Diploma e Master Universitario in Alti Studi Europei
Collegio Europeo di Parma

Course on:

"EU Food Law and Policy"

2023

Prof. Patrick Deboyser

7

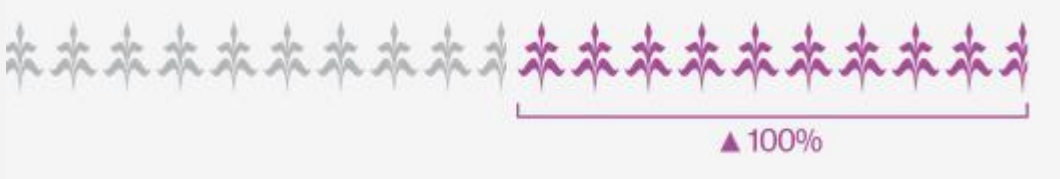
" Genetically Modified Food"

Wednesday 17 April 2024

The Growing World Population

By 2050 the world's population will likely increase by more than 35 %.

To feed that population, crop production will need to double.



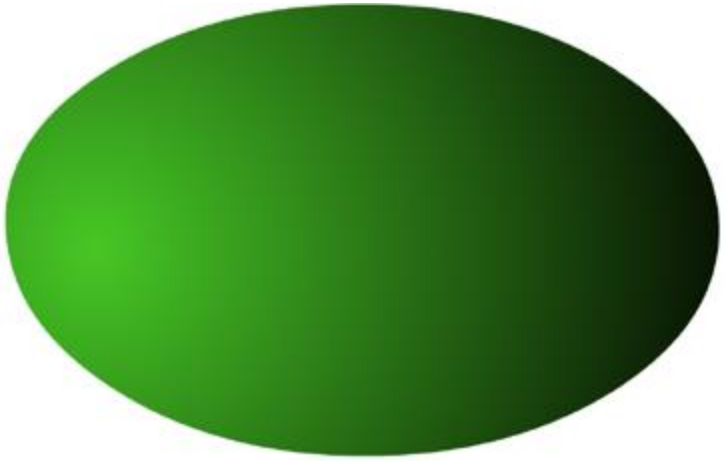
The Green Revolution (1960-2000)

Between 1960 and 2000, yields for all developing countries rose:
- 208% for wheat,
- 109% for rice,
- 157% for maize,
- 78% for potatoes.

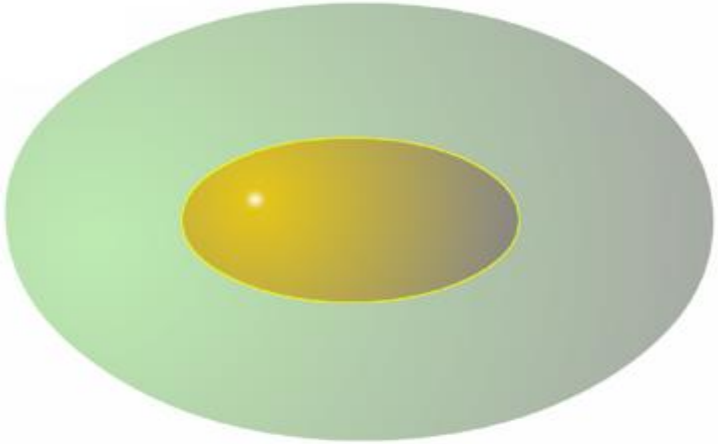
Source: FAO (2004) The State of Food and Agriculture 2003–2004

It came at a very high cost:
- reduction of agricultural biodiversity,
- effect on soil,
- resistance to pathogens,
- increase use of agrochemical, (fertilizers, pesticides, etc.),
- overuse of ground water.
-

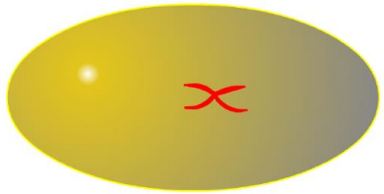
A single plant cell.



Inside the cell is a component called the “nucleus”.

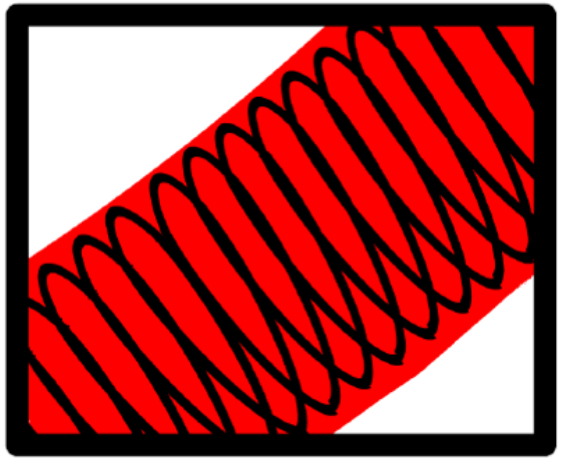


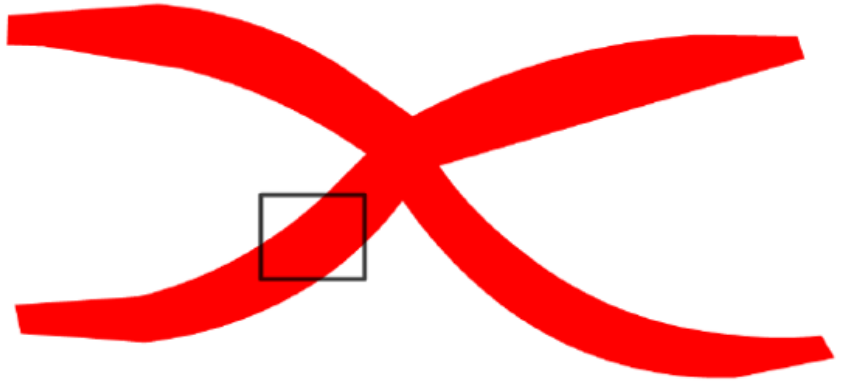
The nucleus is like the ‘brain’ of a cell. It contains all the information a cell needs throughout its entire life.



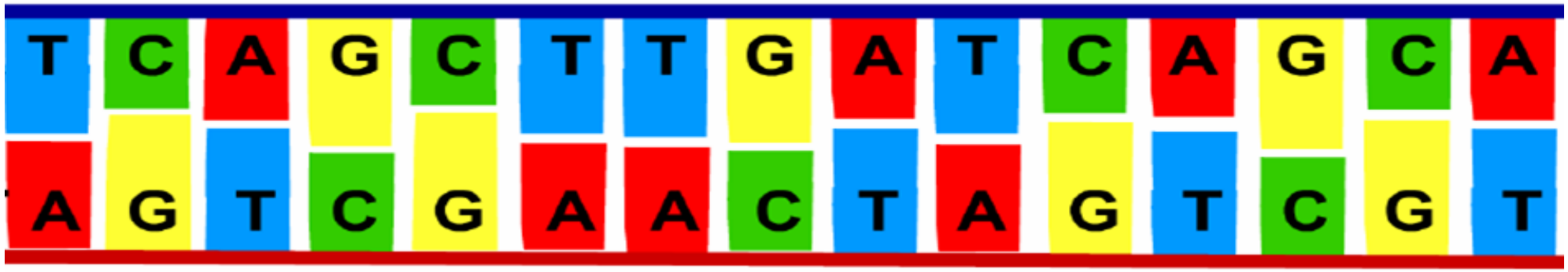
This information is stored in several structures called chromosomes.

The spirals are composed of two strands of DNA twisted together in a double helix.



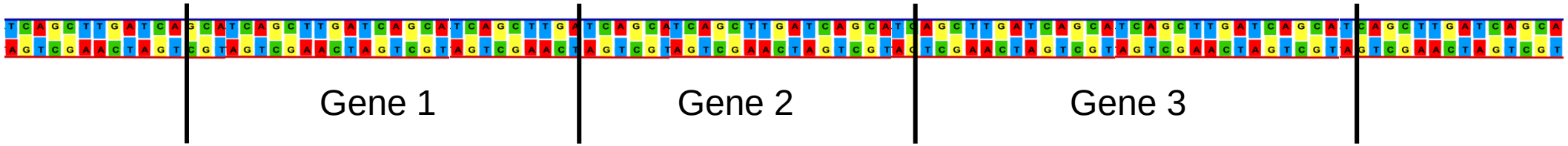


Looking more closely at a small section of a chromosome, its components can be seen.



The nucleotides have specific shapes so that
A always pairs with T, and C always pairs with G.

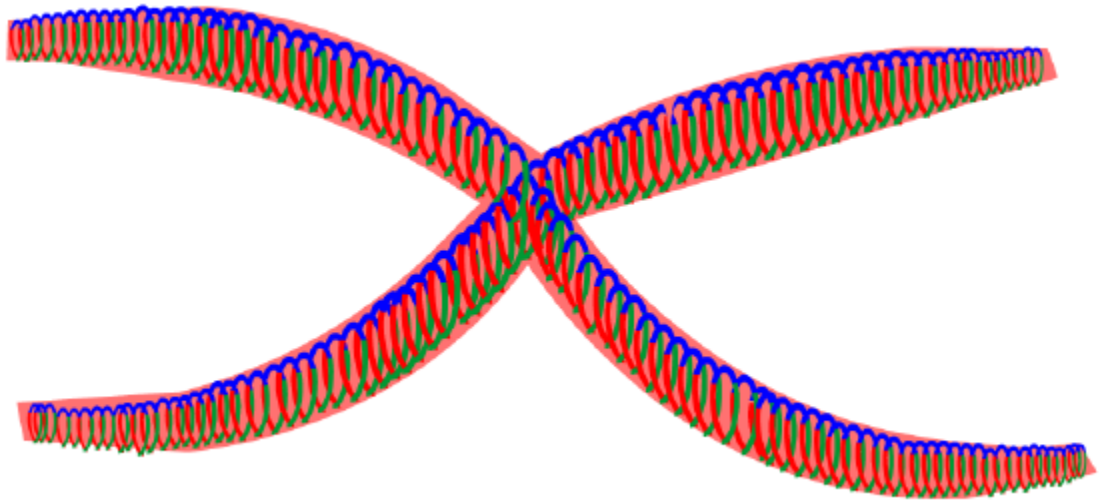
A gene is a specific piece, or length of DNA.



There are thousands of genes on a single chromosome.

