A natural enemy of bacteria is a virus. To defend when attacked by a virus, bacteria use chemical weapons that break up the DNA of the virus. The action of these chemicals on the viral DNA is shown in the diagram below.

Use the diagram above to complete the sentences or answer the following questions:

1. The chemical that cuts the DNA is called a restriction enzyme. Restriction enzymes cut the DNA into ________________.

2. The restriction enzyme used above is called EcoRI. EcoRI cuts DNA everywhere the base pattern __________________ is found.
Another restriction enzyme is called HaeIII. It cuts DNA at the following base sequence:

```
CCGG
GGCC
```

It cuts between the C and the G as follows:

```
CC|GG
GG|CC
```

1. Show the DNA fragments that would result if HaeIII was used to cut the DNA fragment shown in diagram 1.

```
TACCCGGAATTCAATCGGTTGAATTCTAGCGTAC
ATGGCCCTTAAAGTAGGCCCACCTTAAAGATCGCATG
```

2. Do you think restriction enzymes could be used to cut DNA from other organisms?

   ____________________________________________________________

   ____________________________________________________________

3. The words BOB and MADAM are palindromes. What are palindromes?

   ____________________________________________________________

   ____________________________________________________________

4. What do palindromes have to do with the restriction enzymes that cut DNA?

   ____________________________________________________________
Student Activity: A Mix-up at the Hospital

On June 6 at approximately 1:00 pm, Mrs. Smith, Mrs. Stevenson, and Mrs. Jones each delivered a healthy baby boy at Metropolitan General Hospital. At 1:20 pm, the hospital's fire alarm sounded. Nurses and orderlies scrambled to evacuate patients. The three new-babies were rushed to safety. After the danger had passed, the hospital staff were distressed to find that in the confusion, they had forgotten which baby was which! Since the babies were rescued before receiving their identification bracelets, there was no easy way to identify them. Dr. Anne Robinson, head of pediatrics, ordered that DNA typing be performed on the babies and their parents.

The DNA typing laboratory looked at two different highly variable chromosome regions. The DNA profiles are shown below. Your job is to decide which baby belongs to which set of parents. To assign a baby to a set of parents, every band in the baby’s profile should match a band from either the mother or the father. Not all of the bands in the mother’s or father’s profiles will have a counterpart in the baby’s DNA profile. Hint: Use a ruler or straight edge to help you line up the bands.

<table>
<thead>
<tr>
<th>Smiths</th>
<th>Stevensons</th>
<th>Jones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr.</td>
<td>Mrs.</td>
<td>Mr.</td>
</tr>
<tr>
<td>size, bp</td>
<td>fragment</td>
<td>size, bp</td>
</tr>
<tr>
<td>240</td>
<td>—</td>
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<td>30</td>
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</tbody>
</table>

Which baby belongs to which couple? Show which bands each baby inherited from its mother and from its father by marking them with “M” and “F”.

NORTH CAROLINA BIOTECHNOLOGY CENTER

Chapter 4, Section D  *  21
**Student Activity: A Paternity Case**

Mr. I. M. Megabucks, the wealthiest man in the world, has recently died. Since his death, three women have come forward. Each woman claims to have a child by Megabucks and demands a substantial share in his estate for her child. Lawyers for the estate have insisted on DNA typing of each of the alleged heirs. Fortunately, Megabucks anticipated trouble like this before he died, and arranged to have a sample of his blood frozen away for DNA typing.

Laboratory technicians used the Southern hybridization method to look at three highly variable chromosome regions. The results of the blots are shown below. Your job is to analyze the data and determine if any of the children could be Megabucks' heir.

Remember that every person has two of each chromosome, one inherited from his mother and one from his father. Half of every person's DNA comes from his mother and half from his father. So some of the DNA bands showing in the Southern blots of the children will come from their mothers, and the rest from their fathers. The question is, could that father be Megabucks?

1. For the first child, identify the bands in the DNA profile that came from the mother. (Remember that not all of the mother's DNA is transmitted to the child, just one of each pair of chromosomes.) Mark the bands that came from the mother with an M. Circle the remaining bands.
2. Compare the remaining bands with the DNA profile from Megabucks. If he is the father, then all of the circled bands in the child's profile should have a corresponding band in his profile. Use a straight edge to help you line the bands up accurately. (Remember that only half of the father's chromosomes are transmitted to a child, so not every band from the father would match the child's profile.)
3. Repeat the analysis for the other alleged heirs. Are any of them Megabucks' children?

