Laboratório de Genética Molecular de Plantas

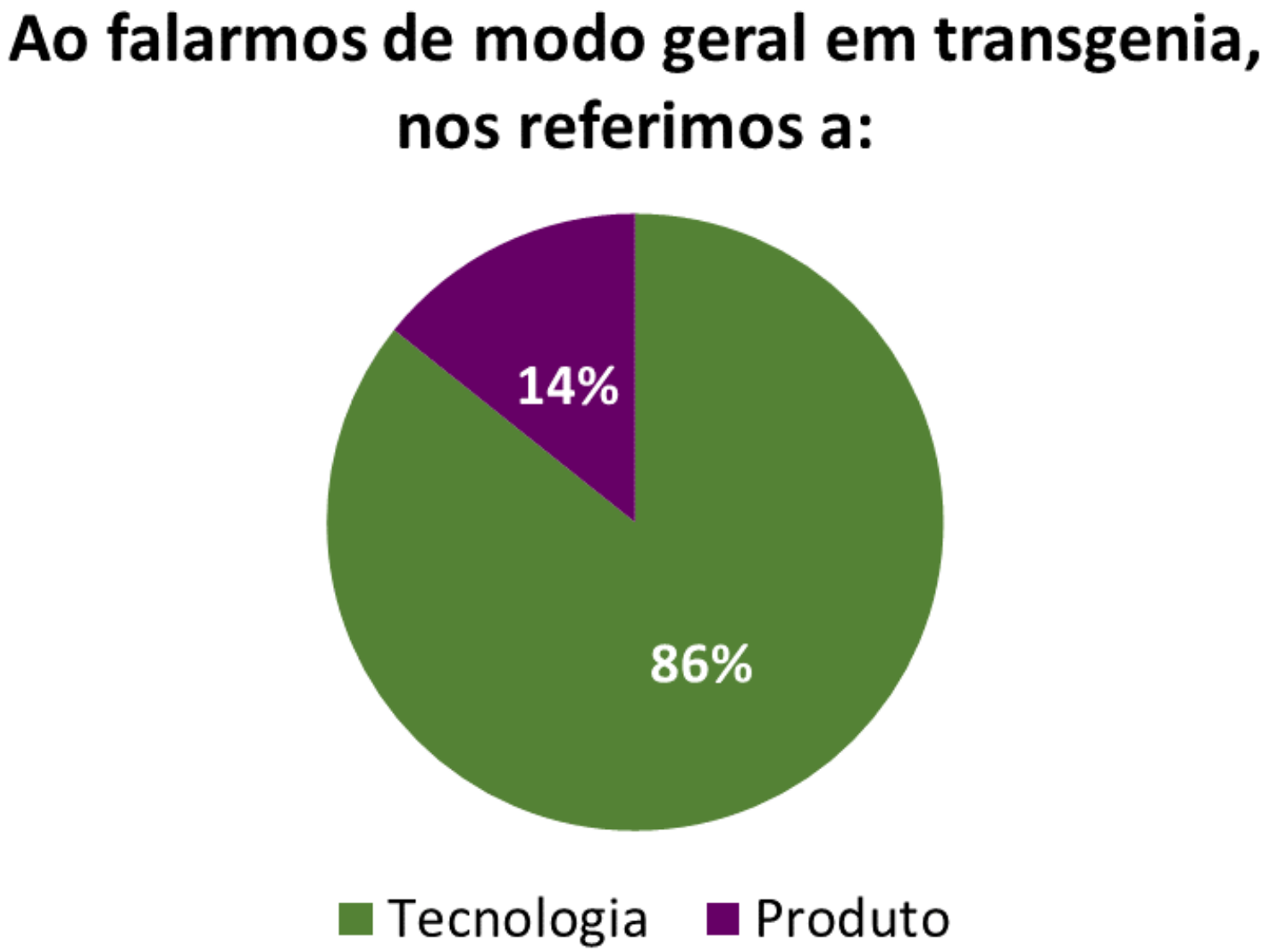
instituto de biociências

Transformação genética de plantas e suas aplicações em pesquisa e biotecnologia
2019

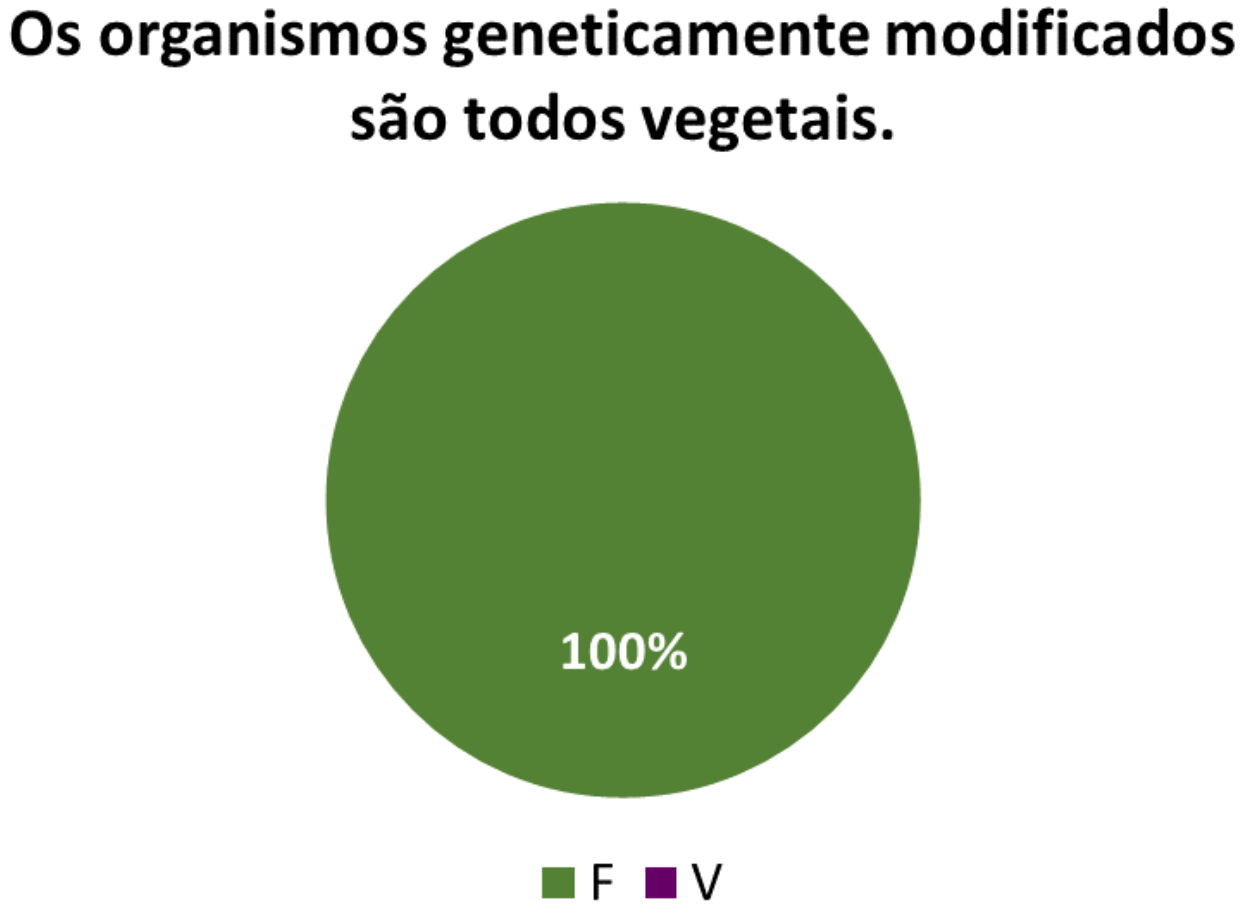
BIB0143 - Recursos Econômicos Vegetais

Bruno Silvestre Lira

63 respostas



O que é um OGM (organismo geneticamente modificados)?



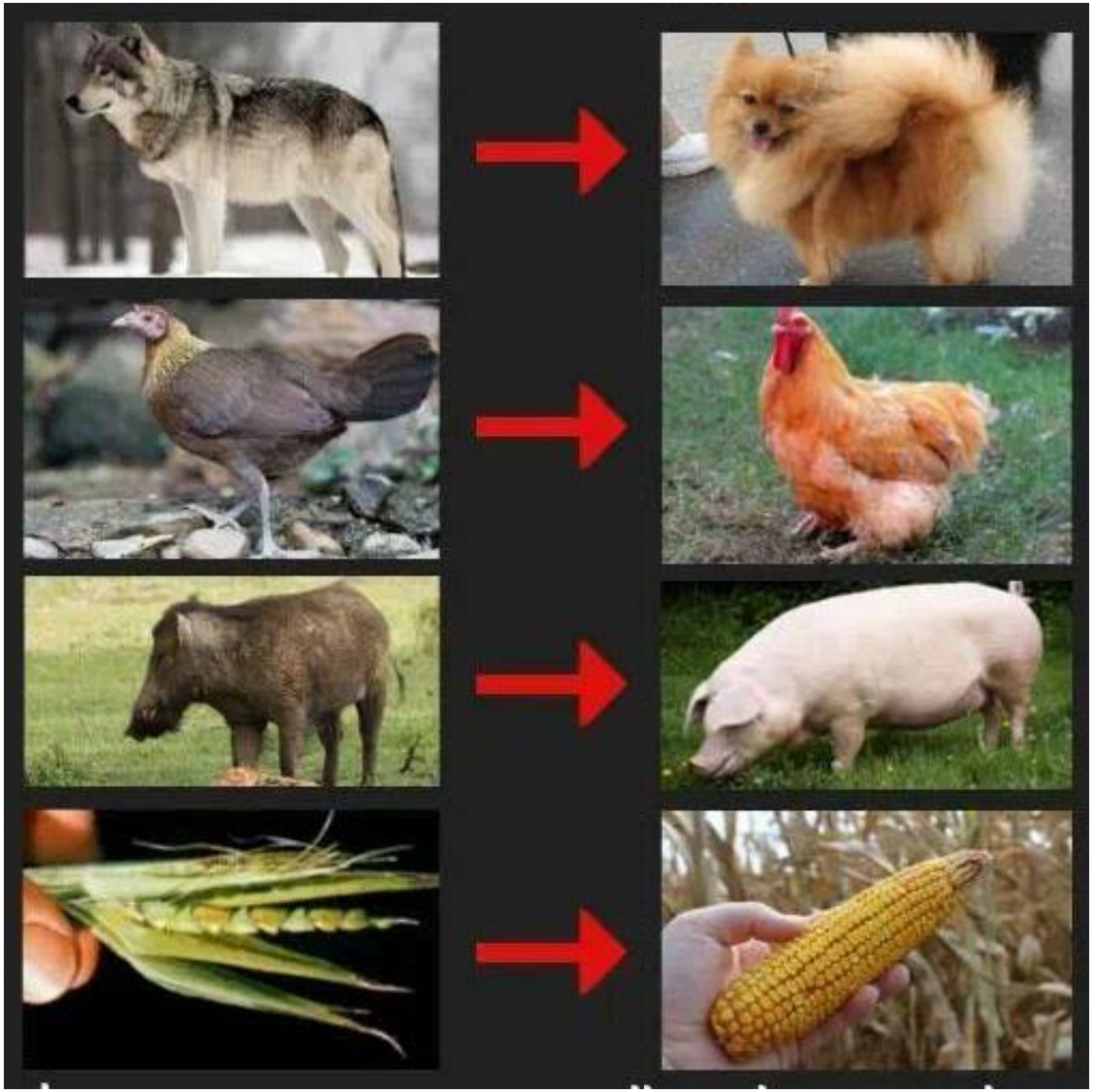
O que é um OGM (organismo geneticamente modificado)?

É a mesma coisa que um organismo transgênico?

O que é um OGM (organismo geneticamente modificados)?

Toda entidade biológica cujo material genético (ADN/ARN) foi alterado por meio de qualquer técnica de engenharia genética, de uma maneira que não ocorreria naturalmente.

Ministério da Agricultura: http://www.agricultura.gov.br/vegetal/organismos-geneticamente-modificados



?

O que é um OGM (organismo geneticamente modificados)?

*Toda entidade biológica cujo material genético (ADN/ARN) foi alterado por meio de **qualquer técnica de engenharia genética**, de uma maneira que não ocorreria naturalmente.*

Ministério da Agricultura: http://www.agricultura.gov.br/vegetal/organismos-geneticamente-modificados

*Organismos manipulados geneticamente, de modo a favorecer características desejadas, como a cor, tamanho etc. Os OGMs possuem alteração em trecho(s) do genoma realizadas **através da tecnologia do RNA/DNA recombinante ou engenharia genética**. Na maior parte das vezes, quando se fala em OGMs, trata-se de organismos transgênicos. Mas OGMs e transgênicos não são sinônimos: todo transgênico é um organismo geneticamente modificado, mas nem todo OGM é um transgênico.*

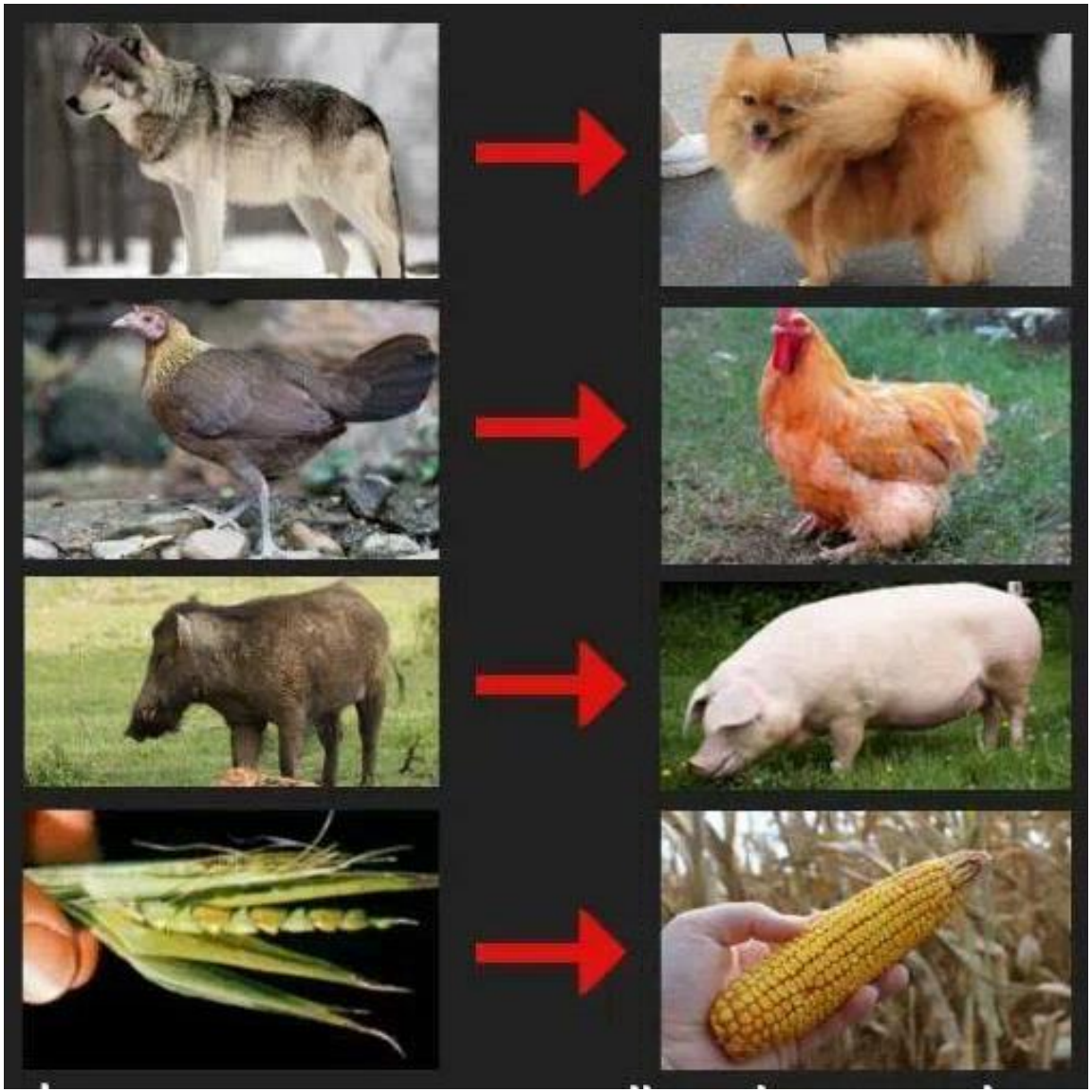
Wikipédia: https://pt.wikipedia.org/wiki/Organismos_geneticamente_modificados

O que é um OGM (organismo geneticamente modificados)?

"Living modified organism" as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology (Cartagena Protocol on Biosafety, 2003)

application of in vitro nucleic acid techniques, or fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and are not techniques used in traditional breeding and selection

Como aconteceu esta modificação?



?

AKSENOVA NATALYA/SHUTTERSTOCK

VIKTAR MALYSHCHYTS/SHUTTERSTOCK

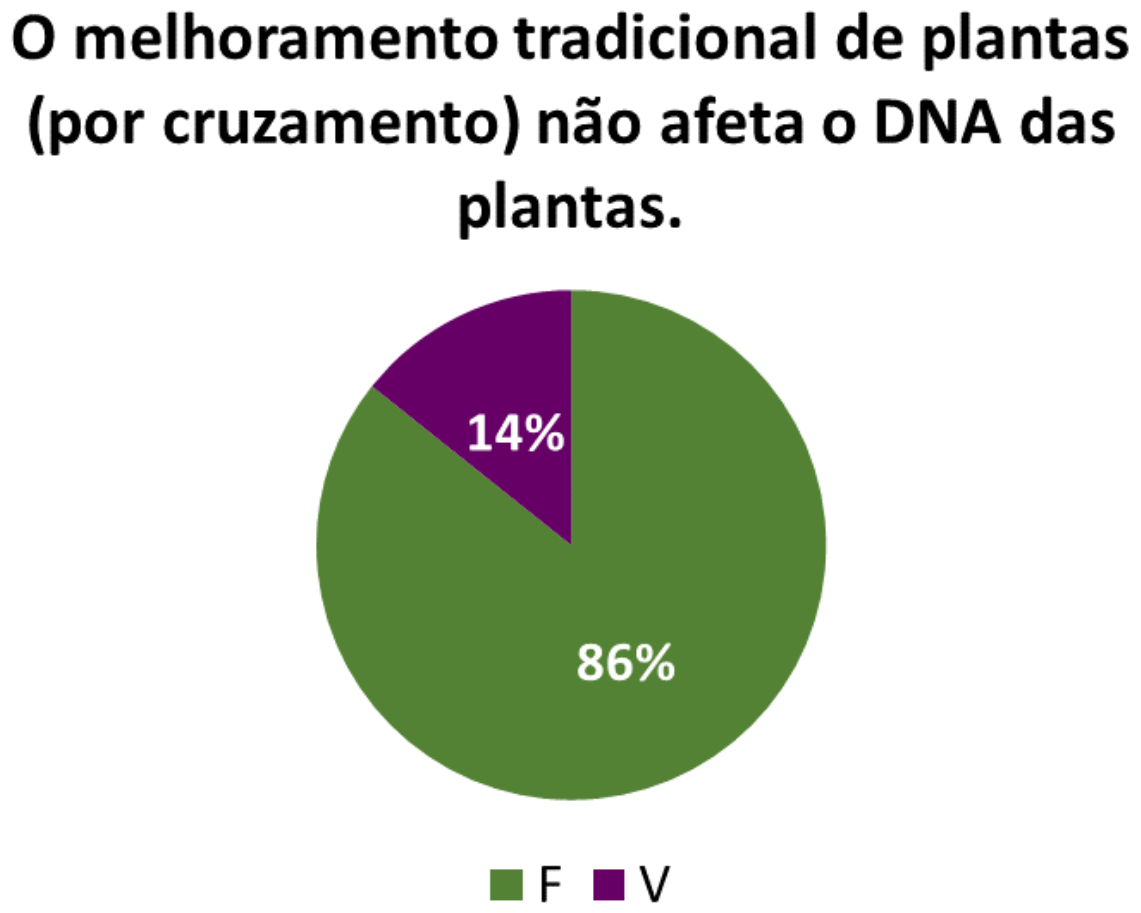
MAKS NARODENKO/SHUTTERSTOCK

Tabela 1.1 Domesticação de algumas espécies de animais e de plantas

Espécie domesticada	Espécie ancestral	Época da domesticação (anos atrás)	Local
Ovelha	Ovelha selvagem (*Ovis ammon*)	12.000	Iraque
Cão	Lobo (*Canis lupus*)	12.000	Palestina-Irã
Cabra	Cabra selvagem (*Capra aegagrus*)	10.000	Irã
Gato	Gato selvagem (*Felis caffra*)	9.500	Chipre ou Egito
Porco	Porco selvagem europeu (*Sus scrofa*)	10.000	Europa-Ásia
Cavalo	Cavalo selvagem (*Equus przevalski*)	8.000	Irã
Marreco	Marreco selvagem comum (*Anas platyrhynchus*)	6.000	China
Camelo	Camelo selvagem (*Camelus bactrianus*)	6.000-5.000	Egito
Jumento	Jumento selvagem (*Equus asinus atlanticus*)	7.000	Egito
Abelha	Abelha (*Apis mellifera*)	4.500	Egito
Bicho-da-seda	Bicho-da-seda (*Bombyx mori*)	3.500	China
Coelho	Coelho selvagem (*Oryctolagus cuniculus*)	2.200	Roma
Arroz	Arroz selvagem asiático (*Oryza sativa*)	15.900	China central
Abóbora	Abóbora (*Cucurbita pepo*)	12.000-10.000	Equador
Trigo	Trigo selvagem (*Triticum monococcum*)	9.800-9.500	Turquia
Milho	Milho selvagem (*Zea mays*)	8.000-7.000	América
Linho	Linho selvagem (*Linum usitatissimum*)	7.000	Curdistão
Lentilha	Lentilha selvagem (*Lens culinaris*)	6.000	Egito
Azeitona	Azeitona (*Olea europaea*)	6.000	Oriente Médio
Feijão	Feijão (*Phaseolus* spp.)	5.000-4.000	Américas Central e do Sul
Soja	Soja (*Glycine max*)	4.000	China

Fonte: <http://www.clt.astate.edu/aromero/histbio04.heredityIprmendel.ppt>. Acesso em: abr. 2010.

O que é um OGM (organismo geneticamente modificados)?

