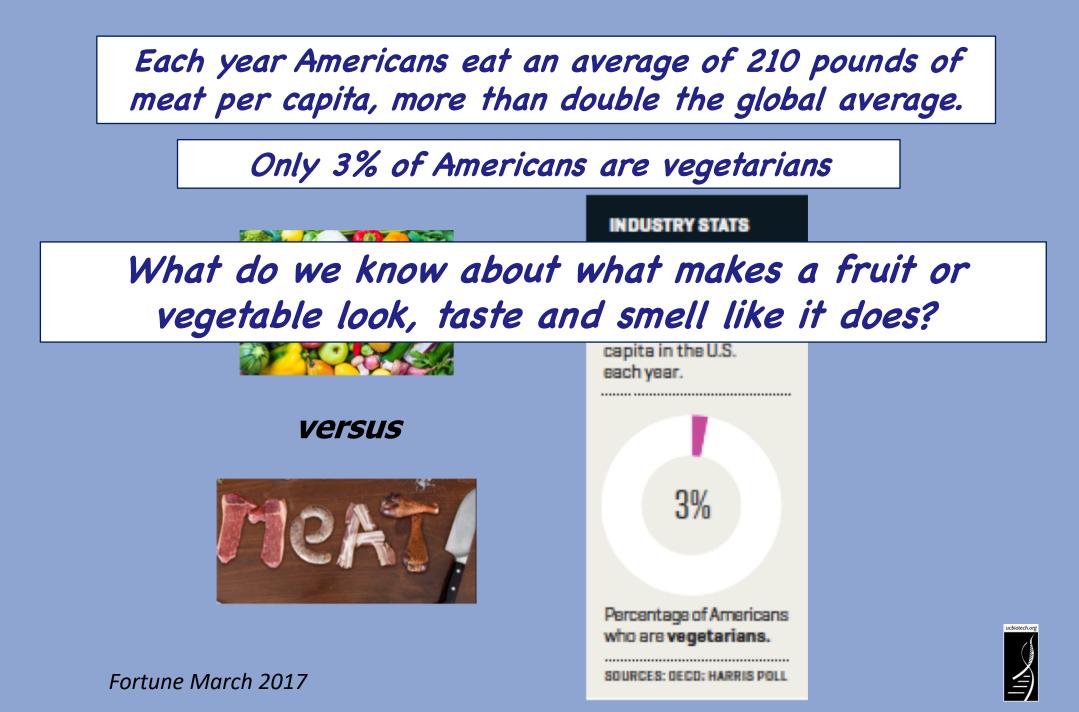
Foods: Past, Present and Future

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HOW MUCH DNA DOYOU EAT?



First we'll start with some basics about genetics...

All living things have DNA, the cnemical that contains all information responsible for the way it looks and how it works. That chemical, a string approximately 5 feet long, can be isolated. The isolated DNA in each food is seen in the tube on the right.



Please tell me whether you think the following statement is true or false: Genetically modified foods have genes and non-genetically modified foods do not.



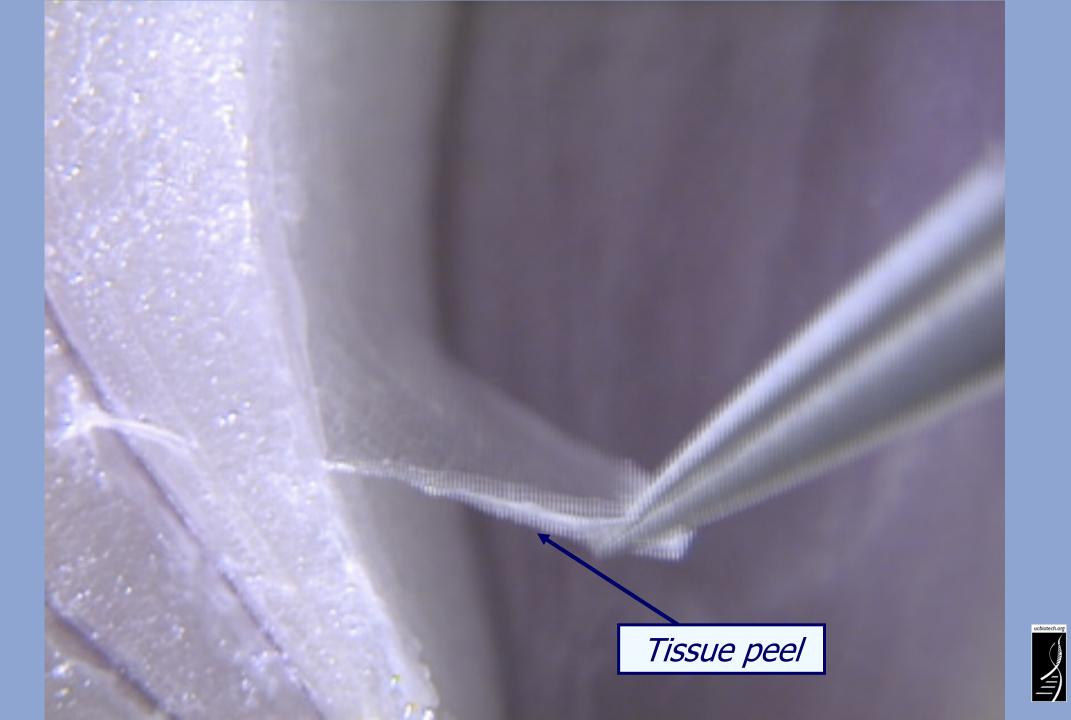
HOW MUCH DNA DOYOU EAT?

