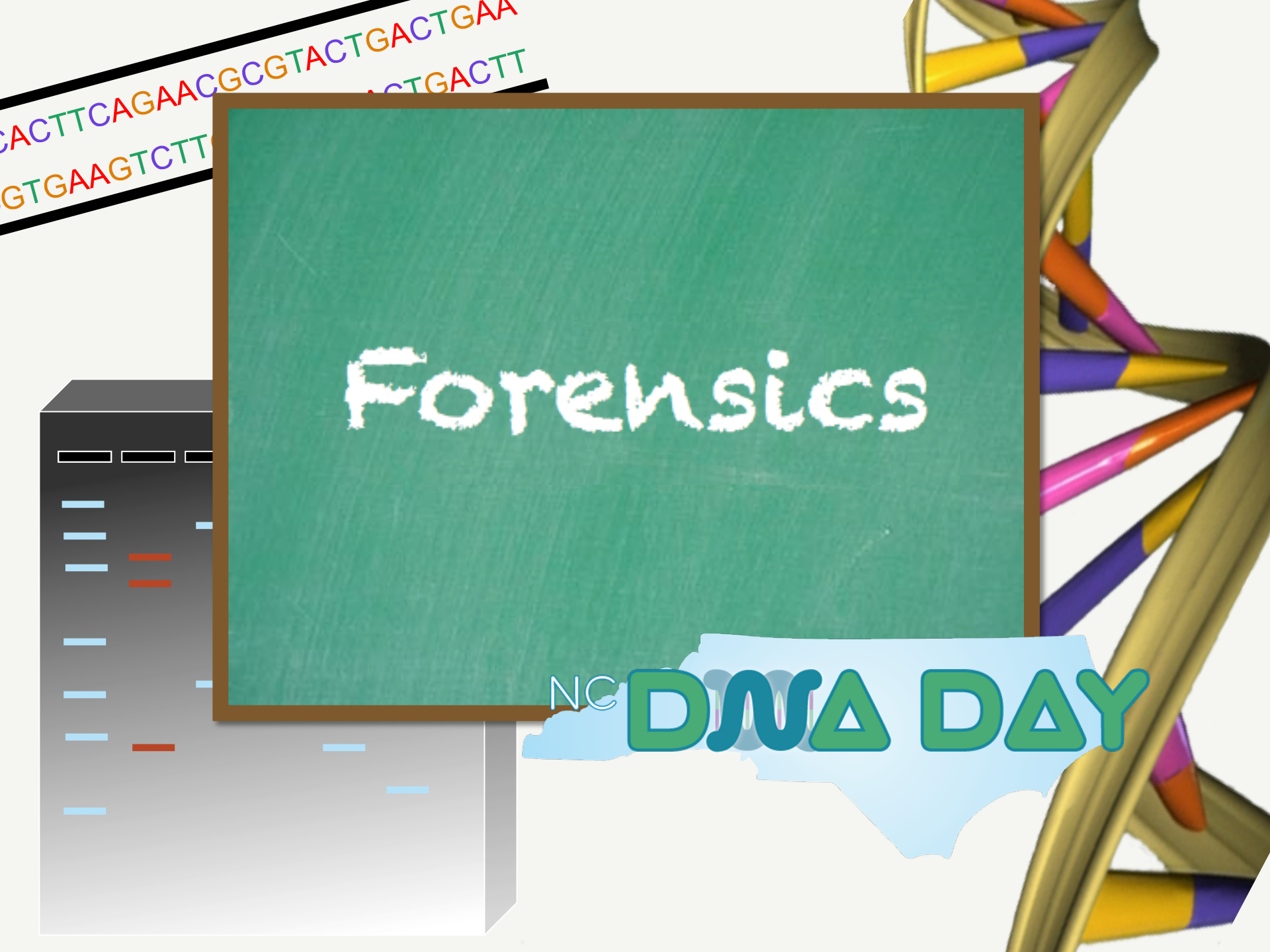

CACTTCAGAACGCGTACTGACTGAA
GTGAAGTCTT
ACTGACTT
Forensics
NC DNA DAY

What is DNA Day?

What is DNA Day?

April 1953

Drs. James Watson and Francis Crick determined the **structure of DNA** *(double helix)*

What is DNA Day?

April 1953

Drs. James Watson and Francis Crick determined the **structure of DNA** *(double helix)*

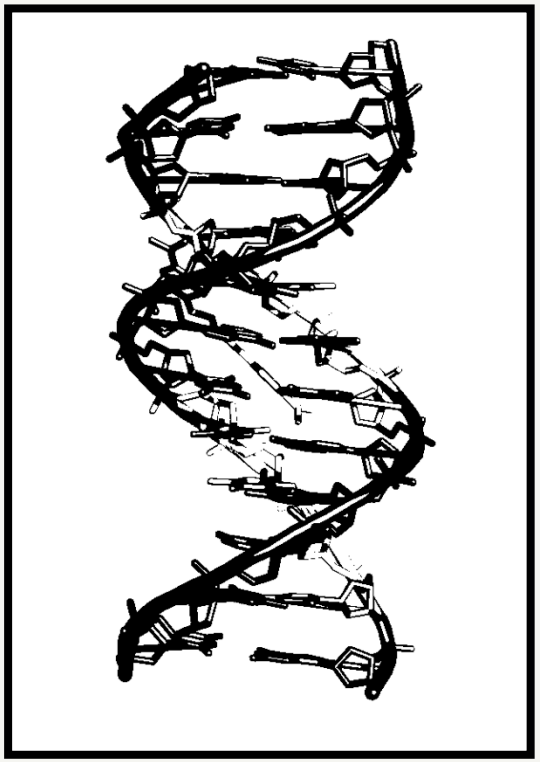
April 2003

Human Genome Project determined the **entire DNA sequence of a human** *(3 billion letters)*

Urgent Announcement from the Principal!

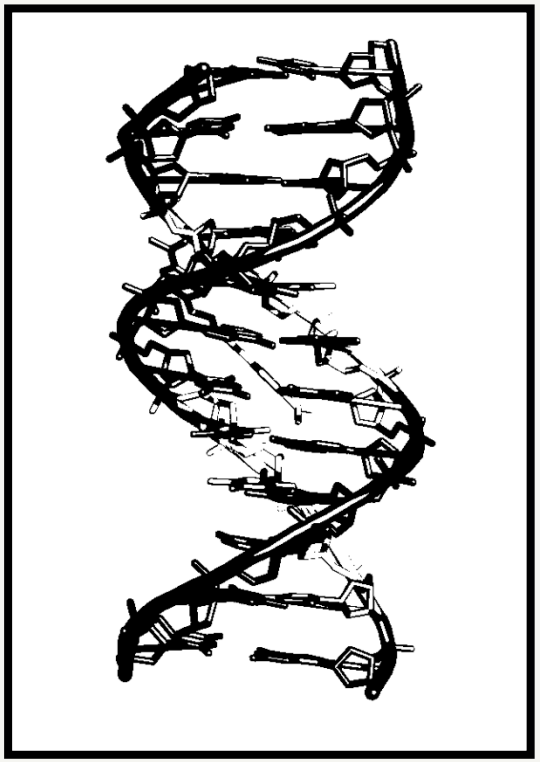
Read “Missing Mascot” Skit

DNA



DNA

- What does DNA stand for?



DNA

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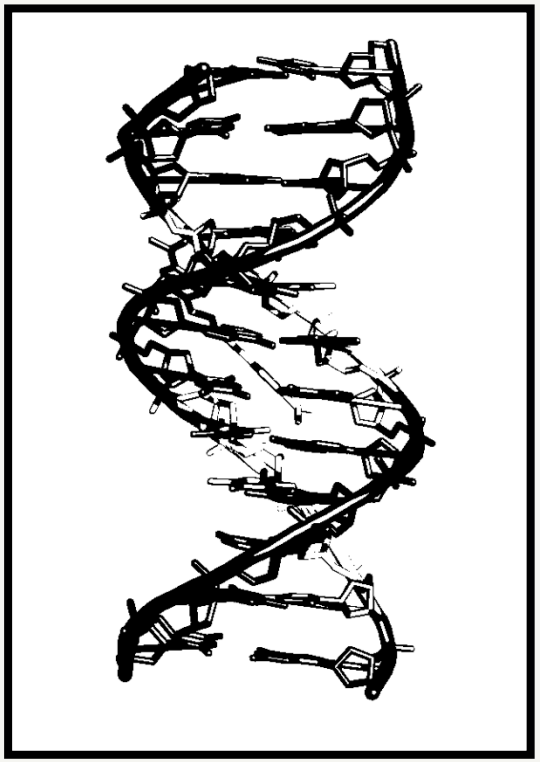

DNA

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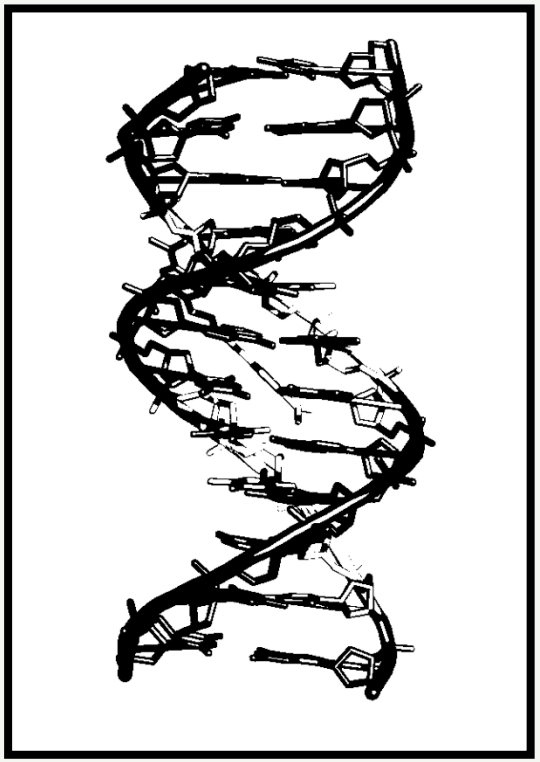
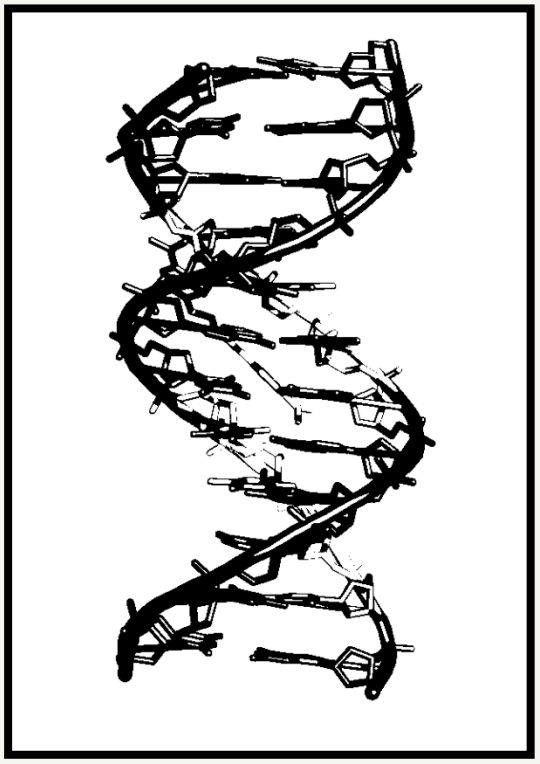
- What is the structure of DNA?



DNA

- What does DNA stand for?
- What is DNA?
- What is the structure of DNA?
- Is DNA negatively or positively charged?



The DNA Alphabet

The DNA Alphabet

- How many nucleotide bases in DNA are there?

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  FOUR

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- What are the names of these bases?

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  Guanine, Adenine, Cytosine and Thymine (G, A, C and T)

The DNA Alphabet

- How many nucleotide bases in DNA are there?

  FOUR

- What are the names of these bases?