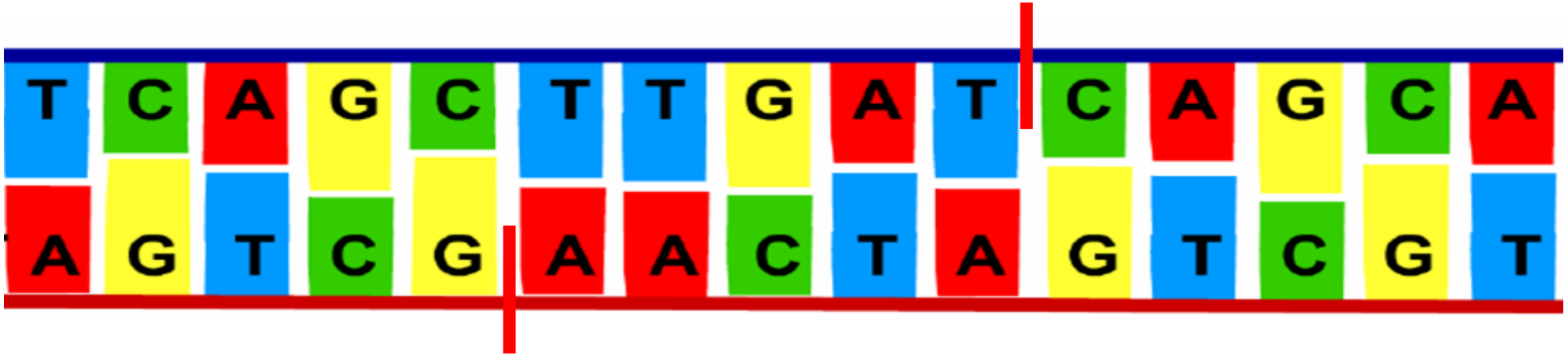
Each gene encodes the information for the construction of a single protein.

Proteins control the traits of living organisms.



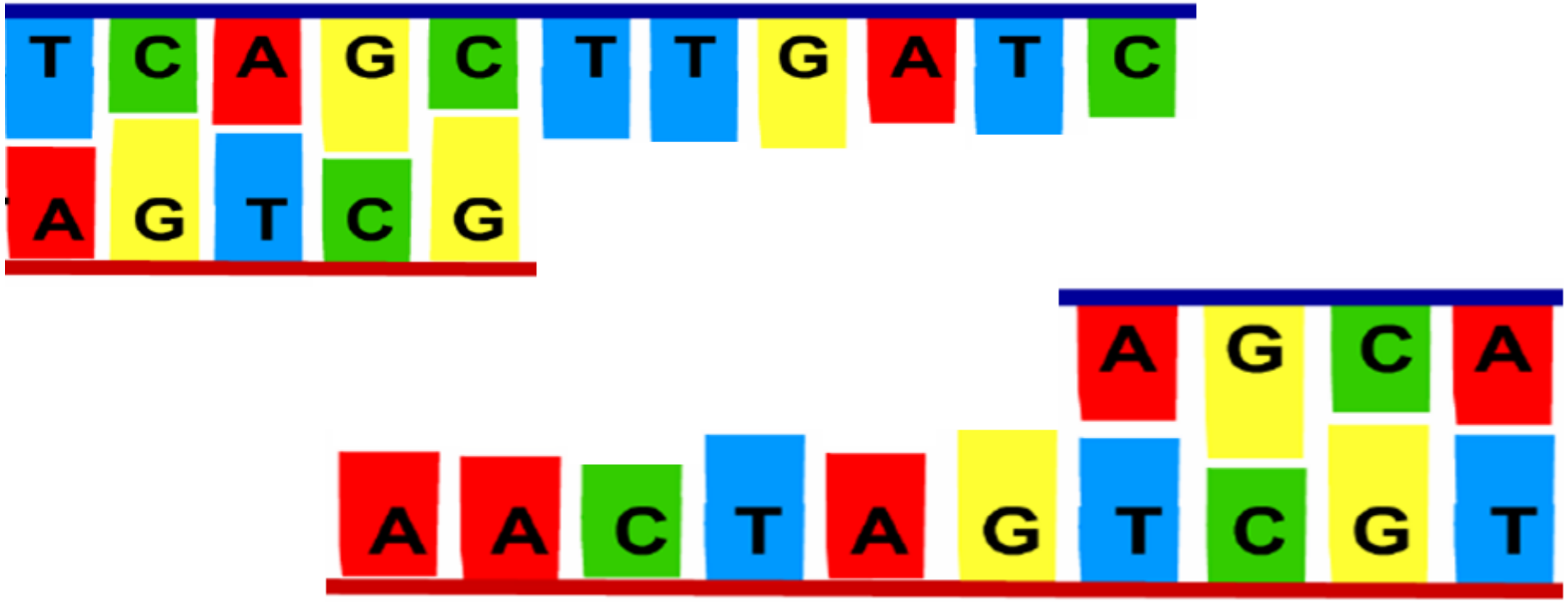
The chromosome is thus composed of thousands of unique genes.

Each of them carries the information for a unique proteine.



DNA has an identical structure in all living things.

Because the genetic code is universal, the possibility is raised that genes can be transferred between completely different species.



The process of transferring, removing or altering genetic information by the modification of DNA is commonly called genetic modification.

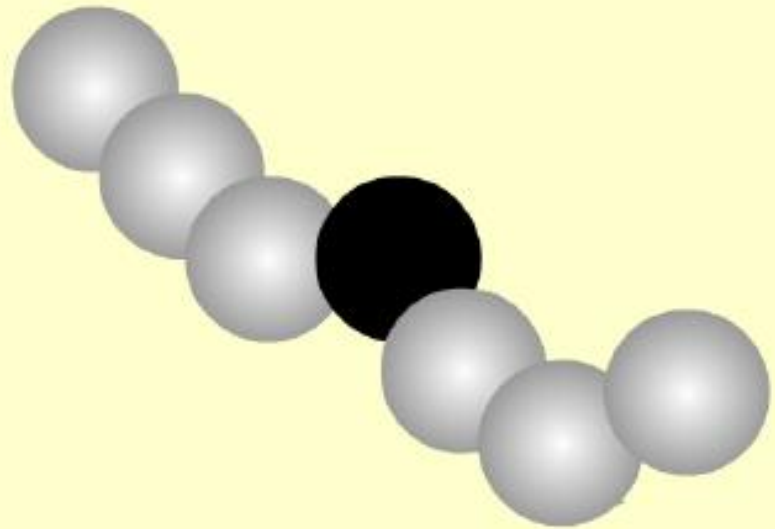
A genetically modified organism (GMO) is:

- an organism in which foreign DNA has been transferred
- an organism from which DNA has been removed
- an organism in which the DNA has been altered.

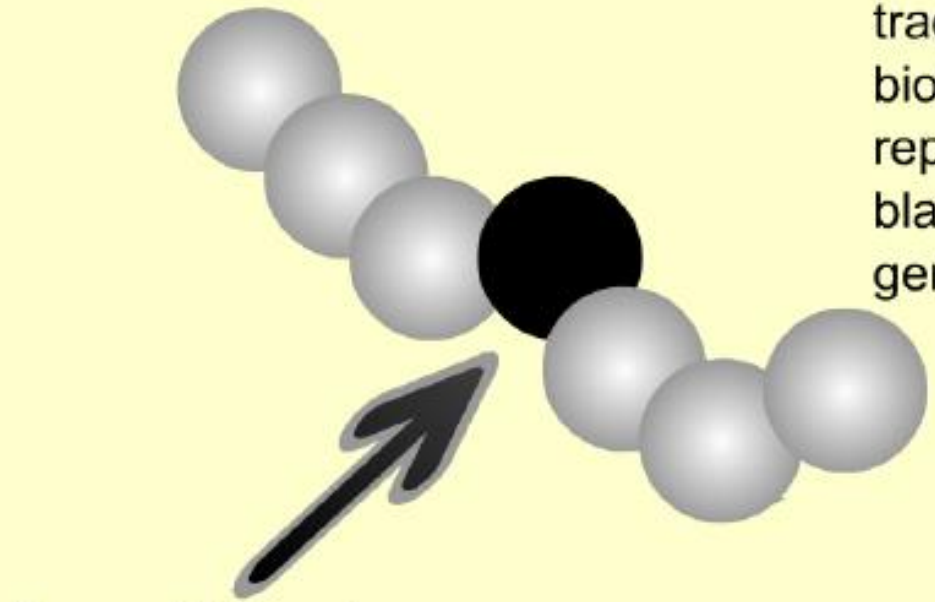
Traditional Breeding

vs.

