GMO's – What in the World is Going On?

www.bereagardens.org

Bob Gregory

Dairy (rBGH)
Canola
Cotton
Sugar (beet)
Soybeans
Corn
Papaya
Squash (summer)
Flax
Potato
Tomato
Rice

Wheat
Apple
Plum
Melon
Chicory
Alfalfa
Tobacco

Yeast
Bacteria
Enzymes

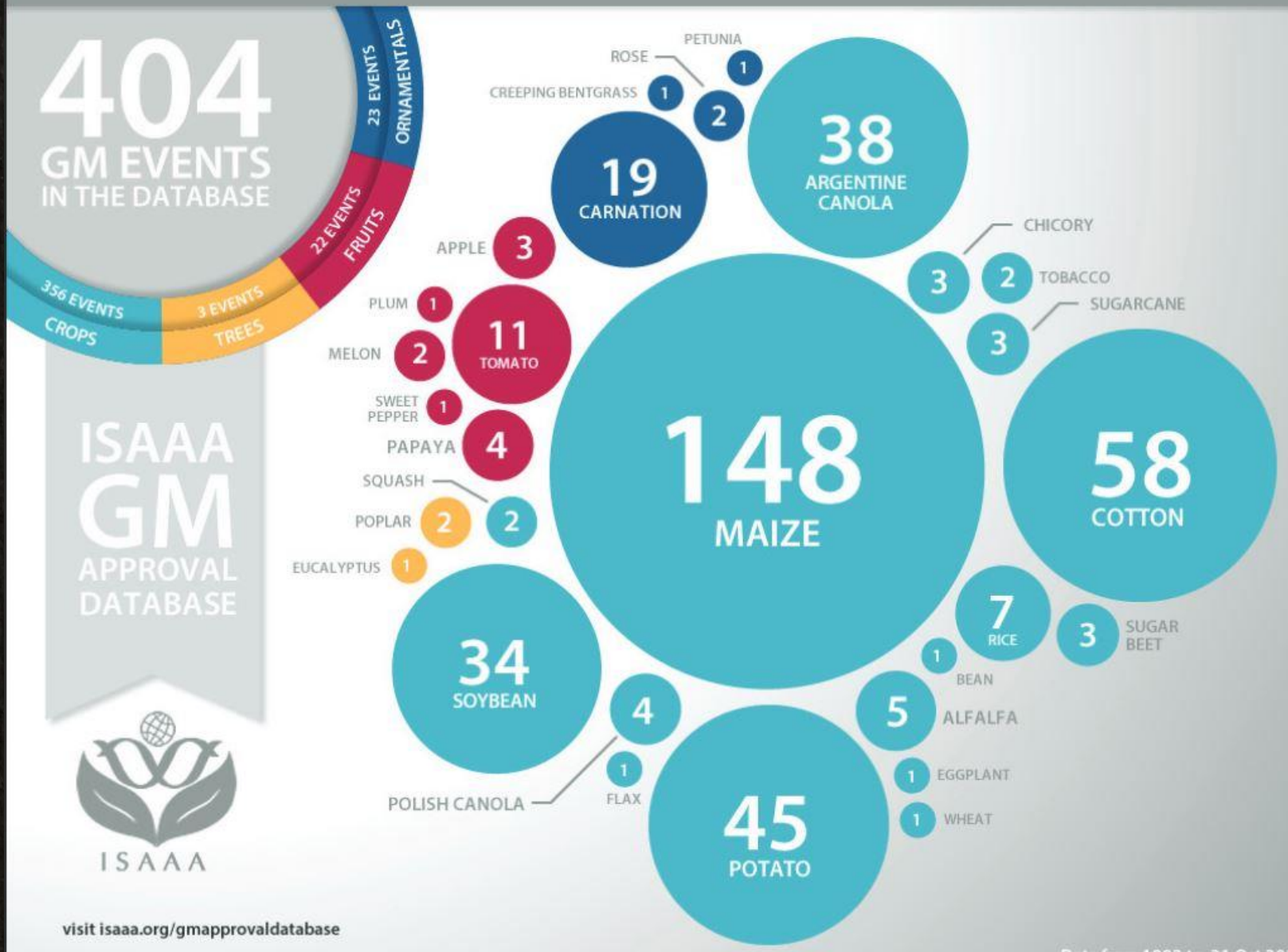
<u>U.S. Approvals only</u>

International Approvals (no labeling on imports)

Sweet Pepper
Eggplant
Sugarcane
Pineapple
Carnation
Creeping Bentgrass
Petunia
Rose
Poplar
Eucalyptus

39 other countries are currently developing GM crops, trees, insects and animals

Approved Transgenic Plant Events, 1992-2016



Do you know where biotech crops are grown?