  Guanine, Adenine, Cytosine and Thymine (G, A, C and T)

*The sequence of these letters make up our genes. The Human Genome Project determined the **order** of each of these letters in **all of our genes.***

Genes contain instructions to make proteins

Genotype

Information is stored in **DNA**

RNA copy

Phenotype

Protein

RNA Synthesis (transcription)

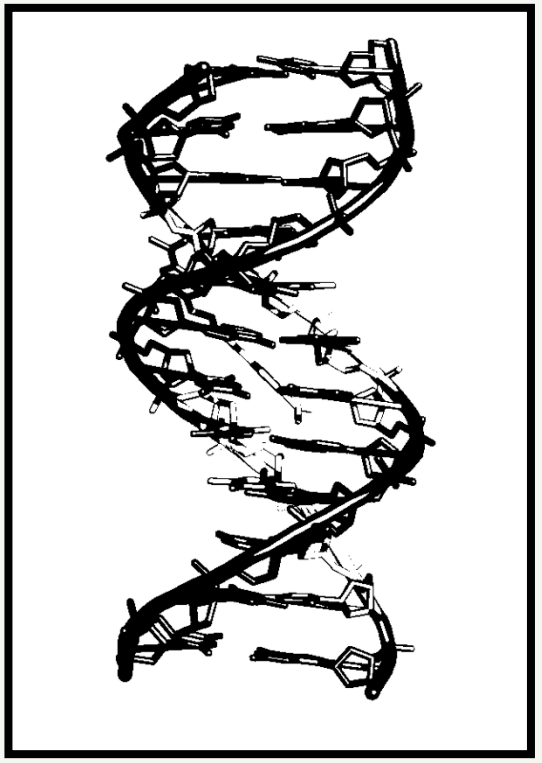
Protein Synthesis (translation)

Amino acids

What makes you YOU?

DNA

Let's discuss DNA and how forensic scientists analyze DNA so that you can solve this crime!



Facts & Figures about DNA

How many bases are there in the human genome?

Facts & Figures about DNA

How many bases are there in the human genome?

a) 3,000
b) 300,000
c) 3 million
d) 3 billion
e) 3 trillion

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Facts & Figures about DNA

We are not all exactly the same – What percent of your DNA is similar to any other person in the world?

Facts & Figures about DNA

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b) 98%
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Facts & Figures about DNA

We are not all exactly the same – What percent of your DNA is similar to any other person in the world?

3 MILLION bases are different!

Facts & Figures about DNA

Forensic scientists focus on these variable regions to generate a “DNA fingerprint” for each individual

What are some sources of DNA?

What are some sources of DNA?

Sweat

Blood

Skin

Semen

Urine

Mucus

Tissue

Ear Wax

Dandruff

Hair

Saliva

What are some sources of DNA?

Sweat Blood Skin Semen Urine

Mucus Tissue Ear Wax Dandruff Hair

Saliva

Ok forensics scientists…
Let's isolate DNA!

DNA Isolation Method

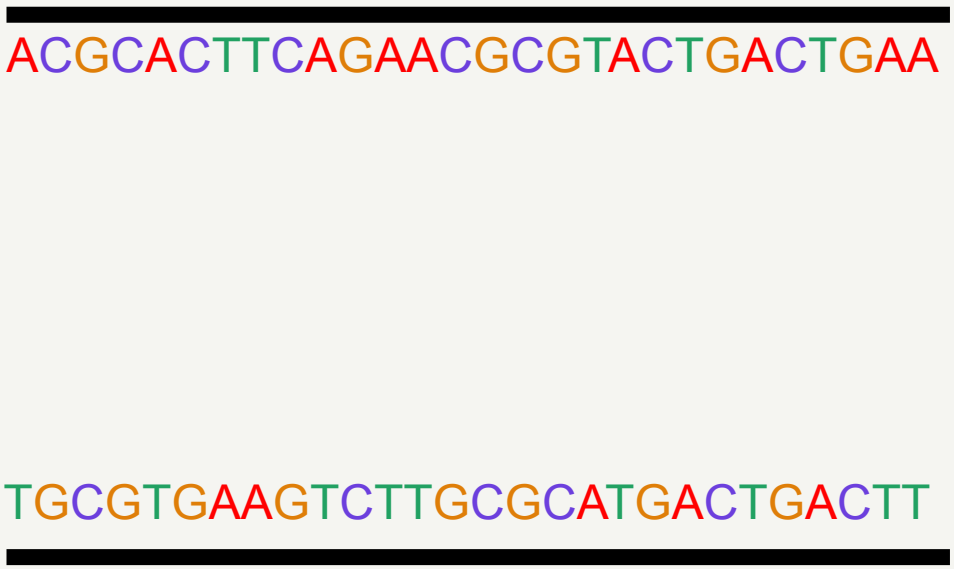
- **Step 1: Add your saliva to the tube**
- **Step 2: Add 1-2 drops of soap to tube and mix well**
- **Step 3: Add a pinch of salt and mix well**
- **Step 4: Add several droppers full of ethanol and mix well**
- **Step 5: Spool your DNA with stick**

How do forensic scientists get so much information from a tiny amount of DNA?

Polymerase Chain Reaction (PCR)

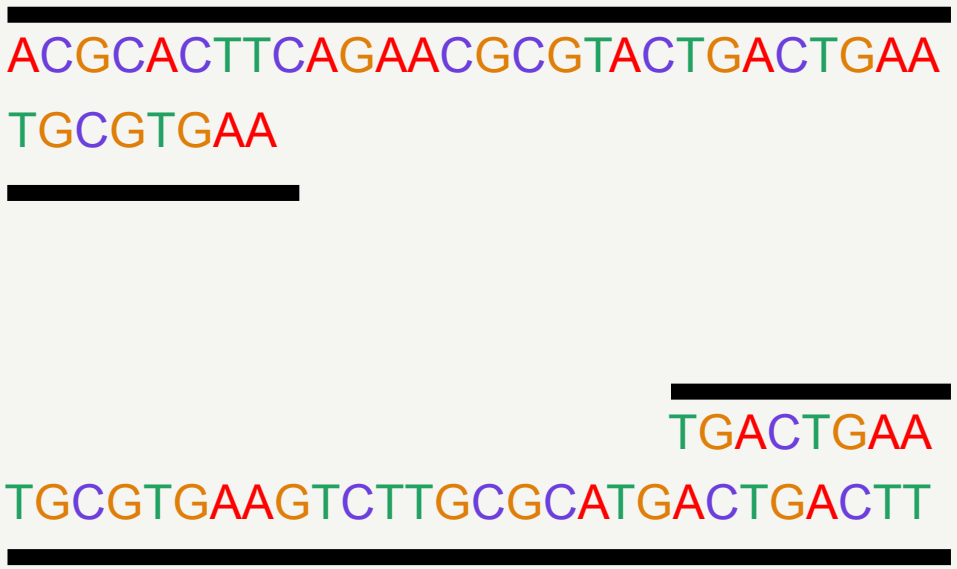
PCR can make many copies
in a very short period of time

Polymerase Chain Reaction (PCR)



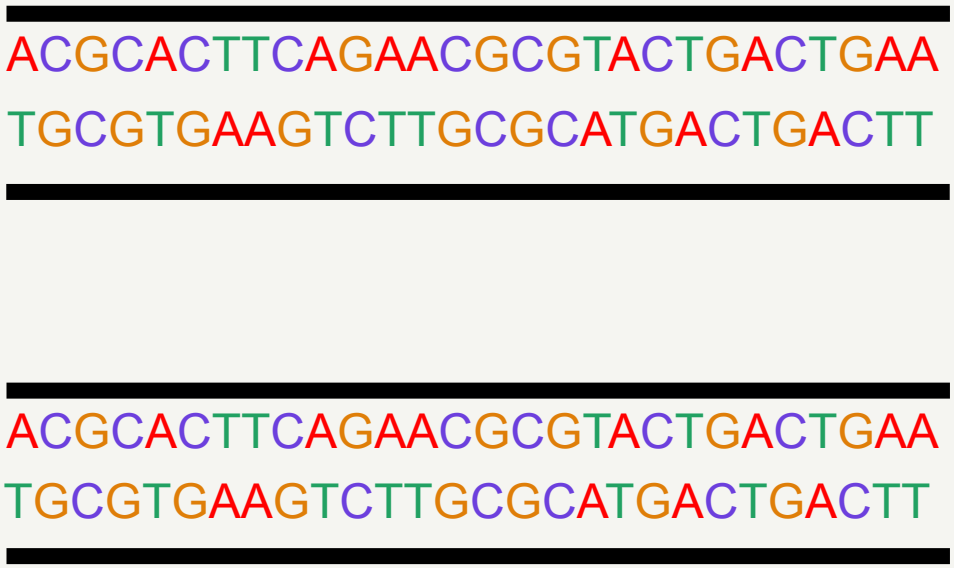
Heat to 94°C: Denature Strands of DNA

Polymerase Chain Reaction (PCR)



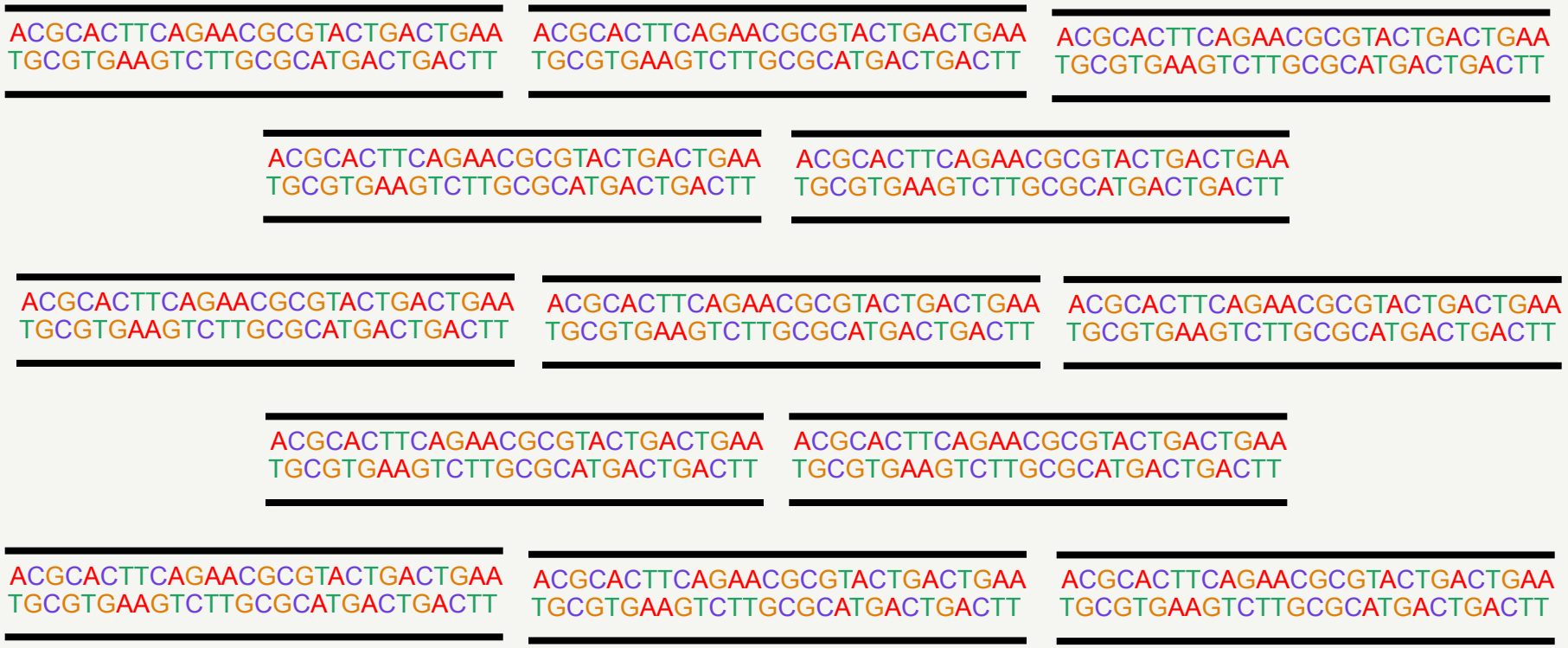
Cool to 55°C: Allow primers to anneal

Polymerase Chain Reaction (PCR)



Heat to 72°C: New DNA strand is synthesized

Polymerase Chain Reaction (PCR)



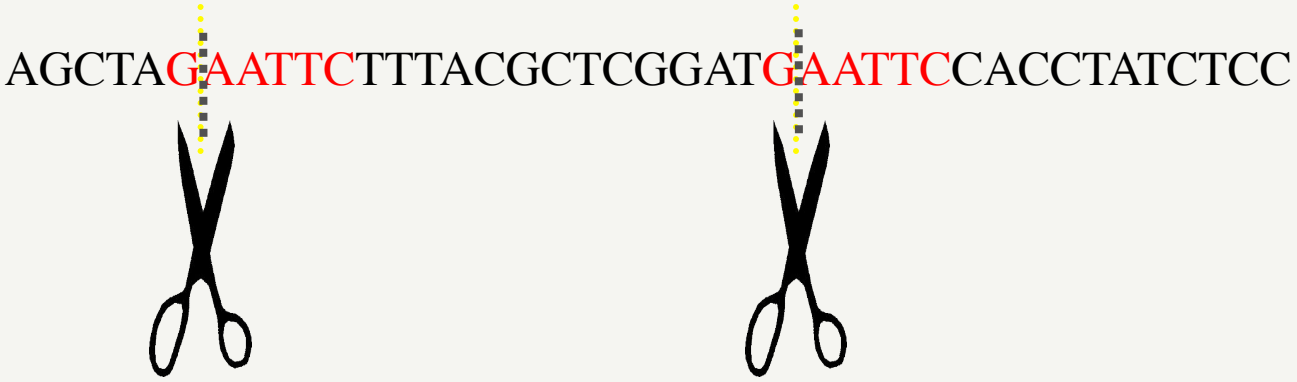
PCR can make many copies
in a very short period of time

…After amplification of the variable regions through PCR

How do we generate a DNA fingerprint?