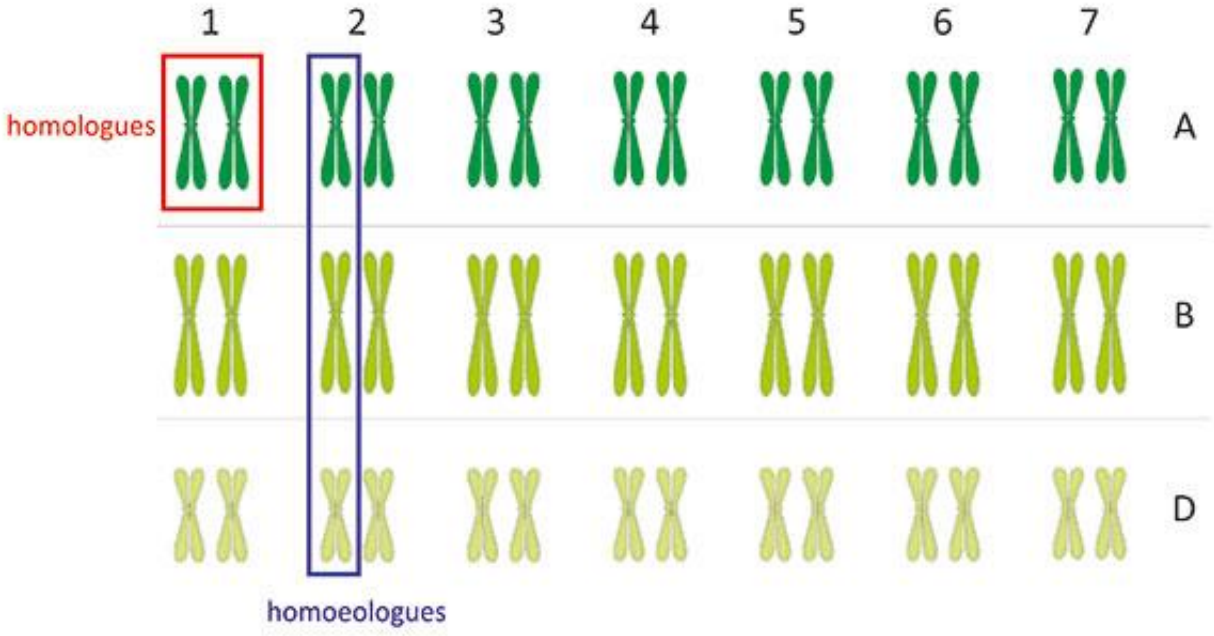


Trigo

17 Gbp
Hexaploide = 42 cromossomos

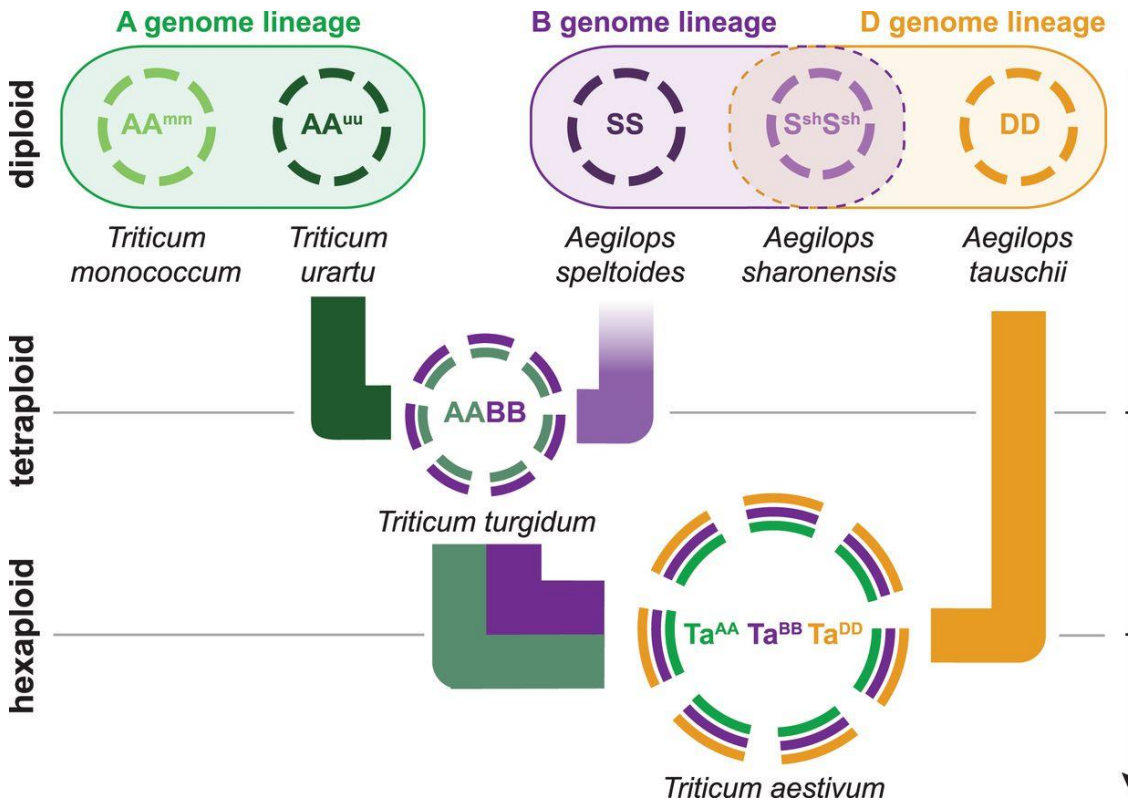
Trigo

17 Gbp
Hexaploide = 42 cromossomos

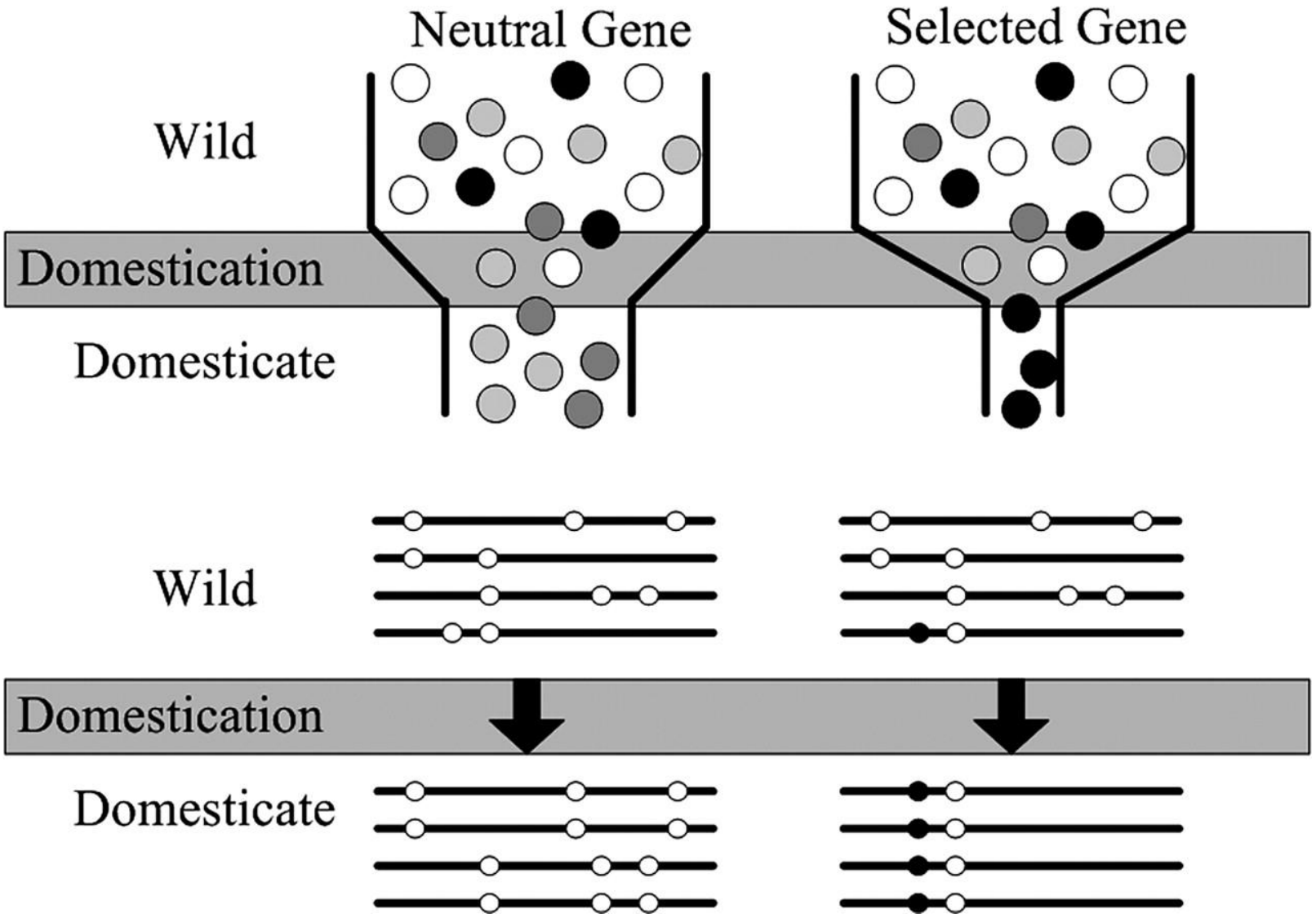


Trigo

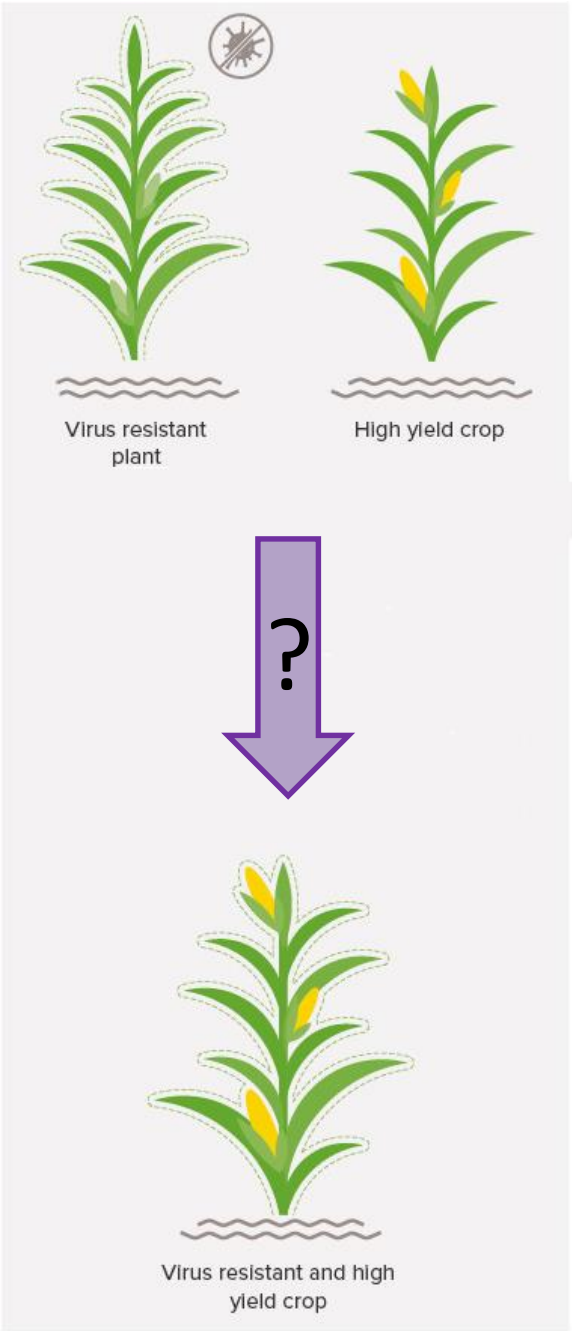
17 Gbp
Hexaploide = 42 cromossomos
3 subgenomas (A; B; D) = 2n = 14



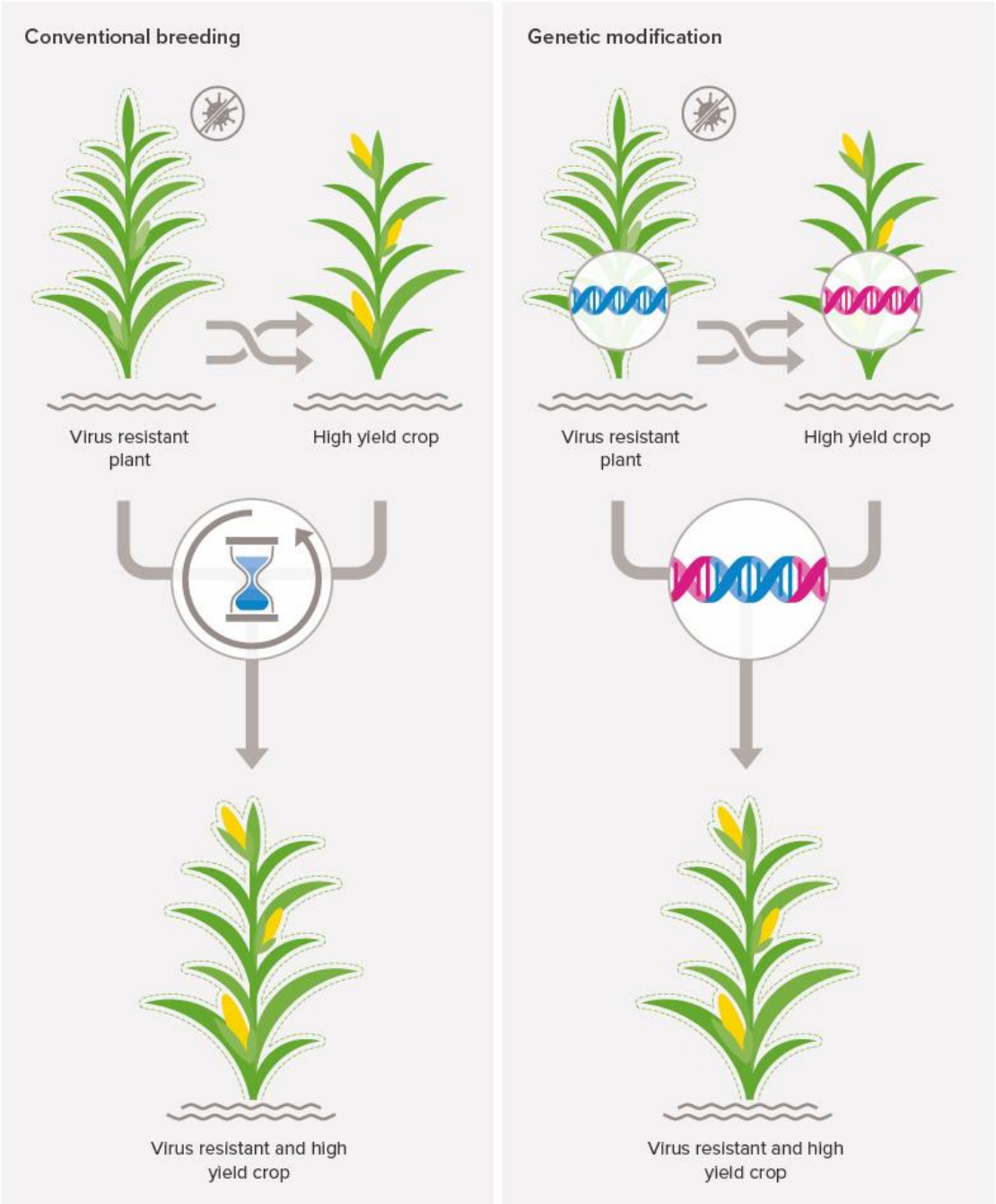
Gargalo de seleção



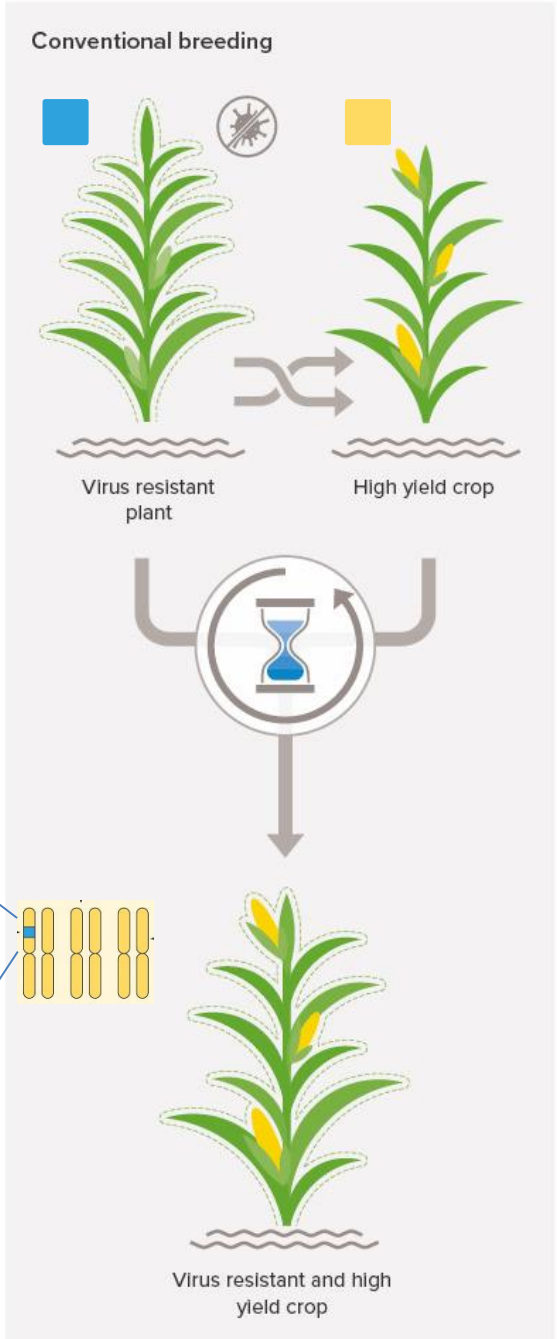
Ross-Ibarra, J., Morrell, P. L., & Gaut, B. S. (2007). Plant domestication, a unique opportunity to identify the genetic basis of adaptation. Proceedings of the National Academy of Sciences, 104(suppl 1), 8641-8648.

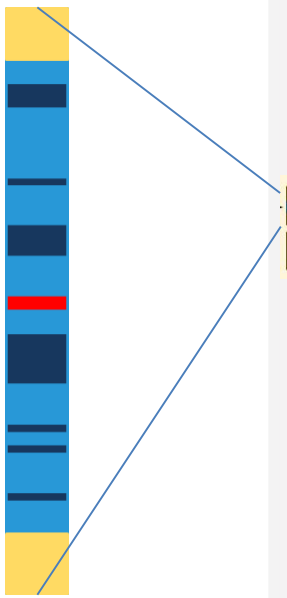


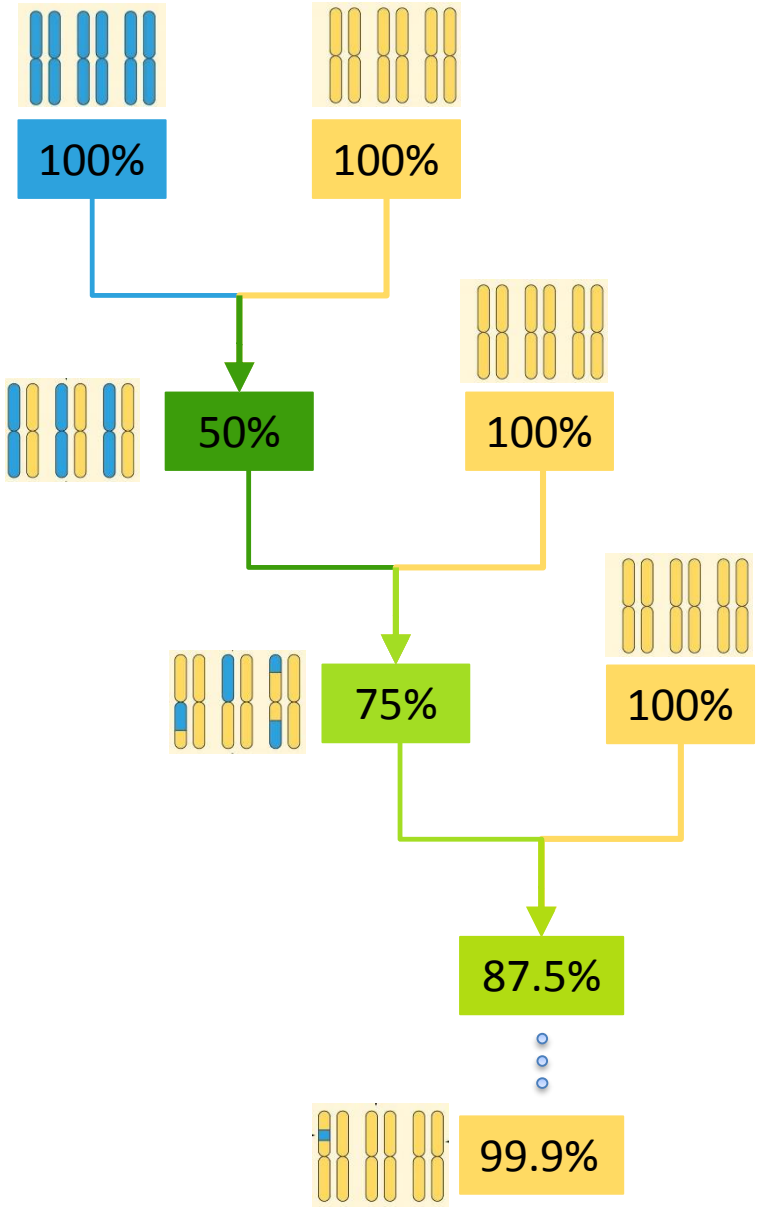
https://royalsociety.org/topics-policy/projects/gm-plants/how-does-gm-differ-from-conventional-plant-breeding/



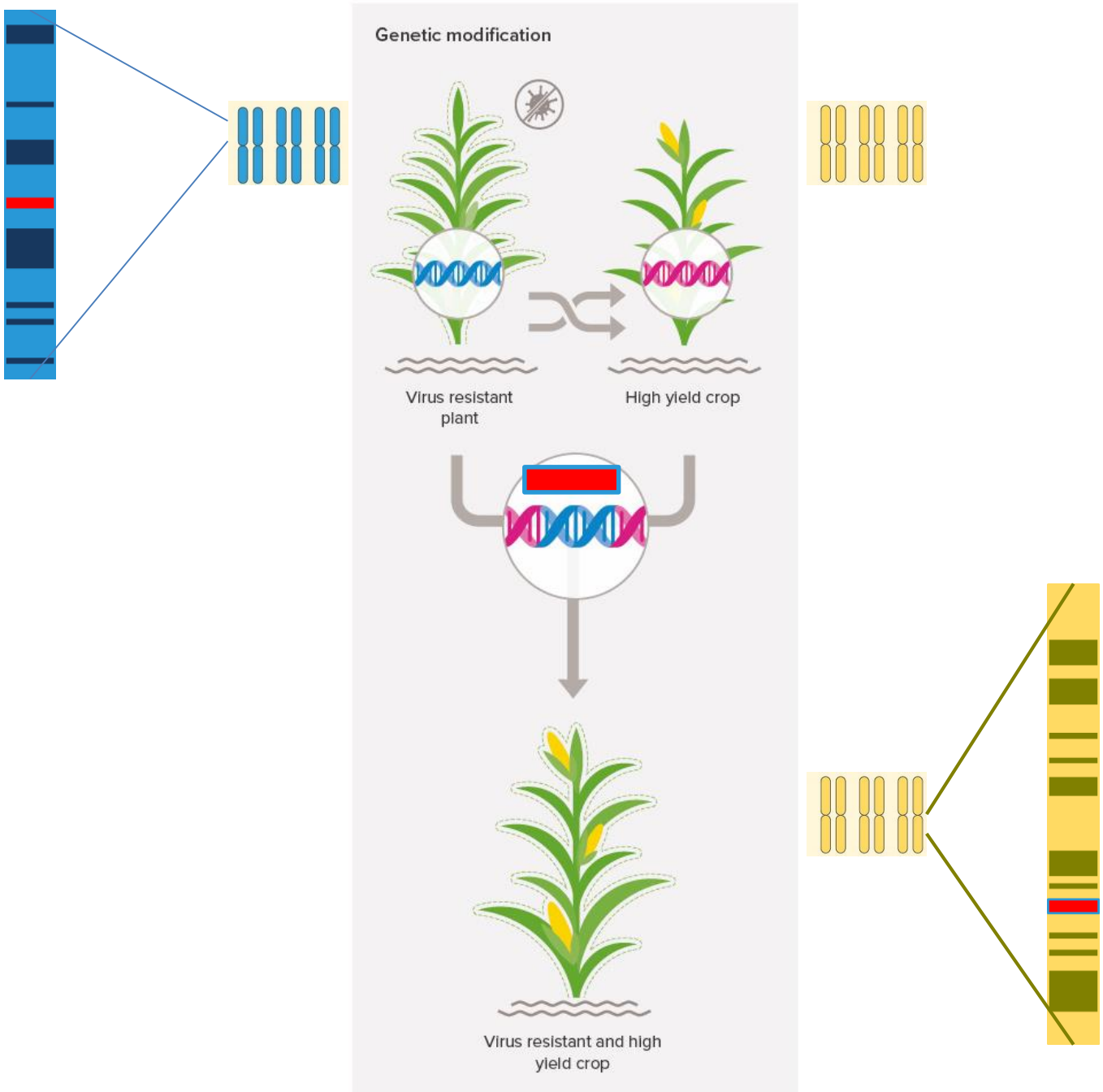
https://royalsociety.org/topics-policy/projects/gm-plants/how-does-gm-differ-from-conventional-plant-breeding/



