Action Research Proposal

Plants Get Sick Too--Fungi!!!

The Effect of Hands-on Activities (Identification of Powdery Mildew Fungus) in the Science Classroom on the Achievement Levels of High School Biology 1 Students

CATALySES Sumer Institute

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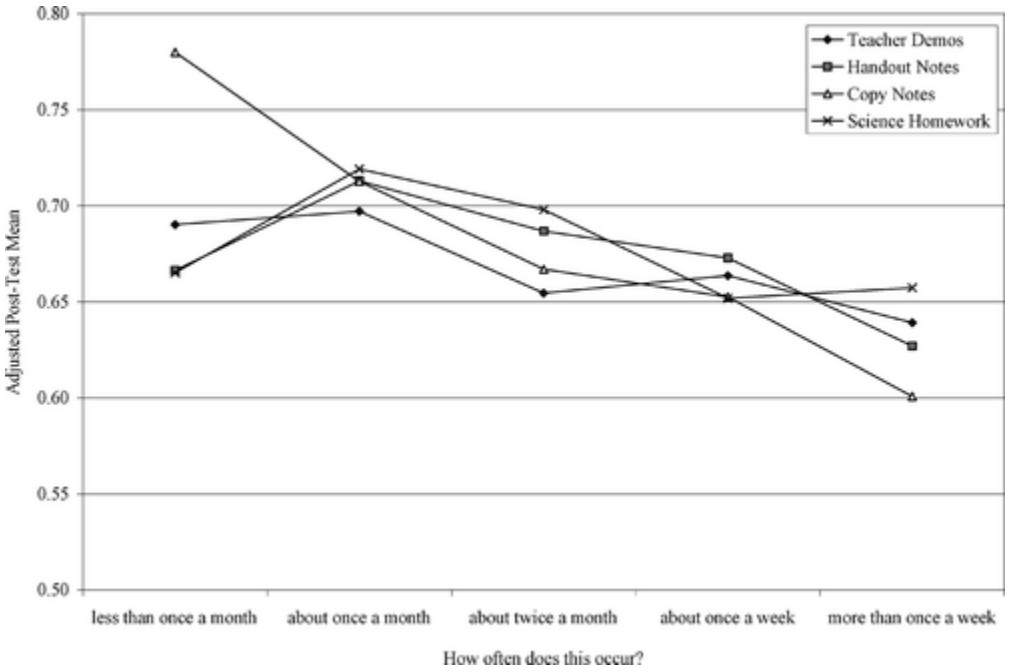
Abstract

This action research proposal will present the findings of the effect hands-on activities have in a blended learning science classroom on the achievement levels of high school biology 1 students. The study will include a unit on Kingdoms using a laboratory exercise on the Identification of Powdery Mildew Fungus (Podosphaera xanthii). The unit will take place during the first nine weeks of the 2018-2019 school year and involve 2 regular, 10th grade Biology students. One class (web based instruction only) will be given the pre-test and post-test only and be considered the control group. The other class will be given the pretest, the Identification of Powdery Mildew Fungus lab as an intervention and then the post test to determine if the intervention increased student knowledge on the Classifying Organisms benchmark. Specifically, if hands-on, inquiry based labs are increased, then student knowledge would also increase. Results will determine pedagogical strategies for the remainder of the school year as shown on the single lesson plan template, through student work samples, and reflection logs.