Biotechnology



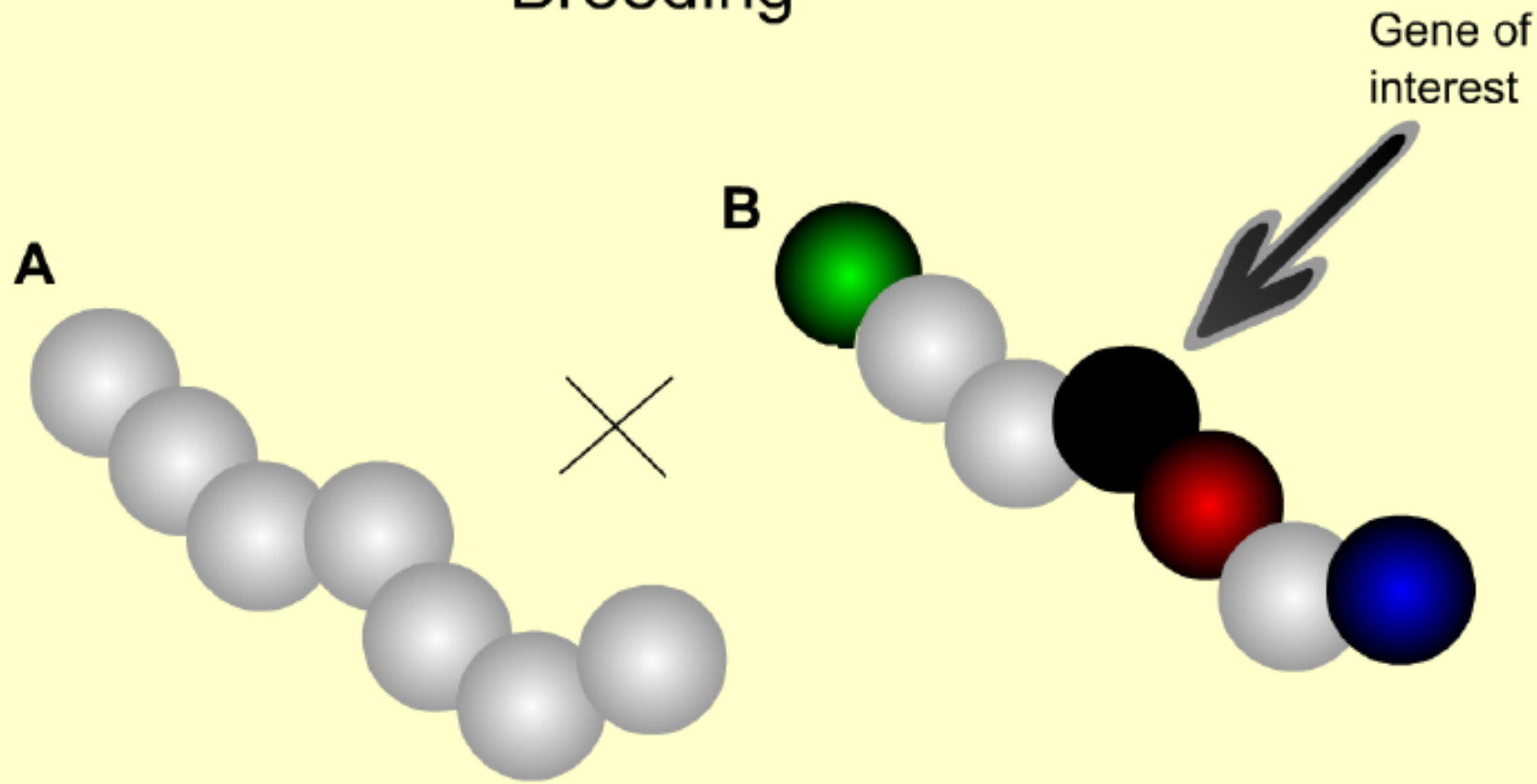
Traditional Breeding



Gene of interest

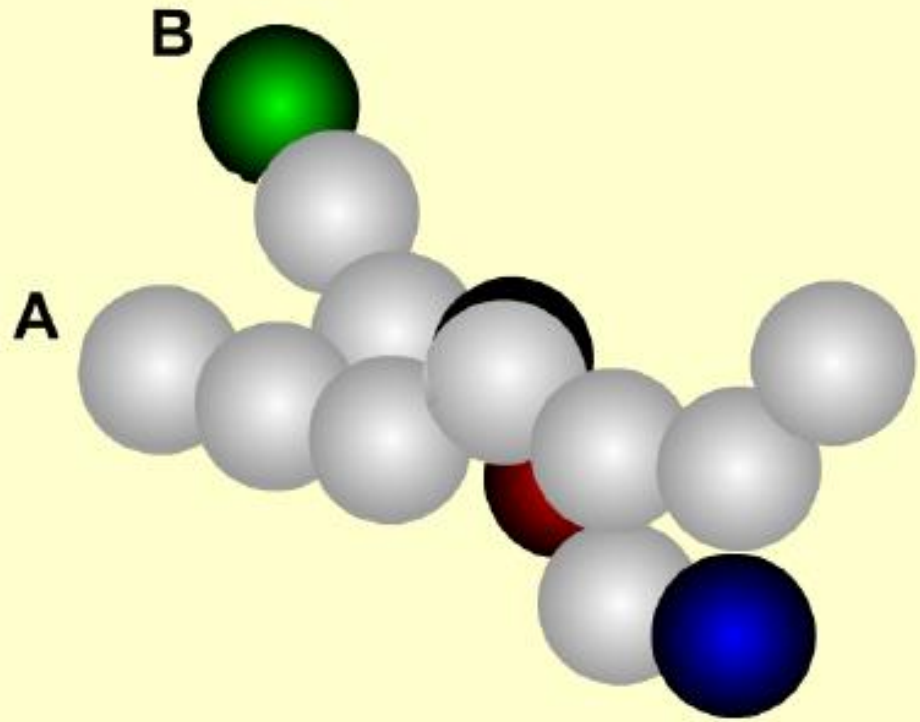
This is a representation of the desired final product which is obtained from both traditional breeding and biotechnology. The spheres represent genes, with the black one representing the gene for the trait of interest.

Traditional Breeding



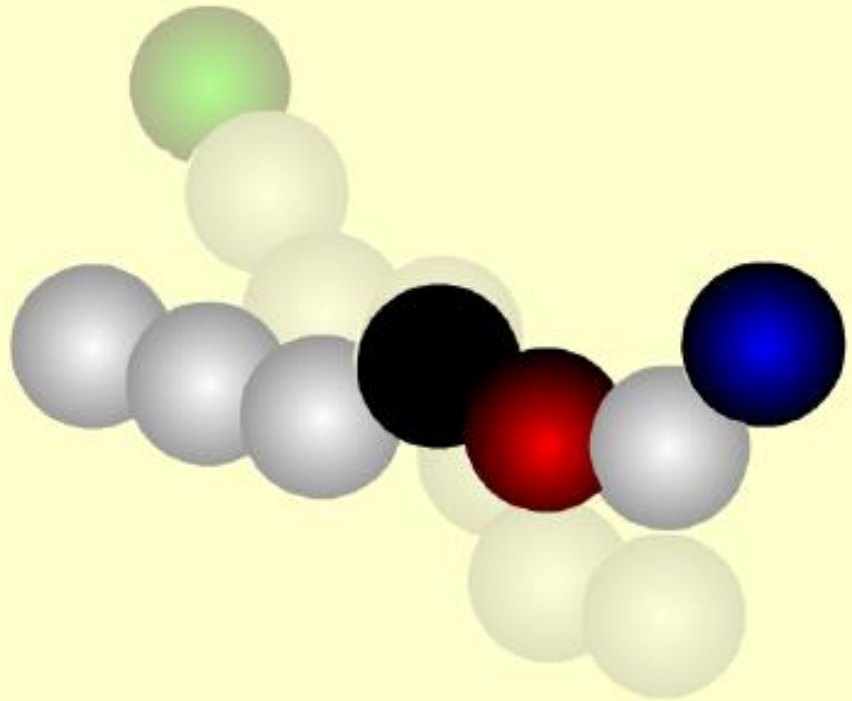
Traditional breeding begins by crossing two plants, A & B. Plant A is having the desired trait transferred into it. The DNA strand with the colored spheres contains the gene (black) to be transferred to plant A.

Traditional Breeding



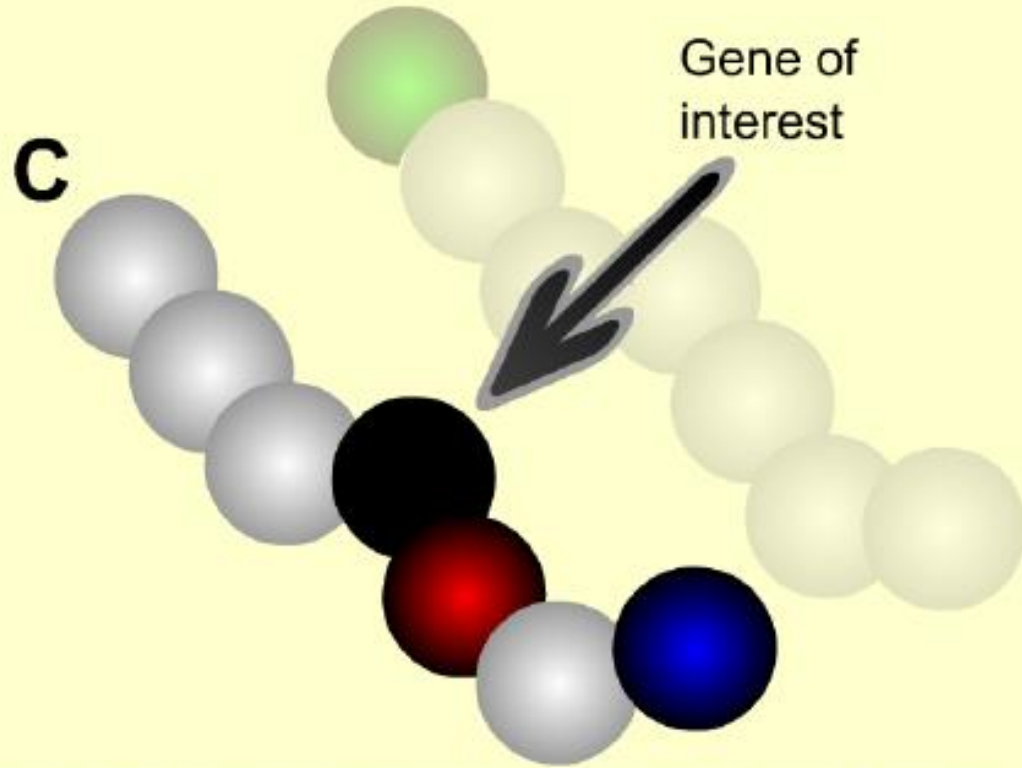
As A and B are crossed, DNA containing the gene of interest is exchanged.

Traditional Breeding



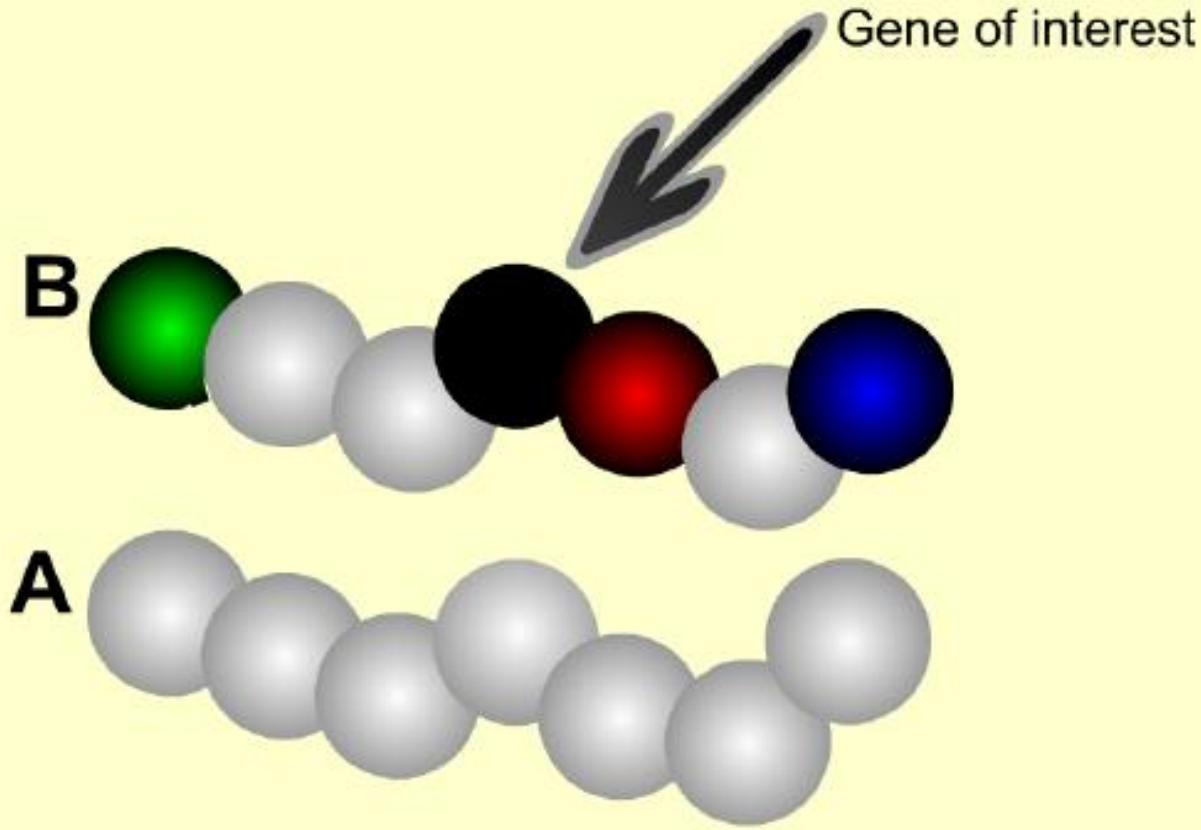
The result is a combination of the genetic makeup from both plants A & B.

