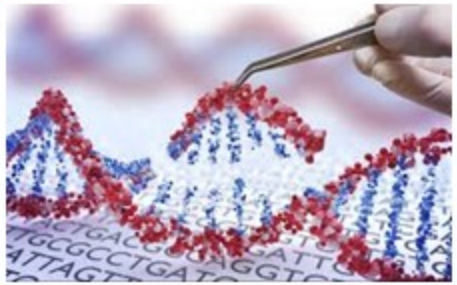
UN environment programme

THE BCH III PROJECT

gef

Modern Biotechnology and the BCH

Prof Ossama AbdelKawy



CEE REGIONAL BCH TRAINING WORKSHOP

JANUARY 2024

RECORDS

- Genetic element
- Promoter
- Terminator
- Marker gene
- Agrobacterium
- Coding sequence
- Truncated gene
- Unique identifier
- Transformation cassette
- Gene gun
- Risk Assessment
- Detection and identification

Introduced or modified genetic element(s)

Some of these genetic elements may be present as fragments or truncated forms. Please see notes below, where applic

BCH-GENE-SCBD-14972-12 PHOSPHINOTHRICIN N-ACETYLTRANSFERASE GENE

Protein coding sequence | Resistance to herbicides (Glufosinate)

BCH-GENE-SCBD-14985-12 CRY1AB | BACILLUS THURINGIENSIS - BT, BACILLUS, BACTU

Protein coding sequence | Resistance to diseases and pests (Insects, Lepidoptera (butterflies and moths))

BCH-GENE-SCBD-14975-5 BETA-LACTAMASE GENE | (BACTERIA)

Protein coding sequence | Resistance to antibiotics (Ampicillin)

BCH-GENE-SCBD-100287-7 CAMV 35S PROMOTER

Promoter

BCH-GENE-SCBD-100290-6 CAMV 35S TERMINATOR

Terminator

Description

This LMO contains two copies of a truncated synthetic version of the full length *cry1Ab* gene from *Bacillus thuringiensis* subsp. *kurstaki*. The synthetic truncated *cry1Ab* gene encodes a protein that corresponds to the first 648 amino acids of the N-terminal of the 1155 amino acid full length native Cry1Ab protein and includes the portion of the native protein that is necessary for insect control.

EN

- *Also note that the cassette has genetic elements belonging to corn to dupe the plant cell so that it does not recognize that*

Additional information concerning the *bla* gene insert in this LMO:

The *bla* gene from *Escherichia coli* is not expressed in plant cells, but was employed as a selectable trait for screening bacterial colonies for the presence of the plasmid vector.

EN

Additional information on the inserted genetic material:

Basic concepts

- What is the difference between Biosafety / Biosecurity?
- What is meant by Biosafety in the context of Cartagena Protocol?

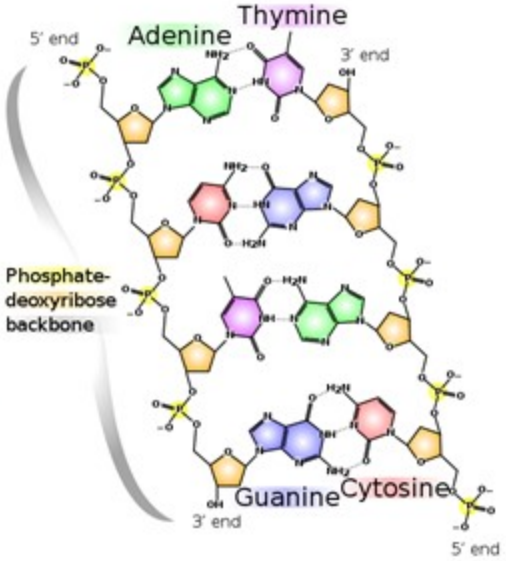
- a term used to describe efforts to minimize and avoid the potential environmental and human health risks resulting from modern biotechnology and its products.

WHAT IS GENETIC MATERIAL?




The medium by which inherited characteristics/traits of a living organism are transmitted from one generation to the next.

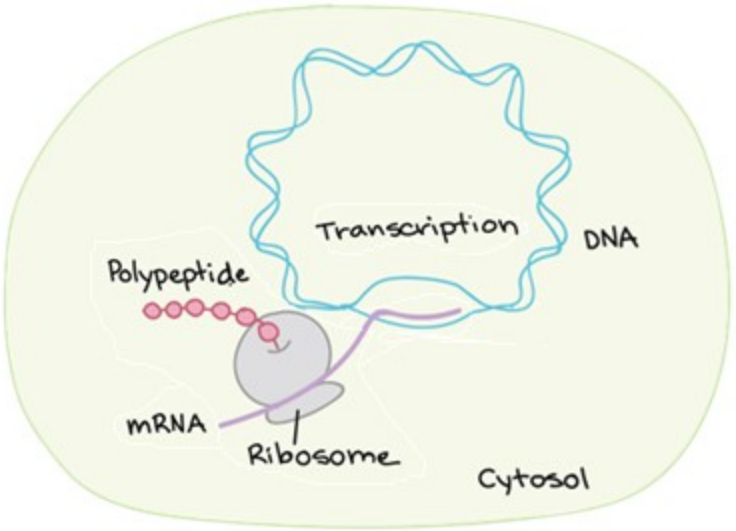
WHAT IS THE GENETIC CODE?

