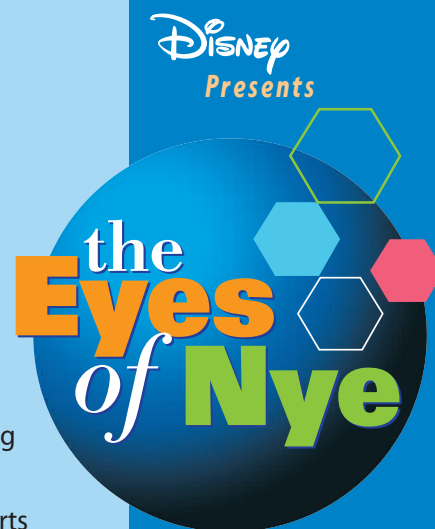


Antibiotics: Man vs. Microbe

For six seasons, millions of students came to understand, appreciate and enjoy the exploration of science through the series, *Bill Nye the Science Guy*. Bill returns with *The Eyes of Nye*, a more in-depth look at science subjects making news, changing lives, and impacting policy. From the future of alternate fuel sources and genetic engineering to population growth trends and issues of race, Bill and his expert cohorts bring science to life right in your classroom, helping you **Motivate** investigation; **Assess** available information; and **Propose** lines of argumentation.



This Educator's Guide includes:

- An **Introduction** that clearly defines the subject and offers an overview of the issue objectives of the guide; how it relates to science from both a social and personal perspective; as well as pertinent questions and insights regarding the topic.
- A listing of all **National Science Education Standards Addressed**.
- Detailed procedures highlighted in the MAP Framework (**Motivate, Assess, Propose**).
- Illustrative **Video Clips** from *The Eyes Of Nye* DVDs with pinpoint chapter cues.
- **Web Site Resources** to help students further investigate and locate research, charts, data as well as experts featured in the program material.
- Easily downloadable **Support Materials** that include articles, transparencies, charts, and much more.

Introduction:

"Antibiotics" refers to chemical substances that have the capacity to destroy or inhibit the growth of bacteria. They are used chiefly in the treatment of infectious diseases. *The Eyes of Nye - Antibiotics: Man vs. Microbe* presents a background of infectious disease trends and the effect of antibiotics on those trends, conditions that contribute to those effects, and the decisions we face and solutions we seek as a result.

The issue of antibiotic use is a growing global concern, and one that is not an "all or none" proposition. The questions posed in *Antibiotics* and the objective of this teacher guide—gaining an understanding of the reasons, possible solutions, and future directions the problem may take—help students prepare for what will surely continue to be a major issue throughout at least a large portion of their lives. The issue also constitutes an excellent example of the never-ending impact of science on technological progress and vice-versa, the

Check the **MAP Teaching and Learning Framework** to explore the phases (motivate, assess, and propose) used in this guide.

scientific significance of our past historical experiences, and our place as humans in our ecosystem and the larger environment.

National Science Education Standards Addressed

Science As Inquiry

- Abilities necessary to do scientific inquiry
 - Identify questions and concepts that guide scientific investigations
 - Recognize and analyze alternative explanations and models
- Understanding about scientific inquiry

Life Science

- The cell
- Biological evolution
- The interdependence of organisms

Science and Technology

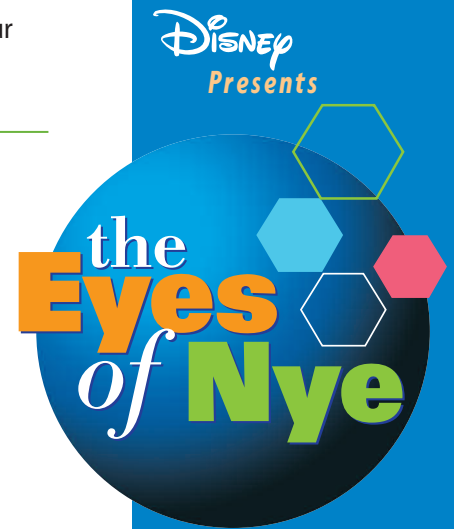
- Understandings about science and technology

Science in Personal and Social Perspectives

- Personal and community health
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science

- Science as a human endeavor
 - Nature of scientific knowledge
 - Historical perspectives
-



On the DVD:

Antibiotics: Man vs. Microbe – Chapters

Chapter 1: Antibiotics Preview

Beginning through 1:52

Ends with title screen.

Chapter 2: Historical Perspectives on Disease and Antibiotics

1:15—7:23

Ends with Bill's reference to antibiotics being "the same drug that used to kill them."

Chapter 3: Antibiotics and Resistance

7:24—10:45

Ends with Dr. Tenover saying, "There is no antibiotic in use for which we have no resistance."

Chapter 4: New Directions in Diagnosis and Treatment

10:45—16:39

Ends with the close of Bill's interview with Dr. Margaret Riley saying, "That's the master plan."

Chapter 5: Curbing Environmental Abuse

16:39 through end of program.

Starts with posted data from the Union of Concerned Scientists.

