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**Biotechnology Stations Activity**

**Station 1: Gel Electrophoresis**

*Basic Questions:*

1. How do scientists “cut” the DNA of interest?
2. How does gel electrophoresis separate the DNA fragments on the agarose gel? (Hint: you must mention the charge of a DNA molecule)
3. How are scientists able to see the DNA fragments once they have separated on the gel?
4. What is a blot? Why is it used?
5. How do scientists denature the double stranded DNA in order to make a copy?
6. What is the role of the nylon filter in the blot process?
7. What is the role of the radioactive probe in the blot process? How about the x-ray film?

*Application/Analysis Questions:*

1. If a scientist was trying to run a gel on a DNA sequence not recognized by any restriction enzymes, what would the resulting gel look like?
2. If a scientist accidentally placed the negative charge at the end of the gel with the wells, what would the resulting gel look like?
3. When would a scientist use gel electrophoresis / blots?

**Station 2: Polymerase Chain Reaction (PCR)**

*Basic Questions:*

1. What is the main goal of PCR?
2. Why is the mixture DNA, Taq polymerase, primers, and free nucleotides heated to 95 degrees Celsius?
3. After heating, why is the temperature reduced to 60 degrees Celsius?
4. Why is Taq polymerase used in this process? At what temperature does Taq polymerase function most efficiently?
5. What happens to the amount of DNA with the target sequence during each PCR cycle?

*Application/Analysis Questions:*

1. Would the PCR process work if the mixture was not reheated to 72 degrees Celsius? Why or why not?
2. When would a scientist use PCR?

**Station 3: DNA Sequencing**

*Basic Questions:*

1. What is the main difference between Sanger sequencing and Cycle Sequencing?
2. What are dNTP’s? How are they involved in DNA sequencing?
3. What is the issue with dideoxynucleotides?
4. Why are four different test tubes used?
5. Why are the test tube samples loaded into a gel?
6. How is cycle sequencing different from the Sanger sequencing techniques discussed above?

*Application/Analysis Questions:*

1. How does gel electrophoresis enable scientists to determine the sequence of nucleotides?

**Station 4: Genomic Library**

*Basic Questions:*

1. List the steps involved in creating a genomic library.
2. What are plasmids?
3. What is meant by the term “recombinant”?
4. Why do scientists use bacteria to “house” the DNA fragments?

Application/Analysis Questions:

1. Why do scientists create a genomic library?
2. Would it be possible to create a genomic library without recombinant bacteria? Why or why not?

**Station 5: Restriction Enzyme Analysis of DNA**

*Basic Questions:*

1. *Restriction Endonuclease Video:* How are the restriction enzymes able to cut both strands of DNA?
2. *Restriction Endonuclease Video:* Why are the cut sites often “offset” from each other?
3. *Restriction Endonuclease Video:* Let’s say we wanted to anneal or attach our “sticky ends” / cut DNA back to each other. What enzyme would we use to accomplish this?
4. *RFLP Video:* Why do we say that the human genome is “polymorphic” for restriction enzyme patterns?
5. *RFLP Video:* What can cause restriction fragment length polymorphisms to occur?

*Application / Analysis Questions:*

1. Let’s say we do not want to reattach sticky ends from human DNA sequences to one another. Where might we attach them?
2. How can RFLP’s be used for DNA fingerprinting?

**Station 6: Bacterial Transformation**

*Basic Questions:*

1. Which bacterial genes did Cohen and Boyer choose as their genes of interest?
2. Why did the scientists add the restriction enzyme EcoRI to the plasmid DNA samples?
3. Why did the scientists add DNA ligase once they mixed the samples? What kind of plasmid were they trying to create?
4. What is the goal of “heat shocking” the *E. coli* bacteria?
5. How did the scientists isolate the plasmids with the genes conferring resistance to both antibiotics?
6. How were scientists able to determine which bacteria contained both original plasmids and which bacteria contained a recombinant plasmid with both genes?

*Application / Analysis Questions:*

1. Could this technique be used to replicate human genes of interest (ex: the human insulin gene for diabetics)? Why or why not?
2. Suppose scientists did not know about the heat shocking technique. Bacteria do naturally transform each other (i.e. exchange plasmids). Would this be more or less efficient than heat shocking?

**Station 7: Microarray**

*Basic Questions:*

1. Before any testing is conducted, scientists create a “microarray chip.” What can be found on this microarray chip?
2. A microarray commonly contains how many nucleotides?
3. When DNA from the organism of interest is mixed with the chip, what happens? What is meant by the term hybridization?
4. What does color intensity indicate? How are the colors generated?

*Analysis Questions:*

1. How might scientists use this technology?

**Station 8: Whole Organism Cloning**

*Basic Questions:*

1. What is a clone?
2. What are two types of “natural” clones?
3. Before 1996, what did scientists believe was the only way to clone an organism? What types of cells had to be used?
4. What is cell differentiation? How is it possible if all cells have the same DNA?
5. Why did the scientists at Roslin Institute grow sheep udder cells under starvation conditions?
6. What did scientists do to the egg cell before inserting the donor nucleus from the udder cell?
7. How could scientists be certain that the baby sheep was a clone of the nucleus donor?

*Application/Analysis Questions:*

1. Would cloning be successful if scientists used udder cells that were not in the G0 stage?

**Station 9: Human Genome Project**

*Basic Questions:*

1. Identify two goals of the Human Genome Project.
2. Click “The Science Behind the Human Genome: Understanding the Basics.” How many base pairs are found in the human genome? How many genes?
3. Explain how the human genome compares with the genomes of other organisms.
4. What are SNP’s? How common are they in humans?

*Application/Analysis Questions*

1. How can the Human Genome Project be used?
2. What are some ethical considerations regarding Human Genome Project research?
3. What is the next step in Human Genome Project research?

**Station 10: Genetically Modified Crops and Transgenic Animals**

*Basic Questions:*

1. What are genetically modified crops?
2. Provide two examples of genetically modified crops.
3. Discuss two benefits of this technology.
4. Discuss two controversies surrounding this technology.
5. On the DiscoveryTech website, scroll through the Top 10 list of genetically modified animals. Provide two examples below.

*Analysis Questions*

1. How might we use this technology to help humans? (*Note: this is just theoretical!)*