Traditional Breeding



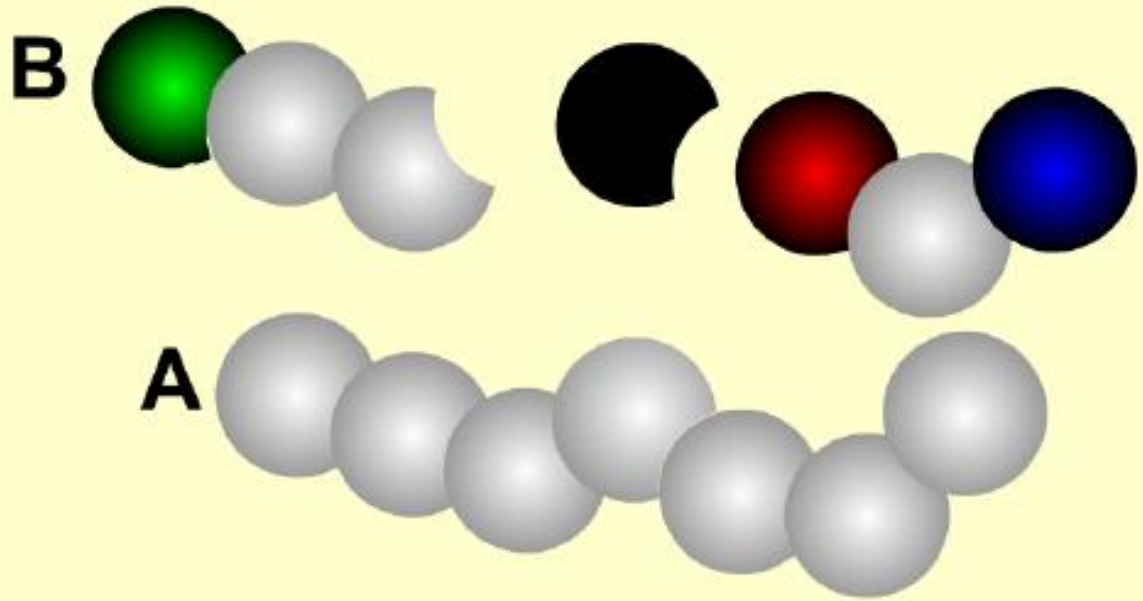
Plant C, is the result of a new combination of genetic makeup from both plants A & B. Plant C contains the gene of interest plus undesired genes positioned close to the target gene.

Biotechnology



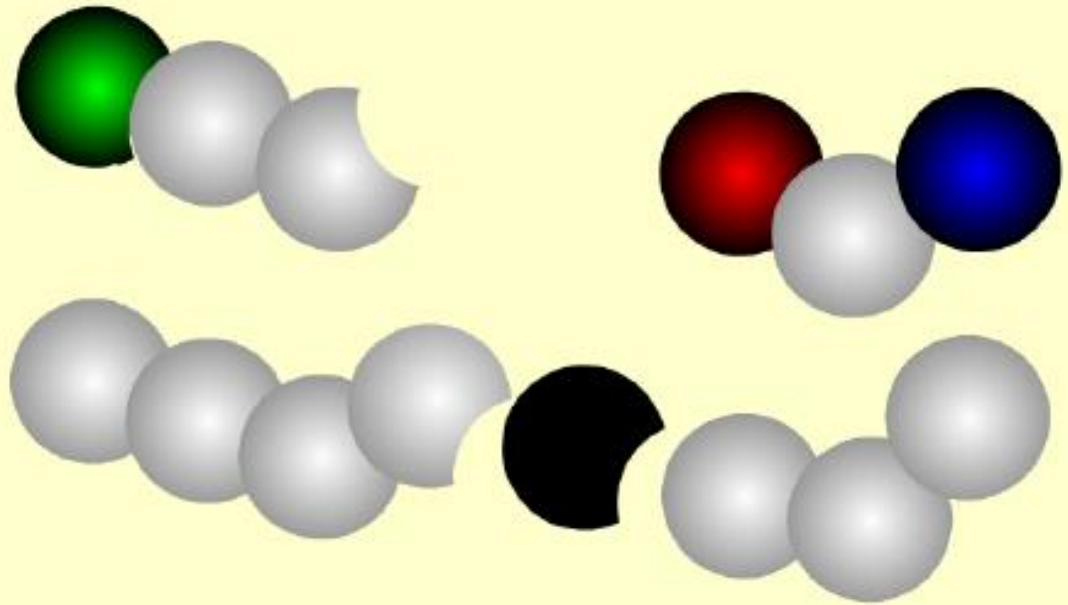
Biotechnology begins with DNA from both plant A and plant B.
Ultimately, plant A will have a gene inserted from plant B.

Biotechnology



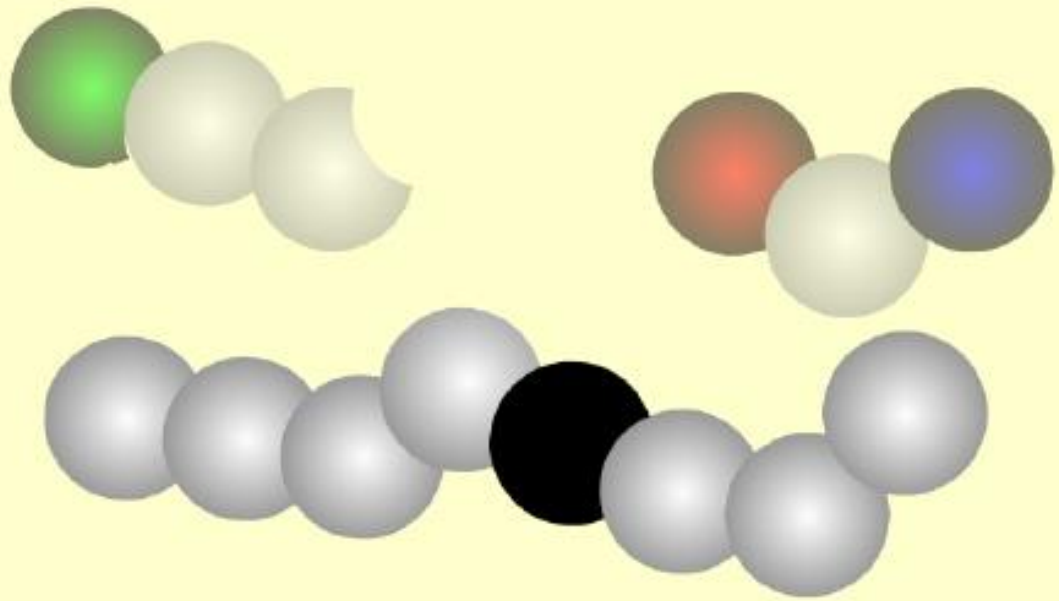
In biotechnology, the desired gene is extracted from plant B.

Biotechnology



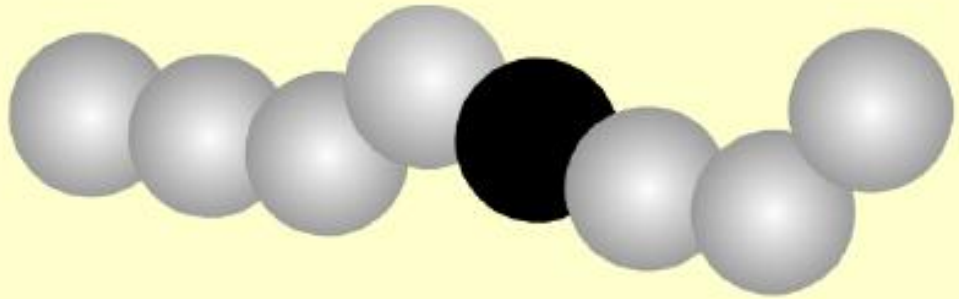
The gene is then directly transferred into plant A.

Biotechnology



New extra gene activity....

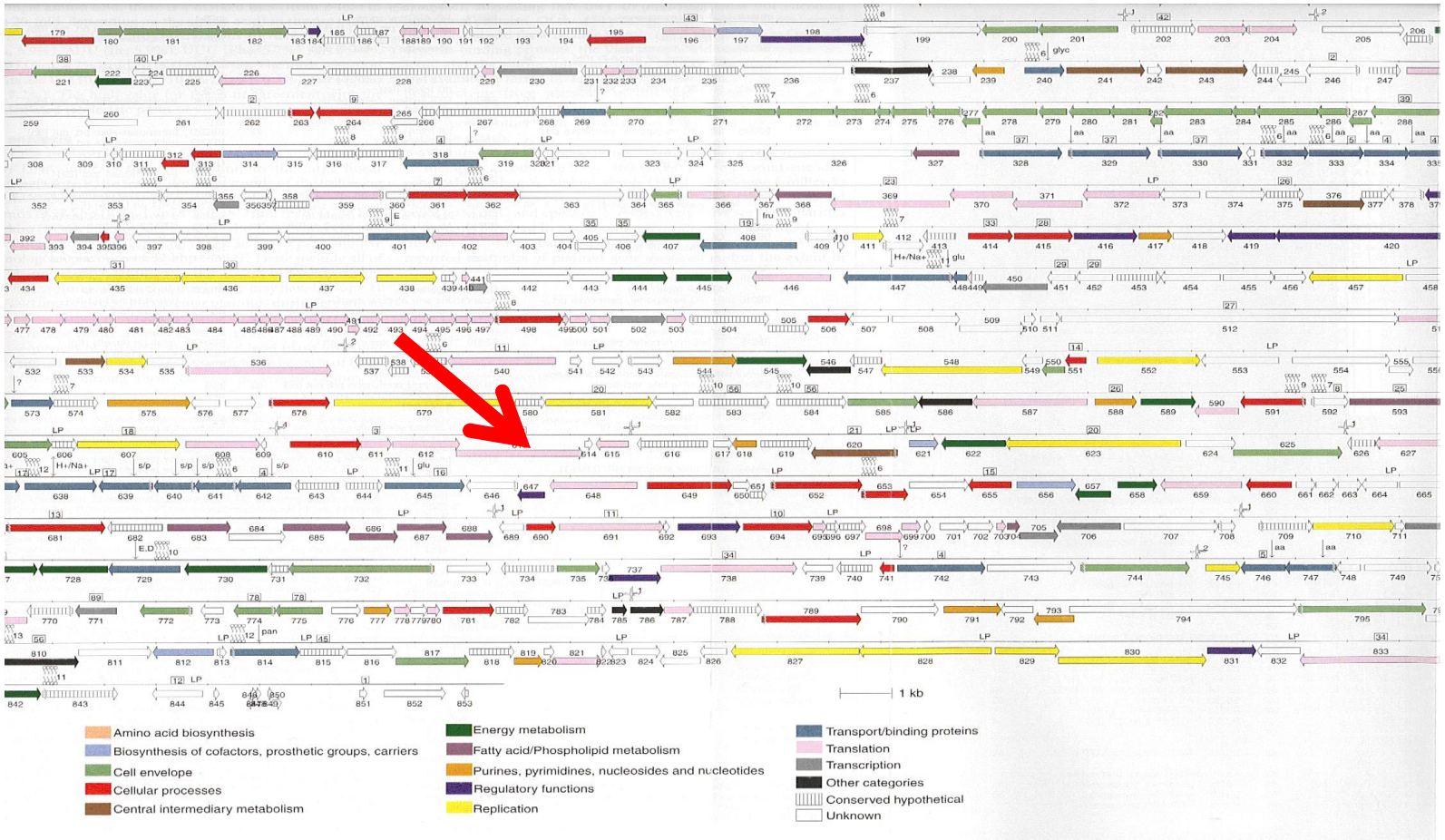
Biotechnology



The result is the direct insertion of the gene into plant A, with no need to backcross out undesired traits.