Antibiotics: Man vs. Microbe – Activity Clips

The Black Plague

1:15—3:27

(referenced in Educator's Guide step 1)

Ends at close of medieval skit.

The Advent of Antibiotics: A Solution and a Problem

3:27—7:23

(referenced in Educator's Guide step 2)

Ends with Bill's reference to antibiotics being "the same drug that used to kill them."

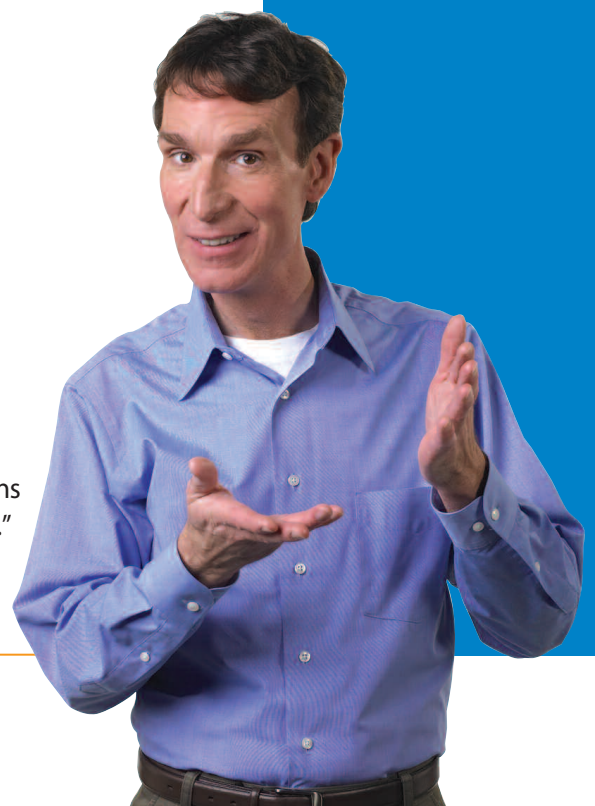
Antibiotics and Bacteria: The Mutual Acquaintance

7:23—8:49

(referenced in Educator's Guide step 3)

Demonstrates the effect of the antibiotics on bacteria and ends with the response of the bacteria—CDC data on the rise of antibiotic-resistant strains of streptococcus pneumoniae displayed after Bill says, "That's the problem."

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Research on Antibiotic-Resistant Bacteria

8:52—10:45

(referenced in Educator's Guide step 6)

Ends with Dr. Tenover saying, "There is no antibiotic in use for which we have no resistance."

Bacteria vs. Virus

11:35—12:46

(referenced in Educator's Guide step 7)

Skit on talk show with antibiotic guest.

Cues from Nature: New Treatments for New Needs

18:13—20:43

(referenced in Educator's Guide step 7)

Starts with Bill in the grocery store talking about overuse of antibiotics in farming and so forth, and ends with him saying there are antibiotics all throughout our environment, and that we can change the world "even on a smaller, more personal scale."

Procedure: Motivate Phase

- 1) Play **"The Black Plague"** to engage students with the nature of infectious disease and the dangers they pose. Ask students to suggest some characteristics (rapid transmittal, modes of infection, deadliness), possible contributing causes (unsanitary conditions, lack of understanding or respect for scientific or medical solutions), and measures we could take to combat the spread of a similar disease. Students may have noticed the references in the skit to washing hands and use of a bloody knife when the medieval barber performed medical procedures.
- 2) Ask students what else we could do to combat infectious disease. Based on past experiences students may suggest ideas related to medical advances, or more directly, use of medicines or antibiotics. Play **"The Advent of Antibiotics: A Solution and a Problem."** Note the quote of the 1969 U.S. Surgeon General, "We have won the war on infectious disease." Ask students, "Was infectious disease defeated?" Students are aware that disease was not defeated, but upon asking *why*, they will have little response. Discuss the data implying that bacteria have recently begun to become resistant to the presence of antibiotics. Ask students if we should have listened to the Surgeon General and believed in the "victory of antibiotics" as we were encouraged to do. In response to "no," ask what the price is of not listening—point out the social attitudes prevalent in the

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the
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of Nye

For historical
options that
engage students,
go to
eyesofnye.org



time of the Plague. Discuss the importance of recognizing the value we derive from the advancement of science through introduction of new technologies such as those we have witnessed in the medical health field, and though these often result in new problems, problems themselves are often motivating forces that precipitate new solutions. A case in point is the delay in the use of penicillin from its development until World War II, when dire circumstances forced it into service.

- 3) To those who replied “yes” (we *should* have listened), ask what price we pay for not seeking additional understanding. Reiterate the notions that social conditions often drive development of new knowledge and that we (societies) are the final arbitrator of decisions that have tremendous impact on new advances that in turn have lasting effects on science and society. Ask students if, given the importance of their role, a “no” or “yes” answer is sufficient, and if not, what else we must ask. Play **“Antibiotics and Bacteria: The Mutual Acquaintance”** to demonstrate the effect of antibiotics on bacteria, hear a summary statement of the problem—bacteria are now mutating faster than antibiotics can kill them—and reinforce the impending danger through the data display depicting the rise of antibiotic-resistant strains of *Streptococcus pneumoniae*. Lead students through a brief discussion of our “need-to-know” about the scientific causes of infectious disease, the means by which disease-causing organisms develop resistance, and the possible solutions to this dilemma that might exist. Pose the broad question, “Should we restrict the ways in which we use antibiotics, and if so, how?” Generate with students at least two scientific and one social question (possibilities follow) that warrant consideration and investigation.

