

Introduction to Mycology

Course

Medical
Microbiology

Unit V

Microorganisms

**Essential
Question**

What is
mycology and
how does
fungus affect
people?

TEKS

130.207(c)4B-G

**Prior Student
Learning**

History of
Microbiology
Microorganisms
Antimicrobials
Quality Control

Estimated time

2-4 hours

Rationale

Although most fungi are beneficial to man, some are opportunistic pathogens that cause human disease. The fungi include yeasts and molds that depend upon non-living matter for their nutritional needs (saprophytes). When fungi depend upon other living organisms for food, they cause parasitic infections.

Objectives

Upon completion of this lesson, the student will be able to:

- Identify characteristics of fungi
- Compare and contrast yeast and mold
- Analyze the impact of environmental variables on the growth of yeast

Engage

Before starting this lesson encourage students to bring in food that is molding. Display several samples and begin a discussion on what is causing the fuzzy green and white things. (These are also great specimens to view under the microscope utilizing a scotch tape prep). Then turn the discussion towards our bodies and what fungi can do to humans. Many fungal infections are opportunistic often affecting the immunocompromised population. If your class is new to this idea bring this into the conversation. (i.e., why would harmless mold like on this slice of bread be a threat to someone's life?)

Key Points

- I. Mycology is the study of fungi and fungi are very diverse but generally classified as either yeast or mold. Fungi are eukaryotic so they have a true nucleus and mitochondria. Like plants fungi have a cell wall but it is made of chitin instead of cellulose. They do not possess chlorophyll so they must absorb energy from the environment. They do best with a neutral pH and need moisture to grow.
- II. Yeasts and molds have different structural and reproductive characteristics
 - A. Yeasts are unicellular, nucleated rounded fungi; reproduce by a process called budding with production of a blastoconidium or daughter cell. Yeast produce creamy bacteria-like colony without aerial hyphae.
 - B. Molds are multicellular, filamentous fungi that have a fuzzy or woolly appearance due to the mycelium. Mycelium is made up of many long strands of tube-like structures called hyphae which may be aerial or vegetative. Molds are often identified by microscopic observation so the details of their structures are of note. Hyphae

may be septate or sparsely septate, indicating how often there is a cross-wall between cells. Hyphae are often either hyaline, lightly pigmented, or dematiaceous or darkly pigmented due to melanin in the cell wall.

C. Molds may reproduce sexually or asexually.

1. Asexual reproduction results in the formation of conidia after mitosis by budding from the conidiogenous cells (specialized cells). Asexual reproduction can also be carried out by forming arthroconidia by fragmentation of fertile hyphae. In the clinical lab most molds are identified on the basis of the structures formed as a result of asexual reproduction.
2. Sexual reproduction requires the joining of two compatible nuclei followed by meiosis.

D. Most clinically significant molds are found in four groups of fungi.

1. Zygomycota: Zygomycetes are rapidly growing organisms normally found in the soil that become opportunistic pathogens. May asexually reproduce creating spores in the sporangium (sporangiospores) or sexually creating zygospores. Common examples include: *Mucor*, *Rizopus*, and *Absidia*.
2. Ascomycota: Characterized by the production of sexual spores known as ascospores but usually identified by asexual structures. Common examples include: *Microsporum spp.*, *Trichophyton spp.* and *Pseudallescheria boydii*.
3. Basidiomycota: Only major pathogen is *Filobasidiella neoformans*, the perfect (sexual) form of *Cryptococcus neoformans var. neoformans*.
4. Fungi Imperfecti: Contains the largest number of organisms that are etiologic agents of infections. Organisms are placed in this group when no mode of sexual reproduction has been identified.

E. Dimorphic fungi are those that can exist in two forms. The yeast or tissue state is seen in vivo (life, in patient) or when grown at 37°C. The mold phase is seen when the organism is grown at room temperature or 25°C. Dimorphic species include *Blastomyces dermatitidis*, *Coccidioides immitis*, *Histoplasma capsulatum var. capsulatum*, *Paracoccidioides brasiliensis*, *Sporothrix schenckii* and *Penicillium marneffeii*.

III. Disease states, primarily Mycosis, the growth of a fungus on or in the body

- A. Superficial mycoses are infections confined to the outermost layer of skin or hair. Characteristics include discoloration or depigmentation and scaling of the skin. Fungal species include: *Malassezia furfur*, *Piedria hortae* and *Trichosporon beiglii*.

- B. Cutaneous mycoses are infections affecting the keratinized layer of skin, hair or nails. Signs include itching, scaling, or ring-like patches on skin. Fungal genera include: *Trichophyton*, *Epidermophyton* and *Microsporum* organisms.
 - C. Subcutaneous mycoses involve deeper skin layers including muscle and connective tissue. Characteristics include progressive, non-healing ulcers and presence of draining tracts. Tropical areas have species *Phialophora* spp. and *Cladosporium* spp. *Sporothrix schenckii* may present in a cutaneous form and disseminate into a systemic infection.
 - D. Systemic mycoses are those infections that affect internal organs or deep tissues of the body. The initial site is often the lung where the organism may disseminate via the circulatory system. General symptoms are fever and fatigue or chronic cough and chest pain. Dimorphic species include: *Histoplasma*, *Coccidioides* and *Blastomyces*.
 - E. Opportunistic fungal infections caused by saprobes are becoming more and more common as we have a more diverse immunocompromised population. There are upwards of 24 different species in this category a few examples are: *Alternaria* spp., *Aspergillus* spp., *Curvularia* spp., *Fusarium* spp., *Mucor* spp., *Penicillium* spp., *Syncephalastrum* spp., and *Ulocladium* spp.
 - F. Clinically significant yeasts are differentiated by colony appearance, microscopic stains and carbohydrate assimilation. The most clinically significant yeasts are *Candida albicans* and *Cryptococcus neoformans*.
 - G. Allergic reactions to specific fungal antigens
 - H. Production and action of fungal exotoxins
- IV. Fungi serve both beneficial and harmful purposes in our environment.
- A. Many have been identified as classic pathogens, causing infections when they come in contact with people. Others are only environmental saprobes that can be opportunistic pathogens in that they cause disease in immunocompromised individuals.
 - B. Yeast is used in the preparation of foods like yogurt, bread and cheese.
 - C. Molds are used in the production of cheeses and other foods and also serve an antimicrobial purpose. Molds can also have a negative impact on our food industry.

