STRUCTURE, CHARACTERISTICS AND REPRODUCTION OF FUNGI II

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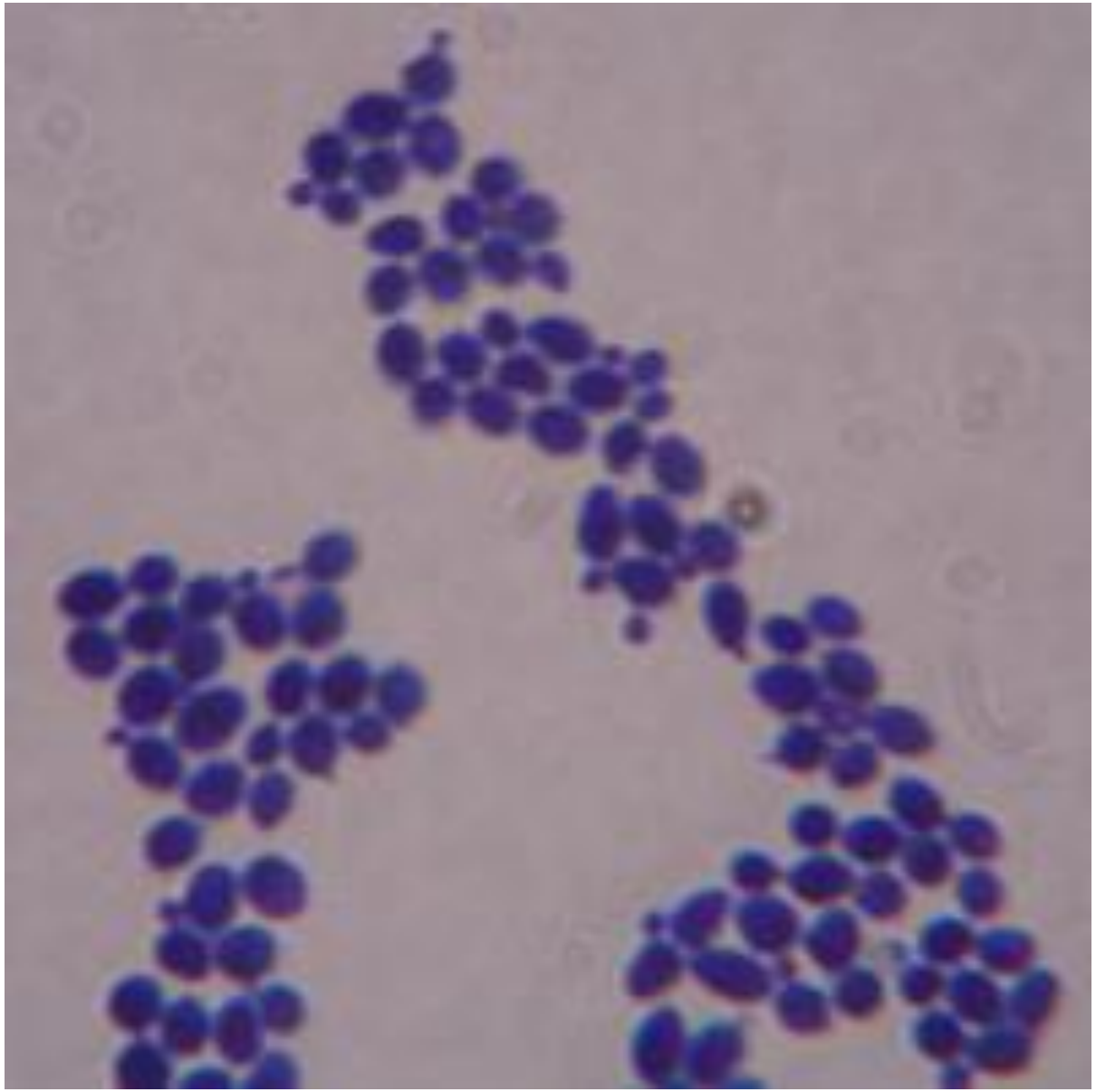
General Characteristics of fungi

