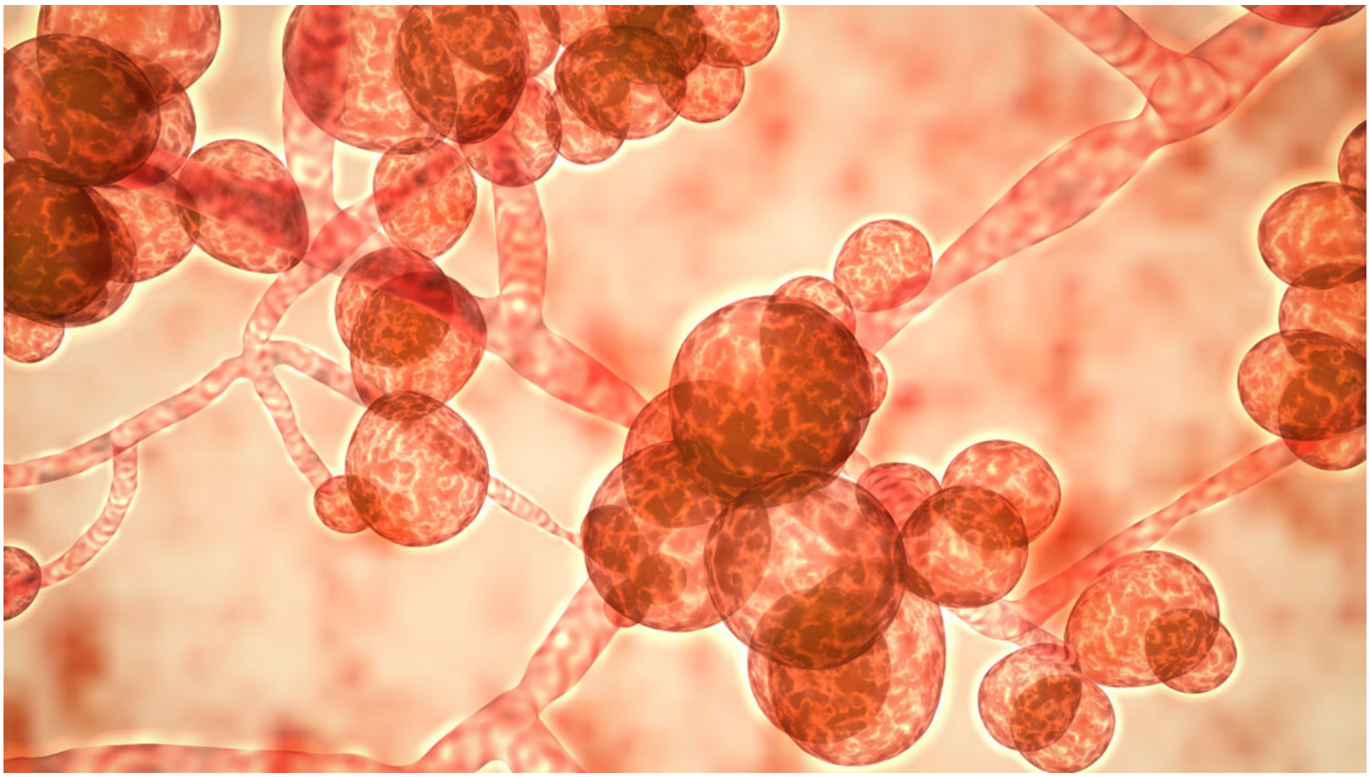
Science News

EDUCATOR GUIDE



DR_MICROBE/iStock/Getty Images Plus

September 14, 2019

Fungal Infections and Climate Change

SOCIETY FOR SCIENCE & THE PUBLIC

September 14, 2019

Fungal Infections and Climate Change

About this Guide

This guide, based on the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species is already a threat," asks students to use the claims, evidence, reasoning model to evaluate a scientific viewpoint and the simulate and analyze the spread of an infection.

This Guide includes:

Article-Based Comprehension Q&A — These questions, based on the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species is already a threat," Readability: 12.5, ask students to think about an emerging fungal infection and how it might be related to climate change. Related standards include NGSS-DCI: HS-LS2, HS-LS3, HS-LS4, HS-ESS3.