Potential scientific questions:

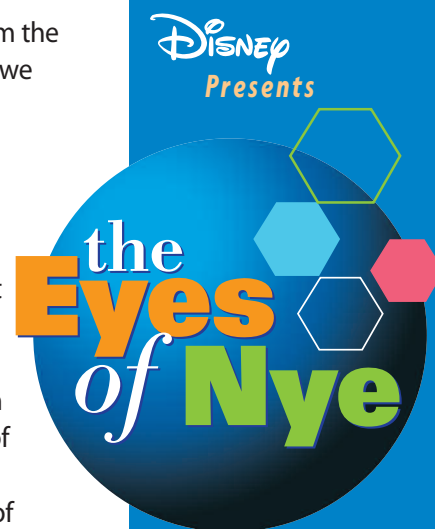
- a) Are antibiotics becoming less successful? Why or why not?
- b) What can possibly be done about it scientifically and technologically?

Potential social/scientific question:

- c) How do we decide on the use or non-use of antibiotics for people and communities, and what factors must we consider in making this decision?

Procedure: Assess Phase

- 4) Recall the demonstration of the effect of the antibiotic on bacteria. Remind students of the brief mention of the antibiotic’s effect on the cell wall of bacteria. Explain that this wall shields the internal structures of a bacterium from the external environment. When the cell wall is destroyed so is the bacterium. Recall, however, that bacteria can also change—increasing the thickness of its cell wall, for instance—and therefore develop strains that are resistant to the antibiotic being used. Explain that this is often accomplished through a biological phenomenon akin to “selection” in which those best suited for survival under certain conditions have the advantage. Illustrate the concept of bacterial selection using the transparency T-BS (see sidebar), describing our body as a type of “ecosystem” where all organisms compete for a finite set of resources. Not only does a strain of bacteria that survives an antibiotic live to do more damage, but



See **The Eyes
of Nye**
Issue Support
**Bacterial
Selection**

is also aided by the depletion of other bacteria and multiplies to fill the void left by those that have been destroyed.

Illustrate the process of bacterial selection that occurs through the use of typical "broad spectrum" antibiotics. You may choose to contrast this with the effect of newer "narrow spectrum" antibiotics now or wait until the latter are addressed in step 11.

Teacher Note: The study of bacteria and antibiotic resistance involves the use of many terms that are often used interchangeably (for instance, antibacterial and antimicrobial), especially in the normal dialogue of specialists to whom the terms are common. Though you should remain consistent in your choice of terms during early stages of students' exposure, questions will still arise as well as the need (as at several points in this guide) to compare or contrast certain terms. Use the glossary provided.

See *The Eyes of Nye* Issue Support [Glossary](#)

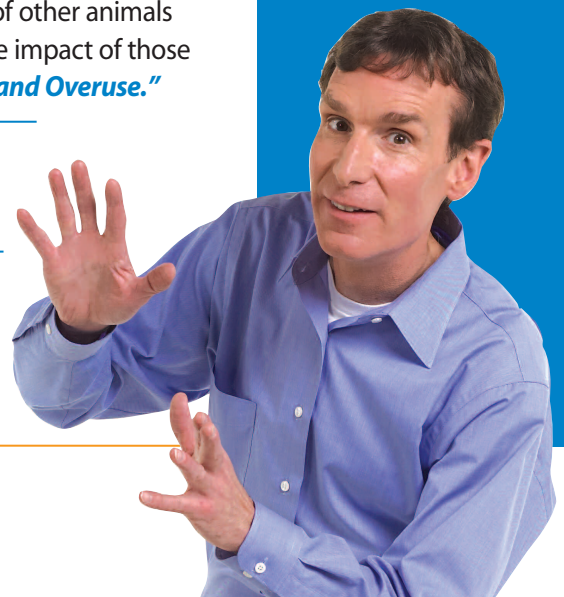
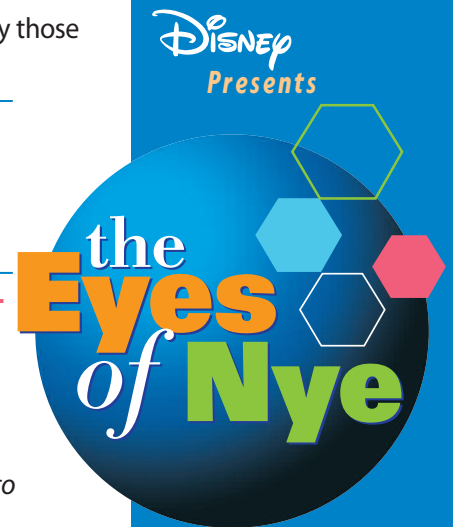
- 5) Play "[Research on Antibiotic-Resistant Bacteria](#)" in which Dr. Fred Tenover at the Centers for Disease Control and Prevention discusses the increase and extent of resistance of bacteria and the devastating effect of this phenomenon in hospital settings. Ask students why bacteria in these settings have such high resistance to antibiotics. Briefly address the concept of treatment driving more resistance.

