

Text Set 9

Pandemic

Grouping
Sequence:
Pairs; groups of 4
for discussion,
tableaux, and
extension jigsaw;
whole class



Though the word *pandemic* is most associated with the Black Death of the fourteenth century and the Spanish influenza of 1918, the first recorded pandemic occurred in 430 BC, during the Peloponnesian war. It killed thirty thousand Greeks. Today we see the phrase *potential pandemic* every time a new flu strain appears. It seems like every year the world is threatened by some kind of exotic flu. Sometimes these turn out to be false alarms, while other times, thousands die. Some of this danger actually may arise from the way we keep animals, as described in the factory farming text set (pages 180–194).

The readings in this lesson are divided into two categories. While the first two help students understand how viruses work, the last four extend the topic by examining a historical or literary context, the process for creating vaccinations, or, in the case of “Path of a Pandemic,” how our current food production methods encourage more deadly mutations. Within these readings, the following big questions arise:

- How dangerous is the flu?
- How do viruses take advantage of various opportunities to mutate and spread?
- How do people often react in the face of a pandemic?
- What steps can we take to reduce the chance of a pandemic?
- How might current food production practices contribute to the rise of new and antibiotic/antiviral resistant diseases?

TEXTS IN ORDER OF USE

Main Lesson:

“What’s in a Name?” (diagrams and charts with text; easier)

“Swine Flu: Virus’ Invasion Sets Off Battle Inside the Body”

Extension:

“The Masque of the Red Death”

“The Path of a Pandemic”

“The Great Pandemic 1918–1919”

“Expediting Production of a Vaccine” (diagram)

CURRICULUM CONNECTIONS

Biology: Cell structure, viruses, infections, epidemics, pandemics.

Health: Common diseases and the immune system, disease prevention.

Social Studies: How disease shapes society and history.

Literature: Edgar Allan Poe, as well as the numerous fiction and nonfiction books that touch or focus on the topic of pandemic: *Fever 1793*; *The Astonishing Life of Octavian Nothing, Traitor to the Nation*; *When Plague Strikes*; *Wickett's Remedy*; *The Demon in the Freezer*; *The Hot Zone*; *The Stand*; *The Plague Tales*.

English Language Arts: Drawing on fiction and nonfiction text to understand a topic or era; choosing the right note-taking strategy for the text genre under study; representing one's thinking visually and dramatically; joining in structured small-group discussions to deepen understanding.

STRATEGIES USED

Pair Reading, Text Annotation, Conversation Questions, Tableaux, Text Coding, Sketching Through the Text, Jigsaw, Save the Last Word for Me

MATERIALS NEEDED

For the main lesson, copies of the first two articles for each student; index cards. For the extension, one set of all four articles for each group (copy the articles single-sided so students can write on the back; also, it is least confusing if you number the choices one through four or copy each article on a different color paper); projectable set of big questions.

Steps and Teaching Language

Strategy 9: **PAIR READING**

PART 1 PAIR READING OF DIAGRAM (15 minutes)

- STEP 1 Introduce the topic** Have students sit with a partner (their choice or teacher determined). *Has anybody ever gotten the flu? Ask for a show of hands. When you get the flu, what are the symptoms? How is it different from a cold? Call on some volunteers. Believe it or not, most of the symptoms you just named are caused by your own body in reaction to the flu virus's invasion. Today we're going to take a closer look at how the flu virus works.*
- STEP 2 Students read the diagram silently** Pass out a copy of "What's in a Name?" to each student. *This diagram is complicated and filled with information. I want you to take a couple of minutes to just read through it silently.*
- STEP 3 Pairs reread and discuss the diagram** After time is up, say: *Now I want you to look over these diagrams and charts a little bit more closely with your partner. Start with the diagram that begins in the upper right with the number 1 under the heading "The Flu Enters the Body."*

Partners, you are going to take turns reading the numbered steps of this diagram aloud. One person reads the text beside number 1, then stops and lets his or her partner explain what is happening in the diagram. Then add anything your partner didn't mention and move on to the next number. Now the other partner does the reading aloud. Continue taking turns as you discuss the rest of this diagram.

Once you've finished moving through the numbers on that first diagram, take turns picking something else off the page to read and discuss. You do not need to go in any particular order. As you discuss the information, be sure to talk about what is surprising and seems important to remember.

