BULLETIN

TO: Analysis Unit 1

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case I—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case I: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

Homer was able to provide Chief Wiggum with information that lead to a list of six suspects. Blood was drawn from these six suspects and the analysis of their DNA is to be performed by your unit.

The suspects were

1. Montgomery Burns
2. Ned Flanders
3. Apu Nahasapeemapetilon
4. Waylon Smithers
5. Bart Simpson
6. Edna Krabappel.

Assignment: It is the job of your analysis unit to determine who took the bite out of the forbidden donut so that the guilty party can pay their respective time in jail for trespassing (if necessary) and theft by taking. Simulate a gel electrophoresis using the DNA from the suspects (DNA code on paper) and the restriction enzymes (scissors) provided. The restriction enzymes cut the DNA after every "**AT**" pair. This will result in varying lengths of DNA for each suspect. Place the DNA bands in the appropriate suspect column such that it corresponds with the number of nucleic acids (y-axis) in that band. So, if your band has 2 nucleic acids, you will place it next to the 2 on the y-axis. After the gel is complete with the suspect DNA, see the Lead Analyst to obtain the DNA evidence found at the scene. Cut this DNA just as you did the suspects, after every "**AT**" pair, and place it in the same fashion. Compare the evidence DNA with that of the suspects to determine who was guilty. Finally, raise your hand and the Lead Analyst will confirm your results. After your result has been confirmed, proceed to the conclusion portion of your assignment.

BULLETIN

TO: Analysis Unit 2

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case II—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case II: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

Homer was able to provide Chief Wiggum with information that led to a list of six suspects. Blood was drawn from these six suspects and the analysis of their DNA is to be performed by your unit.

The suspects were

1. Montgomery Burns
2. Ned Flanders
3. Apu Nahasapeemapetilon
4. Waylon Smithers
5. Bart Simpson
6. Edna Krabappel.

Assignment: It is the job of your analysis unit to determine who took the bite out of the forbidden donut so that the guilty party can pay their respective time in jail for trespassing (if necessary) and theft by taking. Simulate a gel electrophoresis using the DNA from the suspects (DNA code on paper) and the restriction enzymes (scissors) provided. The restriction enzymes cut the DNA after every "**AT**" pair. This will result in varying lengths of DNA for each suspect. Place the DNA bands in the appropriate suspect column such that it corresponds with the number of nucleic acids (y-axis) in that band. So if your band has 2 nucleic acids, you will place it next to the 2 on the y-axis. After the gel is complete with the suspect DNA, see the Lead Analyst to obtain the DNA evidence found at the scene. Cut this DNA just as you did the suspects, after every "**AT**" pair, and place it in the same fashion. Compare the evidence DNA with that of the suspects to determine who was guilty. Finally, raise your hand and the Lead Analyst will confirm your results. After your result has been confirmed, proceed to the conclusion portion of your assignment.

BULLETIN

TO: Analysis Unit 3

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case III—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case III: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

Homer was able to provide Chief Wiggum with information that led to a list of six suspects. Blood was drawn from these six suspects and the analysis of their DNA is to be performed by your unit.

The suspects were

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2. Ned Flanders
3. Apu Nahasapeemapetilon
4. Waylon Smithers
5. Bart Simpson
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Assignment: It is the job of your analysis unit to determine who took the bite out of the forbidden donut so that the guilty party can pay their respective time in jail for trespassing (if necessary) and theft by taking. Simulate a gel electrophoresis using the DNA from the suspects (DNA code on paper) and the restriction enzymes (scissors) provided. The restriction enzymes cut the DNA after every "**AT**" pair. This will result in varying lengths of DNA for each suspect. Place the DNA bands in the appropriate suspect column such that it corresponds with the number of nucleic acids (y-axis) in that band. So if your band has 2 nucleic acids, you will place it next to the 2 on the y-axis. After the gel is complete with the suspect DNA, see the Lead Analyst to obtain the DNA evidence found at the scene. Cut this DNA just as you did the suspects, after every "**AT**" pair, and place it in the same fashion. Compare the evidence DNA with that of the suspects to determine who was guilty. Finally, raise your hand and the Lead Analyst will confirm your results. After your result has been confirmed, proceed to the conclusion portion of your assignment.

BULLETIN

TO: Analysis Unit 4

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case IV—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case IV: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

Homer was able to provide Chief Wiggum with information that led to a list of six suspects. Blood was drawn from these six suspects and the analysis of their DNA is to be performed by your unit.

