Virtual Labs

Contributors

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Intended Audience

<table>
<thead>
<tr>
<th>Age Group</th>
<th>X</th>
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<td>K-4</td>
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<tr>
<td>5-8</td>
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<tr>
<td>9-12</td>
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Intended Audience

<table>
<thead>
<tr>
<th>Feature</th>
<th>X</th>
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<tbody>
<tr>
<td>Classroom Setting</td>
<td></td>
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<tr>
<td>Requires special equipment</td>
<td>X</td>
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<tr>
<td>Uses hands-on manipulatives</td>
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<tr>
<td>Requires mathematical skills</td>
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<tr>
<td>Can be performed individually</td>
<td>X</td>
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<tr>
<td>Requires group work</td>
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<tr>
<td>Requires more than one (45 min class) period</td>
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<tr>
<td>Appropriate for special needs student</td>
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Introduction

Description
In this activity, students will get to experience and interact with complex laboratory experiments on a computer.

Abstract
Hands-on labs teaching students about biotechnology can be expensive and tedious for teachers to prepare. Virtual labs give teachers an inexpensive way to teach students about multiple scientific topics. In this set of activities students will learn about DNA extraction, gel electrophoresis, PCR and cloning through online interactive virtual labs.

Core Themes Addressed

<table>
<thead>
<tr>
<th>Microbial Cell Biology</th>
<th>Microbial Genetics</th>
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<tbody>
<tr>
<td>Microorganisms and Humans</td>
<td>Microorganisms and the Environment</td>
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<tr>
<td>Microbial Evolution and Diversity</td>
<td>Other –Molecular Biology</td>
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Keywords
DNA, Science and Technology, Gel electrophoresis, Cloning

Learning Objectives
At completion of this activity, students will be able to:
1. Explain the correct procedure for extracting DNA and why each step is important
2. Explain how gel electrophoresis works
3. Correctly analyze an agarose gel
4. Explain how polymerase chain reaction works and why it is necessary

National Science Education Standards Addressed

Standard C: Life Science
- The cell
- Molecular basis of heredity

Standard E: Science and Technology
- Understandings about science and technology
Teacher Handout

Virtual Labs

Student Prior Knowledge

Students will need a general understanding of how to use computers and basic knowledge on DNA.

Teacher Background Information

There are 4 virtual labs. Teachers should go through the labs ahead of time so they can answer any questions the students might have.

DNA extraction: http://learn.genetics.utah.edu/content/labs/extraction/

Gel electrophoresis: http://learn.genetics.utah.edu/content/labs/gel/

Polymerase chain reaction: http://learn.genetics.utah.edu/content/labs/pcr/

Cloning: http://learn.genetics.utah.edu/content/tech/cloning/

Class Time

This activity will require a minimum of one 45 minute class period per virtual lab

1. Log on to computers (5 min)
2. Find websites (5 min)
3. Complete virtual lab and questions (20-30 min)
4. Log-off computers (5 min)

Teacher Preparation Time

This lesson will require approximately 55 minutes of preparation time.

1. Teachers should run through the virtual labs before having the students complete them (15 min. per lab)
2. Make sure all computers are up and running (10 minutes)

Materials and Equipment

1. Computers with internet access
2. Student handouts/question sheets
Answers to Student Handouts

DNA Extraction questions

1) What are three ways human DNA can be used?
   Genetic Testing, Body identification, Analysis of forensic evidence

2) Where is DNA located? How much DNA can be found in one cell?
   In the nucleus of a cell, and up to 2 meters of DNA

3) What kind of cells are we using to isolate DNA?
   Cheek Cells

4) What are the four steps to purify DNA?
   Collect cells, Burst cells, Separate DNA from proteins and debris, Isolate concentrated DNA

5) What are 6 of the materials used in the DNA purification?
   Warm water bath, Microcentrifuge, Micropipettors, Buccal swab, sample tubes, lysis solution, concentrated salt solution, resuspension buffer, ethanol, Isoprpyl alcohol

6) What is the purpose of the lysis solution?
   To burst cells open to release the DNA

7) What is the purpose of the salt solution?
   Causes cellular debris to clump together

8) How does a centrifuge work?
   Spins really fast, heavy debris fall to the bottom of the tube

9) What can you do with DNA once it is extracted from a cell?
   Redissolve it, Store it, Experiment on it
**Gel Electrophoresis Questions:**

