What Are Infectious Diseases?

A Look at Illnesses Around the World

COVID HACKS

Healthy Actions • Community
Knowledge • Science

FOR GRADES 9–12

OVERVIEW

Students will conduct research using online text resources and media related to infectious and non-infectious diseases and compare the prevalence of different diseases across countries with different income levels. Students will apply COVID-19 information from the World Health Organization to learn how disease spread is monitored and compare the status of different countries.

LEARNING OBJECTIVE

After completing the unit, students will be able to:
- Explain what an infectious disease is
- Describe the types of diseases that cause the most deaths worldwide
- Explain how a country's income level relates to the types of diseases most common in that country

SCIENCE, HEALTH AND MATH SKILLS

- Comparing and contrasting
- Interpreting information
- Communicating

NGSS SCIENCE AND ENGINEERING PRACTICES

- Analyzing and interpreting data
- Obtaining, evaluating and communicating information

COMMON CORE STANDARDS FOR ENGLISH LANGUAGE ARTS

- ELA-LITERACY.RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- ELA-LITERACY.RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

TIME

- 2 class periods

MATERIALS FOR SCIENCE INVESTIGATION

Teachers
- What Are Infectious Diseases? Slide Deck (www.bioedonline.org)

Students
- Student Research Guide (digital or paper)
- Device with internet access

SET UP AND TEACHING TIPS

This activity can be introduced during one classroom period and completed during the next time you meet with students. Use the accompanying slides to guide a discussion of students' independent research using informational texts and media.

PROCEDURE

◼ ENGAGE AND EXPLORE

1. Tell students that they are going to learn what an infectious disease is and how infectious diseases impact mortality (human death) around the world.

2. Ask students to complete the "What Are Infectious Diseases" Student Activity Sheet before the next class.

◼ EXPLAIN

3. Use the accompanying slides to review what students learned from their activity sheet explorations. If students raise a question for which you do not have an answer, have them add it to a "what I want to know" list. You can suggest a possible online source, such as the Centers for Disease Control and Prevention (CDC) or World Health Organization (WHO), which might provide the information.

NOTE: Slide 4 is optional. If you want to include a formal evaluation with this activity, you may choose to hide the slide and use it afterward with students as an assessment.

SLIDE 2

What is an infectious disease?

- Merriam-Webster dictionary defines "disease" as "a condition of the living animal or plant body or of one of its parts that impairs normal functioning and is typically manifested by distinguishing signs and symptoms."[1]
- Diseases can be "communicable" or "non-communicable."
- Communicable diseases result from the passing of a pathogen (an infectious agent, such as a bacterium, virus, fungi, or parasite) from an infected individual to another individual or group.[2]
- Well-known communicable diseases include tuberculosis, influenza (flu), and strep throat.
- Some communicable diseases, called "zoonotic" diseases, can pass from animals to humans.
- Non-communicable diseases do not pass directly from one person to another. Examples include diabetes, Alzheimer's disease, Parkinson's disease, osteoarthritis, and most cancers. Non-communicable diseases often are "chronic," lasting a year or more and requiring ongoing medical attention.[3]
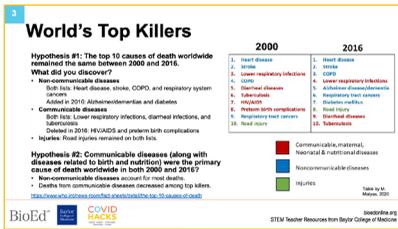
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1   Merriam Webster. Disease. https://www.merriam-webster.com/dictionary/disease.
2   Wikipedia. Disease. https://en.wikipedia.org/wiki/Disease.
3   Centers for Disease Control and Prevention. About Chronic Diseases. https://www.cdc.gov/chronicdisease/about/index.html.
    Centers for Disease Control and Prevention. Zoonotic Diseases. https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html.
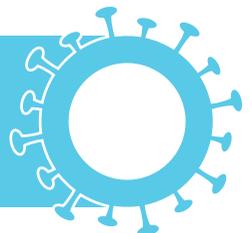
World's top killers

- What are the top killers, the deadliest diseases, in the world?
- The World Health Organization (WHO) collects global data each year to learn how many people in different countries have certain diseases, and how many deaths each disease causes.
- The WHO have a numbering system to categorize every type of disease and health condition, and they receive reports from nearly every country to track global health problems.
- You viewed WHO graphs of the top 10 causes of death in 2010 and 2016 to learn if there were any changes over this 16-year period.
- The main categories of diseases were:

  Communicable, maternal, neonatal, and nutritional conditions; non-communicable diseases; injuries.

- Hypothesis #1 stated that the top 10 causes of death worldwide remained the same between 2000 and 2016. What did you learn?