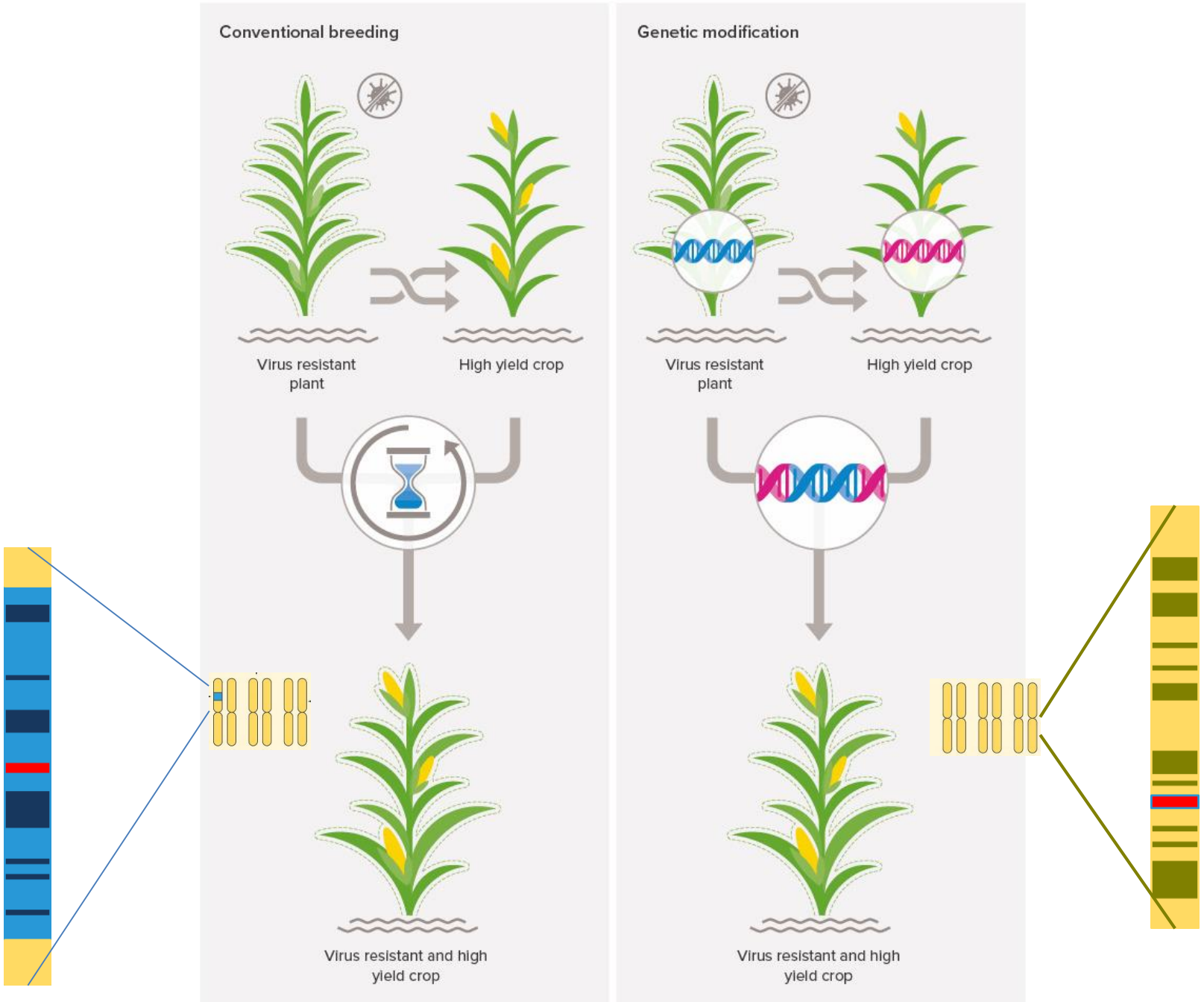




https://royalsociety.org/topics-policy/projects/gm-plants/how-does-gm-differ-from-conventional-plant-breeding/

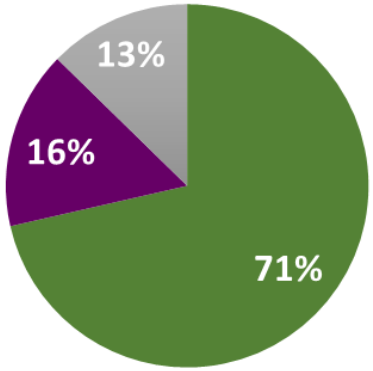


https://royalsociety.org/topics-policy/projects/gm-plants/how-does-gm-differ-from-conventional-plant-breeding/



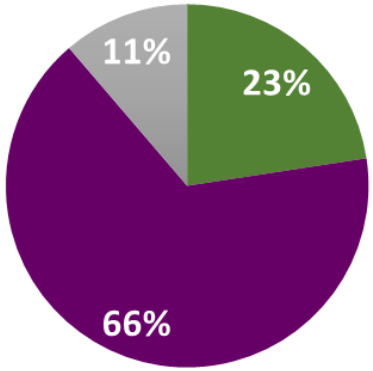
https://royalsociety.org/topics-policy/projects/gm-plants/how-does-gm-differ-from-conventional-plant-breeding/

O tempo para o desenvolvimento de uma variedade é maior no caso de:



- Melhoramento genético tradicional (cruzamento)
- Melhoramento genético por técnicas de engenharia genética (transgênicos)
- Igual para ambos

O tempo para a regulamentação de uma variedade é maior no caso de:



- Melhoramento genético tradicional (cruzamento)
- Melhoramento genético por técnicas de engenharia genética (transgênicos)
- Igual para ambos

Diferentes nomes de acordo à distância evolutiva entre o gene a ser introduzido e o organismo receptor

Table 1. Proposed categories for organisms currently designated 'transgenic' or 'genetically modified'

Categories	Source of genetic modifications	Genetic variability via conventional breeding	Genetic distance
Intragenic	Within genome[a]	Possible	Low
Famigenic	Species in the same family[b]	Possible	↓
Linegenic	Species in the same lineage[c]	Impossible	
Transgenic	Unrelated species[d]	Impossible	
Xenogenic	Laboratory-designed genes[e]	Impossible	High

[a]From directed mutations or recombinations; the extent of modification also reflects those arising in classical, selection-based breeding.
[b]Taxonomic family; the extent of modification also reflects those arising from applying cellular techniques in classical breeding.
[c]Phylogenetic lineage; recombination of genetic material beyond what can be achieved by classical breeding methods.
[d]Contains recombined DNA from unrelated organisms. Reflects the genetic composition of most GMOs commercialized today.
[e]For which no naturally evolved genetic counterpart can be found or expected (for example, synthetic genes and novel combinations of protein domains from various species).

Cisgenesis refers to the transfer of genetic material between sexually compatible organisms.

Transgenesis occurs between sexually incompatible organisms .

(Schouten et al., 2006).

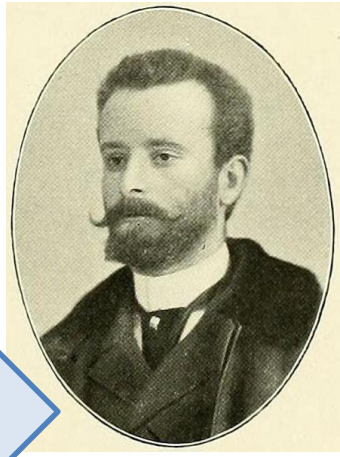
Fonte: Nielsen, 2003.

A really useful pathogen, *Agrobacterium tumefaciens*

From common plant pathogen to useful tool in plant molecular biology and engineering

Crown gall (galha-de-coroa) disease and the tumor-inducing principle

The first written record of crown gall disease, on grape, dates from 1853

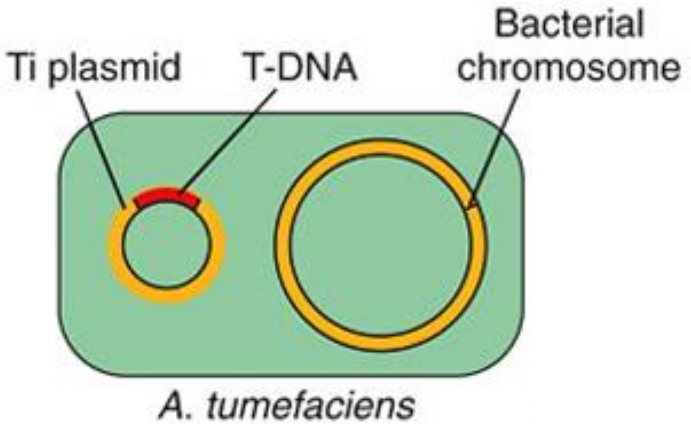


Fridiano Cavara (1897) found bacterias associated to crown gall in grape

Crown gall induces growths at wound sites and severely limits crop yields and growth vigor

Edward L. Barnard, Florida Department of Agriculture and Consumer Services, Bugwood.org; Mike Ellis, Ohio State University; University of Georgia Plant Pathology Archive, University of Georgia, Bugwood.org; Wikimedia commons

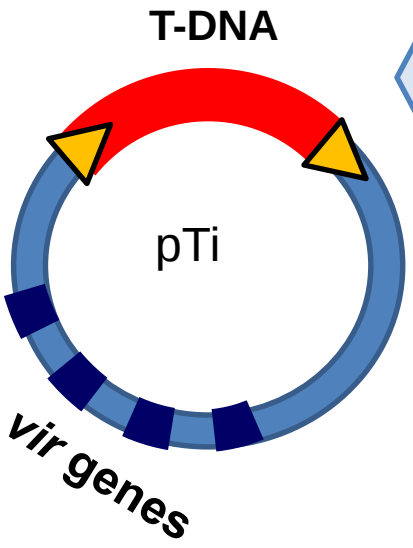
Some DNA from the Ti plasmid is transferred into the plant cells (1977)



http://cms.daegu.ac.kr/sgpark/microbiology/agrobacterium.jpg

Structure and function analysis of the Ti plasmid

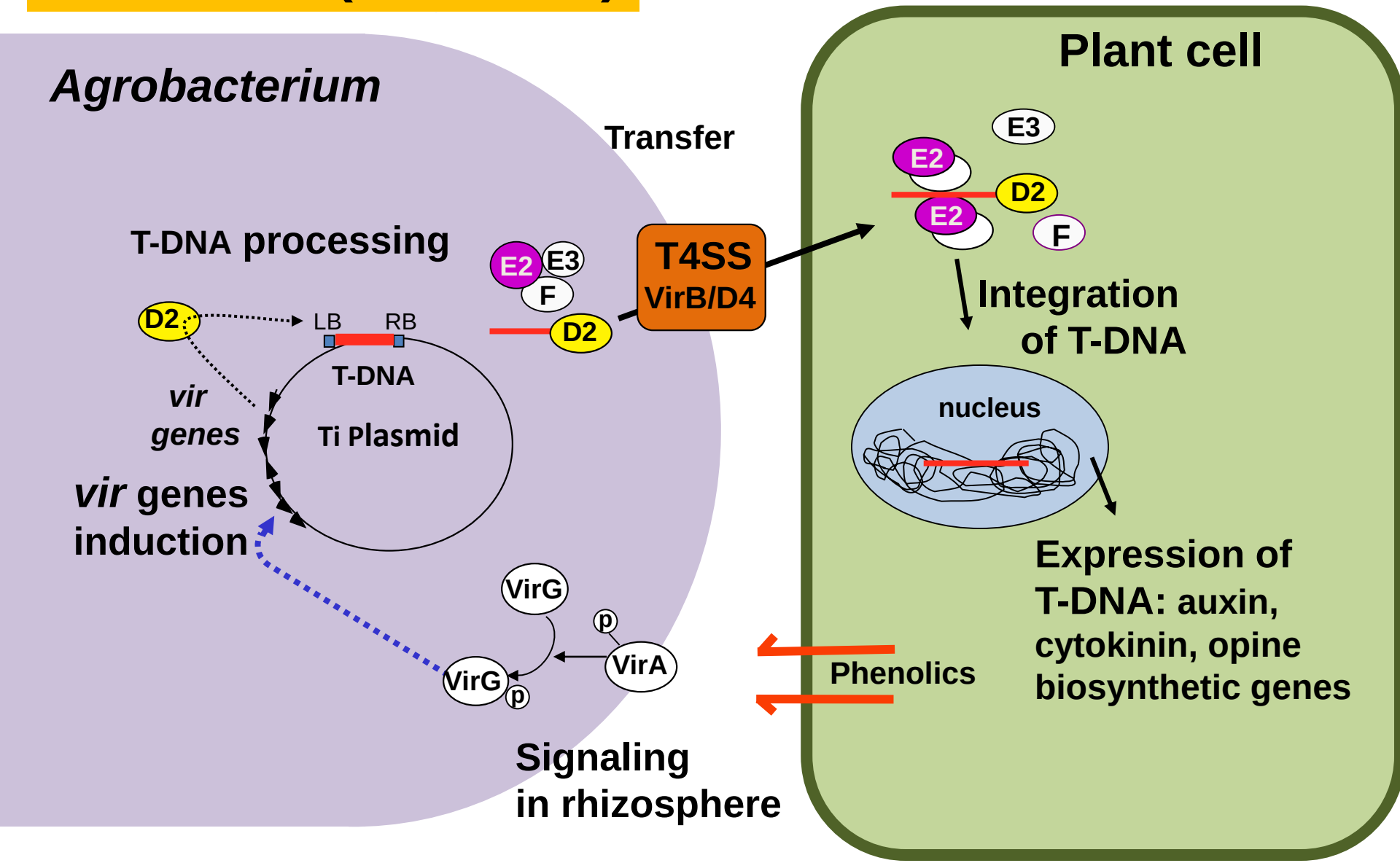
Transfer DNA (T-DNA) moves into the plant cell nucleus. It is flanked by two direct 25 bp repeat border sequences, shown as yellow triangles



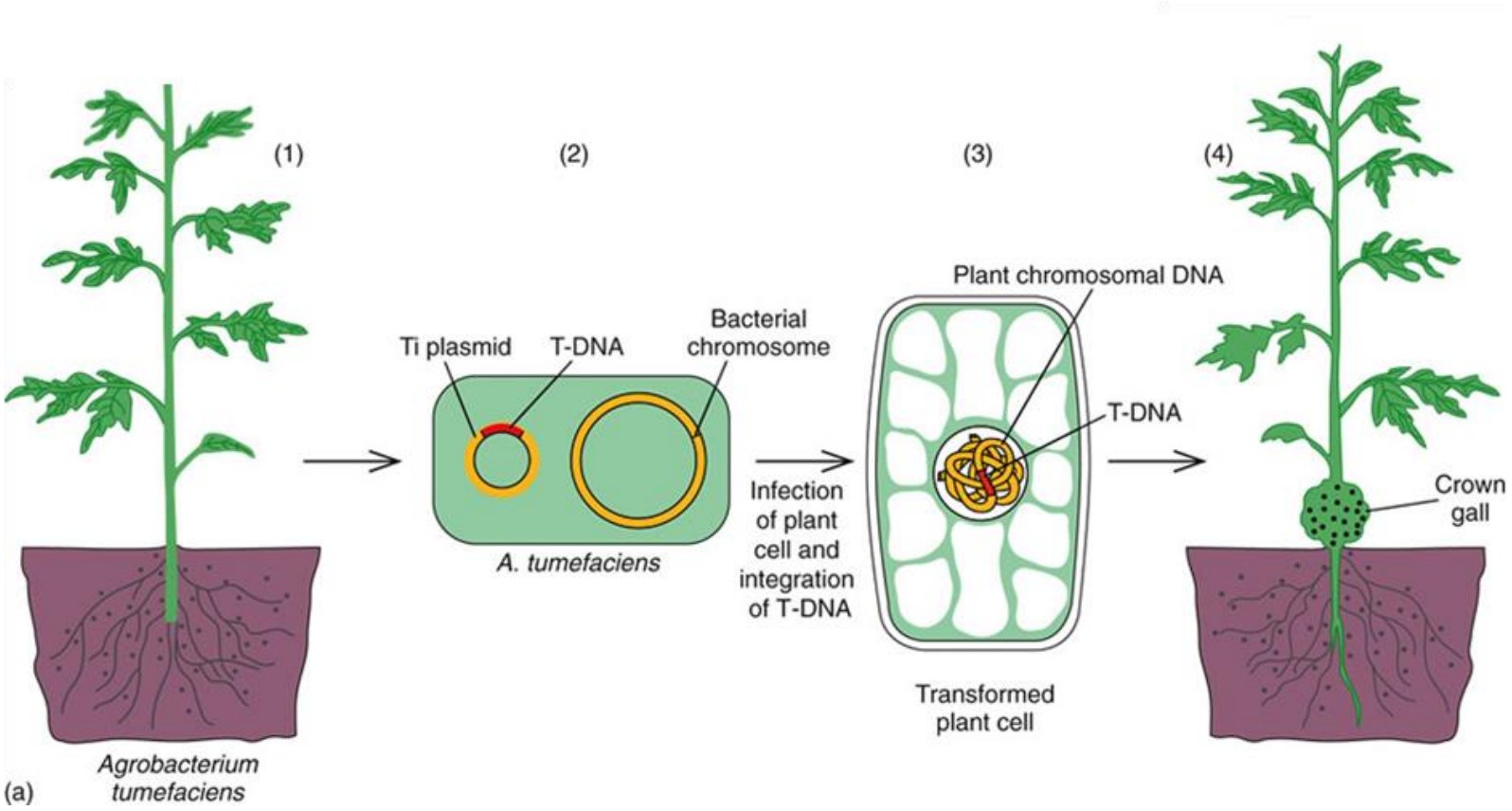
The *virulence* (*vir*) genes are required for T-DNA movement into the plant cell (more on them later)

The organization of Ti plasmids varies between isolates, but all carry one or more **T-DNA region** and one ***vir* region**

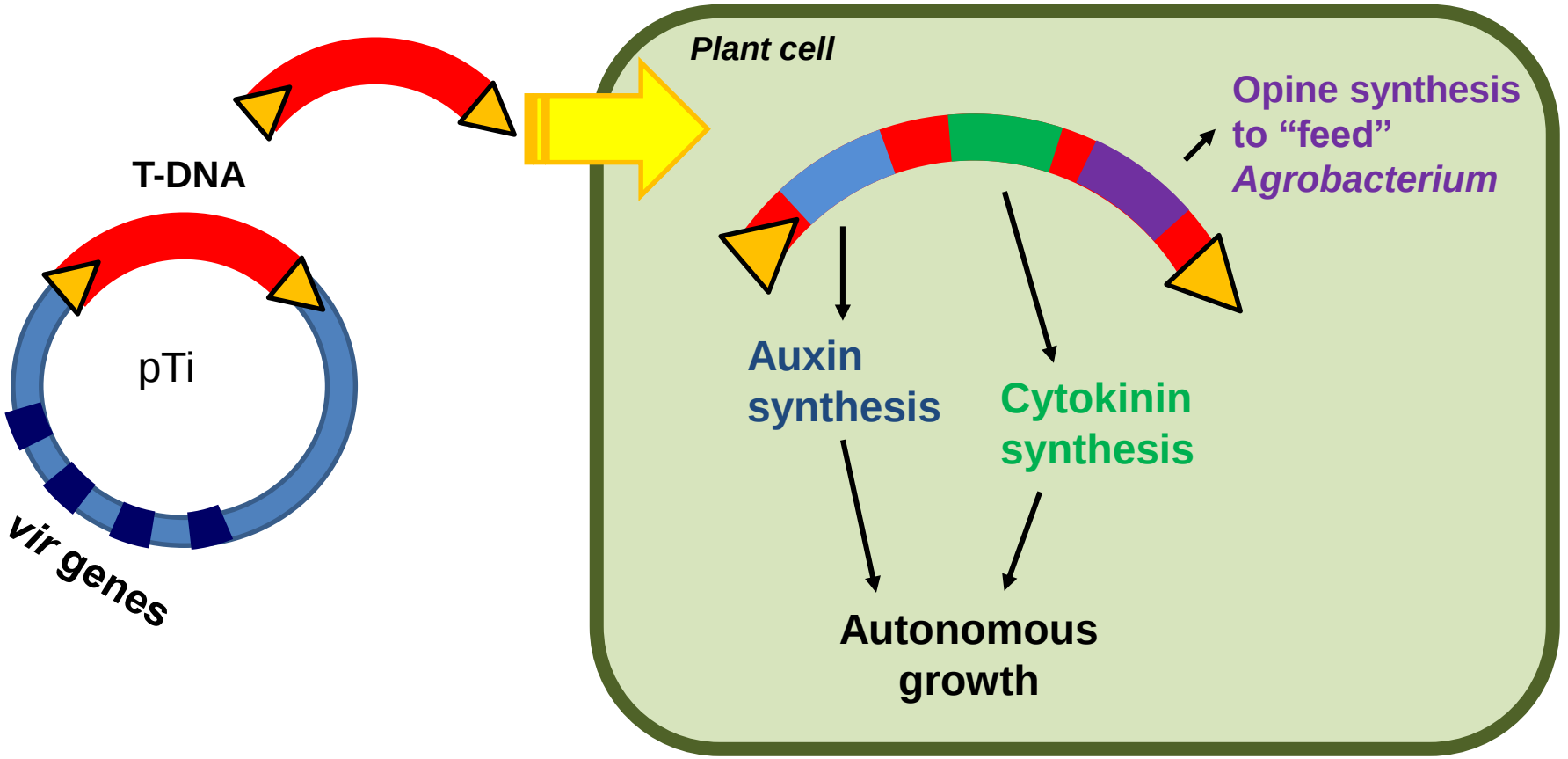
SUMMARY (Animated)



Some DNA from the Ti plasmid is transferred into the plant cells (1977)

