Biotechnology Web Quest

I. Overview:
   a. Science Concepts: Given the high cost of laboratory equipment many biotechnology protocols are too expensive to carry out in a rural science classroom. This experience is designed to replicate the happenings in a research lab carrying out DNA amplification through PCR. After having covered basic core knowledge in immunity and DNA/RNA structure, students will develop an applied understanding of DNA translation and transcription and the role of enzymes in each process by carrying out a virtual laboratory experience in PCR technique. Students will then apply their knowledge about PCR technology and biotechnology (in general) in answering questions on the ethical, legal, and societal concerns and uses through the Web Quest developed.

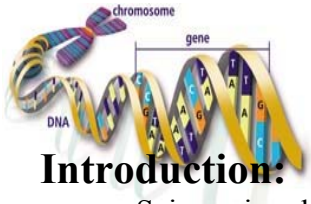
   b. General goals of the virtual laboratory experience:

      - Follow safety rules
      - Make observations of biological processes
      - Select and use correct instruments
      - Collect, organizes, and analyze data
      - Describe the purpose of PCR
      - Give examples of the importance of PCR to scientific research in immunology
      - Outline and demonstrate the process of PCR
      - Apply knowledge of PCR to solve a problem identified

II. Equipment Needed:
   a. Computers
   b. Access to the internet (high speed, TI-T3)
   c. Student Lab Sheets

III. Learning Objectives (from the NY state standards):
   a. DNA is transcribed into RNA which is translated into Proteins by ribosomes
   b. PCR technique and the role in Molecular Biology
   c. Different enzymes can be used to cut, copy, and move segments of DNA
   d. Enzymes and other molecules, receptor molecules, antibodies, have specific shapes that influence both how they function and how they interact with other molecules.

IV. Teaching Objectives:
   a. Students will follow the instructions of the PCR lab handout entitled "PCR…What is it and how does it work?" to learn how PCR works and its application in the many fields of life science. Background on the discovery of this technique by Kary Mullis should be used to introduce the laboratory.
   b. The "Biotechnology Web Quest" can be used as a supplemental activity to reinforce or introduce other biotechnology techniques and uses today.



Biotechnology WebQuest

http://www.ornl.gov/TechResources/Human_Genome/graphics/slides/images1.html

Introduction:

Science involving the understanding and use of DNA has evolved at a revolutionary pace. From the point in which Watson and Crick announced the fundamental double helical structure of DNA great advances have been made in the application and understanding of this remarkable molecule for all walks of life. Projects such as the Human Genome, transgenic organisms, cloning, genetically manufactured foods, and crime solving are just some very common and state-of-the art applications of DNA technology today. But with anything new there are ethical/moral, societal, and political questions to be thought over.

The questions you and your partner will explore are…

1. What are the legal, moral/ethical, and social issues that have arisen as a result of advances in DNA technology?

2. Should science be aware and take responsibility for such issues?

Your Task:

You and your partner must choose one of the following biotechnology advances. Throughout your quest, you will formulate a position, in support of or against, the social, political, and ethical/moral issues this type of research evokes. Your position will be formulated using the *ethical questions guide* provided. A final report will be given in a PowerPoint presentation.

DEFINITIONS:
Ethical/Moral refers to wrong vs. right
Legal refers to laws and regulations
Social refers to how society and individuals are affected by decisions

Process & Resources:

1. Choose one of the four cases below:
(http://rvgs.k12.va.us/faculty/cbohland/gsb/projects/Rev%20Ethical%20Issues%20and%20DNA%20Technology.htm)

Medical and Pharmaceutical Uses:
Case 1a:
Some people are opposed to gene therapy because it tampers with human genes. One type of gene therapy, germ-line gene therapy, could hypothetically change the genes of the human species. In germ-line gene therapy, a fertilized egg's DNA is permanently changed so that the defective gene will not be passed down through generations. For example, the gene for cystic fibrosis could

hypothetically be replaced by the normal gene which will eliminate the risk of cystic fibrosis for future generations. Critics are against tampering with the human gene pool and fear that gene therapy for disease may lead to gene therapy for more trivial matters such as eye color. What do you think about these critics? Do you think tampering with the human gene pool is unethical? Do you think the fear that gene therapy may someday, far in the future, lead to "designer babies" is justified? Would you be for or against tampering with genes of healthy embryos?

