Genetically Modified Organisms

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Today we are going to talk about genetically modified organisms for a couple reasons, first they are intricately linked to several of the topics we will discuss next – sustainable agriculture and biodiversity in particular and because several states now have voted on a GMO labeling measures in the past couple years.

Has any one seen these fish before? They are all zebrafish – a common aquarium fish originally from southeast Asia. This dark blue one with yellow or white stripe is what we call wild-type – color variation found naturally in wild. These are all genetically modified zebrafish called GloFish. They have had various fluorescent proteins introduced to fish embryos causing them to display various fluorescent colors in their skin. GloFish are one of few genetically modified pets available today. Green is from jellyfish, other colors are from corals originally.

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Learning objectives

Note from now I'll be abbreviating genetically modified organism with GMO.

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So why talk about this today? Largely because of Initiative Measure No. 522. Requires most raw agricultural commodities, processed foods, seeds & seed stocks if produced using genetic engineering to be labeled as such for retail sale. Labeling would be required to be on the front of the packaging and clear, and conspicuous.

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Opposition: large chemical companies and surprisingly Wash St. Farm Bureau. Argue that new labeling rules are confusing and inconsistent, and information is already available on the packaging. One of key arguments is that it will raise food prices for Washingtonians largely because food suppliers will have to produce new packaging that is washington state specific – sell product in other 49 states it will have one package, but washington's has to be different, so we will bear the cost of that change.

Final argument is that new regulations make it more difficult to get products to market because of new regulations suppliers must comply with and any mistakes are fineable opening them to potential lawsuits.

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Support for this measure comes largely from local and organic farmers and food suppliers who already do not use GMOs as well as a variety of other groups. Their argument is that by beginning this packaging, washington can immediately market products to 60 other countries worldwide who require this type of labeling and that new labels will not be misleading or unnecessary but straightforward and increase transparency in our food supply. It will not raise food prices nor threaten farmers with fines and lawsuits for compliance. 18 months to comply, effective in 2015.

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So far over 27.7 million dollars have been spent on both sides of this campaign. Why all the hullabaloo? Understanding our love hate relationship with genetic engineering and genetically modified organisms relies on our understanding their applications and side-effects in our environment, economy, and society.

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The idea of genetic modification to enhance crops or animals is as old as human agriculture and likely even before then when hunter-gatherers moved plants they preferred to fed upon around in their environment. At least 10,000 years old. Roots of agriculture and animal husbandry lie in artificial selection in which organisms that exhibit specific traits are chosen to breed subsequent generations. The seeds of tomato plants which produce bigger fruits are preferentially chosen to be planted and grown next season. Cows which produce more milk than others are preferentially selected to birth more calves, while those with lower milk production are not bred at all. The key is that variation in and selection of traits available has been limited to naturally occurring variations. Breeding tomatoes will never produce a blue tomato because that variation does not occur in nature, genes for that variation are not present in its genome.

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This type of artificial selection has produced everything from the variety of dogs we see today to varieties of corn we can buy at the grocery to all these types of vegetables which are derived from the same original wild mustard plant.

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Now modern science has provided new means of genetic modification which we commonly refer to as genetic engineering which produces genetically modified organisms. Genetically modified organisms are those which incorporate new traits into a species that derive or originate from an entirely different species. The legal definition from the Cartagena Protocol on Biosafety which governs international trade in living GMOs is a living modified organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology aka genetic engineering. It is a recent discovery involving modification of the DNA of an organism that has radically advanced agriculture and animal husbandry since its inception. In contrast to selective breeding it is not limited to natural variation of a species.

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Genetic engineering itself is direct manipulation of an organism's genome using biotechnology

We can add genes by insertion which is analogous to horizontal gene transfer

We can delete unwanted or deleterious genes using knock-out procedures

and we can target specific genes for interruption and change using point-specific mutations, adding or deleting exons and introns, and straight up gene deletions.

Although all of these techniques are genetic engineering, almost all if not all of the GMOs we think of and will be talking about are the result of the first technique, adding material from one organism to another.

Slides: example of genetic manipulation via biotechnology. 1St example of Bt corn production by gene addition

Slide: Cloning is a specific example of genetic modification in which an organism is exactly copied. It is natural process in many micro-organism and plants who self-pollinate as well as some lizards and even humans – twins. But humans can also leverage cloning to their advantage when we copy part or all of an organism's DNA. Legionella bacteria on this plate are all clones and Dolly the sheep was the first large eukaryotic organism successfully cloned by humans. We now routinely clone bacteria, yeast, plants & animals. Have we artificially cloned a human yet? Probably, but is that ethical?

Slide: artificial selection, genetic modification & cloning in fruit.

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What types of organisms have been genetically modified?

Salmon modified for salt water tolerance are larger – advantages to being larger?

Slide of GMO timeline.

Timeline – 1986 tobacco resistant to herbicides

Flavr Savr tomatoes have longer shelf life

1995 – Bt potatoes which produce pesticides themselves approved by FDA and EPA

as of 2009, 11 transgenic crops grown in 25 countries.

Slide: What are the benefits & concerns of GMOs?

Slide: Benefits of GMOs

Read slide – all agricultural changes led to enhanced food security and worldwide production

Agriculture examples

in some states, 90% soybean and 50% corn is herbicide resistant

In Argentina, 98% soybean fields were GMOs within 5 years of introduction

Reminders:

Deploy infographic

no class monday

homework readings

Genetics worksheet due next Wednesday