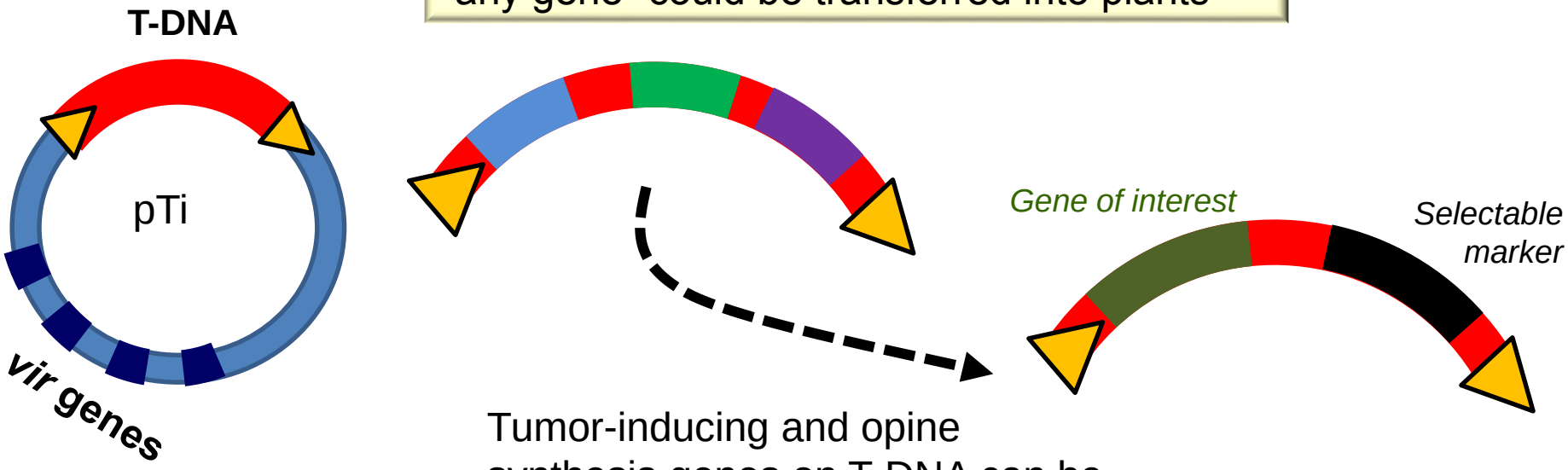


The T-DNA region: tumor-inducing genes and opine synthesis genes



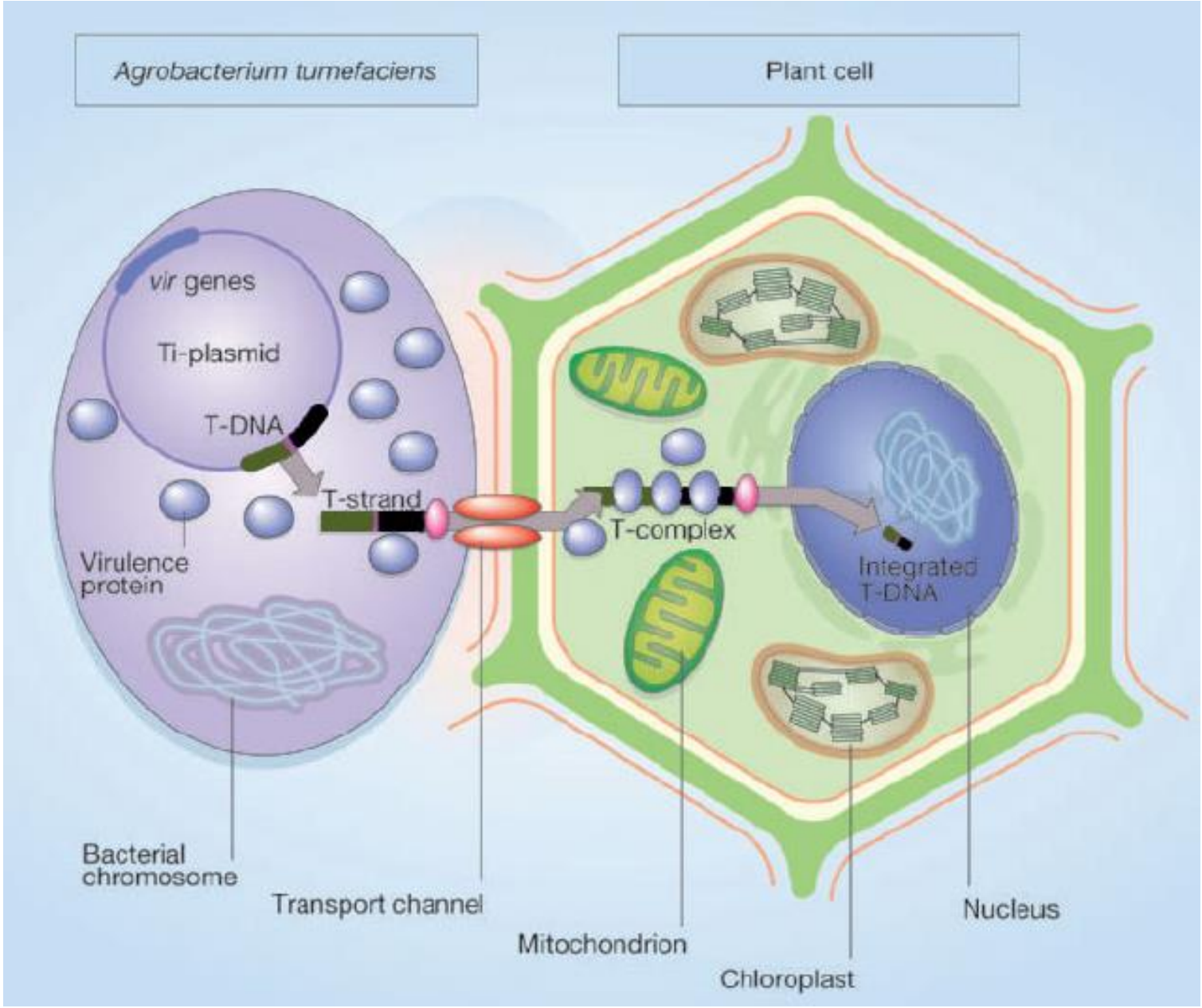
The Ti plasmid can be used to introduce any gene into plants

The discovery that T-DNA was inserted into the plant genome raised the possibility that "any gene" could be transferred into plants



Tumor-inducing and opine synthesis genes on T-DNA can be replaced by a "gene of interest" and selectable marker

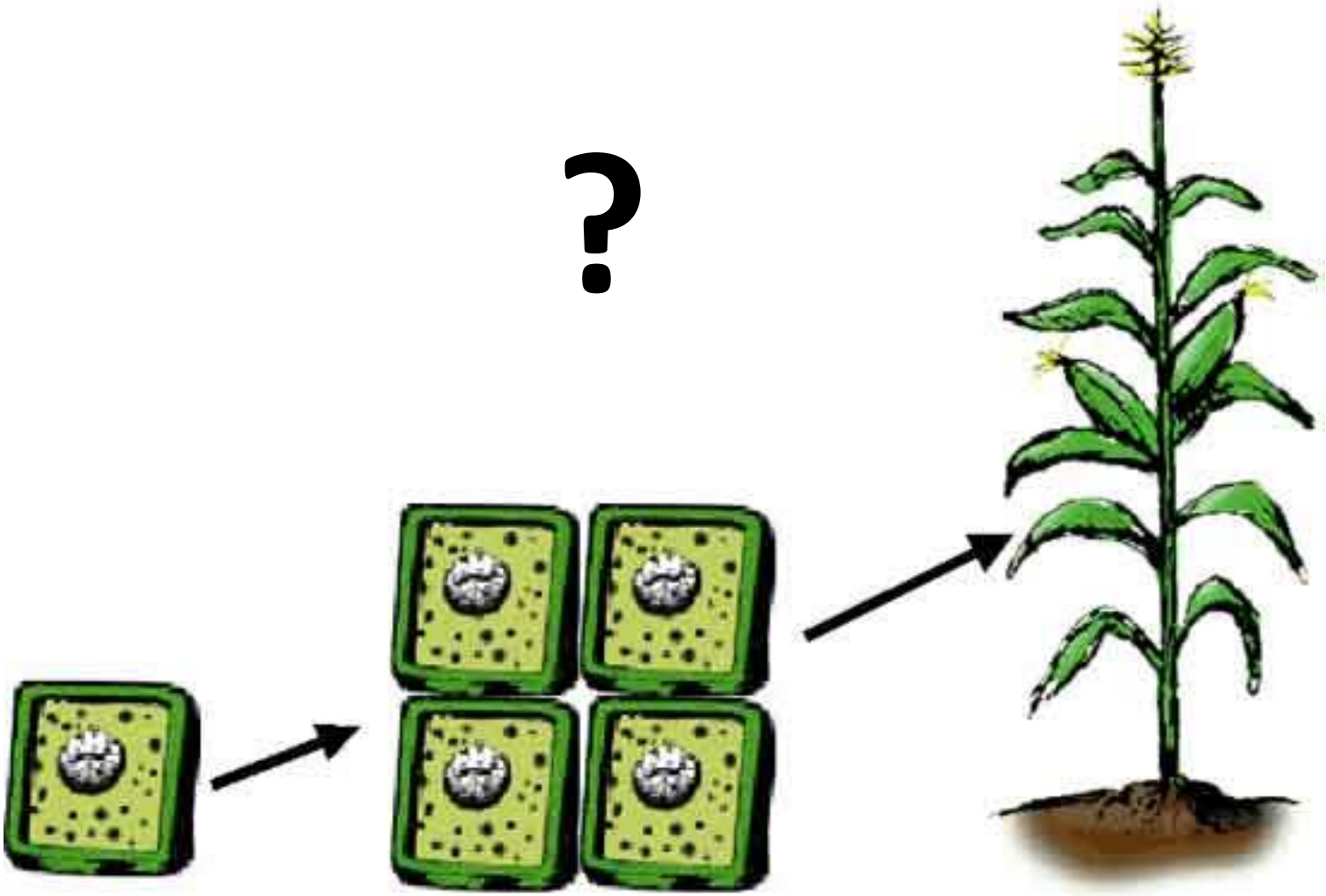
Hoekema, A., Hirsch, P.R., Hooykaas, P.J.J. and Schilperoort, R.A. (1983). A binary plant vector strategy based on separation of vir- and T-region of the *Agrobacterium tumefaciens* Ti-plasmid. Nature. 303: 179-180.



ONE transformed plant cell

http://www.nature.com/nature/journal/v433/n7026/images/433583a-f2.2.jpg

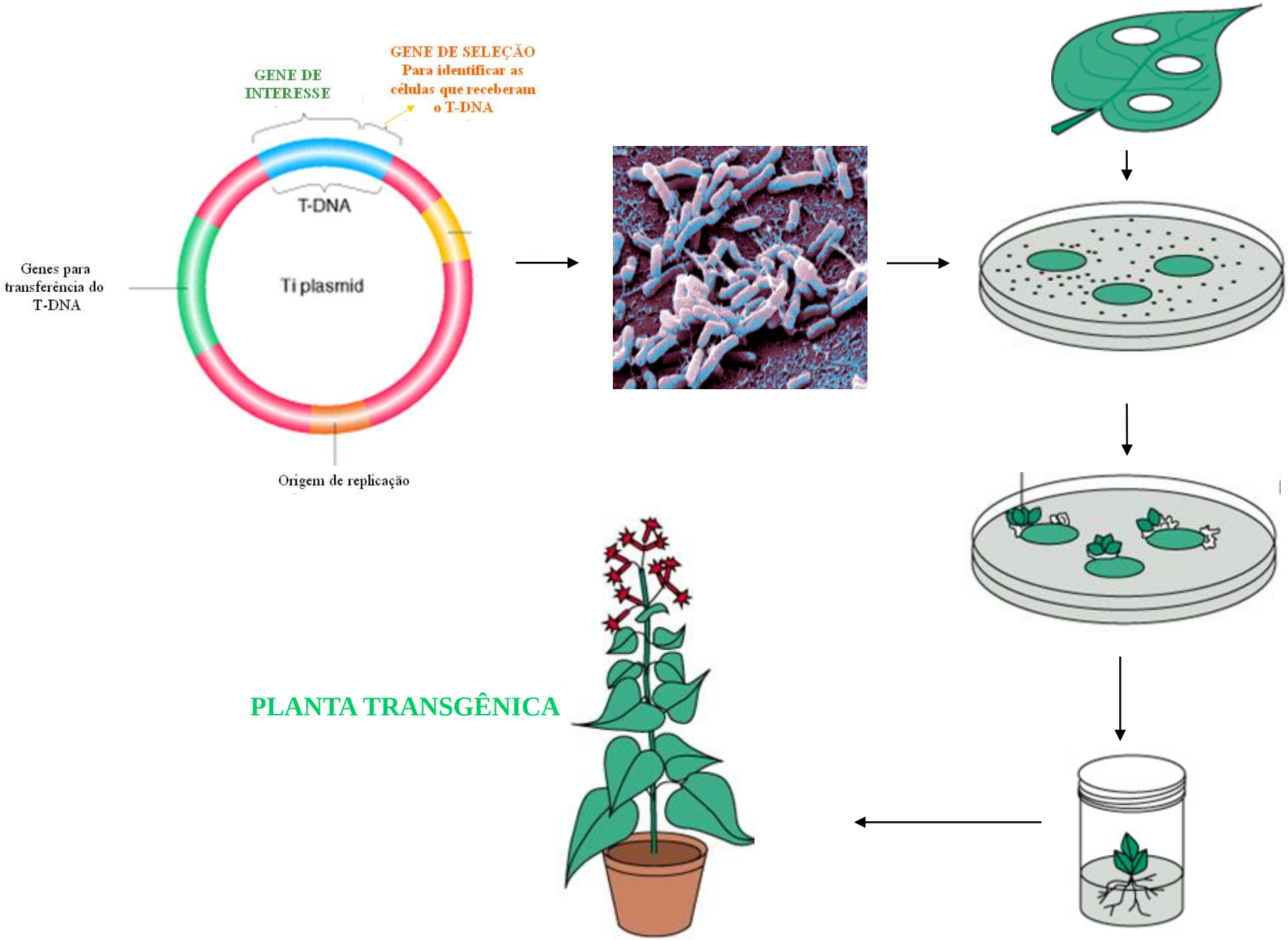
?



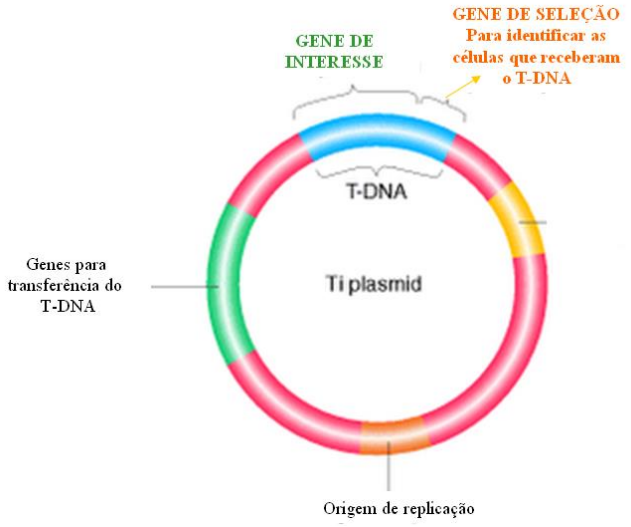
http://passel.unl.edu/Image/siteImages/CelltopltLG.jpg

Mexendo *in vitro* na composição do meio de cultura posso diferenciar qualquer tecido...

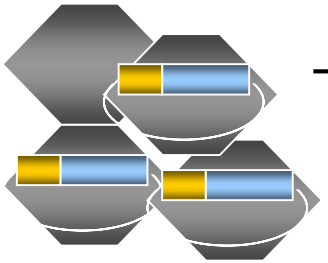
Transformação *via Agrobacterium*

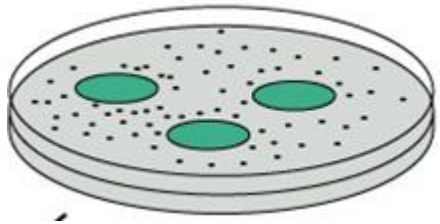


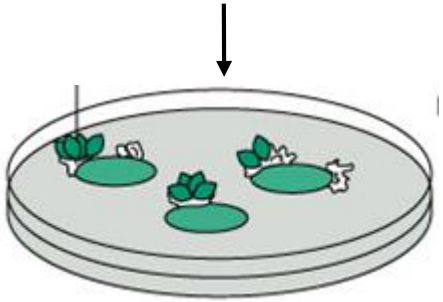
Transformação via bombardeamento: canhão gênico



Partículas de tungstênio carregando DNA

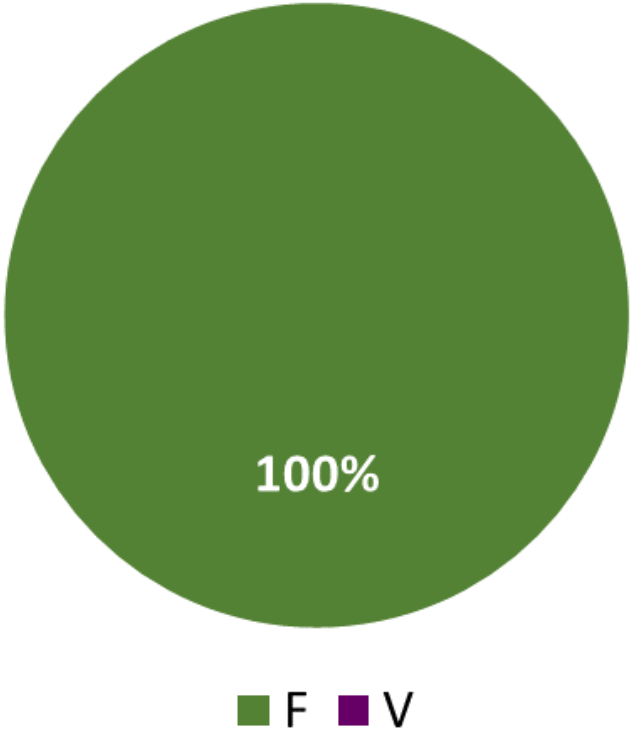






PLANTA TRANSGÊNICA

Um tomate modificado geneticamente com a inserção de um gene de peixe, passará a ter gosto de peixe.



Report on Consumer Views of Genetically Modified Foods (2016)
Canadá (Toronto, Vancouver, Saskatoon, Halifax, Quebec)
78% that tomatoes which have been genetically modified with genes from catfish **would probably taste fishy**;

Transformação Genética:

- ***Auxiliar no estudo da biologia vegetal***

- ***Biotecnologia (melhoramento genético)***

Cisgeneses ou transgeneses- Estratégias:

- ***Expressão de gene***

(que não estava antes nesse organismo e de origens diversas)

- ***Silenciamento de gene***

(reduzir a quantidade de mRNA e consequentemente de proteína)

Cisgeneses ou transgeneses- Estratégias:

- ***Expressão de gene***

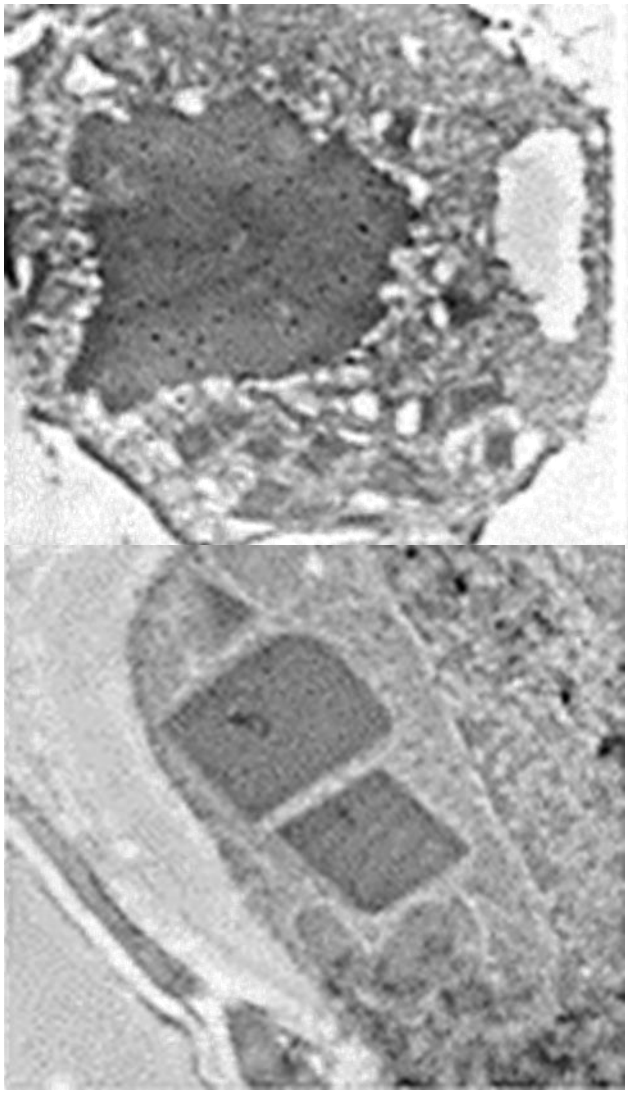
(que não estava antes nesse organismo e de origens diversas)

- ***Silenciamento de gene***

(reduzir a quantidade de mRNA e consequentemente de proteína)

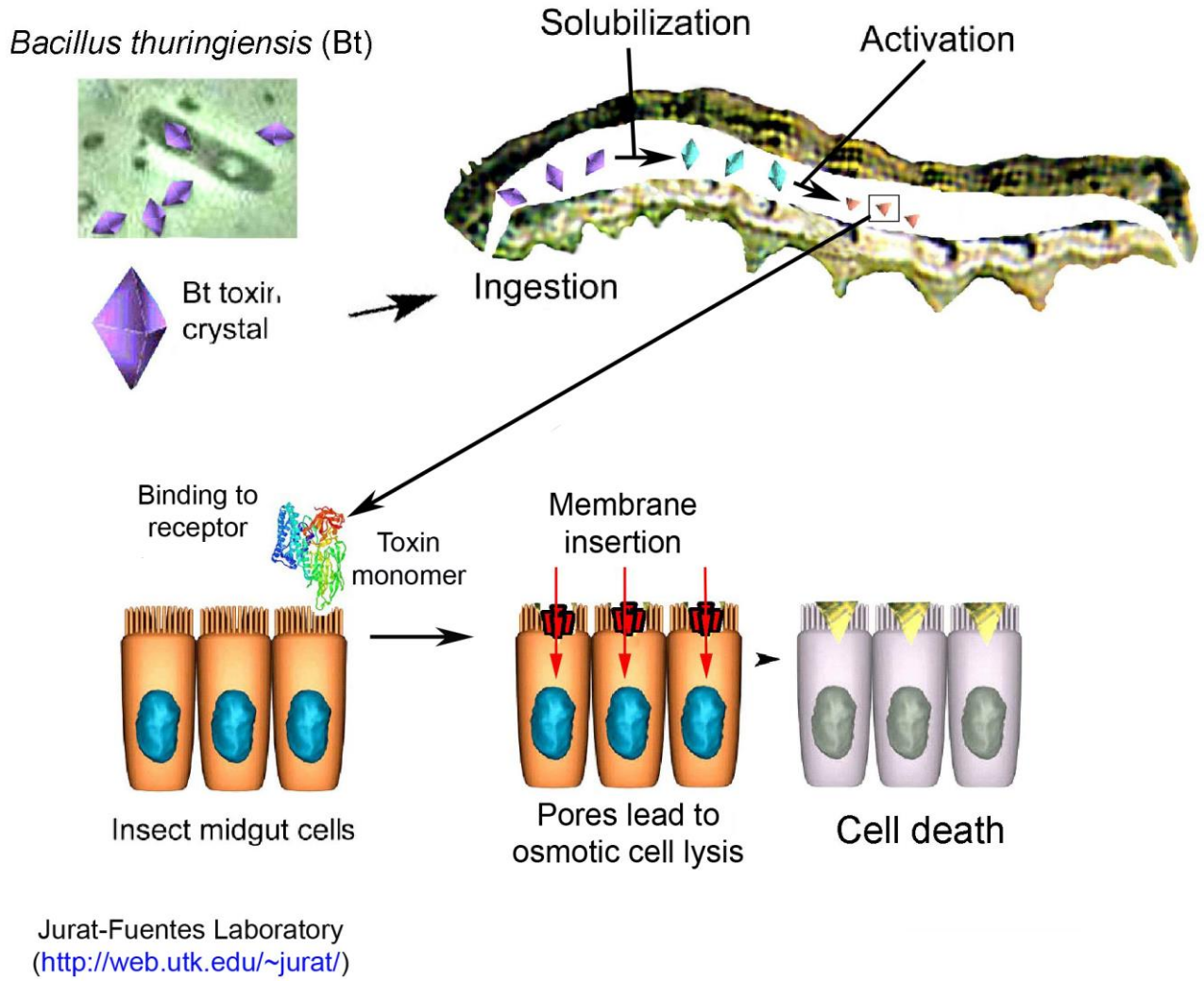
Resistência a insetos: genes *Bt* de *Bacilus turingensis* (transgênico)

