Name ___________________________
Date __________ Period __

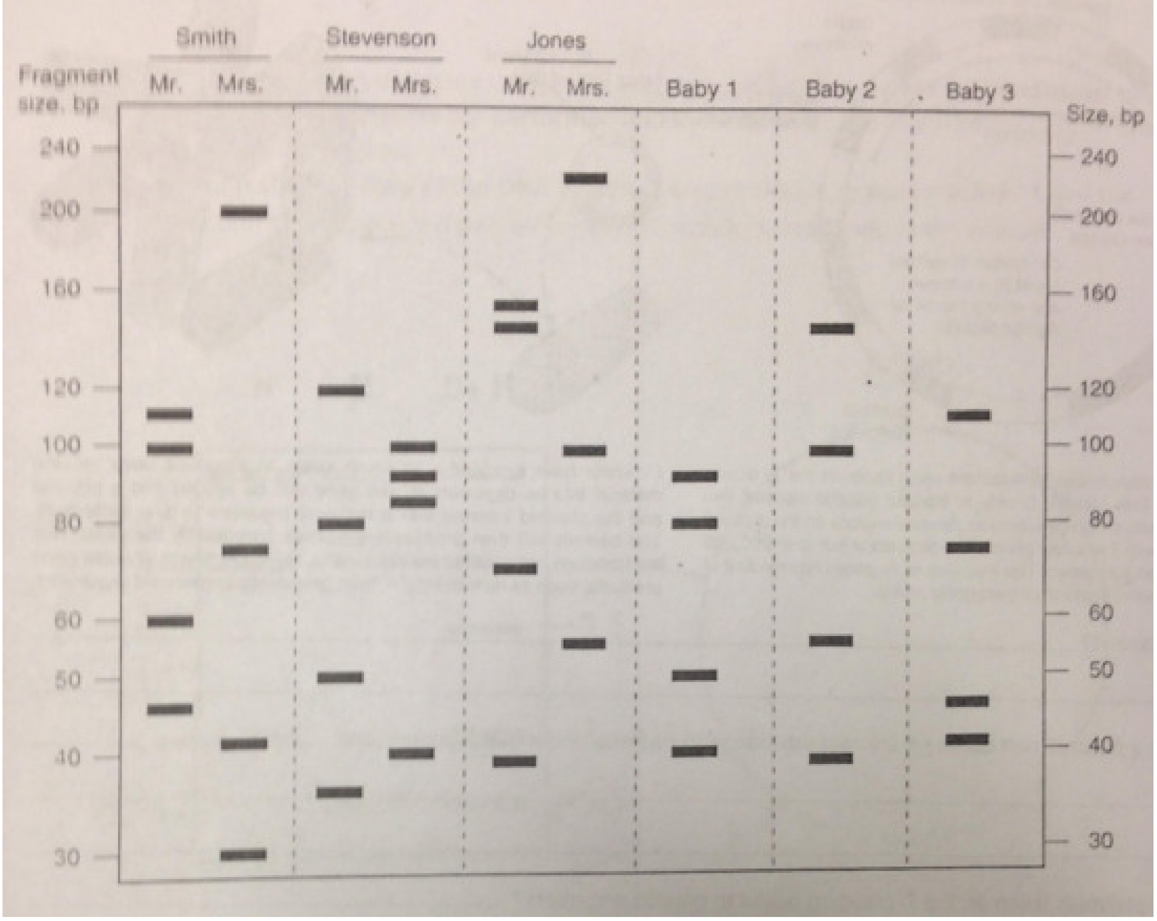
Practice Problem: A Mix Up at the Hospital

On June 6th at approximately 1pm, Mrs. Smith, Mrs. Stevenson, and Mrs. Jones each delivered a healthy baby body at Metro General Hospital. At 1:20pm, the hospital's fire alarm sounded. Nurses and orderlies scrambled to evacuate patients, and the three new babies were rushed to safety. After the danger had passed, the hospital staff was 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 lab looked at two different highly variable chromosome regions. The DNA profiles are shown in Figure 25.1 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 bands in the mother's or father's profile will have a counterpart in the baby's DNA profile.

