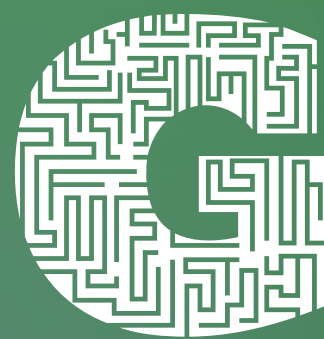


Selective breeding and GMOs



GROW
NEXT GEN

Let's see what people think

Jimmy Kimmel interview

Critics of genetically modified organisms (GMOs) claim that they pose health risks to the public. Jimmy is always interested in people who have strong opinions, so we sent a crew to one of our local farmers markets to ask people why they avoid GMOs and, more specifically, what the letters GMO stand for.

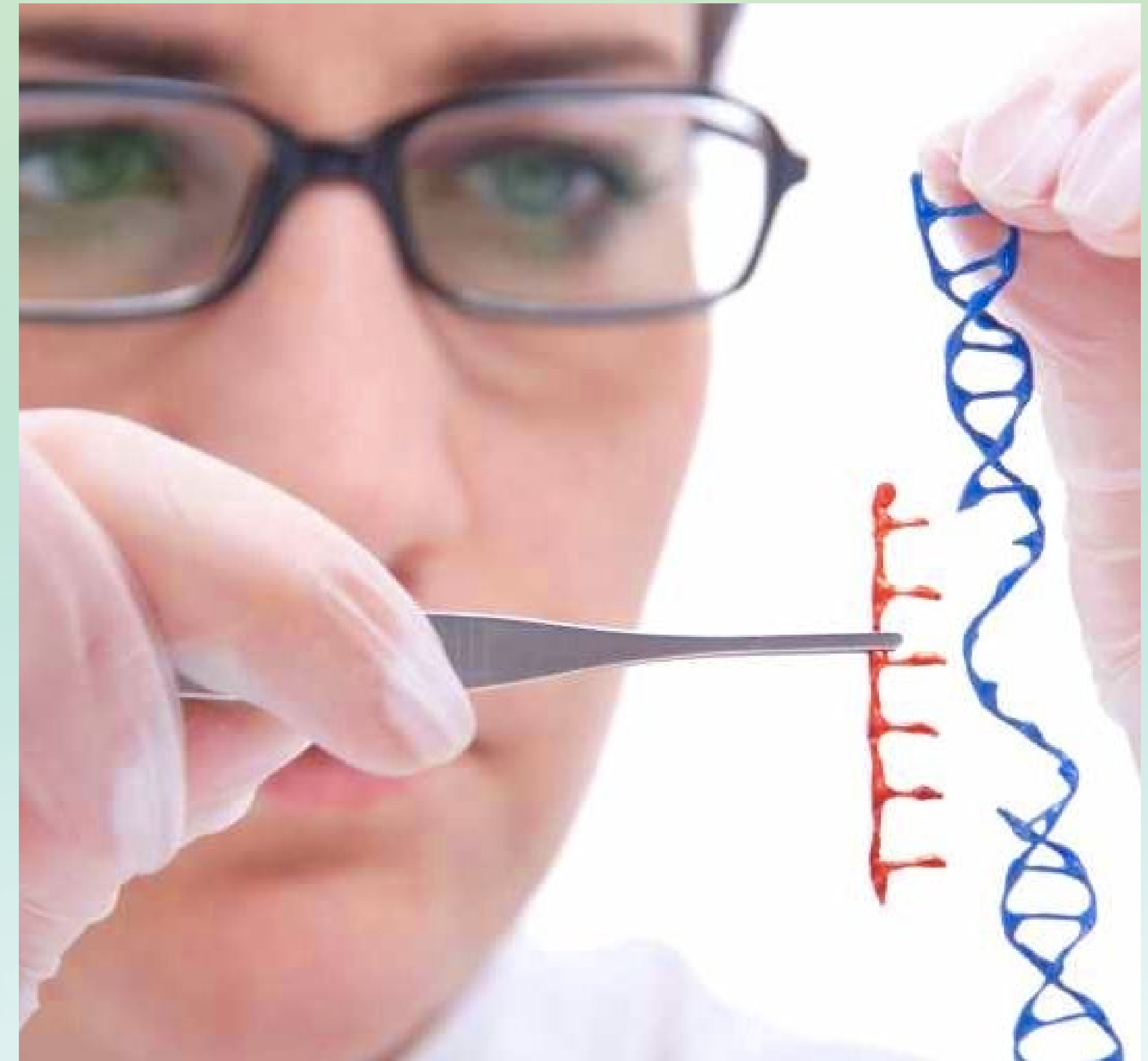


youtu.be/EzEr23XJwFY

What makes something genetically modified?