Keywords: Powdery Mildew, fungus, hands-on, kingdoms, high school

Rationale

The topic of using hands-on instructional practices versus traditional teaching methods, such as lectures and the use of Power Point slides continues to be a debate within schools and counties, and the scientific community, as a whole. The purpose of this study is to explore the relationship among specific instructional practices on high school students' achievement in science. The National Research Council, (NRC, 1995) recommended teachers engage students in active inquiry, which included modeling and guiding scientific attitudes that facilitate learning (Odom, Stoddard, LaNasa, 2007). In particular, classroom practices should support active inquiry with space and resources, where communities of science learners can practice the intellectual rigor and social values conducive to learning science (Odom, Stoddard, LaNasa, 2007). Traditional teaching practices such as copying notes from lecture or learning scientific terms without context provide poor learning opportunities and are inconsistent with NRC(1995) recommendations (Odom, Stoddard, LaNasa, 2007). Furthermore, Ivie (1998) asserts that rote learning, promoted by memorization, may explain the negative association with science homework. According to Simplico (2005), many parents believe their students spend too much time completing tedious, repetitious, and boring homework assignments that have little or no impact on their ability to learn. Tien, Roth, and Kampmeier (2002) found that student-centered learning with peer-led teams improved performance, retention, and attitudes about science. Accordingly, Freedman (1997) reported a strong positive association between laboratory instruction and scores on an objective science knowledge test and student attitudes toward science. He also noted, science laboratory experiences were effective with students of diverse backgrounds who live in large urban areas (Odom, Stoddard, LaNasa, 2007).



-Odom, Stoddard, LaNasa, 2007

Action Research Intervention

There will be an attempt to answer the following question while conducting the research: How do instructional practices affect science achievement as measured by post-test science scores after controlling for pre-test scores? Two of my biology classes will be targeted for data collection. Although data will be recorded from the biology classes, the interventions mentioned for the target classes will also be used for all the other science classes. An important aspect to this action research proposal is to note areas of concerns for my students and implement more hands-on activities throughout the year. The single lesson plan template will serve as a record of strategies tried and those that are implemented throughout the course of the year. The specific labs and hands-on activities should include but not be limited to: Plants Get Sick Too--Fungi!!! The hands-on unit was adapted from The American Phytopathological Society. The plant specimens for the lab which will contain powdery mildew, will be provided by the University of Florida, IFAS Extension Service. The microscopes, microscope slides, coverslips, dissecting needles/single-edge razor blades, clear scotch tape will be provided by Acceleration Academy.

Data Collection and Analyses

Data Collection and Analysis will be done by the use of a pre-test and post-test to assess student knowledge about the concept of the unit Kingdoms and specifically, the characteristics of fungi**. Most of the students in these classes have had little or no laboratory experience.** The pre-test should give a relatively accurate reflection of what they remember about the concept with little to no hands-on experience. After completing the Kingdoms unit, the post test will be given to see if the collaborative, hands-on approach had a positive effect on scores. Statistical analysis will be used to calculate the mean scores within each class and then a comparison will be conducted across the classes. Two, regular level classes of 10th grade biology students will be used. The first group will be given the pre and post-tests with the regular curriculum which includes no hands-on activities for this benchmark and the second group will be given the same pre and post-tests, however, they will be given the additional fungus identification lab after the pre-test and before the post-test.

Connection to CATALySES Sumer Institute

The lab will be done in collaboration with The University of Florida Institute of Food and Agricultural Services (IFAS) Extension. Fresh and dead plant materials containing the Powdery mildew fungus will be provided by IFAS along with other technical support.

References

BrainPOP (1999-2015). FWD Media, Inc. All Rights Reserved.

Freedman, M.P. (1997). Relationship among laboratory instruction, attitude science, and achievement in science knowledge. Journal of Research in Science Teaching Homepage, 34, 343-357

Ivie, S.D. (1998). Asubels Learning Theory: An Approach To Teaching Higher Order Thinking Skill. The High School Journal, 82(1), 35-42.

Odom, A.L., Stoddard, E.R., & LaNasa, S.M. (2007). Teacher practices and middle-school science achievements. International Journal of Science Education, 29(3), 1329-1346.

Simplico, Joseph S.C. (2005). Homework in the 21st Century: The Antiquated and Ineffectual Implementation of a Time Honored Strategy. Education Resources Information Center, 126(1), 138

Tien, T. L., Vicki, R., & Kampmeier, J.A. (2002) Implementation of a Peer-Led Team Learning Instructional Approach in an Undergraduate Organic Chemistry Course. Journal of Research in Science Teaching, 39(7), 606-632.

