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BIOL 110 – Exam 3 Supplement – Fungi

Background Information:

- Eukaryotes include four major kingdoms: Protists, Plants, Fungi, and Animals.
- There are four major phyla of fungi:
 - Chytridiomycota
 - Zygomycota
 - Ascomycota
 - Basidiomycota
- It is thought that fungi evolved from protist ancestors.
- All fungi are eukaryotic and mainly multicellular (except yeast).
- Fungi are mostly nonmotile.
 - Ex: The largest organism known is a fungus which extended 3.5 miles across, was 2,400 years old, and was found in Oregon.

Fungal Structure:

- **Hyphae:**
 - Thin filamentous structure
 - Extensive networks create a large surface area for easy digestion
 - Secrete enzymes that digest cellulose and lignin
- **Mycelium:**
 - A large mass of hyphae
 - The white or gray fuzz we can see
- Have cell walls made of chitin

Fungal Nutrition:

- All fungi are heterotrophic.
- **Absorptive nutrition:** Food is digested externally and then absorbed into the cells.
- Fungi are usually decomposers, recycling nutrients in the ecosystem.
- They secrete acids and enzymes to hydrolyze macromolecules and decompose dead organisms.
- They form symbioses:
 - **Mycorrhizae:** An intimate association between plant roots and fungal hyphae.
 - Usually mutualistic
 - Plants get water and nutrients.
 - Fungi get carbon from the roots.
 - **Lichen:** An intimate association between a fungus and a photosynthetic partner, such as green algae or cyanobacteria.

Fungal Reproduction:

- Haploid (N) stage is dominant
- Sex is not obligatory, can be triggered by stress
- We cannot tell the sex of a fungus, so we use (+) or (-). The distinct strains are compatible for sexual reproduction.
 - **Plasmogamy:** The fusion of the cytoplasm of two or more cells. This produces a **dikaryon** (N + N, a mycelium with two genetically distinct nuclei in the same cytoplasm).
 - **Karyogamy:** The fusion of nuclei during sexual reproduction; produces the diploid stage
- Growth occurs at the tips of hyphae and can be very rapid.

Phylum Chytridiomycota:

- Polyphyletic
- Mostly aquatic
- Sometimes classified as a protist, recently determined a fungi
- Mostly saprobes (decomposers that absorb nutrients from dead organic matter) or parasitic
- Some have flagellated spores (the only motile cells in the kingdom).
- Have a cell wall made of chitin
- Some can infect frogs and cause deformities.

Phylum Zygomycota:

- Polyphyletic
- Most are terrestrial saprobes in soil or on decaying plant material.
- Are commonly bread molds
- Form **mycorrhizae** with forest plants and trees
- Most reproduction occurs asexually.
- Form a **zygosporangium** (when two hyphae meet and fuse, the dikaryon forms, growing into the dikaryotic zygosporangium, which has a thick cell wall to aid against harsh conditions)
- Used to make anesthetics, birth control pills, meat tenderizers, etc.

The Reproductive Cycle of Zygomycetes

- I. **Gametangia** begin to form on the **hyphae** of each different mating type (+ or -)
- II. These **gametangia then fuse**, forming the **Heterokaryotic State**
- III. The **Heterokaryotic Zyposproangium** develops (cell wall thickens)
- IV. **Zygosporer germination** occurs: two haploid **nuclei fuse** into the **diploid** cell
- V. **Meiosis** follows, millions of **haploid zygosporer** are formed in sporangium by **mitosis**
- VI. **Zygosporer germinates, releasing** the millions of **spores** and **restarting the cycle**.

Phylum Ascomycota (Sac Fungi):

- Monophyletic
- Largest, most diverse group in the kingdom
- Includes yeasts and cup fungi
- Parasitic, causing many plant and animal diseases
- Makes penicillin
- Defining morphology is the **ascus** [four to eight sexual spores (**ascospores**) in a microscopic sac]
- Capable of producing many asexual spores called **conidia** as well, which can be very destructive since the asexual reproduction is so fast that it can wipe out plants
 - Ex: Dutch elm disease, American chestnut blight caused by ascomycetes
- **Mycotoxins:** Toxic compounds produced by some fungi
 - **Aflatoxin:** Produced by *Aspergillus*; causes acute and chronic symptoms
 - **Ergot:** Produced by *Claviceps*; grows on grains and can cause hallucinations
 - **Sick house syndrome:** Caused by *Stachybotrys*; grows on wet cellulose

Phylum Basidiomycota (Club Fungi):

- Monophyletic
- Includes mushrooms, puffballs, shelf fungi, rusts
- **Basidia:** Cells that hold the sexual spores; resembles a small club
- Are decomposers, plant pathogens, and symbionts with plants
- **Basidiocarp:** A fruiting body (sometimes with gills) holding millions of spores; this is the mushroom we see
- Can infect many plants—wheat rusts, cedar apple rusts, corn smuts, etc.