> **Student Comprehension Worksheet —** These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — These discussion prompts ask students to evaluate a scientific argument using the claim, evidence, reasoning model. Related standards include NGSS-DCI: HS-LS2, HS-LS3, HS-LS4, HS-ESS3, HS-ETS1.

> **Student Discussion Worksheet —** These questions are formatted so it's easy to print them out as a worksheet.

Activity: Your Nose is Running

> **Summary:** Students will practice making predictions and drawing conclusions. The activity will help students understand how infections spread, especially among organisms living in close proximity. Related standards include NGSS-DCI: HS-LS2, HS-LS3, HS-ETS1.
>
> **Approximate class time:** One class period for the activity and one class period for background research.

September 14, 2019

Fungal Infections and Climate Change

Article-Based Comprehension, Q&A

Directions for teachers: After your students read "Climate change may raise the risk of deadly fungal infections in humans. One species is already a threat," ask them to answer the following questions.

1. What fungal species has recently been found to infect people? (Take notice and use the correct format for writing the name of a species.) When and where did infectious versions of the fungus appear?

Candida auris, or *C. auris*. Infectious strains arose between 2012 and 2015 in Africa, Asia and South America. In the United States, officials began reporting cases of *C. auris* infections in 2016. More than 30 other countries have also reported cases of *C. auris* infections.

2. What makes scientists think the fungus wasn't spread by infected travelers? Explain the scientists' reasoning.

The strains in Africa, Asia and South America were genetically distinct. If travelers were transporting the fungus from one place to another, the genetics would reveal a closer relationship among the fungi.

3. Why have humans and other mammals largely been spared from infections by fungi?

In addition to powerful immune systems that fight off invaders, mammals have body temperatures that are too high for most fungi to replicate.

4. Who is Arturo Casadevall? What is his hypothesis for how the fungus became infectious in humans? What role does he think climate change has played?

Arturo Casadevall is a microbiologist at Johns Hopkins Bloomberg School of Public Health. He thinks that as the climate warms, the fungus may have adapted to warming temperatures in its natural environment. That may have given some strains of *C. auris* the ability to tolerate humans' average body temperature of 37° Celsius, allowing those strains to replicate in and thus infect people.

5. Why are infections of this fungus a threat to people?

The fungus can infect the blood, brain, heart and other parts of the body and some infections can be fatal. Some strains of the fungus are resistant to antifungal medications.

6. How does Casadevall predict other fungi will react to a warmer world?

Other fungi in the wild may similarly adapt to warmer temperatures. He predicts that some species will adapt the ability to withstand humans' body temperature, making the fungi potential threats.

7. People have historically used soapboxes as informal platforms to stand on while giving speeches. Why do you think *Science News* has included this article in a category of story labeled "Soapbox"?

The story is labeled "Soapbox" because Casadevall is sharing his viewpoint on an important issue. Rather than presenting only the scientific evidence, he is using evidence to make an argument that fungi are poised to become a threat to humans as the climate changes. That argument is not yet fully tested or supported.

8. Aside from reporting Casadevall's viewpoint, what information does *Science News* journalist Aimee Cunningham provide about the fungus and other fungal diseases?

The article includes the data about the number of confirmed cases of *C. auris* in the United States. Cunningham also highlights other animals and plants affected by fungal diseases, including frogs, snakes, bats and trees.

SN EDUCATOR GUIDE

September 14, 2019

Fungal Infections and Climate Change

Student Comprehension Worksheet

Directions: After reading "Climate change may raise the risk of deadly fungal infections in humans. One species is already a threat," answer the following questions.

1. What fungal species has recently been found to infect people? (Take notice and use the correct format for writing the name of a species.) When and where did infectious versions of the fungus appear?

2. What makes scientists think the fungus wasn't spread by infected travelers? Explain the scientists' reasoning.

3. Why have humans and other mammals largely been spared from infections by fungi?

4. Who is Arturo Casadevall? What is his hypothesis for how the fungus became infectious in humans? What role does he think climate change has played?

5. Why are infections of this fungus a threat to people?

6. How does Casadevall predict other fungi will react to a warmer world?

7. People have historically used soapboxes as informal platforms to stand on while giving speeches. Why do you think *Science News* has included this article in a category of story labeled "Soapbox"?