Identification of Powdery Mildew Fungi anno 2006

Heffer, V., K.B. Johnson, M.L. Powelson, and N. Shishkoff. 2006. Identification of Powdery Mildew Fungi anno 2006. The Plant Health Instructor. DOI: 10.1094/PHI-I-2006-0706-01

Heffer, V., M.L. Powelson, K.B. Johnson, and **N. Shishkoff**. Oregon State University and USDA-ARS

OBJECTIVES:

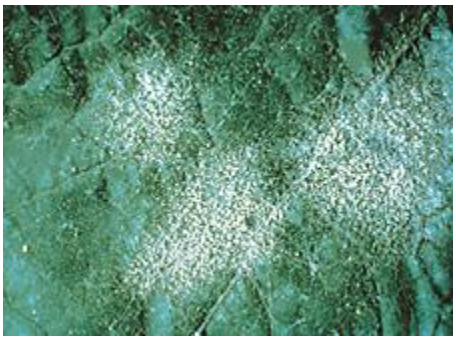
1. To observe powdery mildew diseases.
2. To use characteristics of asexual and sexual fruiting structures on fresh material to identify pathogen to genus.

INTRODUCTION:

Powdery mildew fungi are obligate, biotrophic parasites of the phylum Ascomycota of Kingdom Fungi. The diseases they cause are common, widespread, and easily recognizable. Infection by the fungus is favored by high humidity but not by free water. Individual species of powdery mildew fungi typically have a very narrow host range.

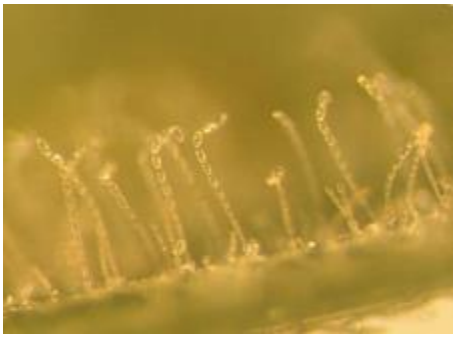
Unlike most fungal pathogens, powdery mildew fungi tend to grow superficially, or **epiphytically**, on plant surfaces. During the growing season, hyphae are produced on both upper and lower leaf surfaces, although some species are restricted to one leaf surface only. Infections can also occur on stems, flowers, or fruit. Specialized absorption cells, termed **haustoria**, extend into the plant epidermal cells to obtain nutrition. While most powdery mildew fungi produce epiphytic mycelium, a few genera produce hyphae that are within the leaf tissue; this is known as **endophytic** growth.

Conidia (asexual spores) are also produced on plant surfaces during the growing season. They develop either singly or in chains on specialized hyphae called **conidiophores**. Conidiophores arise from the epiphytic hyphae, or in the case of endophytic hyphae, the conidiophores emerge through leaf stomata.



Hyphae and conidia of powdery mildew on the surface of a grape leaf. (Courtesy J. Schlesselman)

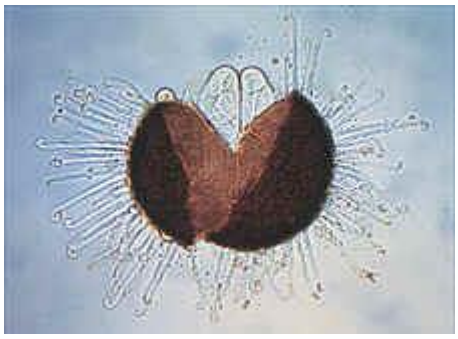
Conidia of powdery mildew in pseudochains, shown in profile. (Courtesy W. Gärtel)



Hyphae and conidia of powdery mildew on the surface of a grape leaf. (Courtesy J. Schlesselman)

At the end of the growing season, powdery mildew fungi produce sexual spores, known as **ascospores**, in a sac-like **ascus** (pl. **asci**) enclosed in a fruiting body called a **chasmothecium** (pl. chasmothecia) (**cleistothecium** is a former term for this structure that is still widely used). The chasmothecium is generally spherical with no natural opening; asci with ascospores are released when a crack develops in the wall of the fruiting body. This type of fruiting body is unique among the Ascomycota. A variety of appendages may occur on the surface of the chasmothecia. These appendages are thought to act like the hooks of Velcro fastener, attaching the fruiting bodies to the host, particularly to the bark of woody plants, where they overwinter.