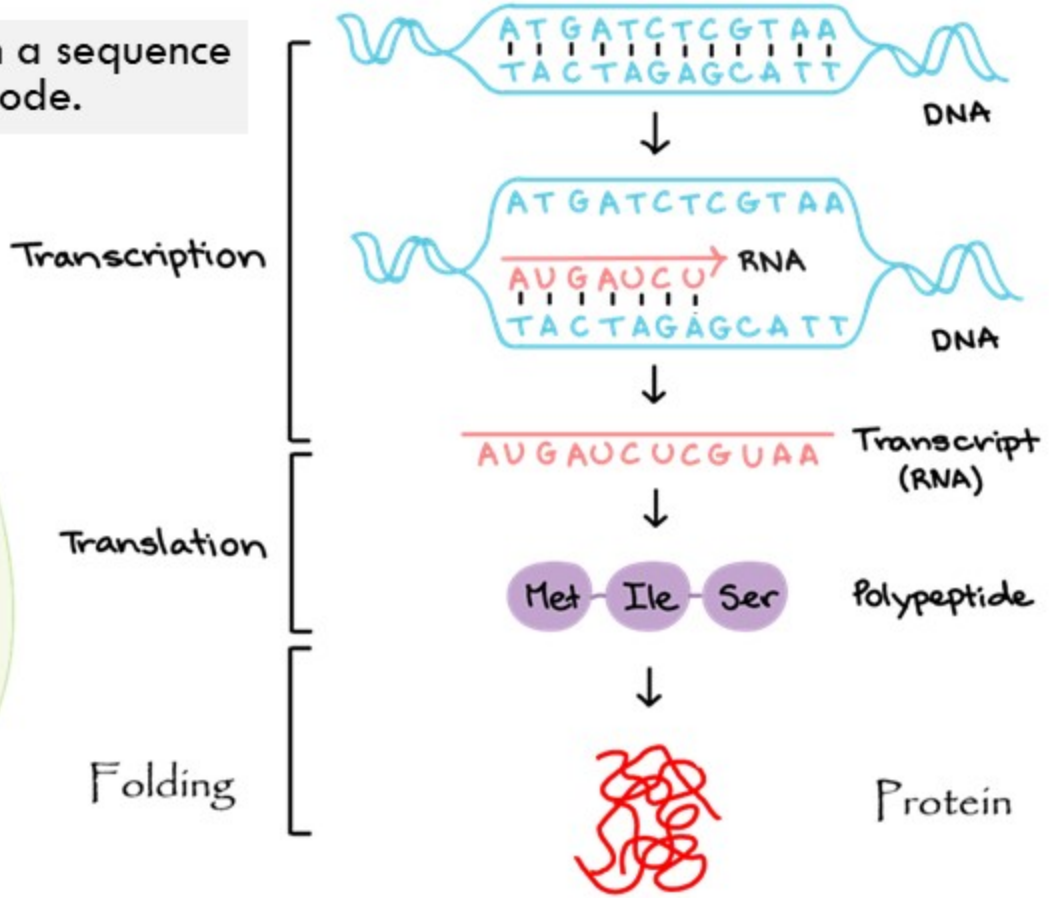


Sequences of nucleic acids that contain instructions for cell development and functions.

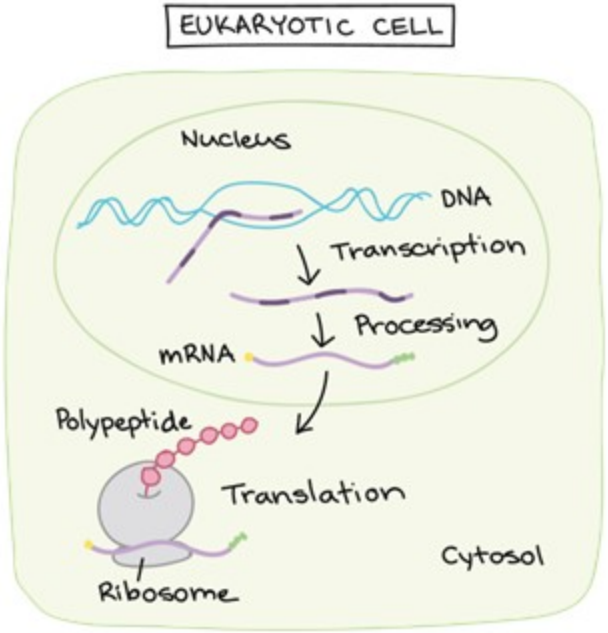
WHAT IS GENE EXPRESSION?

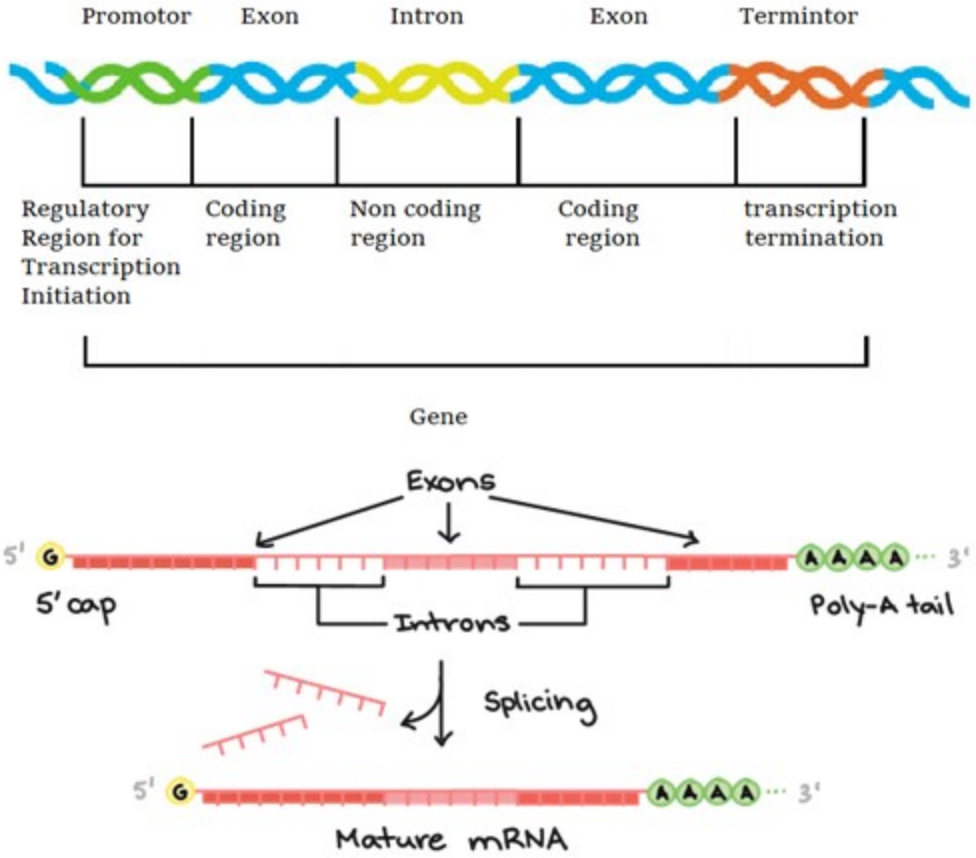
Is the synthesis of a specific protein with a sequence of amino acids encoded in the genetic code.