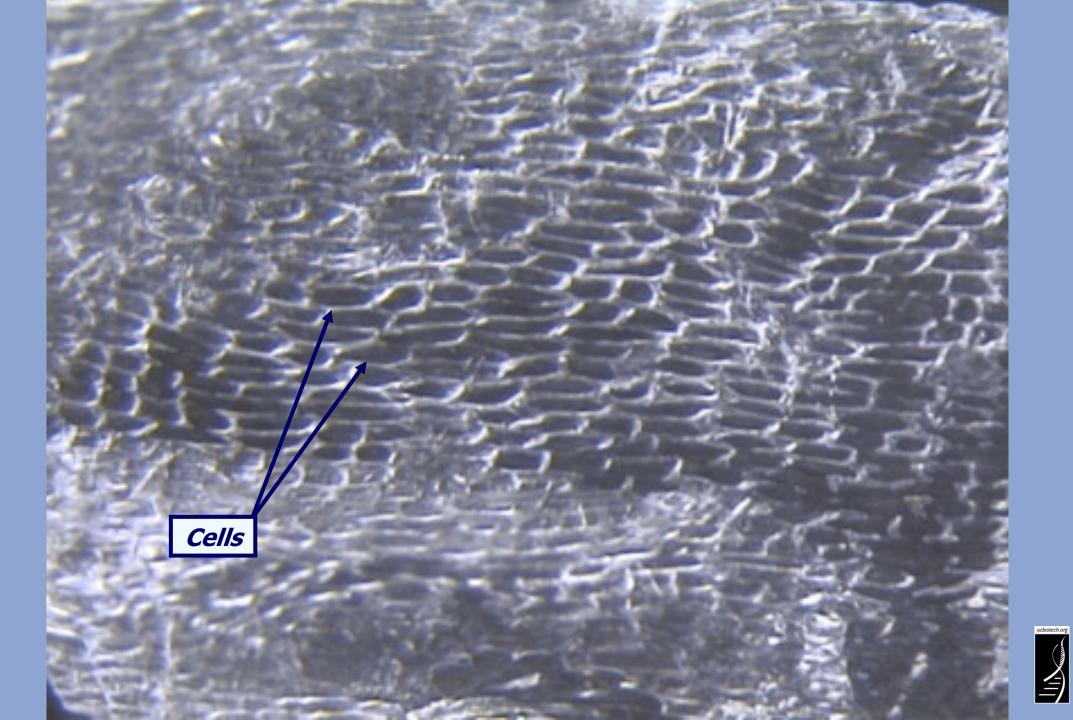


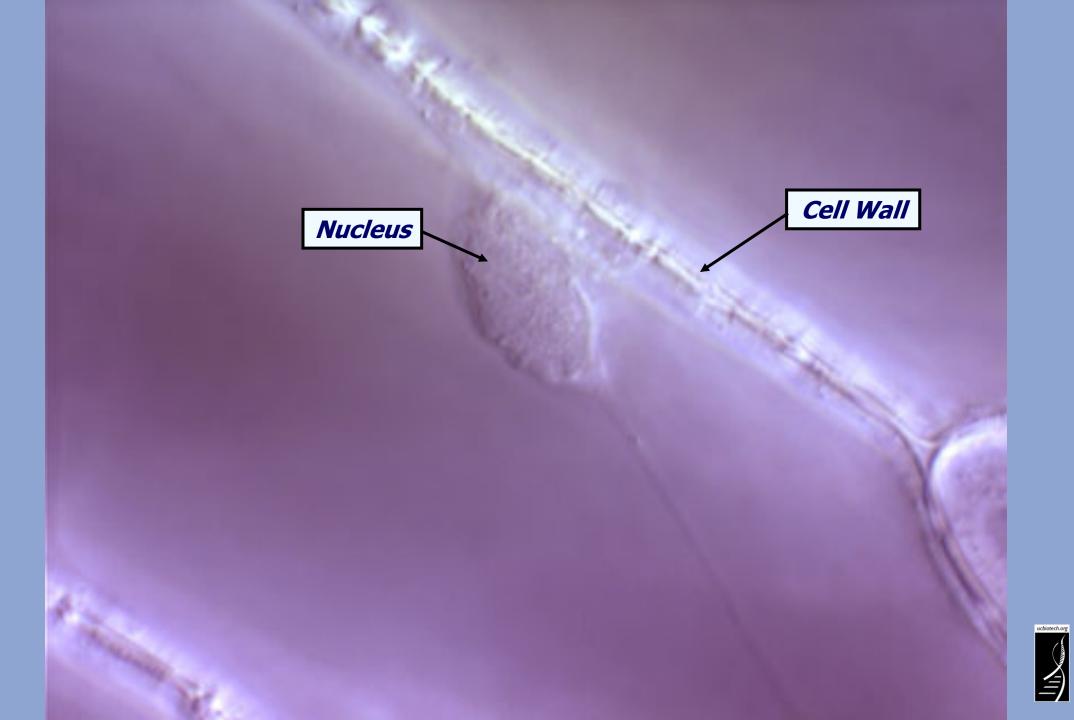