STEP 4 Monitor groups It is more important that pairs complete their discussion of that initial diagram than discuss everything on the page. Also, make sure that students are following the pair reading instructions you outlined.

STEP 5 Share with the whole class

OK, pairs, what was something you noticed on this handout that was interesting or surprising? Going back to that first diagram about how the flu works when it enters the body, did anyone have any questions? I know that drawing is complicated. Spend a few minutes sharing and clearing up any confusion.

PART 2 ANNOTATE AND DISCUSS (15 minutes)

STEP 1 Introduce the text and explain reading directions Direct pairs to form groups of four. Pass out the text "Swine Flu: Virus' Invasion Sets Off Battle Inside the Body."

Strategy 3: **TEXT ANNOTATION**

This article goes into more detail about how your body reacts to a flu invasion. As you read, please annotate in three ways. Mark passages:

★ *that seem important*

? *that raise a question*

 *that connect with what we have already learned*

Strategy 11: **CONVERSATION QUESTIONS**

As always, beside your annotations, jot down some notes on your thoughts or a conversation question that will spark some interesting discussion.

STEP 2 Monitor reading Work the room, helping kids to find all three kinds of responses within the text. If you notice students finishing early, prompt them to first go back and add to their annotations or return to the pair reading diagram and see if they can find any other connections between the diagram and the article.

STEP 3 Groups discuss Turn to your group of four. Share and discuss your annotations. Read aloud what you've underlined before discussing a part. Remember to pose your conversation questions as well. Allow about five minutes for discussion.

PART 3 **TABLEAUX** (20 minutes)

STEP 1 Explain the tableaux assignment Students remain in their groups of four. Pass out an index card to each group.

Working together, pick out one important piece of information you learned about how viruses invade and write that information as an action-filled caption on the index card I gave to your group. As you word your caption, think about how the scene might be described if it were a balloon caption in a superhero comic book.

Give groups a few minutes to come up with their captions. As always, monitor the groups in order to answer questions and keep them on task. Following is a list of potential captions students might create. If a group seems really stuck, nudge them toward one of these.



Possible Tableaux Captions

1. A single sneeze spreads billions of viruses.
2. A new virus strain can sneak past the immune system's gatekeepers.
3. The virus shows its host cell its virus blueprints.
4. The virus hijacks a healthy cell and turns it into a virus factory.
5. A cell explodes and virus copies attack other healthy cells.
6. Cytokines sound an alarm that alerts T-cells to destroy the infected cells.
7. The alarm system creates flu symptoms like fever and aches.

Now create a corresponding action-packed tableau that illustrates your caption. Stand up, practice, and keep revising your scene to make it more informative and visually interesting. Since there is a lot of action in a virus invasion, it's OK if you want to add some movement as well; you do not have to be absolutely still this time! Your job is to help your viewers better understand how viruses work. All of your members need to be part of the scene; your caption will be read by someone in another group.

STEP 2 Monitor groups Give students five minutes or so to practice. As you observe, cajole groups to get out of their chairs and practice. If a group says they are done, make them show you their tableau. Don't be afraid to make suggestions that will enhance the drama, visual effect, or meaning.

STEP 3 Groups perform tableaux Once time is up, have groups elect someone in another nearby group to dramatically read their caption when it is their turn. Have each group perform. Remind the rest of the class that silent attention is needed during each performance and a large round of applause is needed afterwards. After the performances have concluded, group members should write all of their names on their caption card and turn it in to you.

Strategy 21: **TABLEAUX**

- STEP 4 **Review content; share with the whole class** Once performances are concluded, ask students this question: *What important information was portrayed about viruses in these tableaux?* Send students back to the diagram and the article for a quick review and then ask for responses.

EXTENSION

JIGSAW (45 minutes)

- STEP 1 **Introduce the activity** Form groups of four and talk students through the text choices.

"The Masque of the Red Death" is a shortened version of the Edgar Allan Poe classic. In the story Prince Prospero tries to save his friends from a pandemic by locking away everyone in his castle and then throwing a big party.

"The Path of a Pandemic" explains how H1N1 evolved—and how the current way we produce food may produce future and more dangerous pandemics.

"The Great Pandemic 1918–1919" describes how the flu virus spread around the globe, creating death and terrible consequences for tens of thousands.


