

# SI Genetics- Full Discipline Demo

## DNA Extraction, Amplification, and Analysis

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### Final Report - Answer Guide

|                    |                                    |
|--------------------|------------------------------------|
| <b>Institution</b> | Science Interactive University     |
| <b>Session</b>     | SI Genetics - Full Discipline Demo |
| <b>Course</b>      | SI Genetics- Full Discipline Demo  |
| <b>Instructor</b>  | Sales SI Demo                      |

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### Test Your Knowledge

Match each term with the best description.

Terms to match:

- ⌘ Lysis
- ⌘ *Taq* polymerase
- ⌘ Deoxyribonucleic acid
- ⌘ Polymerase chain reaction
- ⌘ Annealing

Descriptions to match:

- 1 Heat-stable enzyme that creates new DNA fragments from existing templates
- 2 Treating a sample with detergents and enzymes to break down surrounding membranes
- 3 Molecule composed of two chains of nucleotides wound in a double helix
- 4 Biomolecular technique utilized to amplify DNA outside of an organism
- 5 Cooling denatured DNA to bond primers

Correct answers:

- 1 *Taq* polymerase    2 Lysis    3 Deoxyribonucleic acid  
4 Polymerase chain reaction    5 Annealing

Identify each statement as true or false.

|                                                                                                                    |                     |
|--------------------------------------------------------------------------------------------------------------------|---------------------|
| <p>⚡</p> <p>Gel electrophoresis is a biomolecular technique used to identify DNA fragments by size and charge.</p> |                     |
| <p>⚡ Small molecules travel through the agarose gel more slowly than large molecules.</p>                          |                     |
| <p>⚡</p> <p>Computer programs are used to analyze DNA reads and compare matching segments between organisms.</p>   |                     |
| <p>⚡</p> <p>DNA sequencing begins by performing PCR on the target DNA strand using only standard PCR reagents.</p> |                     |
| <p><b>True</b></p>                                                                                                 | <p><b>False</b></p> |
| <p>1</p>                                                                                                           | <p>2</p>            |

Correct answers:

1

Gel electrophoresis is a biomolecular technique used to identify DNA fragments by size and charge.

Computer programs are used to analyze DNA reads and compare matching segments between organisms.

2

Small molecules travel through the agarose gel more slowly than large molecules.

DNA sequencing begins by performing PCR on the target DNA strand using only standard PCR reagents.

## Exploration

The arrangement of the \_\_\_\_ DNA nucleotides creates the genetic code unique to all organisms.

- ☐ three
- ☒ four ✓
- ☐ six
- ☐ eight

PCR reactions require \_\_\_\_.

- ☐ primers
- ☐ template DNA
- ☐ nucleotides
- ☒ All of the above ✓

Each dyed sample line in a completed gel is compared to the lines of the ladder to determine the number of base pairs in the fragment.

- ☒ True ✓
- ☐ False

DNA sequencing involves a set of laboratory techniques for determining the order of \_\_\_\_ in a segment of DNA.

