The Characteristic Features of Fungi: Defining The Fungal Kingdom

To begin this section we must make an important distinction between the **true fungi** and a range of **fungus-like organisms** that have traditionally been studied by mycologists, but are fundamentally different from fungi. Here we will focus on the true fungi, often termed the **Mycota** or **Eumycota**. All true fungi have a range of features that clearly separate them from other organisms and that serve to define the fungal **kingdom (Mycota)**.

These features are outlined below

• All fungi are **eukaryotic**. In other words, they have membrane-bound nuclei containing several chromosomes, and they have a range of membrane bound cytoplasmic organelles (mitochondria, vacuoles, etc.). Other characterisitics, shared by all eukaryotes, include: cytoplasmic streaming, DNA that contains noncoding regions termed introns, membranes that typically contain sterols, and ribosomes of the 80S type in contrast to the 70S ribosomes of bacteria ("S" refers to Svedberg unit).

• Fungi typically grow as filaments, termed **hyphae** (singular: hypha), which extend only at their extreme tips. So, fungi exhibit **apical growth** in contrast to many other filamentous organisms (e.g. filamentous green algae) which grow by repeated cell divisions within a chain of cells (intercalary growth). Fungal hyphae branch repeatedly behind their tips, giving rise to a network termed a **mycelium**. However, some fungi grow as single-celled yeasts (e.g. *Saccharomyces cerevisiae*) which reproduce by budding, and some can switch between a yeast phase and a hyphal phase in response to environmental conditions. These **dimorphic fungi** (with two shapes) include several species that are serious pathogens of humans. They often grow as yeast-like cells for proliferation in the body fluids but convert to hyphae for invasion of the tissues.

• Fungi are **heterotrophs (chemo-organotrophs).** In other words, they need preformed organic compounds as energy sources and also as carbon skeletons for cellular synthesis. The cell wall prevents fungi from engulfing food by phagocytosis, so fungi absorb simple, soluble nutrients through the wall and cell membrane. In many cases this is achieved by secreting enzymes at the hyphal tips to degrade complex polymers out of their body and then absorbing the simple, soluble nutrients released by depolymerase (polymer-degrading) enzymes.
Some live in a mutually beneficial symbiotic relationship with another organism, often a plant. The association of fungus and plant root is called a **mycorrhiza**. Some 80–90% of land plants benefit from symbiotic mycorrhiza. The plant benefits by more-efficient mineral (chiefly nitrates and phosphates) uptake.The fungus benefits by the sugars and other nutrients (e.g., lipids) translocated to the root by the plant.

• Fungi have a distinctive range of **wall components**, which typically including **chitin** and **glucans** (polymers of glucose with predominantly β-1,3 and β-1,6 linkages). Short lengths of cellulose (a β-1,4-linked polymer of glucose) have been detected in some fungal walls, especially in some of the primitive fungi. However fungi differ from plants because they do not have cellulose-rich cell walls.

• Fungi have a characteristic range of soluble carbohydrates and storage compounds, including **mannitol** and other sugar alcohols, **trehalose** (a disaccharide of glucose), and **glycogen**. These compounds are similar to those of some animals – notably the arthropods – but are different from those of plants.

• Fungi typically have **haploid nuclei (n)**– an important difference from almost all other eukaryotes. However, fungal hyphae often have several nuclei within each hyphal compartment, and many budding yeasts are diploid. These differences in nuclear status and nuclear arrangements have important implications for fungal genetics.

• Fungi reproduce by both sexual (meiospores) and asexual (mitospores) means, and typically produce **spores**. Fungal spores vary enormously in shape, size and other properties, related to their various roles in dispersal or dormant survival. Fungi disperse themselves by releasing spores, usually windblown. Fungal spores are present almost everywhere (and are a frequent cause of allergies). Spores of the wheat rust fungus have been found at 4000 m in the air and more than 1450 km (900 miles) from the place they were released. No wonder then that most fungi are worldwide in their distribution

Comparison of some features of fungi with those of animals and plants.

Character	*Fungi*	*Animals*	*Plants*
Growth habit	Hyphal tip growth or budding yeasts	Not hyphal	Multicellular tissues
Nutrition	Heterotrophic, absorb soluble nutrients	Heterotrophic, ingest food	Photosynthetic
Cell wall	Typically contains chitin	Absent, but chitin is found in insect exoskeletons	Mainly cellulose
Nuclei	Usually haploid; nuclear membrane persists during division	Typically diploid; the membrane breaks down during nuclear division	Diploid; the membrane breaks down during nuclear division
Histones	Histone 2B	Histone 2B	Plant histones
Microtubules	Sensitive to benzimidazoles and griseofulvin	Sensitive to colchicine	Sensitive to colchicine
Lysine synthesis	Synthesized by AAA pathway	Not synthesized, must be supplied	Synthesized by DAP pathway
Golgi cisternae	Unstacked, tubular	Stacked, plate-like	Stacked, plate-like
Mitochondria	Plate- or disk-like cisternae	Plate- or disk-like cisternae	Tubular cisternae
Translocated carbohydrates	Polyols (mannitol, arabitol, etc.), trehalose	Trehalose in insects	Glucose, fructose, sucrose
Storage compounds	Glycogen, lipids, trehalose	Glycogen, lipids, trehalose in some	Starch
Mitochondrial codon usage	UGA codes for tryptophan	UGA codes for tryptophan	UGA codes for chain termination
Membrane sterols	Ergosterol	Cholesterol	Sitosterol and other plant sterols

AAA, alpha-amino adipic acid pathway; DAP, diamino-pimelic acid pathway.