Restriction Enzyme Digest

DNA can be cut into smaller pieces by restriction enzymes that recognize very specific sequences of DNA.



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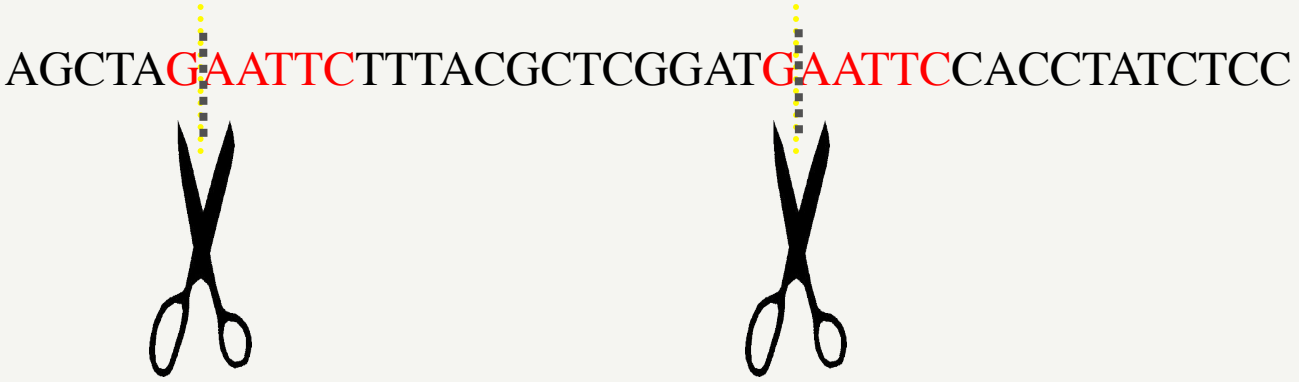
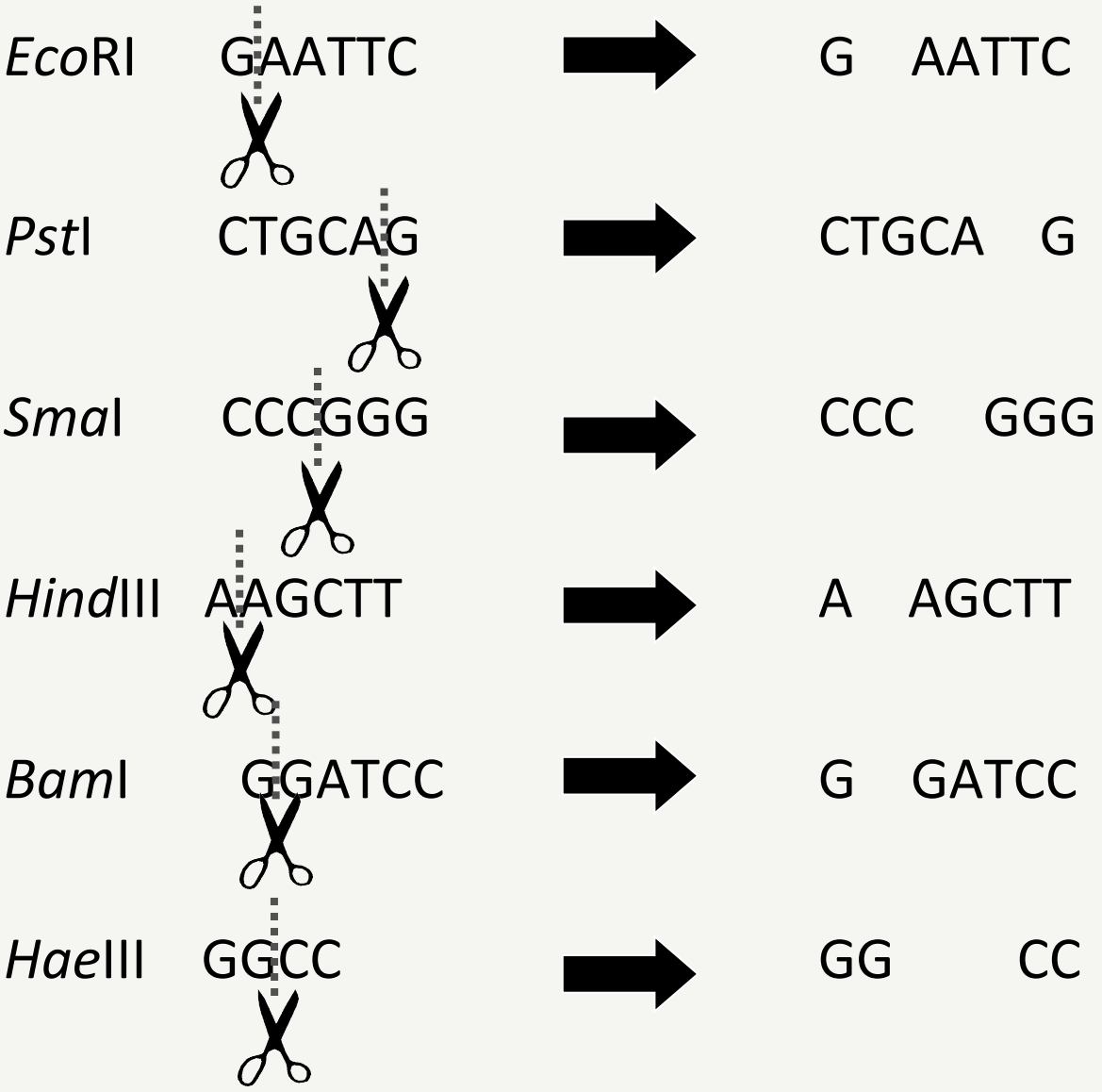


Multiple Restriction Enzymes Exist for Cutting DNA



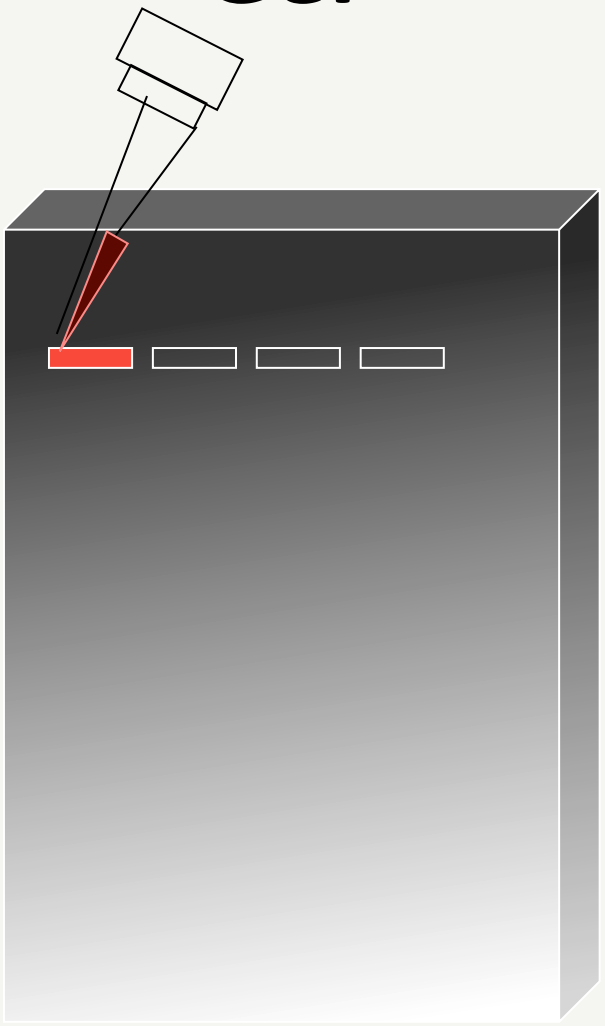
Analyzing DNA in an Electrophoresis Gel

An agarose gel is used to analyze the DNA.

This gel is a matrix and feels like jello.

Analyzing DNA in an Electrophoresis Gel

Marker is loaded in the first lane



Analyzing DNA in an Electrophoresis Gel

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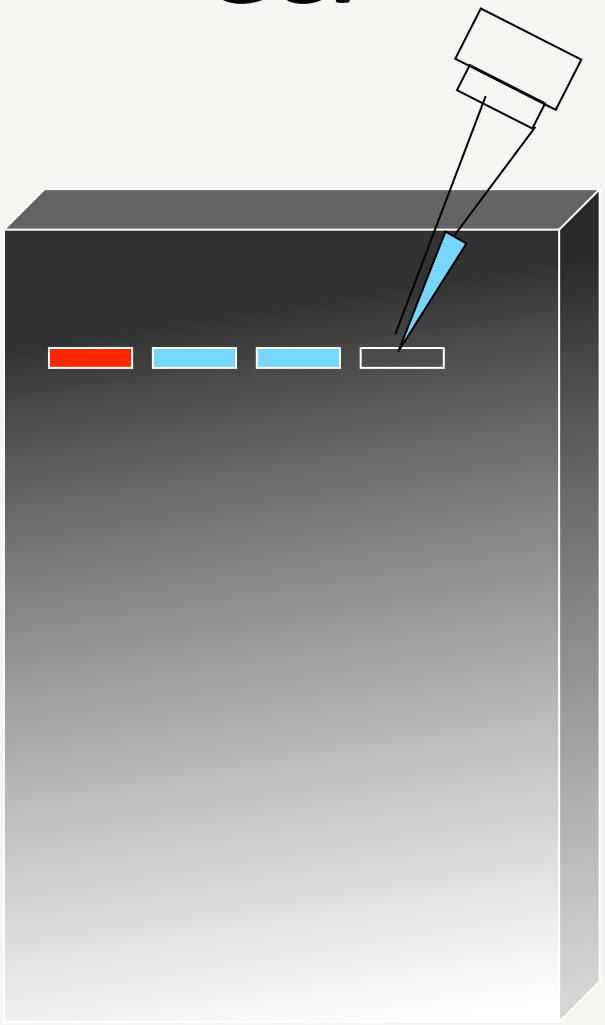
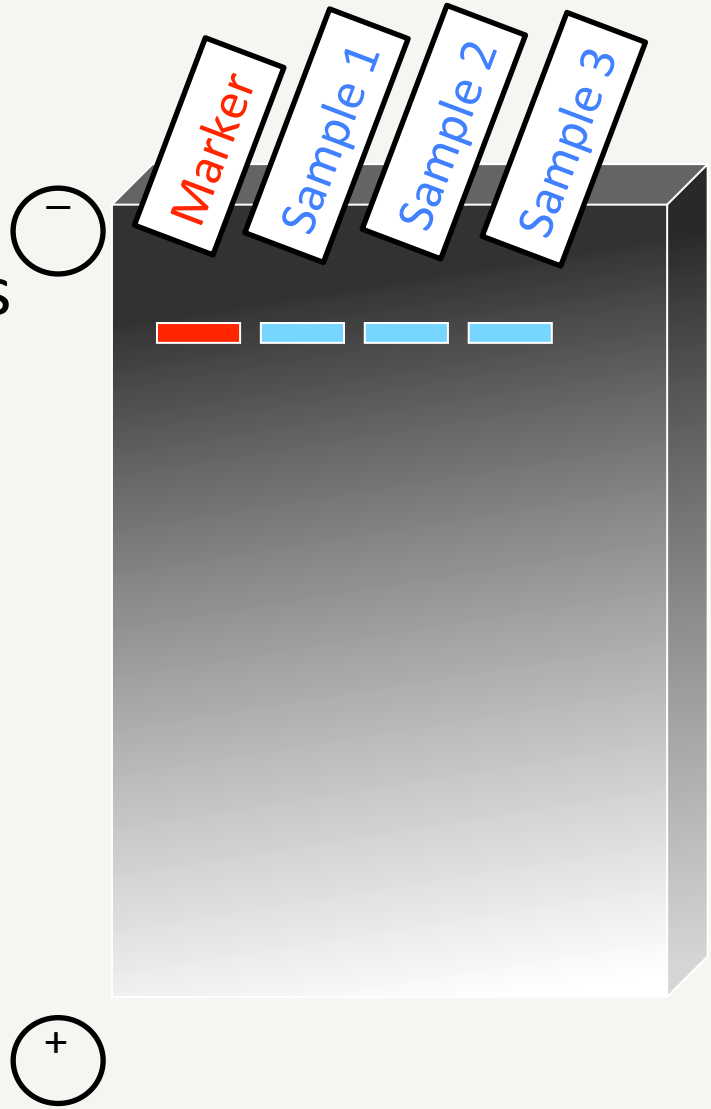