Pectinophora gossypiella



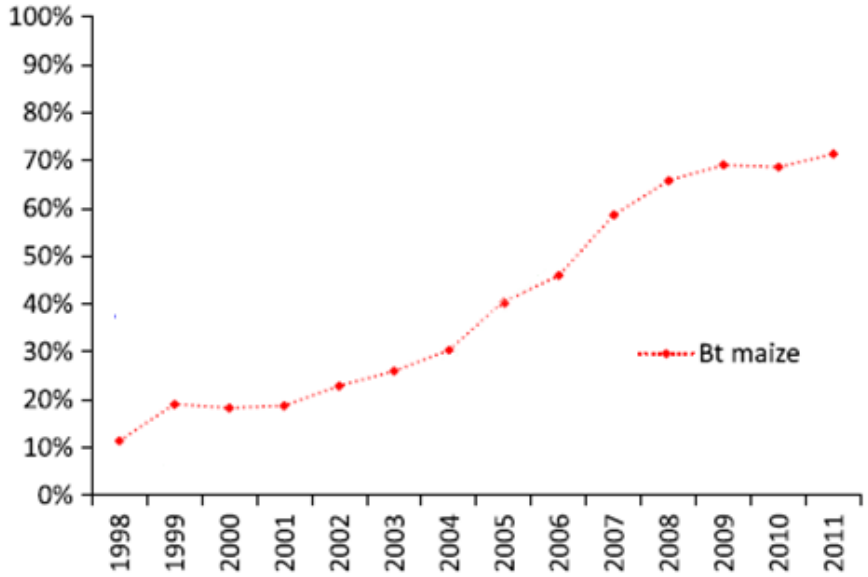
Country	Insecticide reduction	Increase in effective yield	Increase in gross margin	References
	—— % ——		US$ ha^{-1}	
Argentina	47	33	23	Qaim and de Janvry, 2005
Australia	48	0	66	Fitt, 2003
China	65	24	470	Pray *et al.*, 2002
India	41	37	135	Subramanian and Qaim, 2009
Mexico	77	9	295	Traxler *et al.*, 2003
USA	36	10	58	Carpenter *et al.*, 2002

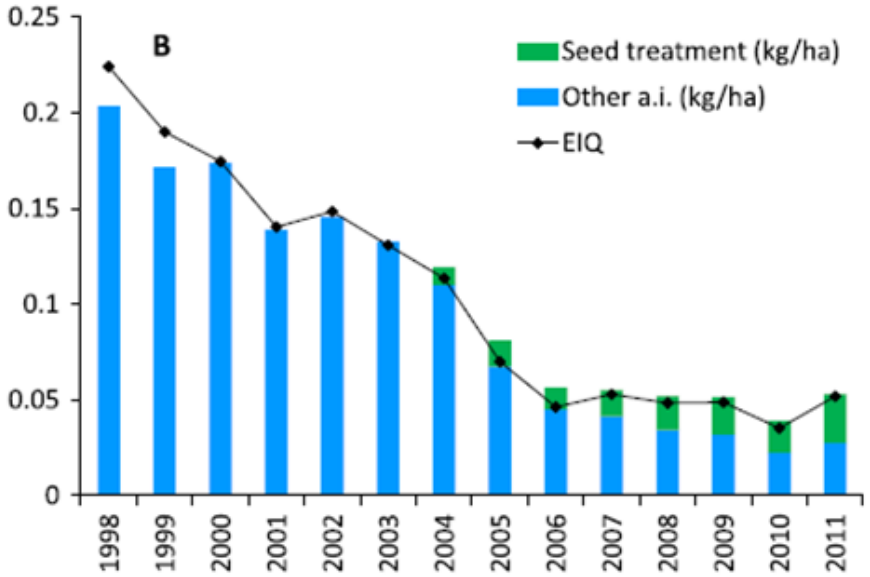
Resistência a insetos: genes *Bt* de *Bacilus turingensis* (transgênico)



Jurat-Fuentes Laboratory
(http://web.utk.edu/~jurat/)

Resistência a insetos: genes *Bt* de *Bacilus turingensis* (transgênico)

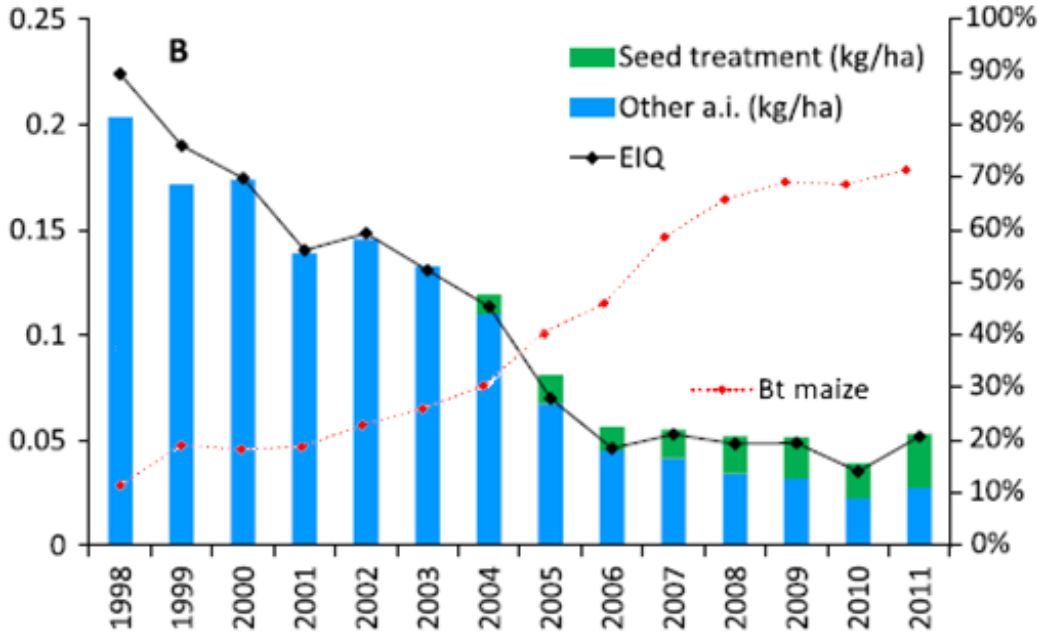




EIQ: Environmental Impact Quotient
a.i. : Active Ingredient

Perry, E. D., Ciliberto, F., Hennessy, D. A., & Moschini, G. (2016). Genetically engineered crops and pesticide use in US maize and soybeans. *Science advances*, *2*(8), e1600850.

Resistência a insetos: genes *Bt* de *Bacilus turingensis* (transgênico)

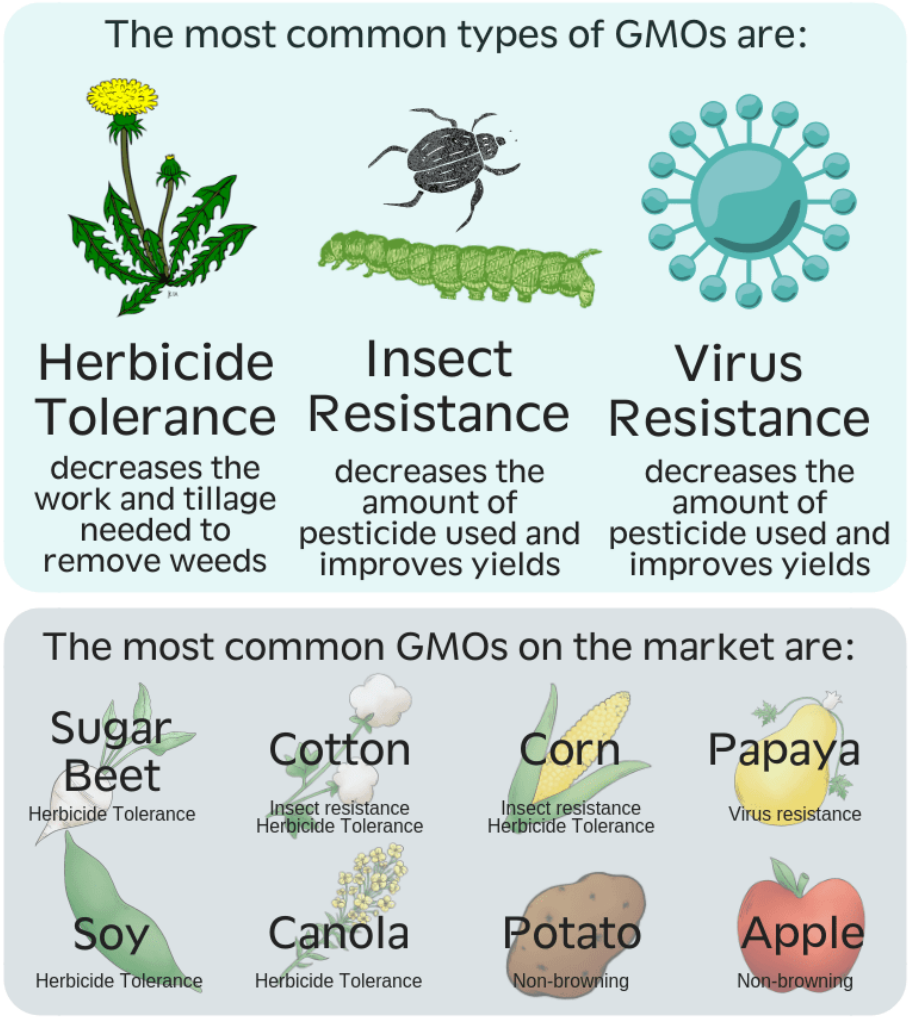


EIQ: Environmental Impact Quotient
a.i. : Active Ingredient

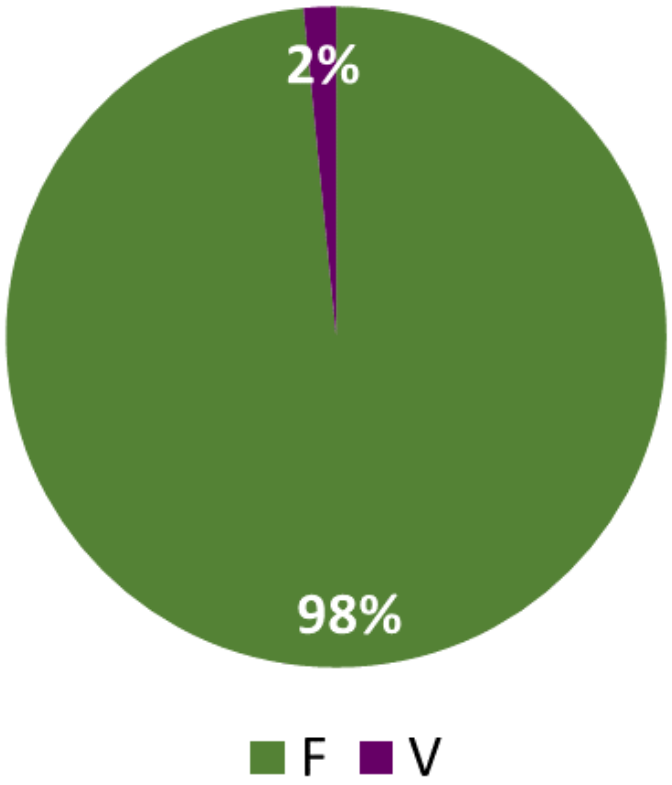
Perry, E. D., Ciliberto, F., Hennessy, D. A., & Moschini, G. (2016). Genetically engineered crops and pesticide use in US maize and soybeans. *Science advances*, *2*(8), e1600850.

- Snow, A. A., Pilson, D., Rieseberg, L. H., Paulsen, M. J., Pleskac, N., Reagon, M. R., ... & Selbo, S. M. (2003). A Bt transgene reduces herbivory and enhances fecundity in wild sunflowers. Ecological applications, 13(2), 279-286.
- Niu, L., Mannakkara, A., Qiu, L., Wang, X., Hua, H., Lei, C., ... & Ma, W. (2017). Transgenic Bt rice lines producing Cry1Ac, Cry2Aa or Cry1Ca have no detrimental effects on Brown Planthopper and Pond Wolf Spider. Scientific reports, 7(1), 1940.
- Yao, Y. S., Han, P., Niu, C. Y., Dong, Y. C., Gao, X. W., Cui, J. J., & Desneux, N. (2016). Transgenic Bt cotton does not disrupt the top-down forces regulating the cotton aphid in central China. *PloS one*, *11*(11), e0166771.
- Raen, A. Z., Cong, D. A. N. G., Fang, W. A. N. G., PENG, Y. F., & YE, G. Y. (2016). Thrips-mediated impacts from transgenic rice expressing Cry1Ab on ecological fitness of non-target predator Orius tantilus (Hemiptera: Anthocoridae). *Journal of integrative agriculture*, *15*(9), 2059-2069.
- Fleming, D., Musser, F., Reisig, D., Greene, J., Taylor, S., Parajulee, M., ... & Stewart, S. (2018). Effects of transgenic Bacillus thuringiensis cotton on insecticide use, heliothine counts, plant damage, and cotton yield: A meta-analysis, 1996-2015. *PloS one*, *13*(7), e0200131.
- Li, L., Yang, X., Wang, L., Yan, H., Su, J., Wang, F., & Lu, B. R. (2016). Limited ecological risk of insect-resistance transgene flow from cultivated rice to its wild ancestor based on life-cycle fitness assessment. *Science bulletin*, *61*(18), 1440-1450.
- Jin, L., Zhang, H., Lu, Y., Yang, Y., Wu, K., Tabashnik, B. E., & Wu, Y. (2015). Large-scale test of the natural refuge strategy for delaying insect resistance to transgenic Bt crops. *Nature biotechnology*, *33*(2), 169.
- Guo, J., He, K., Hellmich, R. L., Bai, S., Zhang, T., Liu, Y., ... & Wang, Z. (2016). Field trials to evaluate the effects of transgenic cry1Ie maize on the community characteristics of arthropod natural enemies. *Scientific reports*, *6*, 22102.
- Shahid, A. A., Bano, S., Khalid, S., Samiullah, T. R., Bajwa, K. S., & Ali, M. A. (2016). Biosafety assessment of transgenic Bt cotton on model animals. *Advancements in Life Sciences*, *3*(3), 97-108.

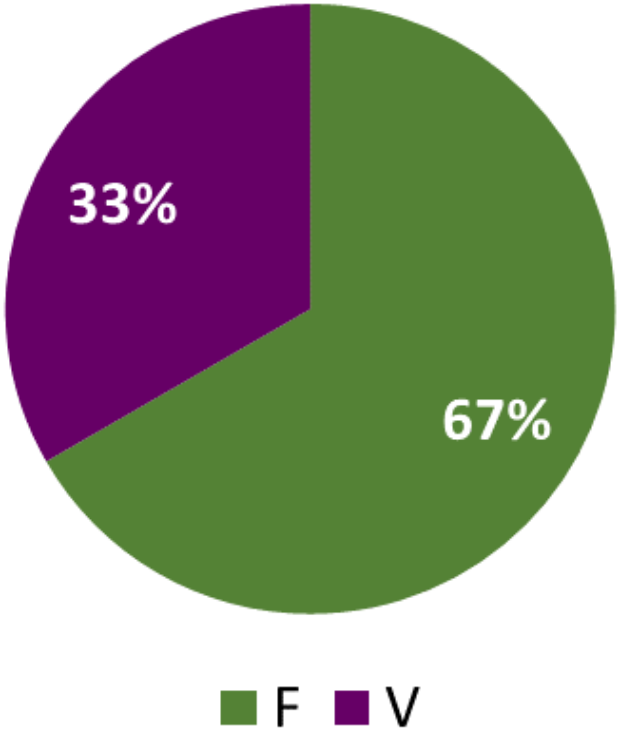
Resistência a insetos: genes *Bt* de *Bacilus turingensis* (transgênico)



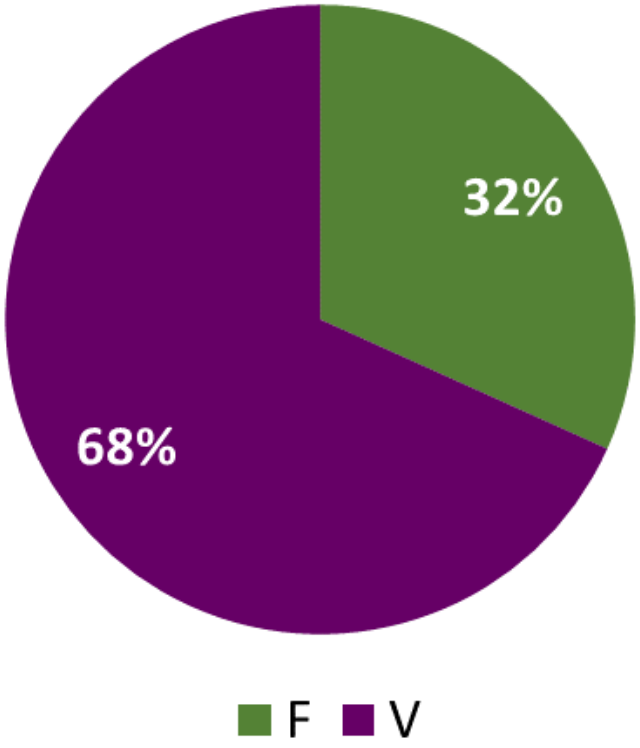
Ao ingerir um organismo geneticamente alterado, a pessoa pode ter seus genes modificados.



Um produto contendo organismo geneticamente alterado pode provocar alergia em algumas pessoas, o que não aconteceria se o produto utilizasse os mesmos ingredientes que não foram alterados geneticamente.



Organismos geneticamente modificados são seguros para o consumo



Safety statements on GMOs have been issued by dozens of institutions including:


European Food Safety Authority

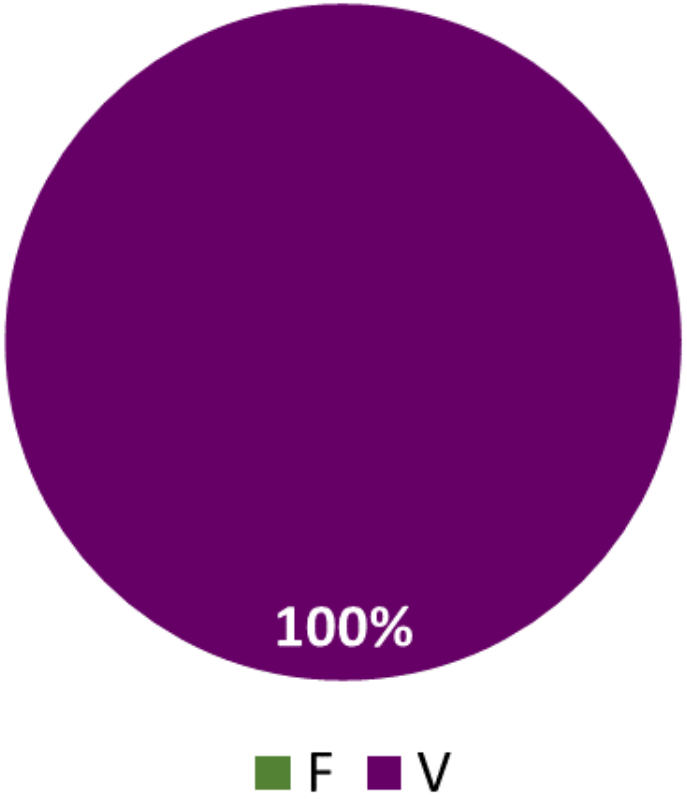

World Health Organization


National Academy of Sciences


Royal Society of Science

Aumentar a qualidade nutricional das culturas: Arroz com pro-vitamina A (carotenoides)

O melhoramento genético pode ser utilizado para suprir carências nutricionais das populações.



Aumentar a qualidade nutricional das culturas: Arroz com pro-vitamina A (carotenoides)

Vitamin A Deficiency and Rice

The problem :

Rice as major staple does not contain any pro-vitamin A.

The consequences:

400 million rice-eating poor suffer from vitamin A deficiency.
6,000 die per day, 500,000 become blind every year.

The transgenic concept:

Introduce, under endosperm-specific regulation, all genes necessary to establish the biochemical pathway.

Why genetic engineering in addition to the traditional interventions?

The genetic basis in the rice gene pool does not offer a basis for a conventional approach.