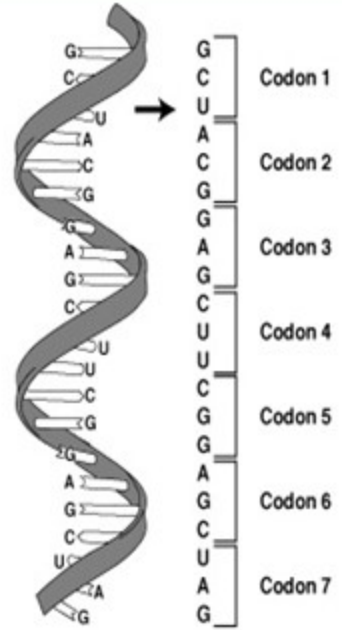


WHAT IS GENE EXPRESSION?





GENETIC CODE



RNA

Ribonucleic acid

1st base

2nd base	U		C		A		G		3rd base
U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
C	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
A	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine (Start)	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
G	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

Nonpolar, aliphatic Polar, uncharged Aromatic Positively charged Negatively charged

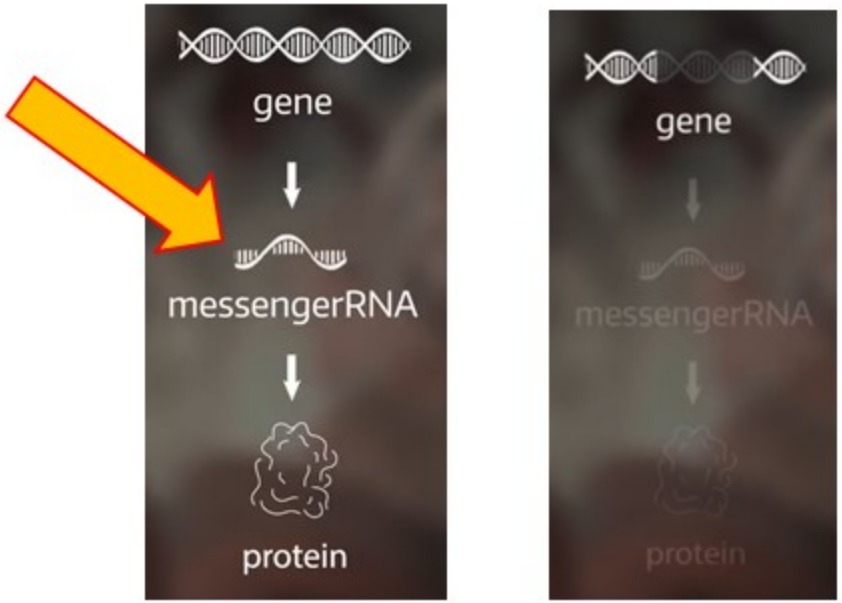
It is universal in all living organisms with negligible exceptions. Three consecutive bases (codon) code for one amino acid

GENE SILENCING?

- Our body consists of different **types of cells** (skin, muscles, or bone cells) with **identical genetic materials**.
- Through **gene silencing** genetic information is **switched off** so during development a cell only reads instructions that are necessary for gaining the **characteristics structures** and **functions**.

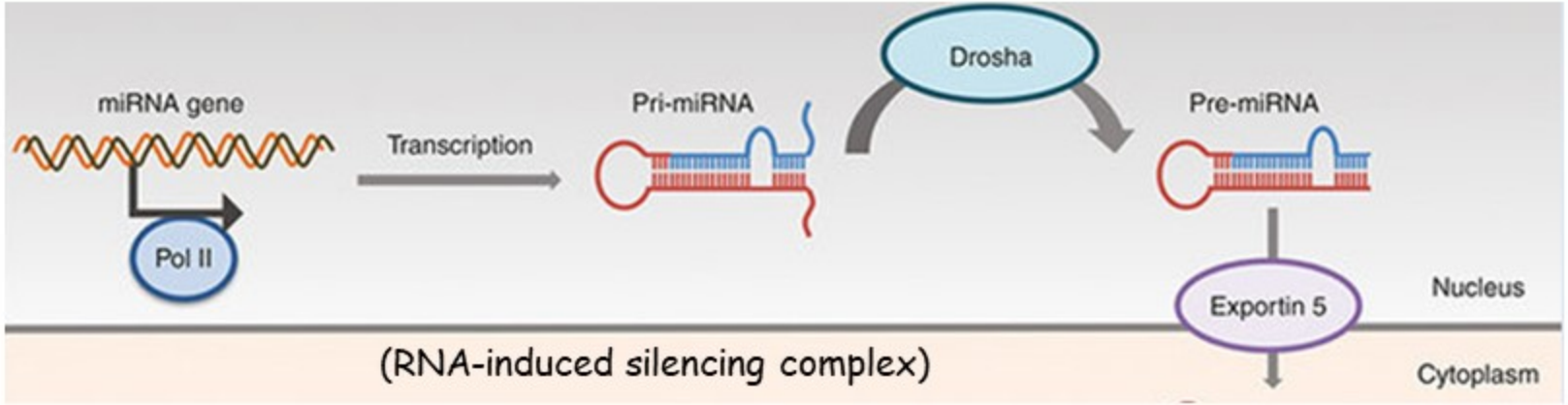
GENE SILENCING?