"Expediting Production of a Vaccine" is a diagram that explains how two different kinds of flu vaccines are produced, but only one of these methods is approved for use in the United States.

- STEP 2 **Groups negotiate reading assignments** Pass out a complete text set to each group and have students decide who will read each piece. Then give the directions.

- STEP 3 **Give instructions for reading**

Now that you've chosen your articles, I want you to stop, think, and react along the way.

Underline at least three passages that you think would be surprising or interesting to other members of your group.

Mark information that connects back to the diagram and article we read as a class with chain links , and jot a quick note explaining the connection.

Then, after you're finished, on the back side of the article, please draw a picture or diagram that captures the important information in your article. And, in the case of those who have the vaccine production text, you have to think about how to visually represent the information in a new way versus just copying the pictures in the article.

Allow at least ten or twelve minutes for this three-way note-taking.

Strategy 4: **TEXT CODING**

Strategy 5: **SKETCHING
THROUGH THE
TEXT**

Strategy 23: **JIGSAW**

STEP 4 Expert pairs meet As students finish reading and annotating, call time. *Everybody stand up and stretch. Pick up your article and pen. Now, we're going to regroup by article. All the ones [or blues, etc., if texts are color coded] gather in this corner, twos in that corner, threes over here, fours over there. Go!* Give everyone a minute to move. *Now that you are with all the others who read the same article, I want you to break into pairs and compare what you annotated. Decide which two or three pieces of information are most important, discuss any connections, and be sure to check out each other's drawings. When you return to your original group, you will be the expert on this article, so make sure you are prepared.*

Give students about five minutes for this pairs discussion and then tell them to return to their *original groups*.

Strategy 10: **SAVE THE LAST WORD FOR ME**

STEP 5 Groups discuss readings

Now that you are back in your original groups, you need to first share your information. Start with your drawing and use Save the Last Word for Me. Hold it up and have the other members explain what is in your picture and what it means. Once they're done, add any further explanation and then read one or two of your most important passages aloud, once again using Save the Last Word. Take a few minutes for each member to show their drawings and read a couple passages.

Monitor carefully and end discussion as soon as groups appear to be finished.

STEP 6 Groups prepare answers to discussion prompts

Now that everyone is done sharing, I want your groups to take the discussion a step further and come up with some answers to these questions. Once your group decides on an answer, everyone should jot it down. (Post these on the board or project.)



- How dangerous is the flu?
- How do viruses take advantage of various opportunities to mutate and spread?
- How do people often react in the face of a pandemic?
- What steps can we take to reduce the chance of a pandemic?
- How might current food production practices contribute to the rise of new and antibiotic/antiviral resistant diseases?

STEP 7 Share with the whole class Once groups have finished, end with some large-group sharing in response to the big questions posed.

What's in a name?

2009 H1N1 and the seasonal flu are more similar than many people might realize. Graphics and research by Chelsea Williams and Brandon Schatsiek

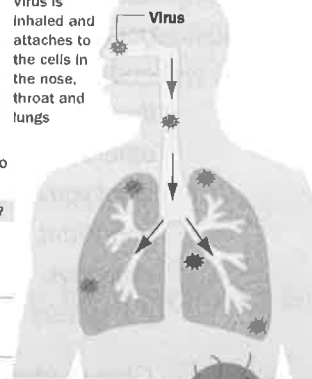
THE ABCs OF INFLUENZA

To understand the differences between 2009 H1N1 and the seasonal flu, it is first important to understand the different types of flu virus – A, B and C. Influenza A is the most common.

TYPE	HOSTS	SYMPTOMS	SUBTYPES	EPIDEMIC OR PANDEMIC?
Influenza A	Humans or animals (primarily wild birds)	Cough, sore throat, runny or stuffy nose, fever, headache, fatigue, muscle ache	Two based on proteins on the surface of the virus: hemagglutinin (H) and neuraminidase (N)	Can cause both epidemics and pandemics
Influenza B	Humans	Less severe than Influenza A	None	Causes epidemics; has not yet caused pandemic
Influenza C	Humans	Causes mild illness	None	Does not cause either

1 THE FLU ENTERS THE BODY

Virus is inhaled and attaches to the cells in the nose, throat and lungs



2 Protein spikes on the surface of the virus bind to the cell

Protein spike

3 The virus is engulfed by the cell

4 The virus releases its RNA (nucleic acid that carries pieces of information)

5 In the nucleus, viral RNA copies are made

6 Viral messenger RNA causes the cell to make viral proteins

7 RNA and viral proteins combine to make more viruses

8 Newly formed viruses leave the cell and spread throughout the respiratory system

REPLICATION REPLICATION REPLICATION

2009 H1N1 and the seasonal flu enter the body, attack and spread in the same way. Both break down the cell membrane of a healthy cell and replicate their RNA to make new viruses that spread throughout the body.

