Biology 11 Name:

Biotechnology

A. Using Restriction Enzymes

The following DNA sequences are sections of the gene for producing normal hemoglobin and sickle hemoglobin. (Notice that only a 1/2 strand of the DNA sequence is given)

Normal hemoglobin DNA

A A G G T C T C C T C T A A T T G G T C T C C T T A G G T C T C C T T

Sickle hemoglobin DNA

A A G G T C T C C T C T A A T T G G T C A C C T T A G G T C T C C T T

1. Find and circle the mutation in the sickle hemoglobin gene.

2. Geneticists use restriction enzymes that act as "molecular scissors" to cut strands of DNA at particular DNA sequences. For example, the restriction enzyme **MstII** recognizes the DNA sequence and cuts the DNA between the first T and the first C of that sequence, reading from left to right.

G G T | C T C C

cut

1. What will be the length of the fragments (how many bases) if the DNA for normal hemoglobin is cut with MstII?

2. What will be the length of the fragments (how many bases) if the DNA for sickle hemoglobin is cut with MstII?

3. A genetic counsellor gives you the following results from the prenatal test (amniocentesis) on a developing fetus.

   a) fragment sizes: 5, 14, 10, 6
   b) fragment sizes: 5, 24, 6

   What is your diagnosis for this fetus?

4. Describe how you could use restriction enzymes like MstII to distinguish sickle hemoglobin DNA from normal hemoglobin DNA.

B. Restriction Enzyme/DNA Fingerprinting Simulation

Restriction enzymes act as "molecular scissors" to cut strands of DNA at a particular sequence.
A gel electrophoresis is then used to "sort" these DNA fragments by their length.
A DNA fingerprint is produced that **may** be unique to each individual

Directions:

1. The restriction enzyme we are using seeks out the nucleotide sequence GCC and cuts between the G and the C.
2. Cut out the grid below and turn it so it runs from left to right. In the top row of the grid, draw a row of 30 bases and include the sequence GCC randomly throughout as often or as rarely as you wish. Complete the bottom or complimentary base pairs row of your DNA.
3. Whenever you have the sequence GCC on the **top layer** of the DNA molecule, draw a line between the G and C (all the way through the molecule).
4. Using scissors (which represent restriction enzymes) cut out the fragments at the points you have marked.
5. Count the number of base pairs in each fragment and write this on the back of the fragment.
6. Go to the diagram at the front of the room, and put your initials beside a simulated electrophoresis gel lane.
7. In that lane, have your teacher show you how to record your DNA fragment lengths on the gel electrophoresis.
8. Compare each suspects DNA fingerprint with the DNA fingerprint produced from the crime scene.

Discussion Questions: Explain all your answers

1. If a person's DNA fingerprint for this 30 base sequence of DNA does match the DNA fingerprint from the crime scene,
   a. Are they the perpetrator of this fictitious crime?

   b. What would you do to provide more DNA evidence in this case?

2. If your DNA fingerprint did not match the DNA fingerprint from the crime scene, does this exclude you as a suspect? Explain.

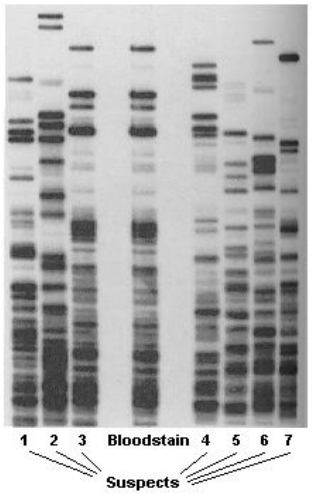
3. Describe how restriction enzymes work?

4. Describe what a DNA fingerprint shows.

C. DNA Forensics: Using DNA Fingerprints to Solve a Crime

Shown below are DNA "fingerprints" from several genes taken from seven suspects (the numbered columns). A quick comparison of these seven DNA "fingerprints" leads to the conclusion that the patterns of DNA bands are unique for each individual.

Who do you think committed the crime?



D. DNA Patterns from four sets of twins

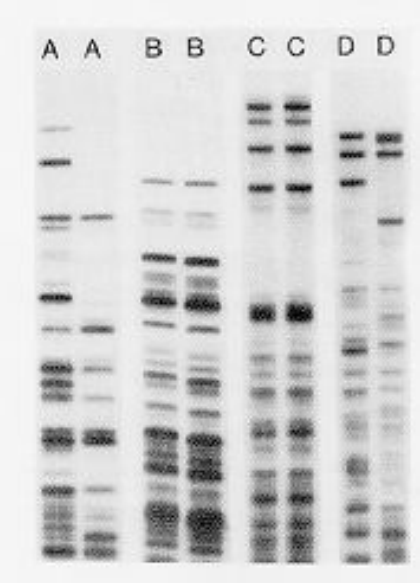
Shown below are DNA fingerprints from four sets of twins. If the band patterns are identical, then the twins should be identical (maternal) but if the band patterns of two twins are different, then the twins are non-identical (fraternal). Non-identical twins should share some of their DNA bands since they share 50% of the genes.

Which twins are identical?

Which twins are fraternal (not identical)?

How are identical twins produced?

How are fraternal twins produced?



E. Recombinant DNA and Transgenic Organisms

Recombinant DNA involves taking genes from one species and adding these to the genome of organisms of a different species. The new genetically engineered organism is called a transgenic organism.

Scientists have developed transgenic potato and strawberry plants that are frost-resistant; potatoes, corn, tobacco, and cotton that resist attacks by certain insect pests; and soybeans, cotton, corn, and oilseed rape (the source of canola oil) that have increased resistance to certain weed-killing chemicals called herbicides. Recombinant DNA has also been used to improve crop yield.

Scientists have transferred a gene that controls plant height, known as a dwarfing gene, from a wheat plant to other cereal plants, such as barley, rye, and oats. The transferred gene causes the new plant to produce more grain and a shorter stalk with fewer leaves. The shorter plant also resists damage from wind and rain better than taller varieties.

Scientists also apply gene-splicing techniques to animal food production. Scientists have transferred the growth hormone gene of rainbow trout directly into carp eggs. The resultant transgenic carp produce both carp and rainbow trout growth hormones and grow to be one-third larger than normal carp. Other fish that have been genetically engineered include salmon, which have been modified for faster growth, and trout, which have been altered so that they are more resistant to infection by a blood virus.

1. Read p. 621 – 623.
2. Describe how recombinant DNA technology is used to produce human insulin for diabetics.

3. Read p. 624: New, Improved Mouse. Describe how this transgenic mouse has been genetically altered?