8. Aside from reporting Casadevall's viewpoint, what information does *Science News* journalist Aimee Cunningham provide about the fungus and other fungal diseases?

SN EDUCATOR GUIDE

September 14, 2019

Fungal Infections and Climate Change

Cross-curricular Discussion, Q&A

Directions for teachers: At the end of scientific or engineering investigations, a claim or conclusion is made about the question or problem explored. A successful claim is supported by sound, relevant evidence and reasoning that clearly links the evidence to the claim based on known scientific concepts.

This discussion will focus on identifying and evaluating a claim, evidence and reasoning reported in the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species already is a threat." The article presents the view of a group of scientists that fungi in a warming world will pose a greater danger to people. Either for homework or in class, ask students to read the *Science News* article and split students into groups. If needed, review the concepts of the claims, evidence, reasoning model and let students discuss and answer the first set of questions. Then give students your preferred claim, evidence, reasoning rubric (you can find one online by searching "claim, evidence, reasoning rubric"), and let them explore this U.S. Centers for Disease Control and Prevention webpage to answer the second set of questions and create a claim of their own. Finally, if time permits in class or for homework, have students apply the questions to a *Science News* article of their choice.

For more educator resources on critical analysis, check out the June 8, 2019 educator guide, "Just the facts."

Directions for students:

Identify: Use the article to discuss and answer the following questions.

1. A claim is an assertion of something as a fact, which may or may not be supported by evidence. What is one scientific claim made by the scientists as described by the article?

Candida auris *is emerging as a new fungal disease with the help of climate change.*

2. Claims often serve as answers to questions. What scientific question might the scientists' claim attempt to answer?

Why does pathogenic versions of C. auris *now have the ability to replicate inside people?*

3. Evidence is the scientific data that are given to support a claim. What information does the article give as evidence?

The genetic differences of pathogenic strains found on different continents. The year U.S. infections were first reported and the number of infections since then. The number of countries that have reported cases. A note about an experiment where other fungi have been coaxed to grow in warmer laboratory conditions.

4. Reasoning is the explanation of why the evidence supports the claim. What reasoning is given in the article?

There are a few statements of reasoning that loosely relate the evidence back to the scientists' claim. One is that because the infectious C. auris *strains on different continents are not closely related genetically, infected travelers couldn't have spread the fungus.*

Rate and revise: Along with the questions below, use the claims, evidence and reasoning rubric provided by your teacher to analyze and rate the scientific argument reported in the article. Next, explore the Centers for Disease Control and Prevention's webpage titled "General Information about *Candida auris*" to suggest a new claim that can be adequately supported with evidence and reasoning.

1. How well does the claim answer the scientific question you identified? Explain your reasoning and rate the claim using the rubric provided.

The claim may be a plausible explanation for the scientific question. If similar environmental conditions due to climate change existed on the different continents where infectious strains appeared, those strains may have independently gained the ability to thrive in warmer conditions. Ratings will vary depending on the rubric used.

2. Does the evidence provided do an adequate job of supporting the claim scientifically? Why or why not? Rate the evidence using the rubric provided.

The evidence given weakly supports the claim. Lab-based experiments provide some evidence that a fungus can adapt to grow in warmer conditions. But the findings are not fully explained, and the evidence does not conclusively prove the claim or rule out alternate claims. Ratings will vary depending on the rubric used.

3. Does the reasoning clearly link the evidence to the claim using known scientific principles? Explain and highlight any missing links in the reasoning. Rate the reasoning using the rubric provided.

No. Though the claim is based on sufficient scientific principles in genetics, reasoning that links the emergence of the fungal disease to climate change is not fully supported by the evidence. The scientists reason that C. auris *has proliferated in humans because it has become tolerant of warmer temperatures but does not provide evidence that this tolerance is due to climate change. Ratings will vary depending on the rubric used.*

4. Are there other plausible claims that could explain the scientific question you identified? Explain, and give an example.

Yes. Variations of C. auris *may have become tolerant to the average human body temperature from an environmental factor that was not directly related to climate change, or from an error that occurred during DNA replication that offered an advantage.*

5. What additional evidence could be given or explored to support the claim?

Shifts in temperature and other environmental factors due to climate change should be documented in affected countries. Other data on how fungi grow in warmer laboratory conditions should be collected, and the genetic profiles of these fungi should be explored.