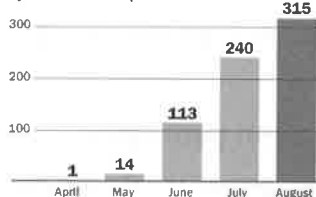
Despite their similarities, H1N1 differs from the seasonal flu in that populations that are normally at risk for severe illness or death from the seasonal flu, such as young children and the elderly, have not been most affected by H1N1. Also, it seems to thrive in the summer, outside of the normal flu season.

UNSEASONAL FLU DEATHS

The number of deaths of people who had 2009 H1N1 increased over the summer months, when most strains of flu are said to die off.

U.S. DEATHS ATTRIBUTED TO H1N1

By month from April 2009



	2009 H1N1*	SEASONAL**
Cases, worldwide	254,206	3 to 5 million
Cases, U.S.	9,079	200,000
Deaths, worldwide	2,837	25,000 to 50,000
Deaths, U.S.	593	36,000

*From April to August 2009
**Annual average

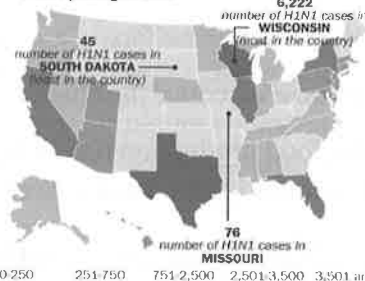
HOW H1N1 NUMBERS ARE COLLECTED

The Centers for Disease Control and Prevention and the World Health Organization originally tested every probable case of 2009 H1N1. However, because there were so many cases around the world, "reporting this information becomes questionable," said Kristen Nordlund, a CDC spokeswoman. The groups have since recorded only serious cases and hospitalizations due to H1N1. On Sept. 17, Missouri had its second confirmed death from H1N1, but the most recent state-by-state numbers are through the end of August.

Sources: WORLD HEALTH ORGANIZATION; CENTERS FOR DISEASE CONTROL AND PREVENTION; THE SPOTNET; MICHAEL COOPERSTOCK, MU HEALTH CARE; BETHANY STONE, MU DIVISION OF BIOLOGICAL SCIENCES

CASES BY STATE ATTRIBUTED TO 2009 H1N1

From April-August 2009



DEATHS BY STATE ATTRIBUTED TO 2009 H1N1

From April-August 2009



Chicago Tribune

Swine flu: Virus' invasion sets off battle inside the body

May 1, 2009

By Robert Mitchum and
Trine Tsouderos

Like a sleeper agent, the flu virus causes its damage from within, turning an organism's cells against itself. A single virus can hijack a healthy cell and transform it into a virus factory, making thousands of copies in a couple of hours. The cell then bursts, allowing the copies to infect other healthy cells and start the process anew. The body fights back by launching a self-sacrificing counter-attack: molecules designed to kill the hijacked cells before the virus does.

Not all flu particles are infectious, but doctors said it takes only a small number to spread infection, whether via a cough on a crowded subway train or an escalator handrail recently touched by a sick person. A single sneeze can contain billions of viruses.

Yet for an infection to take root, the virus particles need to get past the immune system's gatekeepers: antibodies. Previous flu exposures and vaccinations build a security system that can recognize and attack viruses. But the swine flu circu-

lating now is a virus humans have not seen before. And although some scientists theorize that previous exposure to strains from the same family, called H1N1, may offer limited protection, for the most part the swine flu virus can sneak

to kill infected cells before they release their toxic cargo. These defenses come with a cost. Most of the symptoms we attribute to a flu virus are actually the result of the body's defensive maneuvers. For example, fever occurs when cytokines tell the brain to

"A virus is like a blueprint and a cell is like a factory. The virus carries in its own blueprints and says to the cell: Make this."