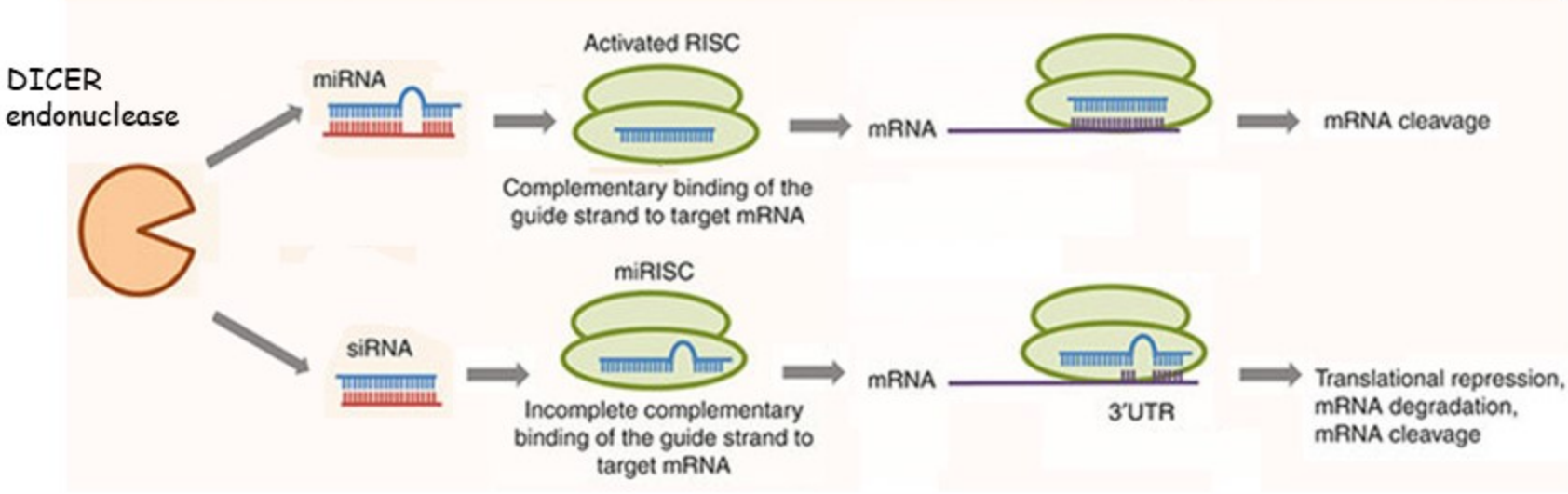
miRNA
siRNA



Turn off genes by inactivating mRNA necessary for translating genetic information into proteins. They participate in regulating the cells from their development to their death.

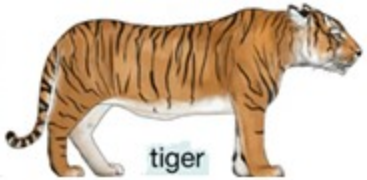
miRNA BIOGENESIS AND RNA-INDUCED GENE SILENCING

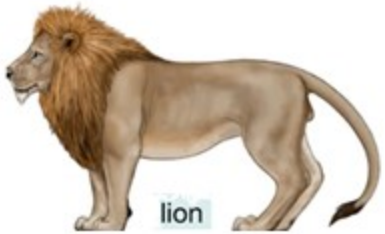




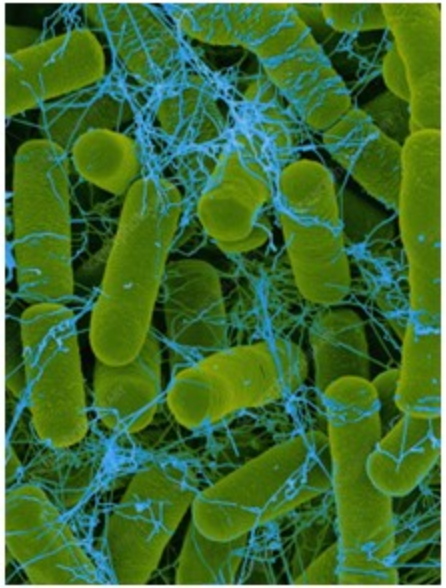
WHAT IS A SPECIES?

- Is a group of living organisms consisting of similar individuals **capable of exchanging genes** or **interbreeding** to **produce fertile offspring.**





GENETIC BARRIERS BETWEEN SPECIES



Each living cell can identify foreign genetic materials belonging to other species and will make it unfunctional by destroying it or by repairing its own DNA, creating barriers between species.

RESTRICTION ENZYMES

- Restriction enzymes are naturally occurring defense mechanisms to digest foreign DNA molecules.

- They recognize specific DNA sequences, mostly 4-6 bp, and cut DNA into fragments by breaking the phosphodiester linkage between two successive nucleotides of DNA.

- Now, if these restriction sites may be present in the organism's DNA, the DNA methylase enzymes carry out methylation of their DNA to protect it from digestion.

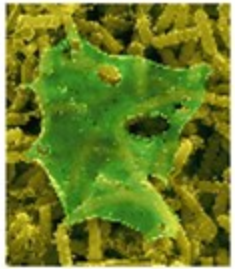
GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

Genetic material is altered or artificially introduced **in vitro** to induce a desirable new trait that **does not occur naturally** in the species. Inserted genes usually come from **a different species**.