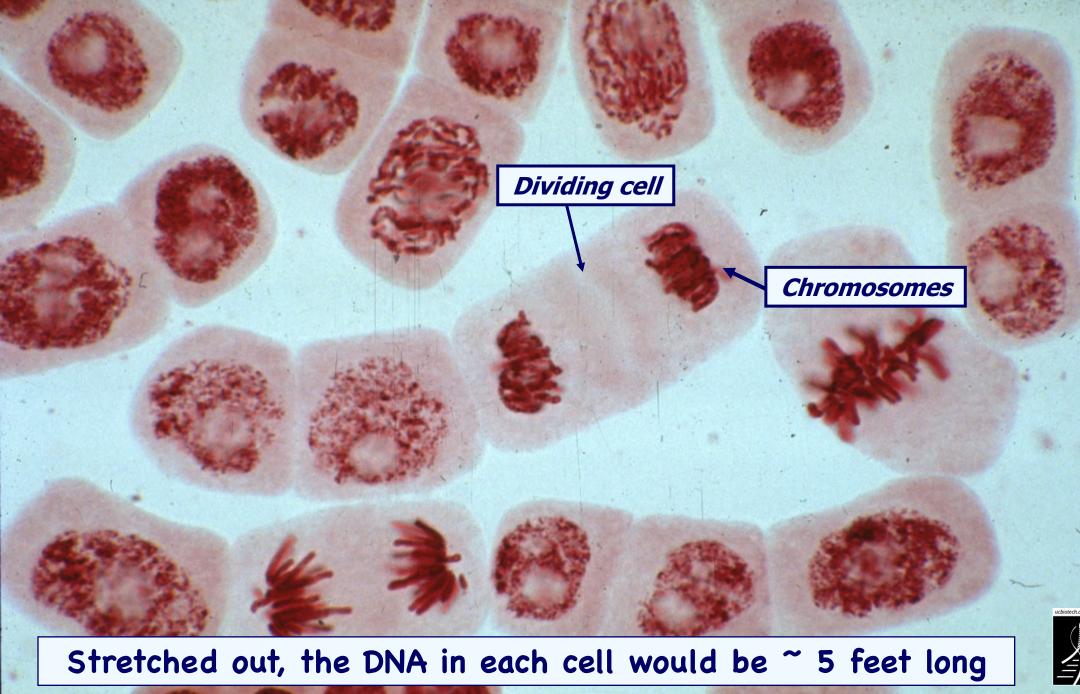
Or what makes an onion, an onion?







