CANADA
4-H Ontario

www.4-hontario.ca

4-H ONTARIO PROJECT

Technology & the World Around Us

RECORD BOOK

Credits

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,
my country, and my world.

The 4-H Motto

Learn To Do By Doing

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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 if 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.

The 4-H program in Ontario is supported by the Ontario Ministry of Agriculture, Food and Rural Affairs.

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

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CANADA
4-H Ontario

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*

INTRODUCTION

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 Guadian: _____

Age as of January 1: _____ Number of Years in 4-H: _____

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

Club Name: _____ Association: _____

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: _____

	DATE & TIME	PLACE	NOTES (THINGS TO BRING, REMEMBER, ETC)
Meeting 1			
Meeting 2			
Meeting 3			
Meeting 4			
Meeting 5			

LEADER NAME & CONTACT INFORMATION	LEADER NAME & CONTACTION INFORMATION

MEMBER EXPECTATIONS AND GOALS

Why did you join the Technology & the World Around us club?

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 Technology & the World Around Us 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.
- Adhere to the 4-H Code of Conduct at all time.
- 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

Technology & the World Around Us 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: Technology & the World Around Us Wordsearch

Do	Time: 15 minutes **Materials needed:** • Technology & the World Around Us Wordsearch (found on the next page) • Writing utensil **Instructions:** • Provide each member with a wordsearch. • Give members 5 to 10 minutes to find the words.
Reflect	**Learning Outcomes:** • The objective is to allow members to become familiar with words associated with technology.
Apply	**Processing Prompts:** • Was it easy or hard to find the words in the wordsearch? • Did any of the words surprise you that they would be included in a wordsearch about technology? • Are there any words that you don't know the meaning of?

Technology & the World Around Us Wordsearch

i p b o m g i m k o q k s g e g c x n f z u c r a z j x c r
u t r a g m c j u t s o r f b t w o x z h m h s m k s j e v
y u t o p w s v v x d t o b m p i a p i k o e h k o p w r u
j h b x g n n u x v b j j m p t d c i n v e n t i o n r p e
o u k b r r k p t q l h m w a r r x e l n z x s y f j s u v
b v s u u e e c e b u r d z k z a d k q r n x g x u z m t b
r y s g h q v s s m z l i q a t g a l z i o s d h o w l i c
y e y w o v c t s h t l j b u m c s f p t i w t d q j m y f
o l f v l f n l n g a t q a l g b z t z a t l j o t k f z e
f g v a m v b d l b f e r m e c n e i c s p g g k b h y o l
y e v t c z b i o f l e m l n m o f v c v y v h x f o d q l
i g l d d g o l x h v t k a a f u r u v p r z k f q t r b o
h r e k a d g s l x r m r p s j r t r h z c c y s y w w j w
h y m w e f y m h n v x e t w b y p n a k n f z z h r r f j
z n j l b m x h s k v u t o w d i c d a c e f y c k k c x h
y u c o p o n p l d z e u p k g s n f n u u w b s d e x y i
p g o s o y e l z a n e p r t t d i a w t q f j z u i z k i
k d o s i k z a v v z s m n o i t a z i n a h c e m d a t a
p p i l m i f s i z m e o a x r k m d h c d w f v o j v n n
y z g r o k p r n n f h c g e i e y k o v d e s z b n b o j
x h i z p n o k o v r a d r h n n c r a f z p v o w j s i j
k f h s z n h i u r y v k i s i o s f r r t p a i q x j t c
g k z l m s s c e z z z g c p f m b e x a k x r v c s m a i
t n x e d i h n e t k t v u v b g b i u k m v y x g e m m d
n x n m c n e j l t a m l l a d y v i r t u a l k q d s o x
q t m e m q g l m z l t e t j c o t m h s j f t q i r x t l
v z r y v k d l y z m w a u l s i a m w d p a w n r d h u f
d p p c u d k x a o c p e r j w b v u f x b b e o c v v a a
l u y w o c f o w o i z f e h s i f b g v i m q p u p i f i
d e q z h a c o d y w g i r z u a u z y y u z z m i q e q d

Agriculture	Laptop	Automation	Math	Computer
Mechanization	Cyber	Precision	Data	Progress
Devies	Quantun	Encryption	Robots	Environment
Science	Globalization	Technology	Invention	Virtual

Meeting #1 Activity #2: How Much Soil is there in the World?

Do	Time: 20 minutes **Materials needed:** • Apple(s) • One sharp knife (for leader demonstration) or plastic knives (for member participation) • Cutting board • Paper towels **Instructions:** • Pretend that this apple is planet Earth. Notice how its skin hugs and protects the surface. Cut the apple in quarters. Three of the four quarters represent how much of the earth is covered with water-- oceans, lakes, rivers, and streams. Set three of four quarters aside. • There is one quarter (25 percent) left, representing the portion of our earth that is dry land. Take this quarter and cut it in half. One of these halves represents land that is desert, swamps, polar, or mountainous regions where it is too hot, too cold, or too high for humans to be productive. Set this half aside. • The other half (one--eighth or 12.5 percent of the apple) represents where humans can live and grow crops. Slice this section lengthwise into four equal parts. Now you have four 1/32nds (3 percent each) of an apple. The first of these represents land too wet for food production. It isn't swamp land, but it may flood during the growing season. The second section represents land that is too rocky and poor to grow food. A third 1/32nd represents areas that are too hot. Set these three sections aside. • The last section (1/32nd or 3 percent of the apple) represents the area of the world developed by humans. Now, carefully peel the last 1/32nd section. This small bit of peel represents the portion of our planet that is soil on which humans depend for food production and similar uses.
Reflect	**Learning Outcomes:** • To allow members to learn the importance of soil as a limited, natural resource and how our food system is dependent on taking proper care of the soil so food can be grown to feed the world. • To have members to realize the importance of having technological advances in the agriculture industry to be able to produce more food with the limited amount of soil available for production.
Apply	**Processing Prompts:** • Does it surprise you that there is so little soil in the world to grow food? • All living things depend on soil to live. What are some of our important natural resources? Answers might include materials such as oil, water, coal, trees, animals and gold. All of those are important natural resources, but we often forget to mention one of our most important natural resources: soil. • What are some things that farmers do to take proper care of the soil?

Meeting #1 Activity #3: Technology in the News

Do	Time: 20 minutes **Materials needed:** • Variety of newspapers and magazines • Markers of various colours **Instructions:** • Distribute newspapers and magazines amongst members. • Have members search through print media and have them circle articles that contain information about agriculture and the agri-food system. • Then, have members go back through the print media and, using a different colour of marker, circle the agriculture and agri-food articles that contain information about technology.
Reflect	**Learning Outcomes:** • To allow members to discover how many articles relate back to agriculture and/or agri-food production. • To help members come to the realization of how much technology there is within the agriculture and agri-food industry.
Apply	**Processing Prompts:** • Was it easy or difficult to find articles about agriculture and agri-food? • Were you surprised at how many agriculture and agri-food articles related to technology? • Do any of the articles discuss a problem/issue within agriculture that technology could help with?

Meeting #2 Activity #1 - Cellular Agriculture

Activity Courtesy of Ontario Genomics

Do	Time: 30 minutes **Materials:** • Access to the Internet to download the report: https://www.candesyne.ca/cellular-agriculture (Executive Summary of the Report follows these activity instructions) **Instructions:** Cellular agriculture (the production of food and other traditional agricultural products like textiles through biological processes) is a relatively new, but rapidly expanding, field of science that brings together biology, chemistry, and engineering to supplement traditional agriculture. Funded by Ontario Genomics and Agriculture and Agri-Food Canada, Ontario Genomics, in partnership with the Food and Agriculture Institute at the University of the Fraser Valley, conducted a series of stakeholder consultations to explore critical considerations for Canada's emerging cellular agriculture industry. This report outlines opportunities for Canada to capitalize on this rapidly expanding global market, how this new field can transform Canadian agriculture and ready us for the future. • Discuss what cellular agriculture is. • Have each member read through the report. • Ask the group if they have any questions about the report and then discuss the pro's and con's of cellular agriculture.
Reflect	**Learning Outcomes:** • To allow members to discover what cellular agriculture is. • To allow members to think critically about the benefits (and drawbacks) of cellular agriculture.
Apply	**Prompting Prompts:** • What did you learn about cellular agriculture? • What are the benefits of cellular agriculture? • Was there information in the report that surprised you? • Do you think cellular agriculture has a place in our world? Do you think it will be successful?

Ontario Genomics

CELLULAR AGRICULTURE

CANADA'S $12.5 BILLION OPPORTUNITY IN FOOD INNOVATION

EXECUTIVE SUMMARY

November 2021

Cellular Agriculture – Canada's $12.5 Billion Opportunity in Food Innovation - Executive Summary

Driven by an accelerating climate crisis, evolving consumer preferences, worsening global food insecurity, and the need to feed a growing global population, cellular agriculture presents an alternative and compelling route to produce proteins, ingredients and other food products[a] thereby augmenting global food systems. In recent years, the cellular agriculture industry has been exploding, with over US$9.7 billion in global investments and more than one hundred active companies worldwide. This is an industry that is flourishing with opportunities for current and new food producers across diverse and multi-sectoral public and private stakeholder groups.

