifers.
- *Alternaria solani* → Early blight of potato.

2. Human & Animal Diseases ☐☐

- *Candida albicans* → Candidiasis.
- *Aspergillus fumigatus* → Aspergillosis.
- *Dermatophytes* (*Trichophyton*, *Microsporum*) → Ringworm, athlete's foot.

3. Food Spoilage

- *Rhizopus*, *Mucor* → spoil bread & fruits.
 - *Aspergillus flavus* → produces **aflatoxin** (hepatotoxic, carcinogenic).
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◆ Mnemonics 💡

- **Medicinal Products** → “**PACEM**”
 - Penicillin – Penicillium
 - Antibiotics (Cephalosporins)
 - Cyclosporin – Immunosuppressant
 - Ergot alkaloids – Claviceps
 - Monascus – Statins
 - **Industrial Uses** → “**ACE**”
 - Acids (citric, fumaric)
 - Cheese ripening
 - Enzymes
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◆ Exam Capsule 🧠

- **Penicillin** → first antibiotic (from *Penicillium notatum*).
- **Claviceps** → ergot alkaloids.
- **Aflatoxin** → *Aspergillus flavus*.
- **Mycorrhiza** → symbiosis improving plant nutrition.
- *Neurospora* & *Yeast* → model organisms in genetics.

📖 Cheat Sheet 9 – Fungal Reproduction 🧫🍄

◆ Overview

Fungi reproduce by **vegetative, asexual, and sexual** methods.

Spores are the most common reproductive units – can be motile or non-motile, unicellular or multicellular.

◆ 1. Vegetative Reproduction 🍄

- **Fragmentation** → mycelium breaks into pieces (*Rhizopus*).
- **Budding** → small outgrowth develops (*Yeast*).

- **Fission** → binary division of cells (Yeast).
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◆ 2. Asexual Reproduction 🧫

- **Zoospores** → motile, flagellated (lower fungi e.g., *Synchytrium*).
 - **Aplanospores** → non-motile spores.
 - **Chlamydospores** → thick-walled resting spores (*Candida*).
 - **Conidia** → exogenous spores on conidiophores (*Aspergillus*, *Penicillium*).
 - **Sporangiospores** → endogenous in sporangium (*Mucor*, *Rhizopus*).
 - **Oidia** → fragmentation of hyphae into spores.
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◆ 3. Sexual Reproduction ❤️

Steps:

1. **Plasmogamy** – fusion of cytoplasm.
2. **Karyogamy** – fusion of nuclei → diploid.
3. **Meiosis** – reduction back to haploid → genetic variation.

Types of Sexual Reproduction

- **Planogametic Copulation** – fusion of motile gametes.
 - **Gametangial Contact** – gametangia contact, gamete transfer (*Albugo*).
 - **Gametangial Copulation** – gametangia fuse (*Mucor*).
 - **Spermatization** – spermatia fertilize receptive hyphae (*Puccinia*).
 - **Somatogamy** – direct fusion of somatic hyphae (*Basidiomycota*).
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◆ Structures Produced

- **Zygospore** → thick-walled resting spore (Zygomycota).
 - **Ascospore** → inside asci (Ascomycota).
 - **Basidiospore** → borne on basidia (Basidiomycota).
 - **Oospore** → Oomycota.
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◆ Mnemonics 💡

- **Asexual Spores** → “ZACCSO”
 - Zoospore
 - Aplanospore

- Chlamydospore
 - Conidia
 - Sporangiospore
 - Oidia
 - **Sexual Reproduction Types** → “PGGSS”
 - Planogametic copulation
 - Gametangial contact
 - Gametangial copulation
 - Spermatization
 - Somatogamy
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◆ Exam Capsule

- Sexual cycle: **Plasmogamy** → **Karyogamy** → **Meiosis**.
- **Ascomycota** → asci & ascospores (8 typical).
- **Basidiomycota** → basidia & basidiospores.
- **Zygomycota** → zygospores.
- **Chytridiomycota** → motile zoospores (unique).

Cheat Sheet 10 – Fungal Spores (Types & Significance)

◆ Asexual Spores

- **Zoospores** → motile, flagellated (*Synchytrium*).
 - **Aplanospores** → non-motile spores.
 - **Chlamydospores** → thick-walled resting spores (*Candida*).
 - **Conidia** → exogenous spores on conidiophores (*Aspergillus*, *Penicillium*).
 - **Sporangiospores** → endogenous, formed inside sporangium (*Mucor*, *Rhizopus*).
 - **Oidia** → small hyphal fragments.
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◆ Sexual Spores

- **Zygospores** → fusion of gametangia (Zygomycota).
- **Ascospores** → formed in asci (Ascomycota).
- **Basidiospores** → borne externally on basidia (Basidiomycota).

- **Oospores** → oogamous reproduction (Oomycetes).
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◆ Special Spores

- **Sporangiospores** (endo) vs. **Conidia** (exo).
 - **Aleurospores** → terminal conidia.
 - **Blastoconidia** → budding (*Candida*).
 - **Arthroconidia** → fragmentation into spores.
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◆ Mnemonics 💡

- **Asexual Spores** → “**ZACCSO**”
 - Zoospores
 - Aplanospores
 - Chlamydospores
 - Conidia
 - Sporangiospores
 - Oidia
 - **Sexual Spores** → “**ZABO**”
 - Zygosporangium
 - Ascospore
 - Basidiospore
 - Oospore
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◆ Exam Capsule 🧠

- **Exogenous spores** = Conidia, Basidiospores.
- **Endogenous spores** = Sporangiospores, Ascospores.
- **Motile spores** = Zoospores (chytrids).
- **Thick-walled resistant** = Chlamydospores, Zygosporangium.