Epiphytic hyphae and chasmothecia on leaf surface. (Courtesy W. Gärtel)



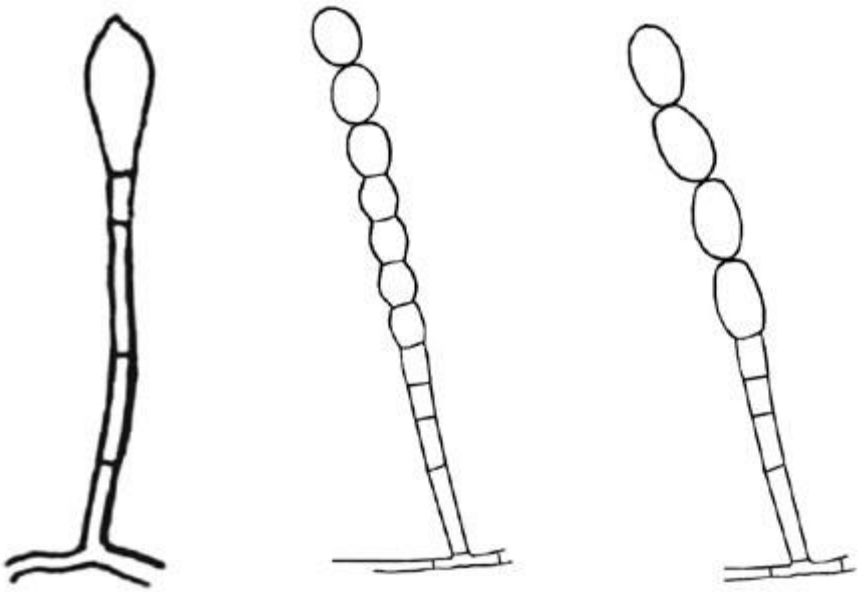
Ruptured chasmothecium showing several asci containing ascospores. *Erysiphe* (Section *Uncinula* sp.) (Courtesy B. Kendrick)

The taxonomy of powdery mildew fungi (order Erysiphales) recently underwent extensive revision based on DNA sequence data. Previously, identification was based largely on the teleomorph (sexual stage) and the morphology of the chasmothecium and its appendages, but the morphology of structure is not as conserved as originally assumed. With the new taxonomy, identification of powdery mildews now also requires attributes of the anamorph (asexual stage), so that it incorporates characteristics of the whole fungus (anamorph plus teleomorph, i.e., the holomorph). Powdery mildew genera are now grouped into five tribes, and some genera have been added or merged. The chart below shows the tribes and some representative genera of each; the previous teleomorphic names (and less commonly used anamorphic names) are given to aid in reference to the older literature.

Tribe	New holomorphic genus	Anamorphic genus	Former teleomorphic genus	Common Hosts

Phyllactineae	*Phyllactinia*	*Ovulariops*	*Phyllactinia*	trees and shrubs
	Leveillula	*Oidiopsis*	*Leveillula*	Solanacae
Erysipheae	*Erysiphe* section *Erysiphe*	*Oidium*	*Erysiphe* section *Erysiphe*	legumes
	Erysiphe section *Microsphaera*	*Oidium*	*Microsphaera*	trees and shrubs
	Erysiphe section *Uncinula*	*Oidium*	*Uncinula*	trees and shrubs
Blumeriae	*Blumeria*	*Oidium*	*Blumeria/Erysiphe*	grasses
Golovinomycetae	*Golovinomyces*	*Oidium*	*Erysiphe* section *Golovinomyces*	cucurbits and composites
Cystotheceae	*Podosphaera* section *Podosphaera*	*Oidium*	*Podosphaera*	Rosaceae
	Podosphaera section *Sphaerotheca*	*Oidium*	*Sphaerotheca*	

A major distinction for identification is whether conidia are produced in chains or singly. However, this distinction can be difficult to observe, and in some genera, particularly in the Erysipheae, conidia that are produced singly can “stick together” to form **pseudochains**, which are not true chains.



conidiophore producing single conidium.

conidiophore producing conidia in true chain.

conidiophore and pseudochain.