Samples are loaded in the rest of the lanes of the gel

Analyzing DNA in an Electrophoresis Gel

Electric current is applied and the negatively charged DNA moves towards the positive end of the gel



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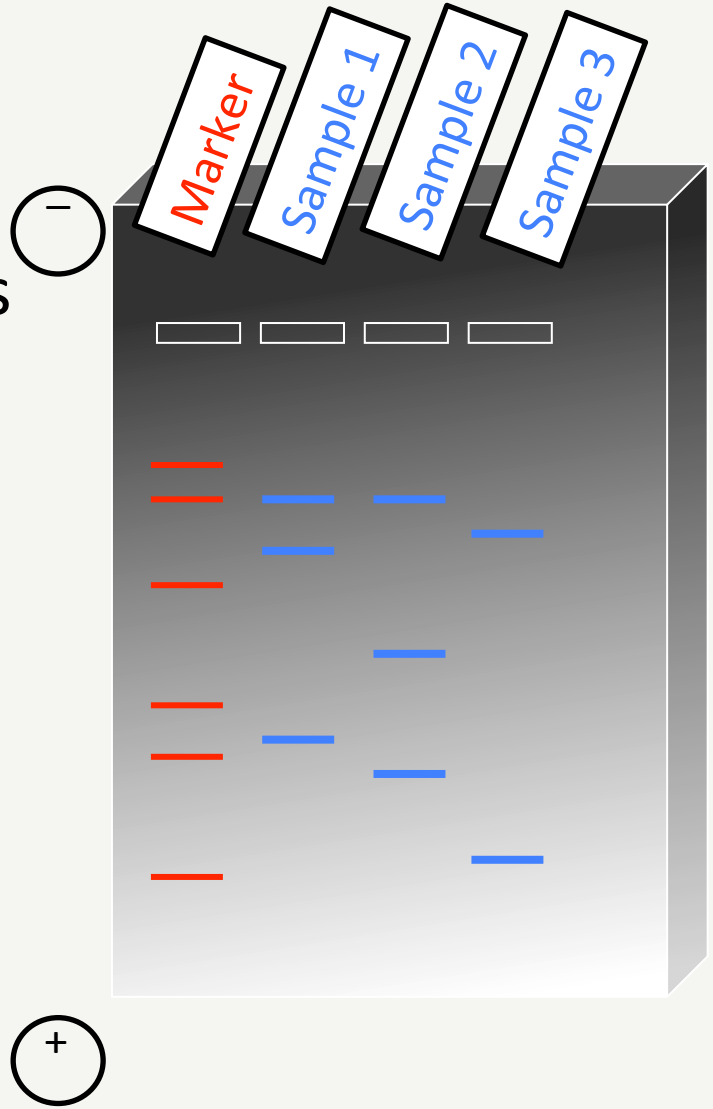

The DNA has to move through the small openings in the matrix of the gel. Which sizes move fastest through the gel?

Analyzing DNA in an Electrophoresis Gel

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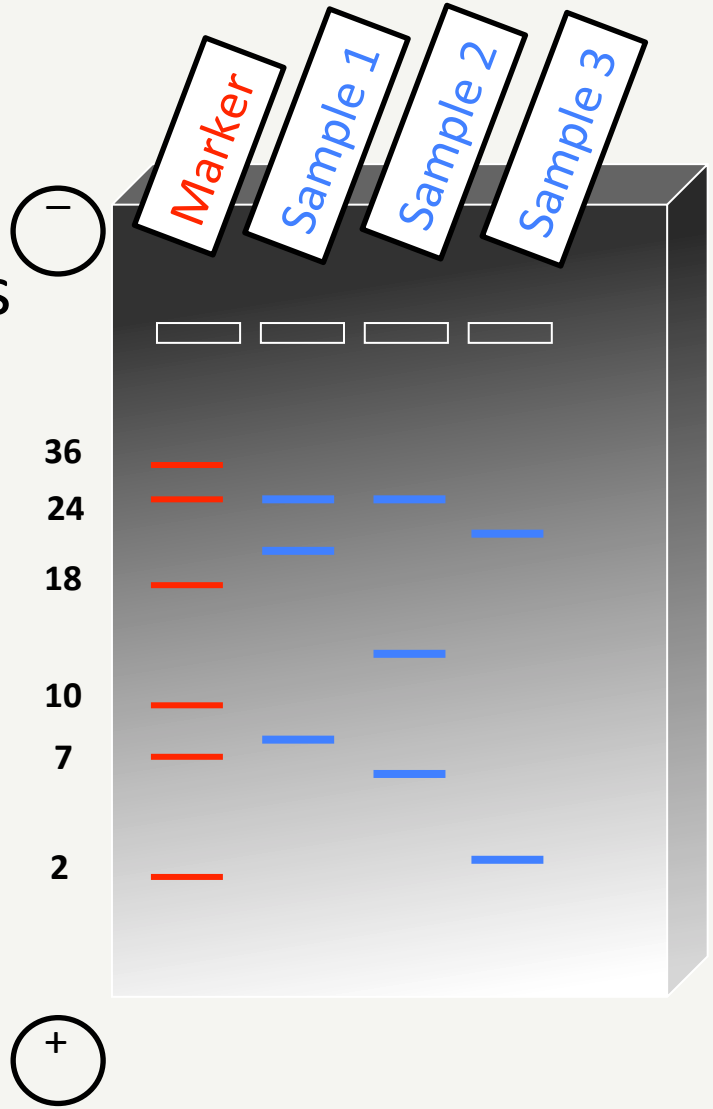

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Analyzing the DNA

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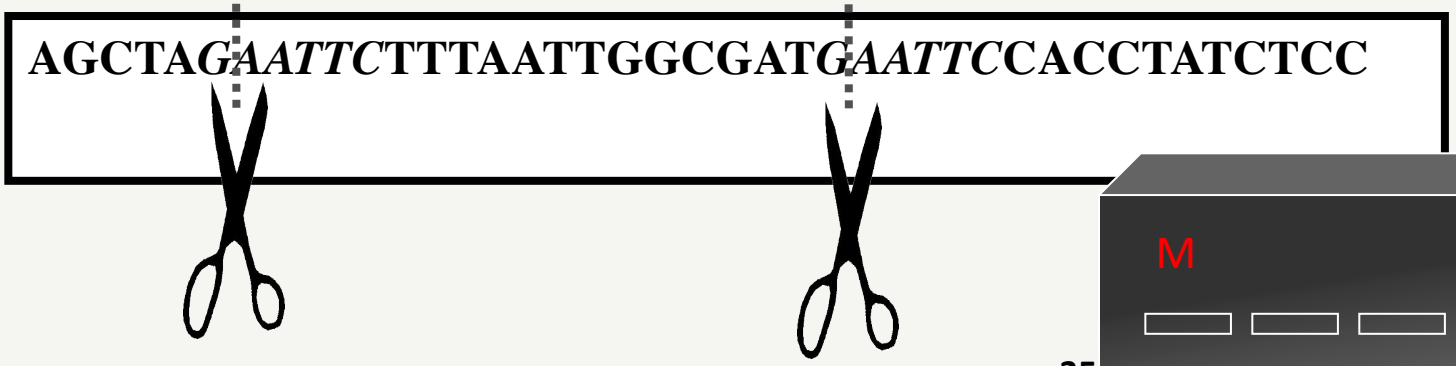
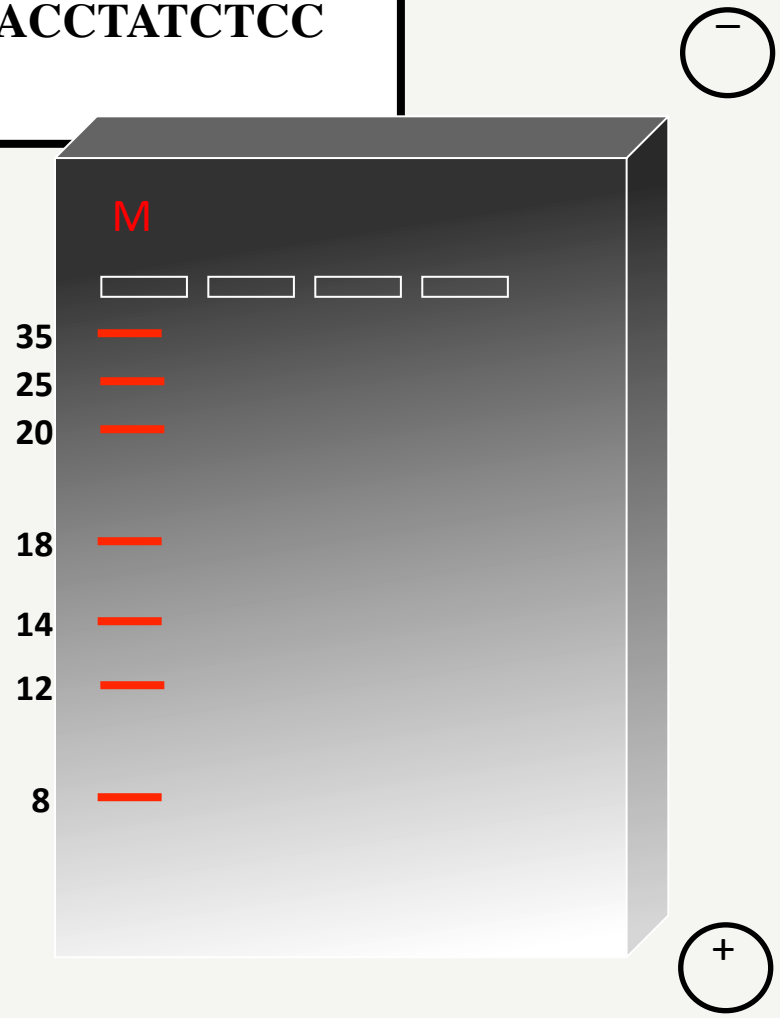
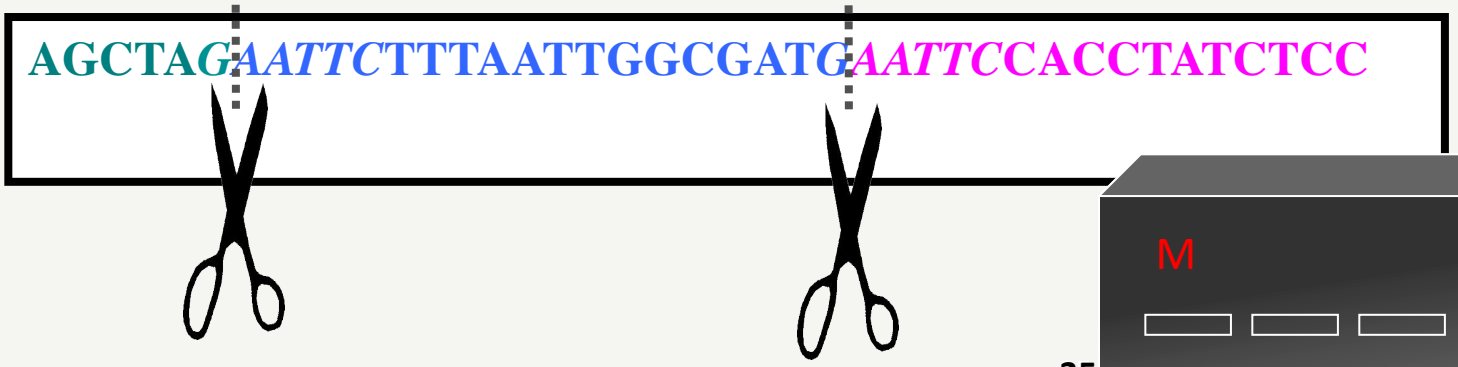


What are the predicted sizes of the DNA fragments after EcoR1 digestion?