6. What types of scientific background knowledge would be useful to further explore the scientists' claim?

Knowledge of genetics, mycology, climatology and human physiology would all be useful fields to further explore the scientists' claim.

7. Based on your answers above and the information provided on the CDC website titled "General Information about *Candida auris*," write a new claim and make a statement of evidence and reasoning.

Claim: The number of U.S. cases of C. auris *infections will continue to increase.*
Evidence: The CDC reports that C. auris *is multidrug resistant, difficult to identify using standard laboratory methods and causes outbreaks in hospital settings. The number of confirmed cases of* C. auris *infections in the United States has increased since 2016.*
Reasoning: Due to the lack of prevention and treatment measures as outlined by the CDC,
C. auris *will likely continue to spread, which will lead to more infected people.*

Compare: Select a news article of your choice from the *Science News* archive, read it and review it using the prompts above. Then compare the news article with the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species already is a threat." Note that the story is categorized as a "soapbox." Soapboxes have historically been used as informal platforms to stand on while giving speeches.

1. Explain the similarities and differences of the scientific explanation given in each article. How do you think this relates to how the articles are labeled?

Student answers will vary. Students that compare the Soapbox article with a news story might note that the Soapbox presents a hypothesis or viewpoint whereas the news story presents a scientific finding. The Soapbox article is labeled as such because it serves as a platform for scientists to present their hypothesis. While the hypothesis may be well-educated and argued based on special knowledge and existing evidence, it has not yet been tested.

September 14, 2019

Fungal Infections and Climate Change

Student Discussion Worksheet

Directions: At the end of every scientific or engineering investigation, a claim or conclusion is made about the question or problem explored. A successful claim is supported by sound, relevant evidence and reasoning that clearly links the evidence to the claim based on known scientific concepts.

This discussion will focus on identifying and evaluating the claim, evidence and reasoning reported in the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species already is a threat." Read the article and split into groups. Discuss then answer the first set of questions provided within your group. Next, use the rubric provided by your teacher and answer the second set of questions to evaluate the scientists' argument. Finally, check out this Centers for Disease Control and Prevention webpage and create a new claim supported by evidence and reasoning. If instructed to do so by your teacher, apply the questions to a *Science News* article of your choice.

Identify: Use the article to discuss and answer the following questions.

1. A claim is an assertion of something as a fact, which may or may not be supported by evidence. What is one scientific claim made by the scientists as described by the article?

2. Claims often serve as answers to questions. What scientific question might the scientists' claim attempt to answer?

3. Evidence is the scientific data that are given to support a claim. What information does the article give as evidence?

4. Reasoning is the explanation of why the evidence supports the claim. What reasoning is given in the article?

Rate and revise: Along with the questions below, use the claims, evidence and reasoning rubric provided by your teacher to analyze and rate the scientific argument reported in the article. Next, explore the Centers for Disease Control and Prevention's webpage titled "General Information about *Candida auris*" to suggest a new claim that can be adequately supported with evidence and reasoning.

1. How well does the claim answer the scientific question you identified? Explain your reasoning and rate the claim using the rubric provided.

2. Does the evidence provided do an adequate job of supporting the claim scientifically? Why or why not? Rate the evidence using the rubric provided.

3. Does the reasoning clearly link the evidence to the claim using known scientific principles? Explain and highlight any missing links in the reasoning. Rate the reasoning using the rubric provided.

4. Are there other plausible claims that could explain the scientific question you identified? Explain, and give an example.

5. What additional evidence could be given or explored to support the claim?

6. What types of scientific background knowledge would be useful to further explore the scientists' claim?

7. Based on your answers above and the information provided on the CDC website titled "General Information about *Candida auris*," write a new claim and make a statement of evidence and reasoning.

Compare: Select a news article of your choice from the *Science News* archive, read it and review it using the prompts above. Then compare the news article with the *Science News* article "Climate change may raise the risk of deadly fungal infections in humans. One species already is a threat." Note that the story is categorized as a "soapbox." Soapboxes have historically been used as informal platforms to stand on while giving speeches.

1. Explain the similarities and differences of the scientific explanation given in each article. How do you think this relates to how the articles are labeled?

