



CANADA
4-H Ontario

www.4-hontario.ca

4-H ONTARIO PROJECT



Introduction to Agricultural Biotechnology **RECORD BOOK**

The 4-H Pledge

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service,
my Health to better living,
for my club, my community and my country.

The 4-H Motto

Learn To Do By Doing

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Thank you to the 4-H Introduction to Agricultural Biotechnology Advisory Committee members who assisted with the creation of this resource:

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4-H Ontario is pleased to be able to provide project resource reference manuals for use by volunteers in clubs. 4-H Ontario screens and trains volunteers to equip them with the tools to serve as positive role models for youth. With so many topics to choose from, 4-H volunteers are trusted to use these resources to provide safe and quality programming while using their judgement to assess the appropriateness of activities for their particular group of youth. By downloading any 4-H resource, you agree to use it for 4-H purposes and give credit to the original creators. Your provincial 4-H organization may have restrictions on the types of 4-H projects or activities which can be completed in your region.

4-H Ontario grants permission to 4-H Volunteers to photocopy this 4-H project resource for use in their local 4-H program. All information presented in this Project Resource was accurate at the time of printing.



The development of this Project Resource was made possible through the support of the Grand River Agricultural Society.





4-H Inclusion Statement

4-H in Canada is open to all* without discrimination based on race, national or ethnic origin, colour, religion, sex, age or, mental or physical disability.**

4-H is dedicated to providing a safe and inclusive environment that allows for universal access and participation. Where barriers to participation are identified, 4-H will, with reasonable accommodation, adapt programs, rules, policies, or expectations to reduce or remove the barriers.

Any accommodations, changes or exceptions will be assessed on an individual basis, taking into account the individual experience of the member and their family. The physical safety and emotional well-being of members, leaders, staff and volunteers is 4-H's highest priority, and is the ultimate consideration in final decisions.

4-H Canada and local 4-H organizations consider inclusion a priority. Leaders are encouraged to work with individuals and their families to identify and discuss accommodations as required, and to reach out to provincial or national office staff for help with unresolved concerns.

**This applies to youth members (ages 6 to 21), volunteers, leaders, staff and professionals.*

***Definition of discrimination as per Canadian Charter of Rights and Freedoms.*

Déclaration sur l'inclusion des 4-H

L'adhésion aux 4-H au Canada est ouverte à tous les jeunes* sans discrimination fondée sur la race, l'origine nationale ou ethnique, la couleur de la peau, la religion, le sexe, l'âge ou le handicap mental ou physique. **

Les 4-H ont pour mission d'offrir un environnement sécuritaire et inclusif qui permet l'accès et la participation de tous. Lorsque des obstacles à la participation sont décelés, les 4-H adapteront, à l'aide de mesures d'adaptation raisonnables, les programmes, les règles, les politiques ou les attentes afin de réduire ou d'éliminer ces obstacles.

Toute mesure d'adaptation, modification ou exception sera évaluée au cas par cas, en tenant compte de l'expérience personnelle du membre et de sa famille. La sécurité physique et le bien-être émotionnel des membres, des animateurs et des animatrices, des membres du personnel et des bénévoles sont la priorité absolue des 4-H et constituent le facteur ultime à considérer lors de la prise des décisions définitives.

Les 4-H du Canada et les organisations locales des 4-H considèrent l'inclusion comme étant une priorité. Les animateurs et les animatrices sont encouragés à collaborer avec les personnes et leurs familles afin de définir et d'examiner les mesures d'adaptation, selon les besoins, et de communiquer avec le personnel du bureau provincial ou national pour obtenir de l'aide en cas de préoccupations non résolues.

**Ceci s'applique aux jeunes membres (âgés de 6 à 21 ans), aux bénévoles, aux animateurs, aux membres du personnel et aux professionnels.*

***Selon la définition de discrimination en vertu de la Charte canadienne des droits et libertés*

RECORD KEEPING - WHY?

Record Books are to document time and money spent, what you have learned, your ideas, memories and what you liked and didn't like. Your Record Book also....