More than 30 countries have planted biotech crops since 1996. See where they were grown in 2016.

18 Million
small, resource-poor farmers benefited from biotech crops in 2016

Biotech canola's adoption rate in Canada has reached **93%**

USA
is the largest producer of biotech crops in the world, planting 39.4% of global hectarage

Canada
USA
Mexico
Honduras
Costa Rica
Colombia
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina

8 countries
in Latin America plant biotech soybean

BRAZIL
is the top developing country in the world planting biotech crops

Czech Republic
Slovakia
Portugal
Spain

SPAIN
is the leading country planting biotech maize in Europe

7.2M
farmers in India planted 10.8 million hectares of Bt cotton in 2016

China
Vietnam
Philippines
Pakistan
India
Sudan
Myanmar
Bangladesh
South Africa
Australia

SUDAN
has been planting Bt cotton since 2012

2.1 Billion
hectares of biotech crops planted since 1996

- Soybean
- Maize
- Cotton
- Canola
- Alfalfa
- Eggplant
- Papaya
- Potato
- Poplar
- Squash
- Sugar beet
- Sweet pepper
- Tomato
- Pineapple

For more information on biotech crops, visit
www.isaaa.org

ISAAA

Source: ISAAA. 2016. Global Status of Commercialized Biotech/GM Crops: 2016. *ISAAA Brief* No. 52. ISAAA: Ithaca, NY.

Where are Biotech Crops Grown in the World?

26 countries planted 185.1 million hectares (457.4 million acres) of biotech crops in 2016, the 21st year of global commercialization of biotech crops

19
DEVELOPING COUNTRIES

7
INDUSTRIAL COUNTRIES

TOP 5 COUNTRIES GROWING BIOTECH CROPS IN 2016 (MILLION HECTARES)

USA	72.9
Brazil	49.1
Argentina	23.8
Canada	11.6
India	10.8

When is a GMO not really a GMO?

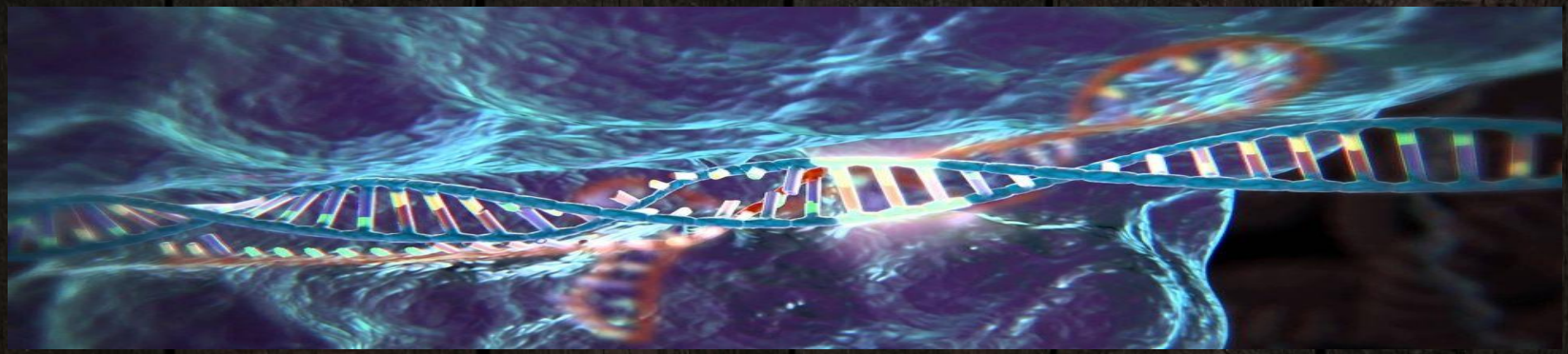
Defining “Transgenic”