Explore experts who have posed claims.

For more on exploring claims and claimants, go to eyesofnye.org

- 6) Begin to explore the second scientific question posed in step 3 by asking students to consider what we could be doing, purposefully or unknowingly, to encourage the increase of antibiotic-resistant strains of bacteria. Some will suggest by now we are using too many antibiotics, and some may be more specific and say we are prescribing antibiotics for "everything." Play "[Bacteria vs. Virus](#)" for a lighthearted but relevant consideration of the problem. Remind students of the response of bacteria to the demise of competing strains in our bodies as you discuss the potential problems caused by misdiagnosing illness or prescribing antibiotics for every illness we encounter. Broaden discussion to include our larger environment and explain that interdependence and competition of organisms play important roles in any natural ecological system. Suggest the extent of resistance we now find in bacteria might indicate more than overuse of antibiotics in human treatments. Many students will know of other animals that have been given antibiotics. Lead discussion from that point to the impact of those antibiotics on bacteria in nature, then play "[Filling the Niches: Misuse and Overuse](#)."

Optional: Distinguish between bacteria and viruses. Ask students to search for information in order to textually or visually compare and contrast or diagram differences.



- 7) Students will by now consider most of the problem to be folly on the part of doctors, patients, farmers, and others. However, ask if they are always sure of what they have when they are sick (no), and if their doctor is *always* sure (surely not). Suggest that our decisions are often difficult, and that while there are things we can do (recall those mentioned above), sometimes the decisions we face about whether or how to use antibiotics (social question in step 3) are personal, dangerous, and very immediate. Begin to focus on these types of decisions we must make by asking if you were a doctor and you were treating a very sick child whose disease was difficult to diagnose, would you consider trying an antibiotic? Suggest to students that sometimes we must consider cases that require treatment. Suggest also that sometimes, as in times past, it takes serious circumstances for us to progress scientifically, technologically, and personally.

Procedure: Propose Phase

- 8) Distribute or explain the background information on *Bordetella pertussis* (see sidebar), better known as “whooping cough.” Discuss the nature of the disease (e.g., predominant in infants, highly contagious and dangerous, difficult to diagnose, side effects and conflicts associated with vaccination). Recall the general trend showing an increase in disease-related deaths due to resistance in recent years, and provide students with historical trend data showing the number of confirmed cases of pertussis up to 1990 (not beyond).

Preview the background information on pertussis, the historical trend, the case, and the case resolution, follow-up note and post-case date before discussing or distributing.

- 9) Present the case of The Problem With Pertussis and ask students to consider the details as though they were a parent of the infant, community member, health official, or all. Ask students to decide what they would do, given this scenario, and allow them to brainstorm ideas, list or describe possibilities, and construct a brief plan of action. Be prepared to suggest prompts where needed—they may consider medical treatment solutions to save the life of the infant, causal factors (where the infant possibly got the disease), community or social ramifications (others that may be in danger or be carriers) and the possibility of an epidemic, assistance from other medical facilities, or political aspects (many governments suppress this type of information). You may use a whole class, small group, or individual approach.
- 10) Provide students with the resolution of The Problem With Pertussis. Discuss the various actions taken in the case, and relate to those proposed by students. Note the case was real, and the resolution as described may or may not have specified certain other actions students suggested in their own plan (we only have what the records indicate). It is also not intended to imply *the* right actions to be taken in a situation like this. Rather, it illustrates a lack of absolute solutions and the need to consider many options and parallel courses. Ask students to predict what has transpired in the problem with pertussis between the time of the case and now. Use the follow-up note and additional post-case data as needed beyond this point. Share the CDC data that indicates in the intervening

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the Eyes of Nye

See *The Eyes
of Nye*
Issue Support
**The Problem with
Pertussis**

years the incidence of confirmed pertussis cases steadily rose to over 11,000 in 2003, the highest since 1964. Also during that time other erythromycin-resistant strains were identified, cases among adults and adolescents increased dramatically, adults were found to be a reservoir for carrying and transmitting the disease, diagnosis (especially in adults) continued to be difficult, treatment with erythromycin continued as the first line of action for confirmed and potential cases, and that vaccines are now being considered for adults (two patents pending as of January 2005, even given past problems with potential reactions). If not addressed, point out the important—and to students, often unfamiliar—interaction among local health authorities and the CDC, and the increasing efforts being devoted to large-scale surveillance and monitoring (see sidebar). Ask students to consider what they would like to see happen over the next 10 years.