- Helps you set goals for this project
- Has space to record important dates, your elected executive and the names and contact information of your leaders and club members
- Is a great way to get and stay organized

Down the road when you look back on your 4-H projects these books will be able to remind you what you learned so you can use those skills later in life. It will bring back memories of the project, your 4-H friends, your story and thoughts at the time of the project. You will never forget because this book will act as a reminder! It will also be useful at the Achievement Program, when looking at your progress and when reviewing your accomplishments.

How do I organize my materials?

1. Make your records neat and easy to read. This will make it easier to find information later on, and to share your information with others.
2. Use a three-ring binder or duotang to hold your materials and divide your information into sections using dividers. This will keep things from becoming lost and will make it easier to find what you need later on. This will also allow you to add extra pages later.

How do I keep good records?

1. Keep track of activities throughout the meetings, as you complete different parts of the project. It's often difficult to remember things that happened in earlier meetings.
2. Make sure the information you write in your Record Book is complete and accurate. If you're not sure about something, ask your leader for help before writing it in your book. You can also consult people in your community or do some research on your own. If you borrow information from someone or someplace else, make sure you write down where you found it.

Remember that this is YOUR Record Book so make it your own! And, remember to bring your Record Book to every meeting!

BASIC INFORMATION

RECORD BOOK FOR 20_____

Name: _____

Address: _____

Name of Parent or Guardian: _____

Age as of December 31: _____ Number of Years in 4-H: _____

List the other 4-H projects you are currently involved in:

Club Name: _____ Association: _____

CLUB MEMBERS:

NAME	PHONE NUMBER	EMAIL

WHO'S WHO

Club President: _____ Ph.#/E-mail: _____

Vice President: _____ Ph.#/E-mail: _____

Secretary: _____ Ph.#/E-mail: _____

Treasurer: _____ Ph.#/E-mail: _____

Press Reporter: _____ Ph.#/E-mail: _____

MEETING DATES:

	DATE & TIME	PLACE	NOTES: (Things to bring, remember, etc.)
<i>Meeting 1</i>			
<i>Meeting 2</i>			
<i>Meeting 3</i>			
<i>Meeting 4</i>			
<i>Meeting 5</i>			
<i>Meeting 6</i>			

LEADER NAME & CONTACT INFORMATION	LEADER NAME & CONTACT INFORMATION

MEMBER EXPECTATIONS AND GOALS

Why did you join the Introduction to Agricultural Biotechnology 4-H project?

What is one goal that you want to achieve in this project?

Do you have any ideas for fun things to do during the project?

Do you have any ideas for an Achievement Program for the Introduction to Agricultural Biotechnology Project? (Keep in mind that an Achievement Program should include the community in some way).

MEMBER RESPONSIBILITIES

- Be a current paid member of 4-H Ontario
- Attend at least 2/3 of the meeting time allotted for this project
- Complete the Record Book for this project. Bring it with you to each meeting!
- Put your Record Book in a binder or duotang so you don't lose any of the pages.
- Complete any other projects as required by the club leaders.
- Remember the more you put into your 4-H club the more you will get out of it!

ROLL CALLS - IN MY OPINION.....

	ROLL CALL	MY ANSWER
1		
2		
3		
4		
5		
6		

PROJECT SUMMARY - INTRODUCTION TO AGRICULTURAL BIOTECHNOLOGY 4-H PROJECT

A. Member Comments

1. What did you gain from taking this project?

2. Which meeting or topic was the most/least interesting? Why?

a. Most:

b. Least:

3. Comment and/or give suggestions for improvements on the overall project (eg. Activities, tours, achievement program plans, member presentations, special activities, judging information).

4. What interests would you like to explore through future 4-H projects?

B. Parent/Guardian Comments:

C. Leader Comments:

This project has been completed satisfactorily!

Member:

Leader:

Date:

Leader:

SAMPLE JUDGING CARD

JUDGING - JUDGING CARD

Criteria:

1. Is the item made/grown properly?
2. Does the item serve the purpose for the class it is in?
3. Is it the proper size for its purpose?
4. Does it smell and/or look like it should?
5. _____
6. _____
7. _____

****note:** additional requirements can be added to list specific to the item being judged

Giving Reasons:

I place this class of _____, _____, _____, _____.

