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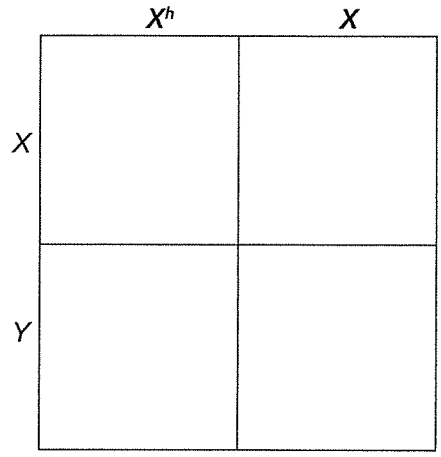
Human Inheritance

Hemophilia, a blood disorder, is a sex-linked trait. Read the passage below. Then complete the Punnett squares and use a separate sheet of paper to answer the questions that follow the passage.

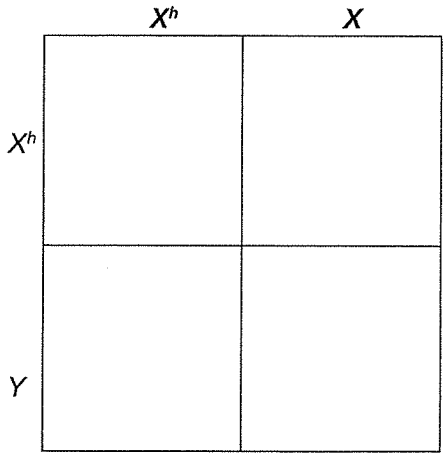
Sex-Linked Genes

Normally when a blood vessel is ruptured, the wound bleeds, but then the blood clots and a scab forms. People who have hemophilia are unable to make certain proteins necessary for blood to clot properly. When cuts and other injuries are obtained, bleeding is difficult to stop without medical treatment. Hemophilia A is a recessive trait and the allele is carried on the X chromosome. This means that a female can be a carrier of the trait without actually suffering from the disorder. A male who receives the trait on the X chromosome will exhibit the disorder.

1. Complete the Punnett Square shown here where X^h represents an X chromosome carrying the allele for hemophilia A.
   - **a.** What percentage of the children of these parents will probably have hemophilia A? What sex will they be?
   - **b.** What percentage of the children of these parents will be carriers of hemophilia A? What sex will they be?



2. Complete the Punnett Square shown here where X^h represents an X chromosome carrying the allele for hemophilia A.
   - **a.** What percentage of the children of these parents will probably have hemophilia A?
   - **b.** What percentage of the children of these parents will be carriers of hemophilia A?
3. A mother and father have three children: two boys and one girl. The father has hemophilia. Neither of the boys has hemophilia A. The girl is a carrier of hemophilia. What are the possible genotypes of the parents?



Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

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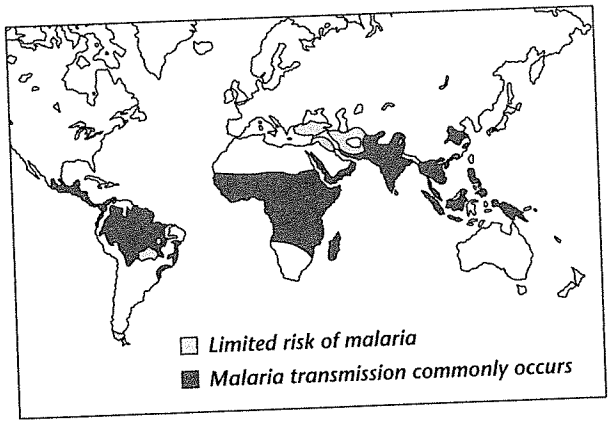
Human Genetic Disorders

Read the passage and study the maps below. Then use a separate sheet of paper to answer the questions that follow.

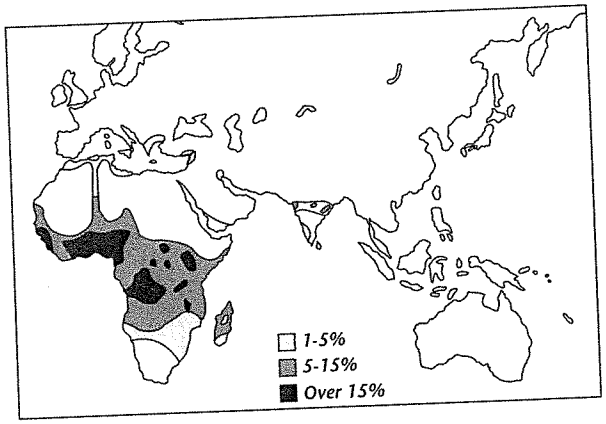
Sickle-Cell Allele and Malaria

The allele for sickle-cell disease is most common in people of African ancestry. The reason for this probably has to do with the relationship between the sickle-cell trait and malaria. Malaria, a disease common in parts of Africa, affects red blood cells. Carriers of the sickle-cell allele are resistant to malaria. Scientists think that the sickle-cell trait helps carriers resist malaria. The map on the left shows the distribution of malaria worldwide today. The map on the right shows the distribution of the sickle-cell allele.