Case 1b:

In 2002, David Duncan became what is believed to be the first healthy human screened for all the known genetic markers for disease. He was a test subject for a biotech startup called Sequenom in San Diego. In the end, he was told he had a gene that put him at a greater risk for developing heart disease. Since heart disease is uncommon in his family, he was also told he might contain other, unidentified genes that are protecting him from the identified mutated one. The chief medical officer at Sequenom envisions "a day when genetic kits that can assay the whole range of human misery will be available at Wal-Mart, as easy to use as a home pregnancy test." What do you think about this vision of the future? Do you think being screened for all of the know markers of disease is a good idea or not? Do you think this is something that could realistically happen in our future?

Forensic Uses

Case 2a:

In addition to convicting criminals, DNA fingerprinting has been used to free wrongfully convicted people. Do you think the state should provide DNA fingerprinting of old evidence for convicted criminals who insist they are innocent? Do you think DNA fingerprinting should be done for everyone who was sentenced to death before DNA fingerprinting became commonplace? Why or why not?

Agricultural Uses

Case 3a:

People have been selectively breeding plants and animals for thousands of years. None of our food crops look anything like their wild ancestors. Cabbage, broccoli, cauliflower, brussel sprouts, and kale all were bred from one species of wild mustard. If it weren't for humans selectively crossing plants together, there would be no broccoli on earth! People who are opposed to genetically engineering crops often say that people shouldn't mess with nature. Do you think that using DNA technology to create new kinds of plants is different from what people have been doing to thousands of years? Why or why not? Do you think using DNA technology to create strains of trout that mature 3 times faster is different from what people have been doing to breed animals for thousands of years (think about how our domesticated turkeys differ from wild turkeys)?

2. While reading related articles and preparing for your presentation answer the following questions as completely as possible (*Ethical questions guide)*:

a) What are the facts?
b) Identify and define the ethical problem, social problem, and/or political problem:
c) Who are the stake makers in the decision?
d) What values are at stake in the decision?
e) What options do you see are available to resolve this dilemma?
f) Which options are the most compelling? Why?
g) How would you resolve the dilemma?
h) What values did you rely on to make your decision?
i) What consequences (if any) do you see your decision has on the others involved?
j) Could you personally live with this decision? If not, re-examine your answers to question 5, 6, and 7 and examine other options to your dilemma!

(accessexcellence.com)

3. Use the following web sites for the case you selected for some background research on each biotechnology area. You may carry out individual research in addition.

Case 1a
Explanation of Germ-Line Gene Therapy:
http://www.ess.ucla.edu/huge/genetic.html

Position Paper against Germline Therapy:
http://www.gene-watch.org/programs/cloning/germline-position.html

Newsletter article from the Human Genome
http://genome.gsc.riken.go.jp/hgmis/publicat/hgn/v10n1/16walter.html

Case 1b
Definition of "genetic screening"
http://www.genome.gov/glossary.cfm?key=genetic%20screening

Stated concerns of genetic screening (browse the online conclusions)
http://www.nuffieldbioethics.org/publications/pp_0000000005.asp

Access Excellence: Issues
http://www.accessexcellence.org/AE/AEPC/WWC/1992/gen_screen1.html
American Society of Human Genetics Report (1995)
http://www.faseb.org/genetics/acmg/pol-13.htm

Case 2a
Basics of DNA Fingerprinting
http://www.biology.washington.edu/fingerprint/dnaintro.html

CNN article with many great links
http://www.cnn.com/2000/LAW/12/22/innocence.project.crim/

Case 3a
Bioethics.net: Current issues and policies on genetically modified crops/organisms
http://www.bioethics.net/news/news.php?newsCat=gmo