SN
EDUCATOR GUIDE

September 14, 2019

Fungal Infections and Climate Change

Activity Guide for Teachers: Your Nose is Running

Purpose: Students will practice making predictions and drawing conclusions. The activity will help students understand how infections spread, especially among organisms living in close proximity.

Procedural overview: In this activity, students will simulate the transmission of an infectious disease through a population. Students will research one infectious disease in plants or animals (white-nose syndrome in bats is used as an example) and draw connections between that disease and the simulated transmission.

Approximate class time: One class period to complete the activity questions, activity and analysis. One class period for research.

Supplies:
Test tubes (one for each student)
Test tube racks (enough to display all the test tubes)
Pipettes with bulbs or droppers
Safety goggles
Nitrile gloves
1 M Silver nitrate
1 M Sodium chloride
Water
Internet access or materials for background research on an infectious disease of your or your students' choice

Directions for teachers:

In this activity, students will research an infectious disease in a plant or animal population (white-nose syndrome in bats is used as an example) and then perform an experiment to show how an infected individual can infect the rest of the population. As potentially harmful chemicals will be present, it is important for students and the teacher to wear safety goggles and gloves at all times during the experiment.

Before starting the activity, students should search the *Science News* or *Science News for Students* archive for an article describing the spread of an infectious disease within a plant or animal population. They can use that article as a starting point for additional research. This can be done with a partner in class or as homework.

Alternatively, you can provide students with the research materials for an infectious disease of your choice. If you choose to use white-nose syndrome, the *Science News for Students* article "New treatment offers hope for bats battling white nose syndrome" and Figure 1 of the primary research study "Environment, host, and fungal traits predict continental-scale white-nose syndrome in bats" would be a good starting place. You can send the students to computers, use a projector to display the article or distribute printouts depending on your classroom needs. After their research, students should answer the questions provided.

Before the simulation begins, the teacher should number test tubes so there are enough for each student in the class to have one. Fill all but one of the test tubes half full with water, and fill the last test tube half full with the sodium chloride solution. Record which test tube contains the saltwater and save this information for later. Place all of the test tubes in racks at the front of the room, so all students may select one test tube at random after they have completed their research and answered the accompanying questions.

Then, explain to students that all of the test tubes in the racks contain plain water except one, which has a solution of sodium chloride and water (aka saltwater), and that the saltwater will form a precipitate in the presence of silver nitrate. Each student will obtain one of the test tubes, and together they will perform a group experiment in three rounds. During each round, each student will exchange half of the liquid in his or her tube with half of the liquid from one other student in the class. Then, the students will find new partners for the next round. The students should record the number from each test tube with which they exchange their liquid.

After the third round of exchanges, the students will replace their test tubes in the racks at the front of the room. The teacher will place a couple of drops of silver nitrate into each of the test tubes and inform the class which test tubes form a precipitate. In the table provided, each student will record whether his or her test tube formed a precipitate and which of the test tubes he or she exchanged liquids with formed a precipitate.

After the simulated transmission, students will answer questions about the simulation and draw connections to the infection they researched.

Directions for students:

Disease research

Follow your teacher's instructions to do background research on an infectious disease in plants or animals. Think about what causes the disease, how it is spread and how it affects the organisms it infects. Use your research to answer the following questions:

1. What causes the infectious disease you researched?

Student answers may vary, but those who researched white-nose syndrome may describe that white-nose syndrome is caused by a fungus called Pseudogymnoascus destructans *that invades the skin of hibernating bats, including their wings. It causes bats to wake up more frequently during winter hibernation, using up their limited fat reserves very rapidly.*

2. What environmental conditions are needed for the disease you researched to thrive?

Student answers will vary as each infectious disease has its own set of environmental conditions under which it thrives. Many of these microbes are temperature sensitive, so extreme heat is not suitable. Additionally, areas that are too cold may prevent the infections from thriving. For white-nose syndrome, hibernating bats lower their body temperatures and the caves where the bats hibernate are cold and humid, an environment where the fungus thrives.

3. How is the disease you researched spread?

Student answers will vary, but most infectious diseases are spread through direct contact with an organism that currently has the disease, or through some form of external transmission, such as through the air or through water. For white-nose syndrome, when bats hibernate for the winter, they are living in close quarters for a long time. Just as humans who stay inside together at school or work during the winter often share colds, bats that are close to each other can share white-nose syndrome.