Cellular agriculture encompasses several innovative approaches that use cell cultures, tissue engineering, or precision fermentation to make food products and other materials. Cellular agriculture is underpinned by the platform technology of engineering (synthetic) biology, a convergence of advanced biological, engineering and computational disciplines to create products for numerous sectors in new and sustainable ways.

The first-of-its-kind in Canada, the current report, *Cellular Agriculture – Canada's $12.5 Billion Opportunity in Food Innovation* is based on extensive stakeholder engagement and builds on the landmark whitepaper, *Engineering Biology – a platform technology to fuel multi-sector economic recovery and modernize biomanufacturing in Canada*. Released in November 2020, by Ontario Genomics and the Canadian National Engineering Biology Steering Committee, this whitepaper highlighted the opportunity to use engineering biology as a platform technology for sustainable and innovative economic recovery and growth in three vertical pillars: Food Security, Low-Carbon Manufacturing, and Advanced Engineering Health Technologies.

The analysis presented here illustrates that the Canadian cellular agriculture landscape is rapidly evolving and shows tremendous promise to develop alongside and augment Canada's conventional agriculture and food industries, with Canadian start-ups already taking advantage of growing opportunities along the supply chain. As the fifth largest exporter of agricultural and agri-food products in the world and aligning with the ambitious vision of the Economic Strategy Table on Agri-Food's vision for Canada to become the favoured protein provider globally, Canada has unique advantages to drive leadership in cellular agriculture. This includes an extensive food and beverage industry, free-trade agreements covering 60% of global GDP, readily available feedstock, and world-class expertise across required disciplines. The report's economic analysis, by Dr. Michael von Massow, indicates that there is an enormous opportunity for Canada to capitalize on cellular agriculture. This includes the ability to

[a] In addition to food ingredients (such as proteins, enzymes, flavour molecules, vitamins, pigments and fats) that can be incorporated with existing products to create value-added hybrid goods, fermented products include dairy, eggs, chocolate, honey, while cellular/cultivated products comprise red meat, poultry, seafood, foie gras and pet food. Non-food cellular agriculture products cover textiles such as leather, wool, silk and cotton.)

diversify and create new product categories for domestic and international markets, supporting company creation and Canadian Intellectual Property generation, as well as an opportunity to address food security concerns in Canada and globally. Optimistic scenarios suggest a $7.5 billion a year industry and up to 86,000 jobs created by 2030, and longer-term Canadian revenues as high as $12.5 billion per year with the creation of up to 142,000 jobs; this is achievable and aligned with Canada's current share of the global market.

Funded by Ontario Genomics and Agriculture and Agri-Food Canada, Ontario Genomics, in partnership with the Food and Agriculture Institute at the University of the Fraser Valley, conducted a series of stakeholder consultations to explore critical considerations for Canada's emerging cellular agriculture industry. Based on these consultations and a review of literature and publicly available information, this report outlines inter-connected actionable opportunities for Canada to capitalize on this rapidly expanding and high-potential global market expected to approach US$100 billion in the next decade. To achieve success, Canada must:

1. *Develop a National Vision and Strategy for a Canadian Cellular Agriculture Industry in the Near Term.* This is foundational to enable a growing domestic ecosystem and fully realize the benefits presented by this industry. An outcomes-driven national vision and strategy should be developed collaboratively, be inclusive of stakeholder requirements and include a clear plan for implementation in the short-, medium- and long-term.
2. *Establish a Clear and Transparent Regulatory Framework for Cellular Agriculture Products in Canada.* Canada is encouraged to proactively develop an agile, iterative, and innovative regulatory framework by building on existing processes to support the evaluation and approval of cellular agriculture products in a timely manner, in alignment with Canada's current rigorous regulatory process and excellent food safety standards.
3. *Provide Supporting Mechanisms for Research and Commercial Development.* Incentivization, through public and private investment and partnerships, and outcomes-driven networks, is critical for a thriving domestic cellular agriculture industry, with infrastructure support for research and development, training, company creation, scale-up and growth, leading to made-in-Canada product commercialization.

Canada's Actionable Opportunities for a Thriving Cellular Agriculture Ecosystem

Based on the input from our stakeholder consultations, along with a review of literature and other publicly available information, we articulate the inter-connected actionable opportunities to inform a policy framework and implementation plan for a thriving Canadian cellular agriculture industry worth up to $12.5 billion a year and creating up to 142,000 jobs.

1. Develop a National Vision and Strategy for a Canadian Cellular Agriculture Industry in the Near Term to enable a domestic ecosystem that fully realizes the benefits presented by this industry. Founded on a clear value proposition and rationale, this strategy should be national in scope and developed collaboratively and cohesively by federal, provincial and territorial governments, industry (including large corporates, start-ups and conventional agriculture), academic and research institutions, not-for-profits, regulatory agencies, and policymakers.

The strategy should define a framework with concrete steps for implementing an action plan in the short, medium and long-term and have clear success metrics. Considerations for the value proposition and rationale include economic and export opportunities, environmental and ethical concerns, current and future domestic and global protein requirements, trade considerations, the changing food and agriculture employment landscape, opportunities in the sector, food security, resiliency in the face of climate change or other shocks, and alignment with Canada's strengths and priorities. In addition, promoting the integration of new production systems with existing conventional ones is critical, with ongoing monitoring to prevent undue disruption to either sector. The framework should include the strategy for government incentivization at both federal and regional levels. In the development of this Canadian-specific framework, models from currently leading cellular agriculture countries should inform pathways for incentivization and funding mechanisms that leverage government support for private sector investment.

Taking the value proposition into account, the action plan should specifically include steps for:

- Substantial and sustained investment in cellular agriculture for dedicated research and development;
- Support for start-up creation and growth through pilot scale-up to commercial-level production;
- Building a talent development pipeline.

The action plan should ensure coordination of and access to essential and existing infrastructure. Upfront investment is necessary to help Canada catch up with other jurisdictions currently ahead in this sector.

Broad communication and outreach are integral to the success of a national strategy. This needs to occur in parallel with technology development to ensure widespread uptake of cellular agriculture products and optimal return on investment. Critical consideration is required to understand consumer perspectives and use for

appropriate messaging to reach various people across different demographics - from children to the elderly, as well as those facing food insecurity - to articulate benefits, address concerns, and overcome potential barriers early.

2. Establish a Clear and Transparent Regulatory Framework for Cellular Agriculture Products in Canada. Canada is encouraged to develop an agile, iterative, and innovative regulatory framework by building on existing processes. The framework should be informed as early as possible by engaging industry stakeholders and other experts with the relevant regulatory departments and agencies (e.g., AAFC, CFIA, Health Canada and Environment and Climate Change Canada), and including cellular agriculture subject matter experts within regulatory bodies. This will ensure that any new policies and regulations have expert input and consider the perspectives of both regulatory agencies and the ultimate end users, and would help simplify and strengthen the Canadian process. A timely, reasonably priced and predictable regulatory process, and a smooth and transparent evaluation process with high approval confidence, can be achieved through an iterative approach. Early engagement between regulators and companies also allows issues to be flagged and addressed promptly. This will be crucial to attract and retain cellular agriculture companies in Canada while ensuring the domestic industry remains globally competitive under Canada's rigorous regulatory process and food safety standards. This process can be further fostered through continuous, clear, and comprehensive communication between the industry and regulators, as well as broad dissemination of positive engagements and success stories. A delineated regulatory pathway that is aligned with the industry's needs has shown much success in Singapore, the most advanced jurisdiction in regard to approvals of cellular agriculture product offerings.

To aid companies in navigating the regulatory process, a government program that appoints industry liaisons or "concierges" could be established. This would particularly benefit start-ups and early-stage companies that are navigating the process for the first time. It is anticipated that, before seeking regulatory approval, standardized safety testing of cellular agriculture food products could provide confirmation of product composition, nutritional profile, and (lack of) toxicity profile. Consideration should be given to an expedited review of products that have already been "passed" by an accredited, external standardized test. As the global cellular agriculture industry grows and matures, Canada will need to ensure its cellular agriculture standards align with emerging international standards to maintain its reputation as a producer of safe, high-quality foods and not impede exports. Currently, this is an underdeveloped area, and being an early mover in standardized safety testing will allow Canada to have substantial input into international standards as they progress. Cross assessment of regulatory processes with other jurisdictions (e.g., Singapore, Australia and New Zealand) should be continued and expanded, as appropriate.

Early development of regulatory guidance for the labelling of these products is also essential for transparency and to empower consumers to make informed choices. Cellular agriculture product labelling should be descriptive, communicate the nature of the product in clear and relatable language, while maintaining appeal as a food item. Labelling should differentiate cellular agriculture products from those in the traditional protein market while creating a positive impression and ensuring both types of products are on a level playing field and competitive in consumer markets.

3. Provide Supporting Mechanisms for Research and Commercial Development. Incentivization, through both public and private investment and partnerships, and outcomes-driven networks, is critical for a thriving domestic cellular agriculture industry, with infrastructure support for R&D, training, company creation, scale-up, and growth leading to made-in-Canada product commercialization.

