## Case of the Crown Jewels

### Introduction

DNA restriction analysis is a technique with wide ranging applications in medicine, research, and forensics. The Case of the Crown Jewels is an activity that simulates the DNA fingerprinting process used by forensic scientists, which relies on restriction analysis to analyze DNA evidence from a fictional crime scene. DNA restriction analysis is based on the following assumptions:

* DNA molecules can be identified by a difference in the sequence of bases
* Enzymes, which are produced naturally by bacteria, cut DNA molecules at specific sites denoted by base sequences

When a restriction enzyme is used to cut different DNA molecules, the size of the fragments generated will be unique to each molecule. As shown in Figure 1, both DNA 1 and DNA 2 are cut with *Hae*III, an enzyme that cuts between the base pairs GG|CC and CC|GG.

**FIGURE 1: Restriction Digest of Two DNA Fragments**

DNA 1

ATGCCGGTGTACCGGTAAGTGTACGACCGGTGATAGATACGG TACGGCCACATGGCCATTCACATGCTGGCCACTATCTATGCC

Cut with *Hae*III

DNA 2

ATGCCATTGTACCGGTACCGGTACGACCAATGATAGATCCGG TACGGTAACATGGCCATGGCCATGCTGGTTACTATCTAGGCC

Cut with *Hae*III

ATGCC GGTGTACC GGTAAGTGTACGACC GGTGATAGATACGG TACGG CCACATGG CCATTCACATGCTGG CCACTATCTATGCC

|  |
| --- |
| ATGCCATTGTACC GGTACC GGTACGACCAATGATAGATCCCG TACGGTAACATGG CCATGG CCATGCTGGTTACTATCTAGGGC |
|  | Resulting Fragments |

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Resulting Fragments

**1 A 1B 1C 1D 2A 2B 2C**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ATGCC |  | GGTGTACC |  | GGTAAGTGTACGACC |  | GGTGATAGATACGG |  | ATGCCATTGTACC |  | GGTACC |  | GGTACGACCAATGATAGATCCCG |
| TACGG |  | CCACATGG |  | CCATTCACATGCTGG |  | CCACTATCTATGCC |  | TACGGTAACATGG |  | CCATGG |  | CCATGCTGGTTACTATCTAGGGC |

After being cut by restriction enzymes, DNA fragments remain mixed in solution and indistinguishable from one another. One way to distinguish between the different fragments created is to compare them by size. Different size fragments of DNA can be separated using gel electrophoresis. Gel electrophoresis is a technique for separating molecules based on the differential movement of charged particles through a matrix when subjected to an electric field. In non-technical terms, DNA is negatively charged, thus, when in the presence of an electric current, DNA will travel according to size (smallest pieces first) towards the positive electrode. By comparing the resulting pattern of DNA fragments on the gel, the DNA strands can be differentiated.

**FIGURE 2: Gel Electrophoresis of Fragments from Restriction Digest with *Hae*III**

Negative Electrode (-)

**Size Marker**

**DNA 1**

**Sample Wells**

*DNA is loaded here*

20 bp **2C**

**1C**

Migration

15 bp **1D**

**2A**

10 bp

**1B**

**2B**

5 bp **1A**

Positive Electrode (+)

bp – base pairs

**Objective:** Working in groups (forensic teams), you will simulate DNA restriction analysis using paper DNA strands and scissors to solve a fictional crime “who stole the crown jewels.”

# CITY POLICE DEPARTMENT

**C O N F I D E N T I A L**

##### POLICE REPORT

**INCIDENT DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| **Incident Type:** | Museum Theft | **Complaint Status:** | Pending DNA Results |
| **Processed by:** | Officer Joe Friday | **Other Officers:** | Officer Dee EnaeOfficer Ligase |

 **PROPERTY**

|  |  |  |  |
| --- | --- | --- | --- |
| **Property Code:** | Jewelry/Precious Metal | **Owner’s Name:** | City Museum |
| **Name:** | Crown Jewels | **Value:** | $1,000,000 |

 **BURGLARY DATA**

**Method of Entry:** Unlawful Entry through broken window

**Narrative:** The crown jewels were allegedly stolen from the City Museum. Once on the scene I noted that the only window in the room was broken. Officer Ligase approached me and said that there were no prints or any apparent evidence left at the crime scene. However, upon further inspection of the window, my partner, Dee Enae, noticed that there was some blood on the sill. The thief had cut himself on the broken glass. The blood sample was collected and sent to the crime lab via the messenger, R. Renee, who gave the package to the technician Edna N. Zime.