Golden Rice 2nd generation (trangênico)

Phytoene desaturase (*CRTI*) from *Erwinia uredovora*

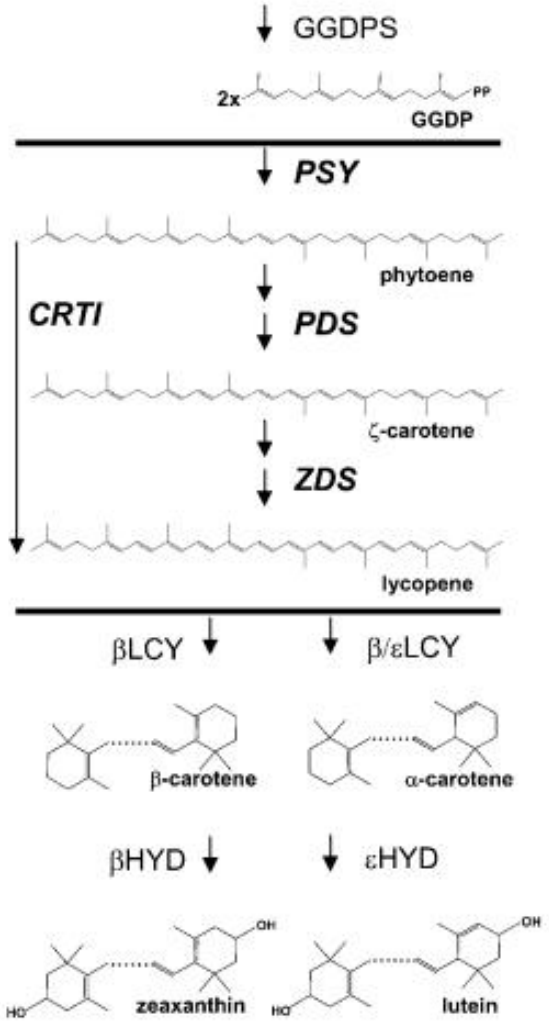


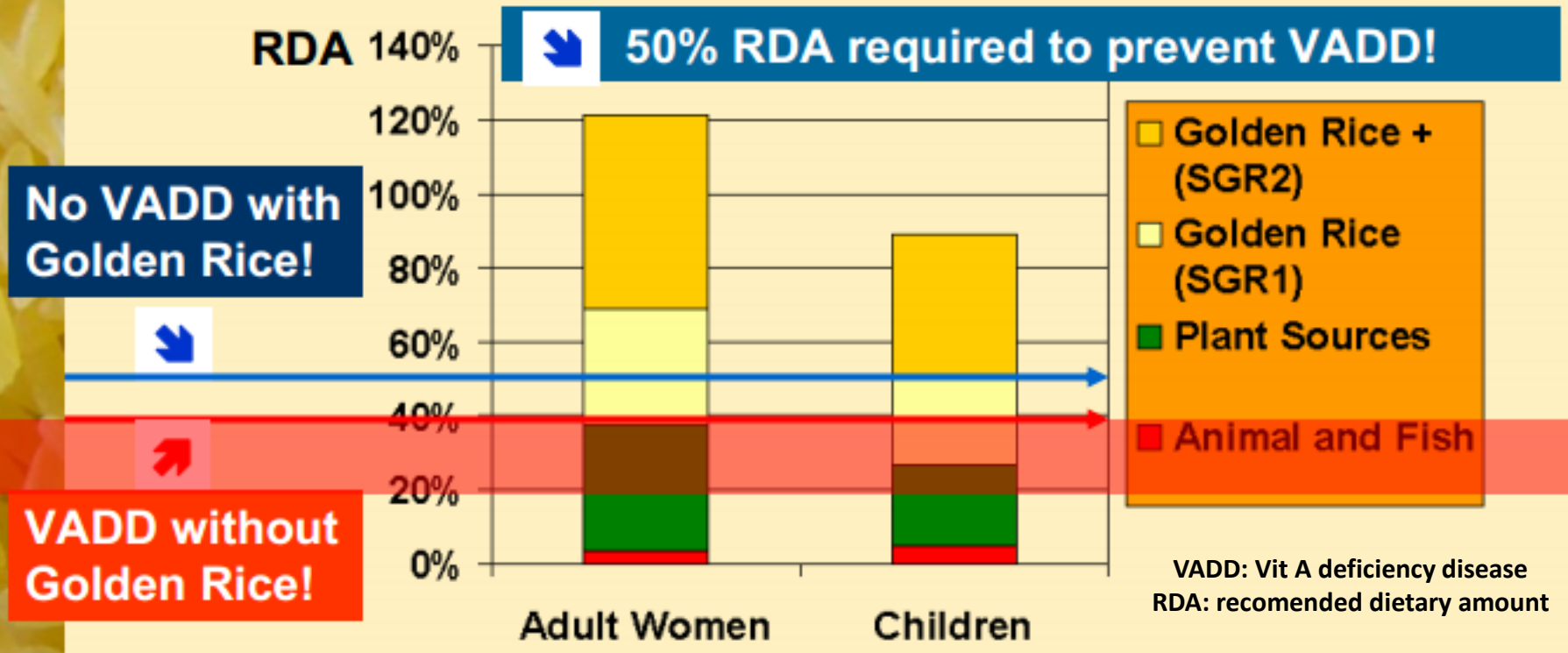
Figure 1. Carotenoid biosynthesis in transgenic rice endosperm. The precursor molecule geranylgeranyl-diphosphate (GGDP) is synthesized in wild-type endosperm. The enzymatic activities between horizontal bars are supplemented by transformation. This can be done either by using the two plant-type desaturases, PDS and ZDS, or by using the bacterial carotene desaturase, CrtI. However, lycopene does not appear as a product; instead, the carotenoids shown below the bottom bar are found in transgenic endosperm, among which β-carotene is predominant.

PSY from maize (*Zea mays*)

Provitamin A-contribution from a typical daily diet:

Calculation from the

International Food Policy Research Institute: **(2)**
Vitamin A contribution from nutrient intake.



VADD: Vit A deficiency disease
RDA: recomended dietary amount

A typical daily diet would prevent vitamin A-deficiency, ...

... but GMO-regulation prevents, so far, use of Golden Rice.

supportprecisionagriculture.org/index.html

Support Precision Agriculture

- Support GMOs and Golden Rice - Home
- Laureates Letter Supporting Precision Agriculture (GMOs)
- NEWS
- More Information About GMOs
- The developing world needs GMOs
- More sense about GMOs
- GMO FAQs
- Related Links: Videos, Web links, Articles, Books
- How You Can Help

SIGN UP

Contact us...

Tweet

Support GMOs and Golden Rice

141 Nobel Laureates plus 13104 scientists and citizens support Precision Agriculture (GMOs)

add your name too!...

WHY YOU SHOULD SUPPORT GMOS AND GOLDEN RICE

- GMOs are safe
- GMOs are green
- GMOs are especially important for small farmers

WHAT ARE GMOS?

WHY GREENPEACE IS WRONG ABOUT GMOS AND GOLDEN RICE

IS TRADITIONAL PLANT BREEDING MORE DANGEROUS THAN GM?

FORMER CRITICS HAVE A CHANGE OF HEART

GMO SUCCESS STORIES

you can open the attachment at your own risk

Bangladesh

Dr Razzak said: "Golden rice is more important than the other varieties of rice as it will be helpful to **fight the vitamin A deficiency**. **The rice variety has already got clearance in USA, Canada and Australia.**

"A committee of the Ministry of Environment will give the clearance for the production of Golden rice. We will be able to start cultivation of the rice in Bangladesh **within two-three months upon getting ministry clearance**," he said.

Cisgeneses ou transgeneses- Estratégias:

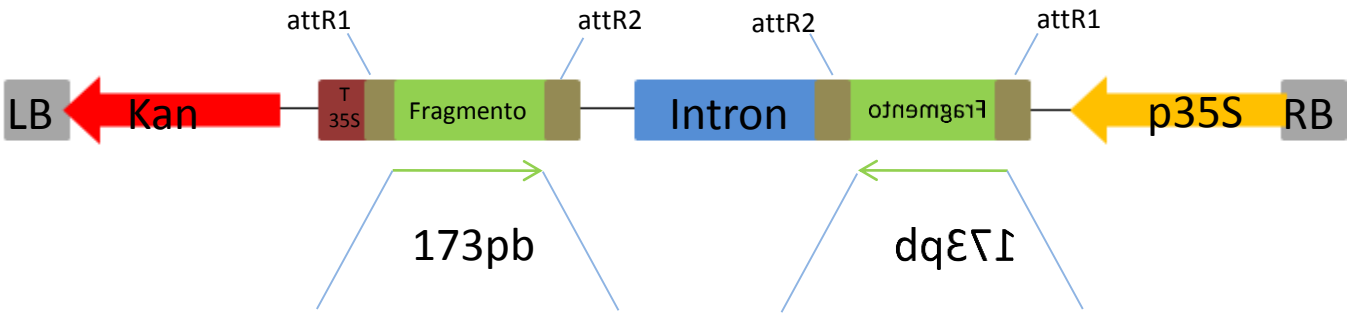
- ***Expressão de gene***

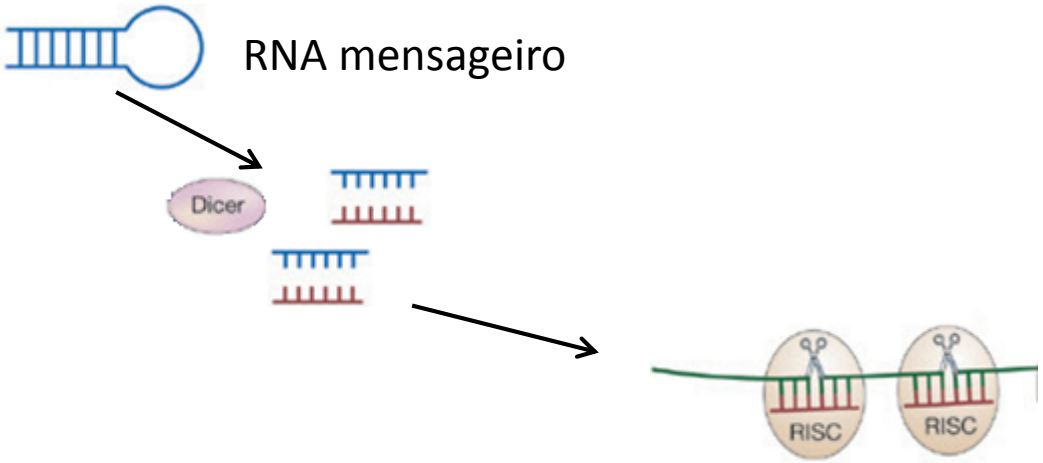
(que não estava antes nesse organismo e de origens diversas)

- ***Silenciamento de gene***

(reduzir a quantidade de mRNA e consequentemente de proteína)

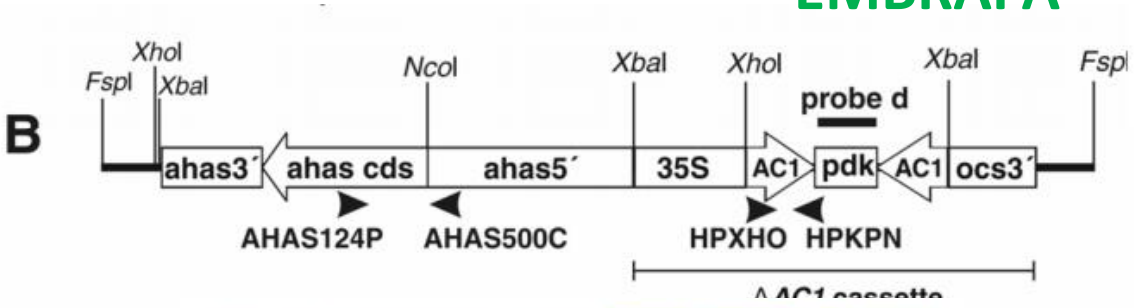
Estratégia para expressar um RNA mensageiro que forma uma estrutura de grampo (hairpin)

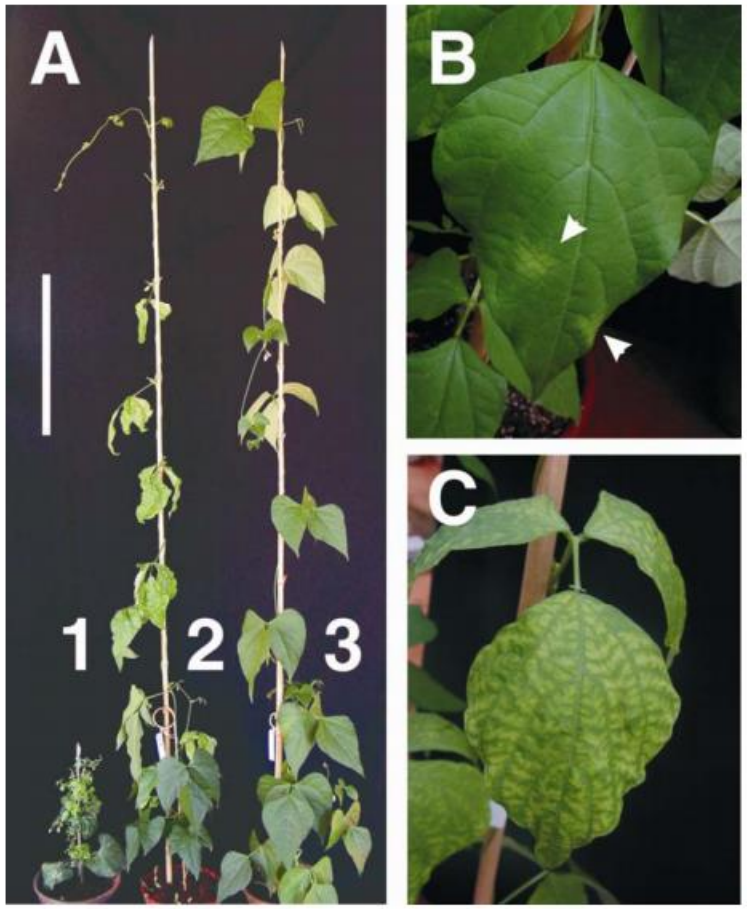




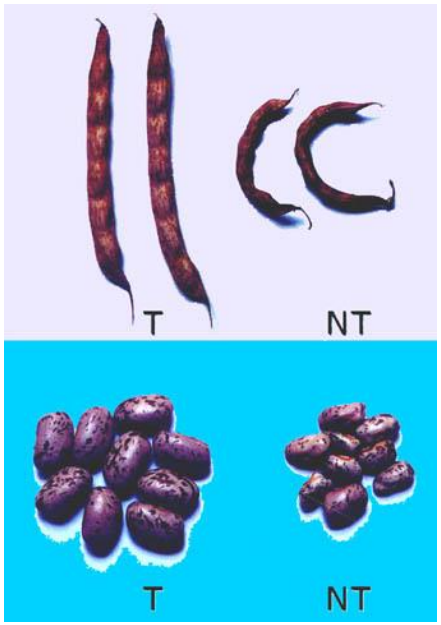
RNAm de gene alvo é DEGRADADO!!!!! E NÃO HÁ PRODUÇÃO DE PROTEÍNA!

RNAi-Mediated Resistance to Bean golden mosaic virus in Genetically Engineered Common Bean (*Phaseolus vulgaris*)- EMBRAPA

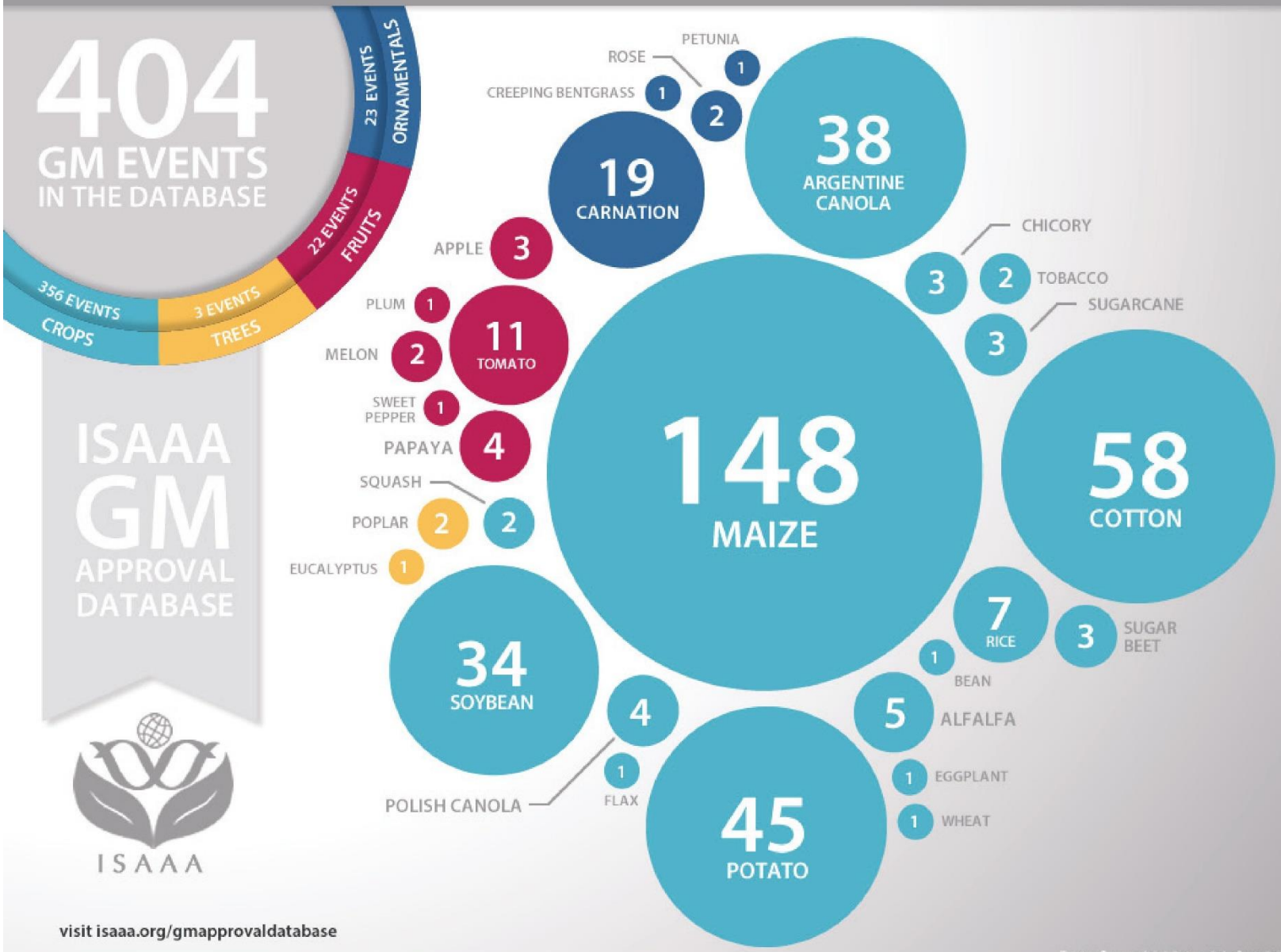




Expressa um mRNA em forma de grampo que da origem a um RNA dupla fita com um fragmento do gene da replicase viral (AC1)



Approved Transgenic Plant Events, 1992-2016

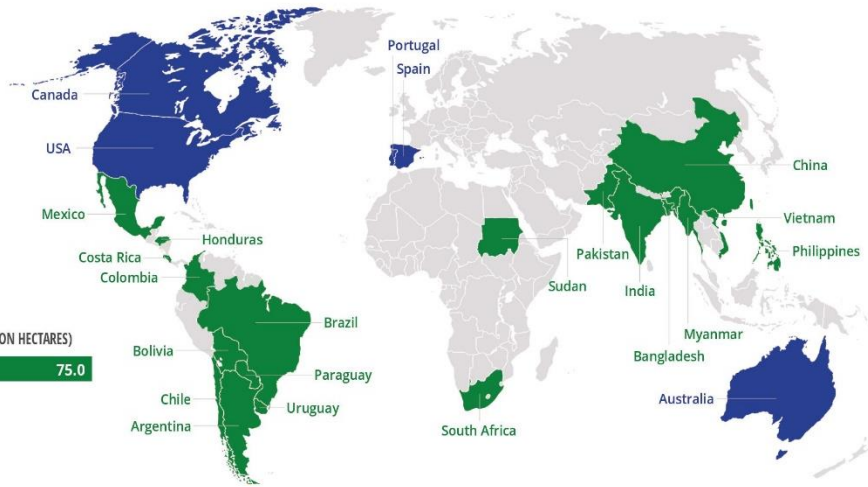


Where are Biotech Crops Grown in the World?

24 countries planted 189.8 million hectares (469 million acres) of biotech crops in 2017, the 22nd year of global commercialization of biotech crops

19 DEVELOPING COUNTRIES

5 INDUSTRIAL COUNTRIES



TOP 5 COUNTRIES GROWING BIOTECH CROPS IN 2017 (MILLION HECTARES)

of biotech crops in the world is grown in **NORTH AMERICA** with the **USA** as the top producer

NUMBER OF COUNTRIES GROWING MAJOR BIOTECH CROPS IN 2017

BRAZIL

is the top developing country planting biotech crops in 2017 with **50.2 MILLION HECTARES**

2 countries in Europe planted **BIOTECH MAIZE** in 2017, led by

SPAIN

which grew ~95% of total biotech crops in Europe

SUDAN

has planted Bt COTTON since 2012. **SOUTH AFRICA** also planted Bt cotton in 2017.

7.5M FARMERS

in **INDIA** planted 11.4 million hectares of Bt COTTON in 2017

BIOTECH CANOLA's adoption rate in Canada has reached

10 countries in Latin America planted **56.88 MILLION HECTARES BIOTECH SOYBEAN** in 2017

17M

small, resource-poor farmers and their families benefited from biotech crops in 2017

BIOTECH MAIZE WAS PLANTED IN **VIETNAM** FOR THE FIRST TIME IN 2015

ISAAA

For more information, visit ISAAA website:
www.isaaa.org

isaaa.org @isaaa_org isaaavideos

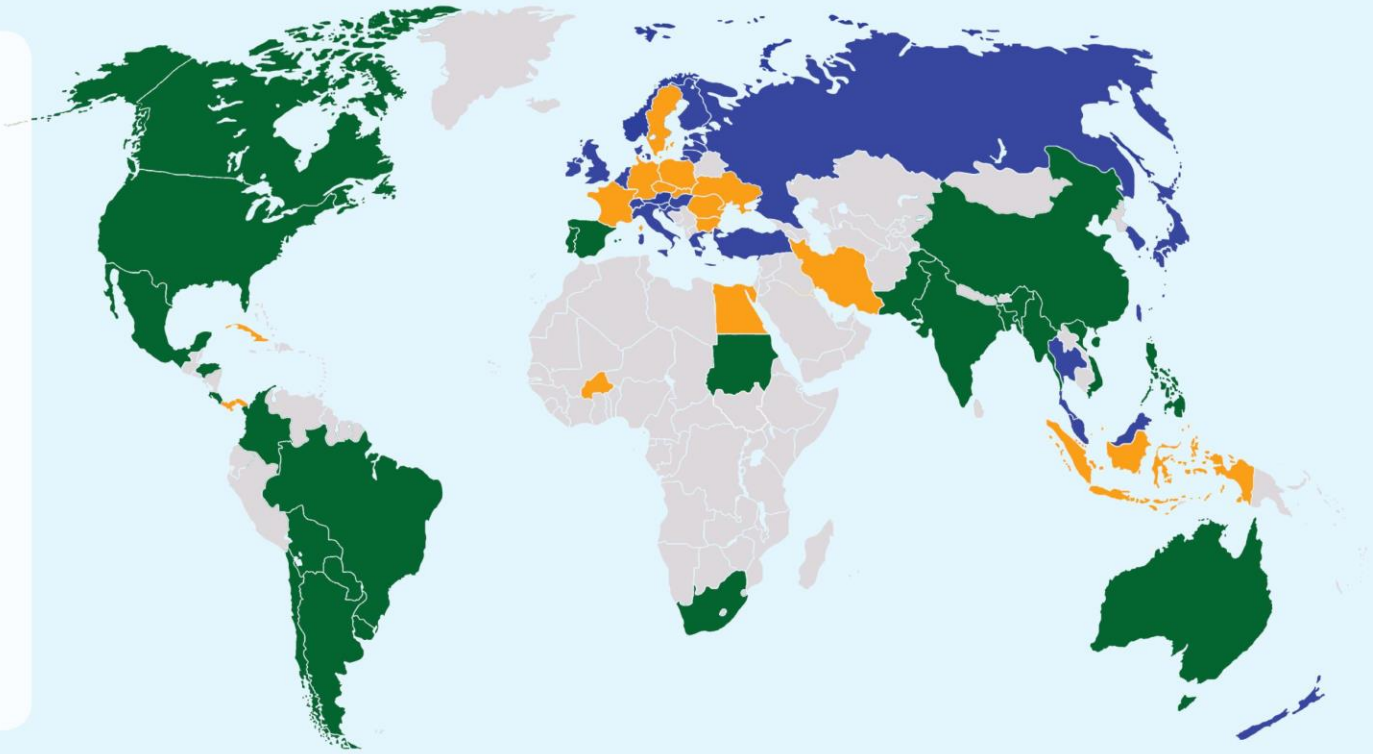
Source: ISAAA. 2017. Global Status of Commercialized Biotech/GM Crops in 2017. *ISAAA Brief No. 53.*

#GMCrops2017
#ISAAAReport2017

22 Years of Biotech Crops in the World

Since the first year of commercial planting of biotech crops in 1996, more than 60 countries from all over the world have either planted or imported biotech crops.

- The 6 founder biotech crop countries in 1996 are **USA, China,** Argentina, **Canada, Australia,** and **Mexico**.
- **Up to 17 million farmers** planted biotech crops in 2017, 95% is from developing countries.
- **24 countries** planted **189.8 million hectares** of biotech crops in 2017, a ~112-fold increase from 1.7 million hectares in 1996.
- In 2017, **24 countries planted** and **43 imported** biotech crops.