- ☐ acids
- ☐ ladders
- ☒ nucleotides ✓
- ☐ sugars

## Exercise 1

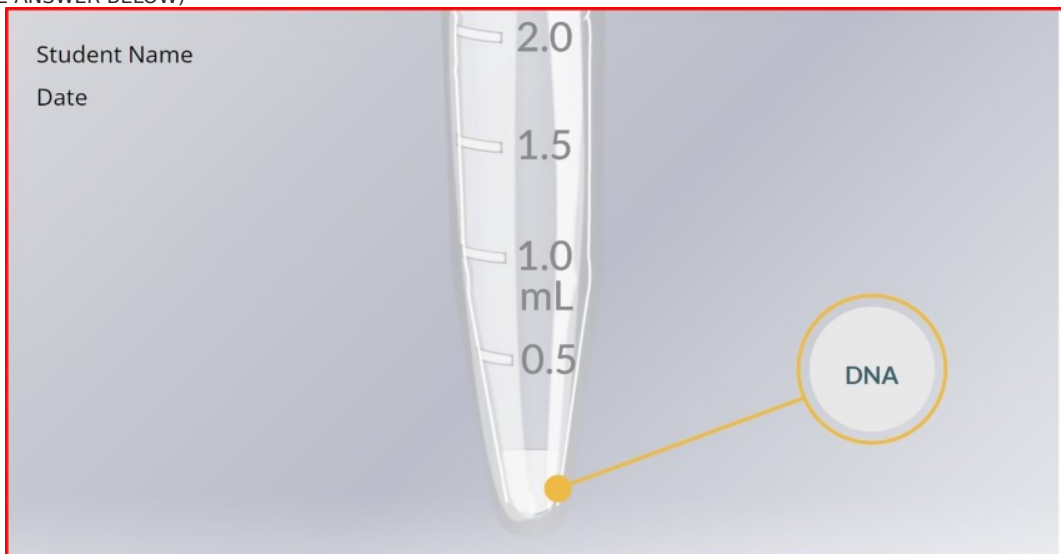
**What are the functions of the lysis solution, salt, and alcohol in the extraction of DNA performed in this exercise?**

0 / 10000 Word Limit

**Why was the DNA sample centrifuged first before the purification step and then secondly after the purification step in this exercise?**

0 / 10000 Word Limit

**Photo 1: Extracted DNA Sample**  
(SAMPLE ANSWER BELOW)



## Exercise 2

Describe what occurred during each step of the PCR process (denaturation, annealing, extension) that the PCR machine cycled through in this exercise.

0 Word(s)

Which of the four suspects most likely is associated with the crime scene? Explain your answer by referencing your results recorded in Photo 2 and Data Table 1.

0 / 10000 Word Limit

Photo 2: Gel Results  
(SAMPLE ANSWER BELOW)





Data Table 1: DNA Fragment Length  
(SAMPLE ANSWER BELOW)

| Source      | Length (bp) |
|-------------|-------------|
| Crime Scene | 484         |
| Suspect 1   | 1817        |
| Suspect 2   | 2000        |
| Suspect 3   | 484         |
| Suspect 4   | 358         |

## Exercise 3

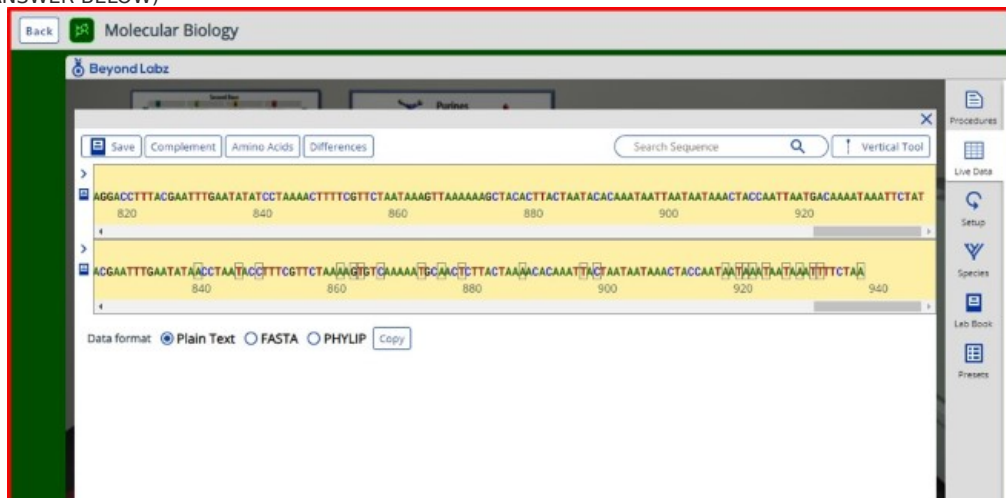
**Describe what the difference is between the reagents added to the microcentrifuge tubes used for gene sequencing and those used for gel electrophoresis. How does this PCR setup prepare the samples for the different ways that the DNA will be analyzed?**

PCR associated with gene sequencing uses standard PCR reagents with the addition of dyed chain-terminating dideoxynucleotide triphosphates (ddNTPs). The ddNTPs attach at the ends of the amplified DNA chains which are marked with a particular color of dye depending on the base (A, T, C or G) that is carried. The amplified, color marked DNA fragments are next loaded into a sequencing machine that uses capillary electrophoresis and chromatograms to identify individual, color-marked nucleotides.

