Turning Over a New Leaf

N°.32

SENIOR

Science

LESSON SUMMARY

Students will be introduced to forest biotechnology and will evaluate biotechnology activities, based on a set of criteria that they will establish.

FORESTS ONTARIO

Focus on Forests

Activity Information

Estimated Duration: Three class periods (one for introduction and small group organization/ discussion; two periods for group presentations; homework as required for technical research)

Materials: *Funding Panel Assessment Chart, Biotechnology Evaluation Criteria List*

Setting: Indoors

Key Vocabulary: Biotechnology, genetically modified organism, genetic engineering

Teacher Background

Simply explained, biotechnology refers to the technology that uses organisms (e.g. plants, animals, fungi, bacteria) to provide products and services. Research is being conducted in Canada on trees with specific desired characteristics (e.g. new resistance to diseases or different infestations of insects). Environmentally sound pest control is also being examined, using viruses that occur naturally, but can attack specific pests. As well, significant research is underway to better understand the environmental impact of genetically modified trees and biological control products. The introduction of biotechnology derived trees or biological control products into the forest ecosystem must be carried out in an environmentally responsible manner. The potential always exists for these organisms to upset a natural balance. The Canadian Forest Service (CFS) works to ensure the safety of Canada's environment through research, regulations and legislation.

The CFS subjects its research to in-depth laboratory testing, followed by extensive greenhouse and field trials. CFS labs across the country research and document biotechnology applications to improve forest regeneration and protection. Some of the research presently underway involves the following:

- **Genetically modified trees –** trees which have been altered by adding or removing one or more specific genes, resulting in new gene combinations. These "transgenic" trees are engineered to: increase resistance to pests and diseases; improve the quality and variety of harvestable timber; improve timber growth and yield; etc. The CFS is also researching transgenic trees that cannot reproduce and therefore cannot change the existing gene pool.
- **Conifer somatic embryogenesis –** technology developed for cloning plants using tissue culture. This process can produce an unlimited number of genetically identical plants from a single seed. Cloned trees can be fast growing, more productive or pest resistant. The potential to increase productivity in commercial forestry operations may reduce the need to harvest the existing natural forest. This, in turn, would allow more forests to be set aside for protected and natural areas.
- **Genetically modified baculoviruses –** naturally occurring viruses, modified to accelerate their actions. This means that the virus will work faster to disable a specific insect (e.g. the spruce budworm), resulting in less damage to tree foliage. These viruses can become alternatives to chemical or other biological approaches to controlling forest pests. As they are naturally occurring, these viruses do not affect other insects, birds, fish, mammals or humans.
- **Environmental impact assessments of forest biotechnology –** a way to evaluate potential adverse impacts of biotechnology processes or products before they are introduced into the environment, as well as to determine if any impacts occur afterwards. Examples might be: gene escape from genetically modified trees to other organisms (e.g. the release of DNA into the soil from tree roots and fallen leaves); insects developing resistance to biocontrol products.

Photocopy the *Funding Panel Assessment Chart* – one master copy, plus one copy per panel member (see Step 3) and the *Biotechnology Evaluation Criteria List*.

ACTIVITY

Step 1 Begin the lesson with a general discussion of biotechnology. Ask your students to describe the meaning of biotechnology, then brainstorm for examples. Students may be familiar with Dolly, the cloned sheep, or the cloning research underway in Quebec. You may consider exploring topics such as: the use of stem cells for human therapy; the ethics of cloning; bioterrorism.

Focus your discussion on plant biotechnology. Introduce the research being done by the Canadian Forest Service (CFS) on genetically modified (transgenic) trees, as well as genetically modified baculoviruses. Explore the importance of introducing biotechnology derived trees or biological pest control products into a forest ecosystem in an environmentally responsible manner.

Step 2 Ask your students to consider these questions: How do you evaluate biotechnology activities? What criteria would you use to determine whether you would choose to use, support and/or fund biotechnology activities in your community?