1. What is gel electrophoresis used for?
   Size separate DNA, or sort DNA strands by length

2. What is the filter that sorts the DNA?
   The gel is the filter

3. What makes the DNA move?
   An electrical current

4. DNA migrates to the ______ Positive_______ end of the gel.

5. True or False: Long strands of DNA migrate farther than short strands of DNA.

6. Why do we stain the gel?
   To make them visible to the naked eye

7. Why add buffer into the gel mix?
   To let the electrical current run through the gel

8. What is the gel comb used for?
   To create wells to load the DNA into

9. True or False: buffer keeps the gel from drying out.

10. Why do we add the loading buffer to the DNA sample?
    To make it easier to load and make the DNA sample denser

11. Why do we also run a standard?
    So we can estimate the size of our DNA sample

12. True or False: the red wire will generate a negative charge.

13. True or False: because DNA is negatively charged, it will migrate to the negative pole.

14. How do we know that the current is running in the gel box?
    Tiny air bubbles are formed

15. Ethidium bromide fits between the _____ rungs____ of the DNA ladder and shows up under _____ fluorescent____ light.

16. Write down your DNA estimates below.
   (largest to smallest) bp= base pair
   
   1 _______ 6000 _______ bp

   2 _______ 3500 _______ bp

   3 _______ 1500 _______ bp
PCR Questions:

1) The human genome is composed of over 3 billion chemical base pairs.
2) The Polymerase Chain Reaction or PCR is used to make copies of DNA.
3) PCR can generate over 100 Billion copies of DNA in hours.
4) What is the purpose of PCR?  
   **To make DNA copies.**
5) A, C, G, and T are the nucleotides needed to make copies of DNA.
6) What is DNA Polymerase?  
   DNA polymerase is an enzyme that reads the DNA codes.
7) What can DNA Polymerase withstand that other enzymes cannot?  
   DNA polymerase can withstand high levels of heat.
8) What does a DNA Thermal Cycler do?  
   The thermal cycler heats and cools the reaction to get the desired results.
9) When the temperature cools to 50 degrees Celcius, the single strands of DNA do what?  
   The single strands of DNA pair up with nucleotides.
10) When the temperature is 72 degrees Celcuis, DNA polymerase adds complimentary nucleotides to the DNA strand
11) When do your desired fragments start to appear?  
    Desired fragments start to appear during cycle 3.
12) On cycle 30, you have over a billion copies of DNA.
Cloning: A Virtual Lab

Q1. What is cloning?
   Cloning is the creation of an organism that is an exact genetic copy of another organism.

Q2. What are the two methods of cloning?
   The two methods of cloning are 1) Artificial Embryo Twinning and 2) Somatic cell nuclear transfer.

Q3. What is a somatic cell?
   A somatic cell is any cell in the body besides the reproductive cells.

Q4. How does somatic cell nuclear transfer (SCNT) differ from the natural way of making an embryo?
   SCNT uses the nucleus from a somatic cell which contains two complete sets of chromosomes. The natural way uses one set of chromosomes from each parent.

Q5. Which mouse are you cloning? From which mouse are you getting the egg cell? Which mouse will be the surrogate mother?
   We are cloning Mimi, getting the egg cell from Megdo, and the surrogate mom will be Momi.

Q6. What is a cumulus cell?
   A cumulus cell is a cell that surrounds and nourishes an egg cell.

Q7. What is the purpose of the blunt pipette?
   The purpose of the blunt pipette is to provide a mild suction to hold the cell in place.

Q8. What is enucleation?
   Enucleation is the removal of the nucleus from a cell.

Q9. How long do the enucleated egg cell and its “new” nucleus need to adjust to one another?
   The enucleated egg cell and the new nucleus need a couple of hours to adjust to one another.

Q10. What is another term for cell division?
    Mitosis is another term for cell division.

Q11. What is a morula?
    A morula is a ball of 16 cells.

Q12. In 1998 scientists at the University of Hawaii did this cloning experiment, what was the name of the mouse they created?
    Cumulina was the name of the mouse the University of Hawaii created.
Virtual DNA Extraction

Name:__________________________________

Block:_________

Follow along the DNA extraction virtual lab (http://learn.genetics.utah.edu/content/labs/extraction/) and answer these questions in complete sentences.

1) What are three ways human DNA can be used?

2) Where is DNA located? How much DNA can be found in one cell?

3) What kind of cells are we using to isolate DNA?