Research and training the next generation of skilled workers

Early government investment would catalyze invention, help de-risk opportunities, and attract private sector investment while incentivizing innovation and driving company creation and entrepreneurship within Canada. Funding could support:

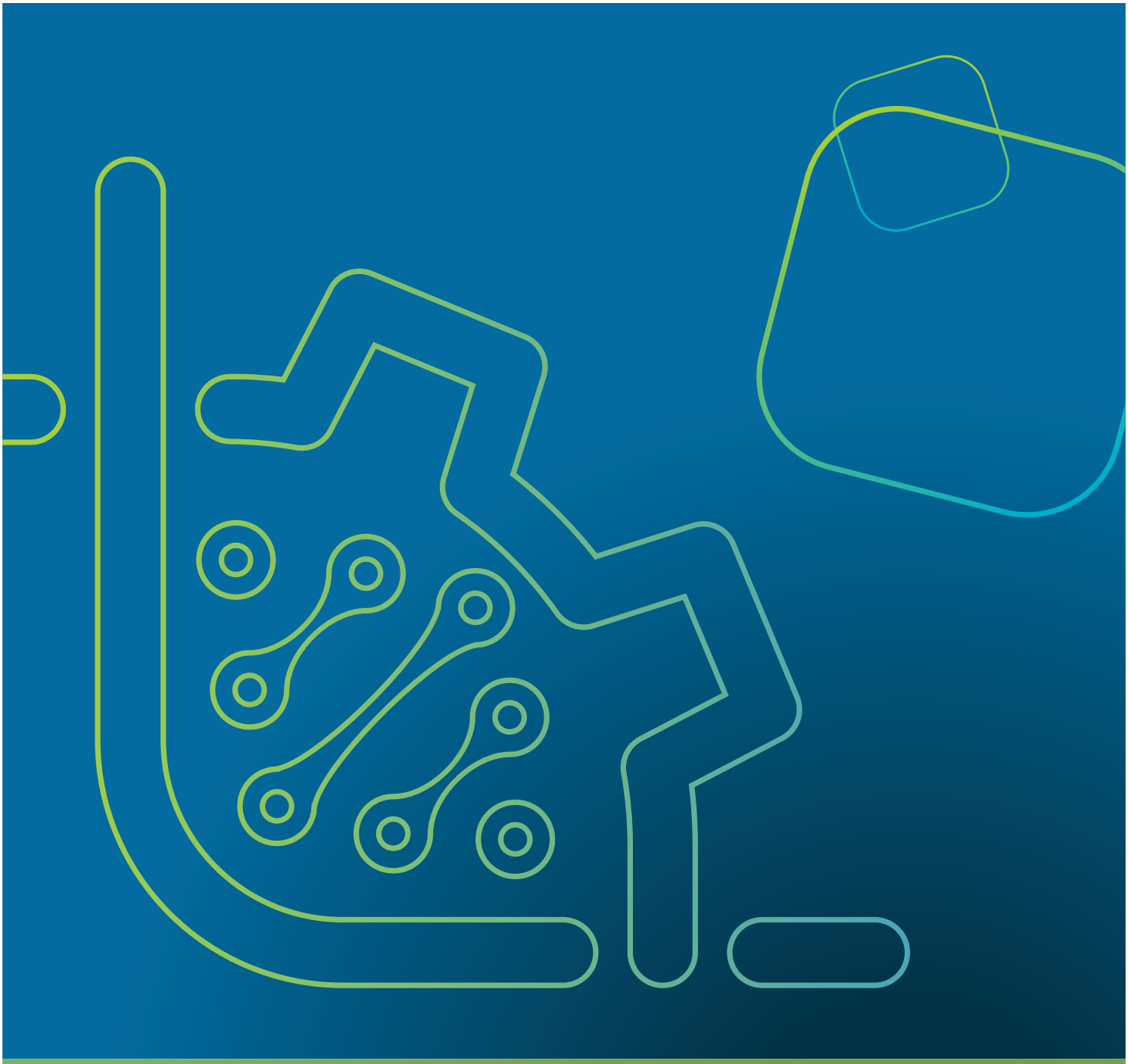
- Both fundamental and industry-driven research to ensure that the necessary and foundational tools and technologies are in place and that research is directed to industry needs.
- Open science to reduce redundancy and speed up product development.
- Alignment with strategic government focus areas or grand challenges, such as climate action, to encourage industry growth through sustainable practices and innovations.
- Key areas of multi, cross- and trans-disciplinary research (e.g., 'omics, engineering biology, AI, food sciences and others) for advancing cellular agriculture technologies that are also applicable to other business verticals (e.g., health, low carbon economy).
- LCAs, TEAs and other analyses that are objective and independent.
- Social sciences research playing a critical role in driving consumer engagement, addressing risk perception and public trust, and developing appropriate communication strategies.

New training programs that offer targeted and cross-disciplinary opportunities and industry placements related to cellular agriculture and engineering biology are critical. There are also opportunities to train and up-skill those with related expertise in other sectors. This would ensure that a domestic talent pipeline of skilled High-Quality Personnel (HQP) could fill the high-quality jobs that the cellular agriculture industry will create.

Growing the economy through start-up support, public private partnerships, and networks

Early start-ups require support in the form of lab space, facilities, and infrastructure, but also public and private seed funding for initial company growth. Canadian and international investors should be incentivized to invest in Canadian companies through clear and well-publicized government support for the industry. As seen in leading cellular agriculture jurisdictions, investment in public and private sector- partnered innovation hubs, including incubators and accelerators, can effectively support companies in their early stages. In addition to physical facilities, these hubs would need to include access to expertise, mentorship, and investment opportunities. While Canada has some capacity in Nova Scotia and New Brunswick, a lack of facilities for pilot/demonstration scale-up and at commercial scale is viewed as the most significant bottleneck globally, and is a primary reason for companies to leave Canada for other jurisdictions, such as the United States or Europe. The initial outlay to establish domestic scale-up capacity in localized ecosystems would be high, but fee-for-service operations could provide a global leadership opportunity to Canada, with potential to attract foreign companies. Such infrastructure can also be adaptable to serve different industries, such as to the production of vaccines in a health emergency or to bypass disruptions in the supply chain of critical materials to support a low carbon economy.

Supporting applied research and commercial development through industry and research collaboration is valuable to ensure the success of the domestic cellular agriculture industry. Partnerships between established companies and start-ups/academics (public-private partnerships) bridge the gap between research and translation, provide access to infrastructure, and create linkages and entry routes into the supply chain for B2B companies. The larger partner benefits from priority access to innovations, diversification and the creation of new product categories with strong market pull. Effective industry partnerships are vital to inform and drive policy and regulation and advocate with a common voice for a clear path to market for Canadian companies. On a larger scale, outcomes-driven networks are crucial to bringing together diverse stakeholders from industry, academia, government, and non-governmental organizations. Such networks should include diverse fields of multi-, cross-, and trans-disciplinary expertise and platforms and include regional, national, and international partnerships for interdisciplinary cross-pollination of ideas to breakdown silos between sectors and geographic regions and facilitate dialogue between disciplines. Network participants can benefit from and provide benefits to other sectors (e.g., health, low carbon economy) through knowledge exchange and parallel applications of novel technologies. These networks must include representation from the food production and conventional agriculture industries to foster mutually beneficial relationships, and transition or expansion to new food products market.



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Meeting #2 Activity #2 - Seed Identification

Do	Time: 20 minutes **Materials:** • Closed jars with a different type of seed in each jar – have a number on each jar • Paper and a writing utensil **Instructions:** • Have members number their paper for the number of jars in this activity • Have members try to identify the seeds in the jars and have them write down their answers
Reflect	**Learning Outcomes:** • To allow members to discover what the seeds look like that crops are grown from. • To initiate a discussion as to the traits of these crops and which traits could be improved upon through genomics.
Apply	**Prompting Prompts:** • Was it easy or hard to identify the seeds? Were some seeds harder than others to identify? • Are all the seeds in this activity able to be grown in your area? • Have you seen any of these seeds planted as a crop? Do you grow any of these seeds on your farm? • What traits do these crops have that could be improved by gene editing?

Meeting #2 Activity #3 - The Story of the Carbon Cycle

Activity Courtesy of AgScape

Do	Time: 20 minutes **Materials:** • The Story of the Carbon Cycle Worksheet (found on the next page) • Access to the Internet • Pen/pencil **Instructions:** • Have members watch the following video: TED-Ed: The Carbon Cycle – Nathaniel Manning: https://www.youtube.com/watch?v=A4cPmHGegKI&feature=youtu.be • Use images and words to create an artistic representation of how the carbon cycle works. Try to capture as many of the elements that contribute to the overall process as you can. Be sure to add in where agriculture fits into the cycle. • Discuss the Carbon Cycle with a partner or as a group and edit or add to your sketch as you share.
Reflect	**Learning Outcomes:** • To allow members to become more familiar the process of the carbon cycle.
Apply	**Prompting Prompts:** • Why is it important to know how the carbon cycle works? • Did anything in the video surprise you? • How does agriculture impact the carbon cycle and contribute to climate change? • How is agriculture impacted by climate change?