Working together, the class will generate a list of criteria that could be used to evaluate or assess biotechnology activity. The list could include:

- Social implications (e.g. ethical considerations, changes to employment opportunities, human health issues)
- Environmental impacts (e.g. gene escape, invasive genetically modified species, impact on genetic diversity or ecological integrity of an ecosystem)
- Costs (e.g. research that is considered to be too expensive, rehabilitation or remediation costs, environmental damage costs)
- Availability (e.g. site location, amount of material available)
- Safety (e.g. human, environmental, biological)

Hand out photocopies of the ***Biotechnology Evaluation Criteria List***. As students generate ideas, write these on the blackboard, for the students to copy onto their ***Biotechnology Evaluation Criteria List***. This list will be used as each group of students (Step 3) evaluates its chosen biotechnology activity. It will also be used when the National Biotechnology Funding Panel (Step 3) evaluates the individual group presentations.

Step 3 Divide the class into research groups. One group will be chosen to represent a National Biotechnology Funding Panel, as part of the Natural Science and Engineering Research Council of Canada (NSERC) which allocates funding for scientific research. Give the student panel a budget with which to fund research projects.

The National Biotechnology Funding Panel should elect one member to serve as its Chair. This member will help facilitate the presentations and handle the question and answer sessions after each presentation.

The National Biotechnology Funding Panel will carry out some degree of research into each biotechnology activity chosen by the other research groups. Panel members will establish a series of specific questions to pose to each of the other groups. The National Biotechnology Funding Panel will make final funding decisions and allocate money to each research project, based on the following criteria: its own research; the class *Biotechnology Evaluation Criteria List*; the group presentations; how each group responds to questions; and its working budget.

Step 4 The remaining groups will each select a biotechnology research topic. These could include:

- Identifying genetically superior trees
- Propagating trees through tissue culture
- Improving trees through genetic engineering
- Protecting forests with biological pest control methods
- Assessing environmental impacts of biotechnologically derived products

The groups will conduct research in order to complete the following activities:

- Describe how the biotechnology works, asking such questions as: What is it? What does it do? Why is it needed or important?
- Evaluate their proposed biotechnology research topic, based on the criteria established by the class
- Prepare a presentation that outlines their research, and provides justification for funding approval

NOTE: The presentations should emphasize the positive aspects of the biotechnology, while also recognizing and addressing potential negative impacts.

Step 5 Following student research time, prepare your classroom for the group presentations. Have the National Biotechnology Funding Panel sit at the front of the classroom. Distribute copies of the *Funding Panel Assessment Chart* to every panel member; give the Chair the master copy as well. During each presentation, panel members will listen critically, take notes and rate each presentation on their charts. They will also watch the clock, to ensure all groups have equal time to plead their case for funding. Set a maximum time limit for each group's presentation.

While listening to each presentation, the rest of the class should be preparing questions for the presenting group. When each presentation is completed, the Chair of the National Biotechnology Funding Panel will ask the panel members if they have any questions. The Chair can then allow time for questions from the rest of the class.

At the end of all the presentations, the National Biotechnology Funding Panel members will need time to discuss their options, either during the class period or as homework. The Chair will write down the panel's final funding decisions on the master copy of the *Funding Panel Assessment Chart*. The Chair will then present the final decisions in the next class and explain the supporting reasons.

Evaluation

The quality of students' work will be assessed on the following basis:

1. Knowledge and understanding (35 marks)	Content of biotechnology research topic
2. Application (25 marks)	Use of research information during presentation
3. Communication (20 marks)	All aspects of the small group presentations, including: information clarity; vocal projection and grammar; and comprehensive presentation of information
4. Thinking and inquiry (20 marks)	Quality of delivery and originality of presentation

Extensions

Have students prepare a descriptive journal article for a magazine (e.g. Canadian Geographic, Equinox) that outlines their forest biotechnology research, explores the benefits to society and concerns raised by biotechnology. They can also announce the funding winners of this activity.

Students may also wish to look at more in-depth forest biotechnology activities being carried out in the Canadian Forest Service's research labs. They could then compare the different Canadian biotechnology sectors – health care, agriculture, food aquaculture, environment and mining – with the forestry sector, to determine which is the most viable and progressive.

FUNDING PANEL ASSESSMENT CHART

(Ratings: 1= highest 5 = lowest)

GROUP	FUNDING REQUEST	ORGANIZATION AND DELIVERY	USE OF BIOTECH EVALUATION CRITERIA	RESPONSE ABILITY	FUNDING VOTES YES / NO	
1	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
2	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
3	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
4	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
5	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
6	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
7	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		
8	$	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5		

BIOTECHNOLOGY EVALUATION CRITERIA LIST
1
2
3
4
5
6
7
8
9
10
11
12