Lecture 25

I. What are they?

A. Fungi are _____ organisms that grow best in dark, moist habitats.

B. Once thought to be plants, they are now thought to be _____[1].

C. They receive their energy from _____ by secreting _____ into the environment. Most fungi are _____, the organic matter from which they take their nutrients is _____.

D. Include both the unicellular, non-filamentous _____ and the multicellular, filamentous _____.

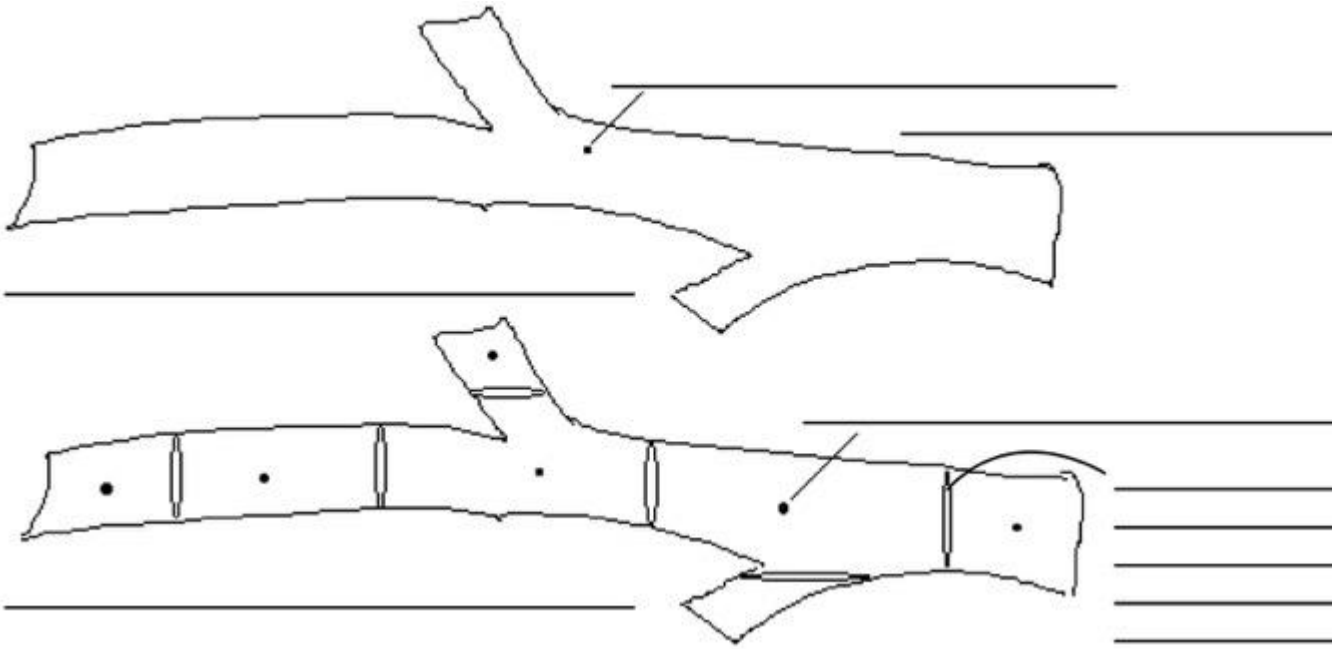
1. Yeasts are typically _____ and are commonly found in nature on fruits and the leaves of trees.