That is a tough question...

Humans have been selectively breeding for over 2000 years. Look at the many breeds of dogs, horses, and the variety of crops. Are these genetically modified?



What is a GMO?

A GMO is an organism whose DNA has been changed through any one or more of a variety of processes.

- **Selective breeding:** Creating hybrids with genes for soybean aphid resistance
- **Experimentally controlled mutation:** Using chemicals to cause specific changes in DNA—has been used in cancer research
- **Insertion of a gene from a different organism:** Usually using a bacterium or virus as a carrier (i.e. Roundup Ready soybeans)
- **Silencing:** “Turning off” a gene that creates a less desirable trait (i.e. high-oleic soybean oil)

How long have we been doing this?

Timeline activity

- You have a card that has an event or person on it, or one that has the date and a description.
- Find your match. If you have the date and description, find the person or event...
- Line up in order of the event dates, oldest to newest.
- Read off your event and description.

Case study

- Soybean aphids are an invasive species that can impact yield.
- It is estimated that the combined loss of yield and cost of fighting soybean aphids is \$2–\$5 billion each year.
- Soybeans have some natural resistance to these pests, but farmers want to improve the chances that their beans will be protected.
- Breeders (seed companies) work to create “stacked” genes that will help to protect the yield using selective breeding.
- The genes that determine resistance are *Rag* genes. We will use two forms: *Rag1* and *Rag2*.

Selective breeding activity

- You have three Starburst candies. These candies represent the traits that determine resistance to soybean aphids.
- Stack your three Starburst and determine your trait combinations using the following table.
 - **Red** is *Rag1*
 - **Pink** is *Rag2*
 - **Yellow** (or any other color) has no resistance

Table of traits for soybean aphid resistance

R	R	R	R	R	R	P	P	P	Y
R	R	Y	R	P	P	P	Y	P	Y
R	Y	Y	P	P	Y	Y	Y	P	Y
<i>Rag1</i>	<i>Rag1</i>	<i>Rag1</i>	<i>Rag1&2</i>	<i>Rag1&2</i>	<i>Rag1&2</i>	<i>Rag2</i>	<i>Rag2</i>	<i>Rag2</i>	<i>None</i>

Find another person at your table and combine your Starbursts.

Offspring results

- Place your six traits in the cup
- Shake the cup
- Draw out three Starbursts (traits)
- Note your combination of traits
- Repeat two more times, noting the result each time



Table of traits for soybean aphid resistance

R	R	R	R	R	R	P	P	P	Y
R	R	Y	R	P	P	P	Y	P	Y
R	Y	Y	P	P	Y	Y	Y	P	Y
<i>Rag1</i>	<i>Rag1</i>	<i>Rag1</i>	<i>Rag1&2</i>	<i>Rag1&2</i>	<i>Rag1&2</i>	<i>Rag2</i>	<i>Rag2</i>	<i>Rag2</i>	<i>None</i>

Rag1 and *Rag2* together are most resistant. *Rag1* and *Rag2* are dominant to plants with no resistance, so if your stack has either *Rag*, the offspring will have resistance.

Create a new cross with maximum resistance to soybean aphids

Using your offspring, find another group with an offspring who will increase your plant's resistance to aphids.



Reflection

- How did the offspring from your cross differ from the “parents”?
- What traits do your offspring have?
- The first process we used is random and the offspring are not predictable. However, scientists can select for traits they desire and there are predictable results, but the ratios of offspring do not always produce 100% what we want each time. The second time, we were more selective... selective breeding!
- These traits (soybean aphid resistance) are controlled by many genes on different areas of several chromosomes.
- Seed researchers can selectively breed for resistance.

What is the advantage of advanced biotechniques (such as selective breeding or genetic engineering)?

- What did you discover?
- What is the advantage of advanced biotechniques (such as selective breeding or genetic engineering)?
- Why does it matter?
 - There are estimated to be over 9 billion people by 2050.
 - They all need a safe and steady food supply. GMOs can help meet that need.

Which crops are GMO? (Only 13!)

- Alfalfa
- Arctic Apple
- Canola
- Cotton
- Corn (field and sweet)
- Eggplant
- Papaya
- Pineapple (pink)
- Potato
- Salmon (AquAdvantage)
- Soybean
- Squash
- Sugar beet

What's happening now?