4) What are the four steps to purify DNA?

5) What are the 10 materials used in the DNA purification?

6) What is the purpose of the lysis solution?

7) What is the purpose of the salt solution?

8) How does a centrifuge work?

9) What can you do with DNA once it is extracted from a cell?
Virtual Gel Electrophoresis

Name____________________ Date________________ Block________

**Purpose:** The purpose of this lab is to allow students to visualize the process of gel electrophoresis.

**Background:** Gel electrophoresis is a scientific technique used to separate DNA. It involves making the buffer and agarose, setting up the agarose, loading the DNA samples, separate DNA via electrophoresis, and stain the gel to see the DNA banding pattern.

**Objective:** Students will perform the virtual gel electrophoresis and answer questions about the process.

**Procedure:**

1. First, enter this address into the search bar: [http://www.learn.genetics.utah.edu/](http://www.learn.genetics.utah.edu/)
2. Click on the virtual labs tab at the bottom of the page.
3. Click on the Gel Electrophoresis link
4. Start the virtual lab.

**Questions:**

1. What is gel electrophoresis used for?

2. What is the filter that sorts the DNA?

3. What makes the DNA move?

4. DNA migrates to the ____________ end of the gel.
5. True or False: Long strands of DNA migrate farther than short strands of DNA.
6. Why do we stain the gel?

7. Why do we add buffer into the gel mix?

8. What is the gel comb used for?

9. True or False: buffer keeps the gel from drying out.
10. Why add the loading buffer to the DNA sample?
11. Why do we also run a standard?
12. True or False: the red wire will generate a negative charge.
13. True or False: because DNA is negatively charged, it will migrate to the negative pole.
14. How do we know that the current is running in the gel box?

15. Ethidium bromide fits between the ___________ of the DNA ladder and shows up under _______________ light.

16. Write down your DNA estimates below.

(largest (1) to smallest (3)) \( \text{bp}= \) base pair

1 ________________bp

2 ________________bp

3 ________________bp
Virtual PCR Questions:

1) The human genome is composed of over ________________ chemical base pairs.

2) The ________________________________ or PCR is used to make copies of DNA.

3) PCR can generate over 100 ________________ copies of DNA in hours.

4) What is the purpose of PCR?

5) _____, _____, _____, and _____ are the nucleotides needed to _____ copies of DNA

6) What is DNA Polymerase?

7) What can DNA Polymerase withstand that other enzymes cannot?

8) What does a DNA Thermal Cycler do?

9) When the temperature cools to 50 degrees Celcius, the single strands of DNA do what?

10) When the temperature is 72 degrees Celcius, DNA polymerase ________________

11) When do your desired fragments start to appear?

12) On cycle ________________, you have over a billion copies of DNA.
Cloning: A Virtual Lab

Name:__________________________________
Block:_________

Objective: Use the laptops to learn the basics about cloning and stem cells.

Warm-up question: Do cells in your brain and cells in your big toe contain the same DNA?

Procedure:

1. ____ Go to http://learn.genetics.utah.edu/ and click on “cloning” at the bottom of the page. Under the mice and sheep in the blue box click on “what is cloning?”

2. ____ Read this page quickly and watch the videos. Make sure to answer the questions below in your lab book.

   Q1.  What is cloning?

   Q2.  What are the two methods of cloning? Pay close attention to the second making sure you understand it.

   Q3.  What is a somatic cell?

   Q4.  How does somatic cell nuclear transfer (SCNT) differ from the natural way of making an embryo? In other words, why are we not clones of our mother or father?

3. ____ After you have answered the questions above and feel you have a firm grasp on cloning you are ready for the next activity. Click the back button on your internet browser to go to the previous web page. Underneath the yellow box with the mice in it click on “click and clone.”

4. ____ Go through the activity and follow the instructions carefully. During the activity you will be provided with information to answer the following question in your lab book.

   Q5.  Which mouse are you cloning? From which mouse are you getting the egg cell? Which mouse will be the surrogate mother?

   Q6.  The somatic cell you use will be a cumulus cell. What is a cumulus cell?

   Q7.  What is the purpose of the blunt pipette?
Q8. What is enucleation?

Q9. How long do the enucleated egg cell and its “new” nucleus need to adjust to one another?

Q10. What is another term for cell division?

Q11. What is a morula?

Q12. In 1998 scientists at the University of Hawaii did this cloning experiment, what was the name of the mouse they created?