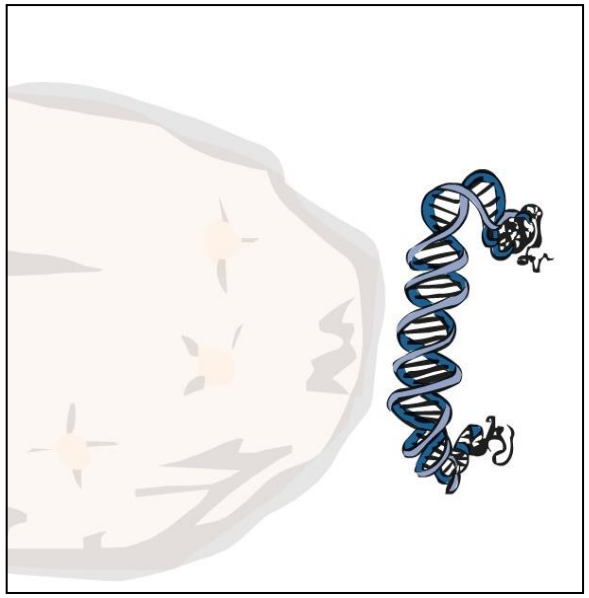
How to make a GM plant ?

1. Identification of gene of interest

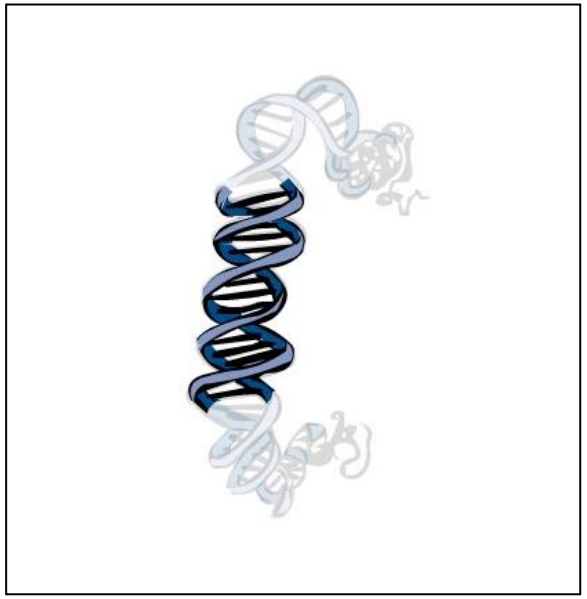


How to make a GM plant ?

2. DNA extraction

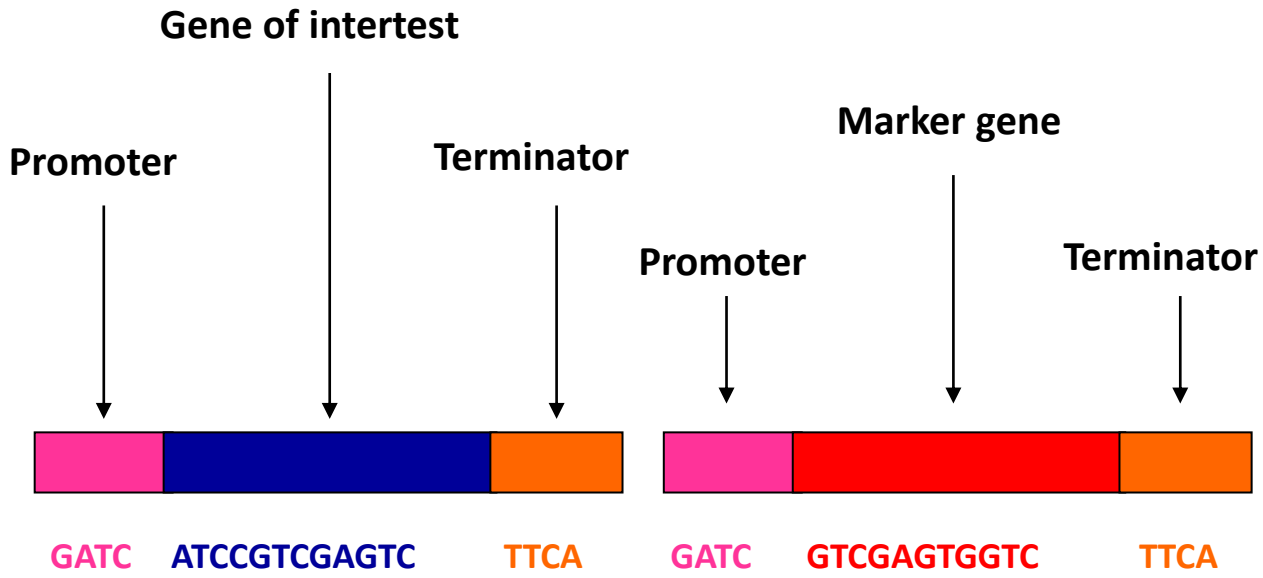


3. Gene cloning



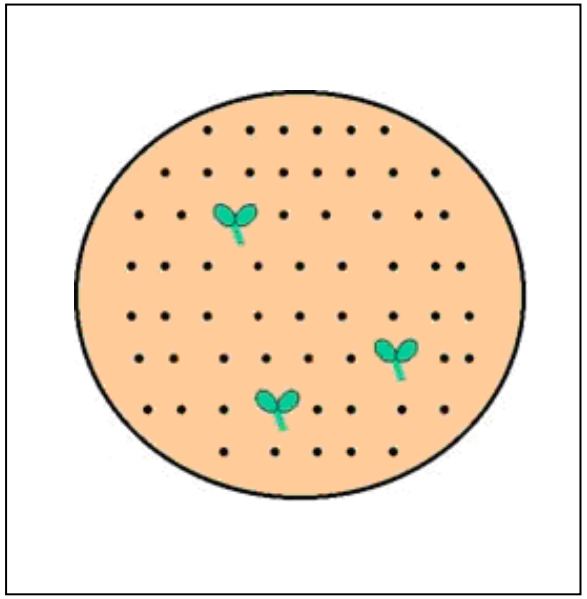
How to make a GM plant ?

4. Gene design



How to make a GM plant ?

6. Selection



7. Regeneration

How to make a GM plant ?

8. Screening

9. Backcrossing

How to make a GM plant ?