The Story of the Carbon Cycle

Watch "The Carbon Cycle" by Nathaniel Manning. Use images and words to create an artistic representation of how the carbon cycle works. Try to capture as many of the elements that contribute to the overall process as you can. Then discuss the Carbon Cycle with a partner and edit or add to your sketch as you share.

Meeting #2 Activity #4 - Design the Perfect Agriculture Crop

Do	Time: 20 minutes **Materials:** • List of traits (found on the next page) • Hat/bowl/bag • Paper • Writing utensil **Instructions:** • Print out list of traits. Cut into individual traits and put into a hat. • Have members choose three traits out of the hat. • Using those traits (and those traits only), they should draw and describe in words their 'perfect agricultural crop' and share with the others.
Reflect	**Learning Outcomes:** • To have members think about desirable traits in agricultural crops • To allow members to be creative when drawing and describing their crop • To continue to develop critical thinking skills
Apply	**Prompting Prompts:** • Why is it important to know which traits are desirable in agricultural crops? • Was it easy or difficult to create your perfect crop? • Did you like the traits that you picked from the hat? • Were there other traits you would have liked your animal to have?

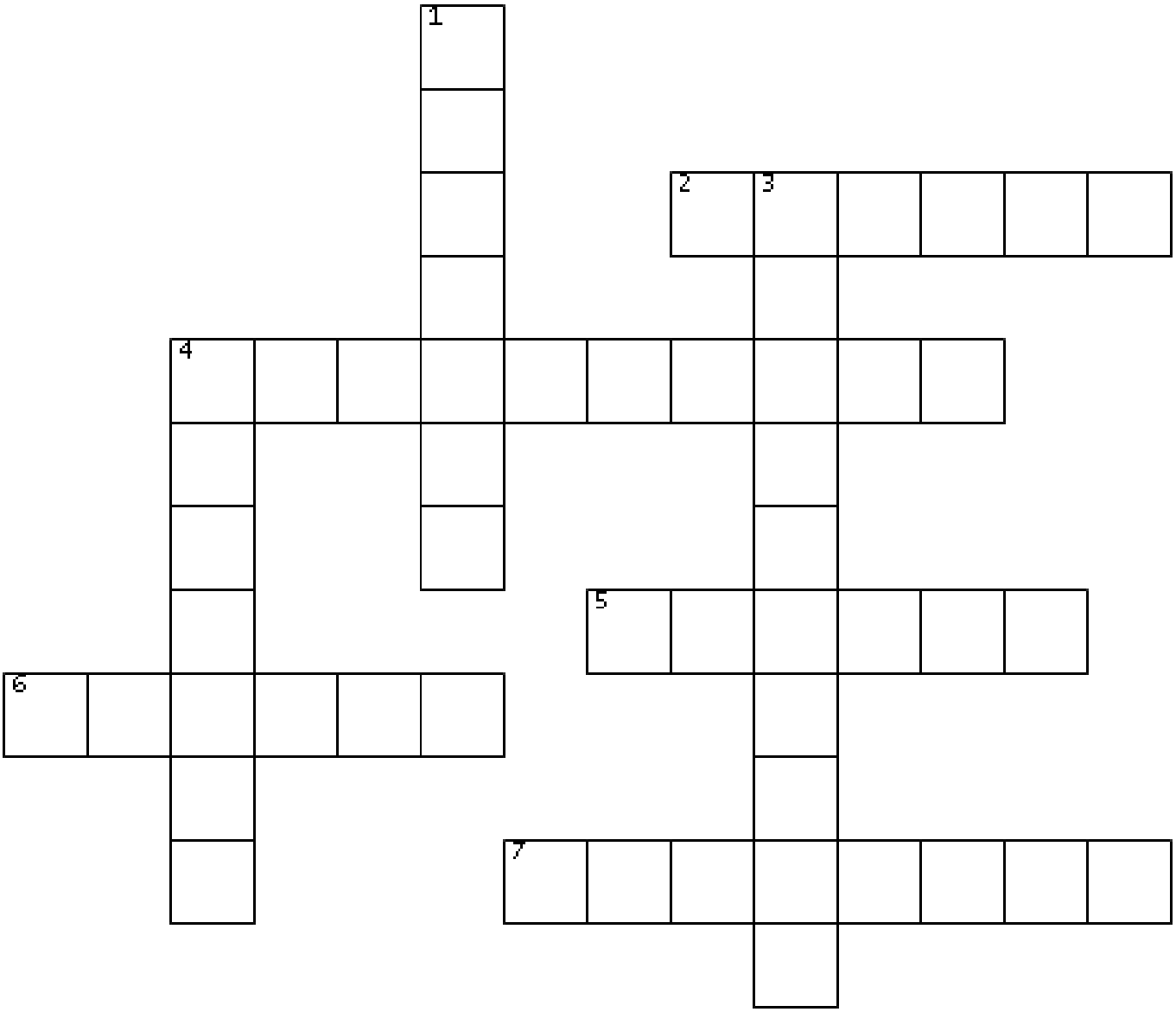
Agricultural Crop Traits

Disease resistant
High yielding
Drought tolerant
Produce larger seeds
High germination rate
High germination rate
Cold tolerant
High # of heat units required
Tall stalk
Self-pollinating
Pest resistant
High yielding

Meeting #3 Activity #1 - Precision Agriculture in the Field Crossword Puzzle

Do	Time: 20 minutes **Materials:** • Precision Agriculture in the Field Crossword Puzzle worksheet (found on the next page) • Paper and a writing utensil **Instructions:** • Have members complete the Precision Agriculture in the Field Crossword puzzle worksheet • Review the answers to ensure everyone was able to complete the puzzle
Reflect	**Learning Outcomes:** • To allow members to review terms/vocabulary covered in Meeting #4
Apply	**Processing Prompts:** • Did you have to review the meeting material to find the answers? Did you find this activity easy or hard? • Were there any answers that surprised you? • Do you understand the definitions of each answer in this puzzle?

Meeting #3 Activity #1 - Precision Agriculture in the Field Crossword Puzzle



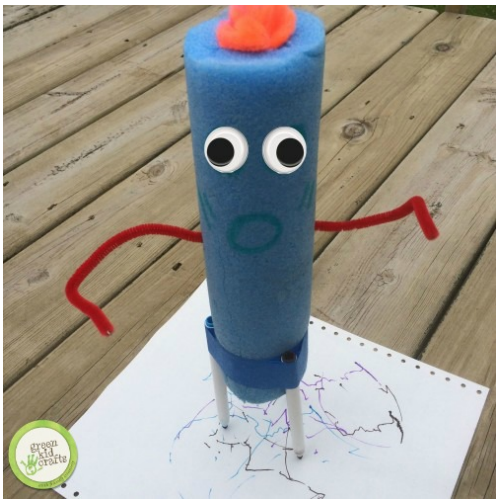
ACROSS

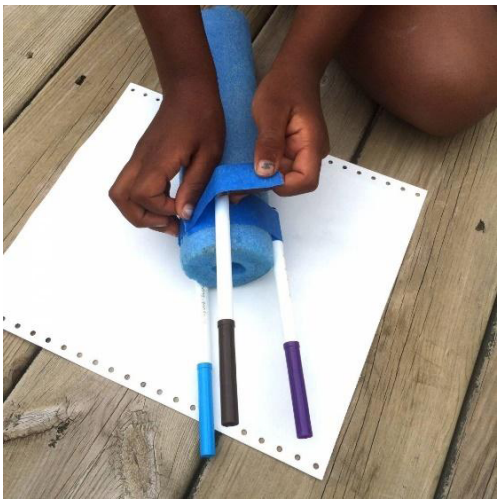
2. one of the largest costs of any farming operation
4. have the ability to detect certain wavelengths of electromagnetic emissions
5. a universal language at the service of precision agriculture
6. used for land mapping - the most advanced versions have infrared sensors and imagery systems
7. converts rotational motion in motors into linear or straight push/pull movements

DOWN

1. what an electric tractor runs on
3. another name for a driver-less vehicle
4. record data in real time relating to the health status of the crops

Meeting #3 Activity #2 - Build Your Own Noodle Bot





Do	Time: 30 minutes **Materials:** • Pool noodle •Electric toothbrush (found in some dollar stores) • Markers • Tape • Decorations Instructions: • Cut pool noodle to a length that is slightly larger than the toothbrush (about 2.5cm longer). • Insert toothbrush into pool noodle. • Tape each marker to the noodle to create a 3-legged stool. It may be easier to also wrap the tape around the whole noodle to capture the markers more securely. • Decorate the pool noodle. Be creative! Pipe cleaners for arms, pom poms for hair and adhesive google eyes can be used. • Place the Noodle-Bot on some paper and turn on the toothbrush. Watch the magic happen!
Reflect	**Learning Outcomes:** • To allow members to create a basic robot. • To have members realize that they can build a robot using basic supplies.
Apply	**Processing Prompts:** • Was it easy or hard to make the bot? • Are there any modifications you could make to the robot to make it do a different task? • Is there anything else besides an electric toothbrush you could use to power the bot? • How can robotics be applied to farm machinery?