I place _____ first because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ 4th because.....

For these reasons, I place this class of _____, _____, _____, _____.

Official Placing _____.

MEETING #1 ACTIVITY #1 WHAT DOES BIOTECHNOLOGY MEAN TO YOU?

Correctly answer the following questions. Feel free to work with other members and ask your leaders questions.

1. What does biotechnology mean?
 - a. The use of human ingenuity and robotics to make physical products
 - b. The use of biological processes in plants, animals and microorganisms for practical or industrial purposes.
 - c. The use of software and other technological components to complete biological analysis
 - d. None of the above.
2. Genes are the _____ material and _____ of an organism
3. The genome of higher organisms are made up of _____?
 - a. Neurons
 - b. RNA
 - c. Protein
 - d. DNA
4. The genome of an organism is found in _____ of cells that have a nucleus?
 - a. 100 %
 - b. 50 %
 - c. 30 %
 - d. 80 %
5. When was the first genetically engineered crop approved in Canada?
 - a. 1994
 - b. 1969
 - c. 2001
 - d. 2018
6. What was the first genetically engineered product produced in Canada (1973)?
 - a. Bt Soy
 - b. Human Insulin
 - c. GE Sheep
 - d. Kosher Salt

7. How many hectares of biotech crops were grown in Canada in 2017?

- a. 3 million Hectares
- b. 1.5 million Hectares
- c. 13.8 million Hectares
- d. 10.2 million Hectares

8. The term GMO stands for: _____

9. There are several genetically engineered crops that are grown in Canada. Can you name 3?

10. True or False: Herbicide and Insect Resistance are the 2 most common Genetic Engineering Traits?

11. There are a few types of genetically engineered animals? Can you name one of these?

12. Biotechnology often is associated with GMO. What are some other products that involve biotechnology?

13. True or False: The purpose of biotechnology is to increase the amount of pesticide and herbicide that farmers will have to use?

14. A _____ organism has a gene from another organism that is foreign to the original organism

15. Are GMOs currently sold on the market safe based on all of our scientific knowledge? Yes/No

16. The population is expected to grow to _____ billion by 2050. This will require farms to produce _____ % more food.

17. What is the largest consumer of GMO products? _____

18. Will herbicide-tolerant and pesticidal genetically engineered crops lead to intensified use of pesticides or herbicides? _____

19. In Canada, it costs _____ million and can take ____ + years for a plant biotech product to get to market?

- a. 150 million, 10 years
- b. 1 million, 10 years
- c. 50 million, 1 year
- d. 100 million, 5 years

20. Health Canada and the Canadian Food Inspection Agency evaluate all biotechnology products for:

- a. Only the effects on human and livestock animal health
- b. Potential effect on human, livestock animal and environmental health
- c. Only the environmental impacts
- d. Only the effect on humans

21. Once a new product makes it to market does it still undergo re-evaluation by regulatory bodies?

- a. Yes
- b. No

MEETING #1 ACTIVITY #3 HEADLINES- WHO DO YOU BELIEVE?

Write down what you think about each of the sources. Write down where you put your tokens as well.

Source 1: _____

Source 2: _____

Source 3: _____

Source 4: _____

Source 5: _____

MEETING #2 ACTIVITY #2 HEADLINES- WHAT IS A TRAIT?

In your own words. What is a trait?

Can you give examples of traits in modern day agriculture?