**How would the results of gene sequencing performed in this exercise differ if two more closely related fly species were sampled? Reference your results recorded in Photo 3 and Data Table 2 in your explanation.**

The DNA reads of two more closely related fly species would be expected to have fewer base pair differences between nucleotides 840-940 than the 24 differences recorded in Photo 3 and Data Table 2 of the fruit fly and house fly species compared in this exercise.

Photo 3: Gene Sequencing Results  
(SAMPLE ANSWER BELOW)





Data Table 2: Nucleotide Differences in ND1 Gene  
(SAMPLE ANSWER BELOW)

|                 |    |
|-----------------|----|
| Segment 840-940 | 24 |
|-----------------|----|

## Competency Review

**A DNA molecule is composed of two chains of \_\_\_\_ wound in a double helix.**

- ☐ proteins
- ☐ lipids
- ☐ starches
- ☒ nucleotides



**During the salting step of DNA extraction, the sample is treated with a concentrated salt solution to clump the \_\_\_\_ released by the lysis of membranes.**

- ☒ lipids and proteins ✓
  - ☐ sugars and starches
  - ☐ nucleotides
  - ☐ enzymes
- 

**During the \_\_\_\_ step of PCR, annealed DNA is heated to 72°C which is the optimal temperature for enzyme-induced DNA replication.**

- ☐ denaturation
  - ☐ annealing
  - ☒ extension ✓
  - ☐ purification
- 

**The three-step PCR process is repeated for 30-40 cycles to amplify sufficient quantities of DNA for analysis.**

- ☒ True ✓
  - ☐ False
- 

**Gel electrophoresis uses \_\_\_\_ to separate DNA fragments.**

- ☐ dye
  - ☐ light
  - ☐ sound
  - ☒ current ✓
-

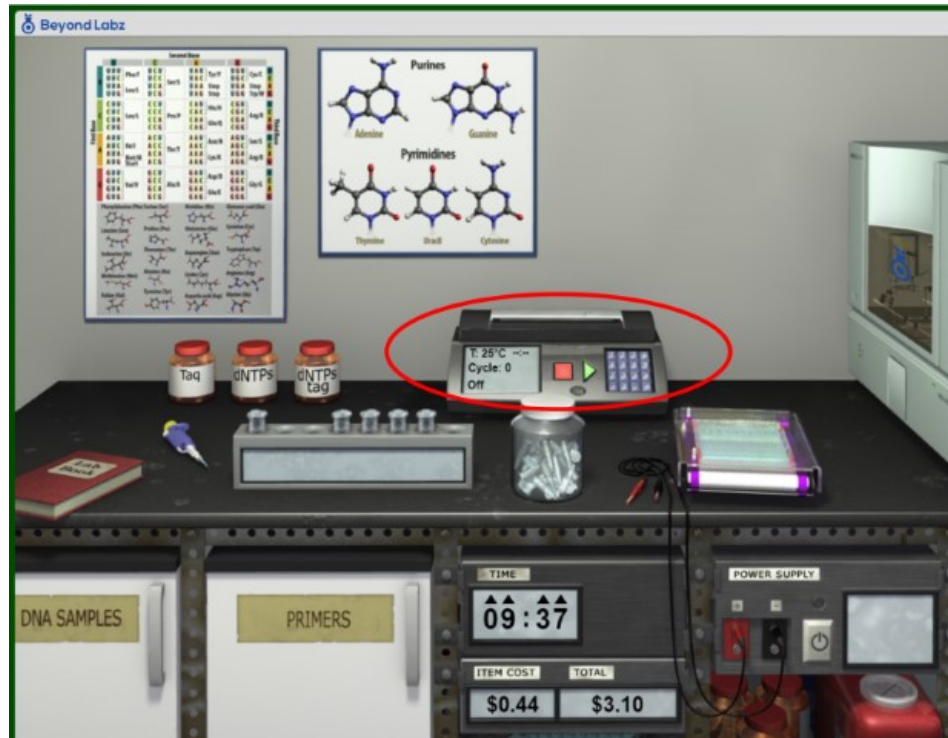
**The output of a DNA sequencing machine is called a \_\_\_\_.**