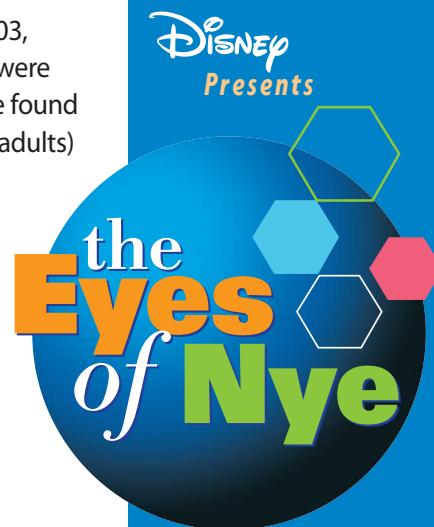
For more on monitoring and surveillance, go to eyesofnye.org

- 11) Tell students that, just as special circumstances often promote technological and scientific progress, learning from the past likewise provides choices we would not otherwise have. Remind them of risks harbored by the environment, and tell them the reverse is also true—our environment provides many possible solutions, if only we search and learn more about it. Play *“Cues From Nature: New Treatments for New Needs”* in which Dr. Margaret Riley discusses research in the development of new treatments based on the proteins (bacteriocins) that certain bacteria release to kill closely-related strains of competing bacteria in a highly targeted manner. Distinguish between this “narrow spectrum” treatment and the “broad spectrum” treatments of the past and present, and ask students to suggest the potential future value in this type of approach for combating the increase of antibiotic-resistant bacteria. Suggest this or another similar form of treatment may be part of the issue in the near future. Leave them considering how it may impact future choices they make in these or other similar situations.

Final Teacher Note: *The Problem With Pertussis* was selected to illustrate numerous factors that compliment The Eyes of Nye - Antibiotics and the learning objectives of this guide. Other cases are available, but avoid “bad endings” or other sensitive details—they do not contribute to the objectives.

Dr. Riley’s work serves as a thoughtful close or as a means of re-entry into an assess phase full of research on new treatment possibilities. It also puts an exclamation point on several recurring themes in the antibiotics issue—the never-ending mutual impact of science and technology, relationships of organisms with the environment and one another, and roles in those interactions, and even learning at the intersection of past theory (e.g., germ theory, evolution, etc.) and findings in newer arenas (e.g., genetics). As such, it is a flagship example for students of “frontier science” sturdily constructed on accepted and consensual principles of “core science.”

For more, go to eyesofnye.org



Further Research

Investigating the Issue: Antibiotics

Historical progress in medical health sciences and technologies, improvements in our quality of life balanced with the potential threats we face from new strains of antibiotic-resistant infectious bacteria, resulting decisions that we (and our students) face in the future as individuals and as members of our society—all form a compelling educational background.

In addition to the information and claims presented in *The Eyes of Nye - Antibiotics*, students may access a variety of information and data sources related to disease, bacteria, antibiotic-resistance, new treatment efforts and solid core science that supports the quest for new learning. Social considerations and ties are woven so tightly into the issue itself they far exceed the need to explore the claims and claimants. These are provided, but the sources for newly emerging science data (for instance, the Centers for Disease Research and Prevention) also become essential sources for information related to the social fabric; the scientific information itself, whether it describes disease trends, case reports, or new research, is a story of nature and people.

Exploring Disease Trends, Causes, and Future Threats

The Centers for Disease Control and Prevention (CDC) provides a wealth of information, literature, data, and recent reports on both research findings and disease cases and outbreaks. Access at: <http://www.cdc.gov>

History and Plague

Yersinia pestis is alive and well. Get a reliable overview of the **plague** from both a historical and modern perspective at:

<http://www.cdc.gov/ncidod/dvbid/plague/history.htm>

Resistance Monitoring

For information on diseases connected to antibiotic resistance, the public health action plan to fight microbial resistance, susceptibility testing, and the CDC's surveillance system, see the Antibiotic/Antimicrobial Resistance Web site at:

<http://www.cdc.gov/drugresistance/>

Or, go to the National Antimicrobial Resistance Monitoring Program at:

<http://www.cdc.gov/narms/>

Studies of biological diversity in nature and the evolution of **microbial defense systems** such as antibiotics could play a large future role in the search for solutions to the problem of resistance in infectious bacteria. Exploration of such topics as the evolutionary arms race, microbial population genetics, production of bacteriocins, colicins and microcins, and the ecological role of microbial defense systems can help students to develop ties between new findings and the importance of established theoretical principles developed and honed through years of research and observation of the environment in which we live. Encourage students to explore the perspectives and scientific foundations of the work of Dr. Margaret Riley (featured in *The Eyes of Nye - Antibiotics*). Also, take a

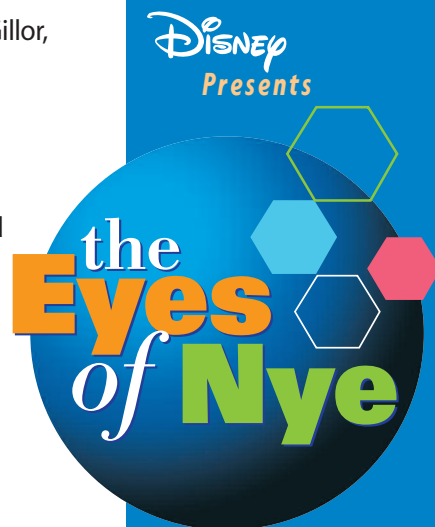


closer look at the contributions and work of various colleagues, including Kirkup, Gillor, Wertz, and Kerr, among others.