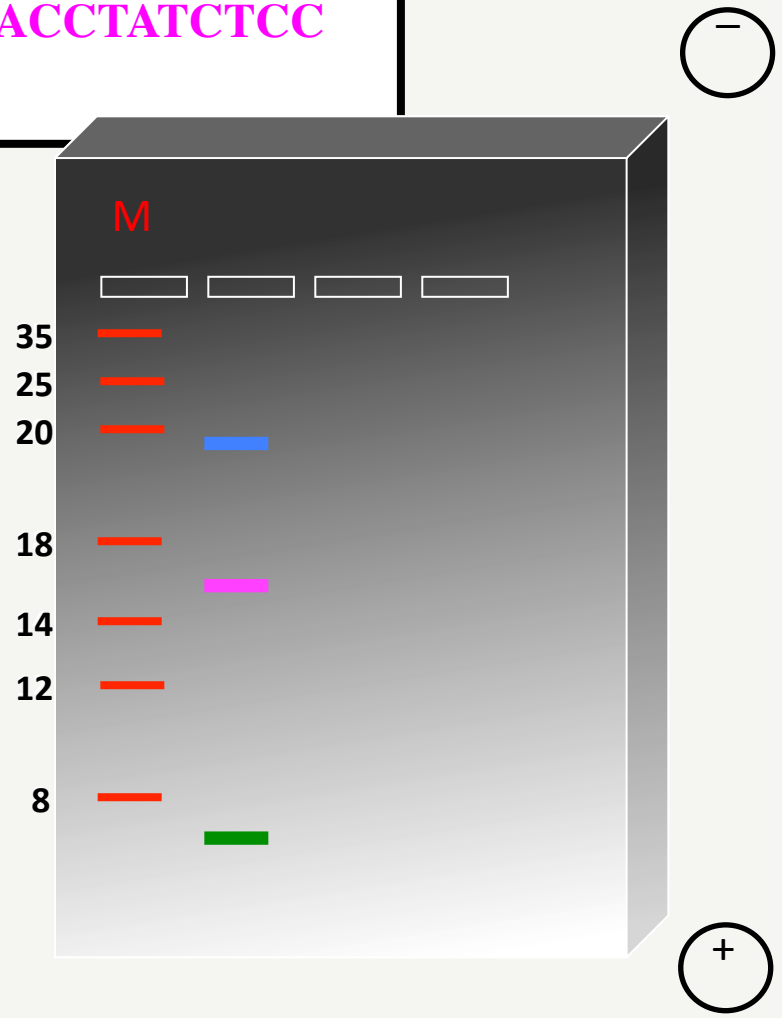
Analyzing the DNA



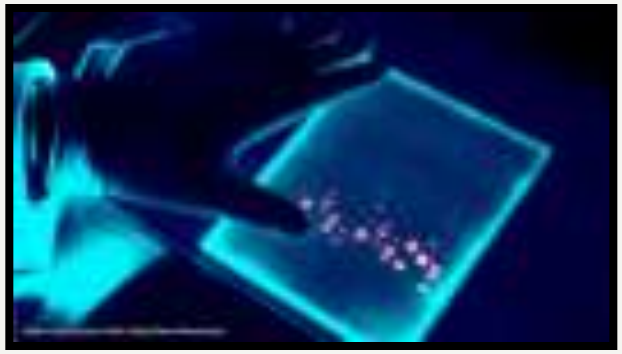
AATTCTTTACGCTCGGATG (19)

AATTCCACCTATCTCC (16)

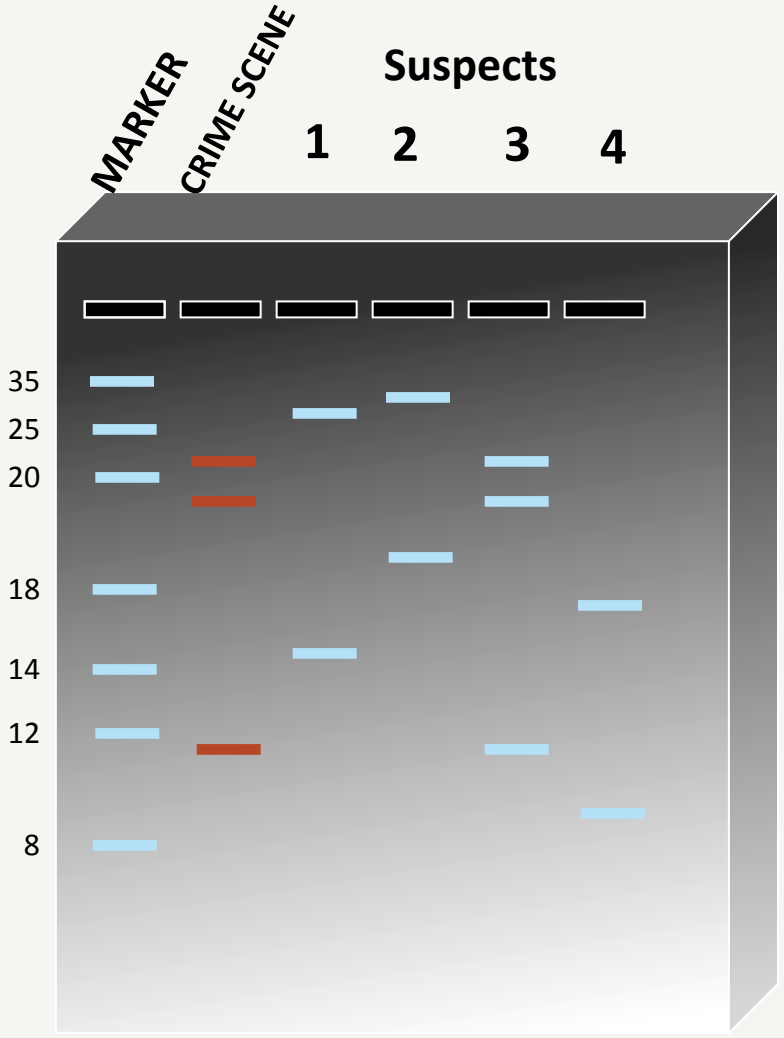
AGCTAG (6)



Solving the Crime



Because of variations in our DNA sequence, every person has a unique restriction digest pattern, allowing DNA from a crime scene to be matched to a particular suspect.



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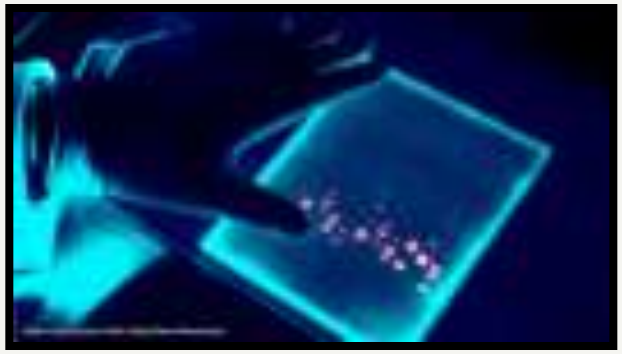

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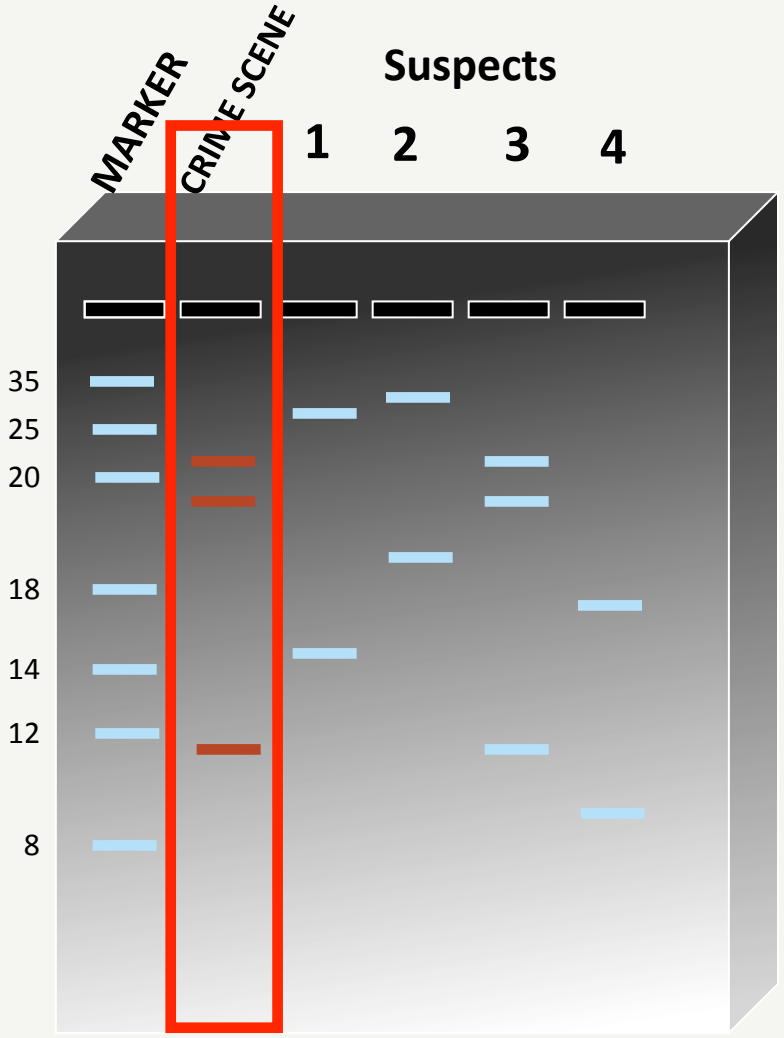

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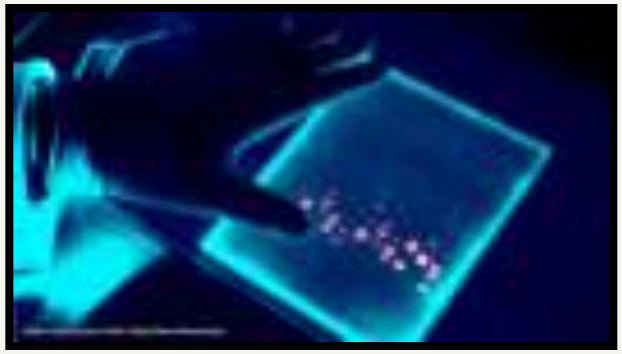