1. Fungi are composed of **Eukaryotic** cells. Cells with a nucleus and organelles are a common feature of Eukaryotic cells. What is unique about many fungi is that they can maintain two distinct nuclei per cell. Also, some fungi appear to have lost their mitochondria, the organelle responsible for aerobic respiration (using Oxygen to generate ATP).
2. Fungi are **Heterotrophic**: Fungi never make their own food, although many can participate in symbioses (such as lichens) with photosynthetic organisms that produce food from sunlight. Instead, they derive their energy from consuming carbon compounds (sugars and fats, etc) from living or dead organisms.

General Characteristics of fungi

3. Fungi use **absorptive nutrition**: Fungi are too small to ingest their prey whole, and they lack mechanical means of biting off and chewing their prey. Fungi feed by secreting enzymes into their environment that partially digest their food. They then absorb simple nutrients (like sugars and amino acids) through holes in their cell membranes. For this reason, fungi tend to live in their food.
4. Fungi have cell walls of **chitin**: Chitin is a substance similar to wood (cellulose). Wood, however is made of glucose molecules linked together in unbranching chains, whereas chitin is made of N-acetyl glucosamine molecules linked together in unbranching chains. The main difference is the N (nitrogen atom) in the N-acetyl glucosamine molecules. Chitin is the substance that makes up the shells of arthropods such as insects and spiders also. Above is a comparison of cellulose and chitin at the molecular level.

Morphology



***Saccharomyces* yeasts budding**

Many fungi produce only single cells (unicells). If they lack flagella, such cells are called yeasts (there are many unrelated yeasts).Yeasts can reproduce by budding. Yeast cells reproduce by budding. Among Ascomycetes, yeasts are typical of the genus *Candida* which includes several species of medical importance (harmful) and the genus *Saccharomyces* which includes *S. cerevisiae*, a very useful microscopic fungus useful in agriculture and industry (helpful).

Morphology

- Many fungi produce only single cells. Some fungi are dimorphic, with yeast phases and filamentous phases
- Hyphae are filaments that make up all structures of multicellular fungi. Some hyphae have cross-walls called septa (singular septum) between cells, and others do not
- A network of hyphae reaching through acres of soil or covering an orange peel, for example, is called a mycelium (a.k.a.: thallus or vegetative part of the fungus)

Morphology

- The mycelium secretes digestive enzymes, absorbs nutrients, mates and in some species of fungi captures live animals for prey.
- Mycelia can organize in a variety of ways in order to accomplish tasks. Some fungi form rhizomorphs which look like plant roots and enable the fungus to grow quickly over trees or the forest floor.
- Other fungi form tight, rock-like masses called sclerotia which allow them to rest or survive difficult environmental conditions such as freezing and drying out.

Occurrence in nature

Fungal mycelia on wood

Occurrence in nature

Fungal mycelia on bread

Occurrence in nature

Fungal mycelia on a plant leaf

Reproduction in Fungi

- In order to reproduce, mycelia form sporangia which produce spores. Sporangia can be formed sexually or asexually
- Spores that are produced sexually are called meiospores, for meiosis, and spores that are produced asexually are called mitospores or conidia

Reproduction in Fungi

- The sporangia in different groups of fungi have unique names. Because one mycelium is usually difficult to distinguish from another, sporangia have been a major feature used to identify and classify fungi
- The mycelium can organize to form complex fruiting bodies such as mushrooms that bear the sporangia on specialized surfaces

Fungal Life Cycles

Unicellular Fungal Life Cycles

- Fungi have diverse life cycles, ranging from very simple to very complex. Mating and sexuality in fungi also take diverse forms
- The following seven examples illustrate some of the diversity in life cycles in fungi, beginning with relatively simple life cycles
- Please realize that each of the major groups of fungi has a diversity of life cycles beyond those listed here.

1. Unicellular asexual fungi. **Example**: *Candida albicans* (ascomycete) is an asexual animal pathogen. Reproduction is by budding of yeast cells.