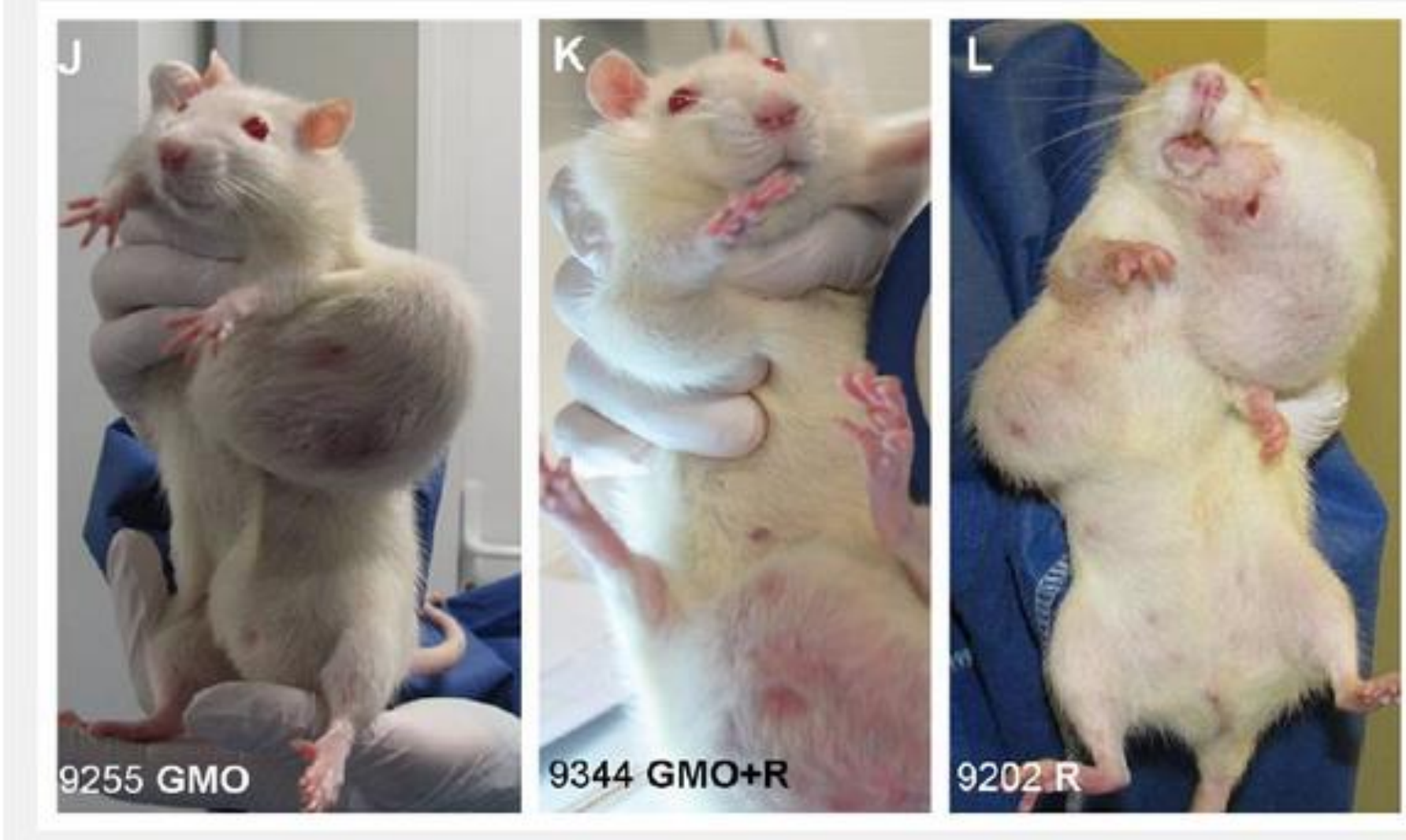
10. Evaluation

Environment

Food safety

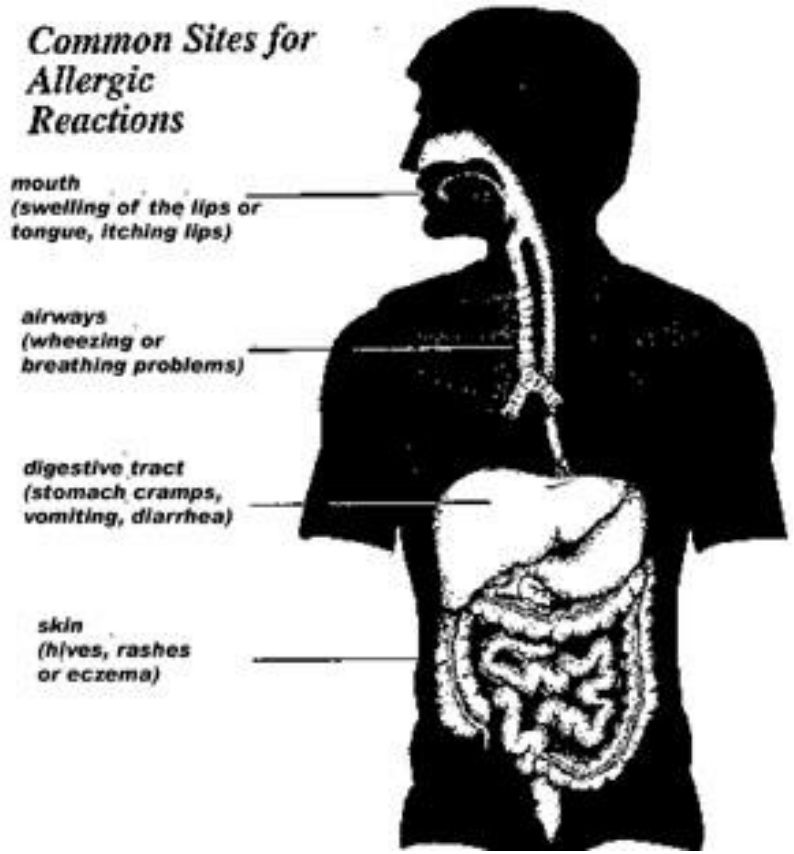
What are the risks of GM plants?

1. Toxicity


J
9255 GMO
K
9344 GMO+R
L
9202 R

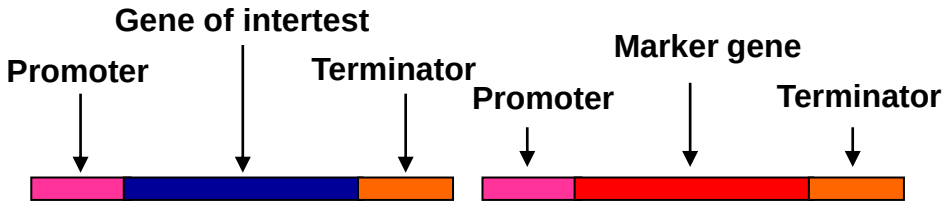
What are the risks of GM plants?

2. Allergenicity



What are the risks of GM plants?

4. Antibiotic resistance



What are the risks of GM plants?

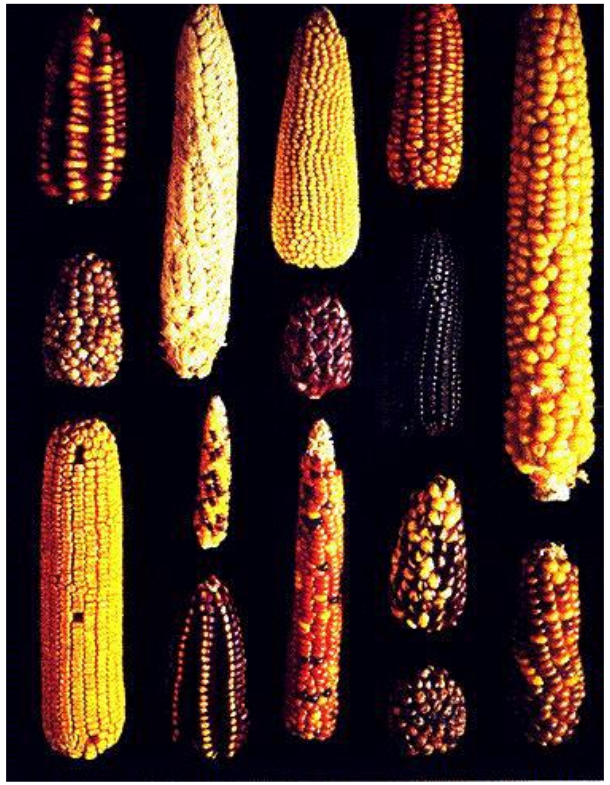
6. Non-target effects

What are the risks of GM plants?

8. Linkage into soil

What are the risks of GM plants?

9. Biodiversity – Centre of origin

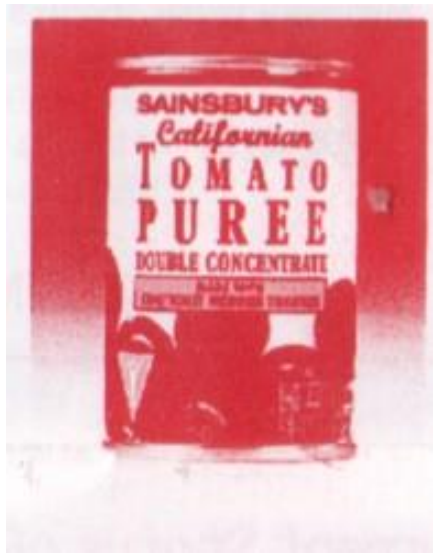


What are the risks of GM plants?