2. Molds are a diverse group ranging from small colonies on fruits and cheeses to large _____ _____.

II. What is the structure of a fungus?

A. The body of a fungus is called the _____.

B. Molds are further characterized by long, branched filaments called _____.

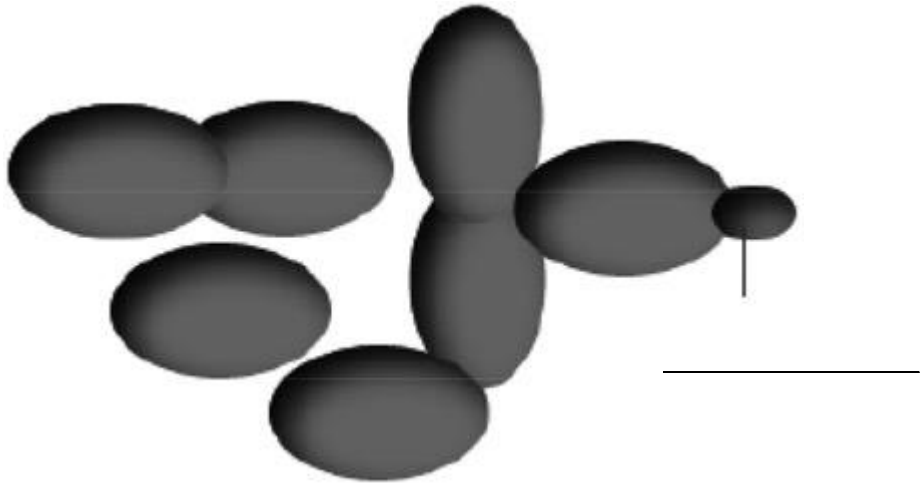


The hyphae form a tangled web, called a _____.

1. http://en.wikipedia.org/wiki/Fungus#Evolutionary_history

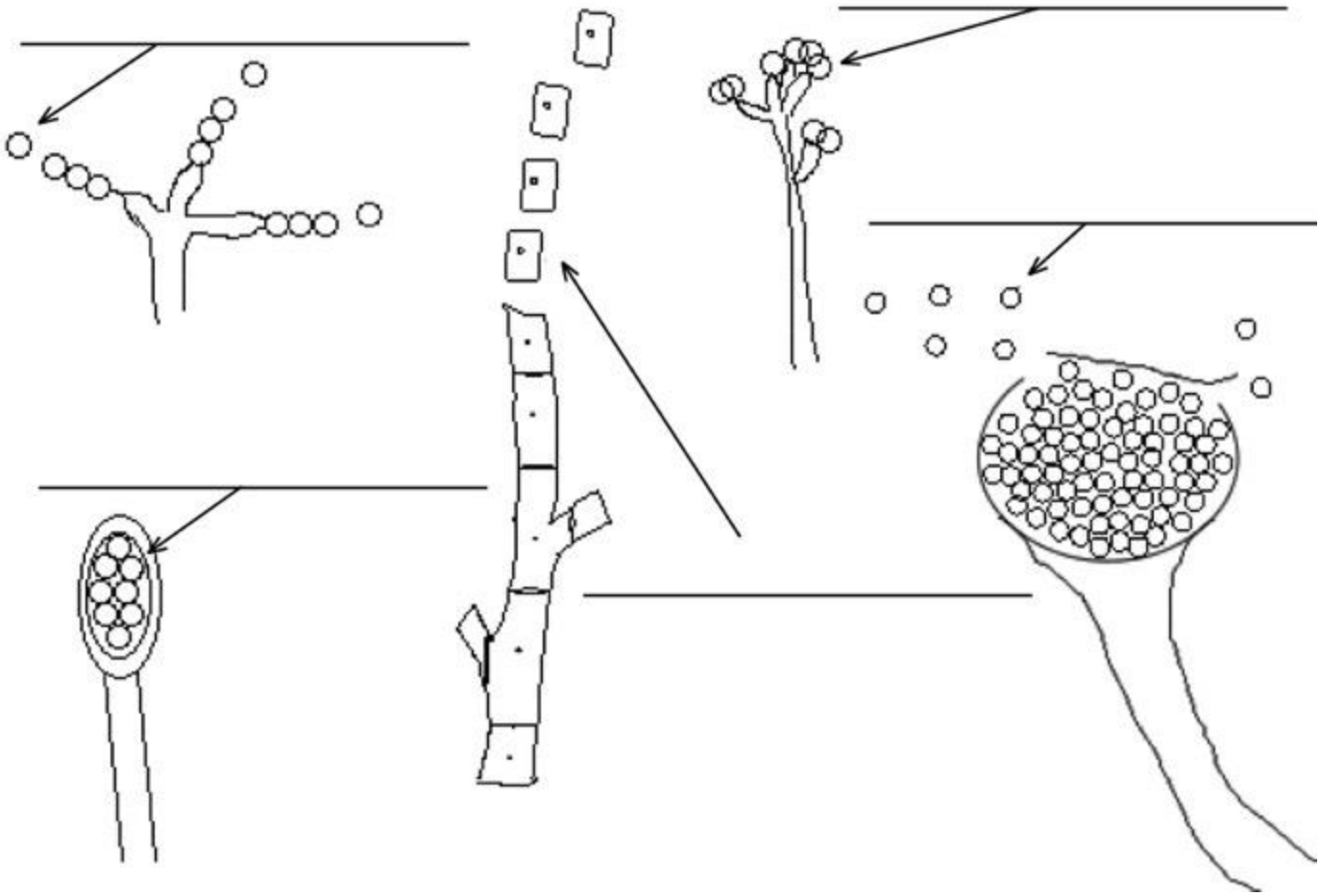
III. How do fungi reproduce?

