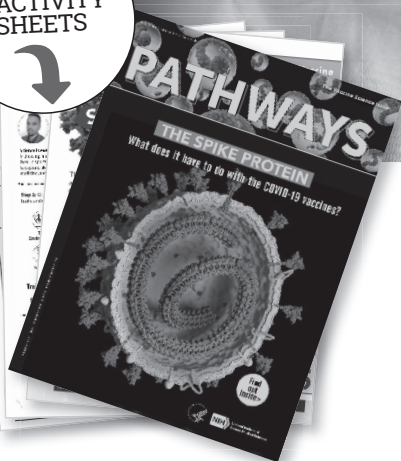


PATHWAYS

The Science
of mRNA Vaccines
and How They
Protect Against
COVID-19

Plus: Using Data to
Predict Outbreaks

MAGAZINES
& ACTIVITY
SHEETS



TEACHING GUIDE

Science and ELA Activities Investigating
Vaccine Science and Research Careers

Visit **scholastic.com/pathways** for
additional lessons, videos, and more.

BROUGHT TO YOU BY:



National Institute of
General Medical Sciences

Biomedical Research and Vaccines: The Fight Against Infectious Disease

Have students take on the role of biomedical researchers as they study a simulated pathogen and design an immunity-building vaccine.

Objective

Students will synthesize information using a range of sources and write for a domain-specific purpose.

Standards

NGSS

- **MS-LS1-3** Body subsystems
- **HS-LS1-2** Interacting body systems

CCSS Literacy in Science

- **RST.1** Cite evidence when analyzing science texts
- **RST.9** Compare and synthesize information from a range of sources
- **W.4** Produce writing appropriate to task

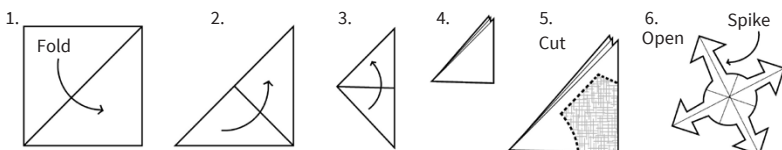
Time

75 minutes + additional time to complete activity sheets as needed

Materials

- *Pathways* magazine
- Paper, scissors, rulers
- Find Your Inner Scientist activity sheet
- Model mRNA Vaccine Science activity sheet
- Optional: Vocabulary sheet at [scholastic.com/pathways](https://www.scholastic.com/pathways)

Steps for Creating a Paper Pathogen



1 Ask student volunteers to take turns **reading** the magazine aloud. Acknowledge that many of us have been impacted by COVID-19. Discuss how science can be an empowering way to address a challenging situation.

2 In pairs, have students do the Find Your Inner Scientist activity sheet.

3 Model how to create a “paper pathogen” (see diagram below). **Direct** students to work in pairs and create a few paper pathogens of their own. Encourage pairs to experiment and come up with varied “spike” shapes.

4 Explain that a **pathogen** is an organism (e.g., bacterium, fungus, virus) that causes disease. Say: This pathogen is a virus. On its surface (point to spikes) there are **antigens**—substances your immune system recognizes as foreign to your body and so it produces **antibodies** in response.

5 Ask pairs to choose their most interesting paper pathogen and cut one of its **antigenic** spikes free. Have students observe and record a description of the antigen’s shape, its measurements, and the location of its notable features.

6 Then, tell students to **create** a one-page guide with **instructions** for how to create a copy of their antigen (students may template their antigen by tracing it).

7 Have students **trade** their guide with another student pair.

8 Ask pairs to use the instructions they’ve received to create four identical copies of the antigen and design four antibodies that can fight it. For

example, they may trace the antigen, then cut around that “negative space” to create shapes that fit the spikes like puzzle pieces. Affix them to a bulletin board.

9 Distribute the Model mRNA Vaccine Science activity sheet. Discuss which parts of their classroom activity represent real-world mRNA vaccine science. Have students fill in steps 1–4.

10 Point to the bulletin board. Ask students to explain how the body would react to a collection of new antigens. *Prompt for:* build antibodies.