OVERVIEW OF THE PROCESS OF GENETIC ENGINEERING

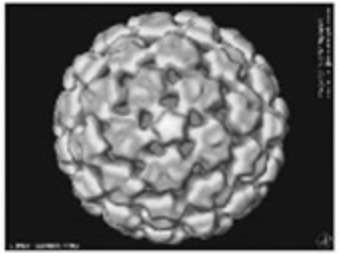
1. Identify and isolate genetic sequence of interest from a donor organism and manipulate it in the laboratory to enhance their expressions in the intended recipient organism

Bacillus thuringiensis

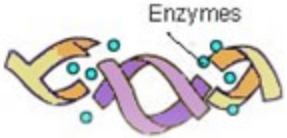


Streptomyces hygroscopicus

Escherichia coli



Cauliflower mosaic virus

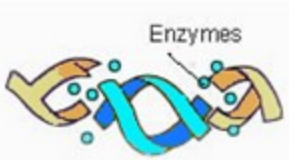


Cry1Ab gene

Resistance to Insects - Lepidoptera (butterflies and moths)

Phosphinothricin N-acetyltransferase gene

Resistance to herbicides - Glufosinate



Beta-lactamase gene

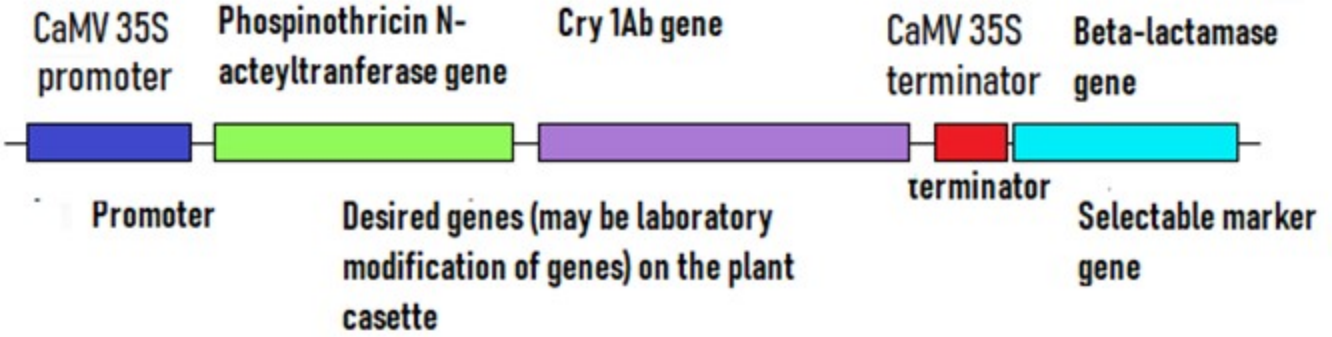
Resistance to antibiotics - Ampicillin

CaMV 35S promoter

CaMV 35S terminator

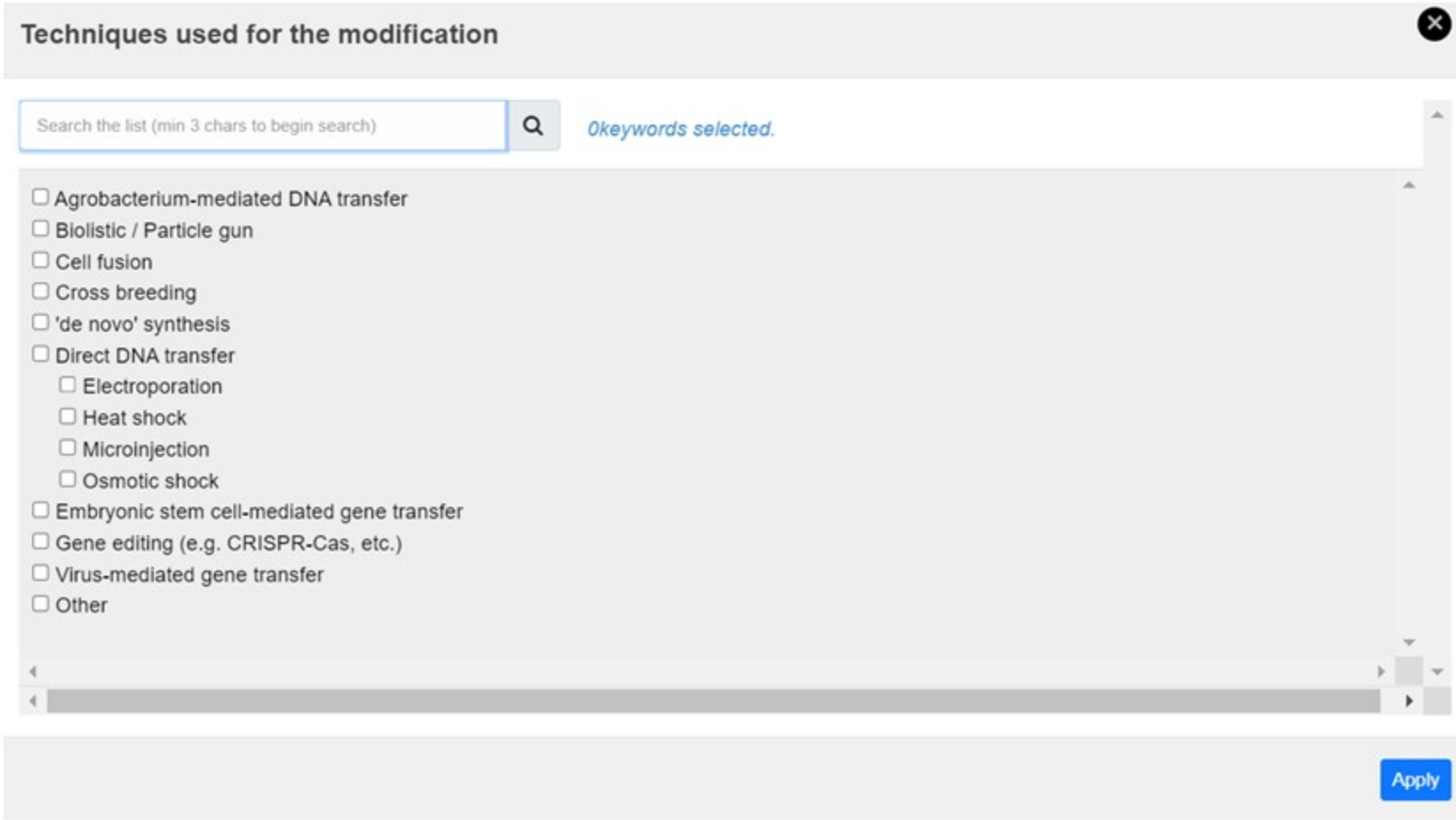
OVERVIEW OF THE PROCESS OF GENETIC ENGINEERING

2. Build the manipulated genes of interest and other nucleotide sequences needed for their proper functioning in an orderly sequence "transformation cassette."



