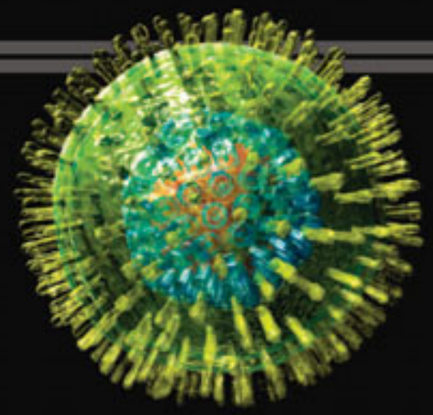
Gene Therapy

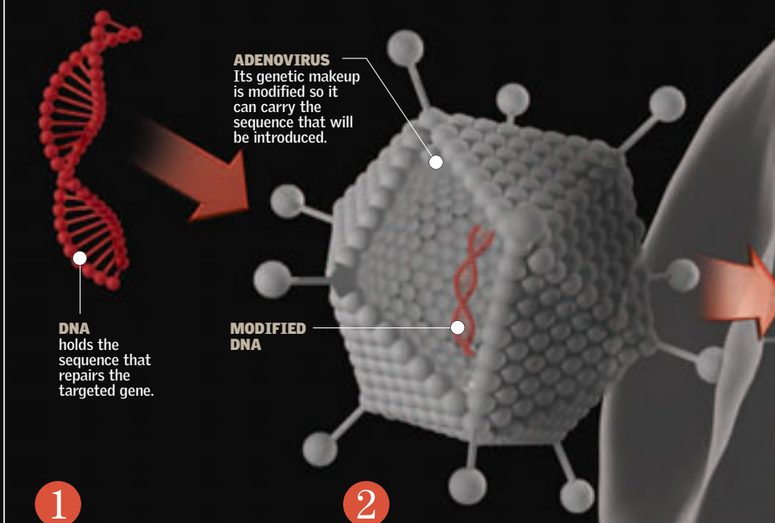
One of the latest breakthroughs in medicine, gene therapy is used to introduce genetic material to correct deficiencies of one or more defective genes that are the cause of an illness. Several different techniques have been developed for use with human patients, almost all of which are at the research stage. The problem with illnesses with a genetic origin is that therapy must modify the cells of the affected organ. To reach all these cells, or a significant number of them, demands elaborate protocols or, as is the case for viruses, the use of nature's biological weapons to cause other illnesses.

Treatable Illnesses

Illnesses with a genetic origin are difficult to treat, since the organism has poorly coded genes and the fault is therefore present in all its cells. Cystic fibrosis and Duchenne muscular dystrophy are examples of monogenetic illnesses that can potentially be treated with these therapies. Gene therapy has also been attempted on cancer and HIV infection, among other pathologies. A definitive cure may be found for many genetic illnesses, but the techniques for gene therapy are still in the development stage.



HERPESVIRUS
The herpesvirus is an icosahedral virus and holds a DNA sequence that needs to be modified so that it will not cause an illness. It is widely used in gene therapy.



1 Identification

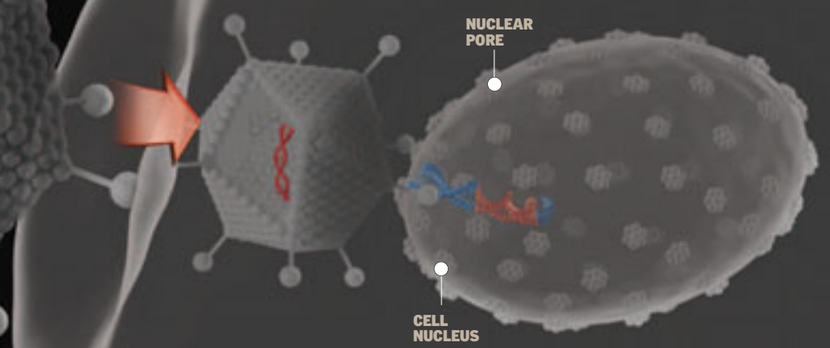
The DNA sequence that corresponds to the gene that causes the deficiency requiring treatment is identified. Then the correct sequence is isolated and multiplied to guarantee a quantity that can modify the organism. Because a monogenetic illness generally affects the function of one organ, the cell volume that is targeted for modification is large. Then a technique is chosen to transfect the cells.

