CRISPR and Food: What We Know So Far

THE GMO BREAKTHROUGH EDUCATION PROJECT

Transforming Global Food Systems through Education

Darryl Benjamin
Real Food Seminars
Montpelier, Vermont
darryl@realfoodseminars.com
802 585 5855

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What is CRISPR?

- CRISPR/Cas9, is essentially a pair of molecular scissors for cutting DNA, so precise and easy to use that it has “taken biology by storm.”
  - Deletes individual segments of DNA: a “molecular scalpel”
  - Companies like Calyxt have portrayed gene editing more like moving the cursor in a word processor to a particular location and making a small change to the text
  - Cheap, quick and easy to use
- Acronym: **Clustered Regularly Interspaced Short Palindromic Repeats**
- Powerful immune defense: Genetic Library of Viruses
- CRISPR can make precise mutations by substituting existing DNA sequences with desired ones. It can disable whole genes by snipping them out or via imprecise repairs that knock out gene function.
- The Cas9 enzyme itself can be manipulated to enhance or suppress gene expression — a powerful way of controlling genes
- Genetic Engineering Will Change Everything Forever – CRISPR

How will CRISPR used in Agriculture and Food?

- A CRISPR-tweaked farm system could have a smaller environmental footprint and even humanitarian benefits, if it means farmers don’t have to dehorn cattle or cull their male bulls.
- Disease-resistant wheat and rice
- De-horned cattle
- Disease-resistant goats
- Vitamin-enriched sweet oranges
- Leaner pork

Pros and Cons

PROs

- The ease and low cost may make genome editing a viable option for smaller, specialty crops, as well as animals.
- The method could eventually be used to tweak almost everything we eat, allowing researchers to select traits that make agriculture more sustainable and productive and our food more nutritious.

CONs

- Mentality that “as long as it works, we don't have to understand how or why it works.”
- With gene editing, there's no longer the ability to really track engineered products,” says Jennifer Kuzma, who studies science policy at North Carolina State University in Raleigh. “It will be hard to detect whether something has been mutated conventionally or genetically engineered.”
- “Off-Target Effects”
- No guarantee of desirable outcome
- The genes used will only work well in in certain genetic backgrounds and environments.

Is CRISPR acceptance predicated on GMO rejection?

- Before CRISPR's precise single-gene cutting, GMOs were made by inserting a gene into the genome at random positions, along with sequences from bacteria, viruses or other species.
- For all the attention to precise edits that do not introduce foreign genes (GMOs), it's important to understand that CRISPR is highly adept at that kind of modification too. Using CRISPR, wheat, corn, pigs, bananas — any agricultural organism, really — could be engineered to include gene sequences from a range of donors: microbes or fungi or fish. "You can easily use CRISPR-Cas9 to edit virtually any genome with your desired donor DNA," explains Fuguo Jiang, a postdoctoral fellow in Doudna's lab. "That is the power of gene editing."

How is CRISPR is being used to modify what we eat?

- **Commodity crops**. Researchers at DuPont and Caribou Biosciences are using CRISPR to create plants that are **drought resistant** and produce **higher yields**. The new plants should hit the market in five to 10 years– remarkably faster than the 10 to 17 years it takes most biotech crops.
- **Bananas**. The Cavendish banana, the most common type, is on the verge of extinction due to a fungal disease. But Korean researchers are attempting to save it, using CRISPR to snip out the receptor that the fungus uses.
- **Pigs**. A group of Chinese researchers have created a pig that is extra muscly, so it can yield healthier cuts of pork, while American researchers have successfully edited pigs to make them resistant to porcine reproductive and respiratory syndrome, a common disease that costs farmers $600 million a year.
- **Peanuts.** In Ireland, researchers at Aranex Biotech are working on a hypoallergenic peanut. Though the enterprise is in its early stages, their use of CRISPR to remove genes that contain allergens may be the most promising attempt yet to create a new crop of allergy-free peanuts.

Is CRISPR regulated?