  Non-communicable diseases: ischemic heart disease, stroke, COPD, and respiratory system cancers were on both lists, but by 2016, Alzheimer's and other dementias, along with diabetes, became top causes of death.
  Communicable diseases: lower respiratory infections, diarrheal infections and tuberculosis were on both lists, but by 2016, HIV/AIDS and preterm birth complications were no longer among the top 10 causes of death.
  Injuries: road injuries remained on both lists.

- Hypothesis #2: Communicable diseases (along with diseases related to birth and nutrition) were the primary cause of death worldwide in both 2000 and 2016.

  Far more deaths are attributed to non-communicable diseases (e.g., heart disease, stroke, and COPD) than to respiratory diseases. However, there were fewer deaths from communicable diseases in 2016 than in 2000.

Diseases can be "communicable" or "non-communicable." Communicable diseases result from the passing of a pathogen (an infectious agent, such as a bacterium, virus, fungi, or parasite) from an infected individual to another individual or group. Non-communicable diseases do not pass directly from one person to another.

SLIDE 4

Does Money Make a Difference?

[Slide content showing Hypothesis #3 with a table titled "Country Income, 2016" with columns for Low, Lower middle, Upper middle, High income groups, categorizing diseases by communicable, noncommunicable, maternal/neonatal/nutritional, and injuries.]

Does money make a difference?
- Hypothesis #3: The primary causes of death in 2016 were not related to the income level of the country.
- What were your conclusions?

  In general, as the overall income of a country increases, noncommunicable diseases are more likely to be the cause of death. In poorer countries, communicable diseases contribute more to mortality.
  Three causes of death were in the top 10 in all country income groups: heart disease, stroke, and lower respiratory infections.

- If you were in charge of national medical resources and public health, what would be your top priorities to reduce the death rate in countries of each income type, based on what you learned?
- COVID-19 is a lower respiratory infection. Which group(s) of countries might you expect to see especially hard hit by the COVID-19 pandemic, and why?

  Poorer countries might be hit hard because they don't have as many resources to deal with a pandemic. However, they deal with a lot of infectious diseases cases and may have proportionally more medical personnel trained for infectious diseases treatment.
  Wealthier countries have more resources, but since most deaths in those countries are due to non-communicable diseases, their medical facilities, supplies, and staff may be more focused on those diseases.

SLIDE 5

Why Are the Causes of Death Changing?

[Slide content with images and bullet points about life expectancy and causes of death.]

Why are the causes of death changing?
- In 1900, US citizens lived to an average age of 47.3 years.
- Primary causes of death were communicable disease: pneumonia, influenza, tuberculosis, diphtheria, smallpox, pertussis (whooping cough), and typhoid fever.
- Vaccinations, improved hygiene, and antibiotics all played a role in changing this.
- Since 1924, vaccines have prevented 40 million cases of diphtheria, 35 million cases of measles, and 103 million cases of childhood diseases.
- As of 2014, life expectancy in the US is 78.7 years.
- In the US, primary causes of death are heart disease, stroke, and cancer.[4]

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[4] Rappuoli, R., Pizza, M., Del Giudice, G., & De Gregorio, E. (2014). Vaccines, New Opportunities for a New Society. Proceedings of the National Academy of Sciences of the United States of America, 111(34):12288–12293.

Why do we get new infectious diseases?
- Pandemics of infectious diseases have been recorded in history as far back as 450 BC, when the "Plague of Athens" killed 100,000 people.
- The Black Death (Yersinia pestis) killed half of the world's population in 541 AD, and a quarter of world's population in the 1340s.
- Tuberculosis became a pandemic in the Middle Ages (1500 AD) and killed millions.
- Smallpox killed millions after it was brought to the New World by European explorers.
- The 1918 Spanish influenza killed approximately 50 million worldwide, including 675,000 in the US.
- In the last 50 years, the world has experienced pandemics and near-pandemics of Ebola, HIV-AIDS, SARS, H1N1 "swine flu", and mosquito-borne viruses (Zika virus and Chikungunya).

Some infectious diseases move from animal populations (where they may not be as deadly) to humans through animal-human contact. Ebola and coronaviruses are examples.
Some infectious disease viruses mutate frequently, preventing the human immune system developing lasting protection ("immunity"). Influenza is an example.
Finally, changing human behaviors have had a major impact on disease spread. Exploration and work in areas that were previously inaccessible brings humans into first or regular contact with novel creatures, microbes, and viruses. Second, easy access to worldwide travel often enables contagious diseases to spread quickly and before the public health community recognizes the disease and its spread.