Colorado State: Explanation of technology and links to issues/concerns
http://www.colostate.edu/programs/lifesciences/TransgenicCrops/teachers.html

4. Once you and your partner have reviewed some of the websites and have analyzed the above questions to formulate a position on your chosen case, organize your power point presentation using an outline and story board. You may use the following outline to get you started.
    a. Title slide (name of technique/question, name of presenters, date)
    b. Case highlights
    c. Explanation of DNA technology questioned
    d. Identification of Issues/concerns with supporting statements, diagrams, charts, etc..
    e. Your position on the case with supporting statements, diagrams, charts, etc…
    f. Closing slide

Evaluation

Your presentation will be evaluated as a group based on the following rubric…

Objective	Beginning 1	Developing 2	Accomplished 3	Exemplary 4	Score
Identification of DNA technology present in case	Some connection made between the case and a DNA technology. Missing a clear description of the technique	Connection made between case and DNA technology. Some of description demonstrates understanding of technique	Technology technique correctly identified with a general description of the technique. May use charts/diagrams.	Technology technique correctly identified. Description is clear and appropriately detailed. Use of charts/diagrams.	

Identification of Ethical/societal /political issues and partner's position on those issues	Identified 1 or less issues. Position is lacking or unclear	Identified 2 issues. May be different in nature or closely related. Position is clear.	Identified 2-3 issues that are different in nature and clearly related to the DNA technique. Position is clear.	Identified 3 or more issues that are different in nature and directly related to the DNA technique. Position is clear.	
Power Point Layout	Sequence not easily followed. Little or no use of color/visuals/audio. 4 or more spelling/grammatical /punctuation errors	Sequence may vary at times. Use of color/visuals/ audio varies. 2-4 spelling/gram matical/ punctuation errors	Sequence is clear and easy to follow. Use of color/visual s/audio good but may vary. 1-2 spelling/ grammatica l/ punctuation errors	Sequence is clear and easy to follow. Use of color/visual s/audio good No spelling/ grammatica l/ punctuation errors	
Presentation	Little to no eye contact with audience. Medium to soft voice. Little use or non functional use of aides. One person may dominate presentation.	Some eye contact. Medium to soft voice. Use of aides is functional. One person may dominate presentation	Most eye contact. Medium to loud voice. Use of aides is functional. Some gesturing. Mostly shared presentatio n.	Full eye contact. Loud voice. Functional use of aides. Appropriate gesturing. Fully shared presentatio n.	

Credits

WebQuest format:
http://projects.edtech.sandi.net/staffdev/tpss99/mywebquest/index.htm

PCR…What is it & How does it work?

Problem: You have located the gene for the production of insulin. The only way we can use this gene is to amplify the DNA it is contained in. When we amplify we are really just creating many copies of this DNA. So how can we make these copies from our small sample in the laboratory? This possibility was not available until 1983 when a scientist, Kary Mullis, came up with the concept of PCR. Consequently, this revolutionary development won him the 1993 Nobel Prize! Now it's up to us to use PCR in solving this case.

What we need:

In order to be successful at carrying out PCR we must first understand what is needed in order to make the reaction work. Using your knowledge about DNA and Replication, try to guess what some of the necessary ingredients are based on the following statements.

1. Something to copy that is contains the insulin producing gene:

   Your guess_____

2. Something that will unzip the double helix strand and copy it:

   Your guess_____

3. Something that initiates the copying process at both ends (5' and 3') of the unzipped strand. These must contain specific sequences to start the copying process at the correct location. (This one we'll have to look up)

4. Something that is available to the copier that will combine to make up the new strand:

   Your guess_____

The Process:

We're preparing to go into the laboratory. So we must prepare the necessary ingredients and have a clear understanding of the process that is about to take place in our vials. Follow the links below to answer the adjacent questions.