Countries planting biotech crops
(USA, Brazil, Argentina, Canada, India, Paraguay, Pakistan, China, South Africa, Bolivia, Uruguay, Australia, Philippines, Myanmar, Sudan, Spain, Mexico, Colombia, Vietnam, Honduras, Chile, Portugal, Bangladesh, and Costa Rica)

Countries not planting, but importing biotech crops
(Austria, Belgium, Croatia, Cyprus, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Netherlands, New Zealand, Norway, Russian Federation, Singapore, Slovenia, South Korea, Switzerland, Taiwan, Thailand, Turkey, and United Kingdom)

Countries that stopped planting, currently importing biotech crops
(Bulgaria, Burkina Faso, Czech Republic, Cuba, Egypt, France, Germany, Indonesia, Iran, Panama, Poland, Romania, Slovakia, Sweden, and Ukraine)

- ISAAA. 2017. Global Status of Commercialized Biotech/GM Crops in 2017. *ISAAA Brief* No. 53. ISAAA: Ithaca, NY.
- ISAAA GMO Approval Database (http://www.isaaa.org/gmapprovaldatabase/default.asp).

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

ISAAA

Do you know where biotech crops are grown?

More than 30 countries have planted biotech crops since 1996. See where they were grown in 2017.

17 Million
small, resource-poor farmers benefited from biotech crops in 2017

Biotech canola's adoption rate in Canada has reached **95%**

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

SPAIN
is the leading country planting biotech maize in Europe

7.5M
farmers in India planted 11.4 million hectares of Bt cotton in 2017

Portugal
Spain
Canada
USA
Mexico
Honduras
Costa Rica
Colombia
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Sudan
South Africa
Pakistan
India
China
Vietnam
Philippines
Myanmar
Bangladesh
Australia

10 countries
in Latin America planted biotech soybean

SUDAN
has been planting Bt cotton since 2012

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

2.3 Billion
hectares of biotech crops planted since 1996

- Soybean
- Maize
- Cotton
- Canola
- Sugar beet
- Alfalfa
- Papaya
- Squash
- Potato
- Apples
- Eggplant
- Pineapple

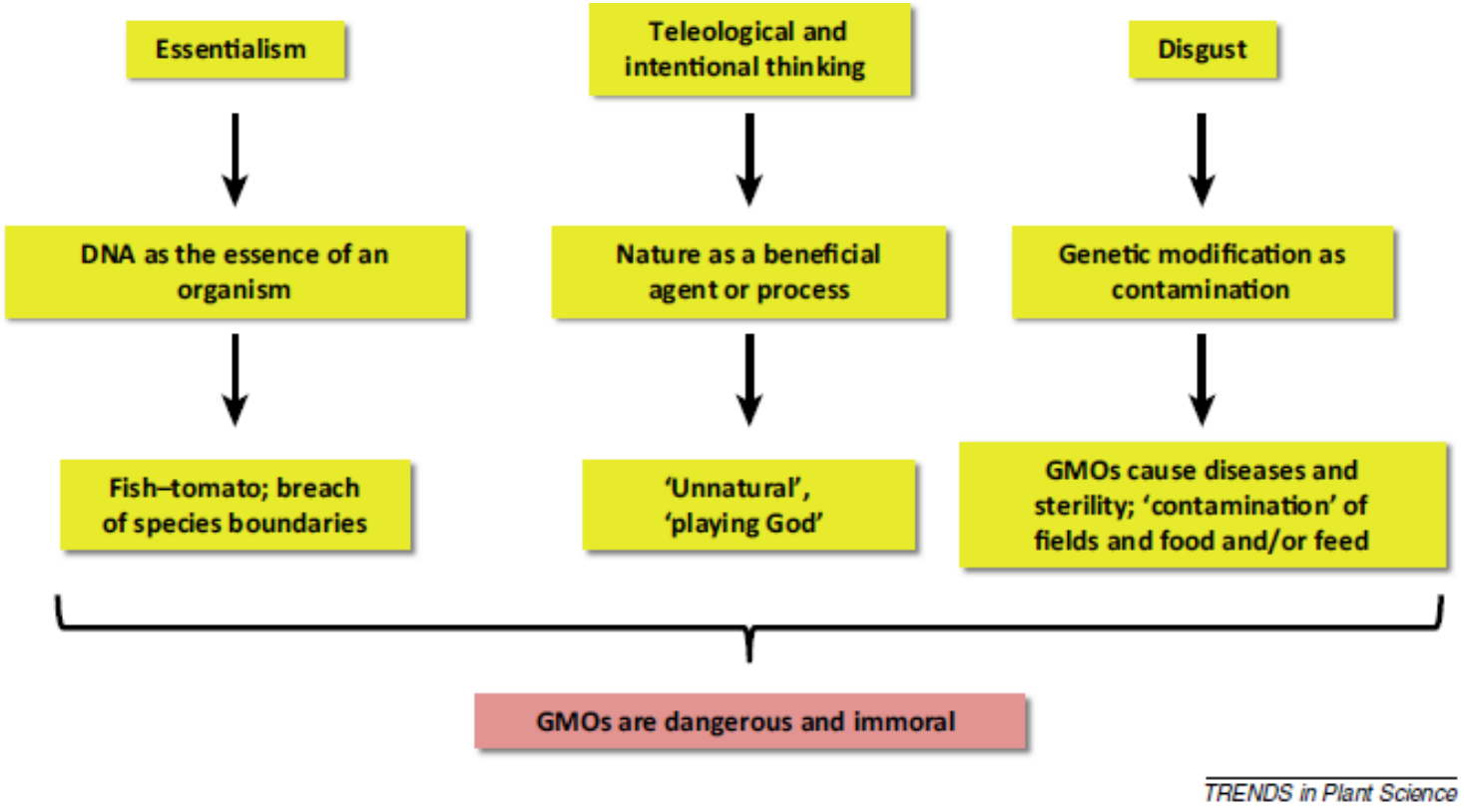
For more information on biotech crops, visit
www.isaaa.org

ISAAA

Source: ISAAA. 2017. Global Status of Commercialized Biotech/GM Crops in 2017. *ISAAA Brief* No. 53. ISAAA: Ithaca, NY.

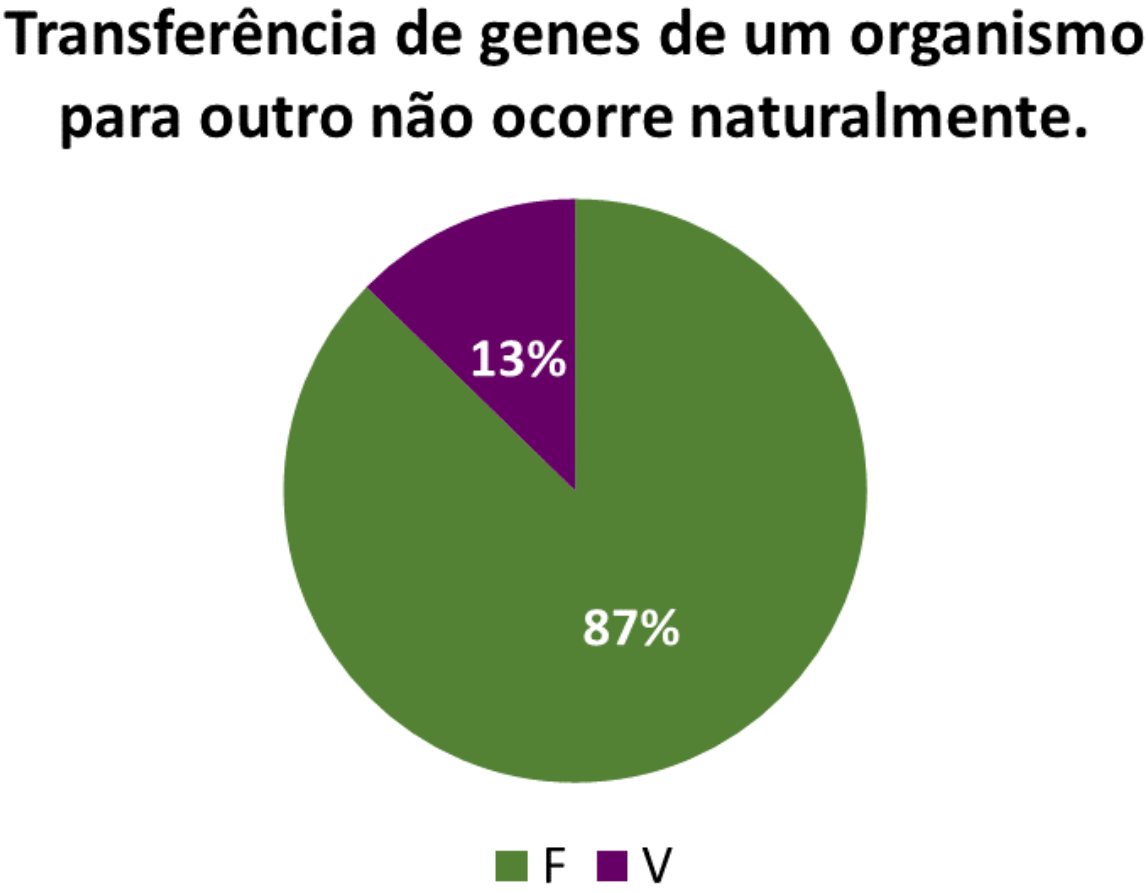
Razão para tanta oposição

Apelo intuitivo a se opor a GMOs

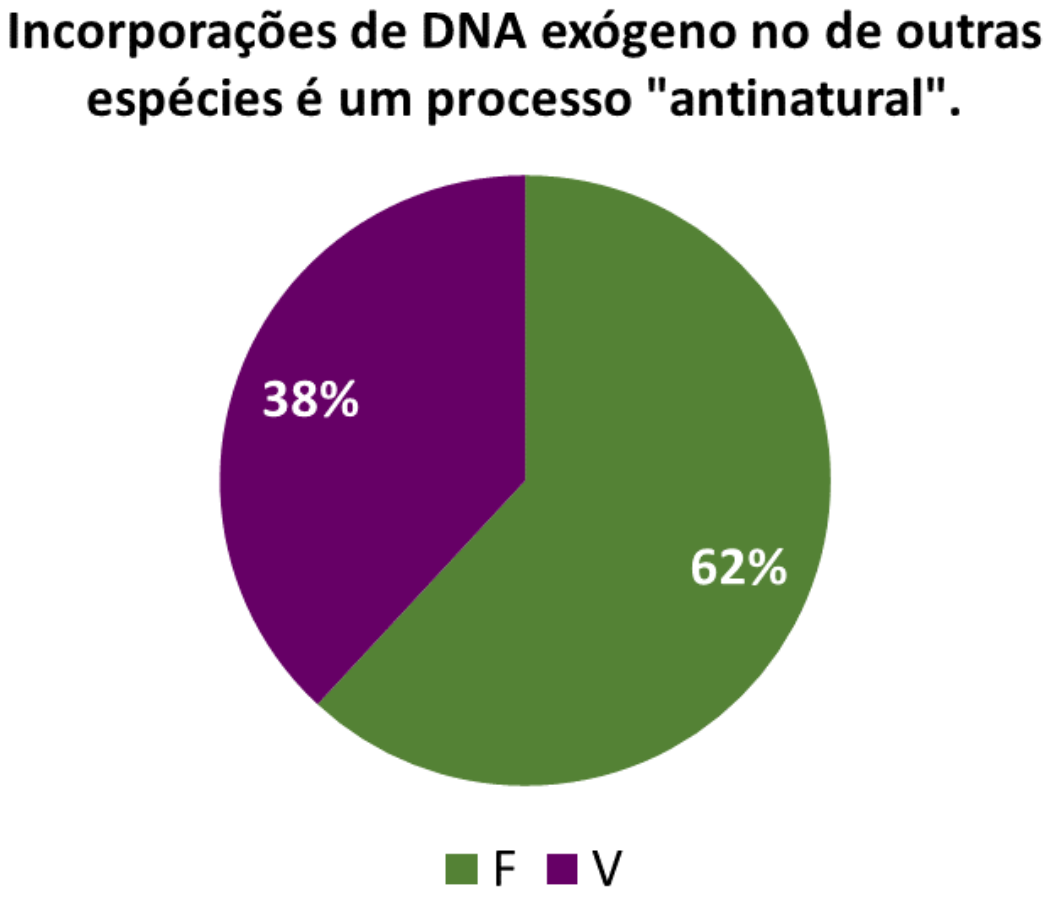


Blancke, S., Van Breusegem, F., De Jaeger, G., Braeckman, J., & Van Montagu, M. (2015). Fatal attraction: the intuitive appeal of GMO opposition. *Trends in plant science*, *20*(7), 414-418.

Apelo intuitivo a se opor a GMOs

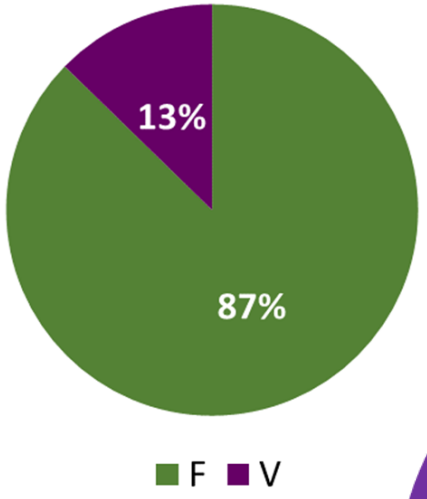


Apelo intuitivo a se opor a GMOs

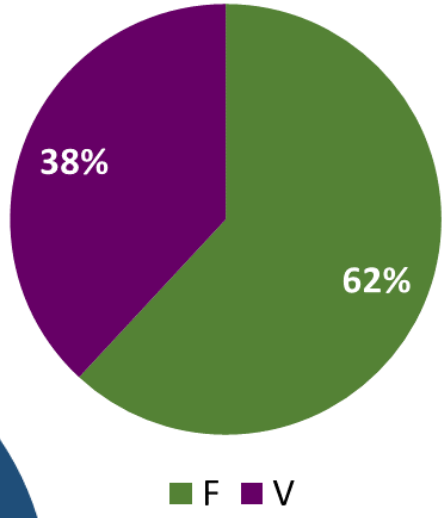


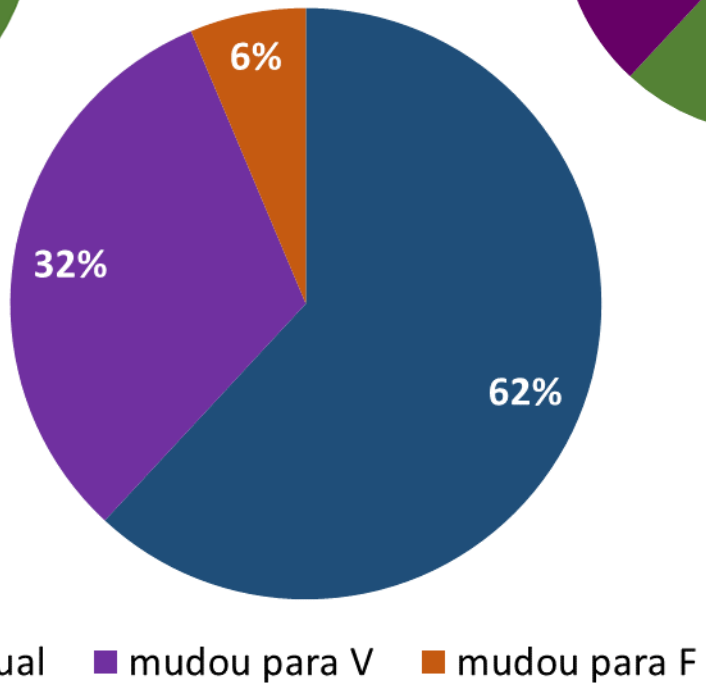
Apelo intuitivo a se opor a GMOs

Transferência de genes de um organismo para outro não ocorre naturalmente.

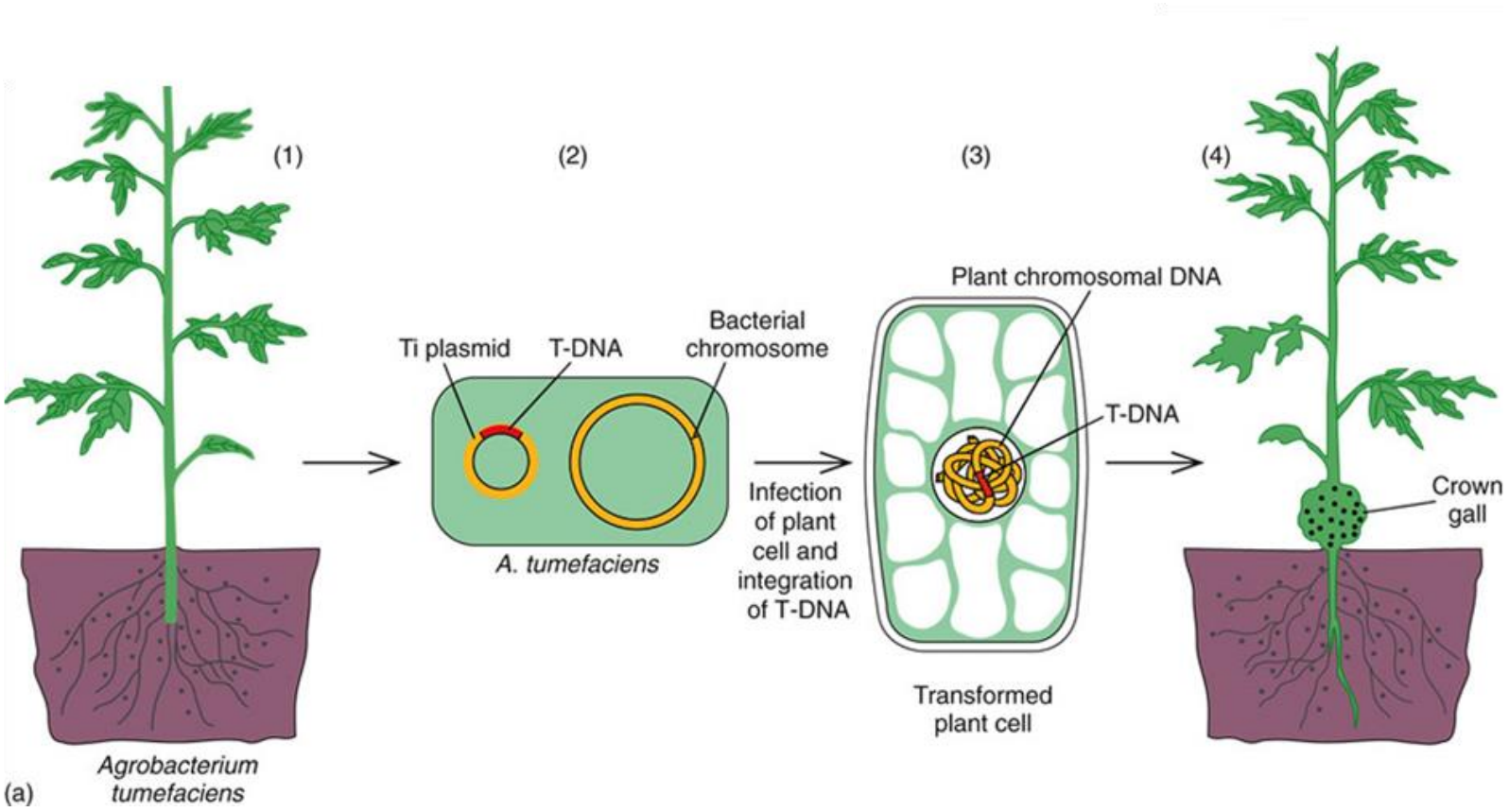


Incorporações de DNA exógeno no de outras espécies é um processo "antinatural".





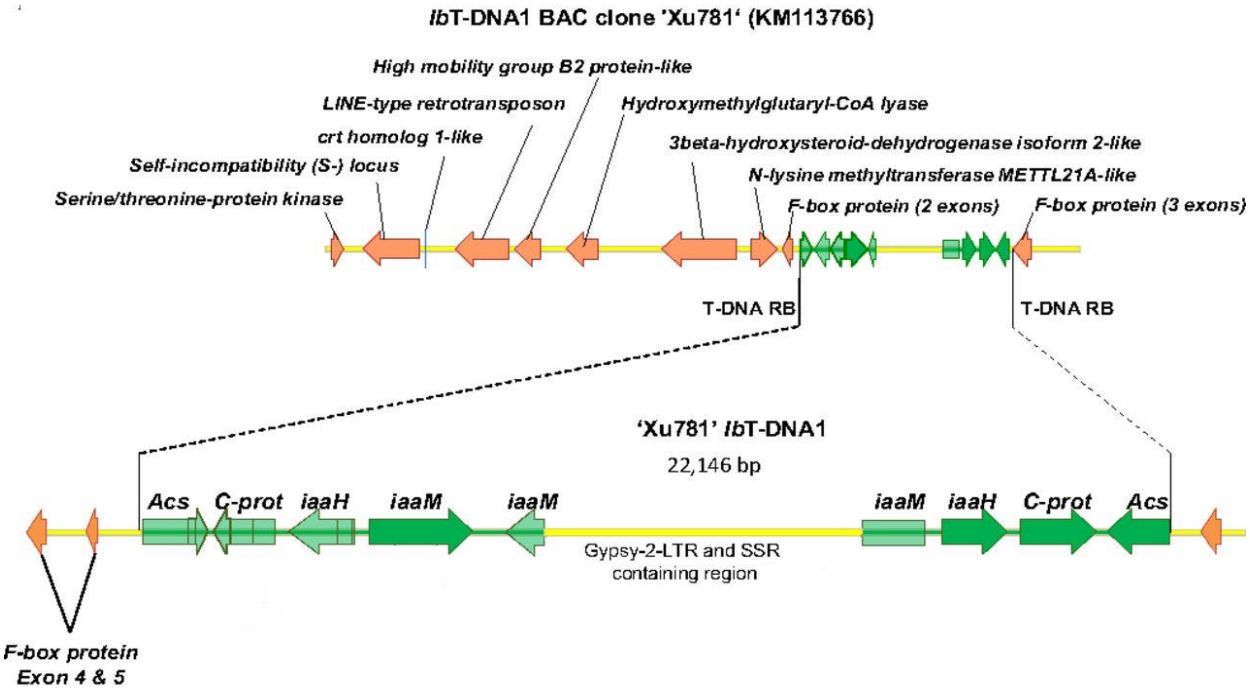
Transferência lateral de genes



A. tumefaciens

291 acessos testados

iaa = biossíntese auxina
acs = biossíntese opina
C-prot = função desconhecida

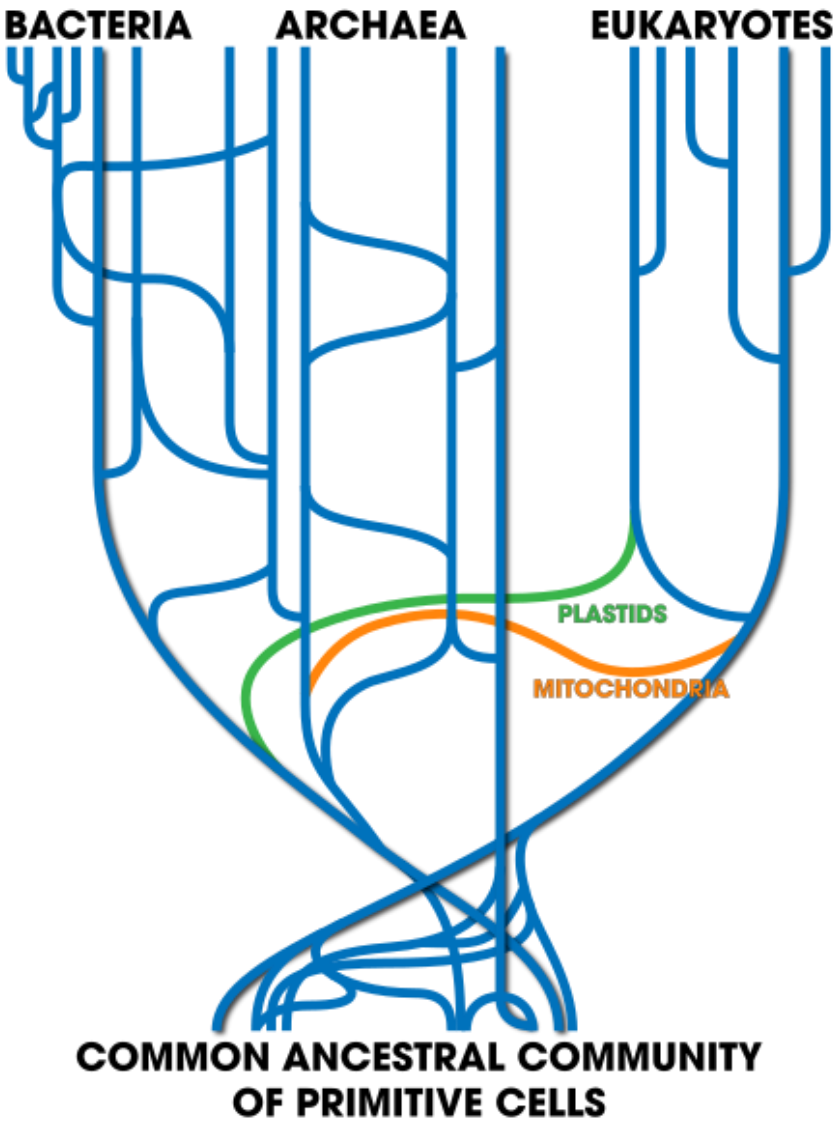


Adaptado de Kyndt, T., Quispe, D., Zhai, H., Jarret, R., Ghislain, M., Liu, Q., ... & Kreuze, J. F. (2015). The genome of cultivated sweet potato contains Agrobacterium T-DNAs with expressed genes: an example of a naturally transgenic food crop. Proceedings of the National Academy of Sciences, 112(18), 5844-5849.

