Appendix A

Activity 1
Hello!

Welcome to the introductory activity of Getting to know GMO's. Before starting, you need to know what a Genetically Modified Organism (GMO) is and what they emerged for.

First some history

You are a farmer from thousands of years ago, and you live in a very hot region that is afflicted by plagues. Because you are a good observer, you notice that the following crops are related and they have defined characteristics:

1. Produces a lot of fruit

2. Produces very sweet fruit

3. Naturally fights insects

You know the techniques for cross-breeding plants. Now respond: Which organisms and in which order would you cross-breed in order to get the best variant?

Activity 1.2

Talking about cross-breeding is talking about genetics. Before the emergence of the current techniques to modify ADN, scientists and experts used ”Punnett Squares” to try to predict how characteristics could be passed on. This was before the concept of “gene” appeared.

The following is an example of how to cross-breed species. You have the characteristics of each species, and you need to calculate the probability of having the combination of characteristics for the desired outcome, be it in sweet fruit or large quantities.

Sweetness: BB
Quantity: Aa

Sweetness: Bb
Quantity: Aa

Sweet Fruit:
Bb

A lot of fruit:
AA

Probability:

Activity 2

You have seen how to pass on specific traits linked to desired characteristics. Now you will zoom in on a cell and you will learn the basic structure of a gene, and the functions of each of its parts.

The genetic code and mutations

As you know, DNA works by coding in triplets, or codons (it will be given to you in the next page). Codify the following DNA chain to a peptide and show the codons. Use the complete name of the amino acids.

ATGCTCGAAGCTCCGGGT:

Now, modify this encoding DNA sequence in any way you can. There is a high number of possible combinations. Do at least 3 and see how it would affect the formation of protein. You can add the nucleotide bases, eliminate them, change their placement, etc. The change (called "mutation") will be reflected in the protein, and they can go unnoticed or change the protein completely. Use one letter abbreviations.

A T G C T C G A A G C T C C G G G T  _____

A T G C T C G A A G C T C C G G G T  _____

A T G C T C G A A G C T C C G G G T  _____

As you might know, the kind of mutation will directly affect the way the gene works. If the mutation happens in a regulation area (start or end of the gene), it could alter its expression by augmenting it, diminishing it, or stopping it.

In the case that the mutation is, as in the previous example, directly on the coding region, the protein produced is what will be modified.

Activity 2.2

You have seen how a gene is structured, but- how does it work or what is it? And, how is it affected if it is modified? To answer these questions, continue with the activity.

An eukaryotic gene (as all plants are) has three basic components: Promoter, start codon/coding region, and terminator codon. In the following diagram, you need to correlate correctly the name, function, and position using the numbers in the boxes and lines.

Component	Location	Function
Terminator		Start and regulate transcription
Promoter		It has exons that will be translated into proteins
Coding Region		Stop translation

In the following section, you need to choose where and how to modify ADN, as well as a brief strategy to solve each problem. This activity will help clarify how the first GMO's emerged. Before humans were able to insert or eliminate entire genes, small modifications were done and the best individuals for each case were selected. This strategy is still in use.

Case 1	
Problem:	Very bitter flavor in the fruit
Data:	It is known that it is due to an over abundance of a protein. However, this [protein] is needed for maturation.