Meeting #3 Activity #3 - Build an Eco-Bot Challenge!

Activity courtesy of the National 4-H Council
https://4-h.org/wp-content/uploads/2016/03/4H_ECO-BOT_FACILITATOR_GUIDE.pdf

Do	Time: 60 minutes **Materials:** • Manual toothbrush • 10mm pager vibrator with wires attached • 3 cm piece Scotch foam mounting double-side tape • 1 cm piece Scotch foam mounting double-side tape • LR44 1.5 volt button cell watch battery • Piece of 8.5 " x 11" copy paper • Piece of 8.5" x 11" cardstock • Scissors • Flexible straws (10) • 3 oz. paper cups (10) • One 27.5cm (11 inch) piece of masking tape • 2.5mL (tablespoon) of bird seed or rice •Timer **The Challenge!** Bailey Beach was the site of an unfortunate toxic spill and it is too hazardous for humans to clean. Your help is needed to establish a containment area to hold the toxic spill in place. Authorities are proposing that a special robot, called an Eco-bot, be used to solve this problem. Instructions: • Follow the instructions found on the Build an Eco-Bot pdf for Parts one, two and three of this activity (found at the end of this activity)
Reflect	**Learning Outcomes:** • To allow members to use STEM principles to build a robot that provides a solution to a societal problem • To create a robot that has real-life applications • To build a base of knowledge about robotics and the methodology used to create a solution to a problem
Apply	**Processing Prompts:** • After building the Eco-Bot, is there anything you would do differently next time? • Are there any different materials you could use to make the Eco-Bot work better? More efficiently? • Can you think of other tasks that the Eco-Bot could do? Other places the Eco-Bot could be used other than at a beach?

INTRODUCTION

Remind Youth of the Facts:

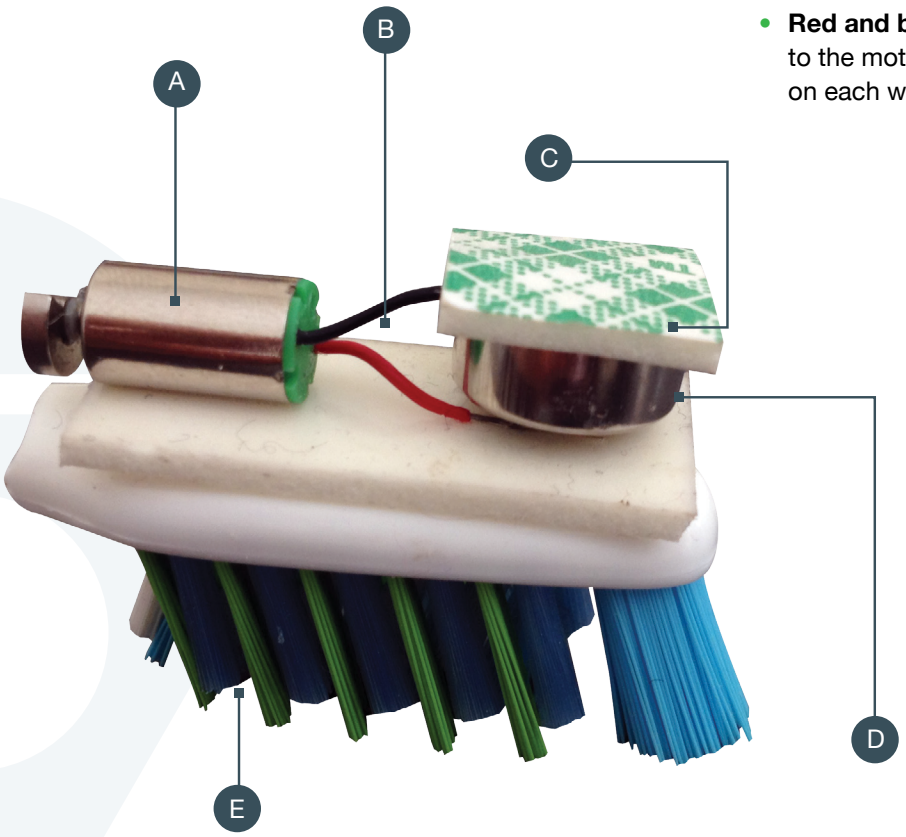
- Bailey Beach was the site of an unfortunate toxic spill and it is too hazardous for humans to clean.
- The EPA needs your help to establish a containment area to hold the toxic spill in place.
- They are proposing that a special robot, called an "Eco-Bot," be used to solve this problem.

As engineers who will program an Eco-Bot to clean a simulated environmental spill, it is important for participants to understand what an Eco-Bot is and what it can do.

Take the Lead: Know Your Parts

Using the Eco-Bot you built earlier, demonstrate how it works on a large table or open space on the floor. Explain that all Eco-Bots have the following parts, each one designed to perform a particular function:

- **Scrubber** – Also known as a toothbrush head, it will be used to "sweep up the spill"
- **Motor** – Controls the scrubber
- **Foam mounting tape** – Holds each of the parts in place
- **Watch battery** – Acts as the power source for the motor
- **Red and black wires** – Connect the power source to the motor (Note: For best results, the insulation on each wire should be stripped back to .5 cm)



Eco-Bot Assembly

A—Motor

B—Red and Black Wires

C—Foam Mounting Tape

D—Button Cell Battery

E—Scrubber

Understand How it Moves

A pager motor has an off-centered weight that unbalances the rotating part of the motor, causing it to vibrate. These vibrations pulse downward through the toothbrush's angled bristles, causing them to "push off" and move the Eco-Bot forward.

TALK ABOUT IT

How does the Eco-Bot work?

What parts are moving?

Which parts do you recognize?

Step 1: Bring Your 'Bot to Life.

Explain to the group that as robotic engineers, the first step is to build your Eco-Bot. Give each pair the supplies needed to build an Eco-Bot and explain how to put it together.

Eco-Bot Assembly

Remove the backing from one side of the 3 cm piece of foam tape and firmly stick it on the flat side of toothbrush head.

Remove the backing from the other side of the tape and gently push the motor on top of it with rotating part hanging off the back-end of toothbrush. This will allow the motor to spin without touching the tape. The wires should be positioned toward the head of the toothbrush.

Gently push the watch battery (+) side up onto the tape with the red wire underneath.

Turn the Eco-Bot on by pressing the black wire onto the battery with the 1 cm piece of foam on top.

Step 2: Observe What It Does.

Encourage participants to observe the action for 3-5 minutes and then ask everyone to turn off their Eco-Bots.

Explain that an Eco-Bot is an autonomous robot that is engineered to do only one thing — move forward. Its continuous forward movement is affected by touching the control surfaces. As the Eco-Bot encounters a control surface, it responds by turning, shifting position, or even falling over.

TALK ABOUT IT

What did you observe about how your Eco-Bot moves?

What problems did you encounter?

What controls the movements of your Eco-Bot?

What sort of tasks do you think the Eco-Bot could be used to accomplish?

LEADER NOTES

Establishing scientific habits of inquiry is essential, but requires practice and repetition. Make it fun, while promoting collaboration and communication within the group.

As the group works, be consistent in initiating discussions and encouraging them to ask questions.

Break from the activity regularly to give participants an opportunity to reflect on what they are doing, but keep the conversations short.

Good inquiry questions to ask include:

What happened when you _____?

Why did you choose to use that (technique, material, method)?

What would you do differently?

Part 2

THE GOAL IS CONTROL

Time Required: 30-45 minutes

OBJECTIVE

Working in pairs, use the engineering design process to create a set of control surfaces to optimize your Eco-Bot's performance in "sweeping up" the toxic spill on Bailey Beach.

MATERIALS YOU WILL NEED:

For each pair of participants you will need:
Challenge Mat for Bailey Beach

Suggested materials for testing environment:
Piece 8.5 x 11 in. copy paper

Piece 8.5 x 11 in. card stock

Scissors

(10) Flexible straws

(10) 3-oz paper cups

One 11 inch piece of masking tape

INTRODUCTION

In this experiment, we will create a "containment area" for the toxic spill. Control surfaces meant to contain the spill and direct the Eco-Bot are tested using straws, cardstock, and paper cups. The turning angles and the amount of friction and barriers that the Eco-Bot encounters are the variables participants can manipulate in programming the Eco-Bot to solve the simulated toxic spill challenge.

Take the Lead: The Role of Control

Before participants begin exploring how they might program their autonomous robot, initiate a conversation about control surfaces. Discuss what they are and what they can and cannot do.

Control Surfaces as Programming

All robots require programming or commands in order to complete tasks. One way that robots are programmed is through the use of control surfaces. **Control surfaces** are materials that restrict and redirect movements of a robot. They are a metaphor for the command structure of a computer program.

Autonomous robots have the ability to "sense" their environment (for example, through touch, sound, temperature or chemical changes). The robot's movement can be programmed by what it touches, hears or feels, and then adapt its behavior accordingly. The Eco-Bot is "programmed" through touch when it comes into contact with the control surfaces.