The COVID-19 Pandemic
- An "epidemic" is the sudden increase in cases of an infectious disease in an area or country. When a disease spreads to several countries and affects large number of people, it is called "pandemic."[5]
- The World Health Organization (WHO) tracks epidemic and pandemic cases by country, as you learned from your Activity Sheet exercise.
- What could you learn from looking at "total cases" in different countries?
- Which metric (total cases, or total cases per 1 million people) do you think is a better measure, and why?
- It depends on what other questions you want to answer. If you want to know which countries will need a vaccine and how many doses they will need, you need to know the total population, the number of cases, and where those cases are concentrated. If you want to know whether the strategies used by different countries are working, you may want to look at the total cases per million people.
- For example, China was able to keep the number of COVID-19 cases relatively low. But most countries would not use the same methods as China did, such as putting extreme limits on travel and prohibiting people from leaving their homes for periods of time, even to walk their dogs.

5   Centers for Disease Control and Prevention. Identifying the Source of the Outbreak. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/about-epidemiology/identifying-source-outbreak.html.

■ EVALUATE

4. Have students use three additional graphs on the WHO website (https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death) to determine whether the most common causes of death around the world are influenced by a country's affluence (overall income levels). Results are provided below and on Slide 4 (described above).

1. Conduct a discussion with students about ways in which they can maintain their social contacts but remain physically distant. Accept all answers. Possibilities include seeing others outdoors at a safe distance or meeting using video calls or conferencing.

- Using the table that you created, what evidence do you see to support or disprove Hypothesis #3?
- What is/are your conclusion(s)?
- What three causes of death were in the top-10 in all country income groups?
- If you were in charge of national medical resources and public health, what would be your top priorities to reduce the death rate in countries of each income group, based on what you learned?
  - **a.** Low-income countries
  - **b.** Lower-middle income countries
  - **c.** Upper-middle income countries
  - **d.** High-income countries
- COVID-19 is a lower respiratory infection. Which group(s) of countries might you expect to see especially hard hit by the COVID-19 pandemic and why

CAUSE GROUP	DISEASE	LOW	LOWER-MIDDLE	UPPER-MIDDLE	HIGH
			Country Income (2016)		
Non-Communicable	Alzheimer & Other Dementias			X	X
	Breast Cancer				X
	Chronic Obstructive Pulmonary Disease (COPD)		X	X	X
	Cirrhosis of the Liver		X		
	Colon & Rectum Cancers				X
	Diabetes Mellitus		X	X	X
	Ischaemic Heart Disease	X	X	X	X
	Kidney Diseases				X
	Liver Cancer			X	
	Stomach Cancer			X	
	Stroke	X	X	X	X
	Trachea, Bronchus, & Lung Cancers			X	X
Communicable, Maternal, Neonatal, & Nutritional	Birth Asphyxia & Birth Trauma	X			
	Diarrheal Diseases	X	X		
	HIV/AIDS	X			
	Lower Respiratory Infections	X	X	X	X
	Malaria	X			
	Preterm Birth Complications	X	X		
	Tuberculosis	X	X		
Injuries	Road injury	X	X	X	

COVID HEALTHY ACTIONS, COMMUNITY KNOWLEDGE AND SCIENCE

■ A SCIENCE-BASED CURRICULUM FOR THE COVID-19 PANDEMIC

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What Are Infectious Diseases? Student Research Guide

COVID HACKS

Healthy Actions • Community
Knowledge • Science

LEARNING OBJECTIVES

After completing this activity, you will be able to:

- Explain what an infectious disease is
- Describe the types of diseases that cause the most deaths worldwide
- Explain how a country's income level relates to the types of diseases most common in that country

ENGAGE

What is a disease? Merriam-Webster dictionary defines "disease" as "a condition of the living animal or plant body or of one of its parts that impairs normal functioning and is typically manifested by distinguishing signs and symptoms."[1] Diseases can be "communicable" or "non-communicable." Communicable or infectious diseases result from the passing of a pathogen (an infectious agent, such as a bacterium, virus, fungi, or parasite) from an infected individual to another individual or group.[2] The disease can spread directly or indirectly through air, surfaces, food, water or other organisms (such as insects). Examples of communicable diseases include tuberculosis, influenza (flu), malaria and strep throat. Some communicable diseases, called "zoonotic" diseases, can pass from animals to humans. Non-communicable diseases do not pass directly from one person to another. Examples include diabetes, Alzheimer's disease, Parkinson's disease, osteoarthritis, and most cancers. Non-communicable diseases often are "chronic," lasting a year or more and requiring ongoing medical attention.[3]

Which diseases have been the deadliest? That depends on the **time period** being studied. The World Health Organization (WHO) collects data from around the world each year to learn how many people in different countries have certain diseases, and how many deaths each disease causes. Go to https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death and examine three hypotheses.

When you evaluate a hypothesis, you should look for evidence that either supports or does not support the hypothesis statement.