11 Move one of the antigens to your whiteboard, draw a rectangle around it, and title it like a “Wanted / Have you seen this antigen?” poster. Explain that once your body creates enough antigen-fighting antibodies, it will “remember” and be on the lookout for the antigen. Hold up an intact paper pathogen, pointing to a spike. If the body encounters the antigen again, it will know what to do—reacting quickly with the right antibodies to fight an infection.

12 In groups, **finish** the Model mRNA Vaccine Science activity sheet.

13 Wrap up with a discussion about new and surprising learnings about vaccine science, careers in biomedical research, and questions students would like to research next.

Activity Sheet Answers: Classroom: 1. paper pathogens created, 2. observations recorded, 3. guides with instructions created, 4. instructions received and antigen copies made, 5. antibodies made, 6. “antigen wanted” poster created, 7. original pathogen/antigens revisited
Magazine: 1. COVID-19 outbreak, 2. Dr. Corbett computer sequencing, Dr. McLellan mapping the antigen, 3. instructions for producing spike protein in stabilized shape are packaged into lipid nanoparticles in the vaccine, 4. muscle cells make copies of spike protein, 5. immune system makes targeted antibodies, 6. memory cells remember instructions, 7. vaccinated immune system reacts more swiftly than it otherwise could, 8. COVID-19 vaccine trials enrolled 30,000 people

Name _____

Find Your Inner Scientist

There are many pathways to becoming a scientist—and many ways to combine science with what you already love to do!



Marcos J. Ramos-Benítez, Ph.D.,
Microbiology and
Immunology

Science is everywhere. There is science in drawing, music, and all aspects of our lives. In sports, there are tons of things to explore, like biomechanics, sports medicine, and data analytics.



Erin A. Mordecai,
Ph.D., Ecology of
Infectious Disease

Add math. Many students find that math is much more interesting outside of the textbook, in the real world, when it's used to solve problems—like how to stop the next pandemic!



Jason McLellan,
Ph.D., Molecular
Biosciences

Go ahead and game. Playing video games when I was younger taught me problem-solving and other ways of thinking—and to make connections between old and new challenges. I still play them!

Step 1: Circle or highlight your top interest(s) as well as your traits and skills, or add your own on a separate sheet. Reflect on how you can combine these to embark on a career in science.



Environment



Social Media



Math



Writing



Sports



Video Games



Science



**Computers/
Tech**



Art



Food/Cooking



**Travel/
Exploration**



Helping

Traits: Patient | Flexible | Creative | Caring | Curious | Analytical | Detail-oriented

Skill Areas: Communication | Numeracy | Logic | Critical Thinking | Organization

Step 2: Choose an area of research from the list below. Then, on a separate page, write a persuasive paragraph that explains how you could use your unique interests and skills to contribute to biomedical research and advancements in the area of research you chose.

Disease
Aging
The Brain
Biomechanics
(how the body moves)

Growth & Development
The Heart
Genetics
Pharmacology
(medications)

Immunology & Viruses
**Data, Modeling &
Artificial Intelligence (AI)**
Mental Health
Chronic Pain

Name _____

Model mRNA Vaccine Science

Which steps from your “paper pathogen” classroom simulation align with real-world mRNA vaccine science? Record related facts and information from your *Pathways* magazine to support your understanding.

In the Classroom		In the World	Supporting Facts and Information From the Magazine
Step 1		A new pathogen emerges that endangers human health.	
Step 2		Scientists work to identify the pathogen and use tech like genome sequencing and cryo-electron microscopy to identify the structure of an antigen (foreign substance) at the atomic level.	
Step 3		Scientists develop an mRNA vaccine that packages how-to instructions for building the antigen.	
Step 4		The vaccine is given to people in clinical trials. Cells in the body use the instructions to create copies of the antigen.	
Step 5		The immune system responds to the presence of antigens by creating antibodies.	
Step 6		The immune system stores a “memory” of the antigen so that it “remembers” what to do if it encounters it again.	
Step 7		If the body encounters the virus, the immune system recognizes the antigen and is prepared to react swiftly to fight infection—quickly generating the antibodies it already knows how to make.	
Step 8		Scientists analyze data from clinical trials to confirm the vaccine is safe and effective; then it’s given to the general public.	