TALK ABOUT IT

How can we program our Eco-Bots to go where we want them to go?

What are the control surfaces that might be involved for a robot that is programmed to vacuum, mow the lawn or work in a factory?

How might autonomous robots work in toxic spill cleanup situations?

The Engineering Design Process in Action

Explain to the group they will apply the engineering design process to do a simulated environmental cleanup. Review the steps in the entire engineering design process BEFORE students begin to work.

LEADER NOTES

Consider using these tips to encourage successful inquiry:

Allow time after each of the engineering design process steps to allow for reflection, observation and questions.

There are no right or wrong ways to do things. Help participants see the choices they make and understand their reasons for making them.

Do not solve their problems or give explanations. Instead assist them by asking questions such as: What works? What doesn't? What have you tried and what happened? What has worked for other teams?

Step 1: Identify the Problem.

Show the group the Challenge Mat and revisit the details you presented earlier about the toxic spill on Bailey Beach.

TALK ABOUT IT

Where is the spill?

Why is it important to contain it?

What control surfaces will you use to program your Eco-Bot to cover the spill area?

What challenges do you have in containing the spill?

Step 2: Generate Ideas.

Encourage the pairs to brainstorm ideas for how to control the movement of their Eco-Bot by introducing control surfaces using straws, cardstock, and cups. This is an opportunity to test ideas using the materials, as time permits. Provide a few questions to help stimulate brainstorming:

TALK ABOUT IT

How can I "program" my Eco-Bot so that its movements will cover the entire area of the spill within the containment area?

Imagine what kinds of control surfaces you will design in order to program the Eco-Bot to cover this entire spill area.

How do the different materials affect the movement of the Eco-Bot?

Step 3: Evaluate and Compare Possible Solutions.

Ask each pair to choose their best ideas and create a plan for cleaning up the spill. Walk around and offer assistance and encouragement as each pair designs their plans.

Step 4: Build a Prototype.

Once they have sketched a drawing of their plan and you have approved it, give them a Challenge Mat, straws, cardstock, cups, a pair of scissors and a 11 inch piece of masking tape so that they can build their prototype. Remind them they can only use the materials they have been given.

Step 5: Test the Prototype.

Let the sweeping begin! Working in pairs, participants will determine how effective their materials are as control surfaces for their Eco-Bot. Place the Eco-Bot into the containment area and allow participants to observe the movements of the Eco-Bot and evaluate the success of their design.

LEADER NOTES

This is a good time to take photos of each pair of participants and capture their "solution" to the challenge.

Give each group 10 minutes to experiment. Remind them that they will have a chance to refine the design later in the engineering design process. Discuss the exercise as a group, recording any key observations and/or questions on a flip chart.

Step 6: Tell Your Story.

When it appears that most groups have built and tested a prototype, take a break. Gather everyone together to discuss their experiences and share their best ideas.

TALK ABOUT IT

How did you use the materials to create control surfaces?

What challenges did you experience?

What other materials would you like to try?

What questions do you have?

LEADER NOTES

Invite each pair or team to contribute their "best idea" and write it on a piece of newsprint. Encourage them to incorporate the ideas they like into their own designs.

Examples might include:
Use two straws to create higher walls so the Eco-Bot cannot "jump" over.

Create tunnels or mazes with cardstock.

Divide the containment area in two parts and use two Eco-Bots to sweep simultaneously.

Step 7: Refine your Design.

Using the design process, ask a new question like: How can we make our Eco-Bot move more efficiently over the toxic spill? Explain that the engineering design process is like a circle. It repeats over and over as you work to refine and make adjustments to solve a problem.

TALK ABOUT IT

How well does your design work?

What problem would you like to fix?

What could you do to improve the cleanup ability of your Eco-Bot?

Part 3

MAKE A CLEAN SWEEP

Time Required: 45-60 minutes

OBJECTIVE

How effective is your Eco-Bot? Can it clean up the toxic spill? Working in pairs, measure how much of the spill is "swept" by the Eco-Bots.

MATERIALS YOU WILL NEED:

Challenge Mat with control surface in place

(1) tablespoon of bird seed or rice

(2) Eco-Bots

Timer

Masking tape

Calculator (for calculating percentages)

LEADER NOTE

When youth have finished experimenting, consider the environment. Feed the birds your leftover birdseed or dump the rice in a compost pile.

INTRODUCTION

The Challenge Mat and Eco-Bot robot serve as **models** that are meant to show the appearance of something, and to help youth to understand the potential for using autonomous robots to cleanup a real spill.

Take the Lead

Participants will use birdseed to represent the toxic spill. When the Eco-Bot "sweeps" it out of the way, it can be assumed the spill has been "cleaned." The grid on the Challenge Mat will allow participants to use a ratio to measure the amount of spill that has been cleaned.

In this experiment, the only independent variable is the control surface. It can be manipulated to influence the robot's performance. The remaining variables are fixed variables that cannot be manipulated. In this way, as in real scientific experiments, participants will change only one variable at a time and compare the outcome.

Step 1: Set Up the Simulation.

Encourage participants to work in pairs and set up their testing area:

1. *Tape the Challenge Mat to a table or a flat surface.*
2. *Add one tablespoon of birdseed to the containment area within the control surfaces you created. Spread it evenly over each spot.*
3. *Decide who will be the **Eco-Bot Analyst** (the person who operates the timer and serves as the recorder) and who will be the **Eco-Bot Engineer** (the person who can "touch" and monitor the Eco-Bot).*
4. *Review the Rules for the Eco-Bot Engineer.*

Rules for the Eco-Bot Engineer

1. Only one team member can be an Eco-Bot Engineer.
2. If the Eco-Bot falls over, you must wait 3 seconds to pick it back up.
3. If the Eco-Bot gets stuck, you must wait 3 seconds to tap it or move it.
4. If the Eco-Bot leaves the containment area, you must wait 3 seconds to put it back.
5. You may only touch your Eco-Bot a total of 5 times during the 2-minute challenge.

LEADER NOTES

Explain that in this simulation, "touches" are considered "malfunctions." Discuss what these malfunctions might mean in a real-world situation:

An out-of-control robot

A timing delay

A need for human intervention

Extra costs

Discuss why a robot that experienced no malfunctions and cleaned 80% of the spill area might be a better prototype than a robot that cleaned 90% of the spill area but had three malfunctions. This could be viewed as a trade-off in reliability versus capacity.

Step 2: Start Your Eco-Bot!

Invite participants to begin testing their Eco-Bot:

1. *Place the Eco-Bot at any location on the Challenge Mat.*
2. *Set the timer for 2 minutes.*
3. *Turn on the Eco-Bot and start the timer.*
4. *Observe the movement of the Eco-Bot and follow the rules if it falls over, gets stuck or leaves the containment area.*
5. *Remove the Eco-Bot at the end of 2 minutes.*

Step 3: Measure Your Eco-Bot's Effectiveness

1. *Instruct participants to collect their data:*
2. *Count the number of times the Eco-Bot Engineer touches the Eco-Bot.*
3. *Count the number of black spaces that are "swept" or completely clear of the contaminant.*
4. *Use the following ratio to calculate the amount of the spill that was cleaned. This will give a percentage (a fraction or ratio with 100 as the understood denominator) that expresses the effectiveness of the Eco-Bot.*

LEADER NOTES

Expect some question or debate as to what is considered a "swept" space. Establish your own rules for determining swept spaces or use the following:

If a space is about half-swept, count 2 half-swept spaces as one.

If there is only a small portion of a space is swept, don't count it.

If a space is mostly swept, count it as one.

$$\frac{X}{125} \text{ (x) } 100 = \_\_\_\_\_\% \text{ of effectiveness}$$

- X = number of black spaces free from birdseed after 2 minutes.
- 125 = approximate number of spaces that are in the containment area.

Step 4: Repeat, Repeat.

Ask participants to repeat the Steps 1-3 two more times. Encourage participants to switch roles, allowing everyone the opportunity to be an Eco-Bot Analyst and an Eco-Bot Engineer.

Step 5: Average It Out.

Compute the average of the percentages and the number of malfunctions.

Step 6: Share the Results.

Test 1 _____% + Test 3 _____%	Test 2 + _____% divided by 3 = _____%

Collect the results from all of the pairs or groups and calculate an average group percentage.

TALK ABOUT IT

Discuss the amount of "touches":

How do these touches represent malfunctions?

Were the touches necessary due to the design of the robot? Or the control surface?

How could you reduce the amount of touches/ malfunctions?

Examine the most successful designs. What do they have in common?

Collect ideas for next steps. What other tests could be done?

LEADER NOTES

If you plan to do the Experiment Extension (page 20), now would an appropriate time to introduce the exercise.

Step 7: Review Your Performance

Encourage participants to share what they observed, what they learned and what they would do differently. This is also a great time to revisit the various lists and brainstorming the group created at earlier stages in the experiment. Discuss and explore how their thinking and understanding of robots has changed and evolved throughout the process.

TALK ABOUT IT

What changes would you make to your control surfaces?

What characteristics/abilities does an autonomous robot need in order to complete a task like this one?

In what ways in this a realistic simulation? What makes it unrealistic?