—Dr. Kenneth Alexander, chief of pediatric infectious diseases,
Comer Children's Hospital, University of Chicago

untouched through the antibody grid. From there, the virus is free to pursue its goal: multiplying as swiftly as possible.

"A virus is like a blueprint and a cell is like a factory," said Dr. Kenneth Alexander, chief of pediatric infectious diseases at Comer Children's Hospital at the University of Chicago. "The virus carries in its own blueprints and says to the cell: Make this."

The presence of the virus, as well as the husks of cells left by the replication process, alerts the immune system that something is wrong. The body sends out an alarm in the form of molecules called cytokines and recruits attackers called T-cells

raise the body's temperature, which helps the immune system fight its enemies.

Especially alarming to public health officials are flu strains that kill young adults, as was seen in 1918 and is being reported from Mexico. In these cases, a person's healthy immune system may overreact, causing a "cytokine storm" that can cause excessive inflammation in the lungs, leading to death. As scientists unravel the genetic makeup of swine flu strains collected in Mexico, the U.S. and New Zealand, they are relieved to find differences between the 1918 strain and the current strain that suggest a lower potential for severe illness.

The Masque of the Red Death (Abridged)

By Edgar Allan Poe

THE "RED DEATH" had long devastated the country. No pestilence had ever been so fatal, or so hideous. Blood was its avatar and its seal—the redness and the horror of blood. There were sharp pains, and sudden dizziness, and then profuse bleeding at the pores, with dissolution. The scarlet stains upon the body and especially upon the face of the victim, were the pest ban which shut him out from the aid and from the sympathy of his fellow-men. And the whole seizure, progress and termination of the disease, were the incidents of half an hour.

But the Prince Prospero was happy and dauntless. When his dominions were half depopulated, he summoned to his presence a thousand hale and light-hearted friends and with these retired to the deep seclusion of one of his castellated abbeys. A strong and lofty wall girdled it in. The abbey was amply provisioned. With such precautions the courtiers might bid defiance to contagion. The external world could take care of itself.

It was toward the close of the fifth or sixth month of his seclusion, and while the pestilence raged most furiously abroad, that the Prince Prospero entertained his thousand friends at a masked ball of the most unusual magnificence. And the revel went whirlingly on, until at length there commenced the sounding of midnight. Before the last echoes of the last chime had utterly sunk into silence, there were many individuals in the crowd who had found leisure to become aware of the presence of a masked figure which had arrested the attention of no single individual before. The figure was tall and gaunt, and shrouded from head to foot in the habiliments of the grave. The mask which concealed the visage was made so nearly to resemble the countenance of a stiffened corpse. The mummer had gone so far as to assume the type of the Red Death.

Prince Prospero, maddening with rage, bore aloft a drawn dagger, and approached the figure. There was a sharp cry—and the dagger dropped gleaming upon the sable carpet, upon which, instantly afterwards, fell prostrate in death the Prince Prospero. The revelers at once threw themselves into seizing the mummer, whose tall figure stood erect and motionless, but, gasped in horror at finding the gravecerements and corpse-like mask which they handled with so violent a rudeness, untenanted by any tangible form.

And now was acknowledged the presence of the Red Death. He had come like a thief in the night. And one by one dropped the revelers in the blood-bedewed halls of their revel, and died each in the despairing posture of his fall. And Darkness and Decay and the Red Death held illimitable dominion over all.

THE PATH OF A PANDEMIC

How one virus spread from pigs and birds to humans around the globe. And why microbes like the H1N1 flu have become a growing threat.

Laurie Garrett, May 18, 2009

Around Thanksgiving 2005 a teenage boy helped his brother-in-law butcher 31 pigs at a local Wisconsin slaughterhouse, and a week later the 17-year-old pinned down another pig while it was gutted. In the lead-up to the holidays the boy's family bought a chicken and kept the animal in their home, out of the harsh Sheboygan autumn. On Dec. 7, the teenager came down with the flu, suffering an illness that lasted three days. It was an H1N1 swine influenza. Largely ignored at the time, the Wisconsin virus was a step along the evolutionary tree, leading to a virus that four years later would stun the world.

Flash-forward to April 2009, and young Édgar Enrique Hernández in faraway La Gloria, Mexico, suffers a bout of flu, found to be caused by a similar mosaic of swine/bird/human flu, also H1N1.