4. What are the symptoms of the infectious disease you researched?

Student answers will vary, but those who investigated white-nose syndrome should discuss the white growths that appear on the snout of the animals. These growths tend to spread across the bat's face.

5. Is there a cure for the infectious disease you researched?

Student answers will vary, but those who investigated white-nose syndrome should suggest that scientists have tried antifungal and antibacterial methods to cure the disease, but with little success. How a disease is treated depends on what causes it. If it is bacterial, then antibiotics could help kill it. If it is viral, then there are ways to treat the symptoms, but usually no way to eliminate the virus.

Disease spread

When your teacher instructs you to do so, put on your safety goggles and gloves and collect one of the test tubes provided; record your test tube number in the table below. One of the test tubes contains a solution of sodium chloride and water (aka saltwater) and will form a precipitate when a reagent, silver nitrate, is added. The rest contain water. During each round of the experiment, you will find a student in the class who has not yet been your partner and using your pipette or dropper exchange half of the liquid in your test tube for half of the liquid in his or her test tube. Repeat this process for three rounds. After the third round of exchanges, place your test tube in the rack at the front of the room. The teacher will then add silver nitrate to each tube and inform the class which test tubes form a precipitate.

Record in the table provided the number of your test tube, the test tubes you exchanged liquid with, and which test tubes formed precipitates at the end of the experiment.

	Test tube number	Did the test tube form a precipitate?
My test tube		
Round 1 Exchanged with:		
Round 2 Exchanged with:		
Round 3 Exchanged with:		
All test tubes that formed precipitates:		

Compare the data you collected with other students in the class. See if you can determine which test tube was the original one that held the saltwater.

Data analysis

6. At the end of the first round of the experiment, how many test tubes have saltwater?

There are two test tubes with saltwater after Round 1: the original test tube and the one that tube exchanged liquid with.

7. At the end of the second round of the experiment, how many test tubes contain saltwater?

There are four test tubes with saltwater after Round 2: the original test tube and the one that tube exchanged liquid with during Round 1, plus the tubes each exchanged with during Round 2.

8. What is the maximum number of test tubes that could contain saltwater at the end of Round 3 of the experiment? What percentage of the class would this be?

*The maximum number would be eight: the four tubes with saltwater at the end of Round 2, plus the four tubes those four exchanged liquid with during Round 3. This is (8/[total student body] * 100) percent of the class.*

9. What equation can model the maximum rate at which the test tubes can become contaminated with saltwater, if everyone exchanges n times?

maximum rate of test tube contamination = 2^n

10. How many of the test tubes in <u>your</u> class contained saltwater by the end of the activity? What percentage of the class's test tubes is this?

Student answers will vary depending on with which tubes exchanged liquid; students should record up to eight test tubes and up to 100 percent.

11. Why might the number of test tubes containing saltwater in your classroom be different than the maximum number you calculated in question eight?

In later rounds of the experiment, test tubes with saltwater can exchange liquid with other test tubes with saltwater, rather than with tubes with regular water. This would reduce the number of tubes that saltwater would spread to.

12. How could you determine which test tube was the one that originally contained saltwater?

By mapping out which test tubes exchanged liquids at each step and which test tubes formed the precipitate at the end. Any test tube that did not have saltwater at the end must have only exchanged with freshwater test tubes for every round. For instance, if Test Tube No. 1 has freshwater at the end, that means that every test tube it exchanged with in any given round must have had freshwater in that round, even if it ended up with saltwater in the end. Mapping out which test tubes had freshwater at each step in this manner would help narrow down the possible original saltwater test tube.

13. How does this activity relate to the spread of the infectious disease you researched?

The activity showed how just one infected organism can pass the disease across the population through some form of contact. As the infected individuals come into contact with others, they are likely to spread the disease. The more contact there is between individuals, the greater the infection rate. With white-nose syndrome, the bats live and hibernate together in large colonies. This means the rate of infection is quite high.