How did the engineering design process help you when completing this challenge?

What role did you play during this activity that was particularly interesting to you? How could this be related to a future career or area of interest?

INTRODUCTION

Meeting #4 Activity #1 - Creating DNA

Do

Time: 20 minutes

DNA is an abbreviation which stands for deoxyribonucleic acid. DNA is present in all living things. Also, the structure of the DNA molecule is the same in all living things. When isolated from a cell and stretched out, DNA looks like a twisted ladder (double-helix). The sides of the DNA ladder are called the backbone and the rungs of the ladder are pairs of small chemicals called cases.

There are 4 chemical bases in DNA:
Adenine (A)
Thymine (T)
Guanine (G)
Cytosine (C)

A always binds with T and G always with C.

Materials Needed:
Strands of licorice
Colouring mini marshmallows (for a healthier alternative, use fruit)
Toothpicks
DNA code (found on the next page)

Instructions:
Using the code on the page following this activity, create one DNA strand by attaching the marshmallows with a toothpick to one licorice piece using the DNA code given on the next page (place toothpicks into the licorice, then push the marshmallow onto the toothpick close to the licorice, leaving enough room for the second matching DNA strand to be attached).
Add the matching base pairs.
Complete the DNA model by attaching the other backbone (licorice) so the model looks like a ladder.
Carefully twist the DNA model so that it looks like a double helix.

Reflect

Learning Outcomes:
To allow members to become familiar with how DNA is structured

Apply

Processing Prompts:
• Why is it important to know what the structure of DNA looks like and how it functions?
• Was it hard to create the DNA strand?
• How does DNA fit with the study of genomics?

DNA Challenge!

Create the following DNA strand:

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

Remember!

A always binds with T, and G with C

Guanine (G) = Green

Cytosine (C) = Pink

Adenine (A) = Yellow

Thymine (T) = Orange

Meeting #4 Activity #2 - Thoughts and Pressures Affecting Technology Development

Do	Time: 20 minutes **Materials Needed:** • Paper and a writing utensil for making notes **Instructions:** • Have members read the following: *For years, our understanding of genetics has been used to improve agricultural practices and food production. Conventional plant and livestock breeding have shaped many of the food products we enjoy today. More recent advances in biotechnology are allowing us to address agricultural issues that were inconceivable with standard genetic technologies. One such advancement is the development of gene-editing technologies that may be used to improve the welfare of farm animals, potentially benefiting farmers and broader. However, people have also expressed concern about the use of biotechnology in food production. This concern — as well as supply chain constraints — can lead to resistance to adopting these technologies by producers, processors, retailers, food service, and other supply chain stakeholders. Research is ongoing to focus on an understanding of perception, trust and adoption among all interested groups from farmers to consumers.* *The introduction of genetically modified foods was largely met with mistrust and skepticism. We must therefore ask: What factors affect societal acceptance of these technologies?* *Taken from GenomeCanada: https://www.genomecanada.ca/en/barriers-and-opportunities-commercialization-gene-edited-beef-and-dairy-products* • Have members work in small groups to come up with a list of factors that will help society accept new genetic technologies • Have each group present their list • If time permits, divide the group in two. Have one group debate why all genetic technologies should be accepted by society with the other group takes the stance that genetic technologies should not be trusted or accepted
Reflect	**Learning Outcomes:** • To have members realize that not all new genetic technologies will be readily accepted by society. • To have members critically think about factors that will help society to accept new genetic technologies.
Apply	**Processing Prompts:** • Was it easy or difficult to come up with a list of factors? • Are you surprised that some new genetic technologies are not readily accepted by society? Why are you surprised? • Can you think of a new technology that was never accepted by society and was never developed any further? • Was it difficult to defend the side you were on for the debate?

Meeting #4 Activity #3 - Design the Perfect Livestock Breed

Do	Time: 20 minutes **Materials Needed:** • List of traits (found on the next page) • Hat/bowl/bag • Paper • Writing utensil **Instructions:** • Print out list of traits. Cut into individual traits and put into a hat. • Have members choose three traits out of the hat. • Using those traits (and those traits only), they should draw and describe in words their 'perfect livestock animal' and share with the others.
Reflect	**Learning Outcomes:** • To have members think about desirable traits in livestock animals • To allow members to be creative when drawing and describing their perfect animal • To continue to develop critical thinking skills
Apply	**Processing Prompts:** • Why is it important to know which traits are desirable in livestock? • Was it easy or difficult to create your perfect livestock animal? • Did you like the traits that you picked from the hat? • Were there other traits you would have liked your animal to have?

Livestock Traits

Good mothering ability
High milk production
Nutritionally efficient
Ease of birthing
Efficient rate of gain
Disease resistant
Structurally sound
Longevity of life
Tall stalk
Protective of offspring
Short gestation/multiple births per year
Produces low rate of methane
Good fertility
Calm and docile temperament
Good muscle growth

Meeting #5 Activity #1 - Breakthrough Technologies

Do	Time: 30 minutes **Materials:** • Breakthrough Technologies document (found on the next page) **Instructions:** • Have members read through the list of breakthrough technologies. • Have each member (or have members work in groups) choose at least two breakthroughs listed and research online to see if there has been any progress on the technology. • Have members present their findings to the group.
Reflect	**Learning Outcomes:** • To allow members to see what emerging technologies are being introduced to the agricultural industry. • To allow members to think critically about the technologies presented and the implications these technologies will have for agriculture.
Apply	**Processing Prompts:** • Were you surprised by any of the information you found about the progress/update of the technology? • Do any of the technologies seem too far-fetched to work in the agriculture industry? Seem impractical? • How do you think these technologies might change the way farmers operate their farms? • Can you think of other applications for the technology listed? Any other industries that could make use of this technology?

Breakthrough Technologies That Support Sustainable, Efficient Livestock Industry

As consumers continue to demand better animal welfare and improved sustainability across the livestock sector, new innovations are emerging that enable producers to monitor herd health in real time, prevent disease outbreaks, and optimize nutrition. Thirteen of these breakthrough technologies were spotlighted at the Animal AgTech Innovation Summit in San Francisco on March 16, 2020. Solutions ranged from a nonantibiotic treatment for bovine mastitis to autonomous livestock monitoring.

The Start-Ups

Armenta (Israel). This company has developed the first nonantibiotic treatment for bovine mastitis using acoustic pulse technology (APT). Mastitis causes annual losses of over $6 billion in the U.S. and Europe. Infected cows treated with APT have shown 70% cure rates and consequently 10% increase in milk yield.

BinSentry (Canada). An agricultural IoT company, this start-up is solving a 40-year-old problem in the animal feed industry – reliable inventory monitoring of on-farm feed bins. BinSentry's IoT sensor enables feedmills and vertical integrators to realize significant cost savings by enabling dramatic increases in operational efficiency.

CattleEye (Ireland). This start-up has created the world's first autonomous livestock monitoring platform, which will improve the lives of farmers as well as their livestock. Its deep learning AI platform is designed to interpret visual imagery of livestock from web cameras and extract valuable insights about those cows.

FarrPro (USA). This start-up was founded to change the way the world rears pork. Its Haven platform reduces piglet mortality, saves energy, and improves sow welfare by creating a microclimate environment for piglets to stay safe, warm, and healthy. The platform is the first step in the company's roadmap to bring traceability and automation to the pork industry and provide the insight and control required to prevent disease outbreaks, rapidly develop vaccines, and safeguard the pork supply chain.

General Probiotics (USA). This company is developing innovative cellbots and antimicrobial probiotics that eliminate harmful pathogens in livestock, enable the production of safe food, and reduce the current dependency on antibiotics. Its core competency is the precise engineering of advanced probiotics using synthetic biology and artificial intelligence.

H2OAlert (The Netherlands). This start-up has created the first uniquely wireless IoT real-time water control management system for dairy and beef cattle. The quality and quantity of the cattle drinking water is checked in real time, 24/7, for pollution and possible malfunctions in the water supply. In this way, the H2OAlert system and the data obtained will result in a direct contribution to animal welfare plus milk and meat production.

Hencol (Sweden). In order to give producers an optimized decision support system, this company is developing the next level of precision livestock farming with its big data and AI algorithms. Hencol enables digitalization of the entire value chain with significant benefits for all.

Jaguza Tech (Uganda). This company has developed an offline and cloud-IoT-based livestock management system, which features animal healthcare monitoring and recordings of IoT sensors, farm management systems, and animal livestock identification as well as utilizing animal smart tags and QR code readings via wireless technologies.

Moonsyst (Hungary). The smart monitoring system this start-up has created for progressive dairy and beef producers collects different parameters of livestock. This real-time data helps producers increase productivity and detect disease, stress, and heat.

Nextbiotics (USA). This company's goal is to leverage cutting-edge synthetic biology tools and bacteriophage technology to provide unique solutions to the antibiotic resistance crisis. It offers solutions to destroy pathogenic (bad) bacteria. Its first product is a feed additive for animal producers to enhance animal nutrition and significantly reduce the use of antibiotics.