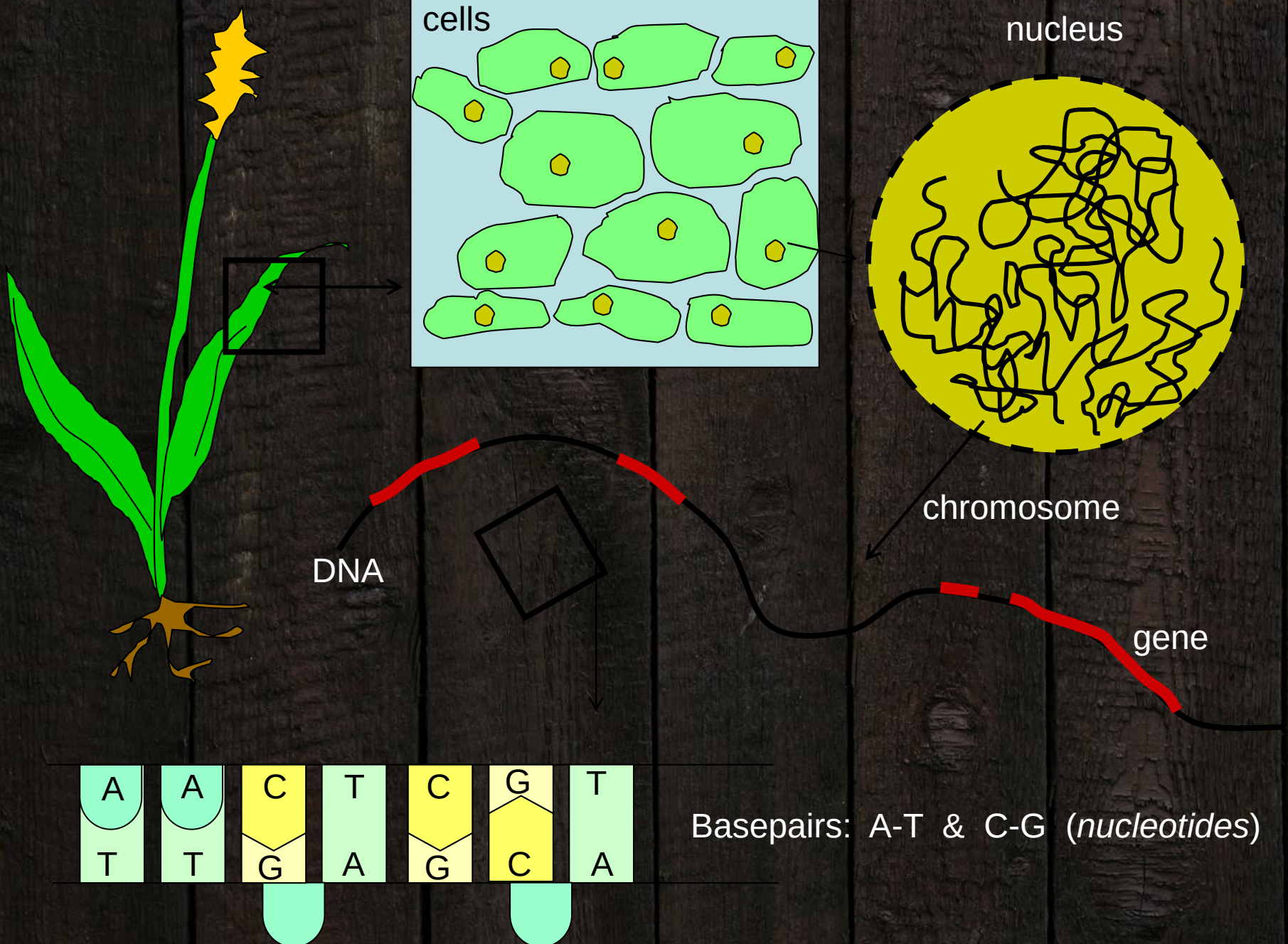
Using a GMO parent to hybridize next generation