Phylum Glomeromycota

- Known as the “arbuscular mycorrhizal fungi”
- All members are mycorrhizae of plants
- Form an arbuscle: a branched shrublike organ capable of penetrating the roots of vascular plants, hence they’re referred to as arbuscular mycorrhizal (AM) fungi
- Remember the relationship is mutualistic:
 - the fungus gets carbon from the plants available food supply
 - the plant gets assistance absorbing water and nutrients

Microsporidians

- A recent addition to the fungal kingdom
- Known to be intracellular parasites of animals and protists, mainly affecting invertebrates.
- Microsporidians lack mitochondria, using mitosomes instead.
- Like most fungi, they have no locomotion.
- Can form spores capable of living outside the host for relatively long periods of time.

Additional Practice Problems

Problem 1:

Which of the following statements is FALSE regarding fungi nutrition?

- A) Food is digested externally and then absorbed into the cells.
- B) Many fungi can form symbioses with plants; this is called mycorrhizae.
- C) All fungi must form some sort of symbiotic relationship.
- D) Many fungi are decomposers and saprobes.

Answer: C

Solution: Though often seen with plants, fungi are not required to form symbiotic relationships.

Problem 2:

Plasmogamy refers to which of the following?

- A) The fusion of two fungal nuclei
- B) Two nuclei inhabiting the same cytoplasm
- C) The fusion of the cytoplasm of two fungi
- D) The production of the diploid stage

Answer: C

Solution: By fusing their cytoplasm, the two nuclei (one from each fungus) can produce the dikaryon.

Problem 3:

Which of the following processes produces the diploid stage in fungi development?

- A) Plasmogamy
- B) Karyogamy
- C) Dikaryogamy
- D) Fungi do not have a diploid stage in their life cycles.

Answer: B

Solution: The two nuclei are fused together in fungi sexual reproduction.

Problem 4:

The Zygosporangium refers to which of the following?

- A) Cells that hold the sexual spores
- B) Asexual spores which can reproduce very quickly
- C) A dikaryotic structure which aids against harsh conditions
- D) An intimate association between a fungus and a photosynthetic plant

Answer: C

Solution: By forming the dikaryotic zygosporangium with thicker cell walls, the fungus increases its chances of survival.

Problem 5:

Fungi in which of the following phyla have flagellated spores?

- A) Chytridiomycota
- B) Zygomycota
- C) Ascomycota
- D) Basidiomycota

Answer: A

Solution: The chytrids, who are mostly aquatic, are the only motile cells in the fungal kingdom due to their flagellated spores.

Problem 6:

Which of the following is FALSE regarding fungi in the phylum Zygomycota?

- A) They are often bread molds.
- B) They can form a zygosporangium but usually reproduce asexually.
- C) They are used to make penicillin.
- D) They often form mycorrhizae with forest plants and trees.

Answer: C

Solution: The phylum ascomycota is used for making penicillin.

Problem 7:

Which of the following statements about fungi is FALSE?

- A) The basidiocarp is the fruiting body of the mushroom
- B) The zygomycetes are often bread molds
- C) The conidia and ascus are characteristics of the sac fungi
- D) Club fungi often cause deformities in frogs

Answer: D

Solution: Such deformities are often caused by fungi in phylum chytridiomycota.

Problem 8:

Which of the following statements about fungi is FALSE?

- A) Conidia are associated with asexual reproduction.
- B) Many of the mycotoxins are produced by the sac fungi.
- C) The rusts and smuts affecting plants and vegetables are a type of club fungi.
- D) The mushroom we see and eat is called a basidia.

Answer: D

Solution: The basidiocarp (not basidia) is the fruiting body of the mushroom we see and eat.

Problem 9:

Chytrids were thought to have diverged earliest in fungal evolution. Which of the following characteristics supports this theory the best?

- A) They are mostly aquatic fungi.
- B) They have flagellated spores.
- C) They have cell walls made of chitin.
- D) They can be saprobes or parasites.

Answer: B

Solution: The flagellated spores, often found in the older protist organism, suggest an early divergence in fungal evolution.

Problem 10:

Which of the following statements is/are **NOT** true about fungal hyphae? Select all that apply.

- A) They can spread for large distances underground.
- B) They are predominately diploid.
- C) They may, or may not, have cell walls separating their cells.
- D) Hyphae form the mycelium.

Answer: B, C

Solution: Hyphae are predominately haploid, not diploid, and all hyphal cells are separated by a cell wall made of chitin.