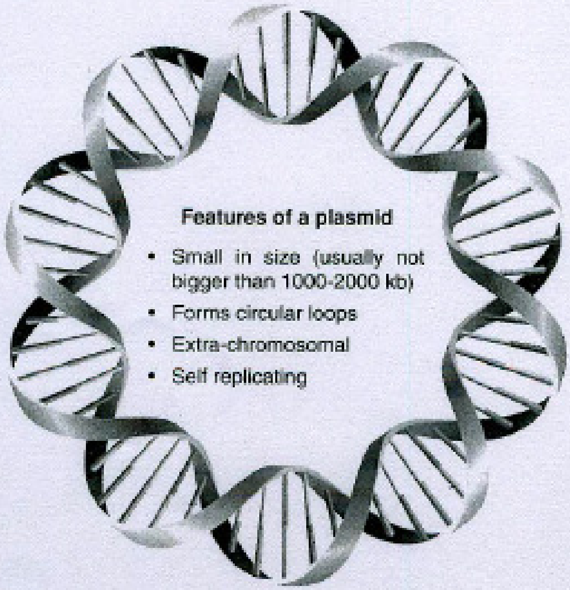
Which baby belongs to which couple? Show which bands each baby inherited from its mother and from its father by marking the bands M and F.

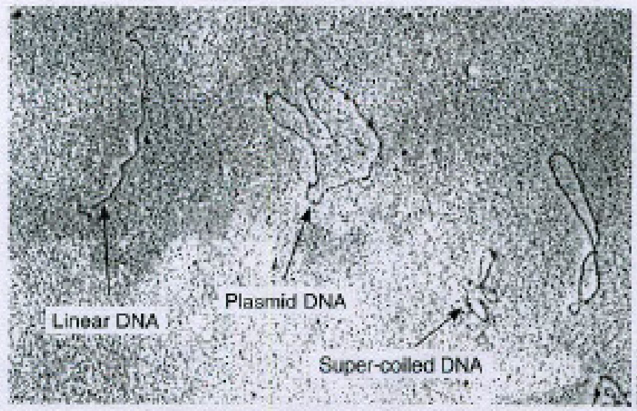
Figure 25.1 DNA profile data from the Smith, Stevenson, and Jones parents and the three infants.



Plasmid DNA

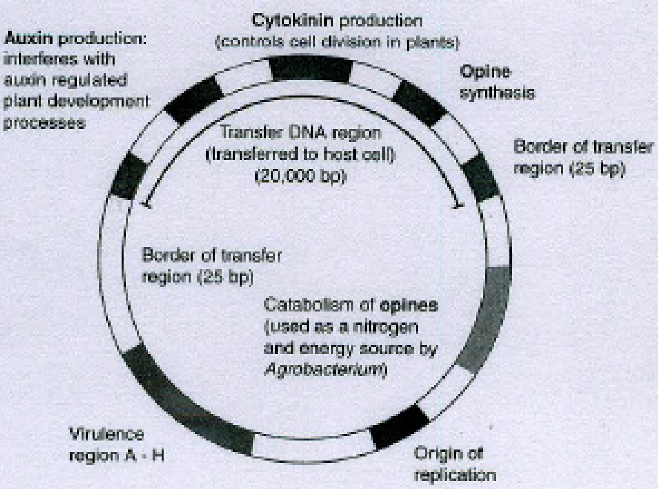
How genetic information is stored depends on the organism. Prokaryotes store most of their genetic information in one large chromosome. However, a small percentage can be found as independently replicating, circular, extra-chromosomal piece of DNA known as **plasmids**. Plasmids may carry important genes, such as those for the production of toxins that eliminate prokaryote competitors. Plasmids are less common in eukaryotes but some species, such as the yeast *Saccharomyces*, do have them. The genetic material from viruses may form plasmid-like structures called episomes once they have infected a cell.