Gene editing using CRISPR-Cas9

(Clustered Regularly Interspaced Palindromic Repeats)

(CRISPR associated protein 9)




cells
nucleus
chromosome
DNA
gene
A
T
A
T
C
G
T
A
C
G
G
C
T
A
Basepairs: A-T & C-G (*nucleotides*)

Epigenetics: "DNA Is Not Destiny" by Ethan Waters

Discover Magazine, November 2006

Dr. Randy Jirtle

Professor of Radiation Oncology

Duke University

"A Challenge to Gene Theory"

Denise Caruso

New York Times, July 1, 2007

Author "Intervention – Confronting the Real Risks of Genetic Engineering and Life on a Biotech Planet"

Using a GMO parent to conventionally breed a new variety

Approval of the GMO parent imparts a “deregulated” status that is conferred to any offspring

Any patent on the original GMO is for the genetic trait and the patent can follow the “gene” even though a new variety is the result

New varieties derived in this fashion encounter no regulation or testing of any fashion.

Gene editing using CRISPR-Cas9

(Clustered Regularly Interspaced Palindromic Repeats)

Q: What responsibilities do developers have if they want to bring to market a product derived from a plant developed using genome editing technologies?
A: Any company looking to market foods made with genome editing techniques is responsible for complying with all applicable laws and regulations. For more than 20 years, developers have routinely consulted FDA about the safety and regulatory status of foods from new genetically engineered plant varieties prior to marketing. FDA intends to continue offering consultations for developers of new plant varieties, including those produced using genome editing, in order to help developers ensure that applicable safety and legal questions are resolved prior to marketing of food products derived from such new plant varieties.
Q: Has the FDA completed any voluntary consultations for genome edited plant varieties intended for animal or human food?
A: As of January 18, 2017, the FDA has not completed a voluntary food safety consultation on food derived from a plant produced using genome editing.

https://www.fda.gov/Food/IngredientsPackagingLabeling/GEPlants/ucm537109.htm

CRISPR is actually a naturally-occurring defense mechanism found in a wide range of bacteria. As far as back the 1980s, scientists observed a strange pattern in some bacterial genomes. One DNA sequence would be repeated over and over again, with unique sequences in between the repeats. They called this odd configuration “clustered regularly interspaced short palindromic repeats,” or CRISPR.

Scientists realized the unique sequences in between the repeats matched the DNA of viruses—specifically viruses that prey on bacteria. It turns out CRISPR is one part of the bacteria’s immune system, which keeps bits of dangerous viruses around so it can recognize and defend against those viruses next time they attack.

The second part of the defense mechanism is a set of enzymes called Cas (CRISPR-associated proteins), which can precisely snip DNA and slice out invading viruses. Conveniently, the genes that encode for Cas are always sitting somewhere near the CRISPR sequences.

Here is how they work together to disable viruses, as Carl Zimmer elegantly explains in Quanta:

As the CRISPR region fills with virus DNA, it becomes a molecular most-wanted gallery, representing the enemies the microbe has encountered. The microbe can then use this viral DNA to turn Cas enzymes into precision-guided weapons. The microbe copies the genetic material in each spacer into an RNA molecule. Cas enzymes then take up one of the RNA molecules and cradle it. Together, the viral RNA and the Cas enzymes drift through the cell. If they encounter genetic material from a virus that matches the CRISPR RNA, the RNA latches on tightly. The Cas enzymes then chop the DNA in two, preventing the virus from replicating.

There are a number Cas enzymes, but the best known is called Cas9. It comes from Streptococcus pyogenes, better known as the bacteria that causes strep throat. Together, they form the CRISPR/Cas9 system, though it's often shortened to just CRISPR.

Some of the CRISPR Edited crops in commerce

Simplot - Innate Potato
Okanagan Specialty Fruits Inc. – Arctic Apples

Penn State – White Mushroom
Del Monte – Pink Pineapple

Floodgates are open for hundreds of new introductions

Lobbying efforts are taking place to consider CRISPR gene edited crops to be qualified for Organic Certification

Independent research indicates high potential for collateral unintended mutations