Other characteristics that aid in classification are the location of mycelium (epiphytic or endophytic) and host specificity. In addition, the presence of one or several asci in each chasmothecium can also be useful for identification. From a practical perspective, the morphology of chasmothecium appendages remains important as a connection with the older descriptions and references concerned with powdery mildew diseases.

Powdery mildews are polycyclic diseases that can impair photosynthesis, stunt growth, and increase the rate of senescence of host tissue. The diseases they cause may be slight or, in some situations, if left untreated, they may result in severe economic losses on crops such as apples, grapes, cucurbits, and cereals.

MATERIALS

- Fresh and dried plant materials with powdery mildew signs
- Clear scotch tape
- Dissecting needles/ single-edge razor blades
- Microscope slides
- Coverslips

CLICK HERE FOR INSTRUCTOR'S NOTES

PROCEDURES

Asexual stage

With a dissecting microscope, examine the surface of a diseased leaf. Look for the presence of mycelium on the leaf surface (epiphytic growth). Genera that are partially or completely endophytic will show reduced mycelium on the surface of the leaf.

Observe the leaf surface for conidia and conidiophores produced on the plant surface by epiphytic hyphae, or emerging through stomata from endophytic hyphae. Folding a section of the leaf may allow these structures to be more easily observed in profile along the crease.

Using a piece of clear tape (smaller than the microscope slide), hold one end of the tape and lightly smooth the rest of the tape (sticky side down) over the conidia and conidiophores. Place the tape, sticky side down, on a drop of water on the microscope slide. Observe with a compound microscope. Attempt to locate an intact conidiophore with conidia, and determine if the conidia are borne on the conidiophore singly or in chains.

Sexual stage

Examine fresh or dried leaves using a dissecting microscope for small black spherical structures (chasmothecia). Remove several with scotch tape (as above) or with a moistened dissecting needle or razor blade, place them in a drop of water on a microscope slide, and add a coverslip if necessary. If the slide is placed over a white sheet of paper, it is possible to see if you have successfully moved some of the (black) chasmothecia to the drop of water on the slide.

Examine the chasmothecium with a compound microscope. Using the descriptions in the key below, determine the type of appendages present on the surface of the fruiting body. After observing the appendages, press gently on the coverslip or tape with the blunt end of a dissecting needle to break open the fruiting body and allow the asci to be released. Immediately examine microscopically to determine if one or several asci are contained in each chasmothecium.

Use the following key and diagrams of some of the common powdery mildew genera to identify the causal agent to genus. [Note: the section name is generally the genus name in literature published before 2003.]

Key to Genera of Powdery Mildew Fungi

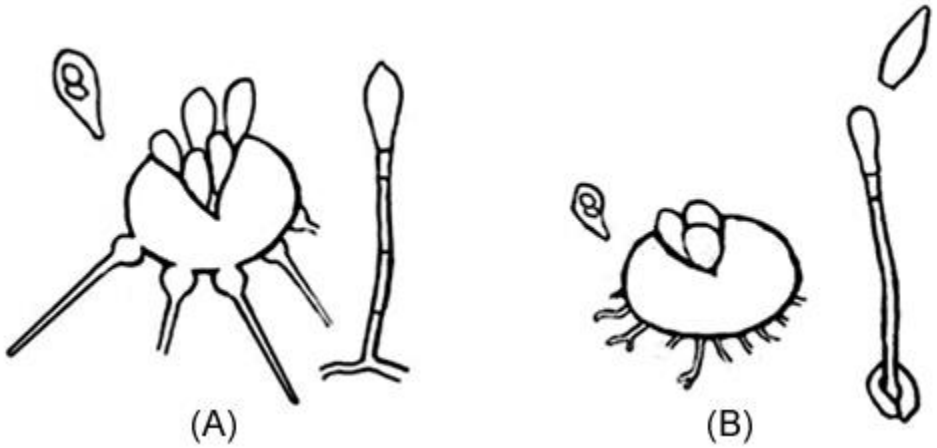
Conidia formed singly

Mycelium partially endophytic

Chasmothecium contains several asci

Appendages straight, bristle-like, with bulb-like base……..…..……..…..…..*Phyllactinia* (A)