Exploring Antibiotics Claims and Claimants

In *The Eyes of Nye - Antibiotics*, the principal information was provided by Doctors Fred Tenover and Margaret Riley. Teachers may encourage students to conduct open-ended searches for information related to these individuals and the institutions at which they conduct their work.

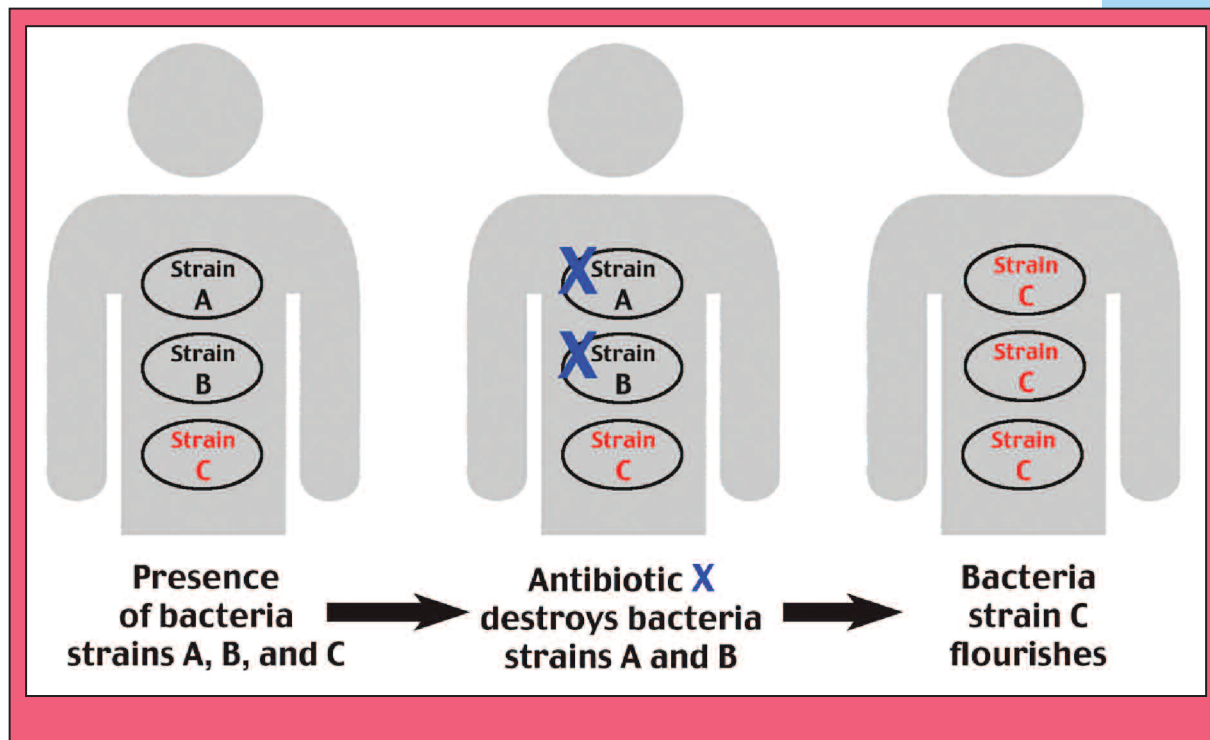
Dr. Fred Tenover	Centers for Disease Research and Prevention
Dr. Margaret Riley	University of Massachusetts (previously at Yale)



Antibiotics: Man vs. Microbe



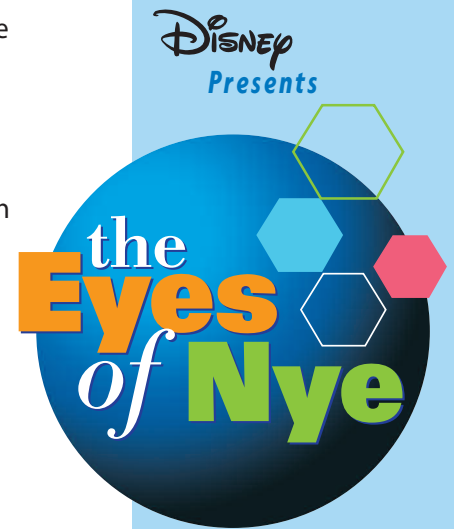
Bacterial Selection (Transparency T-BS)



Glossary of Terms

Antibiotic - any of a large group of chemical substances, produced by microorganisms or partially synthesized, and having the capacity to inhibit the growth of or to destroy bacteria and other microorganisms; used chiefly in the treatment of infectious diseases

Antibody - any of a large number of proteins naturally existing in blood serum, or produced in response to stimulation by an antigen; reacts to overcome the toxic effects of a specific antigen, resulting in an autoimmune response (also called *immunoglobulin*)