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1 Merriam Webster. Disease. https://www.merriam-webster.com/dictionary/disease.

2 Wikipedia. Disease. https://en.wikipedia.org/wiki/Disease.

3 Centers for Disease Control and Prevention. About Chronic Diseases. https://www.cdc.gov/chronicdisease/about/index.html.
Centers for Disease Control and Prevention. Zoonotic Diseases. https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html.

1. **HYPOTHESIS #1**
   The top 10 causes of death worldwide remained the same between 2000 and 2016.
   - Data sources: Graphs "Top 10 global causes of death, 2000" and "Top 10 global causes of death, 2016."
     a. *What evidence do you see to support or disprove Hypothesis #1?*

     b. *What is your conclusion?*

2. **HYPOTHESIS #2**
   Communicable diseases (along with diseases related to birth and nutrition) were the primary cause of death worldwide in both 2000 and 2016.
   - Data sources: Graphs "Top 10 global causes of death, 2000" and "Top 10 global causes of death, 2016."
     a. *What evidence do you see to support or disprove Hypothesis #2?*

     b. *What is your conclusion?*

EXPLORE

Let's look at COVID-19, an infectious disease causing a worldwide pandemic.
Go to the WHO Coronavirus Disease (COVID-19) Dashboard at https://covid19.who.int/.

1. At the top is a map of the world showing current COVID-19 cases. If you roll your mouse over each country, you will see a pop-up list for the country, showing the number of confirmed cases and the number of deaths. List three countries that have more than 300,000 total cases of COVID-19.

2. Let's compare the US and Australia.
   - *How many total cases have there been in the US?*

   - *How many total cases have there been in Australia?*

   - *Is Australia or the U.S. doing a better job at limiting the spread of COVID-19?*
     (Justify your answer.)

3. *Do total cases per country tell the whole story?*
On the left side of the graph, there are boxes that you can click to select "Cases" or "Deaths." Below that is a dropdown menu, from which you can select "Total." Click on the dropdown and select "Total per 1 million population."
- *How many confirmed cases are there in the U.S. per 1 million people?*

- *How many confirmed cases are there in Australia per 1 million people?*

- *Based on this information, which country is doing a better job at limiting the spread of COVID-19?*

- *Which metric (total cases or total cases per 1 million people) do you think is a better measure? Why?*

EVALUATE

In the Engage activity you did earlier, you found that the most common causes of death around the world have changed over time.

Are causes of death also influenced by the income levels where we live?
Go to https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death and test one more hypothesis.

1. **HYPOTHESIS #3**
The primary causes of death in 2016 were not related to the income level of the country.
- Data sources: Refer to the following graphs:
    a. "Top 10 global causes of death in low-income countries in 2016"
    b. "Top 10 global causes of death in lower-middle-income countries in 2016"
    c. "Top 10 global causes of death in upper-middle-income countries in 2016"
    d. "Top 10 global causes of death in high-income countries in 2016"

- Use the table below to record whether each disease was a top-10 cause of death in countries of each income group. Place an "X" where a disease is a cause. Leave the box blank if the disease is not a top-10 cause.

CAUSE GROUP	DISEASE	LOW	LOWER-MIDDLE	UPPER-MIDDLE	HIGH
Non-Communicable	Alzheimer & Other Dementias				
	Breast Cancer				
	Chronic Obstructive Pulmonary Disease (COPD)				
	Cirrhosis of the Liver				
	Colon & Rectum Cancers				
	Diabetes Mellitus				
	Ischaemic Heart Disease				
	Kidney Diseases				
	Liver Cancer				
	Stomach Cancer				
	Stroke				
	Trachea, Bronchus, Lung Cancers				
Communicable, Maternal, Neonatal, & Nutritional	Birth Asphyxia & Birth Trauma				
	Diarrheal Diseases				
	HIV/AIDS				
	Lower Respiratory Infections				
	Malaria				
	Preterm Birth Complications				
	Tuberculosis				
Injuries	Road Injury				

Note: "Country Income (2016)" spans the LOW, LOWER-MIDDLE, UPPER-MIDDLE, and HIGH columns.

- *Using the table that you created, what evidence do you see to support or disprove Hypothesis #3?*

- *What is/are your conclusion(s)?*

- *What three causes of death were in the top 10 in all country income groups?*

- If you were in charge of national medical resources and public health, *What would be your top priorities to reduce the death rate in countries of each income group, based on what you learned?*
  a. Low-income countries:

  b. Lower-middle income countries:

  c. Upper-middle income countries:

  d. High income countries:

- COVID-19 is a lower respiratory infection. *Which group(s) of countries might you expect to see especially hard hit by the COVID-19 pandemic? Why?*