Appendages simple, hypha-like……..……..……..……..…..…..…….*Leveillula* (B)



Conidia formed singly (or in pseudochains)

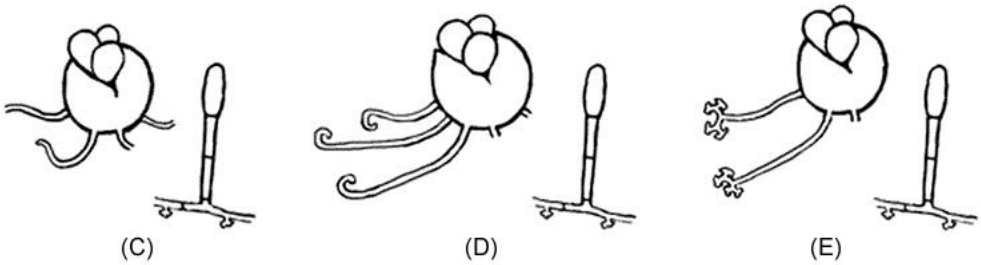
Mycelium epiphytic

Chasmothecium contains several asci

Appendages simple, hypha-like…….....*Erysiphe* (section *Erysiphe*) (C)

Appendages coiled or hooked at tip.....……..…..…*Erysiphe* (section *Uncinula*) (D)

Appendages branched dichotomously at tip..……..…*Erysiphe* (section *Microsphaera*) (E)



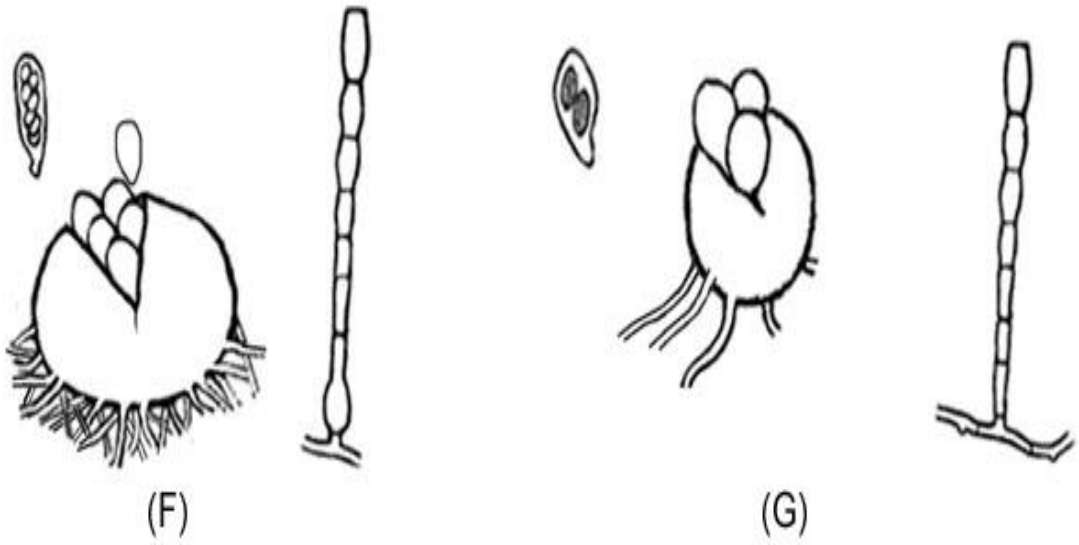
Conidia formed in true chains

Mycelium epiphytic

Chasmothecium contains several asci

Appendages short, simple, hypha-like; infects grasses…..……...……*Blumeria* (F)