A. Yeast generally reproduce _____.



B. Molds can reproduce either sexually or asexually.

1. Asexual reproduction can occur either by central _____ of a parent cell to form two daughter cells or by _____.



2. Sexual reproduction involves the _____ and generally includes the formation of a _____that can survive harsh external conditions.

IV. How do fungi affect us?

A. _____

1. Entire ecosystems would collapse without fungi decomposing dead organisms, fallen leaves, feces, and other organic materials.
2. Nitrogen and carbon wouldn't be recycled for new generations of life.

B. _____

1. You've seen the evidence on your fruit and shower curtains.
2. 10 to 50% of the world's _____ is lost to fungal attack every year.
3. During the Revolutionary war, Britain ____ _____ to fungal rot than enemy attack.[2]

C. Pathogenic Fungi

1. Many fungi are responsible for some well-known human diseases called _____ (e.g. athlete's foot and jock itch).

2. _____ to fungal infection. There are 5,000 pathogens that affect garden plants, agricultural plants and wild plants.[3]

D. _____

1. Fungi have been consumed throughout human history. Some you might be familiar with are _____, morel, cremini, chanterelle, shiitake, and oyster (sautéed with garlic and butter; delicious!)
2. Others are used in the production of _____ _____

3. Penicillium roquefortii and *P. camemberti* are responsible for the color, texture, and flavor of _____ _____.

V. How are fungi classified?

We will look at six fungal divisions. Two more (*Urediniomycetes* and *Ustilaginomycetes*) are often classified as *Basidiomycota* and as such are not listed as separate divisions here. Fungal taxonomy is ever-changing. We will base our discussion largely on the classifications presented in the Prescott text.

A. _____

1. Very simple, _____ fungi that live in freshwater, mud, soil and sometimes the rumen.
2. Reproduce both sexually and asexually and spores are _____ via a posterior flagellum.

B. _____

1. Members of this phylum have coenocytic hyphae and generally _____via sporangiospores.
2. Most bread molds are _____. The common bread mold *Rhizopus stolonifer* is even used in some countries to _____ such as tempeh and sufu.

C. _____

1. This group contains molds with _____ such as lichens, morels, _____, and cap fungi. Many yeasts are also classified into this division.
    i. Letharia vulpina (_____) grows on conifers. The Native Americans of California used Wolf Lichens for medicinal purposes and as arrow poison.[4]

Letharia vulpina
Taken by Rachel in Yellowstone (summer 2006)

2. msn Encyclopedia Encarta
3. Prescott Text (seventh edition) p. 630

ii. Black Truffles (aka "Black Gold")

1.) A culinary treasure, they are worth up to _____![5] 2.) Found mostly in France and northern Italy, farmers train pigs and dogs to _____.

3.) They have a complex flavor, often described as nutty, musky, cheesy, earthy, smoky, smooth....

4.) Napoleon was said to have used them as an _____, and they were forbidden to medieval nuns because of their naughty influences.

2. They are called sac fungi because their sexual spores are produced in a _____. They can also reproduce asexually via _____.

3. Many members of this group are _____, causing plant diseases such as Dutch Elm disease and Chestnut Blight as well as the human and animal disease, _____.

i. Ergotism is a toxic condition commonly accompanied by gangrene, nervous spasms, burning sensations, _____, convulsions and temporary insanity.

ii. An epidemic of ergot in 943 A.D. _____.[6]

iii. The widespread accusations of _____ _____ may have resulted from outbreaks of ergotism.

iv. The active ingredient of ergot is _____.

Shelf fungi
Taken by Rachel in England (summer 2006)

D. _____

1. Members of this phylum have _____ and possess a club-shaped structure called a _____ that produces sexual spores called _____.

2. This group has many _____ members (mushrooms and puffballs) and also includes shelf fungi. Also, in this division are several _____ _____ such as *Amanita phalloides* ("Destroying Angel").