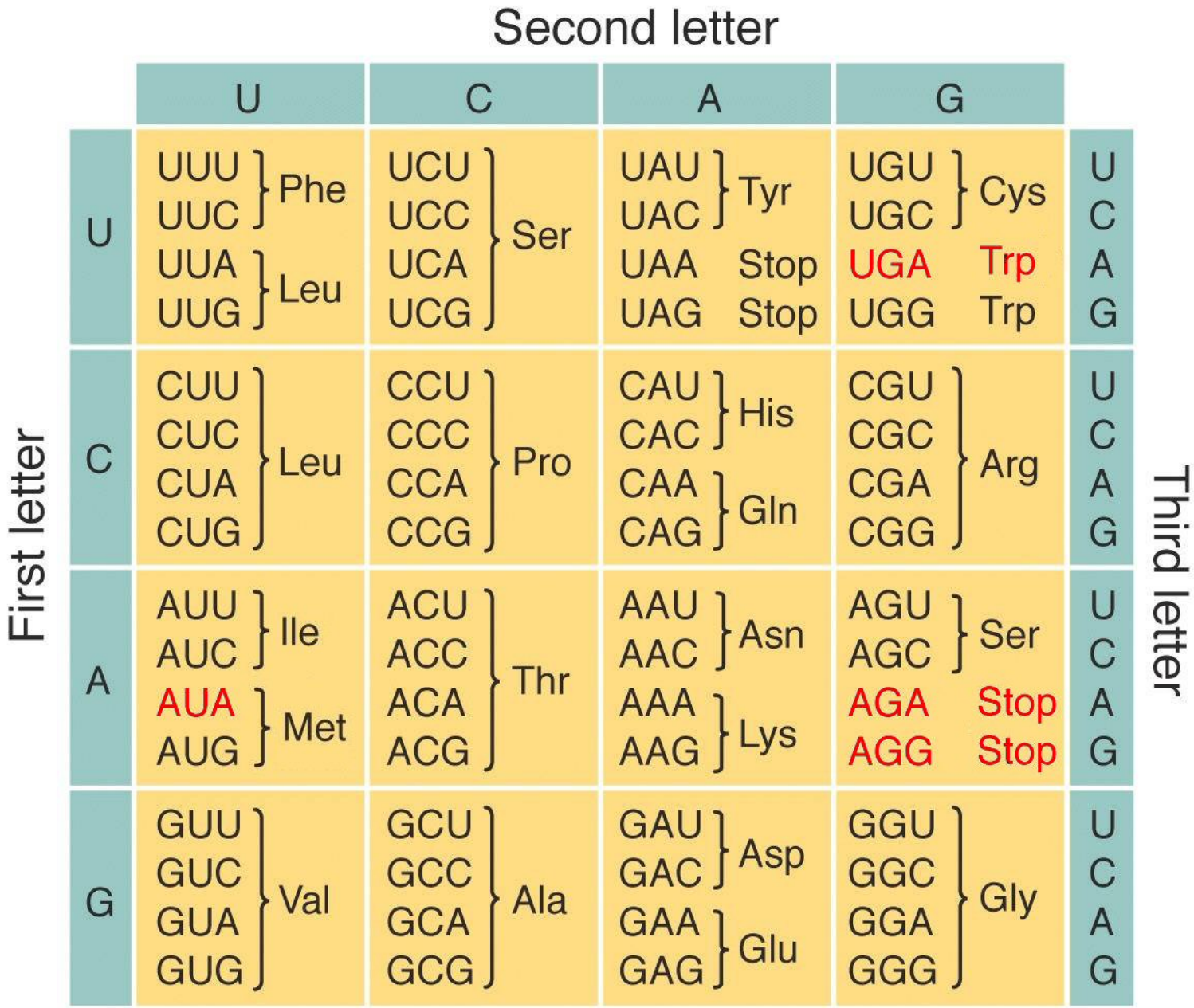
Which region of the gene would you modify?

Brief strategy:

Case 2	
Problem:	Allergen
Data:	A very cherished seed produces allergens. But in comparison it to [its] relatives, it is known that the final stage of a certain protein is responsible for this.

¿Which region of the gene would you modify?

Brief strategy:


Second letter
U
C
A
G
First letter
U
UUU Phe
UUC
UUA Leu
UUG
UCU Ser
UCC
UCA
UCG
UAU Tyr
UAC
UAA Stop
UAG Stop
UGU Cys
UGC
UGA Trp
UGG Trp
C
CUU Leu
CUC
CUA
CUG
CCU Pro
CCC
CCA
CCG
CAU His
CAC
CAA Gln
CAG
CGU Arg
CGC
CGA
CGG
A
AUU Ile
AUC
AUA Met
AUG
ACU Thr
ACC
ACA
ACG
AAU Asn
AAC
AAA Lys
AAG
AGU Ser
AGC
AGA Stop
AGG Stop
G
GUU Val
GUC
GUA
GUG
GCU Ala
GCC
GCA
GCG
GAU Asp
GAC
GAA Glu
GAG
GGU Gly
GGC
GGA
GGG
Third letter
U
C
A
G

Activity 3

In this section, you will learn how to modify genes of various organisms using a variety of options, in order to resolve or confront a situation. Based on your results, you will learn about the types of GMO's that exist.