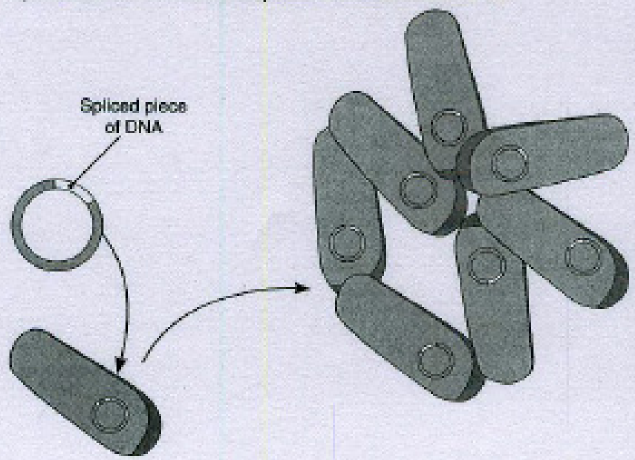


Plasmids vary in size from 1000 base pairs (bp) to hundreds of thousands of base pairs. In bacteria, they play an important role in providing extra genetic material that confers properties such as antibiotic resistance.

Plasmids can be transferred between bacterial cells by a process of plasmid transfer called **conjugation**. Conjugation enables bacteria to obtain genetic material from other individuals by **horizontal gene transfer** (transfer of genetic material to individuals other than offspring) and it is an important mechanism for the spread of antibiotic resistance.



The bacterium *Agrobacterium tumefaciens* often contains the T*i* (tumor inducing) plasmid. This plasmid is able to transfer genetic material into plant cells and causes crown gall disease. Several regions on the plasmid (identified above) help it to infect plants. The plasmid is just over 200,000 bp long and contains 196 genes. The mapping of its genes has made it of great importance in the creation of transgenic plants.



Plasmids have provided a tool with which to introduce novel genetic material into an organism. A new gene can be spliced into a plasmid and the plasmid inserted into a recipient organism (e.g. a bacterium). The bacteria will then produce the product encoded by the gene. This methodology has enabled the industrial-scale production of valuable gene products, such as human insulin, from genetically engineered organisms.

1. What is a plasmid? ______________________________

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2. Explain how a plasmid can convey a survival advantage to bacteria under certain conditions: ______________________________

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3. (a) Why are plasmids (such as the T*i* plasmid) useful to genetic engineers? ______________________________

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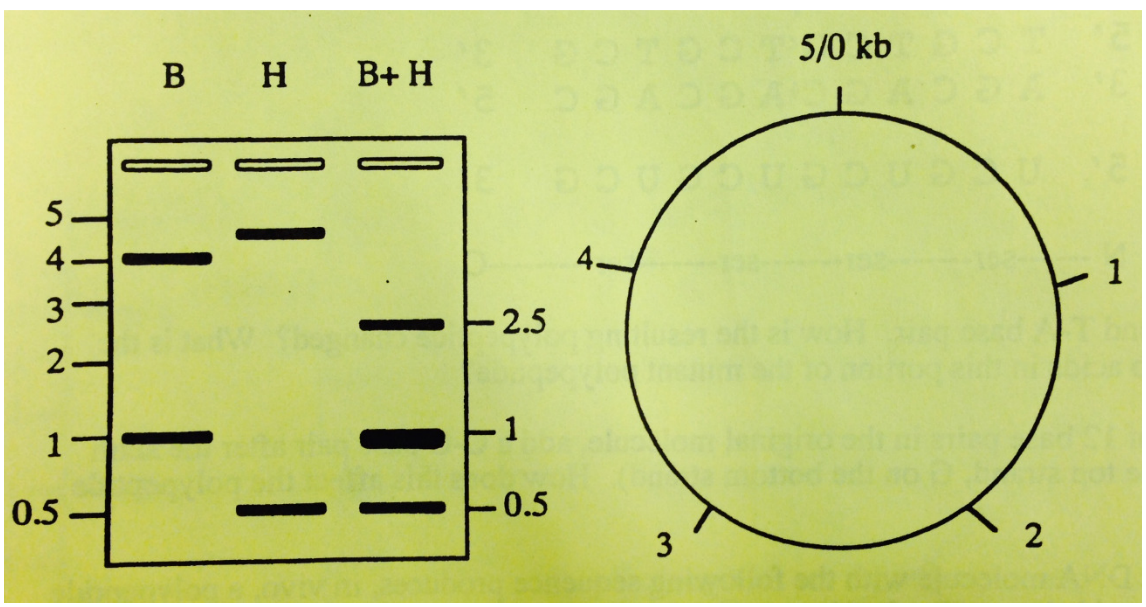
(b) Into which region of the T*i* plasmid would you insert a gene in order for it to be transferred into a host plant cell?