MEETING #3 ACTIVITY #1 CONTROLLING BIOTECHNOLOGY- WORD SEARCH

Controlling Biotechnology

X S J K P V A V N N L O R T N O C N G D I W Z
 F C R X J V A P J C R E G U L A T O R Y W F Z
 E I P M C I V M Y R N T E B H K E P H D R S Y
 B C S U C A Q U A D V A N T A G E R G E F N N
 J E S H Z Q V H M I F D W Z I X H T N C W A A
 G P Z I E R T K J X P D N A W H U P I H K G R
 L O X T U R A P T O C E A N S J N B L C Q I E
 X C X N B F I F V Q O T G L H T L A E H B P G
 A B I K M X I E N V I R O N M E N T B F R O U
 I V L R J M U Z S K N I E T O R P W A X Y R L
 Y C D U S E D I C I T S E P O I B T L R N I A
 C A N A D A Z D R E S I S T A N C E P Z E V T
 X K Q U A P P R O V A L S W M C F I A B S N I
 B I O T E C H N O L O G Y Y S B K M B V J E O
 Y T I B X C U P Q T S F T X D D N Y V K L W N
 C J P E U C F P M E J U W A L F O O D F G X A

APPROVAL
 AQUADVANTAGE
 BIOPESTICIDES
 BIOTECHNOLOGY
 CANADA
 CFIA
 CONTROL
 DNA

ENVIRONMENT
 ENVIROPIG
 FISHERIES
 FOOD
 HEALTH
 LABELING
 LAW
 OCEANS

PROTEIN
 REGULATION
 REGULATORY
 RESISTANCE
 RNA

MEETING #3 ACTIVITY #2 ANIMAL FACT SHEETS

The Enviropig™

Background

The Enviropig™ is the name given to a pig that has been genetically engineered to excrete less phosphorus in its feces. It was the first transgenic animal created to solve an environmental problem. The name is trademarked and was developed by researchers from the University of Guelph.

The problem with Phosphorus is that in large quantities it acts as a pollutant. Plants need phosphorus, but if there is too much of it, then the excess runs off into streams and lakes. This runoff, along with other sources (eg sewage) has resulted in serious problems especially in the Great Lakes Basin in the form of algal blooms.



Algal Bloom (Source: NASA)

Science of the Animal

The Enviropig™ has genetic engineering that causes it to produce the enzyme phytase in its salivary gland. This allows the pig to digest phytate, which is the form of phosphorus found in both corn and soybeans (both large parts of pig feed). To create this enzyme scientists took the enzyme from an E. coli bacterium that naturally produces the phytase gene. Overall, published scientific studies have confirmed that Enviropig™ manure has phosphorus levels that are 30-65% lower than those in regular pig manure. What do you think the effect of this animal could be on controlling algal blooms in the Great Lakes basin?

Problems

It seems that the Enviropig came into the biotechnology world at the wrong time. The University of Guelph euthanized their animals. China has seen the advantage of these animals however and has moved towards reopening this research source. What do you think was the reason that the Enviropig™ project was terminated in Canada?

AquAdvantage® Salmon

Background

The AquAdvantage Salmon® is a transgenic species of Atlantic Salmon that is produced by AquaBounty. If you look at AquaBounty's vision, you will find that they want "to raise the world's finest, most sustainable Atlantic salmon. A fish that is nutritious, delicious, fresh and affordable". Salmon is low in calories, low in saturated and trans fats but is an excellent source of protein, essential vitamins, minerals and omega-3 polyunsaturated fatty acids. The problem arises when we consider feeding 9-billion people by the year 2050. We simply must be getting more out of what we are feeding to our animals. In addition, most of the available land for raising animals is currently in use. The solution is aquaculture. In this realm Aquadvantage® Salmon requires 20-25% less feed than other farmed Atlantic salmon on the market today. How?



An example of non-GMO Salmon (Source: Wikimedia)

Scientific Background

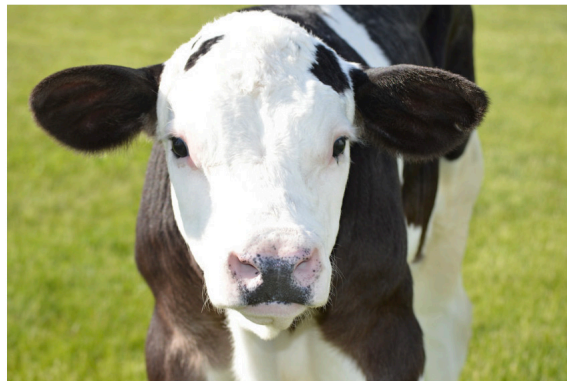
AquAdvantage® salmon contains a recombinant DNA construct that is comprised of the growth hormone from Chinook Salmon under the control of a promoter. Recombinant DNA is a copy of the original host's DNA while the term promoter refers to a gene sequence that promotes expression of another characteristic when it is turned on. In this case the promoter comes from another type of fish called an ocean pout. In the most straightforward terms the reason that the

