

When Pigs Fly: A case study examining genetic engineering and synthetic biology

Introduction:

Over the next four classes we will be engaging in a case study that examines genetic engineering and synthetic biology. We will consider the risks and rewards, the impact of this research on our lives and where we live and the differences between these two related fields. While doing this, you will increase your understanding of genetic engineering procedures and the way science and engineering are conducted.

This case study is built around the questions of a high school senior interested in synthetic biology and his interactions with his father, a molecular biologist. It examines the issues that arise as students and researchers engage in activities that alter genomes of bacteria and viruses. You will also examine the recent H5N1 influenza virus controversy.

Each day you will be given a part of the case to read and research at home. Each part of the case will include questions that need to be answered. The next day we will discuss the case and your answers. Expect new questions to come up in class. On the fourth class you will engage in a role play as a cumulating activity in which you will be assigned the role of a stake holder on this topic.

How to approach a case study:

Case studies are increasingly used in college as a way to engage students in deeper thinking and analysis. One of the goals for this case study is to prepare you for this. There are many ways to approach a case study. Often you are presented with a story and a set of leading questions. Sometimes, you will be provided with links to resources. Here are some steps you can take to enhance your understanding and analysis:

1. As you read the story highlight any terms or phrases you think don't understand. You'll want to research these
2. Make lists of things you understand and things you want to know more about.
3. List the 'givens'. What is the story about? Who are the players and what do they represent? What are the facts of the case?
4. Be aware that the conversations in the case provide direction. They bring up the issues and point to areas for research. The conversations are not sufficient by themselves as a means of learning the material.
5. If you are given resources, read them and take notes. Remember that reading the provided links is not necessarily all you need to do to analyze the case. If the resources direct you to more information that you feel might be important, follow up.
6. If you are not given all necessary resources, use the internet to search for resources based on the phrases you have listed and the questions with which you've been provided.
7. Answer the questions provided at the end of the case after you have completed your research.
8. For the follow up discussion in class, bring your answers to the questions as well as the notes you've made along the way. If you bring copies of papers you've read, highlight them so you can find information quickly. Bring a list of questions you'd like answered during the discussion.
9. Participation in the discussion will take many forms. You will be asked to present the facts of the case, provide opinions, ask questions, and you will be encouraged to directly address your classmates and comment on their contributions. Try to do all of these, but don't take over the conversation.
10. This case has a role play as a final exercise. You should assemble your supporting materials in a way that allows quick access to facts or statements you want to make. Write out some points you want to make so that you present them precisely. Also, consider the other roles. What statements do you think they will make? Will you have counter arguments for their arguments?

You will be graded on:

- Your participation in the general class discussions and the role play.
- The variety of participation you display (offering facts, offering opinions, asking questions, interacting with classmates).
- The degree to which your participation reflects your preparation.
- The degree to which your participation reflects a sophisticated understanding of the issues and material.
- The degree to which your opinions appear well thought out and well supported.
- The accuracy with which you play your role.
- The courtesy and respect you show the other members of the discussion.
- You will be asked to turn in your rubric, notes and answers, on time and stapled.

Requirement	Level 1	Level 2	Level 3	Your score	Teacher score
Overall Participation	You make few contributions to the discussion and role play	You make adequate, but not varied contributions to the discussion and role play	You make many, varied contributions to the discussion and role play		
Preparation (discussions and role play)	Your comments, notes and answers reflect minimal preparation	Your comments, notes and answers reflect adequate preparation	Your comments, notes and answers reflect extensive preparation		
Understanding (discussions and role play)	Your comments, notes and answers reflect poor understanding	Your comments, notes and answers reflect adequate understanding	Your comments, notes and answers reflect sophisticated understanding		
Opinions (discussions and role play)	Your opinions appear to be poorly thought out or poorly supported	Your opinions appear to be well thought out but not well supported	Your opinions appear to be well thought out and well supported		
Accuracy (role play)	Your portrayal reflects a poor understanding of your role	Your portrayal reflects a general impression of your role	Your portrayal reflects an accurate understanding of your role		
Conduct (discussions and role play)	Your contributions lack respect for the characters and your classmates. You take over the conversation or interrupt frequently.	Your contributions are made with respect for the characters and your classmates. At times you are overly excited and interrupt.	Your contributions are made with respect for the characters and your classmates. You do not take over the conversation or interrupt.		
Materials	You turn in notes, answers, and this rubric late or unstapled	You turn in notes, answers, and this rubric on time and stapled			
			Total Score:		

When Pigs Fly: A case study examining genetic engineering and synthetic biology

Part 1

“Sooo, how was your day?”

Michael was stressed and tired, he had had a tough math test, Angela had looked the other way as she passed him in the hall, and baseball tryouts were looming. “It was okay.”

“Anything exciting happen?” Michael’s dad had started every drive home with the exact same questions since preschool.

“Nothing much.”