3. Finally, the cassette is integrated into the recipient organism's genome through a process known as 'transformation'.

OVERVIEW OF THE PROCESS OF GENETIC ENGINEERING



GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

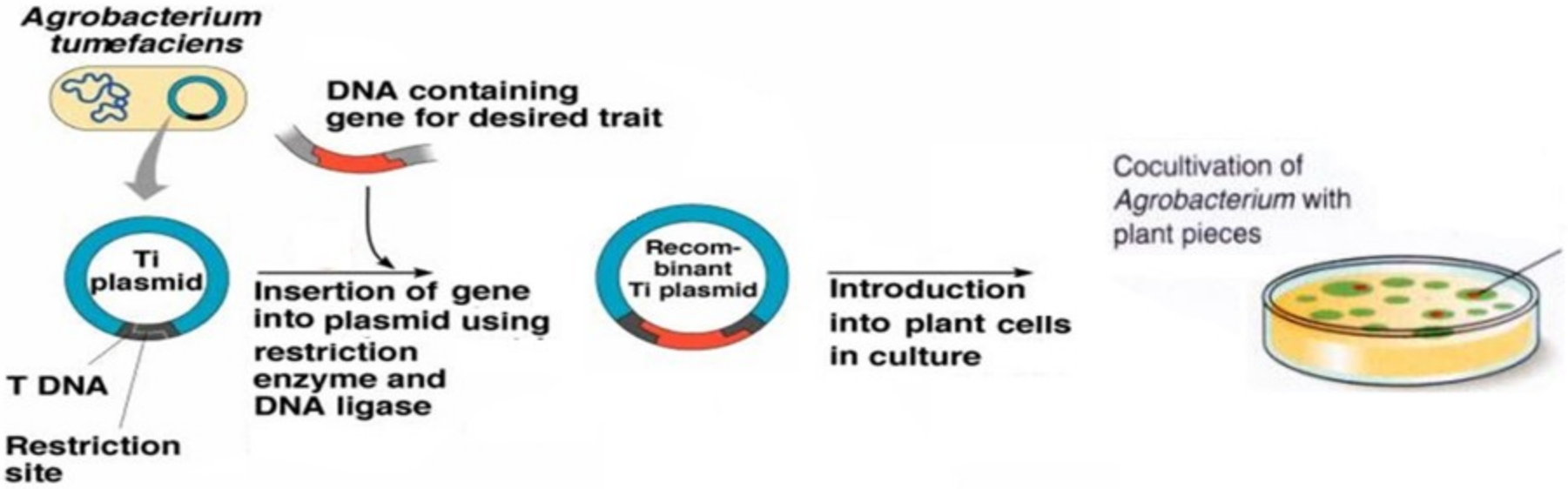
COMMONLY USED METHODS IN GENETIC ENGINEERING

- **Agrobacterium tumefaciens** is a rod-shaped, Gram-negative soil bacterium.

- is the causal agent of **crown gall disease** (the formation of tumors) in over 140 species of eudicots.

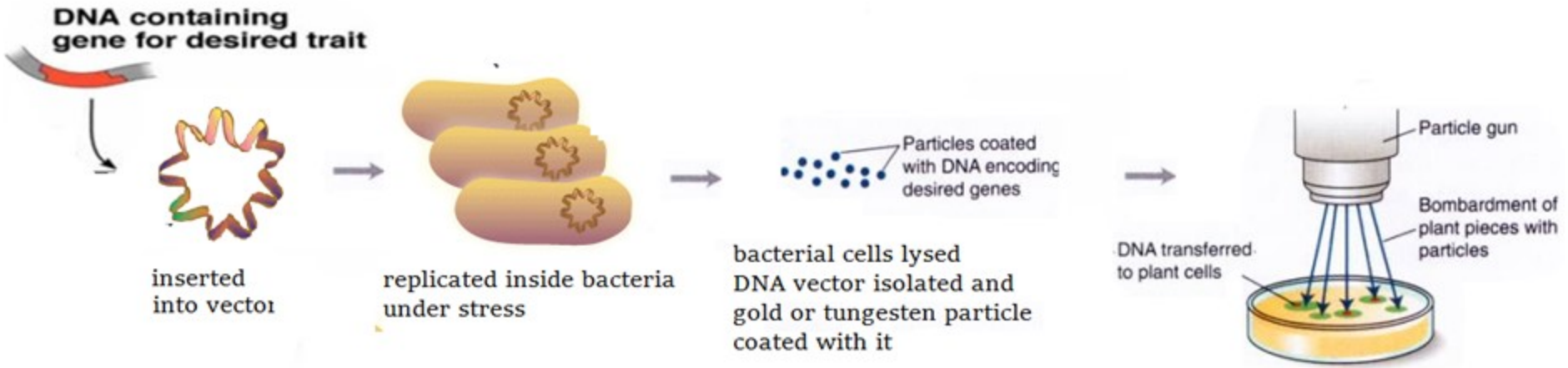
GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

TRANSFORMATION USING AGROBACTERIUM



GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

TRANSFORMATION USING GENE GUN



- After the DNA-coated particles have been delivered to the cells, the DNA is used as a template for transcription (transient expression), and sometimes it integrates into a plant chromosome ('stable' transformation).