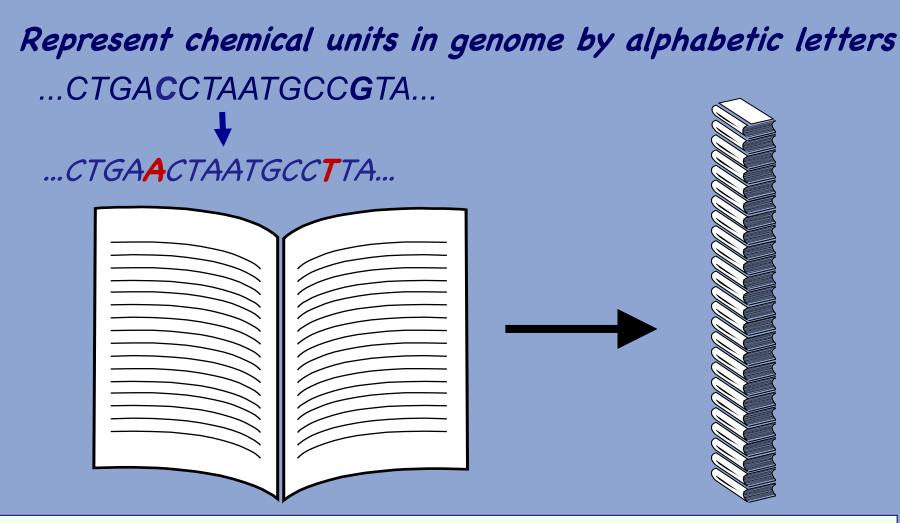








Genetic information in the genome is responsible for traits



Sometimes mistakes happen when copying information in books (genome) \rightarrow creating changes, called mutations





Mutations Have Gotten These Plants from Looking Like This...

To Looking Like They Are Now







Banana







Eggplant



Broccoli, Kale, Cabbage



Mutation breeding intentionally makes changes in a crop's DNA – >3200 officially released crops – like 600 maize, rice, wheat varieties, released since 1950's.



Van Eenennaam 11/29/2016

Photo by Stephen Ausmus, USDA



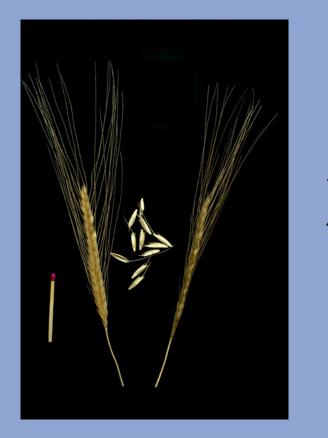
Modern Example

Japanese Farmer Creates Mongee Banana With Softer, Digestible Skin



2/22/2018 A-peeling? Japanese farmers invent edible banana skin | World news | The Guardian

How can genetics be used to create a wheat variety with better nutrition – using ancient wheat?





What happens to the genetic information from the two parents?

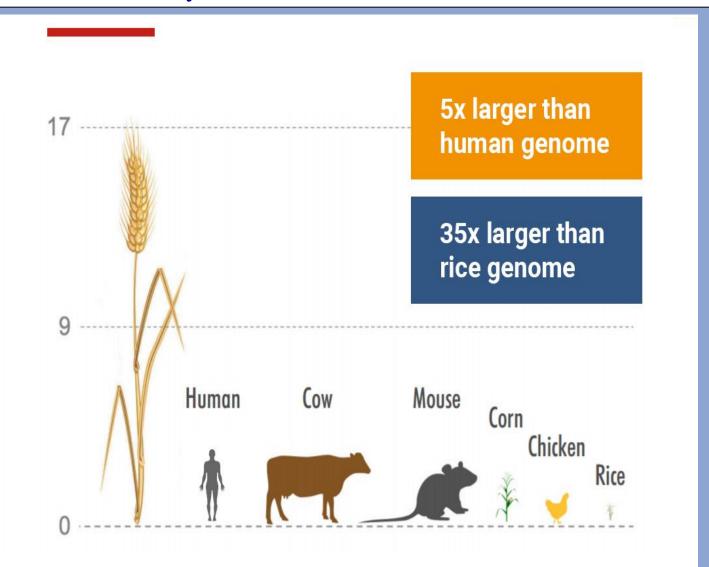
Triticum monococcumTriticum aestivumAncient varietyModern bread variety



Information in the wheat genome Chemical units represented by alphabetic letters ...CTGACCTAATGCCGTA... porta metus. Morbi a tincidunt 1700 books 1700 books (or 1.7 million pages) 1000 pages each