14. Based on the research you have done, what factor(s) could affect the spread of an infectious disease?

Many infectious agents are temperature sensitive, so areas that are warmer or colder than the pathogen's usual habitat may limit its survival and thus its spread. Additionally, living things usually have some form of defense against invading pathogens. Mammals, like bats, have an immune system that attempts to fight off the disease. Plants also produce chemicals that can impact a pathogen's ability to infect its host.

15. What is the likelihood of surviving or dying from the infectious disease you researched?

Answers will vary depending on the disease, but the survival rate of bats with white-nose syndrome can be between just 0 and 10 percent of the population once infected.

Bonus questions

16. Climate change is increasing global temperatures, both on land and in the oceans. How might climate change affect the future spread of the infectious disease you researched?

Increased temperatures might be causing various fungi and other organisms to adapt to higher temperatures. Many of these infectious organisms have been temperature sensitive, meaning they do not survive at higher temperatures. As the planet warms, and the infectious organisms adapt, the range of heat tolerance may also increase. The carriers for diseases may also change their ranges. For example, a disease like malaria that is currently limited to the hot, humid areas of the tropics could make its way into higher latitudes as the ranges of the mosquitoes that carry it expand. Other factors like changing patterns of drought and flooding might also affect the spread of infectious diseases.

17. What can science do to help prevent the spread of infectious diseases?

Answers will vary but might include a discussion of working to slow, decrease or reverse climate change. Students should also discuss the development of vaccines to prevent the spread of diseases or treatments to prevent the growth of infectious agents, including those based on genetic research. For white-nose syndrome, this might include research into using bacteria to help treat the disease.

SN EDUCATOR GUIDE

September 14, 2019

Fungal Infections and Climate Change

Activity Guide for Students: Your Nose is Running

Directions:

Disease research

Follow your teacher's instructions to do background research on an infectious disease in plants or animals. Think about what causes the disease, how it is spread and how it affects the organisms it infects. Use your research to answer the following questions:

1. What causes the infectious disease you researched?

2. What environmental conditions are needed for the disease you researched to thrive?

3. How is the disease you researched spread?

4. What are the symptoms of the infectious disease you researched?

5. Is there a cure for the infectious disease you researched?

Disease spread

When your teacher instructs you to do so, put on your safety goggles and gloves and collect one of the test tubes provided; record your test tube number in the table below. One of the test tubes contains a solution of sodium chloride and water (aka saltwater) and will form a precipitate when a reagent, silver nitrate, is added. The rest contain water. During each round of the experiment, you will find a student in the class who has not yet been your partner and using your pipette or dropper exchange half of the liquid in your test tube for half of the liquid in his or her test tube. Repeat this process for three rounds. After the third round of exchanges, place your test tube in the rack at the front of the room. The teacher will then add silver nitrate to each tube and inform the class which test tubes form a precipitate.

Record in the table provided the number of your test tube, the test tubes you exchanged liquid with, and which test tubes formed precipitates at the end of the experiment.

	Test tube number	Did the test tube form a precipitate?
My test tube		
Round 1 Exchanged with:		
Round 2 Exchanged with:		
Round 3 Exchanged with:		
All test tubes that formed precipitates:		

Compare the data you collected with other students in the class. See if you can determine which test tube was the original one that held the saltwater.

Data analysis

6. At the end of the first round of the experiment, how many test tubes have saltwater?

7. At the end of the second round of the experiment, how many test tubes contain saltwater?

8. What is the maximum number of test tubes that could contain saltwater at the end of Round 3 of the experiment? What percentage of the class would this be?

9. What equation can model the maximum rate at which the test tubes can become contaminated with saltwater, if everyone exchanges n times?

10. How many of the test tubes in <u>your</u> class contained saltwater by the end of the activity? What percentage of the class's test tubes is this?

11. Why might the number of test tubes containing saltwater in your classroom be different than the maximum number you calculated in question eight?

12. How could you determine which test tube was the one that originally contained saltwater?

13. How does this activity relate to the spread of the infectious disease you researched?

14. Based on the research you have done, what factor(s) could affect the spread of an infectious disease?

15. What is the likelihood of surviving or dying from the infectious disease you researched?

Bonus questions

16. Climate change is increasing global temperatures, both on land and in the oceans. How might climate change affect the future spread of the infectious disease you researched?

17. What can science do to help prevent the spread of infectious diseases?