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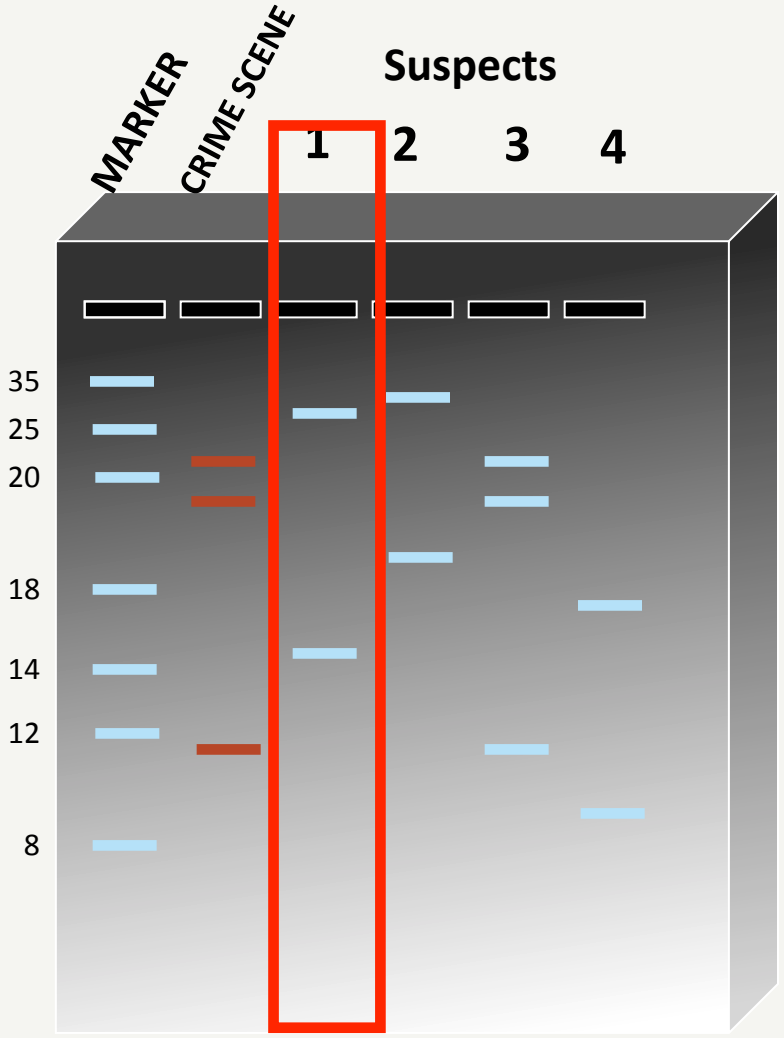

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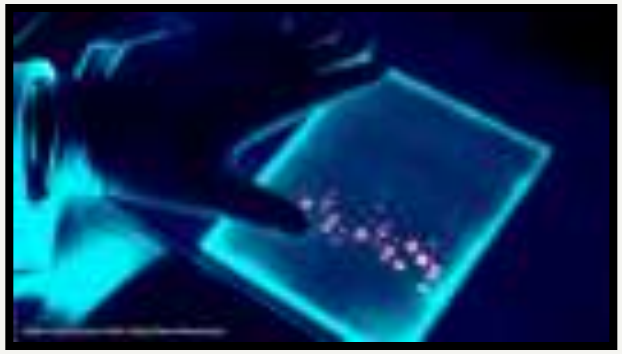

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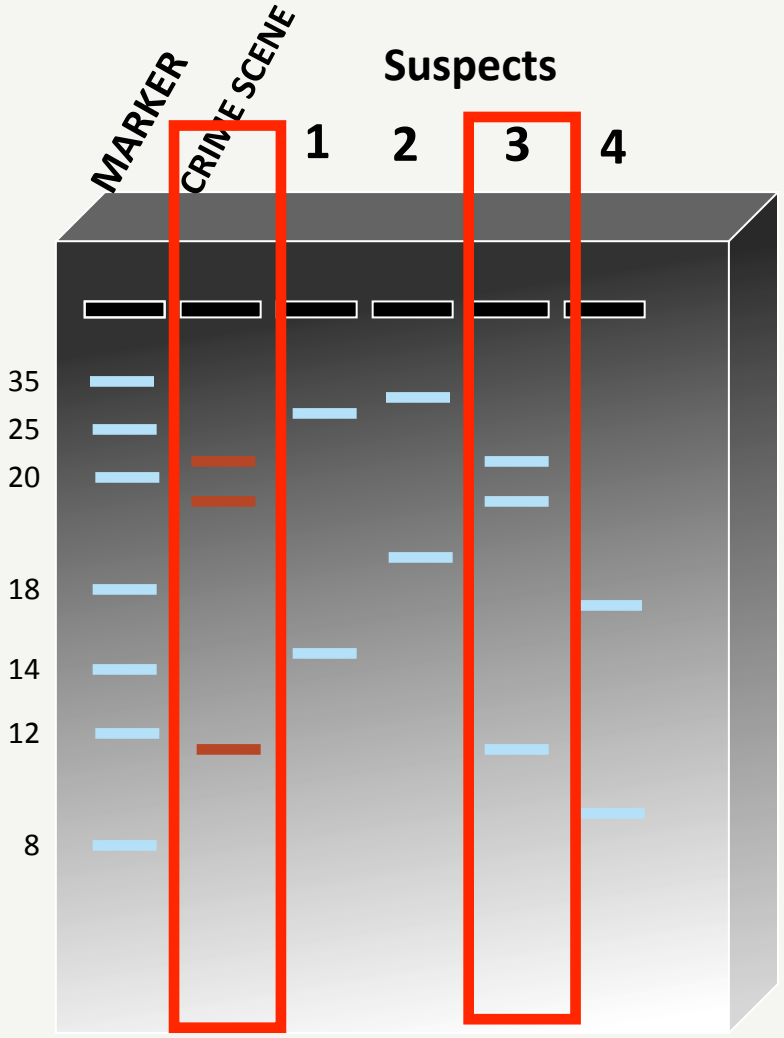
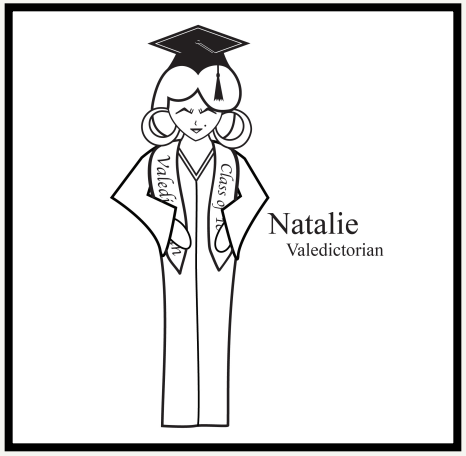


Let’s solve the case of the missing mascot!

The Suspects

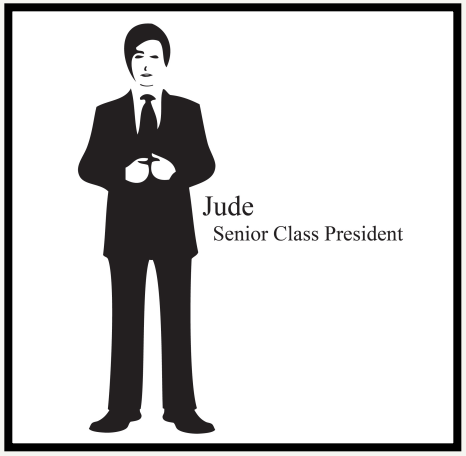
Will
Football Captain



Natalie
Valedictorian

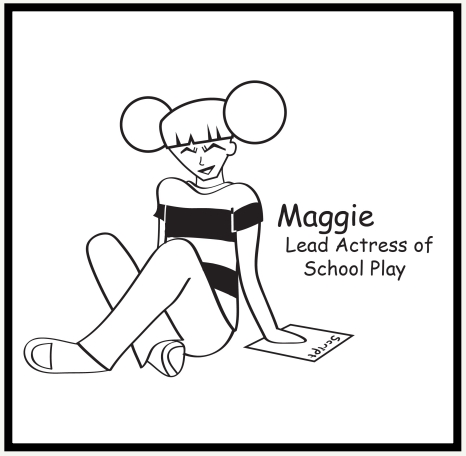
Molly
Homecoming Queen

Liza
Head Cheerleader



Jude
Senior Class President

VINCE
DRUM MAJOR



Maggie
Lead Actress of
School Play

Restriction Enzyme Digest Analysis

- EcoRI cuts the following sequence:

G|AATTC

Restriction Enzyme Digest Analysis

- EcoRI cuts the following sequence:

G|AATTC

- Find all EcoRI cut sites in the DNA sequence of the suspect you represent

Analyze your suspect's DNA

- EcoRI cuts the following sequence:

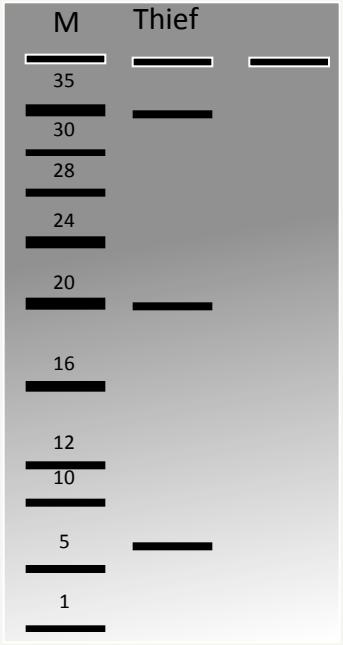
G|AATTC

- Find all EcoRI cut sites in the DNA sequence of the suspect you represent

- Draw the bands on the gel according to their predicted lengths following digestion

Suspect #1: Will

Sex: Male
Weight: 220 lb.
Height: 6’1”
Position: Captain of the Football Team

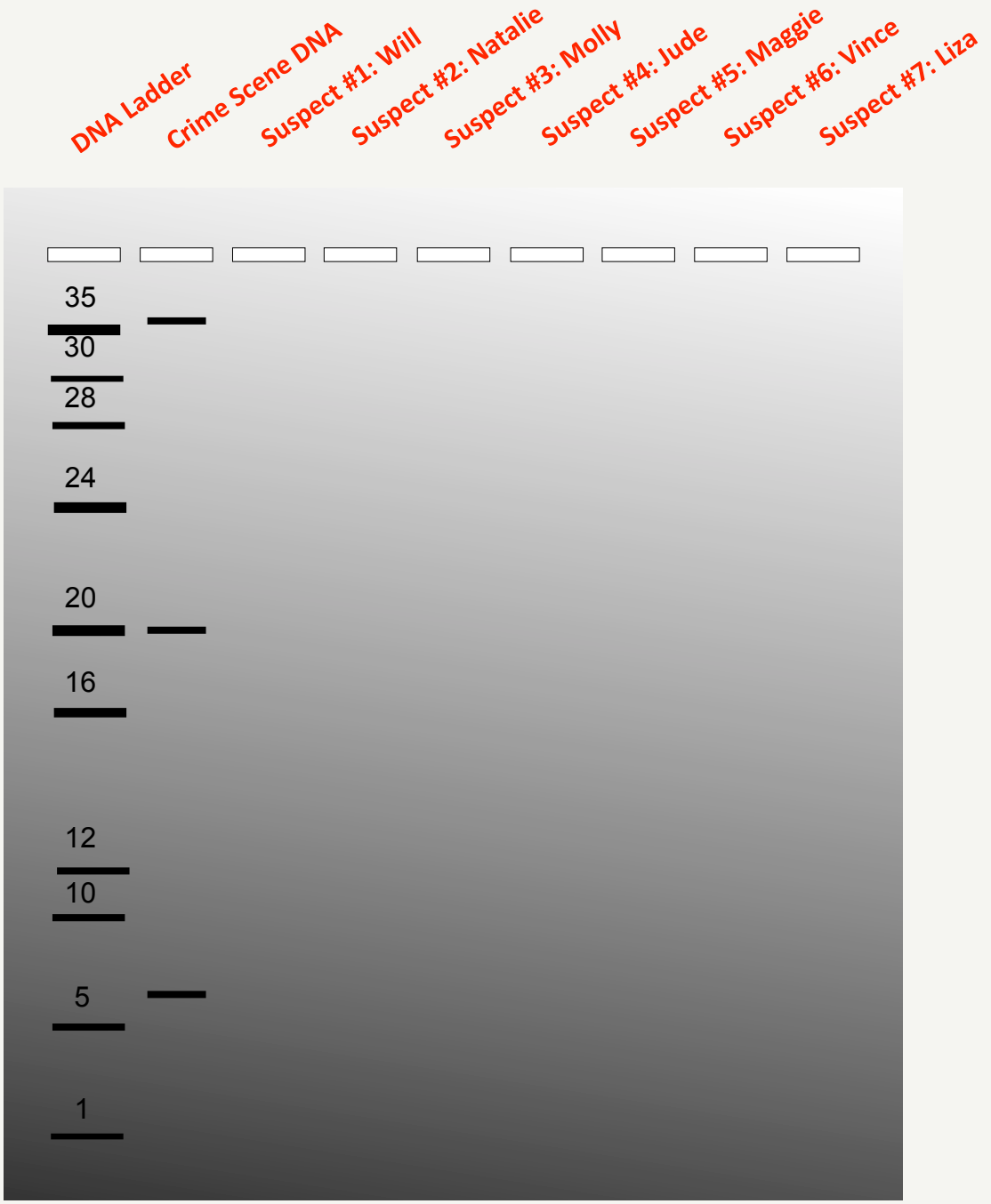


EcoRI: G|AATTC

DNA Sequence:

