Name: _____ TOC#

Genetically Modified Organisms

Introduction:

In the book and movie "The Hunger Games," there are several instances in which "mutations" are discussed. For example, Tracker Jackers are modified wasps that follow another organism and while their stings raise lumps the size of plums on their victims, their venom is engineered to target fear in a victim's brain and alter their memories and causes hallucinations that can drive people to madness. Additionally, The Capitol (a term used to refer to what we would call the government) produced genetically modified birds called jabberjays to spy on rebels. Unexpectedly, these birds bred with native mockingbirds, creating a new hybrid bird called the mockingjay. The Capitol did not intend for this to happen, and the bird became a symbol of rebellion.

Question 1: Based on this information, what do you think a genetically modified organism is?

Question 2: What lessons can we draw about genetic engineering from these examples? Could a scenario like this, where a genetically engineered organism hybridizes with a wild animal or plant, happen in the real world? Why or why not?

Background:

Genetically modified organisms (GMOs) can be defined as organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally. This allows selected individual genes to be transferred from one organism into another, also between non-related species. Frequently this is completed through the use of recombinant technology.

Frequently, the discussion around genetically modified organisms is about genetically modified food. Industry, government, and many academic scientists tout the benefits of genetically modified (GM) foods for agriculture, ecosystems, and human health and well-being, including feeding a world population bursting at the seams. With equal passion, consumer groups, environmental activists, religious organizations, and some scientists warn of unforeseen health, environmental, and socioeconomic consequences. Today you will learn about the process and some current uses of genetically modified organisms and come up with your own opinion.

Question 3: What is your current opinion about genetically modified organisms, especially as a food source.

In order to create GMOs, scientists must isolate genes for the desired trait and You have already learned about a major component of creating GMOs: recombinant DNA.

Question 4: Define the Following:

Recombinant DNA:

Restriction enzyme:

Plasmid (also known as a vector):

Genetically Modified Crops

Why do we create genetically modified crops?

"The introduction of the first transgenic plant 30 years ago heralded the start of a second green revolution, providing food to the starving, profits to farmers and environmental benefits to boot. Many GM crops fulfilled the promise. But their success has been mired in controversy with many questioning their safety, their profitability and their green credentials. A polarized debate has left little room for consensus" Nature.com. Often farmers are plagued by pests, or regions may not have enough food to feed their populations. Here, genetically modified crops can play a large role. Monsanto, a company specializing in genetically modified plants has created a genetically modified corn that has new properties. This is called Bt Corn. Watch the video about this corn as a class. http://ca.pbslearningmedia.org/resource/tdc02.sci.life.gen.btcorn/bt-corn/

Question 5:

a. As the 5 minute video plays, write down pros and cons of the modified crop

Pro	Con

b. Why was Bt Corn created?

Creating A Transgenic Crop

Go to the following website http://www.pbs.org/wgbh/harvest/engineer/transgen.html and answer the questions in order to explain the steps of growing a transgenic crop. These questions go in order, so if you can find the answer, you have probably gone too far.

1. What is your task?

2. Explain step 1:

3. What is a vector?

4. What else has been added to the vector? Why do you think this is important?

5. Explain step 2:

6. What is special about agrobacterium

7. Explain step 3:

8. Explain step 4:

9. What is the outcome of step 4?

10. Explain step 5:

11. Explain step 6:

12. Why is the herbicide sprayed?

13. Explain step 7:

14. How do you know if your transformation was complete and you created a transgenic crop?

Genetically Modified Animals

Plants are not the only thing that can be genetically modified. Often, animals can be genetically engineered to live in ways they could not live before. For example, We will genetically enginner a bacteria that will fluoresce using jellyfish DNA. The company AquaBounty has genetically enginnered a salmon with new properties.

Read the following two articles about genetically engineered salmon.

- Highlight any information you find interesting or shocking.
- Underline an information you think is an argument against GMOs.
- Star any information you think is an argument for GMOs.

Super salmon or 'Frankenfish'? FDA to decide

By MARY CLARE JALONICK
9/20/2010 *7:21:01 PM ET* NBCNews.com

Fish or Frankenfish?

A Massachusetts company wants to market a genetically engineered version of Atlantic salmon, and regulators are weighing the request. If approval is given, it would be the first time the government allowed such modified animals to join the foods that go onto the nation's dinner tables.

Ron Stotish, chief executive of AquaBounty, said at Monday's first of two days of hearings that his company's fish product is safe and environmentally sustainable. Food and Drug Administration officials have largely agreed with him, saying that the salmon, which grows twice as fast as its conventional "sisters," is as safe to eat as the traditional variety. But they have not yet decided whether to approve the request.