Back in 2005, Centers for Disease Control scientists discovered that the H1N1 virus had pieces of its RNA genetic material that matched a human flu seen earlier, two swine types that had been circulating in Asia and Wisconsin for several years and an unknown avian-flu virus. Last year researchers from Iowa State University in Ames warned that pigs located in industrial-scale farms were being subjected to influenza infections from farm poultry, wild birds and their human handlers. As a result of the constantly changing genetic makeup of individual influenza viruses in pigs, the U.S. swine industry is continually scrambling to respond to the

influenza viruses circulating within individual production systems.

Investigation of the 1918 influenza pandemic, which is now estimated to have killed up to 100 million people worldwide in 18 months, revealed that the viral culprit was a type H1N1 human flu that had infected pigs, and then circulated back to humans. Today pigs are still an ideal mixing vessel for the creation of new avian/mammalian influenza viruses capable of causing novel diseases with the potential for producing pandemics in the human population. It is apparent that, in the U.S. swine industry, transmission of influenza viruses between swine and humans is fairly common.

It is a strange world wherein billions of animals are concentrated into tiny spaces, breeding stock is flown to production sites all over the world and poorly paid migrant workers are exposed to infected animals. And it's going to get much worse, as the world's once poor populations of India and China enter the middle class. In 1983 the world consumed 152 million tons of meat a year. The United Nations Food and Agriculture Organization estimates that by 2020 world consumption could top 386 million tons of pork, chicken, beef and farmed fish.

This is the ecology that, in the cases of pigs and chickens, is breeding influenza. It is an ecology that promotes viral evolution. And if we don't do something about it, this ecology will one day spawn a severe pandemic that will dwarf that of 1918.

The Great Pandemic 1918–1919

Throughout history, influenza viruses have mutated and caused pandemics or global epidemics

http://1918.pandemicflu.gov/the_pandemic/01.htm

INFLUENZA STRIKES

In early March of 1918, officials in Haskell County in Kansas sent a worrisome report to the Public Health Service. Eighteen cases of influenza of a severe type had been reported there. By May, reports of severe influenza trickled in from Europe. Young soldiers, men in the prime of life, were becoming ill in large numbers. Most of these men recovered quickly but some developed a secondary pneumonia of “a most virulent and deadly type.”

As the bodies accumulated, funeral parlors ran out of caskets and bodies went uncollected in morgues.

Within two months, influenza had spread from the military to the civilian population in Europe. From there, the disease spread outward—to Asia, Africa, South America, and back again to North America. In Boston, dockworkers at Commonwealth Pier reported sick in massive numbers during the last week in August. Suffering from

fevers as high as 105 degrees, these workers had severe muscle and joint pains. For most of these men, recovery quickly followed. But 5% to 10% of these patients developed severe and massive pneumonia. Death often followed.

Public health experts had little time to register their shock at the severity of this outbreak. Within days, the disease had spread outward to the city of Boston itself. By mid-September, the epidemic had spread even further with states as far away as California, North Dakota, Florida and Texas reporting severe epidemics.

The pandemic of 1918–1919 occurred in three waves. The first wave had occurred when mild influenza erupted in the late spring and summer of 1918. The second wave occurred with an outbreak of severe influenza in the fall of 1918 and the final wave occurred in the spring of 1919.

Entire families became ill. In Philadelphia, a city especially hard hit, so many children were orphaned that the Bureau of Child Hygiene found itself overwhelmed and unable to care for them. As the bodies accumulated, funeral parlors ran out of caskets and bodies went uncollected in morgues.

As the disease spread, schools and businesses emptied. Telegraph and telephone services collapsed as operators took to their beds. Garbage went uncollected as garbage men reported sick. The mail piled up as postal carriers failed to come to work.

Public health officials sought to stem the rising panic by censoring newspapers and issuing simple directives. Posters and cartoons were also printed, warning people of the dangers of influenza.

In November, two months after the pandemic had erupted, the Public Health Service began reporting that influenza cases were declining.