- ☒ read ✓
  - ☐ gel
  - ☐ pellet
  - ☐ well
- 

**A \_\_\_\_ is used to concentrate purified DNA at the end of the extraction process.**

- ☐ water bath
  - ☒ centrifuge ✓
  - ☐ thermocycler
  - ☐ sequencer
-

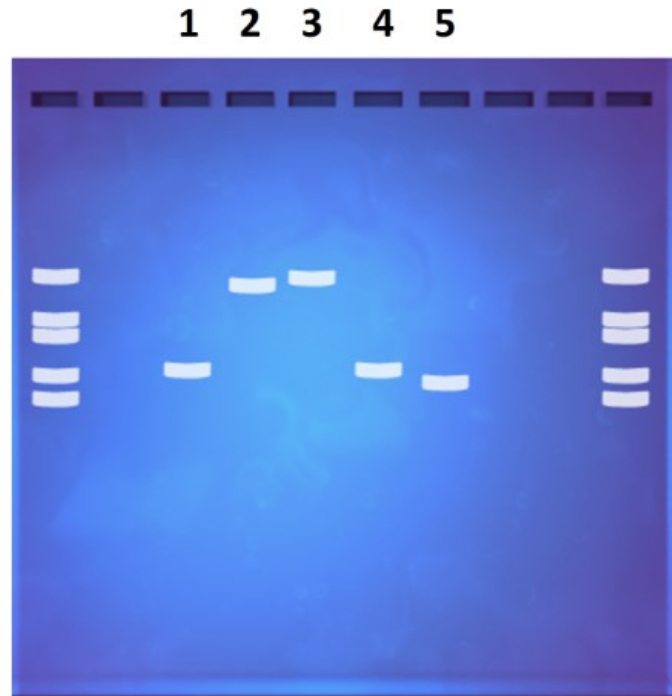
The circled device at the back of the image of the virtual molecular biology lab bench below is used for \_\_\_\_ DNA fragments.



- ☐ extracting
- ☒ amplifying
- ☐ sorting
- ☐ sequencing



DNA fragments \_\_\_\_ are the same size in the image of the electrophoresis gel below.



- ☐ 2 and 3
- ☐ 4 and 5
- ☐ 1 and 5
- ☒ 1 and 4



## Extension Questions

**Sarah, a molecular biologist, is a proud parent of two beagle puppies. After a day at work, Sarah arrived home to find her favorite pair of shoes with chew holes from dog teeth. Apply your knowledge of DNA extraction, amplification, and analysis to describe how Sarah could use her lab bench to determine which of her puppies destroyed her shoes. (SAMPLE ANSWER BELOW)**

Sarah could collect saliva from the chewed upon shoes and from each puppy and then perform the four-step process of DNA extraction to isolate pure DNA samples for amplification and analysis. Sarah could then add primers, nucleotides, enzymes and PCR reagents to each DNA sample and perform PCR for 30-40 cycles to amplify fragments for analysis by gel electrophoresis. After electrophoresis, Sarah could compare the well for the saliva sample from the shoe to the wells for the DNA samples from each puppy to determine which one(s) chewed her shoes.