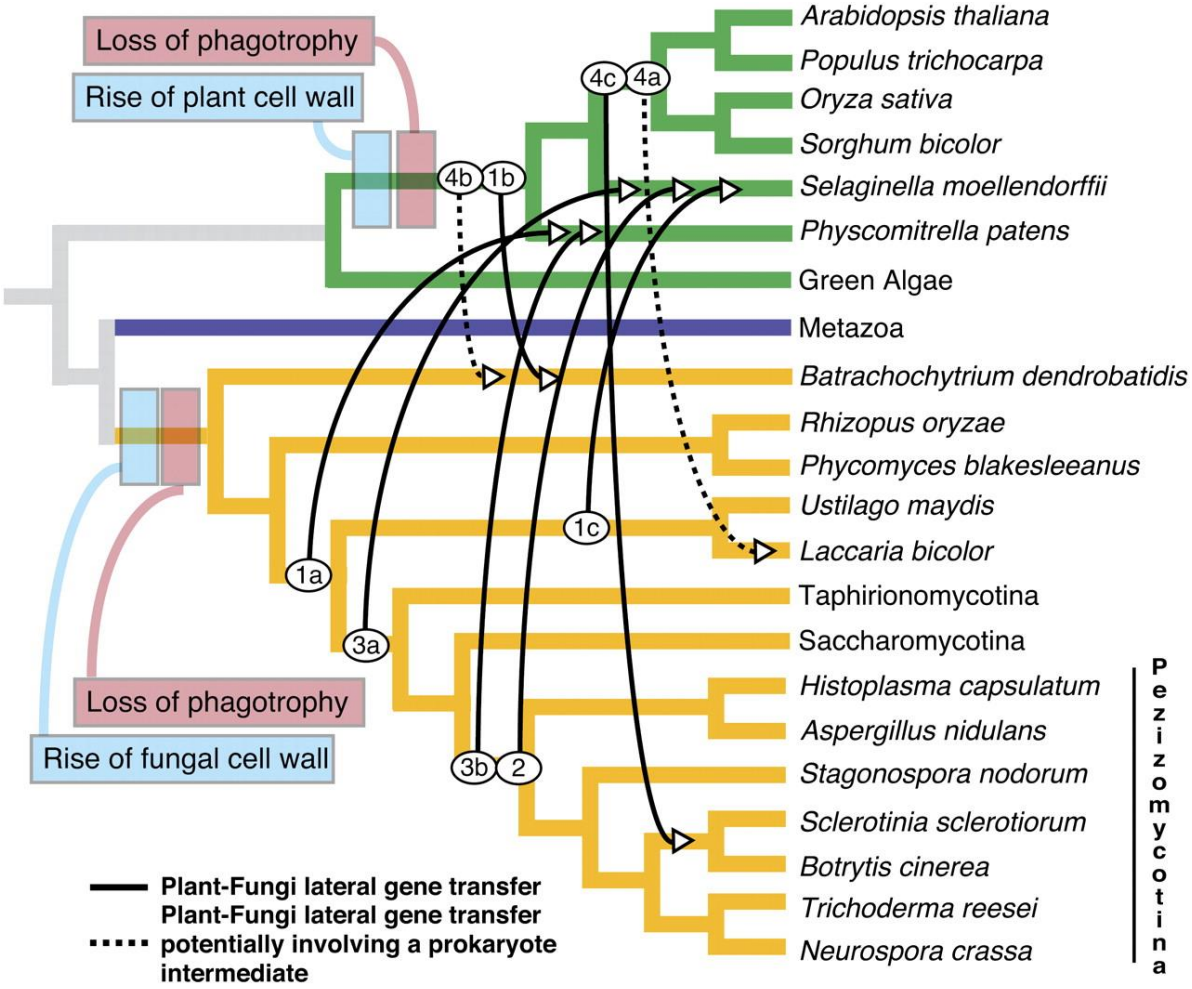
Transferência lateral de genes

Há outros exemplos?

Transferência lateral de genes



Transferência lateral de genes

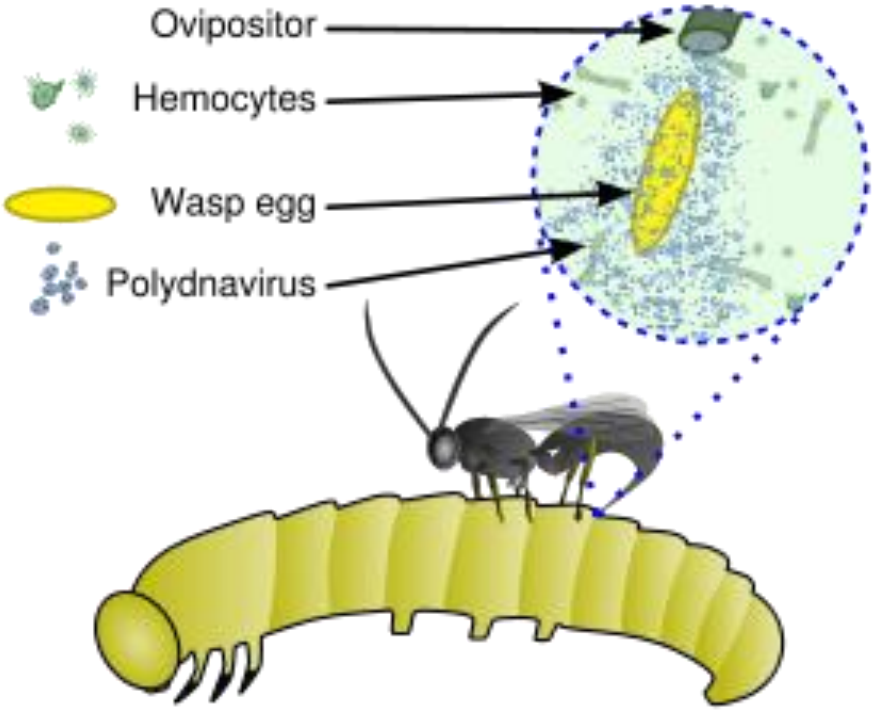


Richards, T. A., Soanes, D. M., Foster, P. G., Leonard, G., Thornton, C. R., & Talbot, N. J. (2009). Phylogenomic analysis demonstrates a pattern of rare and ancient horizontal gene transfer between plants and fungi. *The Plant Cell*, *21*(7), 1897-1911.

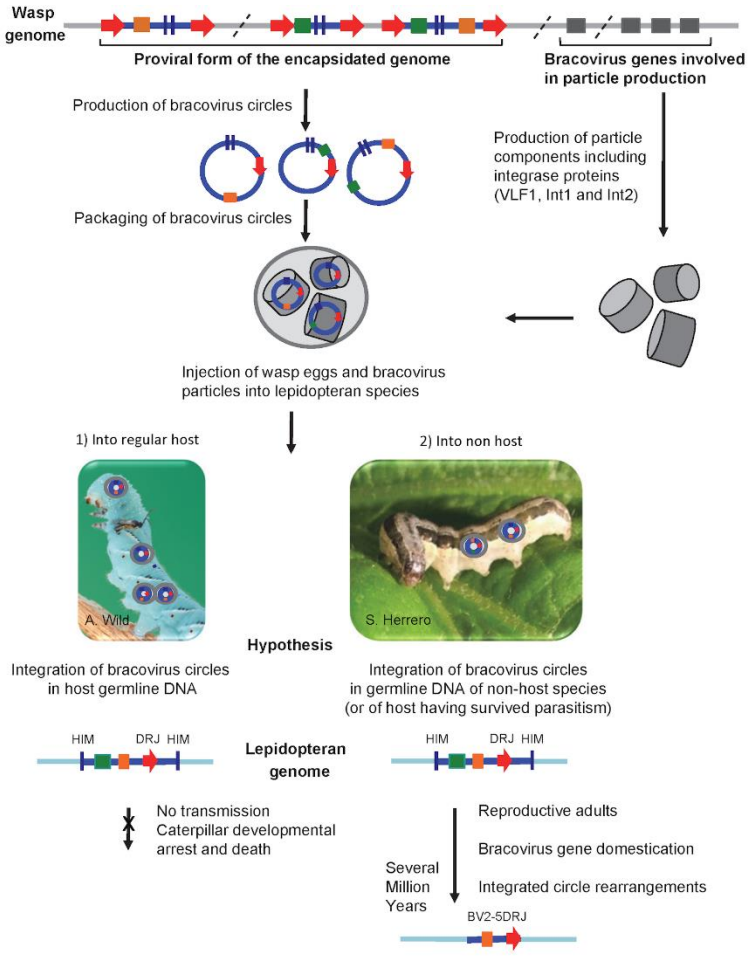
Transferência lateral de genes

Cotesia congregata

Transferência lateral de genes



Transferência lateral de genes



1 – Virus integrado em Hymenoptera ancestral

2 – Genes integrados em Lepidoptera ancestral

Gasmi, L., Boulain, H., Gauthier, J., Hua-Van, A., Musset, K., Jakubowska, A. K., ... & Drezen, J. M. (2015). Recurrent domestication by lepidoptera of genes from their parasites mediated by bracoviruses. *PLoS genetics*, *11*(9), e1005470.

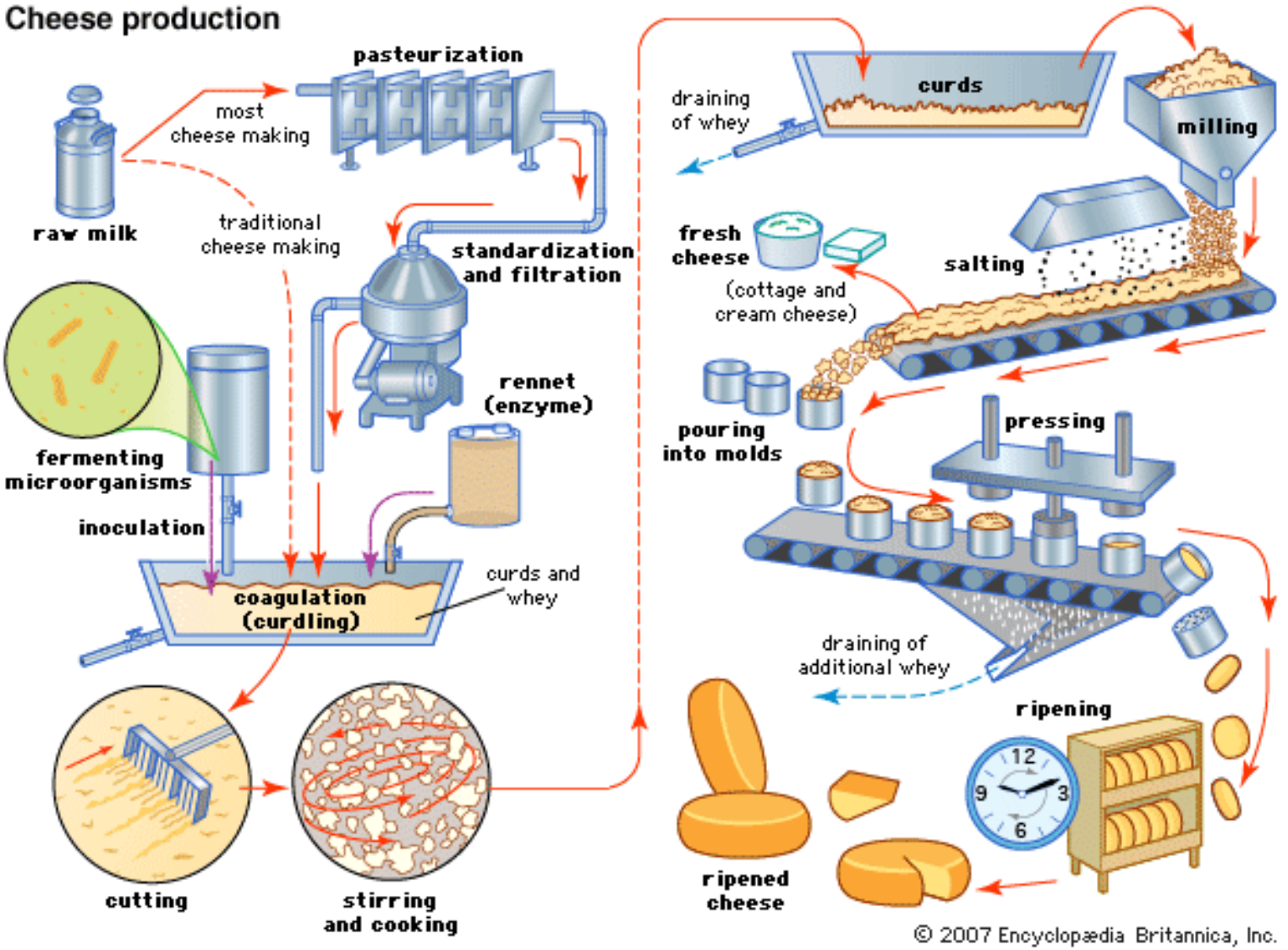
Há transgênicos em outras áreas?

Quimosina

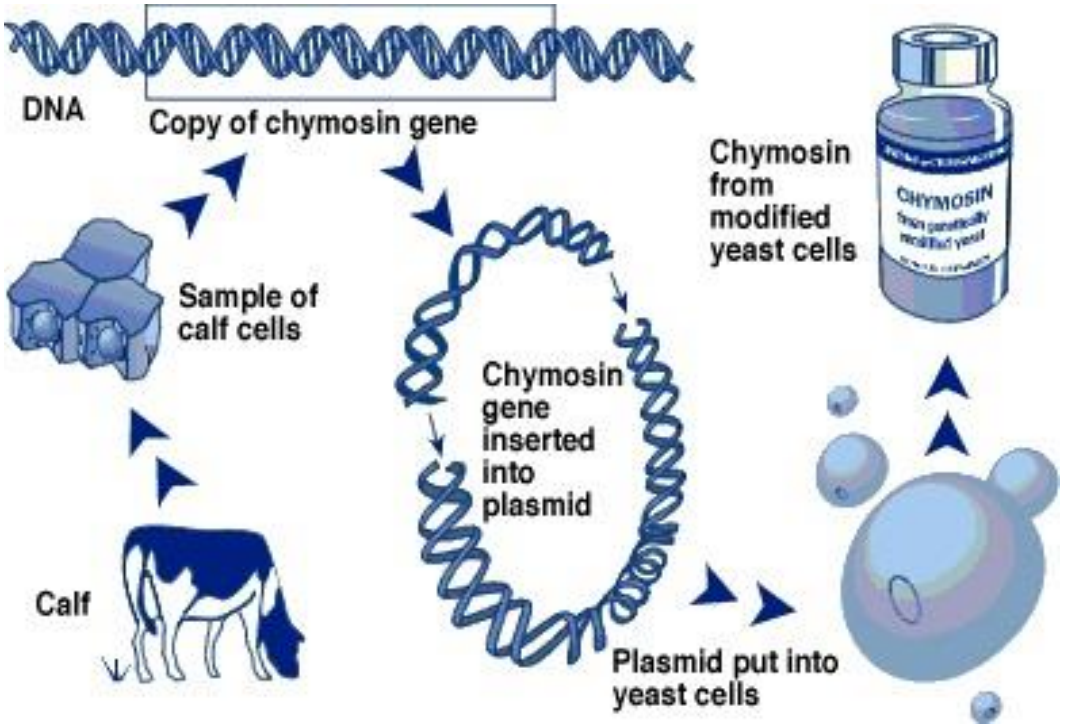
Enzima encontrado no quarto estômago de ruminantes lactantes coagula o leite (“coalho”)

Quimosina/renina

Enzima
estôma
coa



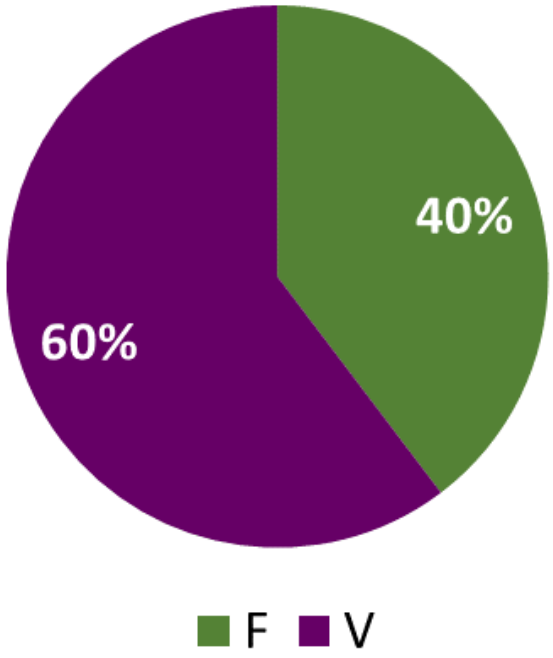
Quimosina/renina



http://www.ncbe.reading.ac.uk/ncbe/gmfood/chymosin.html

Quimosina/renina

Um extrato, que não possui DNA, obtido de uma planta transgênica, deve ser considerado um produto transgênico.



Diversas aplicações de transgênicos

- Medicina
- Queijos

Menor (ou nenhuma) oposição

- Rotulação

U.S. Department of Agriculture
National Bioengineered Food Disclosure Standard

Assinado 20/12/18

Aplicação 01/01/2020-21

U.S. Department of Agriculture
National Bioengineered Food Disclosure Standard

Assinado 20/12/18

Aplicação 01/01/2020-21

NON GMO Project VERIFIED
nongmoproject.org

amazon

All himalayan pink salt gmo free

100% Natural & Healthy Himalayan Pink Salt (2lb) by Naturevibe Botar
GMO (32 ounces) (Coarse Grade) by Naturevibe Botanicals

9 customer reviews

FIND BRANDS STARTING WITH: Any

(SHOWING 1 TO 191 OF 1)

Whole Foods Market (191 products)

12 Grain Boule
5K Omega Mix
70% Dark Chocolate Almonds
70% Dark Chocolate Raisins
70% Dark Chocolate Walnuts
72% Cacao Organic Dark Chocolate & Almond Tanzania Schoolhouse Project
72% Cacao Organic Dark Chocolate Tanzania Schoolhouse Project
Aged Balsamic Vinegar Of Modena
Aged Balsamic Vinegar Of Modena - Density 1.16
Aged Balsamic Vinegar Of Modena - Density 1.30
Almond Butter Stock
ALMOND BUTTER STOCK UNSALTED
CREAMY ORGANIC PEANUT BUTTER SALTED
CREAMY ORGANIC PEANUT BUTTER UNSALTED
CREAMY PEANUT BUTTER SALTED
Creamy Pink Peppercorn Dressing
Crostini Original
Crostini Rosemary
Crostini Sea Salt & Rosemary
CRUNCHY ALMOND BUTTER UNSALTED
CRUNCHY PEANUT BUTTER SALTED
Crystallized Ginger Slices
Deluxe Whole Cranberries
Dijon Mustard - Course Ground
Dried Cranberries
Lemon Italian Sparkling Mineral Water (PET)
Lemon Raspberry Italian Sparkling Mineral Water
Lemonade Rings
Lime Italian Sparkling Mineral Water
Lime Italian Sparkling Mineral Water (PET)
Lime Itlalian Mineral Water
Low Fat Hummus
Marcona Almonds
Marinara Pasta Sauce
Medium Cantina Style Salsa - Thick & Chunky
Meyer Lemon Poppy Seed Dressing
Mild Cantina Style Salsa - Fire Roasted
Organic Vindaloo Curry Seasoning
Organic Whole Cashews
Organic Whole Dry Roasted Salted Cashews
Organic Whole Dry Roasted Unsalted Cashews
Organic Whole Raw Cashews
Organic Women's Multi-Vitamin Gummies
Original Hummus
Pad See Ew With Tofu
Pad Thai
PEANUT BUTTER STOCK UNSALTED
Peanut Coconut Sauce
PEANUTS DRY ROASTED SALTED
PEANUTS DRY ROASTED

Lime Italian Sparkling Mineral Water

★★★★★ 1 Ratings | Rate This

Lime Naturally Flavored, Low mineral content.

Total Dissolved Solids: 360mg/L.,Sodium free.

WHERE TO BUY

Nutrition Facts

Serving Size 1 Bottle
Servings Per Container 1

Amount per serving	
Calories 0	Calories from fat:
	% Daily Value*
Total Fat 0g	0%
Sodium 10mg	0%
Total Carbohydrate 0g	0%
Protein 0g	
Calcium	4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Product Size: 16.9
UPC: 1111087061

Ingredients

Mineral Water, Carbon Dioxide, Natural Lime Flavor.

*Actual product packaging and materials may contain additional and/or different ingredient, nutritional, or proper usage information than the information displayed on our website. Prior to using or consuming a product, you are responsible to read all labels, warnings,

- Conselho de Informações sobre Biotecnologia (http://www.cib.org.br)

(info geral)

- Comissão Técnica Nacional de Biossegurança (http://www.ctnbio.gov.br)

(legislação)

- International Service for the Adquisition of Agri-Biotech Applications (http://www.isaaa.org)

(números globais)

- Center of Environmenta Risk Assessment (www.cera-gmc.org)

(detalhes dos eventos)

https://gmoanswers.com/

https://geneticliteracyproject.org/