Appendages hypha-like, flexuous, simple or irregularly branched; infects dicots…....*Golovinomyces* (G)



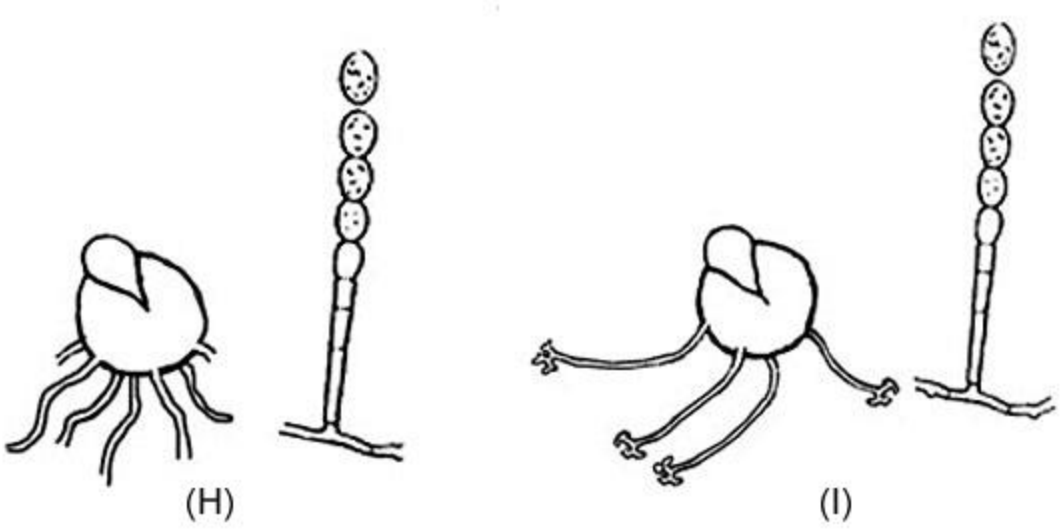
Conidia formed in true chains

Mycelium epiphytic

Chasmothecium contains a single ascus:

Appendages simple, hypha-like……..…..…….…*Podosphaera* (section *Sphaerotheca*) (H)

Appendages bristle-like, branched dichotomously at tip…..…...*Podosphaera* (section *Podosphaera*) (I)



(LAB SHEETS TO BE PRINTED AND FILLED OUT BY STUDENTS)
Click here to print Lab Sheets from a separate page

OBSERVATIONS

Diagram the conidiophores and conidia seen on the diseased leaf.

In the table below, record the location of conidiophores, the type of conidia formation, the number of asci per chasmothecium, and a description of the appendages found on the chasmothecium. Using this information, determine the pathogen genus for each powdery mildew.

Plant host	Conidiophores (arising from epiphytic hyphae or emerging through stomata)	Conidia formation (singly, or in chains)	# of asci per chasmothecium (one or several)	Appendage morphology	Pathogen genus

CONCLUSIONS AND QUESTIONS

1. What physiological functions of the plant are impaired by powdery mildew fungi?
2. What is the function of the chasmothecium in the disease cycle?
3. What is the function of the conidia in the disease cycle?
4. Why are fungal pathogens frequently assigned to more than one genera? Why is the generic name based on the holomorph (whole fungus) concept important in the powdery mildews?
5. Speculate as to why free water on the surface of a plant might be unfavorable to a powdery mildew pathogen.

Lesson Plan
Submitted by: Amine Brown
Email: abrown@accelerationacademy.org
School: Acceleration Academies
Date: June 29, 2018

Grade Level: 10, 11
Subject(s):
Science/Biology
Duration: 45 minutes
Description: This lesson will be used as a part of a unit on kingdoms. Students learn about the characteristics of fungi.

SSS Standards :

SC.6.L.15.1: Analyze and describe how and why organisms are classified according to shared characteristics with emphasis on the Linnaean system combined with the concept of Domains.

SC.7.N.1.6:Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.