As they turned off Pond Street, Michael looked up and saw the weathervane that had a flying pig instead of a rooster. They had been popular on this side of the river since the Sox had won the series in 2004. It was also the emblem of the West New Hartford High School iGEM team.

“Oh yeah, Mr. Kelly told us that some people complained about what the iGEM team is doing, you know, after the article about us in the paper. I guess they went to the Superintendent.”

This was the second year of the HS iGEM team at West. The team was excited about their project to engineer a gene that would make yogurt resistant to forming ice crystals when frozen. They were anticipating their first taste of YoGelato, ‘Yogurt as smooth as gelato’. Some of the kids thought that they could actually start a company, though others knew that the project relied heavily on the work of a University level iGEM team of a few years earlier.

“Who would complain about that? You kids are just doing some bacterial transformations. Schools have done them for years.” Dr. Peter Chodas was an Associate Professor in the Department of Molecular Biology at the University of New Hartford.

“It was those folks from the organic coop. They’re afraid that we will release bacteria that are genetically engineered to resist frost and that it will get in their crops and make them not organic or something. Mr. Kelly said that they were even more concerned about frost free weeds.”

“I’m sure it’s not probable in your case, but they have some legitimate concerns that just need to be addressed. Did you direct them to the BioBuilder site to see the procedure you do?”

“No, maybe we should. But Dad, why wouldn’t they want to have frost resistant crops? And anyway, they’re crazy. The genes can’t jump from the bacteria to the plants.”

“Have you learned about transposons in AP Bio yet, Mikey?”

“Not yet, but still, you do this kind of stuff every day. You’ve contributed research to the Golden Rice project. And you’ve written about the situation with the bananas in Africa.”

“Yes, but I’ve also written about my concerns over Monsanto and how they patent the seeds. You know how angry I got that they engineered their seeds to resist their herbicides which they then sell.”

“You’re such a liberal,” interrupted Michael.

“Actually, Mikey, the resistance to GMOs is more of a liberal issue. In Europe, it’s the Green Party that causes the most problems. They’re not against evolution, they just don’t want people directing it even though we’ve been directing evolution ever since we’ve lived with animals. Still, we do have to be careful when we move those genes around. You do take precautions, don’t you son?” Peter arched an eyebrow and smirked.

“Funny, Dad. Yes, we do proper disposal techniques. But they even complained about that. Actually, they complained that we used antibiotic resistant bacteria. That certainly got the Superintendent’s ear. Mr. Kelly explained that we had to use them so we knew if the plasmid was taken up and the bacteria transformed. And besides, the anti-freeze protein is in all kinds of things and has been moved to many plants...”

“You know, we went through all this at the hearings when we built the biotech center. They basically said that as long as we took precautions and were far enough away, they could cope. They didn’t like it, but they weren’t unreasonable. It’s weird though. They’re on the other side of the river from West. Ahh, perhaps they’re Sox fans.”

“There’s that, Dad. But seriously, Mr. Kelly said they were especially concerned because we were doing synthetic biology. They think we are creating unnatural genes. It seems to be different than the old fashioned genetic engineering you do.”

“I’ve got to admit that I’ve wondered a bit about that myself. I guess I worry about computer scientists and chemists mixing and matching genes. But these are smart people, Mikey, they are careful. I’m having lunch with JoAnn and Zach tomorrow, I can talk to them about this. But I do think you should do some research into the organic folks concerns and see if you can address them with a letter or something, just like you should send them to BioBuilder or other sites to learn about synthetic biology. Do you have a lot of homework tonight?”

“No, but the Yankee game is on.”

“It’s spring training, doesn’t count,” said Dr. Snow as they pulled into the driveway. “And I’d begin by reading your bio textbook. Make sure you understand exactly what genetic engineering is and techniques like PCR and using restriction enzymes. Oh yeah, I almost forgot. Mom’s making wild salmon for dinner tonight.”

“Yeah, no GM farmed salmon for you, huh, Green-Dad?”

“You know it just doesn’t taste right. And don’t be such a wise...!”

Questions:

1. How is bacterial transformation done? What safety precautions are taken?
2. The story mentions examples of genetic engineering that affects our food supply. Research and briefly describe them.
3. What safety precautions are done when GMO’s are introduced to the environment?
4. What are transposons? Why are they important to this discussion?
5. Is genetic engineering consistent with evolution? If not, is that a problem?
6. What is iGEM? What is synthetic biology?

Some links to get you started:

<http://www.BioBuilder.org>

http://igem.org/Main_Page

<http://www.synberc.org/content/articles/what-synthetic-biology>

http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml

<http://www.goldenrice.org/>

<http://www.npr.org/2011/12/09/143453487/debating-genetically-modified-salmon>

<http://www.nongmoproject.org/learn-more/gmos-and-your-family/>

<http://www.naturalnews.com/GMO.html>

http://articles.cnn.com/2011-03-22/world/uganda.banana.gm_1_banana-harvest-banana-plant-gm-crops?s=PM:WORLD

http://oba.od.nih.gov/rdna/nih_guidelines_oba.html