Roper (USA). This start-up is revolutionizing beef production with a solar-powered, GPS ear tag and companion mobile app. Roper's technology provides geolocation and health monitoring of cattle in a pasture, which enables producers to cut management time by 30% and maximize fertility and nutrition, sustainably manage grazing, and pinpoint sick or distressed cattle.

Simple Ag Solutions (USA). A B2B, software-as-a-service company, this start-up is bridging the gap between animal health and production. Its platform was developed for livestock and poultry producers to help manage antibiotic use, optimize production, and facilitate audits.

Source: https://www.agriculture.com/news/livestock/13-breakthrough-technologies-support-sustainable-efficient-livestock-industry

Meeting #5 Activity #2 - Technology in the Barn Wordsearch

Do	Time: 20 minutes **Materials:** • Technology in the Barn Wordsearch (found on the next page) • Paper and a writing utensil **Instructions:** • Have members find the words listed in the wordsearch. • Discuss what each technology listed is and which type of livestock barn/pasture it might be found in.
Reflect	**Learning Outcomes:** • To allow members to discover and review various types of technology found in livestock barns and pasture.
Apply	**Processing Prompts:** • Did you recognize each piece of technology listed and which livestock barn/pasture it can be used in? • Have you seen any of these types of technology in use? • Are there other industries that could use this type of technology? • Are there ways this technology could be adapted for other uses besides its original use?

Meeting #5 Activity #2 - Technology in the Barn Wordsearch

c b s a y l b p e y c v u k l a t e s y j e s q d l s c q b f x v m f e k w w v
o r y u g y r b v p a i c i t a m o t u a a f g h l a c h i w w x p t c u p c t
z e e t o t j h e q t d a d x o n c r j c z f f p b a d j i f s e z o p w s h w
y x k o l k b m t f t e c v d a p n g n r b w g i x f o q e c k l t u e c j b d
h p r n o v u z g w l o h e a l t h o i i t o u o c h a k r b k s k s b x y x z
a p u o n k g c x z e k d o h e i j q j w h p u l b i q u g z e e u c k b q k p
z y t m h n q k i z a k z x q z p t b f n a i s m i q e x r v o r n g r q f e e
c b j o c o y m z c d o m r q u n n o f h i b t w c t z n i s o j e s l m a e h
m a h u e i y c s j y b z s h q c m b j j m c o b j b p l c b c d a s y o x z w
o q c s t s i i z r z u u b k e l k x r n y r b t m i s o o y t k a y d w l i o
f e u n t i y t z j x s n o i t a v o n n i e l c g u v t u d t e f e n a l q s
d f j n c c s e y r t r u u k s s n v m j u i l s x z i k g t w s s o c w r g w
t i v k e e y c g a a m w w j m b n x d d g f e c v c b a i t l a e e c r w a p
f t f g b r r h i y c c p u o z g w a j o n r c i m z k n p l y g g f c y u c v
o k e g f p p n w s y h r g m o i a y n u p u a y h j u q j k w i i s o m w y o
y w s k e g a i v r t q n c u s r m k s y k s p d v t i l i f f k p o v e e a m
b p u f k b u c y p k a k c f z r y h u e a a s l p m r w d y r e u a q j h p n
w r f k i l g i s a x p o d d n w i k j r c i r s b f r x t n r o d k u i d m z
x h n l g i m a o h n z m g a r u e e d g n w m c e l v n y u r k k f s r d o l
e f i m s n y n u o v v f w h r t y w q q v d m d w n c g t s a c d d f b v y r
m t a i c h u w g q q a e r o w y s r o s n e s i l l o a l e k l k b g y x t c
y w i y u g i t a n h h b u t z k d k j v w y u y q b r r n q u l a v v c l j e
m r g o c t h d r d i g i t a l i z a t i o n y v l e b g d o l q w r x n a p y
w e e v p e e h s i e r m g i h o j b q q d s k k p o i r o a t o s r m s g h l
s d l g w j i e b c t w o e j q b y n u r w e g m w n o y v l y z l n c s u p n
s s z r a l b z b u q i e t d y l h b h n c t e h e l j u w x p s t o c y z f m
l o f a o m b s t k s o o a i c l c x s a g t a e a c r o n e e d i o h b x h w
w l n s t l i b o e c c k n h n j f y z l x p r u w w i a q a t m x w f d w a f
w f a v e h l j w j v s g n e p o o w h k a v t x k p d t x d g l g e z e l f d
j f e y b p i q n k e u a g e u u m r x w r r x v u a z a i z y c q d m m p o e
y w o k q b y p p t x r h y b f b n t u v i t v w s g u p b c m l e p x i v v v
c h d t t w z n z a n g f u v s l c r i v e u f a l f a q e n r w v r z b f d r
z r j x m o u t t y l e d t b e i u g o c o u z i d p r m e b w u c z j a k j d
y e s o j m d q r h g z d w r v q v p p u s n b v b e l o k g z z c p p y v v d
x w f t a i d i a z u l g a o c p d h s v d x d n o b r a a u w w m s u v p z d
e n v i r o n m e n t g o v l x c y i i g h t z h m u g p j x p y h i a m i u a
y u t a j v f p r h c m p g p w a g i d w i r u m p a u h l w a d s s o x j e m
x g z l u o m m l u z r n l x n u o p r f u g p e x i q t f k s v x e w j d y l
t a z v o y a i g p a r e e r y z s g m z y h g o u x c s w n k c m k u e u j i
f p i d g u j q r d u e u i f a u w q u z e w h t e s r r t o p w l q h y i k a

alarms automatic autonomous cattle cellbots

chickens digitalization drones efficiency engineer

environment goats health imagery innovation

livestock monitoring nutrition pigs precision

robotic sensors sheep sustainability technician

technology temperature turkeys video virtual

Meeting #5 Activity #3 - Design Your Own Barn

Activity courtesy of AgScape

Do	Time: 40 to 60 minutes **Materials:** • Computer/online device with access to the Internet **Instructions:** • Have members set up their TinkerCAD account: https://www.tinkercad.com/. Then have them visit https://www.tinkercad.com/learn/ designs to explore the program and learn the basic design functions before moving on to the activity. • Members should then design barn or feedlot in TinkerCAD (or an equivalent coding/building program or using hand-held manipulatives) incorporating at least one technology mentioned in this meeting. Consider spacing, ventilation, access to the outdoors/fresh air (if its an option depending on the type of livestock), safety, food and water access and other points that are important for animal welfare. • Members are to create a presentation to highlight the barn they have created. • In addition to the barn design, have members visit https://www.agcareers.com/career-profiles/ to explore careers related to the farm/barn style they've created. The presentation should include a minimum of 5 key careers that are related to the specific animal health and welfare-related elements included in the barn design. • All of the research is to be put together in a short presentation to share with the group. Various forms of media (audio/visual/video) could be used in the presentation.
Reflect	**Learning Outcomes:** • To allow members to become familiar with the software used in designing barns (and other structures). • To have members use critical thinking skills to decide which elements need to be included in their barn design. • To discover careers related to the barn/type of livestock that was designed.
Apply	**Processing Prompts:** • Was it easy or hard to learn a new computer program? • Were you able to design your barn the way you wanted or did the computer program have limitations? • Now that you have your barn designed, are there any changes you would like to make? • After seeing designs from other members in the club, are there any changes you would like to make to your design? • Did any of the careers you heard in relation to each barn that was designed surprise you? • Are there any careers you want to find out more information about?

Meeting #6 Activity #1 - Find Your Purpose-Driven Career (Careers in Agriculture & Food)

Do	Time: 20 minutes **Materials:** • Computer/table/device and access to the Internet **Instructions:** • Visit the thinkAG website: https://thinkag.ca/en-ca/ • Follow through the steps listed on the home page for the careers quiz, exploring agriculture and food careers, learning about careers in Canada's food supply chain and viewing scholarship and post-secondary opportunities that are available.
Reflect	**Learning Outcomes:** • To assist members in discovering their career interests and talents. • To allow members to think about a career they not have previously considered.
Apply	**Processing Prompts:** • Did the results of the careers quiz surprise you? • Are you thinking of a career that you may not have previously considered? • Where are skills needed in Canada's food supply system? • Is there more information you would like to research about certain career paths?

Meeting #6 Activity #2 - Food Packaging Design Challenge

Do	Time: 30 minutes **Materials:** • Computer with access to the Internet or craft supplies **Instructions:** • Have members work in small groups to create a food package design for a new kind of homemade-style soup. Have members keep the following in mind while creating the packaging: ◊ Environmentally friendly/biodegradable ◊ Consumer/eye appeal ◊ Messaging on the packaging (nutrition, where it's made, etc.) ◊ Suitability to the type of food being sold ◊ Ease of opening the packaging ◊ Food safety concerns *Alternate activity* – have each small group choose a different type of food to design a package for.
Reflect	**Learning Outcomes:** • To allow members to be creative while also keeping many other factors in mind when designing packaging for food.
Apply	**Processing Prompts:** • Were you able to consider all factors when designing the packaging? • Is the packaging practical for the type of food it's designed for? • Would the packaging you designed be easy to produce in mass quantities? • Is the packaging environmentally friendly? • Is there a way to make the packaging tell you if the food inside is safe to eat?