10. Coexistence

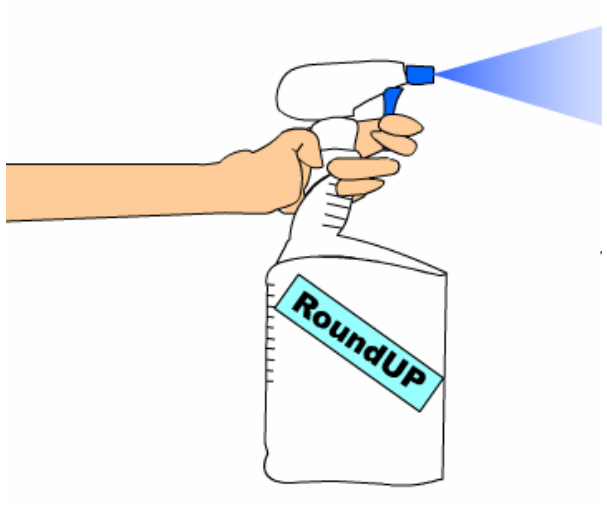
Current and future GM applications

1. Delayed ripening technology



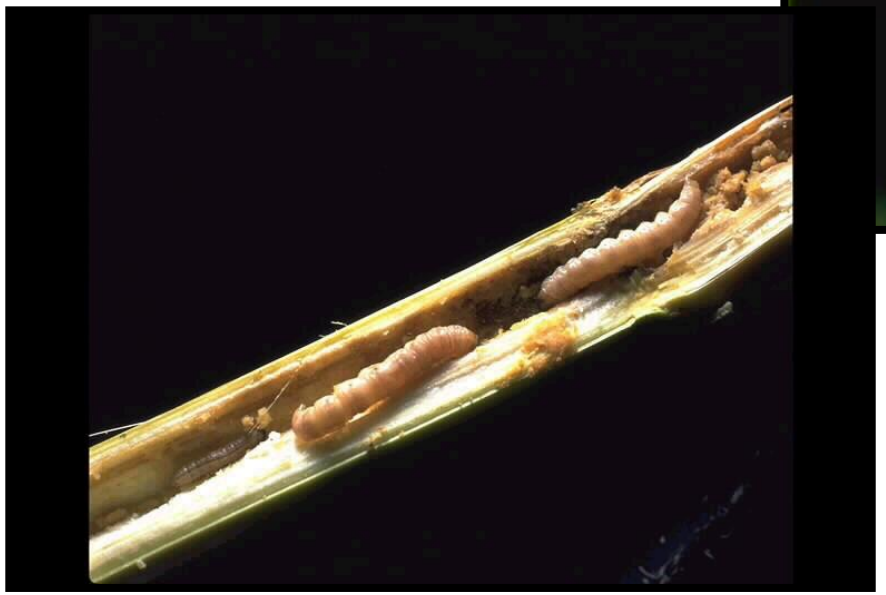
Current and future GM applications

2. Herbicide tolerance

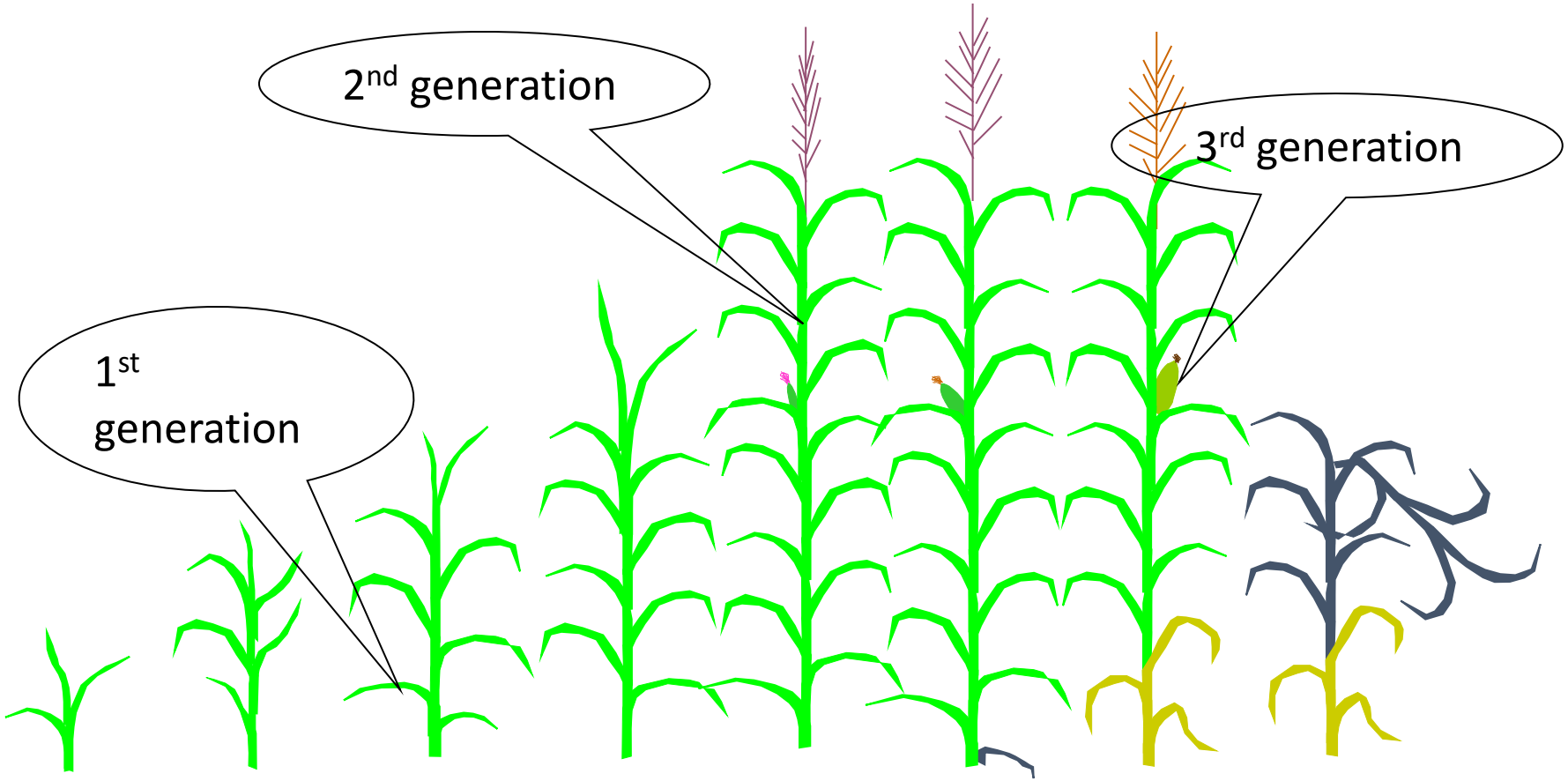


Current and future GM applications

3. Bt insect resistance



The European corn borer (*Ostrinia nubilalis*)….


2nd generation
3rd generation
1st
generation

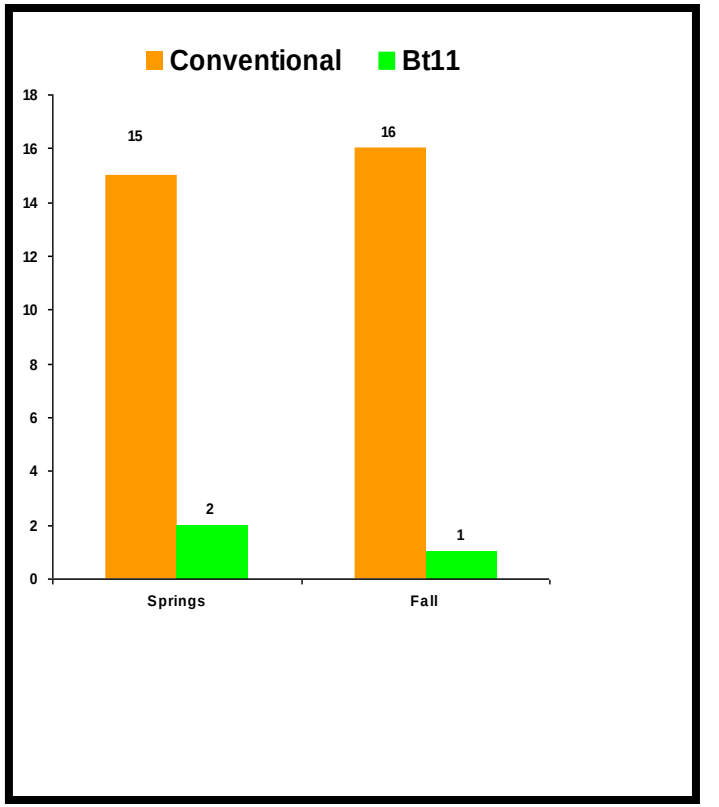
The classic battle against the corn borer

Bt 11 sweet maize

Resistance against the corn borer is obtained by inserting in the plant a gene from the *Bacillus thuringiensis* which will express a toxin in the leafs, the shank and the ear during the entire season.

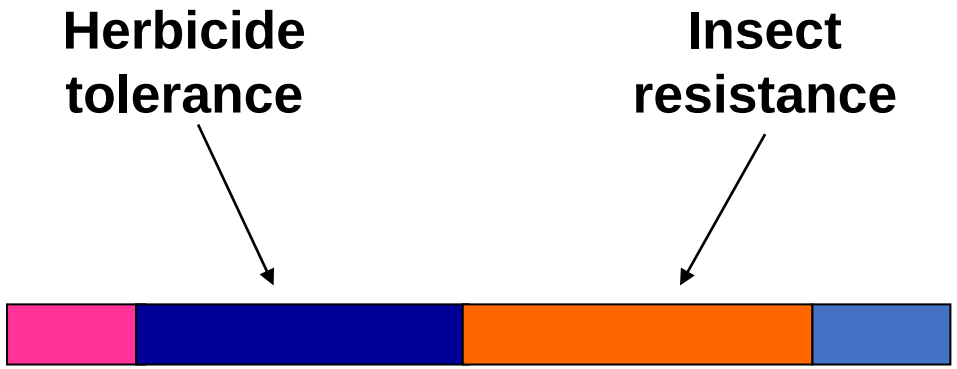
Bt-11 and the use of pesticides

In Florida, farmers spray pesticides 1 or 2 times in fields planted with Bt11, rather than 15 or 16 times in fields planted with conventional sweet maize.

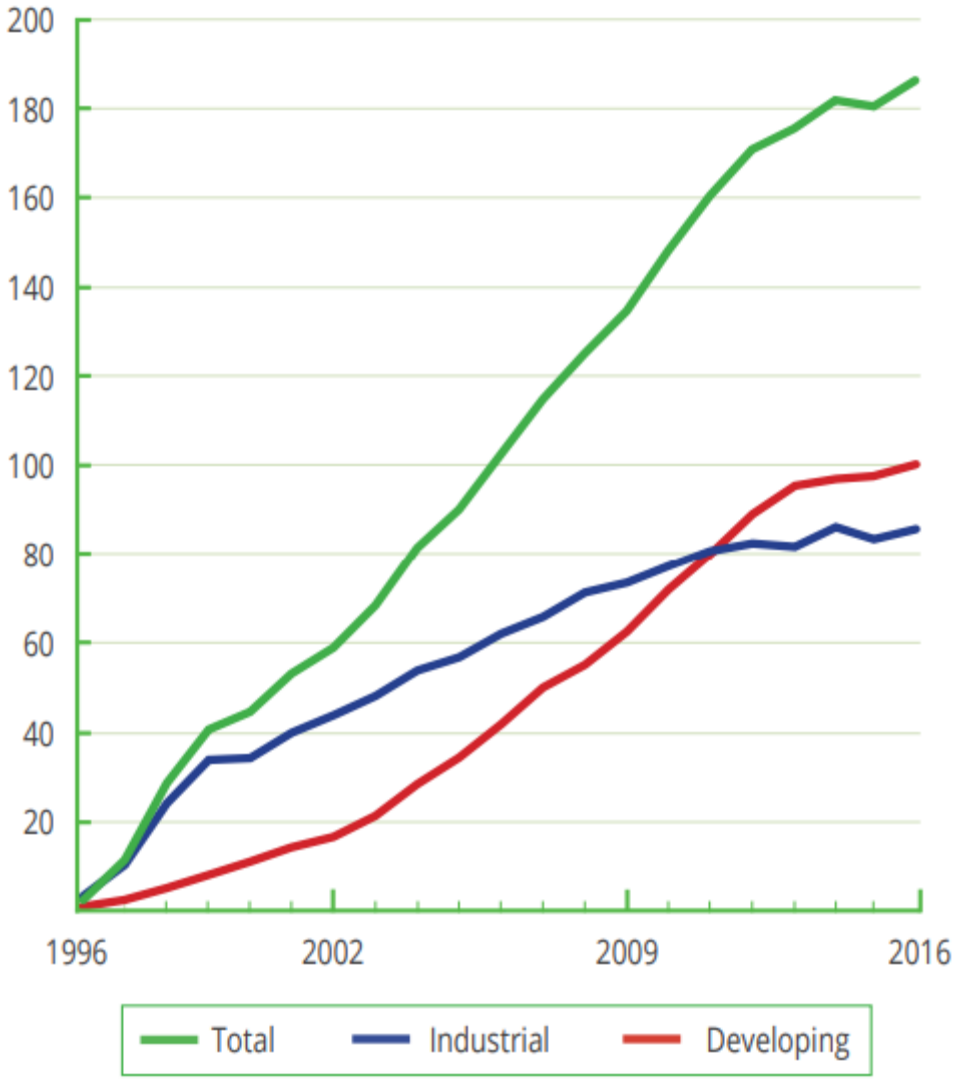


Current and future GM applications

4. Stacked genes



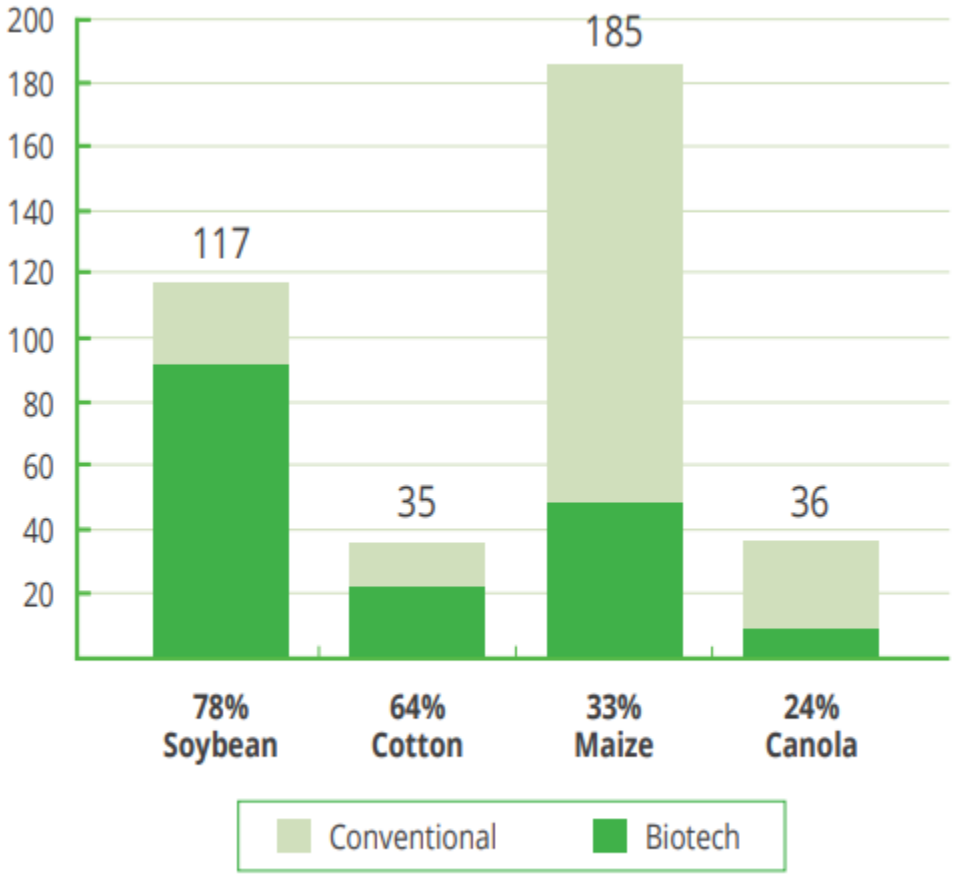
Global Area of Biotech Crops, 1996 to 2016 (Million Hectares)