Activity

- I. Complete the Fungi Laboratory Investigation
- II. Use these digital flash cards to get students familiar with mycology photos: <http://quizlet.com/5109839/mycology-photos-flash-cards/>

Assessment

Laboratory Investigation Rubric

Materials

Pictures of fungi available at: *(note the teacher should preview and chose photos wisely as there are many of actual patient infection sites as well as macro and microscopic fungi)*

<http://www.mycology.adelaide.edu.au/gallery/kaminski/>

Many great photo galleries and multimedia files on each type of fungal infection (there is one key for all multimedia files)

Another helpful site is this one:

<http://www.doctorfungus.org/imageban/index.htm>

There are photo, video and lecture galleries. Really helpful if you need to brush up on your mycology or want to earn CEs.

For the lab:

Prepared slides of pathogenic and non-pathogenic fungi

Microscope

Petri Dishes

Dilute 6.2% iodine solution

India Ink

Slides

Cover Slips

Yeast cake

Inoculating needle

Bunsen burner

Gloves

Laboratory coat or apron

Goggles

Biohazard containers

Surface disinfectant

Paper towels

Accommodations for Learning Differences

For reinforcement, the student will design a poster differentiating characteristics of yeast and mold cell.

For enrichment, the student will research and report on the prevalence of one of the following fungal diseases in the state of Texas, listing factors that affect the incidence of the disease:

- a. Aspergillus
- b. Cryptococcus
- c. Coccidioides
- d. Black mold
- e. Histoplasma

Resources

Mahon, Connie R. and George Manuselis, Textbook of Diagnostic Microbiology. Chapter 23, Medically Significant Fungi. © 2000, W.B. Saunders Company, Philadelphia.

National and State Education Standards**National Health Science Cluster Standards**

HLC01.01 Health care worker will know the academic subject matter required for proficiency within their area. They will use this knowledge as needed in their role. Measurement Criteria: Compare selected diseases/disorders including respective classification(s), causes, diagnoses, therapies and care/rehabilitation to include biotechnological applications.

TEKS

130.207(c)(4)(B) identify the chemical processes of microorganisms

130.207(c)(4)(C) recognize the factors required for microbial reproduction and growth

130.207(c)(4)(D) explain pathogenic and non-pathogenic microbes in the human body

130.207(c)(4)(E) describe the morphology and characteristics of microorganisms using a variety of microbiological techniques

130.207(c)(4)(F) discuss the results of laboratory procedures that are used to identify microorganisms

130.207(c)(4)(G) explain how pathogens affect the human body.

Texas College and Career Readiness Standards

Mathematical Standards IV Statistical Reasoning B. Describe Data 1. Determine types of data, 2. Select and apply appropriate visual representation of data.

Science standards VI Biology 2. Explain in your own words how cells can be categorized into two major cell types: prokaryotic and eukaryotic, and describe major features that distinguish one from the other.

Fungi Laboratory Investigation

Purpose:

In this laboratory investigation, the student will identify characteristics of fungi.

Background Information:

Materials:

Prepared slides of pathogenic and nonpathogenic fungi (yeast and mold)

Microscope

Petri dishes

Dilute 6.2% iodine solution or India ink

Slides

Cover slips

Yeast cake

Inoculating loop

Eye dropper

Bunsen burner

Lab coats

Biohazard container

Surface disinfectant

Paper towels

Gloves

Goggles

Procedure:

1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare work area.
4. Examine and study prepared slides of pathogenic and nonpathogenic fungi noting their structure and the budding. Identify the parts of the yeast cell.
5. Dissolve a portion of yeast cake in warm water in a petri dish and allow to stand overnight at room temperature or warmer.
6. Flame and cool the inoculating loop.
7. Using the loop, place a drop of this mix on a slide and cover with a cover slip. Flame and cool the loop. Examine the yeast cells under the microscope after staining with iodine and India ink.
8. Add a drop of iodine or India ink to the edge of the cover slip to stain the cells.
9. Examine the yeast cells under the microscope.
10. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

Data:

Draw the prepared slides of fungi and identify the parts.

Draw and identify the yeast cells as observed under the microscope.

Conclusion:

1. Compare and contrast yeast and mold cells.
2. Explain how fungi can be differentiated from bacterial cells.
3. Research and describe diseases caused by opportunistic fungi.

Laboratory Investigation Rubric

Student: _____ Date: _____

Scoring Criteria	4 Excellent	3 Good	2 Needs Some Improvement	1 Needs Much Improvement	N/A
Problem is appropriately identified.					
Problem is precise, clear, and relevant.					
Association between the problem and the predicted results is direct and relevant.					
All variables are clearly operationalized.					
Demonstrates comprehension of the use of scientific concepts and vocabulary.					
All significant data is measured.					
Data is recorded effectively and efficiently.					
Data table is well designed to the task requirements.					
All graphs are appropriate.					
All data accurately plotted.					
Graph visually compelling, highlights conclusions of the study.					
Conclusion relates directly to hypothesis.					
Conclusion has relevancy in resolution of the original problem.					
Conclusion relates the study to general interest.					