TCGATGAATTCTATCGGAATTCTCGGACTTCTCGAGAATTCTGCGGATTTCTCGGATTCA

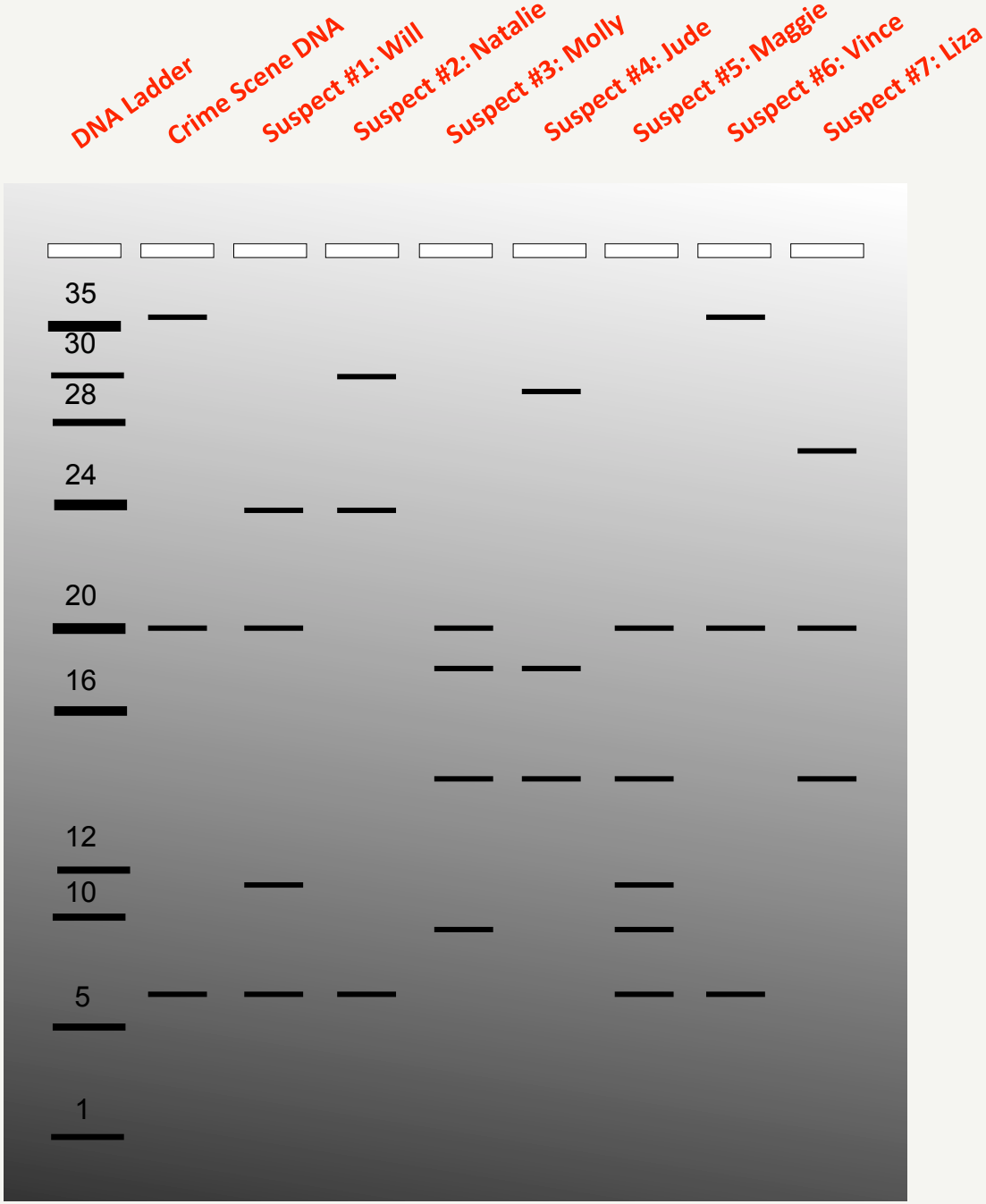
DNA Fragment Sizes: _____


DNA Ladder
Crime Scene DNA
Suspect #1: Will
Suspect #2: Natalie
Suspect #3: Molly
Suspect #4: Jude
Suspect #5: Maggie
Suspect #6: Vince
Suspect #7: Liza
35
30
28
24
20
16
12
10
5
1

Can we ID the thief?

Can we ID the thief?

Please PAUSE and analyze your suspect's DNA.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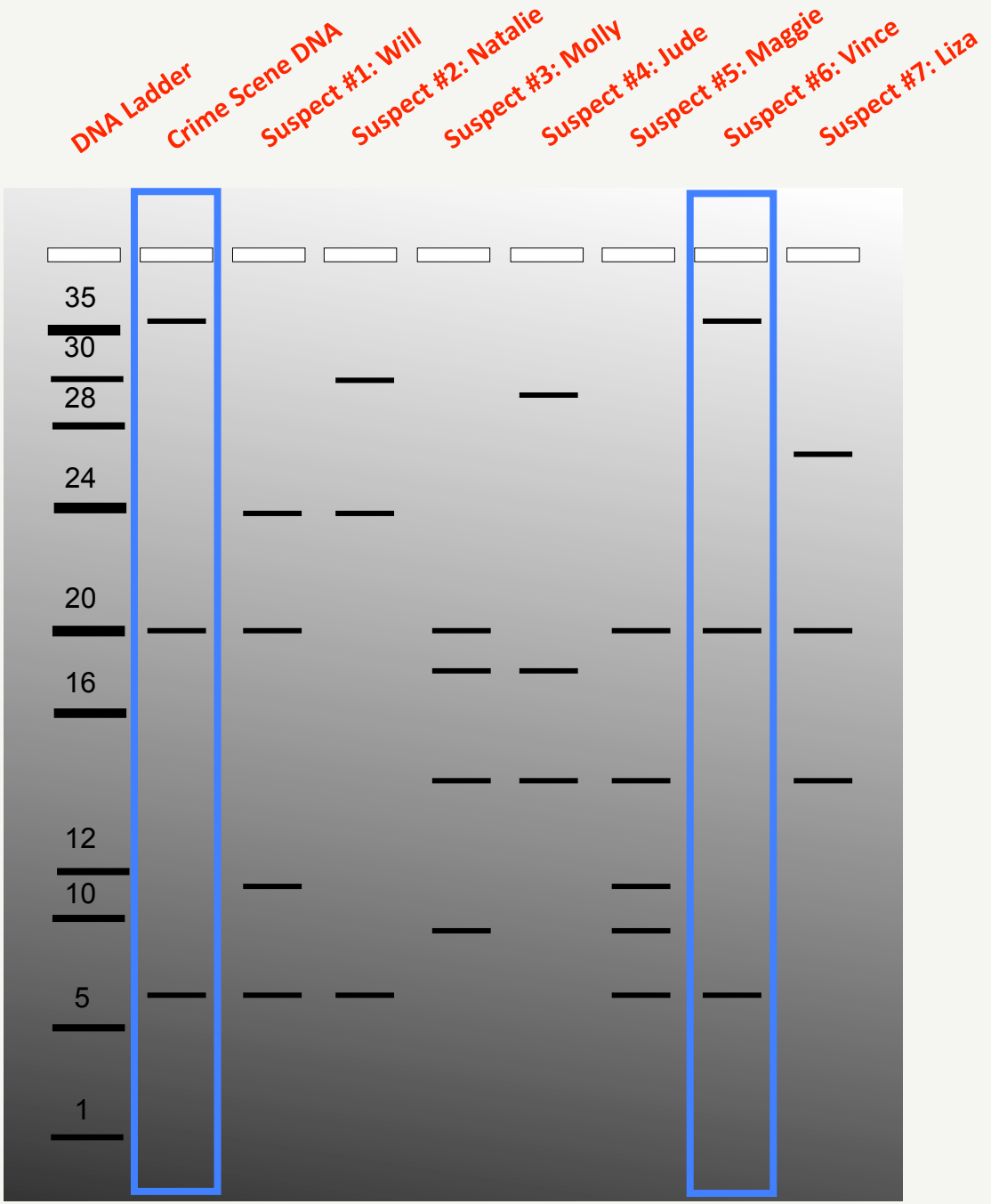
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24
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1


VINCE
DRUM MAJOR


GUILTY!
VINCE
DRUM MAJOR

Let's Compare their DNA!

Will: TCGAT**GAATTC**TATCG**GAATTC**TCG**GACTTC**TCGA**GAATTC**TGCG**GATTTC**TCGGATTCA
(6,11,19,24)

Natalie: TCGAT**GAATTC**TATCG**CAATTC**TCG**CAATTC**TCGA**GAATTC**TGCG**GATTTC**TCGGATTCA
(6,30,24)

Molly: TCGAT**GAAGTC**TATCG**GAATTC**TCG**GAATTC**TCGA**CAATTC**TGCG**GAATTC**TCGGATTCA
(17,9,20,14)

Jude: TCGAT**CAATTC**TATCG**GAATTC**TCG**GATTTC**TCGA**CAATTC**TGCG**GAATTC**TCGGATTCA
(17,29,14)

Maggie: TCGAT**GAATTC**TATCG**GAATTC**TCG**GAATTC**TCGA**CAATTC**TGCG**GAATTC**TCGGATTCA
(6,11,9,20,14)

Vince: TCGAT**GAATTC**TATCG**AAATTC**TCG**GAATTC**TCGA**GAATCC**TGCG**GACTTC**TCGGATTCA
(6,20,34)

Liza: TCGAT**GAACTC**TATCG**GAATTT**TCG**GAATTC**TCGA**GATTTC**TGCG**GAATTC**TCGGATTCA
(26,20,14)

non-cut site

EcoRI cut site

ETHICAL CONSIDERATIONS

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- Do you think that it is fair that students are required to submit a DNA sample simply because they are a member of the Senior class?

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- On what basis should people be required to submit a DNA sample in a criminal investigation?

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ETHICAL CONSIDERATIONS

- Do you think that it is fair that students are required to submit a DNA sample simply because they are a member of the Senior class?
- On what basis should people be required to submit a DNA sample in a criminal investigation?
- What are some potential sources for error in such an investigation?
- Keeping these in mind, do you think that DNA fingerprinting alone provides substantial enough evidence for positive identification of a criminal?

