Chapter 4-18: Gene Therapy

Gene therapy is a medical procedure in which cells are taken from a patient, altered by the addition of genes, and then replaced. These new genes code for the protein or proteins that the patient is lacking. Gene therapy may be performed with blood cells, skin cells and intestinal cells, but not with sperm or egg cells.

Substituting working copies of genes to replace defective ones is a practical outgrowth of recombinant DNA technology and genetic engineering, and a number of methods for transferring genes into human cells are under investigation.

This plate shows the process of gene therapy that involves a number of steps. As you color the diagrams, read the paragraphs below.

There are several ways of replacing a patient's defective genes with healthy ones. Some methods involve laboratory-cultivated cells and some involve synthetic carriers. In this plate, we demonstrate a method that uses cells that are derived from the **patient's body (A)**. The **patient's cells (B)** are represented by one large cell in our diagram. Within the **cell nucleus (C)** are the forty-six human chromosomes, here we show only three of the forty-six **patient's chromosomes (D)**.

Preparing genes for gene therapy is a lengthy and difficult procedure. First, the functional gene must be located and isolated, and then a method must be found to produce large quantities of the gene. This procedure can take months. A form of DNA fingerprinting discussed in the previous plate is used to identify the gene of interest. The **gene for insertion (E)** is shown on the diagram.

In order to transport the healthy gene into the cell, a carrier, or vector, must be used. Certain gene therapy experiments use **retroviruses (F)** as carrier particles. Retroviruses have an icosahedral coating and a genome made up of RNA. (Viruses are discussed in a separate plate in this book.)

As you can see, the process of gene therapy begins when cells are isolated from the patient who is to receive the therapy. At this point, the functional gene has been isolated and amplified, and a suitable vector must be chosen to transport it into the cell. Continue your coloring as you read below. Light colors are probably best, since many of the details are quite small.

Retroviruses have the ability to cross the membrane of human body cells. In the plate, we show a retrovirus carrying a gene into one of the isolated patient's cells (B).

Once the virus has entered the cell, its **retroviral RNA (G)** is released. In the lower cell, we see the remaining capsid of the retrovirus. In the cytosol, the retroviral RNA (G) is used as a model for the synthesis of a molecule of **complementary DNA (H)**. Normally DNA is used as a model to make RNA. Here, however, the RNA is used as a model for the synthesis of a DNA molecule. For this reason, the virus is called a retrovirus. The enzyme that brings about the synthesis of DNA is called reverse transcriptase.