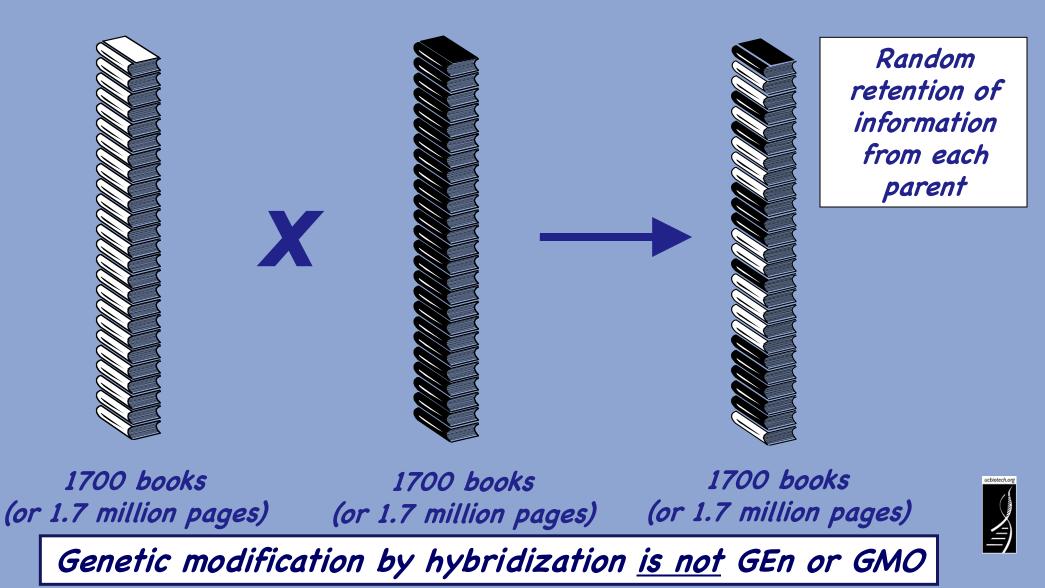


How does the genetic information (genome) in wheat compare to what's in a human?



Source: Earlham Institute communications team, Chris Bennett

Hybridization or cross breeding of wheat



Example: New soybean with lower allergenicity and less anti-nutritional qualities created after many years of breeding



SOURCE: "Triple Null: New Genetically Modified Soybean A Big Benefit For Food http://www.science20.com/news_articles.ou/e_null_new_genetically_modified_soybean_a_big_ben

r_food_allergies-1553

Putting this in context, these breeding efforts were critical to increasing crop production...

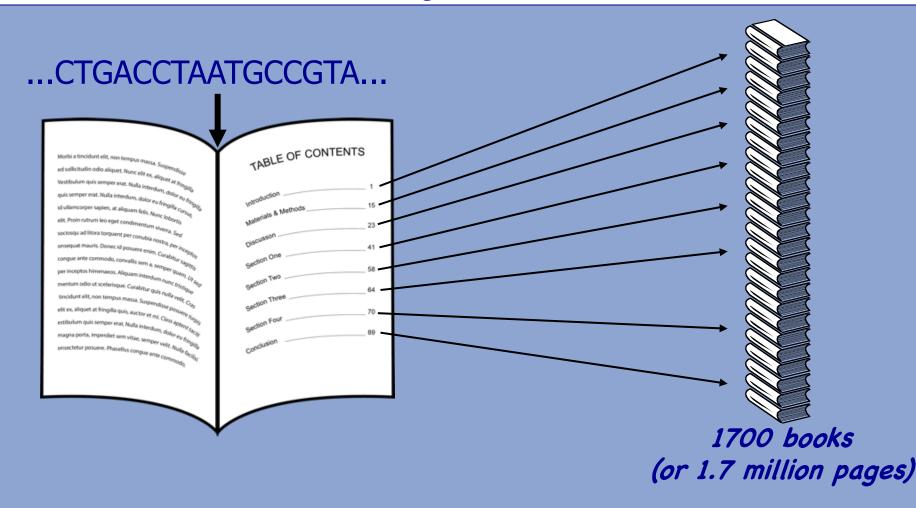
Product	2014 total production	2014 acreage	Acreage needed at 1950's rate	Additional Resources needed
Soybeans	3.927.090,000 bu 235,562,540,000 lb	82,591,000 acres	180,971,889 acres	~98 million acres (= size CA)
Corn	14,215,532,000 bu	83,136,000 acres	372,134,346 acres	~289 million acres (= 3X size CA)
Broiler Chickens	51,373,100,000 lbs	8,544,100,000 head	16,679,545,455 head	~8 billion head requiring 81.5 billion lbs feed