### Results of Hybridization Analysis

<table>
<thead>
<tr>
<th>Fragment size, bp</th>
<th>Megabucks</th>
<th>X</th>
<th>X's child</th>
<th>Y</th>
<th>Y's child</th>
<th>Z</th>
<th>Z's child</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td></td>
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</table>
Student Activity: The Case of the Bloody Knife

Late one April night, government agents received an anonymous tip that the National Art Museum was about to be robbed of a priceless jewel collection. When they arrived at the museum, they saw that the jewels were gone. Lying face-down on the floor next to the empty jewel case was the dead body of a man. The chief inspector recognized as the international jewel thief Heinrich Milhouse. Milhouse had been shot in the chest at close range; his clothes were saturated with blood. Underneath the body the inspectors found a bloody knife.

At the airport the next day, police apprehended Englewood Smink, the murdered thief's occasional partner in crime. Smink denied all knowledge of the murder and the theft. When asked about the fresh cut on his hand, Smink said that he had had an accident in the kitchen that morning.

Suspicious, the chief inspector ordered DNA tests on the victim, the blood on the victim's clothes, the blood on the end of the knife found under the victim, and Smink. Police lab technicians used the polymerase chain reaction to look at two different chromosome regions that contain a VNTR. They used one set of primers for each region. The chromosome regions, primers, and results of the tests are shown below.

**Chromosome region 1**
3' AGCGTGCAGCAGTC... variable number of ATCT repeats ... CAATGGCGGACTCAATGCCA
5' TCCGAGCTGGACGTGACG ... TAGA ... GTTACACGGCTGAGTTACGGT

Primer set 1: 5'-CCGAGCTGGACGTGACG + 3'-AATGGCGGACTCAATG

**Chromosome region 2**
3' GCTGGCGAATGCTACAGGTG ... variable number of GGTCA repeats ... GCAGTGCAGCCTGCGGTAG
5' CGACGCTTACGATGTCAG ... CCAGT ... CGCTAGTCGCAGCCATC

Primer set 2: 5'-GACGCTTACGATGTCACG + 3'-GGGATCGAGCTGCGGTA

What is your interpretation of the data? State your reasons. Should Smink be released? Should other tests be performed?
Cloning in Focus

Web Lesson: Cloning in Focus
Genetic Science Learning Center
http://learn.genetics.utah.edu/content/tech/cloning/

Open the link and view each of the sections under "Cloning in Focus". For each section, answer the question.

What is Cloning?

1. Who is Dolly? ______________________

2. When a zygote divides into separate cells, it is called: ______________________

3. Somatic cells are also called ______________________

4. In order to clone a gene, a gene is inserted into a ______________________

5. In order to create an embryo from a somatic cell, the donor egg cell must have its ______________________ removed.

Click and Clone

6. List all the materials needed to clone a mouse.

7. Place the following steps in the correct order.

   - Stimulate cell division
   - Deliver baby
   - Remove and discard the nucleus from the egg cell
   - Isolate donor cells from egg donor and germ cell donor
   - Transfer the somatic cell nucleus into the egg cell
   - Implant embryo into a surrogate mother

8. There are two time gaps in the process of cloning. What are they? (ie. what do you have to wait for?)

9. What color will the cloned mouse be? ___________ What is the name of this mouse?

Cloning Myths

10. Briefly describe in your own words, why CC the cat was not identical in color to Rainbow, even though she was a clone/

http://www.biologycorner.com/worksheets/cloning.html
Is it Cloning or Not?

11. For each of the following scenarios, indicate YES (it is cloning) or NO (it is not cloning)

___________ Sperm taken from a male goat is combined with a female’s egg in a petri dish. The resulting embryo is implanted into the female’s uterus to develop.

___________ A sheep embryo, composed of 16 cells, is removed from the mother’s uterus and separated into individual cells. Each cell is allowed to multiply, creating 16 separate embryos, which are then implanted in different female sheep to develop to maturity.