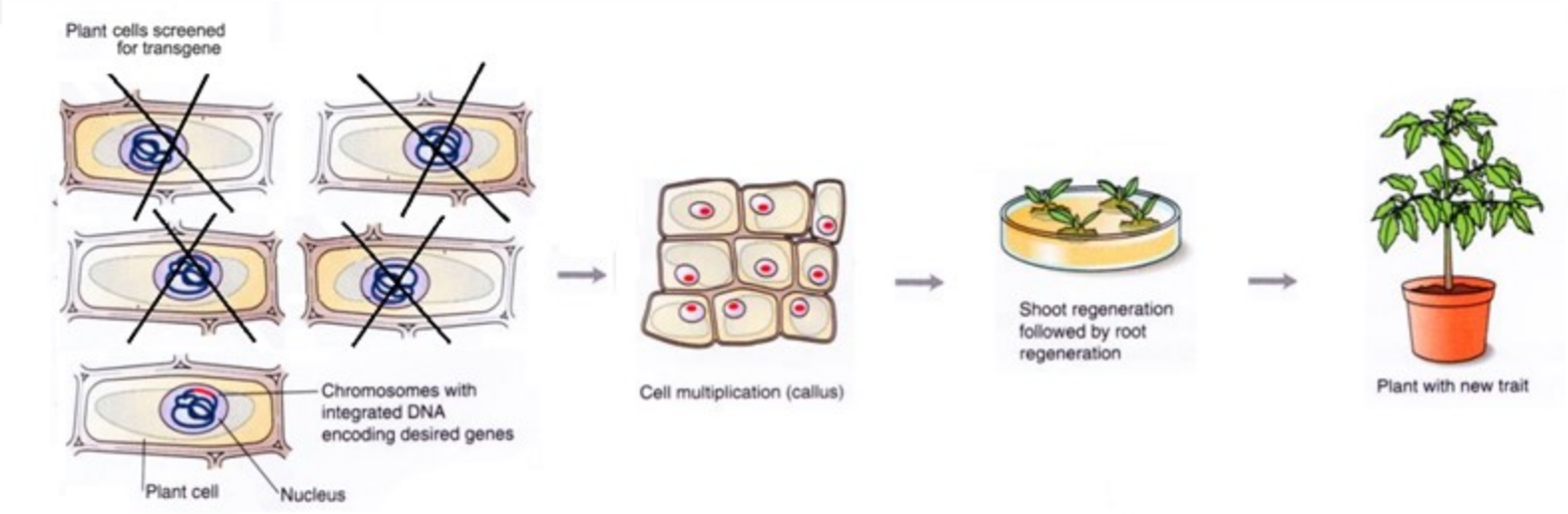
GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

LMO PLANT GENERATION

- Transformed cells are then selected, e.g., with the help of a marker gene

- Then are treated with a series of plant hormones, such as auxins and gibberellins, to divide and differentiate into an entire plant.

- The new plant that originated from a successfully transformed cell has new traits that are heritable (LMO).



CPB. ART 3.

Use of Terms

For the purposes of this Protocol:

(g) "Living modified organism" means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology;

(i) "Modern biotechnology" means the application of:

a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or

b. Fusion of cells beyond the taxonomic family,

that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection;

Genetic Element Registry

Total records: 928

Export

Record ID	Unique identification	Identity & transformation event	Organism	Description
BCH-LMO-SCBD-114444-1	AAT-7Ø9AA-4	**Pod Borer-resistant cowpea** AAT709A	Vigna unguiculata Cowpea, Black eyed pea	Resistance to diseases and pests - Insects - Lepidoptera (butterflies and moths), Resistance to antibiotics - Kanamycin
BCH-LMO-SCBD-14752-6	ACS-BNØ11-5	**Navigator™ canola** Oxy-235	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed Rape, Rape, BRANA	Resistance to herbicides - Bromoxynil
BCH-LMO-SCBD-15101-6	ACS-BNØ1Ø-4	**Falcon™ rapeseed** GS40/90pHoe6/Ac	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed Rape, Rape, BRANA	Resistance to herbicides - Glufosinate
BCH-LMO-SCBD-14753-6	ACS-BNØØ1-4	**InVigor™ canola** RF1 (B93-101)	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed Rape, Rape, BRANA	Resistance to herbicides - Glufosinate, Resistance to antibiotics - Kanamycin, Changes in physiology and/or production - Fertility restoration
BCH-LMO-SCBD-14754-5	ACS-BNØØ2-5	**InVigor™ canola** RF2 (B94-2)	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed Rape, Rape, BRANA	Resistance to herbicides - Glufosinate, Resistance to antibiotics - Kanamycin, Changes in physiology and/or production - Fertility restoration
BCH-LMO-SCBD-14755-7	ACS-BNØØ3-6	**InVigor™ canola** RF3	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed Rape, Rape, BRANA	Resistance to herbicides - Glufosinate, Changes in physiology and/or production - Fertility restoration
BCH-LMO-SCBD-116285-1	ACS-BNØØ3-6 × MON-ØØØ73-7	**Herbicide tolerant, male fertility restoring canola** RF3 × RT73	Brassica napus Turnip, Rapeseed, Canola Plant, Oilseed	Resistance to herbicides - Glufosinate, Glyphosate, Changes in physiology and/or production - Reproduction, Fertility restoration

UNIQUE IDENTIFIERS

WHAT IS A UNIQUE IDENTIFIER?