- By ‘editing’ plant genes, companies avoid regulation.
- The USDA doesn’t consider CRISPR food a GMO when the technique is used to simply delete a gene, rather than add anything from another species.
- Lack of an overarching sustainability or justice directive for genomic agricultural science.
- The key to making good decisions, first of all, is to understand that not all applications of CRISPR are created equal — or have equal implications for the sustainability of agriculture.
- The European Commission has not yet decided how it will treat genomic editing, including CRISPR. Nor has the U.S. Food and Drug Administration confirmed whether CRISPR animals will be regulated in the future.
- In Nature Biotechnology, plant researchers at the University of California, Davis, wrote that the regulatory framework had become “obsolete and an obstacle to the development of new agricultural products.”
- “There’s not this blockage of transgenesis that freaks out people for no reason,” he said. “I think it is a question of perception.” (André Choulika, chief executive of Cellectis, one of the companies developing gene-edited crops)
- Critics warned that the industry is repeating the same mistakes of GMOs.
- A USDA advisory board in November 2016 unanimously recommended that standards for organic foods exclude gene-edited crops even if they were grown without chemical fertilizers and abided by the other strictures of organic farming.

Who are its major proponents (who stands to benefit)?

- Berkeley-based **Caribou Biosciences** has teamed up with DuPont to work on CRISPR-edited commodity crops such as corn, soybeans, canola, rice, and wheat, which they expect to have on the market in five to 10 years.
- **Cibus**, a San Diego-based startup making CRISPR-edited flax, position their products as a non-GMO food.
- **Monsanto** has licensed the use of CRISPR-Cas genome-editing technology from the Broad Institute at Harvard University and MIT.
- Mission Statement: "**Calyxt**, Inc. is a fast-growing, consumer-oriented ag company that utilizes its innovative, patented TALEN® technology to usher in a new era of agriculture and develop crop products with healthier characteristics for consumers – all the while helping farmers and food and agriculture industries reduce their environmental footprints in the context of climate change. Calyxt believes that agricultural technologies can have a profound, positive impact on humanity and is looking to engage those who share this passion for food and agriculture. Calyxt is located in Minneapolis-St. Paul, Minn., and is a wholly owned subsidiary of Cellectis. Our motto is '**Healthier Food for a Better Life**'."

Why should we be concerned?

- Should we really be enabling farmers to spray more glyphosate into their fields when the World Health Organization has found the chemical to be a “probable” carcinogen and when it’s been associated with collapsing populations of monarch butterflies?
- Using gene drives to snuff out wild organisms because they carry diseases or nibble on crops could have serious unintended consequences, such as destabilizing food webs and facilitating invasions by other species.
- Is scaled-up livestock production what society should now be chasing at all, given the environmental and public health upshots of intensive animal farming — not to mention mounting medical evidence that people should eat less meat?
- Unregulated gene-edited crops could create trade havoc if traces of them accidentally mixed into exports to countries that prohibited them.

How do we promote responsible use and public awareness?

- **Protect against unintended consequences.** If we want to make sure this powerful technology promotes just and sustainable food, we'll need to accompany its development with a **policy framework** that reflects the nuances of its biology and its diverse applications — and that responds to the concerns of people who are affected when technologies migrate from lab to land.
- **Transparency.** To ensure benefits outweigh downsides will require a change more revolutionary than any tech breakthrough: an **inclusive process for deliberating on** and providing adequate societal **oversight** of risks, trade-offs and opportunity costs of CRISPR engineering. It will hinge on the **involvement of everyday people** — not just scientists or companies — in decisions about the food system.

Resources for Change on our websites:

- Facebook: https://www.facebook.com/breakthroughgmoeducation/
- Website: http://www.breakthroughgmoeducation.org/wp-login.php

Take a Stand

It's up to us to generate change!

Demand:

"NO DATA, NO MARKET!"

"PEOPLE FIRST, THEN TECHNOLOGY!"

Four things you can do:

1. Appeal to government agencies to require transparency in our food system. (See resources on our website: www.breakthroughgmoeducation.org).
2. Integrate awareness of fabricated and engineered foods into your daily lives by adopting a more healthy and sustainable lifestyle.
3. Educate others in your community and family, growing the circle of awareness.
4. Share it forward: think of three people you will share this information with.

We Have a Right to Healthy Food

We have a right to the purity of our food. We have the right to know if our food is real or engineered/fabricated. We should feel safe that our families, members of our community, and future generations will live long, healthy lives that are not compromised by our food supply.

Commit to a single act to promote transparency in engineered/fabricated foods.

- Demand transparency in labelling
- Demand transparency in safety assessments
- Demand transparency in scientific research (positive and negative)
- Demand transparency in marketing: who will benefit?
- Demand public involvement in decision-making
- Support sustainable food and farming