Problem 11:

Fungi obtain nutrients by _____.

- A) bringing food particles into their mouths through phagocytosis
- B) using carbon dioxide as a source of carbon and sunlight as a source of energy.
- C) filtering particles from the soil and using their hyphae to engulf them.
- D) secreting digestive enzymes into the environment and transporting nutrients into their cells.

Answer: D

Solution: Fungi digest their food externally, before absorbing the resulting nutrients.

Problem 12:

The number of chromosomes in a dikaryotic cell is _____.

- A) greater than in a diploid cell
- B) fewer than in a diploid cell
- C) equal to a diploid cell
- D) none of the above

Answer: C

Solution: The dikaryotic cell has two genetically distinct haploid (N) nuclei, which has the equivalent number of chromosomes as a diploid (2N) cell.

Problem 13:

Which of the following statements about fungi is/are true? Select all that apply.

- A) Fungi only use sexual reproduction.
- B) Fungi use meiosis to produce sperm and eggs.
- C) Fungi can undergo sexual and asexual reproduction.
- D) Fungal cells are diploid during most of their life cycle.

Answer: C

Solution: Fungi mainly use asexual reproduction, but can choose to undergo sexual reproduction under stressful conditions. In fungi, meiosis ultimately leads to the formation of spores, not sperm/eggs.

Problem 14:

Most fungi and many bacteria live underground, in the soil. Interestingly, most medical antibiotics and hallucinogenic drugs are derived from fungi. Which of the explanations listed below do you think is the most likely reason that many fungi produce antibiotics?

- A) Because antibiotics reduce bacterial competition for nutrients.
- B) Because antibiotics promote their digestion of food.
- C) Because antibiotics eliminate other fungal competitors for nutrients.
- D) Because antibiotics discourage animal predators.

Answer: A

Solution: Since fungi and bacteria often compete for available nutrients, producing antibiotics would be an effective way for fungi to harm local bacteria and thereby reduce the bacteria's ability to consume any available nutrients.

Problem 15:

In a fungal life cycle, if the number of chromosomes in a diploid nucleus is 10, which one of the following statements is true?

- A) The spores will also be diploid and have 5 chromosomes per cell.
- B) Plasmogamy will produce a dikaryon with 20 chromosomes.
- C) The spores will be haploid and have 10 chromosomes per cell.
- D) The spores will be haploid and have 5 chromosomes per cell.

Answer: D

Solution: Fungal spores are haploid, and have half the number of chromosomes.

Problem 16:

Many of the fungi that have mutualistic relationships with plants also act as predators. These fungi need to trap microscopic animals to supplement their diet. This is because even though the plants supply the fungi with plenty of _____, the plants (and the fungi) have limited access to _____, which they can obtain by trapping and consuming these microscopic animals.

- A) water, nutrients.
- B) carbon, water
- C) carbon dioxide, water.
- D) water, carbon.
- E) carbon, nutrients.

Answer: E

Solution: Fungi depend on plants for their source of carbon, while plants require various nutrients that fungi can assist them in obtaining.

Problem 17:

When pathogenic fungi are found growing on the roots of grape vines, grape farmers sometimes respond by covering the ground around their vines with plastic sheeting and pumping a gaseous fungicide into the soil. The most important concern of grape farmers who engage in this practice should be that the _____.

- A) fungicide might also kill the native yeasts residing on the surfaces of the grapes.
- B) lichens growing on the vines' branches are not harmed.
- C) fungicide might also kill mycorrhizae.
- D) sheeting is transparent so that photosynthesis can continue.

Answer: C

Solution: By killing the pathogenic fungi, the farmers might also inadvertently kill the mycorrhizal fungi that are benefiting the plants growth, and thus ultimately cause harm to the plants themselves.

Problem 18:

In most fungi, karyogamy does not immediately follow plasmogamy, which consequently _____.

- A) means that sexual reproduction can occur in specialized structures
- B) results in multiple diploid nuclei per cell.
- C) allows fungi to reproduce asexually most of the time
- D) results in heterokaryotic or dikaryotic cells.

Answer: D

Solution: Plasmogamy results in the formation of a dikaryon (two haploid nuclei).

Problem 19:

Which is **FALSE** and does **NOT** apply equally well to both sexual and asexual spores?

- A) Asexually produced spores and sexually produced spores both have haploid nuclei.
- B) Asexually produced spores and sexually produced spores both represent the dispersal stage
- C) Asexually produced spores and sexually produced spores both are produced by meiosis
- D) Upon germination, both asexually produced spores and sexually produced spores will subsequently undergo S phase and mitosis

Answer: C

Solution: In fungi, asexual spores are NOT produced by meiosis.