fish can use 20-25% less feed is that it grows so fast and has good feed efficiency. Why do you think there has been so much backlash over the aquadvantage salmon in the industry? Do you think labelling laws need to be strict in order to deal with these problems? Brainstorm.

Polled Cattle

Background

It is estimated that 80% of dairy cows have their horns removed each year. This is not done maliciously but rather to protect both their handlers and other cattle. Cattle are herd species that fight for dominance. However, the process of “disbudding” or removing the horns is both potentially painful for the animal while also being a costly expense for the farmer. Within the realm of dairy cattle when an animal is born without horns it is naturally polled. The polled trait has been on the radar of farmers for a long time and selective breeding has reduced the need to disbud animals.



Polled Cattle (Source: USDA.gov)

Scientific Background

In 2016 it was pointed out that 80% of dairy cows needed to be disbudded while only 25% of beef cows had to go through this procedure. The reason is the small number of sires within the dairy industry producing polled offspring (6%). The result of this was the use of a biotechnology technique called TALENs (transcription activator-liked effector nucleases). Think of this as a fancy way of cutting DNA at a very specific site and having the opportunity of putting in your gene of interest. In this case the gene of interest was one from polled animals. Scientists used this gene and were able to create a polled animal in the next generation. Overall the technology could be used to decrease the need for disbudding in dairy cows.

MEETING #3 ACTIVITY #3 HOUSING AND CONTAINMENT CONTROL

Criteria:

1. Are the methods appropriate?
2. Does it serve its purpose?
3. Does this address the problem?
4. Is it necessary?

5. _____
6. _____
7. _____

****note:** additional requirements can be added to list specific to the item being judged

Giving Reasons:

I place this class of _____, _____, _____, _____.

I place _____ first because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ 4th because.....

For these reasons, I place this class of _____, _____, _____, _____.

Official Placing _____.

MEETING #4 ACTIVITY #1 PRECISION AGRICULTURE JUDGING

Criteria:

1. Is the item made/grown properly?
2. Does the item serve the purpose for the class it is in?
3. Is it the proper size for its purpose?
4. Does it smell and/or look like it should?
5. _____
6. _____
7. _____

****note:** additional requirements can be added to list specific to the item being judged

Giving Reasons:

I place this class of _____, _____, _____, _____.

I place _____ first because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ over _____ because.....

I place _____ 4th because.....

For these reasons, I place this class of _____, _____, _____, _____.

Official Placing _____.

MEETING #4 ACTIVITY #4 PATENTS AND INTELLECTUAL PROPERTY



MEETING #4 ACTIVITY #4 PATENTS AND INTELLECTUAL PROPERTY



MEETING #5 ACTIVITY #2 THE GOLDEN RICE DILEMMA

What is Golden Rice? _____

What issue is the golden rice trying to address?

Are you for or against the use of golden rice?

Do you think the opposition is simply opposing the golden rice to send a political message about Golden Rice?

Are there any risks to GMOs?

How do you think the developing countries feel?

Do you think we should continue our investment in this type of research?

What is another example of a genetically modified organism debate?

Do you think we should argue about the process to make Golden Rice or the product use itself (the product)?

MEETING #5 ACTIVITY #3 REPLICATION, TRANSCRIPTION, TRANSLATION AND SEQUENCING

1. Take your original sequence of ATCG (bases) of a DNA strand and replicate this to get a complementary copy. All higher organisms use sequence of A,T,G,C in DNA to code for their genetic make up. In replication (make another copy of DNA strand), adenine (A) pairs with thymine (T) while guanine (G) pairs with cytosine (C). Whenever you see a T replace it for an A. When you see a G replace it for a C. If you do this you will get a replicated piece of the original DNA. (Allow members to do this).