Think about TV crime dramas…

What kind of forensic analysis do they do?

bite marks *blood spatter* *handwriting* *ballistics*

tool marks *voices* *hair* *fibers*

DNA

Toobin J. *New Yorker 30-35, 2007.*

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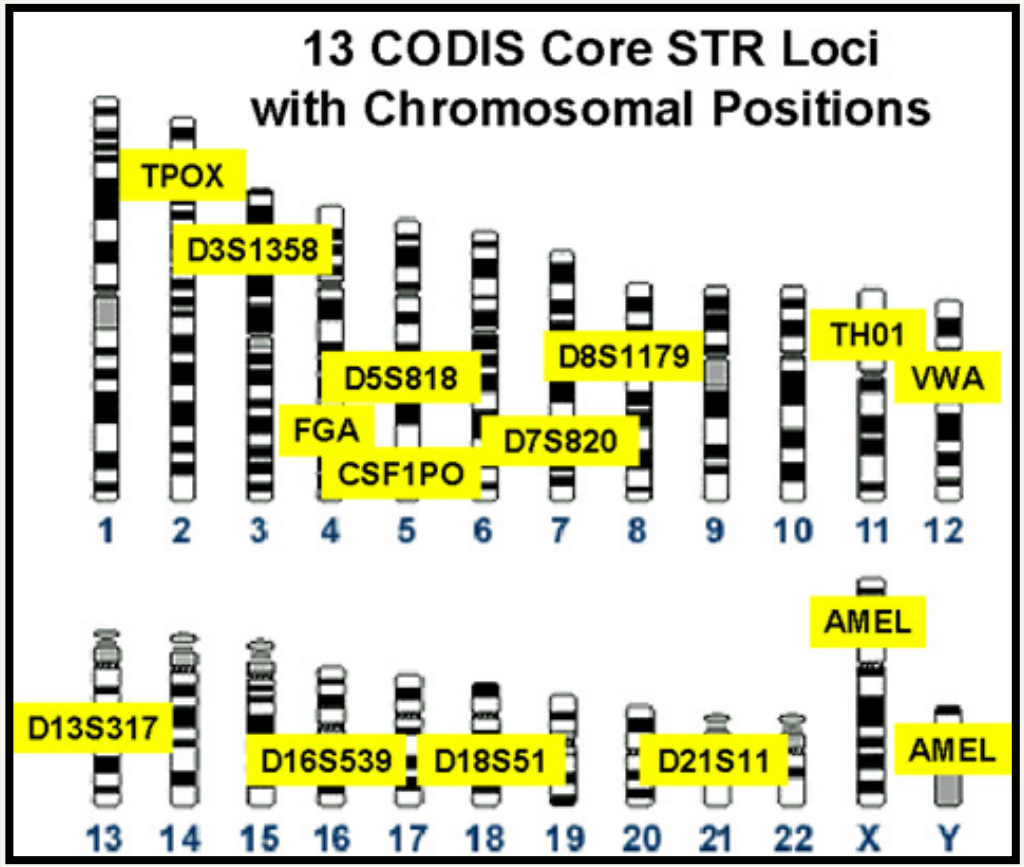
DNA

only evidence which can link a suspect to a crime with mathematical certainty

Toobin J. *New Yorker 30-35, 2007.*

Real World DNA Analysis



CODIS - Combined DNA Index System

STR - Short Tandem Repeat

Jobling MA, Gill P. Nat Rev Genet. 2004;5:739-751. http://www.dna.gov/dna-databases/codis

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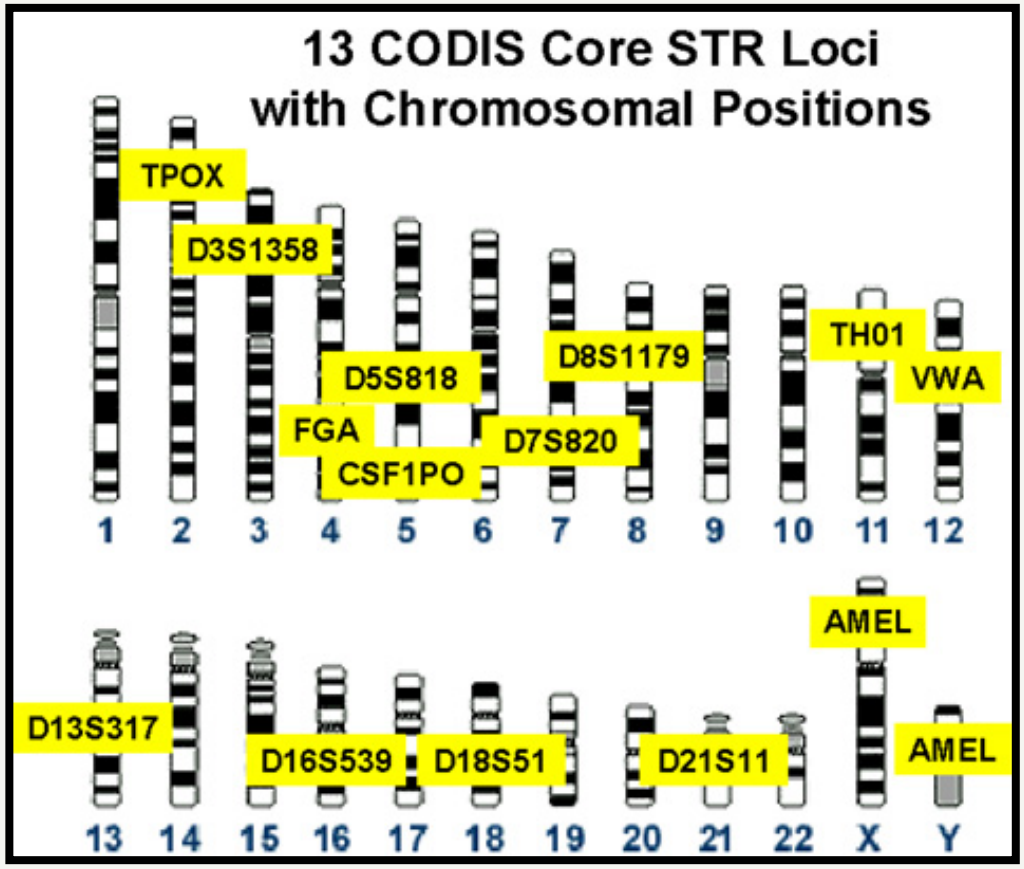

CODIS - Combined DNA Index System

STR - Short Tandem Repeat

A complete DNA profile is unique to 1 in <u>100,000,000,000</u> people! (in the US)

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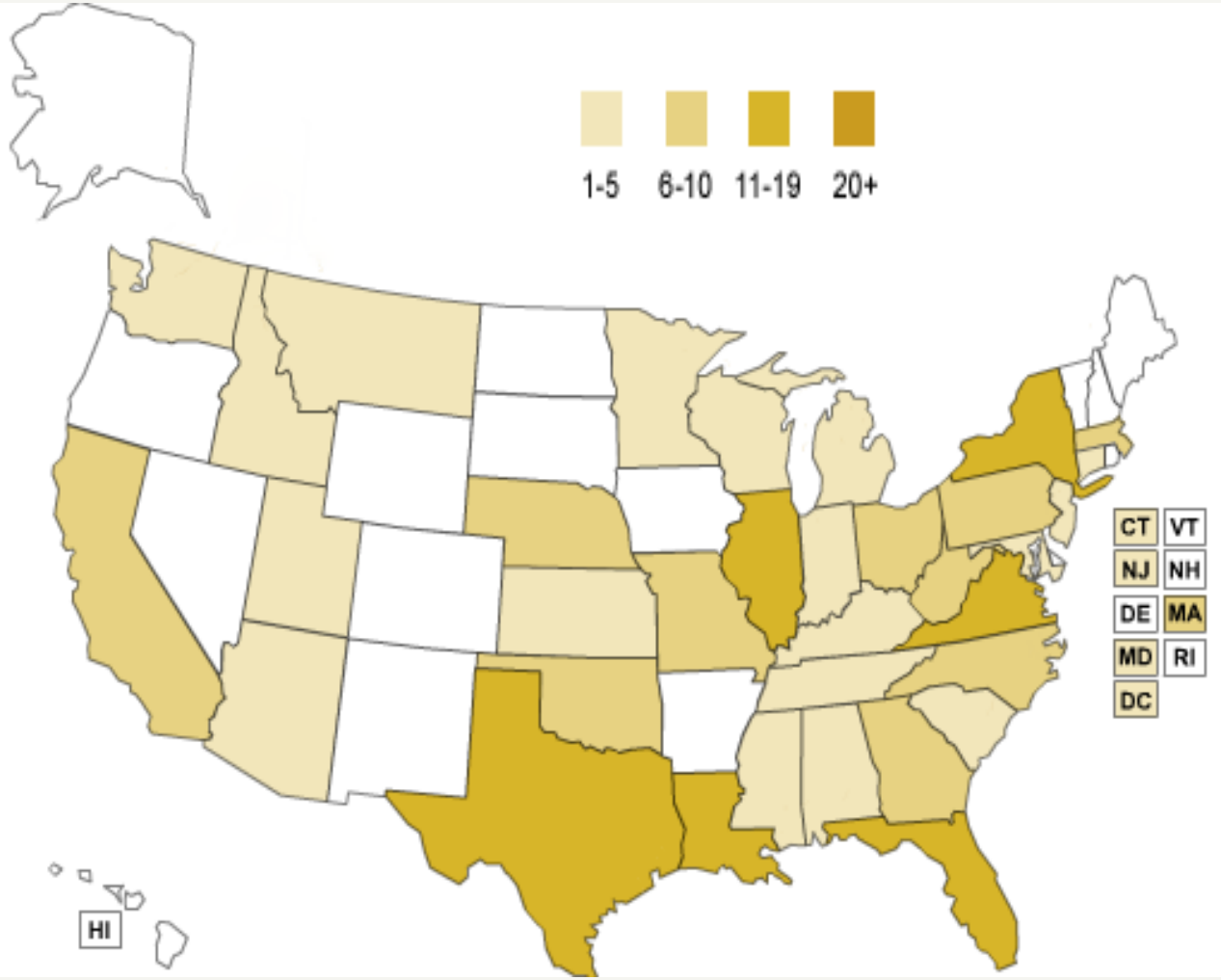
INNOCENCE PROJECT

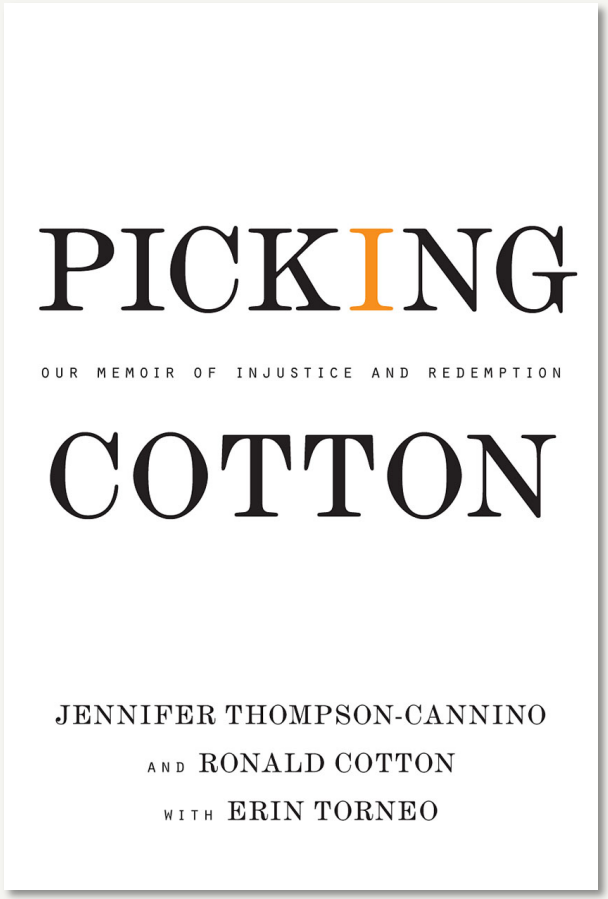
Organization dedicated to exonerating wrongfully convicted people through DNA testing.



As of Feb. 2011

266 people in the United States have been exonerated thanks to DNA testing; 7 in the state of NC

http://geology.com/state-map/



"A true story of forgiveness and hope."

What Happened?

Incident Year: 1984
Jurisdiction: NC
Charge: Rape, Burglary

Year of Conviction: 1985, 1987
Exoneration Date: 6/30/95
Sentence Served: 10.5 Years
Real perpetrator found? Yes

"…he had none of those things because I'd picked him."

-Quote by Jennifer Thompson-Cannino (the victim) from Picking Cotton

What Do You Think?

SUMMARY

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- DNA evidence is the only evidence that can undeniably identify perpetrators of crime
- DNA evidence is important to exonerate wrongly convicted individuals

About the Scientist:

- What do I study?
- Why do I love science?
- Questions?