2. Unicellular sexual fungi. **Example**: *Chytriomyces hyalinus* (chytridiomycete) is an aquatic fungus that grows on chitin such as the exoskeletons of aquatic insects. It produces a single diploid cell that immediately undergoes meiosis. Single celled zoospores perpetuate the haploid phase.

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Multicellular Fungal Life Cycles

3. Filamentous asexual fungi. **Example**: *Fusarium oxysporum* (ascomycete) and related taxa include many of the most serious plant pathogens. Reproduction and dispersal is via conidia.

4. Filamentous fungi with sexual and asexual reproduction, but no multicellular fruiting bodies. **Example**: *Rhizopus stolonifer* (zygomycete) is a common, fast-growing black mold of bread, strawberries and other foods, which has non-septate hyphae. Asexual spores are produced on stalked sporangia. Sexual reproduction involves the fusion of haploid hyphae, and production of a single diploid cell, the zygospore, which undergoes meiosis on germination to recycle the haploid phase.

Multicellular Fungal Life Cycles

5. Filamentous fungi with sexual reproduction and multicellular fruiting bodies. **Example**: *Agaricus bisporus* (basidiomycete) is the common button mushroom. Sexually produced spores give rise to primary (haploid) mycelia, which fuse to form the secondary mycelium. Karyogamy (nuclear fusion) is delayed, so the secondary mycelium is said to be dikaryotic, or simply a dikaryon. The dikaryon produces diagnostic clamp connections at the septa. When conditions permit, the dikaryon produces a multicellular fruiting body. The club-shaped meiosporangia are called basidia. Karyogamy occurs in the basidia and is immediately followed by meiosis and spore production. As in the other fungi discussed, there is only a single diploid cell in the life cycle.

Multicellular Fungal Life Cycles

6. Filamentous fungi with sexual and asexual reproduction.

Example : *Peziza vesiculosa* (ascomycete) produces cup-shaped multicellular fruiting bodies, where sexual reproduction occurs. The meiosporangia are sac-shaped cells called asci. As in basidiomycetes, karyogamy and meiosis occur in the asci. Haploid ascospores germinate to form the primary mycelia, which can produce microscopic asexual reproductive structures. The asexual form has been given its own name, *Oedocephalum*. Conidia produced by the *Oedocephalum* stage can recycle the haploid phase. Fusion of primary mycelia produces a dikaryon, which gives rise to the fruiting body, as in basidiomycetes. In fungi with sexual and asexual phases, the sexual phase is called the teleomorph and the asexual phase is called the anamorph. These are also called meiosporic and mitosporic phases, respectively.

Multicellular Fungal Life Cycles

7. Plant pathogens with sexual and asexual reproduction on multiple hosts.
Example: *Puccinia graminis* (barberry-wheat rust; basidiomycete). Sexually produced basidiospores infect barberries. Spermogonia are reproductive structures that are produced on the upper surface of the barberry leaves. Spermogonia produce single celled spermatia and receptive hyphae. Spermatia contact receptive hyphae and fuse to form the dikaryon. The dikaryon produces an asexual reproductive structure, the aecium, on the underside of the barberry leaf. Dikaryotic aeciospores infect wheat. The dikaryotic mycelium on wheat produces reproductive structures called uredinia, which produce asexual, dikaryotic urediniospores that can reinfect wheat. Eventually, the dikaryon on wheat produces reproductive structures called telia. Teliospores are produced asexually and are dikaryotic overwintering structures. In spring, the nuclei in teliospores fuse (karyogamy), produce a stalked basidium, undergo meiosis, and produce basidiospores that infect barberry. In total there are two hosts, four kinds of spore-producing structures, and one diploid cell in the life cycle!

Typical Examination Questions

1. Describe the unique and common features of named fungal groups.

2. Describe the various reproductive life cycles associated with fungi.

Further Reading

1. General Introduction to fungal biology (http://www.clarku.edu/faculty/dhibbett/TFTOL/content/1intropprogress.html)

2. http://bioweb.uwlax.edu/bio203/s2007/nelson_andr/

Thanks

Questions, Comments and Advice!