2 Vehicle

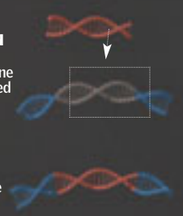
An adenovirus is an icosahedral virus that contains double-stranded DNA and lacks an outer envelope. It is primarily the cause of a number of mild respiratory illnesses. If the virus can be modified to be nonpathogenic, it has the potential for use in transporting a modified sequence of DNA in a region called a cassette. Even though its capacity is limited, its effectiveness rate is very high.

3 Replacement

The modified adenovirus is inoculated in a cell culture to generate the viral infection. It then enters the cells and multiplies in the cytoplasm, copying its DNA, including the modification carried in the cassette, in the nucleus of the infected cell, where it transcribes the new information.

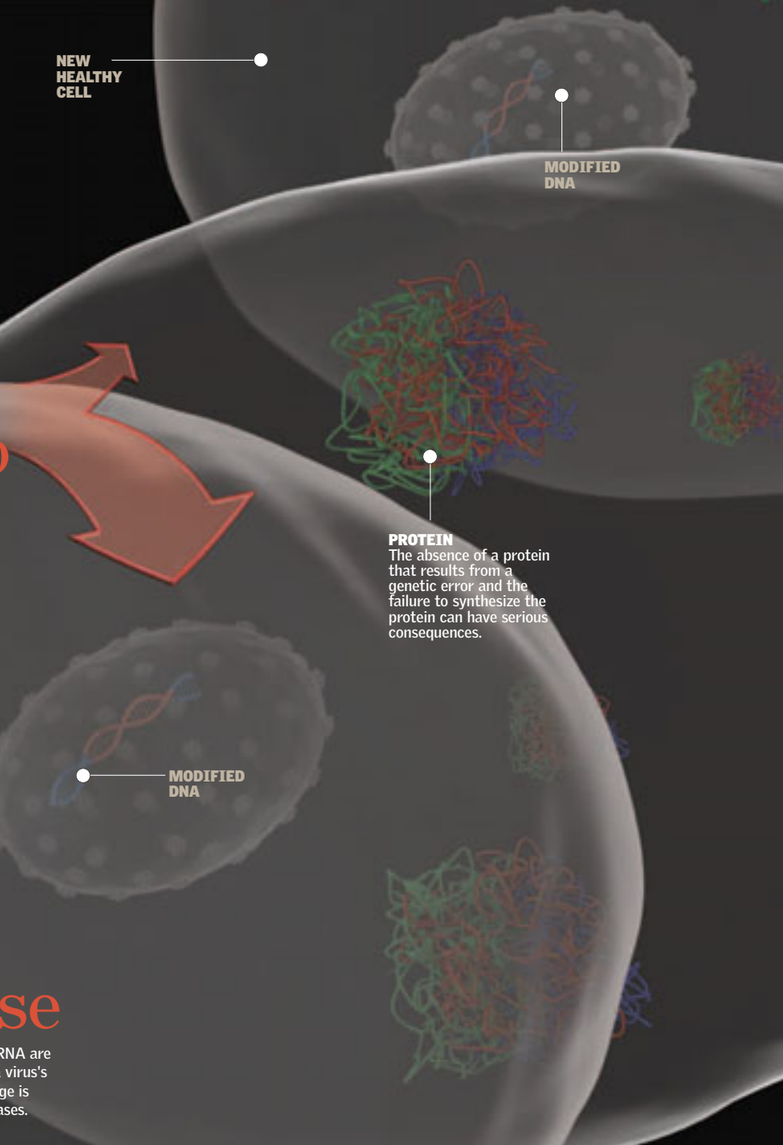


DNA TRANSCRIPTION



4 Synthesis

The infected culture cells, which have the new genetic information, can now synthesize the compound that caused the dysfunction. Generally these are proteins that cannot be synthesized because the gene for their elaboration is disassociated or damaged. The process begins once the cells divide and transcribe the gene in question. The protein that was not synthesized before is now transcribed and produced.



Relationship

It is critical that the hypothetical number of cells to be modified and the number of viruses needed for the therapy to work are in the correct relationship.

Kilobase

The unit in which DNA and RNA are measured; the capacity of a virus's cassette, which on average is approximately five kilobases.

NONVIRAL GENE THERAPIES
Many are based on physical means such as electrical techniques. They have the advantage of producing material in vitro, which allows for a large transfer capacity not limited by the number of bases that can be transfected by a virus. The problem is that these methods are not efficient for reaching target cells in the organism. The most important therapies of this type are microinjection, calcium phosphate precipitation, and electroporation (the use of an electric field to increase the permeability of the cell membrane).