SC.8.N.1.6: Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence. Students will also have knowledge on differentiating Prokaryotes and Eukaryotes.

Objectives:

- Students will be able to distinguish a mushroom from a plant.
- Student will be able to identify the defining characteristics of fungi.
- Students will be able to identify the four main groups of fungi.
- Students will be able to describe the problems that parasitic fungi cause.

Materials:

- mushrooms
- food samples: bread, fruit, vegetables, potato chips, etc.
- water
- Petri dishes
- Quiz

Vocabulary: *Chitin* – Complex carbohydrate that makes up the cell wall.

Procedure:

Inquiry Activity: (10 min)

Examine a mushroom without damaging it. Carefully separate the stalk and cap of the mushroom. Try to break the stalk across and lengthwise. Crumble a piece of the stalk. Describe the shape of the parts that make up the stalk. Break the cap in two and examine the thin sheets on the underside of the cap.

Ask students whether they think mushrooms should be classified as plants, as they once were. What are all the different kinds of fungi you can think of? (Many students will mention molds, yeasts, morels, and mushrooms sold in groceries. Some might also mention rusts, mildew, and lichens.)

Lecture Notes – Characteristics of Fungi: (10 min),

- Chitin – A complex carbohydrate that makes up the cell wall; it is also found in the external skeletons of insects.
- Heterotrophs depend on other organisms for food.
- Except for yeast, all fungi are multicellular.
- The bodies of multicellular fungi are composed of many hyphae tangled together into a thick mass called a mycelium.
- What do you think is the function of the fruiting body, the part of the mushroom you see above ground?
    - The fruiting body is a reproductive structure that develops from a mycelium that grows beneath the surface of the ground.
- There are many kinds of Fungi. Two main kinds are Molds and Mushrooms.
    - *Molds* – Prefer to grow in warm, moist places; produce spore cases called sporangia; hyphae grow down into food releasing enzymes which digest the food and permit it to be absorbed.
    - *Mushrooms* – 3 Types: Mushroom, Puffball, Bracket
      Some are parasitic, but most live on dead/decaying matter; release enzymes that digest organic matter; some are edible.

Lab Activity: (10 min)

Divide students into lab groups. Give each group a different food sample (bread, fruit, vegetables, potato chips, etc.). Have students dampen the food with water and expose it to the air for the rest of the day. Place samples in a warm, dark place for 2-3 days. Have students observe and make drawings of any mold that grows on their samples. Ask students to compare their observations.

Lecture Notes: (10-15 min)

Classification of Fungi

- Zygomycetes have life cycles that include a zygospore.
- The phylum Ascomycota is named for the ascus, a reproductive structure that contains spores.
- The phylum Basidiomycota, or club fungi, gets its name from the basidium, a specialized reproductive structure that resembles a club.
- Deuteromycota is an extremely varied phylum. It is composed of those fungi that are not placed in other phyla because researchers have never been able to observe a sexual phase in their life cycles.

Ecology of Fungi

- Fungi are found in every ecosystem, where they recycle nutrients by breaking down the bodies of other organisms.
- Parasitic fungi cause serious plant and animal diseases. A few fungi cause diseases in humans.
- Some fungi form symbiotic relationships in which both partners benefit. Example: lichens and mycorrhizae.

Assessment: See Quiz listed in **Materials**.

Useful Internet Resources:

* Natural Perspective: Fungus Kingdom
http://www.perspective.com/nature/fungi/
* Fun Facts about Fungi Catalog
http://www.herb.lsa.umich.edu/kidpage/
* Fact Sheet: Stachybotrys
http://hlunix.hl.state.ut.us/els/epidemiology/envepi/eep_stac.html
* Ananova
http://www.ananova.com/news/story/sm_707270.html
* Science News
http://www.findarticles.com/cf_dls/m1200/12_157/61793399/p1/article.jhtml
* MSN Learning and Research: Fungus
http://encarta.msn.com/encnet/refpages/refarticle.aspx?refid=761551534
* Life Science Safari – Fungus
http://vilenski.org/science/safari/fungus/fungus.html