The suspects were

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Assignment: It is the job of your analysis unit to determine who took the bite out of the forbidden donut so that the guilty party can pay their respective time in jail for trespassing (if necessary) and theft by taking. Simulate a gel electrophoresis using the DNA from the suspects (DNA code on paper) and the restriction enzymes (scissors) provided. The restriction enzymes cut the DNA after every "**AT**" pair. This will result in varying lengths of DNA for each suspect. Place the DNA bands in the appropriate suspect column such that it corresponds with the number of nucleic acids (y-axis) in that band. So if your band has 2 nucleic acids, you will place it next to the 2 on the y-axis. After the gel is complete with the suspect DNA, see the Lead Analyst to obtain the DNA evidence found at the scene. Cut this DNA just as you did the suspects, after every "**AT**" pair, and place it in the same fashion. Compare the evidence DNA with that of the suspects to determine who was guilty. Finally, raise your hand and the Lead Analyst will confirm your results. After your result has been confirmed, proceed to the conclusion portion of your assignment.

BULLETIN

TO: Analysis Unit 5

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case V—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case V: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

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BULLETIN

TO: Analysis Unit 6

FROM: Crime Lab

SUBJECT: Forbidden Donut

The following is a criminal investigative case in which the use of DNA fingerprinting might help solve the mystery. The case involves a bite taken out of Homer's forbidden donut. The DNA from the suspects, agarose gel, and restriction enzymes are provided. In addition the Lead Analyst is withholding the DNA evidence found at the scene. Once you have performed the electrophoresis on the suspect DNA, see the Lead Analyst to receive the DNA evidence found at the scene. It is up to your unit, as the forensic criminologists, to make the proper comparisons and determine the guilty party in the case.

DNA Fingerprinting—Electrophoresis at Work
DNA Case VI—Forbidden Donut

Background: Your analysis unit will use gel electrophoresis to determine the guilty party. Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the "screen", smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance from the starting point, allowing the scientist to identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current "causes" the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals called, *restriction enzymes,* are used to cut up pieces of DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect's DNA are the same.

DNA Case VI: The scene was in Springfield at the Simpson household. The donut was secured in a trophy case and only Homer Simpson had the key. When he returned home from work at the Springfield Nuclear Power Plant on Friday afternoon, the glass was broken and he realized that someone had taken a bite out of his ***Forbidden Donut!*** He quickly telephoned Chief Wiggum and told him of this forsaken crime. Chief Wiggum responded to the scene of the crime and gathered evidence. He sealed the donut in a bag and dusted for fingerprints. Chief Wiggum then took the donut to the crime lab and a saliva sample was taken from the donut and DNA was extracted from the saliva. The DNA from the saliva is that of the person who took a bite out of Homer's donut.

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Assignment: It is the job of your analysis unit to determine who took the bite out of the forbidden donut so that the guilty party can pay their respective time in jail for trespassing (if necessary) and theft by taking. Simulate a gel electrophoresis using the DNA from the suspects (DNA code on paper) and the restriction enzymes (scissors) provided. The restriction enzymes cut the DNA after every "**AT**" pair. This will result in varying lengths of DNA for each suspect. Place the DNA bands in the appropriate suspect column such that it corresponds with the number of nucleic acids (y-axis) in that band. So if your band has 2 nucleic acids, you will place it next to the 2 on the y-axis. After the gel is complete with the suspect DNA, see the Lead Analyst to obtain the DNA evidence found at the scene. Cut this DNA just as you did the suspects, after every "**AT**" pair, and place it in the same fashion. Compare the evidence DNA with that of the suspects to determine who was guilty. Finally, raise your hand and the Lead Analyst will confirm your results. After your result has been confirmed, proceed to the conclusion portion of your assignment.

CRIME LAB REPORT

Analyst: _____

CASE/Analysis Unit: _____

Date of Analysis: _____

1. **Who was guilty of the crime?**

2. **How did you determine who was guilty? Explain the steps in terms of the process of gel electrophoresis.**

3. **What is used in gel electrophoresis to cut the DNA into segments?** (HINT: The answer is not scissors, but what did the scissors represent?)

4. **Besides saliva used in your Case, what other types of evidence could you extract DNA from to determine who committed the crime?**

5. **Turn in all handouts, your completed gel electrophoresis simulation, and this crime lab report <u>for each analyst</u>, in one stack, to the Lead Analyst.**

Notes for the Instructor:

- Provide information ahead of this lab about gel electrophoresis, for example see the prepared PowerPoint presentation
- Inevitable questions: (1) “I have two strips with the same amount of letters on them. What should I do?” –Just place one band at that location. The electrophoresis works by separating different size fragments, thus two fragments the same length should move the same distance. (2) “I have a strip longer than 22 letters. What should I do?” –Just place the band at “22.” Indicate that any fragment over 22 letters is too long/big to move through the gel.
- This lesson was developed for a group of 4-5 students. The number of groups may vary, but it was developed such that a different criminal could be given for up to 6 groups. See the Excel file for pages of DNA sequence. Have one sequence from each suspect on a different colored piece of paper to use as the “evidence” DNA.

This is how the gel should look on ½ sheet of posterboard with room for segments!