Where Malaria Occurs Today



Percentage of Population with Sickle-Cell Allele



1. Where is malaria most common today?
2. Where is the sickle-cell allele most frequent?
3. Malaria is caused by a microscopic parasite that infects the blood. Based on this fact, hypothesize why people with sickle-cell trait are resistant to malaria. (Hint: A parasite is an organism that lives and feeds on or in another organism.)
4. Suppose malaria were eliminated as a human disease. Predict how the frequency of the sickle-cell allele might change over time. Explain your prediction.

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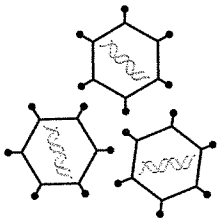
Advances in Genetics

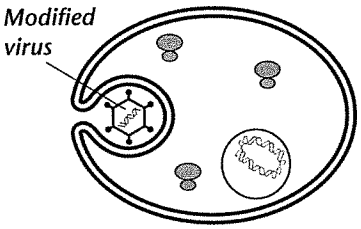
Read the passage below. Then use a separate sheet of paper to answer the questions that follow.

A Closer Look at Gene Therapy for Cystic Fibrosis

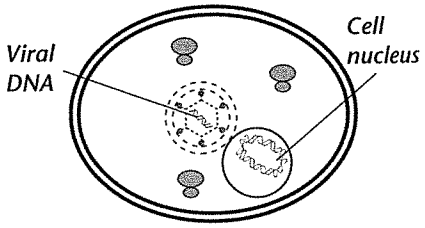
In people with cystic fibrosis, a protein called CFTR is absent from cells in the lungs. Without this protein, mucus builds up in the lungs and causes many of the symptoms of the disease. Gene therapy experiments were developed to attempt to treat cystic fibrosis. The process, which is illustrated in the figure below, involved genetically engineering a cold virus so that it could produce the CTFR protein. The virus was then delivered to the patient's lungs through a tube inserted through the mouth or nose.



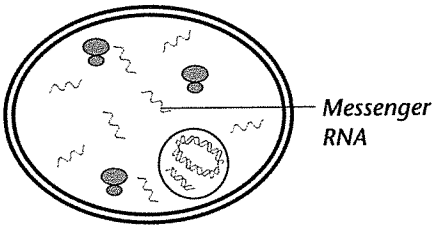
A Modified viruses carry a gene for the CFTR protein that is missing in people with cystic fibrosis.



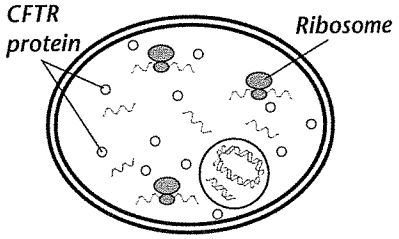
B After the virus attaches to a lung cell, the cell membrane begins to surround the virus.



C Cell enzymes break down the outer coat of the virus, and the viral DNA moves into the cell nucleus.



D In the nucleus, a strand of messenger RNA is produced by copying the genetic information in the viral DNA. The messenger RNA moves into the cytoplasm.



E The cell's ribosomes use the messenger RNA to produce the CFTR protein.

1. What role does CFTR play in the body?
2. Why is it necessary for the viral DNA to enter the cell's nucleus before it can do its job?
3. Where in the treated cells is CFTR actually produced?
4. The cold viruses used in gene therapy for cystic fibrosis are genetically engineered so they cannot reproduce, and thus cannot cause a viral infection in the patient. Because of this, the therapy does not lead to a permanent cure for cystic fibrosis. Explain why this is the case.

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Using Genetic Information

Each person's genetic information not only tells us a great deal about that individual, but also reveals a wealth of information about our common past. Read the passage below. Then use a separate sheet of paper to answer the questions that follow.

The Genographic Project

Human migration is the movement of people from one place to another. This movement has occurred throughout human history. The Genographic Project, led by geneticist Dr. Spencer Pratt, is a research program undertaken by the National Geographic Society, the Waitt Family Foundation, IBM, and research labs around the world. The project, launched in 2005, seeks to anonymously sample DNA from thousands of people from diverse populations to learn about migration patterns in early human history and to explore our common origins. Researchers hope to reveal how, in spite of our diverse appearances, we are all part of the same family tree.

Every person's DNA is a combination of two parental sets of DNA, which gives each of us our own individuality. Unless you have an identical twin, your chromosomes are unique to you. But some parts of our chromosomes remain intact generation after generation. These parts of the DNA chain only change when a mutation occurs in an individual. This mutation becomes a genetic marker that is passed down through the generations. Researchers can compare these genetic markers from samples all over the globe to trace a common timeline back through the ages.

Researchers have identified a common male ancestor of every living man today, who they call "Adam." Because this common ancestor lived in Africa 60,000 years ago, scientists believe that all humans only began migrating out of Africa at this time. By tracing changes in genetic information, scientists have developed a map showing the migration routes from Africa to all corners of the globe. For example, through their research, scientists were able to determine that the first humans arrived in Australia some 50,000 years ago.

1. Why do you think the research program is called the Genographic Project?
2. Explain how researchers are able to use DNA samples to trace the paths of human migration.
3. Scientists working on the Genographic Project carefully follow ethical guidelines in the application of their research. What concerns about medical privacy do you think people might have about this work? What have scientists done to deal with these concerns?