ATG ACG GGG CCC GAT CAT GCA ACG TTT GTG GGG TAA

Now that you have a replicated strand of the original DNA you can convert the replicated strand that you just made into Ribonucleic Acid (RNA). This process is called transcription. RNA is the copy of the original DNA and allows for protein to be made quicker and for DNA to be protected. In this case the old rules apply but Thymine (T) is replaced with another nucleotide, Uracil (U). In this case adenine (A) becomes uracil (U) while guanine (G) still pairs with cytosine (C). (Hint you can use the original sequence in this case and replace the Thymine's with Uracil's)

(Same as the one you wrote in above)

2. Now you are ready to translate your RNA into protein. Normally you would look for the start sequence which is made up of the three letters ATG which would tell the translation into protein to start. We group nucleotides into codons (sets of three) in order to perform translation. The reason is that is the way that nature dictates it. There are 20 amino acids, but we will avoid that here and use words instead. We will also avoid the discussion about reading frame as you start with AUG and end with one of three codons. You can use the table below to translate your codon code into a message. Say you had CCC as your codon from the previous question. Go down the codon table to CCC and across to the word under the translation heading. This will be your word. In this case Process.

Translate the codons using the table below:

Codon	Translation	Codon	Translation
GUG	TO	GGG	THE
ACG	IS	GAU	BY
AUG	TRANSLATION	GGG	PROTEIN
CCC	PROCESS	CAU	WHICH
AAA	TERMINATE	AAG	REALLY
UUU	CONVERTED	GCA	RNA
UAG	Question Mark (?)	UAA	Exclamation Mark (!)

MEETING #6 ACTIVITY #1 DIGESTION AND LIGATION

Restriction Enzyme 1: YZZGGG

Restriction Enzyme 3: AABAAA

Restriction Enzyme 2: YTZGQY

Restriction Enzyme 4 : QRTZYX

WYZZGGGHENSCIENTISTSARECREATINGMATERIALTOMAKETRANSGENICORGANISMSTHESCIENTISTWILLOFTENCHOOSEANORGANISMTHYTTZGQYATHASTHEDESIREDTRAITSTHATTHEYARELOOKINGFOR.THESCIENTISTWILLTHENTAKETHEDNAOFTHATORGANISMANDUSEATECHNIQUECALLEDTHEPOLYMERASECHAINREACTIONAABAAA.THISTECHNIQUECOPIESONYZZGGGLYTHESPECIFICSEQUENCEANDDOUBLESTHENUMBEROFDNAMOLECULESFORTHATTARGETSEQUENCEEVERYTIMETHEREACTIONTAKESPLACE.THISHASTHECAPACITYTOPRODUCEPOTENTIALLYMILLIONSOFCOPIESOFTHEGENEOFINTERESTYTZGQYTHATCANTHEBEDIGESTED.THISACTIVITYILLUSTRATESDIGESTIONWELL.

THEFIRSTPARTOFTHISACTIVITYHASYOUUSINGRESTRICTIONENZYMESTOFINDANDREMQRTZYXVESEQUENCESOFDNA.THATISWHATHAPPENSINSCIENTIFICLABSALLAROUNDTHEWORLD.THEONLYDIFFERENCEISTHATWHENSCIENTISTSDIGESTAGENE OFINTEREST,THEYALSODIGESTAVECTORORSOMEOTHERPIECEOFDNA.AVECTORISANOTHERPIECEOFDNATHATHASAFUNCTION.INTHISCASEAVECTORCANINCLUDEACIRCULARPLASMIDYTZGQYIDORMAYINCLUDEANORGANISM'SDNAIFTHECONDITIONSARERIGHT.BYUSINGANENZYMESCIENTISTCANPUTTHESESTRANDBACKTOGETHERJUSTLIKEYOUHAVEDONEINTHISACTIVITY.AABAAATHEYCANTHENEXPRESSTHEIRGENEOFINTERESTTOPRODUCETHEIRPROTEINORDESIREDEFFECT.