Critics call the modified salmon a "frankenfish" that could cause allergies in humans and the eventual decimation of the wild salmon population. An FDA advisory committee is reviewing the science of the genetically engineered fish this week and hearing such criticisms as the agency ponders approval.
Whether the public will have an appetite for it is another matter. Genetic engineering is already widely used for crops, but the government until now has not considered allowing the consumption of modified animals. Although the potential benefits — and profits — are huge, many people have qualms about manipulating the genetic code of other living creatures.

Part of the hearing is focusing on labeling of the fish. It is possible that if the modified salmon is approved, consumers would not even know they were eating it. Current FDA regulations require modified foods to be labeled as such only if the food is substantially different from the conventional version, and the agency has said that the modified salmon is essentially the same as the Atlantic salmon.

If approved, the fish could be in grocery stores in two years, the company estimates. Approval would open the door for a variety of other genetically engineered animals, including a pig that is being developed in Canada or cattle that are resistant to mad cow disease. Each would have to be individually approved by the FDA. "For future applications out there the sky's the limit," said David Edwards of the Biotechnology Industry Association. "If you can imagine it, scientists can try to do it."

The FDA posted a number of documents relating to the hearing on its website. AquaBounty says it would be the first in the world to market genetically engineered fish. The company submitted its first application for FDA approval in 1995, but the agency did not decide until two years ago to consider applications for genetically engineered animals — a move seen as a breakthrough by the biotechnology industry.

Not clones
Genetically engineered — or GE — animals are not clones, which the FDA has already said are safe to eat. Clones are copies of an animal. With GE animals, the DNA has been altered to produce a desirable characteristic.

In the case of the salmon, AquaBounty has added a growth hormone from a Chinook salmon that allows the fish to produce their growth hormone all year long. The engineers were able to keep the hormone active by using

another gene from an eel-like fish called an ocean pout that acts like an on switch for the hormone, according to the company. Conventional salmon produce the growth hormone only some of the time.

In documents released ahead of the hearing, the FDA said there were no biologically relevant differences between the engineered salmon and conventional salmon, and there is a reasonable certainty of no harm from its consumption. FDA scientists speaking Monday said there are very few differences between the modified and conventional fish.

Critics have two main concerns: The safety of the food to humans and the salmon's effect on the environment.

Because the altered fish has never been eaten before, they say, it could include dangerous allergens, especially because seafood is highly allergenic. They also worry that the fish will escape and intermingle with the wild salmon population, which is already endangered.They would grow fast and consume more food to the detriment of the conventional wild salmon, the critics fear.

The FDA tried to allay both of those concerns Monday, saying the fish shouldn't cause any allergies not already found in conventional salmon and that there is little chance they could escape.
Critics speaking at the meeting said they were concerned about the unintended consequences of approval, arguing the FDA is relying on too little data.

Wenonah Hauter, director of the advocacy group Food & Water Watch, said the FDA process is inadequate because it allows the company to keep some proprietary information private. Modified foods are regulated under the same process used for animal drugs.

"With all due respect, we don't believe a veterinary advisory committee is the appropriate place to discuss these food safety issues," Hauter told the panel.

European nations have been much more cautious in embracing engineered foods. Ruediger Rosenthal, a spokesman for Bund-Friends of the Earth Germany, said it is unlikely the modified fish would make it across the Atlantic for sale as many Europeans are very skeptical of genetically modified foods.

AquaBounty CEO Stotish countered his product has come under more scrutiny than most food.
"This is perhaps the most studied fish in history," he said. "Environmentally this is a very sustainable technology." The company has several safeguards in place to quell concerns. The fish would be bred female and sterile, though a small percentage might be able to breed. They would be bred in confined pools where the potential for escape would be low.

In its environmental analysis of the fish released earlier this month, the FDA agreed with the company that there are enough safeguards in place.

Stotish says the fish would be bred in better conditions than many of the world's farmed salmon and could be located closer to towns and cities to help feed more people. The company has also said the increase in engineered salmon production could help relieve endangered wild salmon populations.
The company is also arguing that the fish do not need to be labeled as genetically engineered. Stotish said, "The label could even be misleading because it implies a difference that doesn't exist."

Transgenic salmon nears approval-May 2013

Slow US regulatory process highlights hurdles of getting engineered food animals to dinner tables.

In the remote highlands of Panama, in tanks protected by netting, barbed wire and guard dogs, swim the world's most expensive and scrutinized fish. These swift-growing salmon have been at the centre of a 18-year, US$60-million battle to bring the first genetically modified (GM) animal to US dinner tables — a struggle that may be nearing its end.