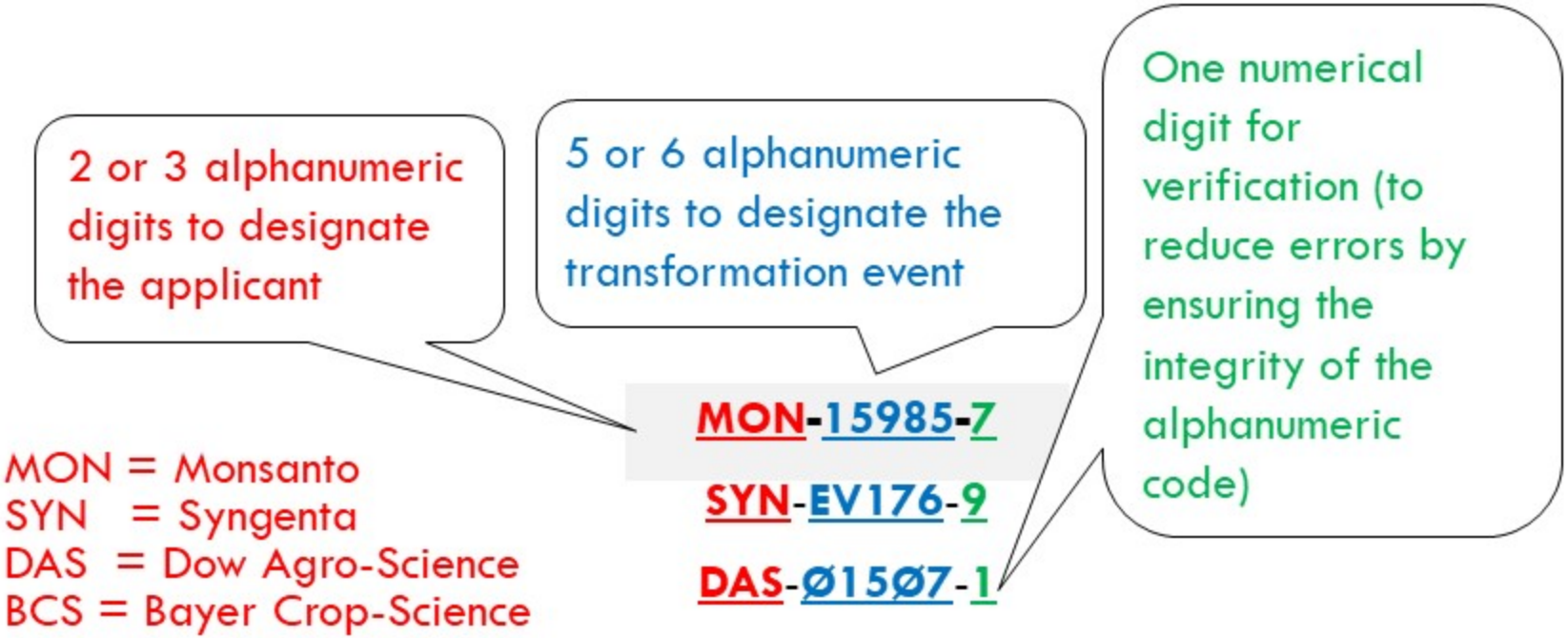
- It is a digital alphanumeric code for each living-modified plant approved for commercial use, including food or feed.

- Unique Identifiers are generated by the developers of a new transgenic plant and included in the dossiers that they forward to national authorities during the safety assessment process.

- Once approved, national authorities can forward the unique identifier to the OECD Secretariat for inclusion in the OECD's product database, from which the information is automatically shared with the Biosafety Clearing House.

UNIQUE IDENTIFIERS

UNDERSTANDING THE CODE



GENETIC ENGINEERING – MODERN BIOTECHNOLOGY

WHAT IS A STACKED LMO?

- It is an LMO possessing new traits resulting from more than one transformation cassette. It can be produced by several approaches, including conventional cross-breeding involving two LMOs that are either single transformation events or already stacked events, the transformation of an LMO, or simultaneous transformation with different transformation cassettes or vectors.

- Accordingly, the cassettes containing the transgenes and other genetic elements inserted in the original transformation events may be physically unlinked (i.e., located separately in the genome) and can segregate independently.

- Stacked LMOs may occur in the field in cross-pollinating plants like maize (corn) if more than one LMO are planted near each other.

UNIQUE IDENTIFIERS

UNDERSTANDING THE CODE

- For stacked LMOs, the unique identifiers show the multiple combined GM events.

BCS-BNØ12-7 X ACS-BNØØ3-6 X MON-883Ø2-9

BCS-GHØØ2-5 X BCS-GHØØ4-7

LMO with 3 stacked events

LMO with 2 stacked events

EXERCISES


SUBJECT
RESEARCH
METHOD
KNOWLEDGE
CASE STUDY
CONCLUSION
CRITERIA
EVIDENCE
DATA


Case Study
research
subject
case
studies
knowledge
cases
may
theoretical
single
study
local
thus
focus
whether
retrospective
Outlier
evidence
criteria
information
object
based
quantitative
in-depth
circumstances
researchers
multiple


case studies

SEARCHING FOR INFORMATION

CASE STUDY (CSFI08):

You have recently been given a food product that indicates that it contains a genetically modified organism identified as 'SYN-EV176-9'. Use the BCH to answer the following questions.

Q1. What type of organism is 'SYN-EV176-9'?

Q2. How has 'SYN-EV176-9' been modified from its parent organism (i.e., what new characteristics does it display)?

Q3. Is 'SYN-EV176-9' known by any other names?

Q4. What gene has been inserted into 'SYN-EV176-9'? Where did the gene come from?

Q5. Have any countries approved 'SYN-EV176-9' for human food, animal feed, or processing? Which ones?

SEARCHING FOR INFORMATION

CASE STUDY (CSFI08):

Q6. Have any countries decided that 'SYN-EV176-9' cannot be used for any reason? If so, why?

Q7. Where could you go for further information about this organism?

Q8. What product does the inserted gene produce?

Q9. What other organisms in the BCH have the same inserted traits as 'SYN-EV176-9'?

Q10. What genes have been inserted into the other organisms to give these same traits?

SEARCHING FOR INFORMATION

CASE STUDY (CSFI15):

You are a phytosanitary officer in the Czech Republic. You are inspecting a field planted with MON-ØØ81Ø-6 - YieldGard™ maize.

Q. What stacked events can be present with this event?

Thank you !

For more information, please email

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