1. The ingredients: Click on the link and list the ingredients that will go into our vial in preparation for PCR. http://www.accessexcellence.org/AB/IE/PCR_Xeroxing_DNA.html

a. _____

b. _____

c. _____

d. _____

1.

2.

Compare this list to your original guess. How did you do?

1. The PCR Steps: Click on the link and list the steps involved in a cycle of PCR. Provide the term for each step and a brief description of what the term means.
   http://allserv.rug.ac.be/~avierstr/principles/pcr.html

   Step 1: (Term)_____ (Temperature °C)_____
   What does it do?

Step 2: (Term)_____ (Temperature °C)_____
What does it do?

Step 3: (Term)_____ (Temperature °C)_____
What does it do?

Lets watch this process in action . Remember, this all takes place in your vial which is placed in a machine called a thermocycler. The thermocycler simply regulates the temperature changes!! Click on this link to watch http://allserv.rug.ac.be/~avierstr/principles/pcrani.html

Your in Control!

In the test tube… http://www.amnh.org/learn/pd/genetics/pcr/interactive.html

Now that you have the background knowledge necessary to carry out PCR you can try it for yourself. Click on this link to carry out the next two experiments. Record your work for the following experiments:

Experiment 1:

a) Ingredients added:
- DNA template
- Primer B
- Primer A
- DNA Polymerase
- Nucleotides

b) Number of DNA Strands produced after 1 cycle _____
Number of DNA Strands produces after 2 cycles _____

Predict the number DNA Strands produced after 4 cycles _____

Experiment 2:

a) Ingredients added:
- DNA template
- Primer B
- DNA Polymerase
- Nucleotides

b) Prediction/Hypothesis:

c) Observations (include number of strands made, number of strands copied, etc….)

d) Conclusions (interpret your results, did you prove or disprove your hypothesis, give possible explanations for your findings)

As the laboratory technician…. http://www.hhmi.org/biointeractive/vlabs/index.htm

Understanding what is happening inside the test tube is very important in succeeding at PCR. But just as important is being familiar with the kinds of laboratory equipment you need to use in order to carry out PCR. Click on the link above to experience PCR as laboratory technician trying to identify a sample of mystery bacteria. Follow the directions provided below.

1. Click on the "Bacterial Id Lab"
2. Read the introduction and provide the following information

a) What is name of the piece of DNA used to identify bacteria? _____
b) How will we know what kind of bacteria is in our sample?

3. Click to enter the lab. Next, click on the drawer containing the gloves to begin.
4. Click on "PCR Amplification" located at the bottom left of the screen.
5. Click on "Reference" at the top of the screen and identify as many of the tools you can. List them below. You may end up adding to this list as we continue.

6. As you follow the directions on your screen, try to answer the following questions:
   a) What is contained in the PCR Master Mix?

   b) What is in our Positive control vial?

   c) What is in our Negative control vial?

   d) What is in our Experimental vial?

   e) What is the purpose of the thermocycler?

7. You'll notice that there are many other steps beyond PCR that will allow us to analyze our PCR product in order to identify the sample bacteria. PCR is just one important step needed to make the rest of the investigation possible! Continue through the investigation to answer the following questions.

a. What technique will be used to separate the individual DNA pieces just created through PCR?

b. In this particular example, how will the individual strands provide useful information about the identity of the sample bacteria? What will you look for?

7. Use the following sources to identify the possible uses of PCR in science.
   a) http://www.btci.org/k12/bft/pcr_infoforteachers.html
   b) http://articles.findarticles.com/p/articles/mi_m0DED/is_5_22/ai_81211904
   c) http://www.sciencemag.org/feature/e-market/benchtop/pcr.shl
      i. scroll to section titled "the cloning connection"

8. Summarize how PCR can be and has been useful in the field of life science. Give specific examples of where PCR is used and how.

9. In the introduction to this lab you were told that scientists have located the gene for the production of human insulin, which can only be used once amplified. Now that you have a good idea of how PCR works and were in science this technology has been applied, briefly explain why a scientist might use PCR in working on the insulin problem described.