E. _____

1. Most are _____ fungi that form a _____ with the roots of plants.

2. Around _____ have an association with mycorrhizae.[7] "Plants don't have roots, they have mycorrhizae!"

3. Mycorrhizae help _____ throughout the soil and draw up additional water and minerals.

F. _____

1. _____ of fish, humans and insects.

2. _____, such as mitochondria.

3. Spores germinate in response to host signals. A _____ from the spore. This tube penetrates the host cell and allows the parasite to enter.

VI. To sum up:

A. Fungi are a diverse and vital group of organisms, crucial to life on earth.

B. The next time you eat a mushroom pizza, give a little thanks to the guys on top. And remember, mycology is better than yours!

4. Lichens of North America (Sharnoff et. al.) ISBN: 0-300-08249-5
5. http://www.businessweek.com/magazine/content/04_03/c3866097.htm
6. Prescott Text (seventh edition) p. 637
7. Prescott Text (seventh edition) p. 697

Background information for writing this lecture was obtained largely from Prescott's Microbiology (seventh edition). Other information was from: Campbell's Biology, Nester's Microbiology: A Human Perspective, Murray's Manual of Clinical Microbiology and Microsoft Encarta Encyclopedia. Visit the following web sites for pictures and more information:

- www.ftns.wau.nl/imb/research/wrf.html
- www.lichen.com/bigpix/Asarmentosa.html
- athletesfoot.com/scalyfootpage.html
- www.terra.hu/novkorny/pic/2/nm/amanpha2.jpg
- www.ucmp.berkeley.edu/fungi/chytrids.html
- www.wisc.edu/botany/fungi/oct99.html
- www.mykoweb.com/photos/Puffball_(mgw-01).jpg
- http://en.wikipedia.org/wiki/Fungus#Evolutionary_history

Classification of fungi

Group	Common Name	Hyphal Organization	Reproduction Characteristics	Example
Chytridiomycota	Chytrids	coenocytic hyphae (if present)	Asexual: motile zoospores Sexual: sporangiospores	*Allomyces*
Zygomycota	Bread molds	coenocytic hyphae	Asexual: sporangiospores Sexual: zygospores	*Rhizopus stolonifer*
Ascomycota	Sac fungi	septate hyphae	Asexual: conidiospores Sexual: ascospores	*Saccharomyces cerevisiae* *Aspergillus* *Penicillium*
Basidiomycota	Club fungi	septate hyphae	Asexual: often absent Sexual: basidiospores	Mushrooms
Glomeromycota	Mycorrhizae	coenocytic hyphae	Only asexual reproduction known via spores or fragmentation	*Acaulospora*
Microsporidia	Often still referred to as protists	N/A	Asexual or sexual (complex life cycle)	*Enterocystozoon*

Chytridiomycota **(chytrids)**

The simplest of the fungi, the chytrids are microscopic and found in freshwater, mud, soil and sometimes the rumen.

Zygomycota **(bread molds)**

Members of the subdivision *Zygomycota* have coenocytic hyphae. Asexual reproduction is via sporangiospores, which can be released from the sporangium and carried by air currents. When the spores reach an appropriate substrate, they germinate to produce new hyphae. Bread molds do not usually cause human disease. In fact, in some countries they are used in food production. *Rhizopus*, however, is an opportunistic human pathogen; it is especially dangerous to people with diabetes mellitus that is not well controlled.

Ascomycota **(sac fungi)**

Members of the subdivision *Ascomycota* include molds that have septate hyphae and some yeasts. They are called sac fungi because their sexual spores, called ascospores, are produced in a sac or ascus. Asexual reproduction is via conidiospores. The *Ascomycetes* include fungi that cause chestnut blight and Dutch elm disease. *Claviceps purpurea* is a parasite on rye grass that causes ergot.

Basidiomycota **(club fungi)**

Basidiomycetes also possess septate hyphae. The sexual spores, called basidiospores, are produced by a club-shaped structure called a basidium. In mushrooms the basidia are found along the gills or pores on the underside of the cap. Some mushrooms produce toxins that are lethal to humans.

Glomeromycota **(mycorrhizae)**

Most are mycorrhizal fungi that form a mutualistic symbiosis with the roots of plants.

Microsporidia

Obligate intracellular parasites of fish, humans and insects.