 **SUSPECT DATA**

**Suspect Number: 1**

**Name**: **Pockets Peterson**

**Brief Description of Suspicion:** A widely known and successful crime thief. Peterson has been known to brag that he could get by any security system. He said he would prove it by someday taking the crown jewels. No stone has been known to have higher security.

**Suspect Number: 2**

**Name: Cruella “The Cat” Blanchard**

**Brief Description of Suspicion:** Owns the largest private collection of precious stones in the world. She has offered millions of dollars for them. Having been a member of the prestigious ninja swat team, she has the talent and guts to pull off such a crime.

**Suspect Number: 3**

**Name: Professor Angstrom**

**Brief Description of Suspicion:** Past curator of the museum that housed the crown jewels. He was recently fired from his job and replaced by the boss’s niece. His motive may be revenge.

**Suspect Number**: **4**

**Name: The Resident Scientist**

**Brief Description of Suspicion:** Credited for discovery of the crown jewels. She claims they are rightfully hers.

 **CRIME LAB DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| **Crime Lab Investigator:** | Edna N. Zime | **Evidence Messenger:** | R. Renee |
| **List of Evidence Received:** | Plastic bag with Blood | **List of Procedures Used:** | DNA Extraction |
|  | DNA from four suspects |  | Polymerase Chain Reaction DNA restriction analysis |

**Narrative:** After receiving the package with the plastic bag marked *Crime Scene*, the crime scene DNA was extracted from the blood sample in the bag. Because the sample was so small the DNA was amplified using the polymerase chain reaction. Lab assistants used DNA isolated from four suspects and compared them to the crime scene DNA using DNA restriction analysis.

**Results:** See attached *DNA Results Poster* from lab assistants

**DNA EVIDENCE EVALUATION**

**C O N F I D E N T I A**

**L**

**WORK ONLY ON YOUR DNA SAMPLE**

1. Turn your paper strip with the DNA base sequences over so the side with the bases is facing you. Use your pen (restriction enzymes) to “cut” your DNA samples only where you see this base pattern: CCGG. Cut between the C and G as shown in this example:

 TACCGGTAATTCATCCGGTCAATTCTAGCGTAC

 ATGGCCATTAAGTAGGCCAGTTAAGATCGCATG

TACC ATGG

GGTAATTCATCC CCATTAAGTAGG

GGTCAATTCTAGCGTAC CCAGTTAAGATCGCATG

1. Count the number of base pairs (bp) in each piece of DNA that you have created. A base pair consists of two complementary bases. Record the number of base pairs in each underneath the DNA fragment.

GCTAATTCATCC CGATTAAGTAGG

**12 base pairs**

1. Mark the DNA sequences on the chart according to the number of base pairs. Be sure to put your sample in the proper column.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Crime** | **Suspect** | **Suspect** | **Suspect** | **Suspect** | **Number of** |
| **DNA** | **1** | **2** | **3** | **4** | **Base Pairs (bp)** |



**Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA**

GTCGACCGGTGACCGTGCGTACACAGTGCTCCGGATAGCTGATAGCTCCGGTG CAGCTGGCCACTGGCACGCATGTGTCACGAGGCCTATCGACTATCGAGGCCAC

**Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA**

#### GTCCCAGCCGGACCGTACCGGTAGATCAGCCGGTAGATTGATAGCGTGATGTG CAGGGTCGGCCTGGCATGGCCATCTAGTCGGCCATCTAACTATCGCACTACAC

**Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA**

#### GTCTACGTAATCGTAGCCATCCGGACAGTGTGCACGATCGTACATGCTACGTG CAGATGCATTAGCATCGGTAGGCCTGTCACACGTGCTAGCATGTACGATGCAC

**Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA**

#### GTCGACCGGTGACCGTGCGTACACAGTGCTCCGGATAGCTGATAGCTCCGGTG CAGCTGGCCACTGGCACGCATGTGTCACGAGGCCTATCGACTATCGAGGCCAC

**Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA**

#### GTCTCCATCCGGACTACCATACATCTGGTGTACCCGGTGATATCGTCCGGGTG CAGAGGTAGGCCTGATGGTATGTAGACCACATGGGCCACTATAGCAGGCCCAC

Names of Team Members:

**Name of the person who’s DNA was found at the crime scene:**

**Evidence:** Explain how you came to your conclusion (you may include diagrams and explanations):