Source: ISAAA, 2016

Country	GM surface	GM Crops
U.S.A.	66.8 million ha.	Maize, Soybean, Cotton, Canola, Sugarbeet, Alfalfa, Papaya, Squash
Brazil	25,4 million ha.	Soybean, Maize, Cotton
Argentina	22,9 million ha.	Soybean, Maize, Cotton
India	9,4 million ha.	Cotton
Canada	8,9 million ha.	Canola, Maize, Soybean, Sugarbeet
China	3,5 million ha.	Cotton, Tomato, Poplar, Papaya, Sweet pepper
Paraguay	2,6 million ha.	Soybean
Pakistan	2,4 million ha.	Cotton
South Africa	2,2 million ha.	Maize, Soybean, Cotton
Uruguay	1,1 million ha.	Soybean, Maize

Global Adoption Rates (%) by Crops, 2016 (Million Hectares)



Source: ISAAA, 2016

Current and future GM applications

5. Nutritional enhancement

Current and future GM applications

6. Virus resistance

Current and future GM applications

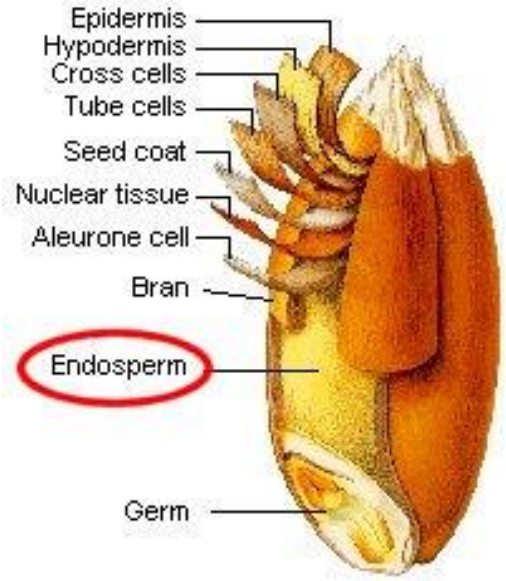
8. Fortification

Vitamin A deficiency is a major contributor to childhood mortality in developing countries.

Each year more than one million childhood deaths associated with vitamin A deficiency occur.

Vitamin A deficiency is also the single most important cause of blindness among children.

‘Golden rice’



Golden Rice is a genetically modified grain able to improve the supply of Vitamin A in the human diet. The resulting transgenic rice is able to produce and store beta-carotene. It is called Golden Rice because of the slightly yellow starchy part of the grain resulting from the added beta-carotene.

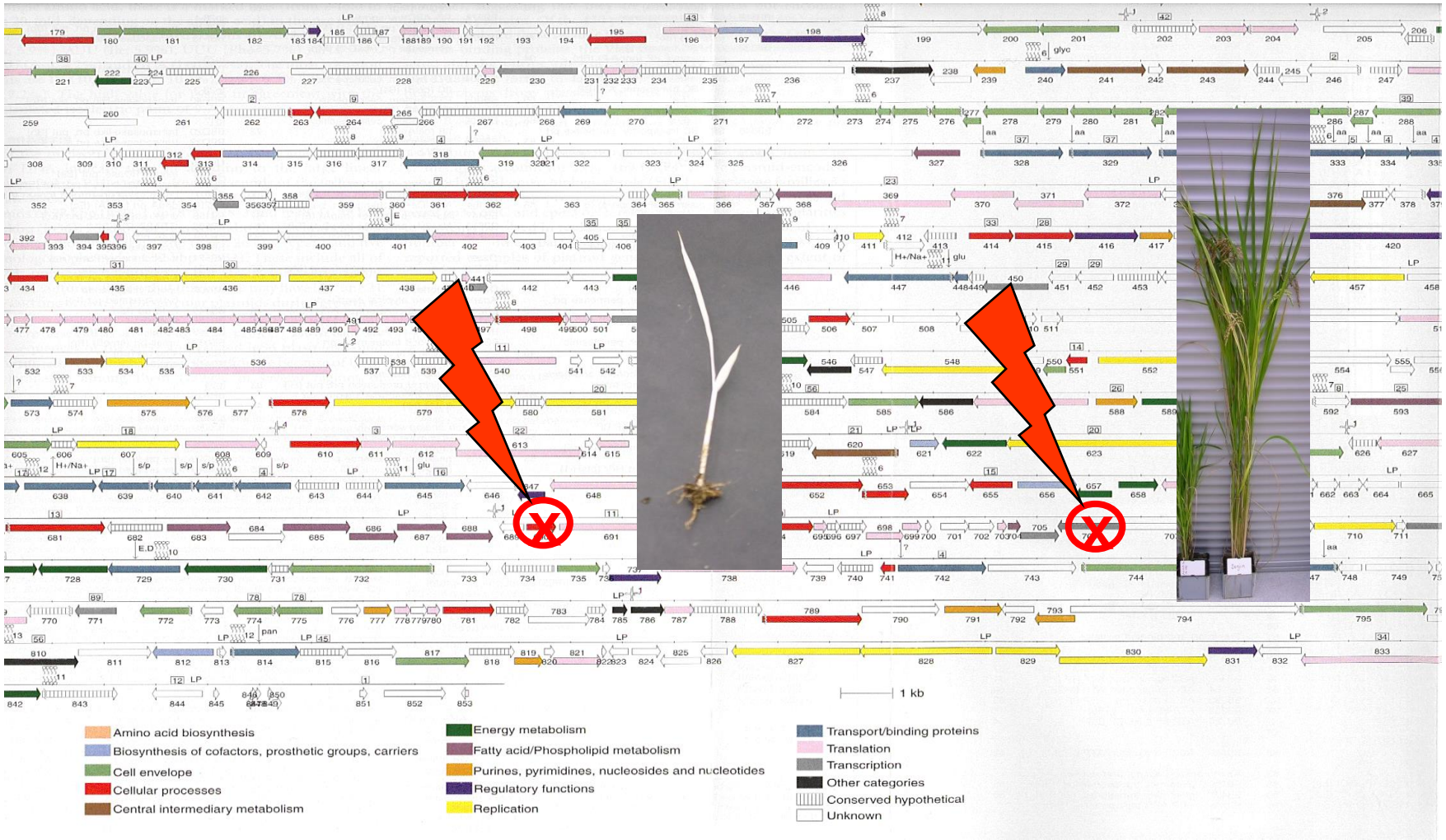
Rice : the most important fact

9. Tolerance to stress

Modern rice varieties, developed through research, need much less water than 40 years ago

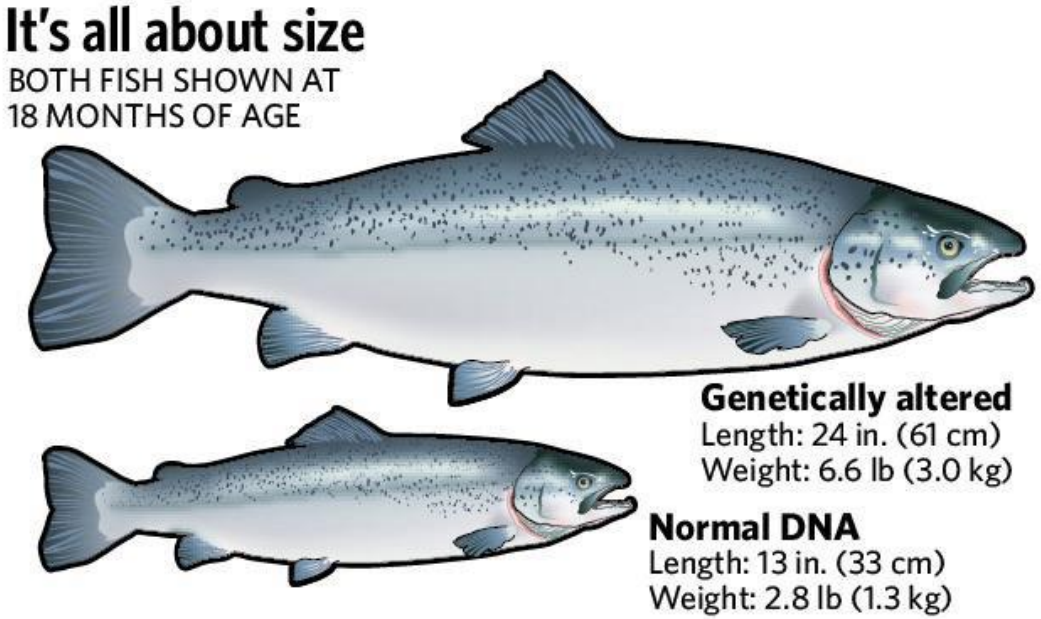
China has less fresh water per capita than any African country other than Egypt!

Knocking off a gene



Current and future GM applications

10. GM animals



- AquaBounty AquAdvantage salmon can reach adult size in 16 to 28 months instead of 36 months for regular Atlantic salmon. These transgenic salmon eat 25 per cent less feed and are about 20 per cent more efficient at converting that food to flesh.

Tilapia x Pig = Tilapig

Course on EU Food Law and Policy				Visit to EFSA	
Tuesday 16 April 2024		Wednesday 17 April 2024		Thursday 18 April 2024	
General Food Law		**Food Information to Consumers**		Via Carlo Magno, 1A	
09:00 - 10:30	Part 1 A brief history of the EU Food Law	09:00 - 10:30	Part 1 Mandatory Food Information	09:00 - 10:30	Presentation of EU agencies EU food safety system and EFSA **Prof. Alberto Spagnolli**
	Coffee break		*Coffee break*		*Coffee break*
11:00 - 12:30	Part 2 General Principles of Food Law	11:00 - 12:30	Part 2 Nutrition Labelling Nutrition/Health Claims	11:00 - 12:30	New genomic techniques (NGTs) Communication at EFSA Opportunities for Young Professionals
	Lunch break		*Lunch break*		*Lunch break*
General Food Law		**Genetically Modified Food**			
14:00 - 16:00	Part 3 EU Agri-Food Trade Part 4 Food Quality in the EU Part 5 EU Food Law - Overview	14:00 - 16:00	Part 1 What is biotechnology? Part 2 Development/applications		
End of day			*End of day*		

Diploma e Master Universitario in Alti Studi Europei
Collegio Europeo di Parma

Thank You !

http://patrick.deboyser.be