Antigen - any of a class of substances, usually proteins or carbohydrates, that stimulate production of antibodies, and therefore an immune response to a specific disease

Antimicrobial - inhibiting the growth of or destroying microbes

Bacteria - plural of bacterium. Any of numerous microscopic, spherical, rod-shaped, or spiral organisms, various species of which produce disease. Bacteria are living cells with no distinct nucleus, and get their nutrition through absorption or a host, such as a person

Broad-spectrum - noting an antibiotic effective against a wide range of organisms

Cases - instances of an occurrence, such as a disease

Chronic disease - an ailment one has had a long time or that recurs frequently; not spreading

Contact - one who has lately been exposed to an infected person

Disease - a condition of an organ, part, structure, or system of the body in which there is incorrect function resulting from the effect of heredity, infection, diet, or environment; illness; sickness; ailment

Ecology - the branch of biology dealing with the relations between organisms and their environment

Environment - the aggregate of surrounding things, conditions, or influences, affecting the existence or development of someone or something

Epidemic - affecting at the same time a large number of persons in a locality, and spreading from person to person, as a disease not permanently prevalent there

Erythromycin - a broad-spectrum antibiotic, used chiefly in treatment of disease

Infection - the state of being affected by disease-producing germs

Infectious - communicable by infection, as from one person to another or from one part of the body to another; spreading

Monitoring - observing critically; checking closely or continuously

Mutate - to change; alter

Narrow-spectrum - noting an antibiotic effective against a small range of organisms

Outbreak - a sudden rise in the incidence of a disease

Pandemic - occurring over a wide geographic area and affecting an exceptionally high proportion of the population

Pathogen - any disease-producing organism

Penicillin - the first antibiotic, produced by the molds of the genus penicillium, primarily causing bacteria to stop growing rather than destroying it, used in medicines chiefly for infections caused by various bacteria

Pertussis - whooping cough

Plague - an epidemic disease of high mortality; pestilence

Protein - any of a group nitrogenous organic compounds of high molecular weight, synthesized by plants and animals that upon hydrolysis by enzymes yield amino acids, and that in animal metabolism are required by all life processes

Sanitary - clean, free of germs, unpolluted, antiseptic

Strain - a variety of microorganisms

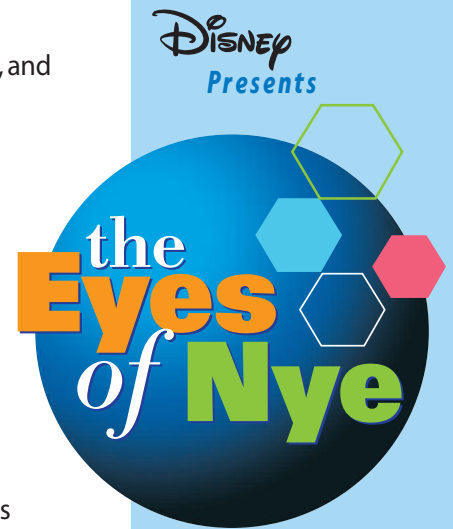
Streptococcus pneumoniae - bacteria occurring in pairs or chains causing pneumonia, ear infections, and other diseases in humans

Surgeon general - the chief of medical services in one of the armed forces

Surveillance - close and continuous observation or testing

Transmittal - to convey infection abroad or to another

Virus - an infectious microbe that has no cell membrane; reproduces only in living cells



The Problem With Pertussis

Background Information

Pertussis (better known as "whooping cough") is a highly infectious respiratory infection caused by the bacterium *Bordetella pertussis*.

Symptoms begin to show as early as 4 days or as late as 21 days after contracting the disease. 3 clinical stages exist:

- **Catarrhal stage:** Characterized by runny nose, sneezing, low fever, mild cough (similar to common cold). During this stage, infected persons are at their most contagious. Cough becomes more severe over 1-2 weeks, leading to next stage.
- **Paroxysmal stage:** Usually the stage when (if) diagnosis takes place. Characterized by bursts (paroxysms) of rapid coughs and difficulty expelling thick mucus. The end of coughing outbursts usually accompanied by high-pitched whoop, and often a blue tint to the skin. Vomiting and exhaustion commonly follow. May last 1-10 weeks.
- **Convalescent stage:** Characterized by gradual recovery over 2-3 weeks, but lapses may occur for many months.

A **clinical case** of pertussis is defined as an acute cough illness lasting at least 2 weeks with either paroxysms (sudden or violent outbursts) of coughing, inspiratory (air drawn into lungs) "whoop," or posttussive (after cough) vomiting without other apparent cause.

- Council of State and Territorial Epidemiologists (CSTE)
- Centers for Disease Control and Prevention (CDC)

The **treatment** of choice for pertussis is the antibiotic erythromycin. There are alternatives that can be prescribed for those patients who do not tolerate erythromycin well. Those that are cases as well as those who are close contacts are typically treated. Sometimes those at risk of contact are treated.

Historical Trend

The first *described* outbreak of pertussis was in the 16th century. The bacterium *Bordetella pertussis* (referred to as *B. pertussis*) was first isolated in 1906. It has only been found to occur in humans.