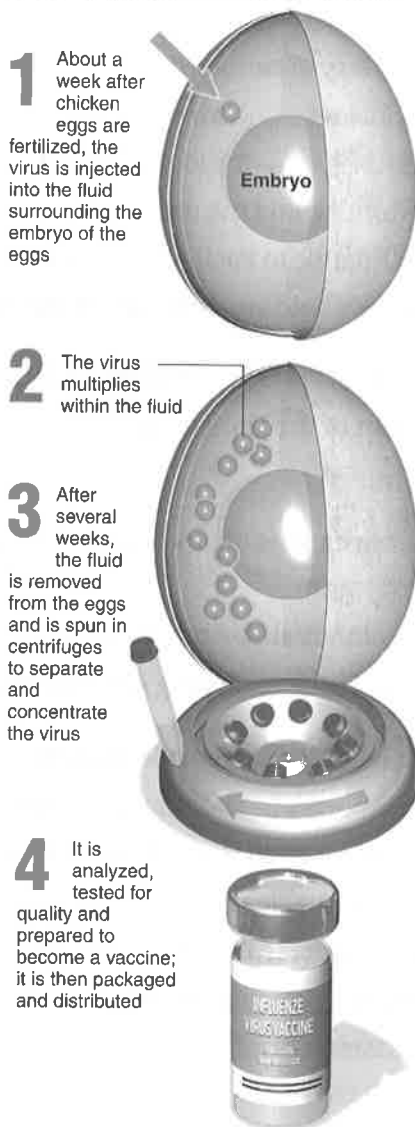
By the time the pandemic had ended, in the summer of 1919, nearly 675,000 Americans were dead from influenza. Hundreds of thousands more were orphaned and widowed.

Expediting production of a vaccine

Drugmakers around the world have received or are awaiting strains of the H1N1 swine flu virus to begin making a vaccine. The urgency of the situation provides an opportunity for companies to further develop a relatively new cell-based method of creating vaccines, which can potentially reduce the amount of time it takes to bring the product to market.

Egg-based

Production time: 20-28 weeks



Advantages

- A well-established method for vaccine production
- Relatively inexpensive

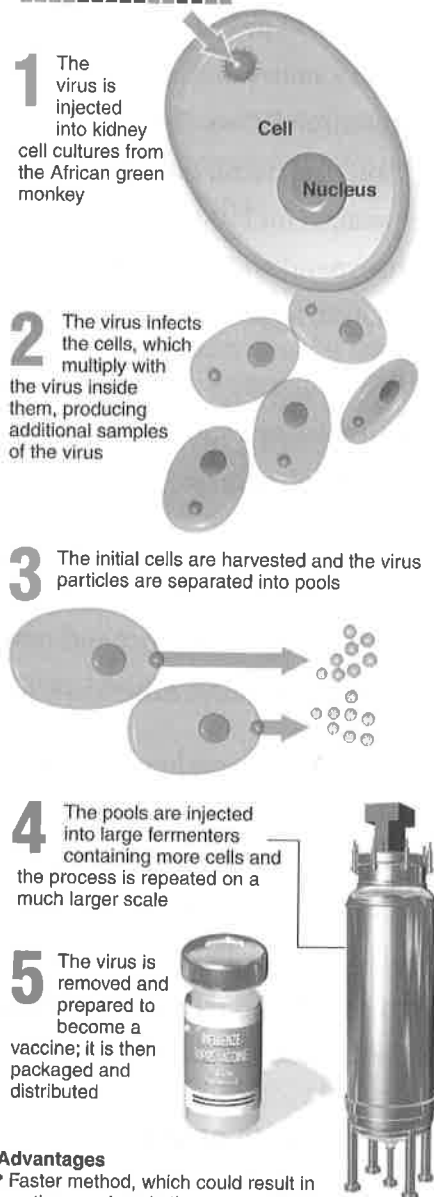
Disadvantages

- Requires large amounts of eggs that are not produced on demand (a single vaccine dose requires 1-2 eggs)
- Extensive planning and preparation can limit the effectiveness on quickly-developing viruses

Source: Baxter, New England Journal of Medicine, GlaxoSmithKline
Graphic: Max Rust and Phil Geib, Tribune Newspapers

Cell-based

Production time: 12-15 weeks



Advantages

- Faster method, which could result in creating vaccines in time to prevent the spread of the virus
- Avoids potential impurities that can occur in the egg-based method

Disadvantages

- High initial costs to set up the process
- Still unestablished; no cell-based vaccine has been approved by U.S. regulators for commercial use