ucbiotech.org

New breeding methods

Uses table of contents of genes for <u>marker assisted selection</u>





Genetic modification that <u>is not</u> GEn or GMO

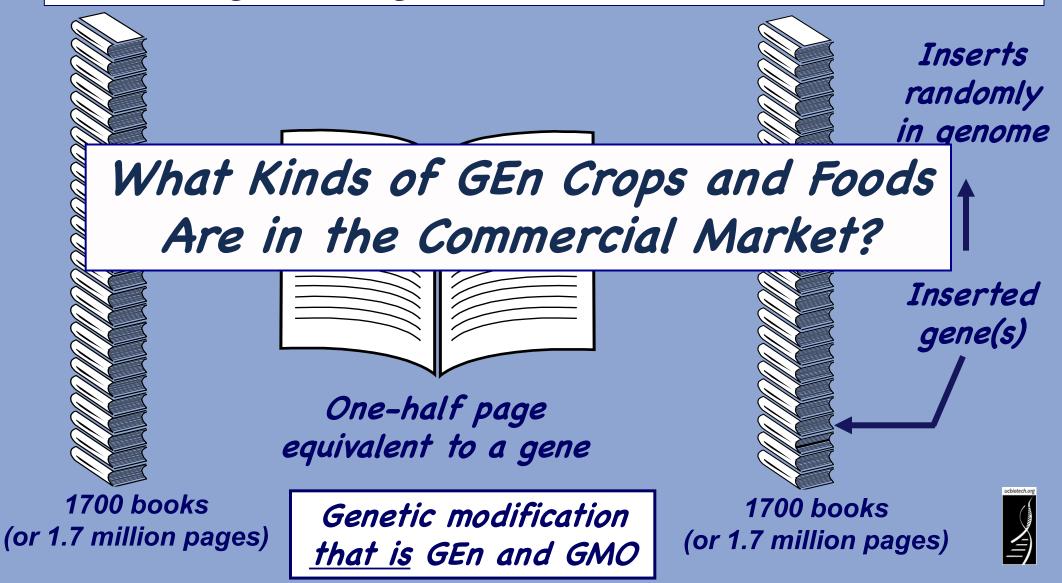


Marker-assisted selection used to protect rice against bacterial blight and blast disease

Limited to diversity in crop and compatible relatives



Another means to modify genomes uses genetic engineering (GEn) to create "GMOs"



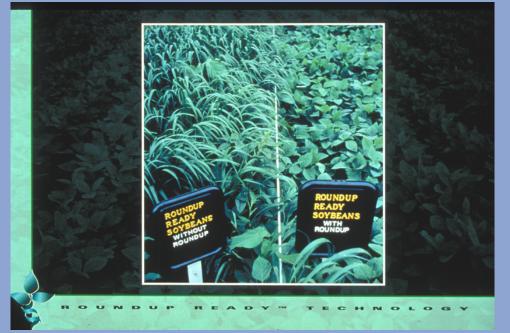
Number of different commercially available, large acreage GEn (GMO) crops is limited



These traits are not aimed at changing nutritional qualities



Insect-tolerant Bt crops engineered for resistance using gene from naturally occurring bacterium



Herbicide-tolerant engineered with gene to tolerate herbicide application





But because these are large-acreage GEn crops, it leads to estimates that 60-80% of processed foods in U.S. have GEn or GMO ingredients – mostly minor