Genetic Engineering Problems

1. How would you combine human DNA and bacterial DNA together so that the bacteria would produce a desired human protein/hormone? Use the following words in your answer:

- Bacteria
- Complementary base-pairs
- Human DNA
- Human protein
- Ligase
- Plasmid
- Recombinant DNA
- Restriction enzyme
- Sticky ends

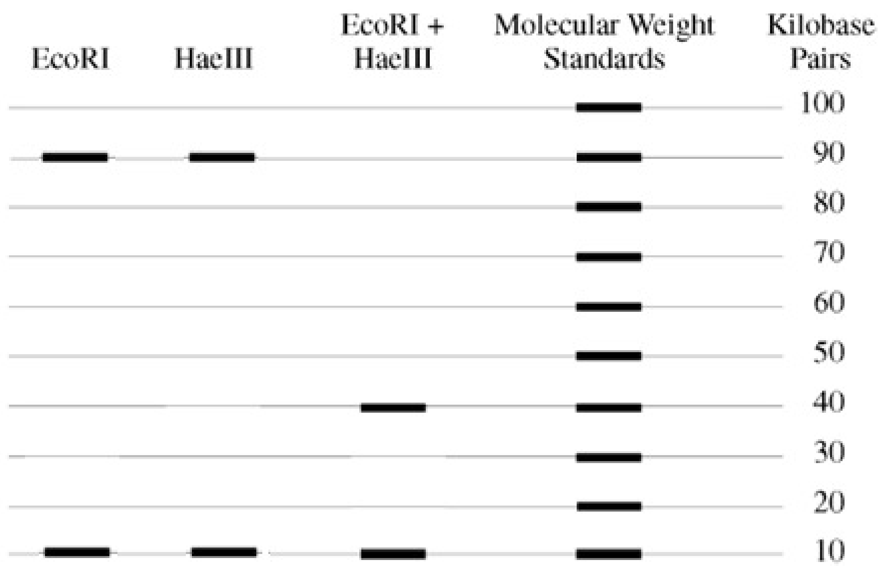
2. A 5 kb circular DNA molecule is digested with two restriction enzymes, BspHI (B) and HhaI (H). Single and double digests are performed and the fragments are analyzed on a gel. A drawing of the gel is shown below.
   Make a restriction map of the DNA molecule on the 5kb circle shown below. Label the restriction sites with the letter, either B or H, which corresponds to the enzyme.



3.

A bacterial plasmid is 100 kb in length. The plasmid DNA was digested to completion with two restriction enzymes in three separate treatments: EcoRI, HaeIII, and EcoRI + HaeIII (double digest). The fragments were then separated with electrophoresis, as shown.

RESULTS OF GEL ELECTROPHORESIS



(a) Using the circle provided, **construct** a labeled diagram of the restriction map of the plasmid. **Explain** how you developed your map.

(b) **Describe** how:

- recombinant DNA technology could be used to insert a gene of interest into a bacterium
- recombinant bacteria could be identified
- expression of the gene of interest could be ensured

(c) **Discuss** how a specific genetically modified organism might provide a benefit for humans and at the same time pose a threat to a population or ecosystem.