Last week marked the end of the public's opportunity to weigh in on a US Food and Drug Administration (FDA) draft assessment of the salmon. Genetically engineered to grow twice as fast as their unaltered brethren, the fish pose no significant environmental threat to the United States when grown in landlocked tanks, says the FDA. The agency needs only to finalize that assessment before deciding whether to approve the fish for human consumption. The number of opportunities for a surprise delay — a recurring theme in the history of these salmon — is dwindling (see 'Against the current').

The US Food and Drug Administration (FDA) has been slow to approve a genetically modified (GM) salmon made by AquaBounty of Maynard, Massachusetts. The fish would be the first GM animal authorized for human consumption.

Environmental groups are preparing to take the battle to consumers by fighting the sale of the fish in grocery stores across the country. Others point out that it will be years before the salmon are anything more than a curiosity. At full capacity, the Panama facility can produce only about 100 tonnes of salmon a year, says Gregory Jaffe, director of biotechnology at the Center for Science in the Public Interest, a consumer group in Washington DC that monitors the regulation of GM foods. That amount is a trifle compared to the roughly 230,000 tonnes of farmed Atlantic salmon that the United States imported in 2012. "You'd have to try hard to eat it," says Jaffe. "It won't be as hard as winning the lottery, but it will be close."

For the firm that developed the fish, AquaBounty Technologies of Maynard, Massachusetts, those 100 tonnes are a hard-won prize. In 1989, the salmon were engineered to overexpress a growth-hormone gene. The result: 'AquAdvantage' fish that grew to full size in around 18 months rather than the usual 3 years. The company applied for FDA approval in 1995 and has been stuck in regulatory limbo ever since. AquaBounty has had to demonstrate the food's safety, and gauge the environmental risk of the sterile fish escaping its tanks and successfully mating with wild salmon. By contrast, the FDA approved the first GM crop for human consumption — the Flavr Savr tomato — after just three years of regulatory consideration.

The uncertainty has taken its toll [to make make a profit after losses] Stotish says that the company must expand. Following FDA approval, AquaBounty hopes to sell its salmon eggs to farmers and expand to markets in Argentina, Canada, Chile and China.

To sell AquAdvantage fish in the United States, each farm would require separate FDA approval, but because the food safety of the fish has already been vetted, the approval process would require only an environmental evaluation, says Jaffe.

Yet even with regulatory approval, the battle over AquaBounty's salmon will be far from over. In March, several speciality grocery stores, including Whole Foods, an international chain based in Austin, Texas, said that they would not sell AquAdvantage fish. Lawmakers in Alaska and Oregon, which both export wild salmon,

have repeatedly tried to block the GM fish because they fear contamination of the wild stock and worry that it could drive down the price of farmed salmon.

AquaBounty's long struggle has discouraged other US companies from producing GM animals for food. Mark Walton, chief marketing officer at Recombinetics, an animal-biotechnology company in St Paul, Minnesota, says that his company will focus initially on medical applications — using modified farm animals as disease models, for example — rather than on livestock for food. Medical applications of GM technology do not stir consumer passions in the same way as GM foods, and there is a regulatory precedent: in 2009, the FDA approved a goat that makes an anti-clotting drug in its milk. If Recombinetics invests in agricultural products, Walton adds, the items will probably be marketed outside the United States first. "The AquaBounty example has [made] the company very skeptical about how much investment to pour into the US regulatory process," he says.

Yet Stotish says that GM animal products will inevitably find their way to grocery stores. He points to heavy investment in the technology in China, where dozens of GM farm animals are in development. "I think we will end up eating genetically modified animals of a variety of species," says Stotish. "But they'll come from other countries."

Timeline of AquaBounty Salmon

1989 Canadian researchers engineer wild Atlantic salmon to overexpress growth hormone.
1995 AquaBounty files an Investigational New Animal Drug application with the FDA.
2001 AquaBounty submits its first regulatory study to the FDA.
2009 The FDA releases guidance for its evaluation of genetically engineered animals as veterinary drugs; AquaBounty completes its FDA submission.
2010 The FDA says that GM salmon is safe to eat.
2012 The FDA completes its draft environmental assessment in May, but does not release it to the public until December.
2013 The public-comment period for the draft environmental assessment is extended by two months and concludes on 26 April.

Ledford, Heidi. *Nature* 497, 17–18 (02 May 2013). http://www.nature.com/news/transgenic-salmon-nears-approval-1.12903

Reflection/Opinion

Write a two paragraph opinion on whether we should continue to create/grow/breed genetically modified organisms. Make sure to discuss if you think they should be created, if we consume them, should they be labeled, and do the pros outweigh the cons.