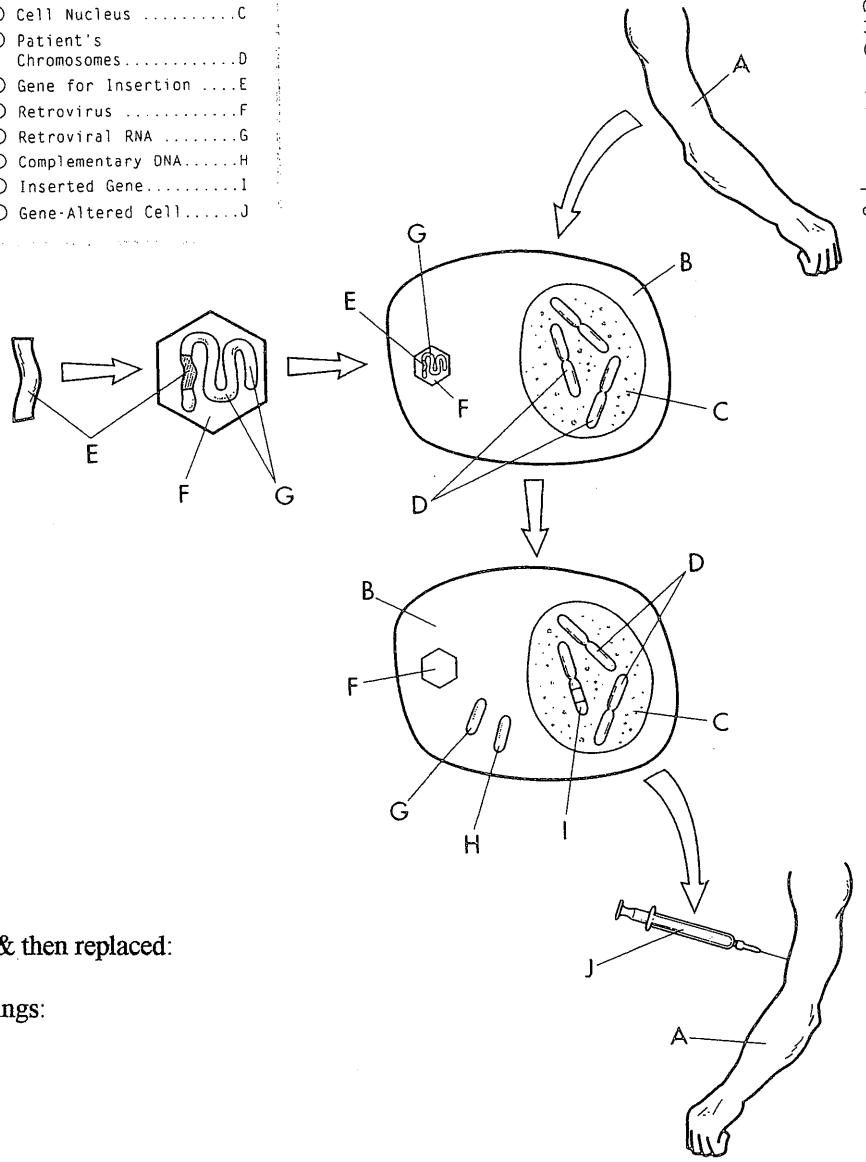
The new strand of complementary DNA inserts into a human chromosome, and when it does so, it carries along the inserted gene. Thus, in the second cell, we see the patient's chromosomes plus the **inserted gene (I)**.

The final step in the process is when the **gene-altered cells (J)** are loaded into a syringe and then injected back into the patient's body (A). Here they will multiply, grow, and produce the proteins encoded for by the new genes.

One area in which gene therapy has been very helpful is in the treatment of cystic fibrosis. A major problem of patients with cystic fibrosis is the buildup of sticky mucous in the lungs, which is a result of the accumulation of ions within cells of the lungs. Normally, these ions pass out of the cells through a protein channel, but this protein is lacking in patients with cystic fibrosis because the genes that code for them are defective. In gene therapy, normal genes are placed in the patient and the protein is produced. This allows the ions to pass out of the cells and the sticky mucus begins to dissipate.

Gene Therapy

- ○ Patient's Body .....A
- ○ Patient's Cells.....B
- ○ Cell Nucleus C
- ○ Patient's Chromosomes.....D
- ○ Gene for Insertion ....E
- ○ Retrovirus .....F
- ○ Retroviral RNA .....G
- ○ Complementary DNA.....H
- ○ Inserted Gene.....I
- ○ Gene-Altered Cell.....J



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a. Medical procedure in which cells are taken from a patient, altered by the addition of gene, & then replaced:
b. With what kind of cells can gene therapy not be preformed?
c. Methods in replacing a patients defective genes with healthy ones can involve these two things:
d. What must first be done when preparing genes for gene therapy?
e. What then must be found?
f. What must be used to transport the healthy gene into the cell?
g. Describe a retrovirus.
h. Why would one use a retrovirus as a vector?
i. What is released once the virus has entered the cell?
j. For what is the retroviral RNA used?
k. What is the enzyme that brings about the synthesis of DNA?
l. What happens to the new strand of complimentary DNA?
m. What is the final step in the process?
n. After they multiply & grow, what will they produce?
o. For what illness has gene therapy been helpful?
p. Why do patients of cystic fibrosis have buildup of mucous/accumulation of ions within cells of the lungs?