SOURCE: https://factsaboutgmos.org/disclosure-statement

There are only a few whole, genetically engineered foods in the U.S market



Two more are just being introduced





Arctic Apple™

Introduced in 400 Midwest stores in Oct. 2017







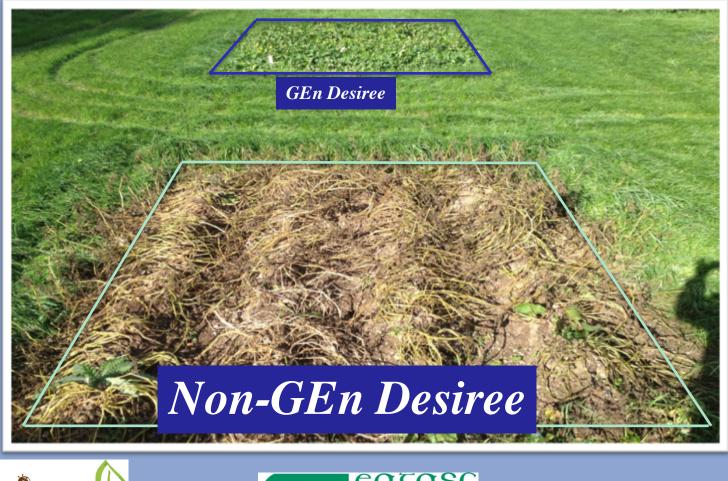


Field Trials in California with Grape Root Stocks Engineered for Resistance to Fanleaf Virus



SOURCE: http://www.democratandchronicle.com/apps/pbcs.dll/article?AID=/20080806/BUSINESS/808060336/1001

2013 engineered potato field study – Ireland Desiree potato variety, highly susceptible to late blight, engineered with gene from wild potato variety



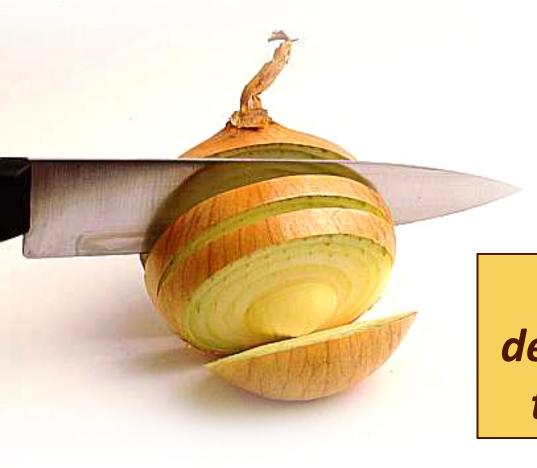












Tear-free onion developed by turning off tear-inducing enzyme



SOURCE: "Scientists create 'no tears' onions", Herald and Weekly Times, 2/1/08 http://www.checkbiotech.org/green_News_Genetics.aspx?Name=genetics&infold=16834

First Multi-nutrient Rice Engineered with Increased Iron, Zinc and Vitamin A



against-malnutrition/) Singh et al. 2017. Single genetic locus improvement of iron, zinc and β-carotene content in rice grains, doi:10.1038/s41598-017-07198-5. https://www.nature.com/articles/s41598-017-07198-5

SOURCE: "Multi-nutrient rice against malnutrition", Morning Ag Clips, 8/8/17 (https://www.morningagclips.com/multi-nutrient-rice-

Genetically modified wheat used to make coeliacfriendly bread



Daily bread: if gluten's not for you Superstock

Used genetics to knock out" 35 of the 45 gliadin genes involved in coeliac; efforts



Sanchez-Leon S. et al., 2017. Plant Biotechnology Journal September 18, 2017 DOI: 10.1111/pbi.12837

C John Innes Centre

High anthocyanin purple engineered tomatoes protect against cardiovascular disease and certain cancers. Diets with 10% purple tomatoes increased lifespan of cancer-prone mice



MIT Technology Review

Chinese Researchers Stop Wheat Disease with Gene Editing

Researchers have created wheat that is resistant to a common disease, using advanced gene editing methods.

By David Talbot on July 21, 2014

Advanced genome-editing techniques have been used to create a strain of wheat resistant to a destructive fungal pathogen – called powdery mildew – that is a major bane to the world's top food source, according to scientists at one of China's leading centers for agricultural research.

And now there is a new method of genetic modification: Genome Editing (GEd)

Advanced genome-editing techniques used to create wheat resistant to powdery mildew by deleting genes that repress defenses against mildew