First, promoters and coding sequences. You would get these sequences from the organisms that are presented to you. Make the combinations that you think are pertinent. There is no limit to such combinations, or where they could get to.

Promoters


Banana

Activation when in contact with fungi


Cauliflower Virus

Constant activation


Corn

Activation in all tissues of the plant

Coding region


Banana

Defense against fungi


Bacteria bacillus

Toxins that kill insects


Flower

Blue coloring


Bacteria Agrobacterium

Resistant to herbicides


Papaya Ringspot Virus

Resistant to the same virus

Now, choose one more organism among the following, where you will do the transfection* of your construction =


Banana


Corn

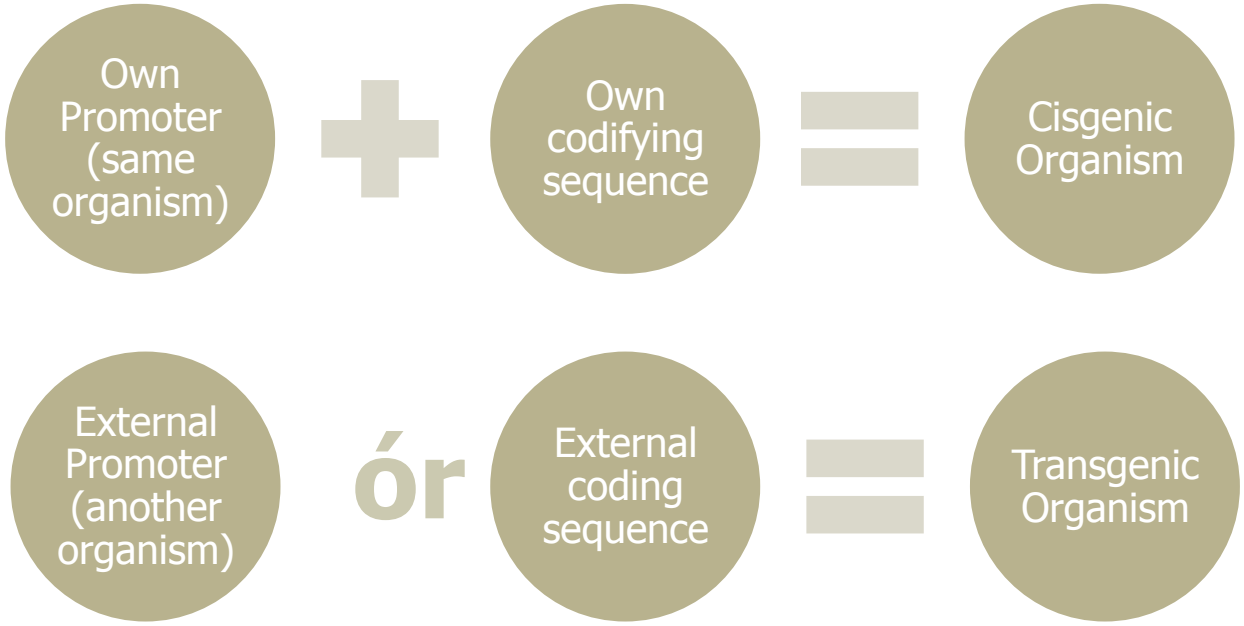

Papaya


Cotton


Soy

*Introducing exogenous DNA in eukaryotic organisms

Next, using the following formulas, you will determine if your organism is genetically modified, cisgenic, or transgenic.



If one of the components is external, your organism would be considered transgenic.

Activity 3.2

In this section, you need to decide the structure of your gene, based on the crop needs. You can use the tools provided in Activity 2, or you can search the literature for more. Remember that it is all based on real data.

Infection of the Black Sigatoka illnesss, caused by fungus.

Insect attacks

Illnesses caused by the papaya Ringspot Virus

Natural modification of color

Infestation of undesirable weed

Map 2 shows the crops of most importance in each region of the world.

With the construction you made, suggest at least three countries that might be interested in your new GMO's.

Use this map to show 3 countries where your GMO can be accepted or commercialized.

Map 2. Crops of importance by region