Throughout the 20th century, pertussis was one of the most common childhood diseases in the United States as well as many other countries. Before the vaccine became available in the 1940s, the annual number of reported cases typically exceeded 175,000. From 1980 to 1990 the annual incidence of pertussis averaged approximately 2900.

The vaccine greatly decreased the incidence, but since the 1970s has been the object of debate itself, as many reports and studies have linked it to possible reactions such as seizures, learning disabilities, and neurological disorders. In countries where rates of vaccination are low due to anti-vaccine movements, incidence of pertussis has been 10-100 times greater. Vaccines are typically not effective after 5-10 years. There are no vaccines currently (2005) licensed for use in persons age 7 or older.

Case

(Yuma County, Arizona, May - October 1994)

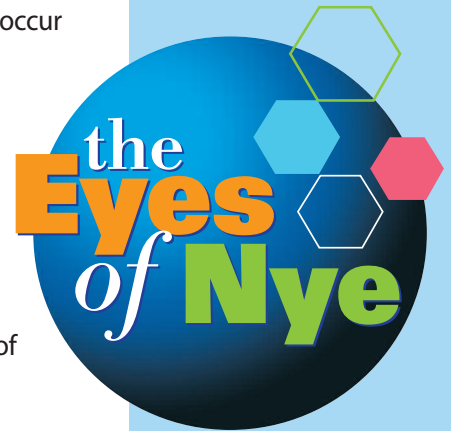
On May 23, 1994, a 2-month-old male infant was diagnosed and treated for bronchitis. He had exhibited a cough for a week but had no previous history of antibiotic treatment. His parents reported he had not received the pertussis vaccine. Within three days, he was hospitalized with severe cough, vomiting, problems breathing and blueness of the skin. *B. pertussis* infection was diagnosed and he received erythromycin treatment for 12 days. Symptoms continued, tests and cultures confirmed the persistence of pertussis organisms. Intravenous erythromycin treatment was initiated to no avail. The dosage was increased over the next week but his condition remained unchanged.

Case Resolution

Finally, susceptibility testing at the hospital laboratory suggested that the pertussis strain was resistant to erythromycin but sensitive to another antibiotic. Erythromycin was discontinued, the new antibiotic initiated, and his condition improved rapidly. Further testing at CDC confirmed that the strain was highly resistant to erythromycin.

About 2 weeks before the infant's illness began, his 17-year-old mother had developed a cough associated with vomiting. A culture obtained from the mother was negative. She also had no history of recently receiving antibiotic treatment. Because of the case, the Yuma County Department of Public Health distributed culture kits and instructions to county residents and asked medical providers to obtain cultures from any patients with an unexplained acute cough lasting 7 or more days. Letters were also mailed to 2500 primary-care providers in Arizona to encourage collection of cultures for diagnosis, and health officials in two nearby California counties were alerted to the isolation of an erythromycin-resistant pertussis strain in Yuma County. A total of 18 confirmed cases were identified during the next

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two months. In a period of enhanced surveillance, seven more cases were isolated, as well as 22 *B. pertussis* strains from persons in other Arizona counties and 13 from patients in California. All were susceptible to erythromycin.

Follow-Up Case Note

Due to the small number of samples tested for susceptibility, the number of possible resistant strains cannot be accurately estimated. However, the absence of additional erythromycin-resistant strains in Arizona and neighboring counties suggests that the resistance is not widespread. Erythromycin is the drug of choice for treating persons with *B. pertussis* as well as family and contacts who have been exposed. For adults who are susceptible to pertussis because of a decrease in vaccine-induced immunity or for infants who are too young to be adequately vaccinated and are at risk for severe disease, erythromycin treatment is also the primary control measure.

However, cultures should be obtained from persons who do not improve with erythromycin treatment. Most will not be positive for *B. pertussis* but these cultures should nevertheless be sent to CDC for further testing. Tests to evaluate susceptibility of *B. pertussis* have not been standardized and are not widely available. Efforts to standardize susceptibility testing are ongoing at CDC. Preliminary results of studies at CDC suggest the manner in which *B. pertussis* resists erythromycin is different from other notable bacteria. Studies related to this phenomenon are also ongoing.

This case is based on information contained in the Centers for Disease Control and Prevention *Mortality and Morbidity Weekly Report* (MMWR), and has been adapted for classroom use. Report issued November 11, 1994/ 43(44); 807-810 (MMWR Brief Report: Epidemiologic Notes and Reports Erythromycin-Resistant *Bordetella pertussis*—Yuma County, Arizona, May-October 1994)

Additional Post-Case Data

Number of cases reported annually in the United States:

1993	~ 6,500
2002	~ 9,700
2003	~ 11,500

Of interest:

- Of those diseases for which childhood vaccination is recommended in the United States, only pertussis increased in incidence during the last 20 years of the 20th century.
- Incidence in adults between 1990 and 2001 increased 400%, but much of this is thought to be the result of increased surveillance and reporting.
- There were an estimated 285,000 deaths worldwide in 2001 due to *Bordetella pertussis*.

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