- We are using both traditional methods of breeding and other techniques (gene insertion, gene silencing, and CRISPR) to boost yield in both corn and soybeans.
- Learn more about GMOs: GMOanswers.com
- Learn more about careers in agriculture: grownextgen.org/careers

GrowNextGen: High-quality STEM resources for agriculture science

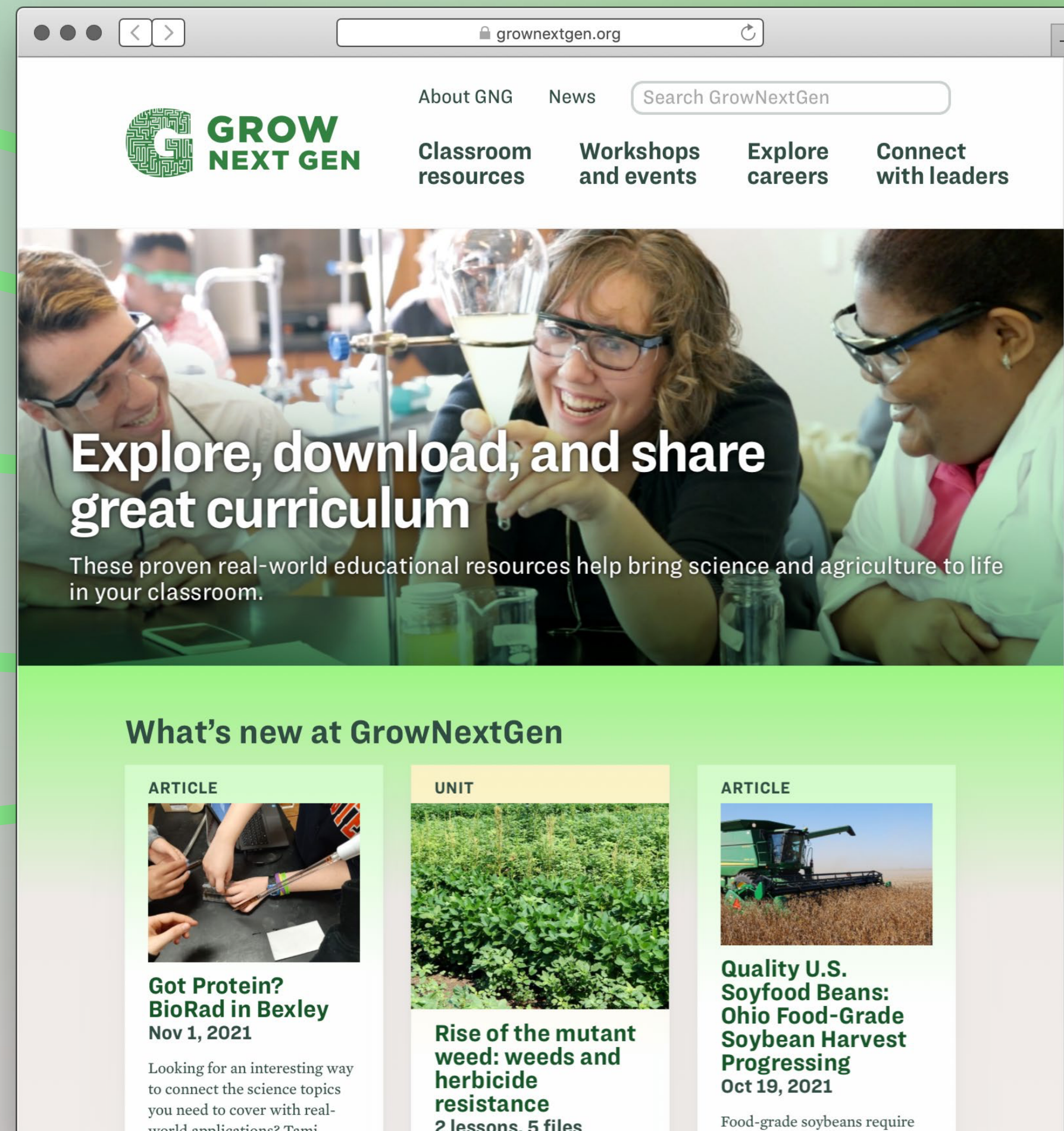
Classroom success stories

Virtual field trips

Student research projects

Teacher leaders

Industry experts



Curriculum

Teacher workshops

E-learning

Career videos

Generously provided by the Ohio Soybean Council