___________ A cow with many desirable traits is stimulated with hormones to produce a number of egg cells. Each of these eggs is fertilized and implanted into a surrogate mother.

___________ In vitro fertilization

___________ Cell nuclei from an extinct wolly mammoth are placed into enucleated cow cells.

What Are the Risks of Cloning?

12. What is one reason why cloning animals has such a high failure rate?

13. What is a telomere and how does it affect cloned animals?

What Are Some Issues in Cloning?

14. Pick one of the questions to ponder and ....ponder it. Write a brief essay on your thoughts and opinions.

http://www.biologycorner.com/worksheets/cloning.html

8/4/2005
CASE OF JOSE VAMAS

Between 1976 and 1983, during Argentina’s repressive military rule, an estimated 15,000 adults and children were abducted and imprisoned. Many infants were separated from their parents and raised by their abductors. By 1985, the new democratic government in Argentina was cooperating to help reunite children with their biological parents.

As a forensic scientist working for the government, the following case has been given to you:

Jose Vamas was separated from his parents when he was 3 months old. His parents hired a private investigator who was able to use military records and birthdates to identify four children who may be their child, Jose. A blood sample was taken from each child and a section of the DNA in each sample isolated and amplified using the polymerase chain reaction (PCR). At your disposal is DNA taken from the blood sample collected from Jose at birth. It is up to you and your forensic team to determine whether one of the four children is Jose Vamas.

Each person on your team will be given a model of one of the DNA samples collected. Follow the procedure and see if your team can identify Jose Vamas.
INSTRUCTIONS:
Work only on your DNA sample.

1. Turn your DNA samples over so the side with the bases is facing you. Use your scissors (restriction enzymes) to cut your DNA samples only where you see the following base pattern:
   CCGG
   GGCC

Cut between the G and the C as shown in the example.
Example:

   TACC  GGTAATTCATCC  GGTCATTCTAGCGTA
   ATGG  CCATTAAGTAGG  CCAGTTAAGATCGCAT

2. Count the number of base pairs (b.p.) in each piece of DNA that you have. Record the number of base pairs in each piece on the blank side of the DNA fragment.

Example:
   G  Example of one base pair
   C

   GGTAATTCATCC  Base side
   CCATTAAGTAGG

   12 Base pairs  Blank side
3. There is a chart like the one below for each team at the front of the room. Put your DNA fragments on the chart according to size. Be sure to put your sample in the proper column. Keep the base side down.

<table>
<thead>
<tr>
<th>Jose Vamas' DNA Sample</th>
<th>Child #1</th>
<th>Child #2</th>
<th>Child #3</th>
<th>Child #4</th>
<th># of base pairs</th>
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<tbody>
<tr>
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</table>

With your team, complete the Final Report.
DNA Sample From Jose Vamas at Birth
GTCGACCCGGTGACCGTGACCGTAGCTCACAGTGCTCCGGATAGCTGATAGCTCCGGTG
CAGCTGGCCACTGGCACCGCATGTGTGCACGAGGCTATCGACTATCGAGGCCAC

DNA from Child #1
GTCGACCCGGTGACCGTGACCGTAGCTCACAGTGCTCCGGATAGCTGATAGCTCCGGTG
CAGCTGGCCACTGGCACCGCATGTGTGCACGAGGCTATCGACTATCGAGGCCAC

DNA from Child #2
AGTCGCCGCTGACCAGCTACCCGGTAGATCAGCCCGGATGAGATTCATAGCCTCTAG
TCAGGTCCGGCCCTGGCATGGGACATCTAGTCGGGCACTCTTTACTATCGCACTTAATC

DNA from Child #3
CGATACGTAATCGTAGCCATCCCGGACAGTGTCACGATCCTACCTGCCG
GCTATGCATTAGCATCGGCTAGGCCTGTCACACGCTAGCATGTCAGTAGCC

DNA from Child #4
ATCTCCATCCGGACTACCATACTCCTGTTGTTACCCGGGTGATACGTCCGGGATT
TAGAGGTACCACTGGTATGCTGAGGACACATGGGCACTATAGCAGGCTCAA
THE CASE OF JOSE VAMAS
FINAL REPORT

Team Members:

Which child did your team identify as Jose Vamas?

Evidence: Explain how you came to your conclusion (you may include diagrams).