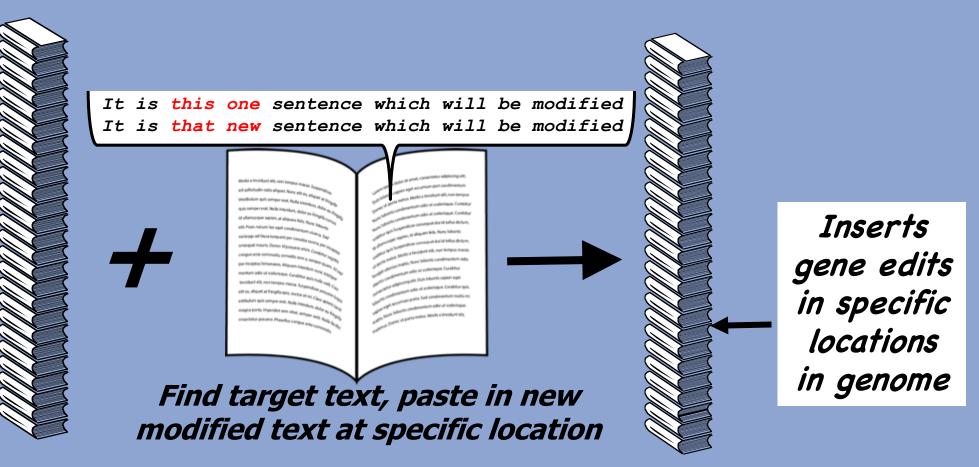
Also use genome editing to make tomatoes with more inner compartments and higher yields





Rodriguez-Leal, A. et al. 2017. Engineering Quantitative Trait Variation for Crop Improvement by Genome Editing. Cell 171: 480-490.

New Genetic Method: Genome Editing-1





EXAMPLES of such edited products:

nature

NATURE | NEWS

Gene-edited CRISPR mushroom escapes US regulation



University



A variety of camelina that's gene-ed- activity, thereby allowing it to produce ited to increase oil content can be grown more oil, said Kristi Snell, the compa-possibility of "stacking" the trait assowithout undergoing the USDA's regula-ny's chief science officer.

tory process for biotech crops. Camelina is an oilseed that's been The agency has determined the studied as an alternative crop in Eastern Camelina is an oilseed that's been

as CRISPR to "knock out" a gene from "You need to get the yield up to make camelina, eliminating a biological plant it viable."

Yield10 Bioscience is examining the ciated with increased oil content with Canelina motified using CRISPR

technology doesn't fail under the Turn to CAMELINA, Page 12 USDA's regulatory purview.



IHARE Coogler



A new genetically engineered corn variety developed by one of the world's largest seed companies won't undergo the same review by regulators as other GMO crops.

Company

A Capital Press

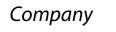
USDA won't regulate biotech wheat variety

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Company









The New Hork Times http://nyti.ms/2jmyzyo

SCIENCE

These Foods Aren't Genetically Modified but They Are 'Edited'

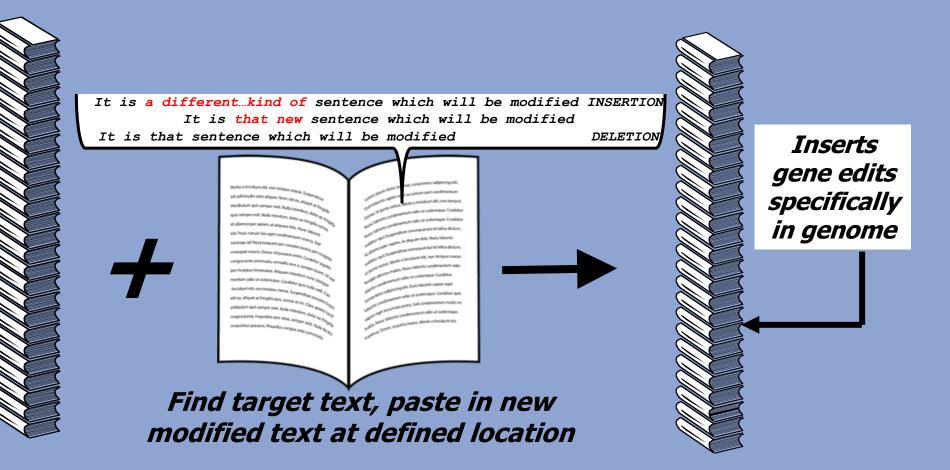
By KENNETH CHANG JAN. 9, 2017

In a few years, you could be eating the next generation of genetically altered foods - potatoes that do not turn brown or soybeans with a healthier mix of fatty acids.

And you may have no idea that something is different, because there may be no mention on the labeling even after a law passed by Congress last year to disclose

Cellectis, a company creating edited crops, hosted a dinner at Benoit New York, the Alain Ducasse Manhattan restaurant, and served dishes made from its gene-edited soybeans and potatoes. Guests included professors, journalists and celebrities like actor, Neil Patrick Harris.

New Genetic Method: Genome Editing-2





Michael will give you more information on Genome Editing

